City of

Roma, Texas

Master Drainage Plan for Arroyo Roma and Arroyo Los Morenos Watersheds

Board of Commissioners:

Fernando Peña, Mayor
Jose F. Moraida, Commissioner
Gabriel E. Recio, Commissioner

Presented:

March 24, 1999

By

Perez/Freese and Nichols, L.L.C.

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City of Roma, Texas

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STATE OF TEXAS
T. ANTHONY REID
33686
REGISTERED
PROFESSIONAL ENGINEER
3-24-99

Prepared by:

Perez/Freese and Nichols, L.L.C.
3233 North McColl Road
McAllen, Texas 78501

STATE OF TEXAS
JORGE D. PEREZ
34594
REGISTERED
PROFESSIONAL ENGINEER
3/24/99

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The Roma vicinity has grown in population and area at a very fast rate over the last 40 years. The increased population growth, together with unplanned development, has caused construction of residences and structures over historical floodways and floodplains of both Arroyo Roma and Arroyo Los Morenos and other tributaries within the study area. Flooding problems experienced in the Los Saenz area described in this study as "Special Flood Prone Areas" may be attributed to poor and/or blocked drainage caused by the construction of U.S. Highway 83 and it's subsequent widenings and improvements in recent years. It is estimated within our study area that approximately 9,000 residents may be affected by the 100-Year flood event caused by Arroyo Roma, Los Morenos, "Special Flood Prone Areas" and backwater from the Rio Grande River to varying degrees of damage. Based on historical and engineering evidence, and after reviewing this study, it can be seen that the potential 100-Year flood can be catastrophic in terms of life, health and property damage. The probability of the 100-Year event occurring simultaneously in the Arroyos Roma, Los Morenos and the Rio Grande River are considered to be of low probability. It is more likely that flooding may be experienced more frequently from the Arroyo Roma and Los Morenos. The cost to property damage associated with the 100-Year flood could easily reach the millions of dollars and could, additionally cause damages to the City's infrastructure; water treatment, wastewater treatment and collection, roads and bridges, etc.

This conceptual Master Drainage Plan has identified flood prone areas and has offered alternatives to help solve the potential for flood damage to the Roma Vicinity caused by Arroyo Roma and Arroyo Los Morenos as well as the Rio Grande River. This report has studied and analyzed five alternatives for flood control of the Arroyo Roma Floodplain, two alternatives for the Arroyo Los Morenos Floodplain, and one alternative for the Los Saenz "Special Flood Prone Area."

Summary of Alternatives

Arroyo Roma Watershed	
Alternative	**Cost**
Alternate No. 1 Construct earthen channel from the Rio Grande River to East Morelos Avenue with Reinforced Drop Structures	$12,546,690
Alternate No. 2 Construct Diversion Tunnel prior to East Morelos Avenue, and construction of smaller earthen channel and drop structures downstream to the Rio Grande River	$10,735,530
Alternate No. 3 Construct Detention Reservoir upstream of East Morelos Avenue and a smaller earthen channel and drop structures downstream to the Rio Grande River	$14,268,826
Alternate No. 4 **Construct a reinforced box culvert from East Morelos Avenue downstream to Madrigal Avenue, then an earthen channel downstream to the Rio Grande River**	***$9,394,580**
Alternate No. 5 Purchase homes and dwellings along entire 100-year flood plain along Arroyo Roma from East Morelos Avenue to Madrigal Avenue	$15,358,200
Arroyo Los Morenos Watershed	
Alternative	**Cost**
Alternate No. 1 Construct earthen channel diversions prior to populated areas and divert water westerly through the Los Saenz vicinity then southerly to the Rio Grande River and easterly to the traditional Los Morenos Arroyo, then to the Rio Grande River	$12,164,724
Alternate No. 2 **Construct earthen channel diversion from westerly contributing creeks to the Arroyo Los Morenos traditional floodway, then southerly to the Rio Grande River**	***$12,088,076**
Los Saenz (Special Flood Hazzard Areas)	
Construct reinforced concrete culvert pipe along north side of U.S. Highway 83 and construct new culvert under U.S. 83, and discharge to a proposed earthen channel, then flowing to the Rio Grande River	***$730,028**

* Recommended Alternatives

The least costly alternative for the Arroyo Roma floodway is recommended to include construction of 2-8'x11' reinforced concrete box culverts from East Morelos Avenue to U.S. Highway 83 and an open earthen channel downstream to the Rio Grande River. The estimated cost of these improvements, including channelization downstream of U.S. Highway 83 is $9.4 Million. The least costly alternative for the Arroyo Los Morenos floodway is $12.1 Million. This work would include earthen channelization of Arroyo Los Morenos with bottom widths ranging from 30 feet to 115 feet downstream of U.S. Highway 83. The Los Saenz least costly alternative is estimated to be $0.7 Million. The opinion of probable total costs for all improvements is **$22.2 Million.**

Included in the report is a suggested "Project Implementation Schedule" that breaks down the proposed recommended improvements of three separate watersheds into phases programed to be completed in the year 2004. The yearly expenditures average $3.7Million.

PROJECT IMPLEMENTATION SCHEDULE

ARROYO ROMA

Year	Description of Work	Cost
1998	• Contact the Texas Department of Transportation for work at Arroyo Roma and U.S. 83 • Contract Engineering Services to prepare engineering drawings for all improvements • Contract Surveying Services to prepare land acquisition/easement surveys for proposed improvements	
1999	Obtain/Negotiate Drainage Easements and ROW for Arroyo Roma	
1999	Construction of Arroyo Roma channel improvements from the Rio Grande River to U.S. Highway 83	$424,060
	Construction of culvert improvements by TxDot on Arroyo Roma at U.S. Highway 83	$314,470
	Subtotal 1999	$941,330
2000	Construction of Box Culvert and wingwalls at Arroyo Roma from U.S. Highway 83 to Bravo Avenue (School Property)	$2,518,100
2001	Construct Box Culvert from Bravo Avenue to Garfield Avenue	$2,990,000
2002	Construct Box Culvert improvements on Arroyo Roma from Garfield Avenue to East Morelos Avenue	$2,945,150
TOTAL		$9,394,580

PROJECT IMPLEMENTATION SCHEDULE
ARROYO LOS MORENOS

Year	Description of Work	Cost
1998	• Contact the Texas Department of Transportation for work at Arroyo Roma, Los Morenos and 4th Street (San Juan Avenue - Los Saenz) • Contract Engineering Services to prepare engineering drawings for all improvements • Contract Surveying Services to prepare land acquisition/easement surveys for proposed improvements	
1999	Obtain/Negotiate Drainage Easements and ROW for Arroyo Los Morenos	$1,099,800
	Construction of channel improvements for Arroyo Los Morenos from the Rio Grande River to U.S. highway 83	$2,695,550
	Construction of culvert improvements by TxDot for Arroyo Los Morenos	$318,500
	Subtotal	$4,113,850
2000	Construction of channel improvements at Arroyo Los Morenos from U.S. 83 to Escobar Road	$1,218,126
2002	Construct channel improvements from Escobar Road to Evita Road on Arroyo Los Morenos	$901,550
2003	Construct channel improvements on Arroyo Los Morenos from Evita Road to Efren Ramirez Road	$2,924,090
2004	Construct channel improvements on Arroyo Los Morenos from Efren Ramirez Road to the end of the project	$2,930,460
TOTAL		$12,088,076

PROJECT IMPLEMENTATION SCHEDULE
LOS SAENZ

Year	Description of Work	Cost
1998	Contact the Texas Department of Transportation for work at Arroyo Roma, Los Morenos and 4th Street (San Juan Avenue - Los Saenz) Contract Engineering Services to prepare engineering drawings for all improvements Contract Surveying Services to prepare land acquisition/easement surveys for proposed improvements	
1999	Obtain Drainage Easements and ROW for 4th Street Channel Improvements (Los Saenz) and Channel Downstream of U.S. 83 to Rio Grande River	$115,440
2000	Construction of Channel Improvements for the 4th Street Channel (Los Saenz)	$614,588
2001	Construct Culvert Pipe along north side U.S. 83 from Escandon Ave. (Los Saenz) to 4th Street Culvert at U.S. 83 (by TxDot)	
Total		$730,028

We acknowledge that construction of the proposed improvements will not be inexpensive. This report has listed several options for paying for the proposed improvements, including collection of revenues for construction from new development, grants, loans, force account work and drainage district tax revenues.

In order to stop further expenditures, it is recommended that the City of Roma and Strarr County limit construction within the identified floodways, floodplains and otherwise historical floodways either shown and contained in this report or not, until this Master Plan is incorporated into the City and County's ordinances and regulations. Limited development in hardship cases could be allowed only if detailed engineering studies show no additional future costs to the already programmed drainage improvements or that such improvements cause no significant impact to flooding (as defined by FEMA's regulations and guidelines). In these special cases, again only after engineering studies have satisfied no- impact, it is recommended that developers convey all necessary drainage easements and install all necessary drainage infrastructures within the limits of their subdivisions at the developer's expense and escrow monies for future construction deemed part of the Master Plan. In other areas within the watersheds and not mentioned in this study, care should be taken in allowing development without requiring a detailed engineering drainage analysis.

Master Drainage Plan for
Arroyo Roma and Arroyo Los Morenos Watersheds
City of Roma, Texas

1.0 Introduction

1.1 Basic Philosophy

Urbanizing (developing) watersheds contribute to downstream stormwater runoff problems because of the cumulative effects. In many cases, land development in upstream areas has occurred with little or no regard to the consequences to downstream areas. This is especially true in the Roma vicinity since portions of floodways and floodplains have been built-up without proper compensation of adverse effects downstream.

Local governments are autonomous entities primarily concerned with land use and stormwater runoff within their own boundaries. There are exceptions where municipalities receive water or sanitary sewer services from outside areas. Sometimes conflicts have arisen among adjoining communities, particularly over land use issues and its effect on the management of stormwater runoff. This situation has clearly occurred in the Roma vicinity since the majority of contributing watersheds of the Arroyo Roma and Los Morenos lie outside the City's jurisdiction.

The basic philosophy on the need for watershed management within urban areas has, over the past several decades, changed dramatically. Nationwide experience with the effects of inadequate past practices indicates that stormwater has not always been well managed. This experience has led to a major redirection in the way many communities perceive urban drainage and attempt to deal with it effectively.

The City of Roma has recognized the importance of addressing stormwater management and contracted with Perez/Freese and Nichols, L.L.C., in January 1998 to develop a **Master Drainage Plan for Arroyo Roma and Arroyo Los Morenos Watersheds** for the City and its surrounding areas. The study is funded in part through the Texas Water Development Board Flood Protection Planning Study, contract No. 96-483-160, the City of Roma and Starr County.

The basic scope of work is as follows:

A. An analysis and explanation of the problems and needs within the City area and the total planning area within the study limits:

1. Description of the efforts that the City and resident have taken to provide necessary adequate facilities.
2. Existing and projected population affected by flooding to be determined.
3. Existing drainage facilities, storm sewer culverts, and channels to be analyzed for capacity & improvements determined.
4 Existing and projected run-off flows and future development run-off flows to be analyzed hydraulically.
5 Run-off characteristics such as high velocity damage in certain areas to be analyzed and resolution considered;

B. The identification, selection, and evaluation of alternatives, of not more than three, including preparation of a cost-effective analysis of the alternatives for providing adequate drainage in the City. The alternative evaluation will also consider facilities which will allow for greatest utilization of local labor during facility construction, operation and maintenance;

C. Documentation and Consultant with residents of the Project areas to determine the most economic solution without overriding social or environmental factors. Documentation of public consent for the construction of Flood Control to serve the distressed area;

D. Documentation and mapping of the number of dwellings occupied and number of dwellings to be affected by flooding for possible relocation consideration within the planning area.

E. A description of the proposed options, including an identification of any existing facilities to be acquired, replaced, enlarged, or improved;3

F. Comprehensive Engineering Hydraulic Design Data to be determined for feasibility of diverting the Arroyo Roma prior to entering the City of Roma;

G. Detailed Construction Cost Estimates for each segment of construction, estimates of the operation and maintenance costs for the recommended facilities. Separate costs for the dwelling relocation assistance, if any required.

H. Detailed implementation schedule for designing, permitting, financing, and constructing the facilities, and for any other major milestones. If the project is to be phased, major milestones, costs and descriptions of each component and segment of the project shall be provided;

I. A determination of the amount of funds available from federal, state, local and private organizations for plans and specifications, project construction, and operation of the recommended facilities;

J. Provide the City of Roma a monthly progress report on the first Thursday of each month;

K. Details or draft of any proposed interlocal agreement or other agreements or contracts needed to implement the project;

L. Prepare final report.

Stormwater is a difficult resource to manage primarily because drainage systems are constantly in a state of change. Even a natural drainage system is not static: streams meander, banks erode and lakes are filled by sediment after each rainfall. Urbanization and development compounds this problem because it increases the rate and quantity of runoff, and urban runoff is often polluted with chemicals and litter that is carried into the rivers and lakes. It is important to keep in mind that all development increases the stormwater runoff and contributes to the problems.

The combination of increased runoff, erosion and excess sediment and pollution threatens public safety and real properties and damages the habitat of plants and animals dependent on the streams.

A generally accepted concept is that real property within a city should contribute to the remedy of the problem caused by increased stormwater runoff. Two important principles underlie this stormwater management concept:

- First, that all real property within a city will be benefitted by the installation of an adequate storm drainage system;
- Second, that the cost of installing an adequate drainage system should therefore be assessed against the real property in a city.

These two principles are not easy for property owners to understand at first view, but they are the keys to an effective stormwater management effort. A property owner may not have a problem immediately on his property, but he contributes a proportionate share to problems downstream. A unified and safe drainage system is the benefit of the basin as a whole. Each property individual should contribute to the improvements necessary to solve the problem.

The problems that exist today will not go away, and the longer they are put off the more costly they will become to solve. Through advance planning, there will be fewer facilities and they will be larger and more strategically placed to minimize long-term maintenance costs and can be multipurpose in use (for open space, parks and recreation as well as for drainage).

Recognition that stormwater management includes much more than just flood control is important. Keeping streets open to emergency vehicle traffic, maintaining ponds and open channels so they do not become health and safety hazards, and promoting the use of drainage facilities for recreational purposes, all contribute to enhancing and maintaining the high and healthy quality of life for the entire community.

1.2 Statement of the Problem

The City of Roma, like many other cities, has reached a point of critical crises related to management of stormwater runoff from the watershed. A number of factors and conditions have merged together to pose a major challenge to the City. The growth and development of the community are manifested in a long-term, often subtle, and pervasive change in the City's drainage systems. Symptoms of the changes are evident in drainage system failures, localized flooding and escalating costs of control. Unfortunately, there is no single cause or simple cure for the problems of stormwater management.

We must ask; what are the factors which combine to make urban stormwater management a major challenge in Roma? They are a diverse group of problems, circumstances, and conditions. When considered separately, they do not fully indicate the seriousness of the situation. The seriousness is apparent, however, when they are considered together. The four most prominent factors in the present problems are changes in hydrology, resource conflicts, surrounding jurisdictions, and economics.

Changes in Hydrology: As the City has grown, impervious surfaces such as rooftops and pavements have covered over soils which were relatively pervious. An increasing proportion of the precipitation which had previously filtered through the soil to the groundwater has been repelled. Instead, it is diverted by roofs, streets and parking lots to channels and culverts, and carried to receiving streams in the most efficient manner, i.e., as quickly as possible in the smallest facility considered being adequate.

Although Roma may have some natural and manmade stormwater detention or retention facilities on developed sites and upper reaches of the watersheds, these systems are not coordinated to mitigate major storms. In many cases, the stock ponds used for agricultural uses are of unknown design parameters; as to whether they can withstand high amounts of rainfall, and can the dams resist flash flooding. The overall impact of urban development will result in large increases in runoff from smaller, more frequent storms which may not be effectively controlled by on-site detention systems designed for more severe events. The change in hydrology is a basic condition which must be recognized. The clearing of land, even for agricultural and cattle grazing use in the upper reaches can have adverse effects downstream.

Resource Conflicts: Urban levels of development are rarely achieved without conflicts in the use of the natural resources, especially when stormwaters impede potential uses of the land. Unfortunately, land development in general has not typically been achieved by solving the drainage problems. More often the symptoms, like flooding, have merely been moved to another location and passed on to the neighbor next door, or the neighbor downstream.

Urban runoff is a unique by-product of land development. The quantity and quality of stormwater runoff in Roma may pose major problems for the community in general. As new growth occurs in the area, resolution of short-term resource conflicts related to drainage control should be made with a better vision of long-term needs and impacts. The alternative consequence is that economic and social costs will continue to mount in the form of repetitive stormwater management problems.

Surrounding Jurisdictions: Stormwater runoff does not recognize established jurisdiction lines and close coordination with Starr County is essential for a successful master plan. The concept of a stormwater management in a watershed is not a new one. A coordinated effort can assist with the management of land within a watershed to enhance the well-being and quality of life of citizens within the watershed. Once a decision is reached to consider a coordinated watershed program, public meetings can be convened to help promote the need for comprehensive stormwater management planning and subsequent implementation. Ultimately, a regional stormwater management district may have to be considered given the difficulty for individual units of City government to act on development controls that aid in the stormwater management outside of it's borders and jurisdiction. Hence, a regional entity is often needed to implement, regulate and enforce a comprehensive stormwater management plan.

Economics: The problems cited above, which are primarily physical and structural, are compounded by economic factors which make solutions more difficult to achieve. Texas cities are in a period of a serious revenue shortfall in which programs of long-standing are being closely scrutinized, trimmed, and sometimes eliminated. This overriding revenue crunch further exaggerates what has always been a major obstacle to effective stormwater control: the lack of stable and adequate local financing upon which long-range programs can be based.

Lurking behind the immediate economic problems of local governments is an even more imposing potential problem. Existing infrastructure improvements of all types in the United States, both public and private, are collectively growing old and wearing out. Many will have to be rebuilt or they will fall apart within our lifetimes.

Regardless of what level of government will be responsible for rebuilding public systems, it will meet intense competition for limited capital resources to finance the reconstruction. Private industry faces many similar reinvestment needs, and many other costs of government are also rapidly rising.

The demand for financing to rebuild large public and private systems will likely keep the cost of money, in terms of interest rates, high throughout the next two decades. Even if federal policies regarding growth of the money supply change and interest rates remain somewhat low, it is likely that prices will inflate again. Inflation in the construction industry has historically been higher than average price inflation, driving the costs of public capital improvement projects up rapidly. This economic "Catch-22" may be the most serious of all the problems that Roma's drainage program must face.

Summation: The previously discussed factors create potentially serious situations as each drainage problem is compounded by the effect induced by changes in the other factors. This situation indicated the need to consider a comprehensive, balanced, and consolidated a stormwater management program through tough, enforceable ordinances and fiscal regulations imposed on any new development within the City's and County's jurisdiction.

2.0 Explanation of the Problems and Needs

2.1 Description of Known Flooded Areas

2.1.1 Arroyo Roma

Over the past 30 to 40 years, flash flooding has increasingly been prevalent in the Arroyo Roma area where school buildings and homes along its path and floodplain have experienced flood water damage. Before 1950, the floodways were mainly open natural wooded areas, some dedicated to grazing and other agricultural uses. Since that time, structures have been constructed within known flood plains and historic waterways and this situation has contributed to more frequent flood damage. During the past 15 years, Roma and it's study areas have experienced high rates of growth. Previous agricultural and open land has urbanized with little or no provisions for drainage and flood management. Subdivisions have developed over known waterways and floodplains, often blocking, diverting or hindering flow. This situation has significantly contributed to increased flood frequency for homes and structures along the Arroyo Roma, even for low frequency storms. Given the steep slopes of the upper reaches of the arroyos, flooding in the watersheds occur as flash floods, often with little or no warning. Over the recent past, loss of property and life have been reported in Arroyo Roma. Widespread flooding occurs in the populated areas of the city, from East Morelos Ave. downstream to U.S. Highway 83. The City of Roma has instituted a warning system to notify residents of low-lying areas of potential flooding. Warning signage is also posted warning of "Potential Flood Hazard Areas"

2.1.2 Arroyo Los Morenos

In the case of the Arroyo Los Morenos watershed, the lack of clear and concentrated waterways in the lower reaches means that flooding occurs as "sheet flow" over widely-spread developed areas. The upper reaches of the watershed are mainly open and used for agricultural purposes. Numerous livestock watering ponds line some of the arroyo's tributaries. Potentially, these ponds, during periods of high rainfall may breech, causing a catastrophic situation for residents downstream. Over the years, development of subdivisions, construction of roadways such as U.S. Highway 83, and other improvements have aggravated flooding by elimination and damming paths for flood water flows. Similar to the Arroyo Roma watershed, homes and other buildings have been constructed over water ways and flood plains. Barrier walls, earthen levees and other diversions have been constructed in the areas north and south of U.S. Highway 83, potentially causing additional localized flooding. Areas identified as flood-prone (under existing conditions) are shown in Exhibit 2.1. Areas north of U.S. Highway 83 in the Los Saenz vicinity have been designated in this study as ***"Special Flood Prone Areas"*** which are caused by the lack of an adequate outlet of storm water. This localized flooding situation has been aggravated by "dam-like" roadway construction of U.S. Highway 83. Flooding in these identified "Special Flood Prone Areas" has been observed in close proximity to U.S. Highway 83, behind the Police Service Building in Los Saenz, and flooding has been reported to depths of 3-4 feet, according to anecdotal information.

2.1.3 Rio Grande River

As within the Arroyo Roma and Los Morenos watersheds and floodways, homes and businesses have been constructed within the 100-year flood plain of the Rio Grande River (as delineated in current FEMA Flood Insurance Maps). Some base information for the Rio Grande River has been obtained from the International Boundary and Water Commission which show a 100-year base flood elevation of approximately 185 feet above Mean Sea Level. Data in the Roma gaging station from the IBWC is sparse especially since the construction of Falcon Dam approximately 15-20 miles upstream. According to IBWC officials, flood studies of the Rio Grande in the Roma area have not been conducted by the Commission. Anecdotal evidence however, indicates serious flooding along the Rio Grande's flood plain during Hurricane Bulah (1967). (This flood event has been estimated to be a 100-year event, occurring **after** the construction of Falcon Dam in 1953.)

Drainage Master Planning of the Roma vicinity should include the Rio Grande River's floodplain limits and backwaters. In addition to City and County regulations and ordinances that may result from suggestions of this Master Plan, regulations of Federal Agencies such as the U.S. Army Corps of Engineers, U.S. Coast Guard and the International Boundary and Water Commission are already in force and must be considered in any future development along the river and its backwater. Until further studies are conducted of the Rio Grande, the existing FEMA flood, prone maps should be used.

2.2 Description of Existing Storm Drainage Facilities

The majority of drainage facilities and improvements within the study limits have been concentrated in the Arroyo Roma watershed and have been constructed since 1965. These improvements have been financed mainly by State Grants with Local matching funds. Existing drainage improvements to Arroyo Roma from E. Morelos Avenue to U.S. Highway 83 were constructed in 1992 and include street improvements to Bethel Street upstream of the Roma School property and the installation of curb-type inlets to capture storm waters from north of East Morelos Ave., then flowing through a 48" diameter reinforced concrete pipe downstream to Bravo Avenue. From Bravo Avenue, the storm waters flow into a 4'x8' reinforced concrete box culvert downstream along Madrigal Street to Harrison Alley where it discharges into an improved earthen channel. The channel discharges into an existing 4 barrel 8'x11' reinforced concrete bridge at U.S. Highway 83. From that point, waters flow through natural channels and floodways to the Rio Grande. The design frequency for the improvements upstream of U.S. Highway 83 to East Morelos Avenue is seven (7) years, according to the Design Engineer for those projects.

Other drainage improvements include various box culverts and "equalizer" culvert pipes under U.S. Highway 83 constructed by the Texas Department of Transportation (TxDOT) in connection with roadway construction. Additionally, 2-24" drainage pipes downstream of an existing 2'x4' reinforced concrete box culvert on U.S. Highway 83 and Sixth Street have been installed by the City of Roma. These pipes discharge into an open earthen channel alongside of the Roma Community Center, the Wastewater Treatment Plant, then the Rio Grande River.

2.3 Existing and Projected Population Affected by Flooding

The 100-Year flood plain limits shown in this report is based on the existing development conditions, then using aerial photography taken in 1993 by the Texas Department of Transportation, overlays of the flood plains were made to estimate the existing number of dwellings affected by flooding. The estimated population was calculated assuming 4.5 persons per dwelling. Table 2.1 shows the approximate number of affected dwellings and buildings that currently exist. Population projections from 1993 to 1998 were estimated by counting the number of vacant lots still remaining in flood plains and estimating the percentage of those lots that would have been developed using Texas Water Development Board population projection rates of 1.57% per year. The estimated number of lots assumed to be developed between 1993 and 1998 was then multiplied by 4.5 persons per lot, and that population figure was then added to the 1993 estimates. The City of Roma is currently enforcing FEMA's **Flood Plain Development Standards** within their City Limits. Some of the areas in our study area are outside the City's jurisdiction, but we expect that either the City of Roma or Starr County (also a member of FEMA's program), will prudently enforce the regulations to prohibit further development in flood plains in the future thereby eliminating any population growth within the existing floodplains.

2.4 Location of Dwellings Affected by Flooding

The number of dwellings affected by flooding is shown in Table 2.1. Existing 100-Year flood conditions were used to determine the limits of the flood plains and the number of dwellings and buildings were estimated from the 1993 aerial photo obtained from the Texas Department of Transportation. As with the current population estimates, a 1.57% per year increase was made to the 1993 count in order to estimate the current number of dwellings. The severity of flooding for each dwelling will increase to its proximity to the low point of the floodway. Base maps obtained from the U.S. Geological Survey have been used to delineate the flood plains. Dwellings and other buildings are shown on these maps, but these maps are not up to date and were prepared in 1965.

Table 2.1

Existing Dwellings and Population Affected by the 100-Year Flooding

Watershed	Sub-Watershed	No. of Dwellings (1993)	No. of Dwellings *(Current)	No. of School Buildings	Est. Population (1993)	Est. Population *(Current)
Arroyo Roma						
(AR)	Arroyo Roma b	302	321	22	1,359	1,446
	Arroyo Roma c	14	15		63	67
Subtotal		316	336	22	1422	1,513
Rio Grande						
River	A7	0	0		0	0
	A8b	27	28		121.5	129
	A9c	8	9		36.0	38
	A10d	3	3		13.5	14
	A11d	11	12		49.5	53
Subtotal		49	52		220.5	234
Los Morenos						
(ALM)	ALMb	325	345		1,462.5	1,556
	ALMc	646	688		2,907.0	2,094
Subtotal		971	1,033		4,369.5	4,650
Flood Special						
Zone	A8a	98	104		441.0	469
	A9b	87	92		378.0	402
	A10c	204	217		918.0	977
	A11c	133	141		598.5	636
	ALMb	20	20		90.0	96
Subtotal		539	573		2,425.5	2,580
TOTAL		1,875	1,944	22	8,437.5	8,977

** Number of existing dwellings/population were estimated from a 1993 aerial photo, and projected at the rate of 1.57% per year according to the Texas Water Development Board population projections for the City of Roma, Texas updated 5/20/98 by J. Hoffmann.*

3.0 Development of Design Peak Flows

3.1 Study Area

The limits of the study area are illustrated on Figure 3.1. The Arroyo Roma study area extends from approximately two miles north of the City of Roma, through the city, to the Rio Grande River. The contributing drainage area is 2,730 acres. The Arroyo Los Morenos study area extends from approximately 0.8 miles north of U.S. Highway 83, through the developed area, to the Rio Grande. Its drainage area is 4,850 acres . A portion of the communities of Los Saenz and Escobares are located in the Arroyo Los Morenos watershed portion of the study area. The combined study areas represent approximately seven square miles of Starr County (4,500 acres). The flooding in the study area is affected by the type of development and general land uses in the watershed that extend north of the study area as illustrated on Figure 3.1.

The Scope of work included the analysis of both existing and future watershed conditions. The presently developed and future developed areas only represent a small portion of the total watershed areas. Also, the existing random urban development pattern will be filled and the impacts on the difference between the existing and future development conditions will be quite small. For these reasons, only one analysis was completed for this conceptual Master Plan Development

3.3 Contributing Drainage Areas

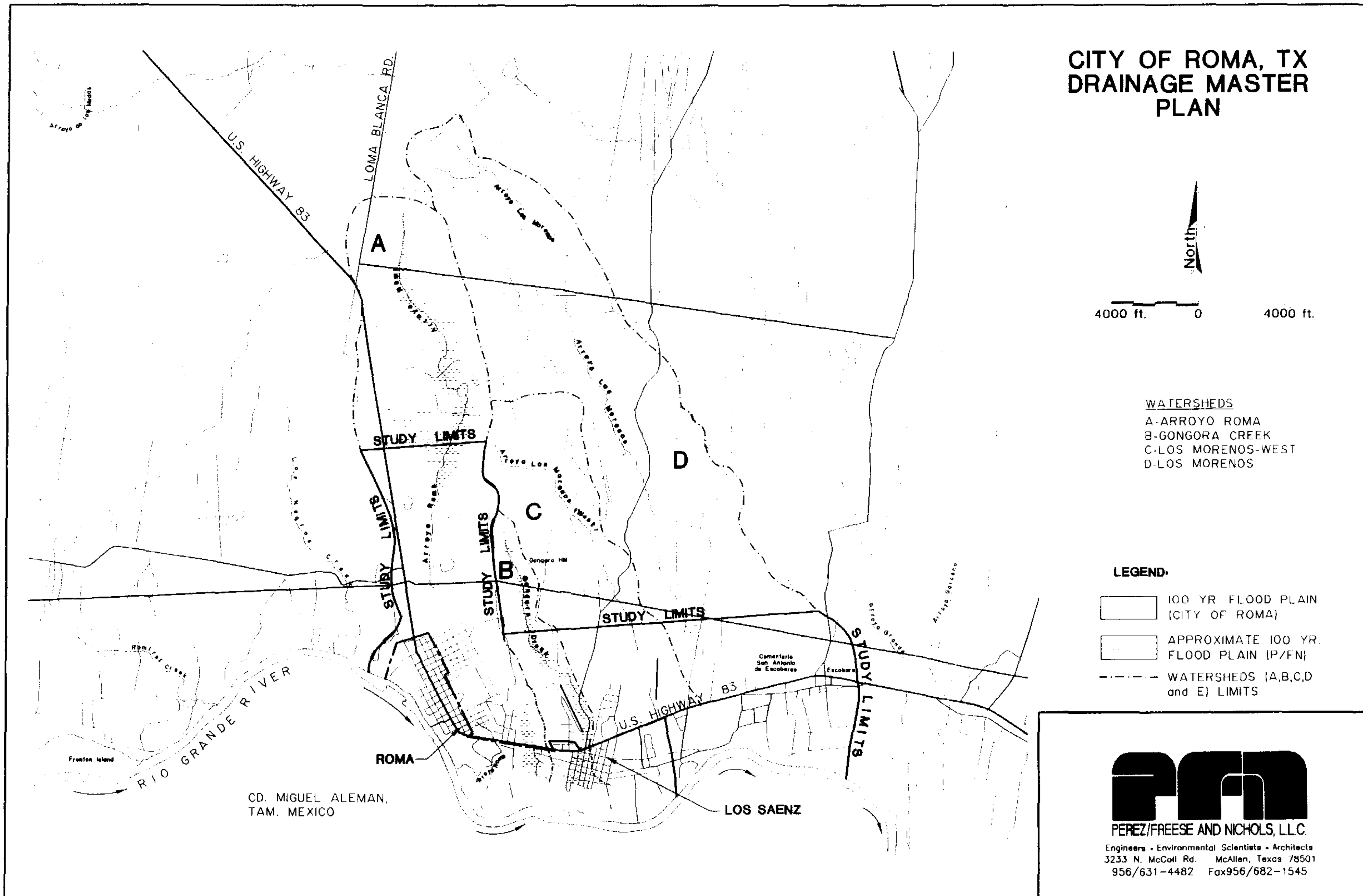
The City of Roma is located in a hilly portion of western Starr County on the northern bank of the Rio Grande across the river from Ciudad Miguel Aleman, Tamaulipas, Mexico. The City of Roma has developed along both sides of U.S. Highway 83 as illustrated on Figure 3.2. The limits of the principal drainage areas that cross the study area are defined on Figure 3.2. The two largest drainage areas are Arroyo Roma and Arroyo Los Morenos.

In each of these cases, the streams drain a relatively steep hilly area. When the streams arrive near the Rio Grande, they transition onto a fairly flat area, which is primarily the overbank floodplain of the Rio Grande. U.S. Highway 83 was constructed through this relatively flat floodplain area on an elevated fill. This fill acts as a dam and barrier to natural drainage paths. A series of culverts were constructed under U.S. Highway 83 to allow passage or equalization of stormwater from the north to reach the Rio Grande River. The conformation of the adequacy of these culverts to handle the flood flows will be an important element in the development of the Master Drainage Plan.

The drainage areas have been subdivided into smaller sections to permit a more detailed accounting of the watershed characteristics and to help for a better definition of the design flows where proposed improvements are anticipated. The physical characteristics of each contributing subdrainage area, as determined from the available U.S.G.S. Topographic Maps, are summarized in Table 3.1.

3.3 Storm Runoff Computations

Using standard engineering empirical design procedures, stormwater discharges produced by watersheds 200 acres or larger should be computed using a unit hydrograph method. Some of the watersheds listed in Table 3.1 have watershed areas less than 200 acres. The unit hydrograph method can be used for watershed with areas less than 200 acres, and this approach has been adopted for use in this analysis for consistency. There are two acceptable unit hydrograph methods for drainage system design in the City of Roma: *Snyder's Unit Hydrograph Method* and the *Soil Conservation Service Unit Hydrograph Method* (SCS Method). For this study, each contributing



CITY OF ROMA, TX
DRAINAGE MASTER
PLAN
North
4000 ft.
0
4000 ft.
WATERSHEDS
A-ARROYO ROMA
B-GONGORA CREEK
C-LOS MORENOS-WEST
D-LOS MORENOS
LEGEND
100 YR FLOOD PLAIN (CITY OF ROMA)
APPROXIMATE 100 YR FLOOD PLAIN (P/FN)
WATERSHEDS (A,B,C,D and E) LIMITS
U.S. HIGHWAY 83
LOMA BLANCA RD.
A
B
C
D
STUDY LIMITS
STUDY LIMITS
STUDY LIMITS
STUDY LIMITS
STUDY LIMITS
STUDY LIMITS
Arroyo Los Morenos
Gongora Hill
Comenterio San Antonio de Escobares
Escobares
Arroyo Grande
RIO GRANDE RIVER
Fronton Island
ROMA
LOS SAENZ
CD. MIGUEL ALEMAN, TAM. MEXICO
PEREZ/FREESE AND NICHOLS, L.L.C.
Engineers • Environmental Scientists • Architects
3233 N. McColl Rd. McAllen, Texas 78501
956/631-4482 Fax956/682-1545

Figure 3.1

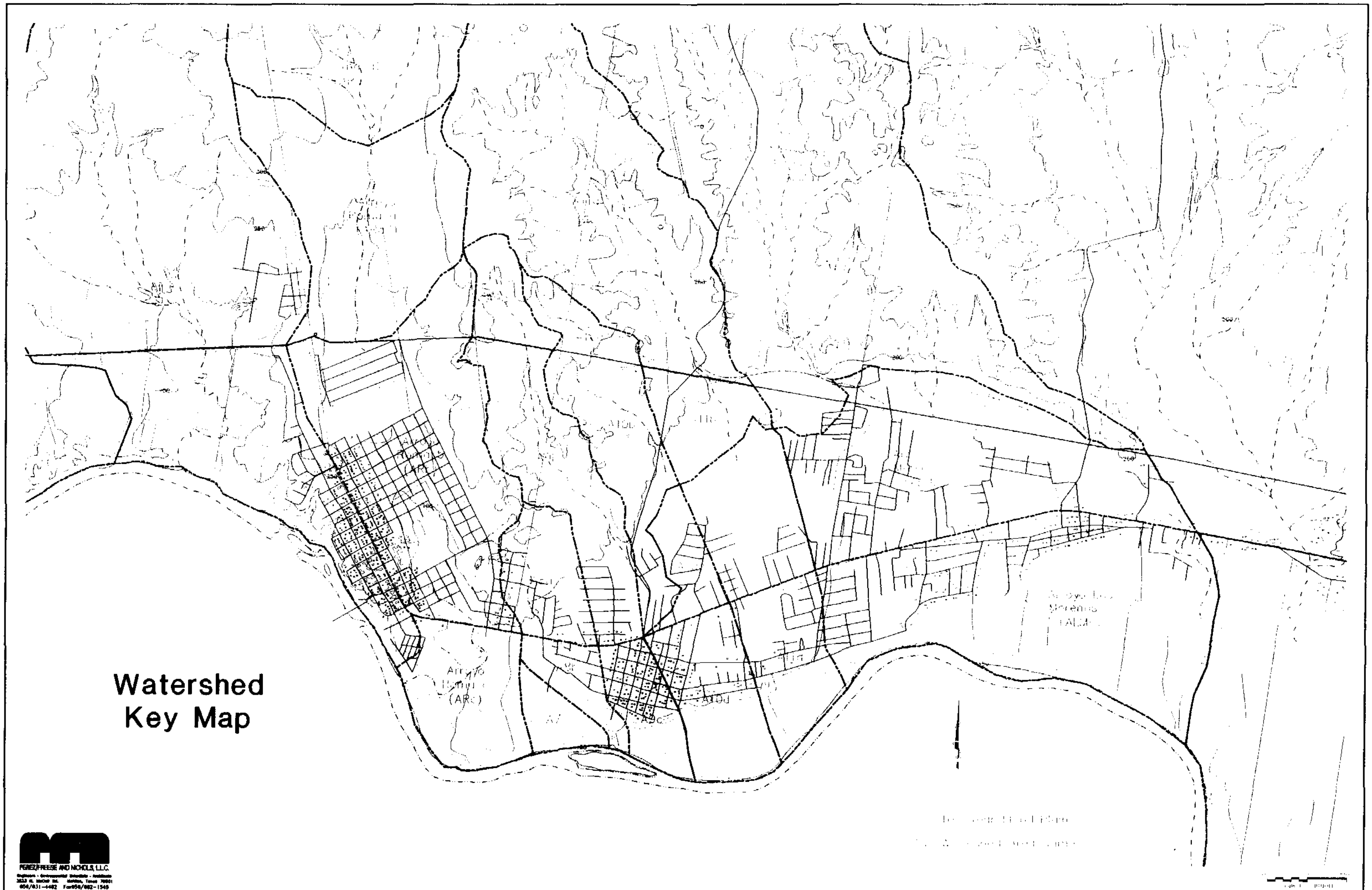

Watershed
Key Map
PEREZ/FREESE AND NICHOLS, L.L.C.
Arroyo Hondo (ARc)
A7
ABc
ABd

Figure 3.2

Table 3.1

Drainage Areas Characteristics

Area No.	Area (acres)	Sum of Areas (acres)	Channel Slope (feet/feet)	Flow Length (feet)
ARa1	1,386	1,386	0.0122	14,780
ARa2	522	1,908	0.0056	5,160
ARb	701	2,608	0.0051	8,062
ARc	240	2848	0.0089	3,826
ALMa	3,310	3,310	0.0083	28,213
ALMb	702	4,011	0.0020	9,792
ALMc	838	4,849	0.0036	5,555
A7	47	47	0.0125	2,810
A8a	144	144	0.0158	3,793
A8b	77	221	0.0121	3,310
A9a	87	87	0.0267	3,002
A9b	307	394	0.0077	8,457
A9c	112	506	0.0132	3,407
A10a	72	72	0.0210	3,335
A10b	229	301	0.0131	4,597
A10c	85	385	0.0006	3.272
A10d	210	596	0.0087	4,366
A11a	890	890	0.0133	12,029
A11b	130	1,020	0.0052	1,928
A11c	214	1,234	0.005	3,680
A11d	181	1,415	0.0106	3,590

watershed was modeled using the SCS Synthetic Unit Hydrograph method as contained in the ***Watershed Modeling*** (1) procedures in the ***Eagle Point*** computer software package. Hydrologic elements were used to compute runoff hydrographs at selected design points. The hydraulic models were used to determine storage-discharge relationships to route flood hydrographs in the hydrologic models. By definition, a unit hydrograph is a graphic representation of discharge versus time for a storm producing one inch of runoff resulting from 1 inch of effective rainfall generated uniformly over the basin area at a uniform rate during a specified period of time or duration. The curvilinear shape was used to compute the SCS unit hydrograph, and values were selected for the shape factor and the runoff curve number. The unit hydrographs were computed using a standard shape factor of 484, a constant runoff curve number = 80 for all subdrainage areas except Ara2, Arb, and Arc. For these three subdrainage areas a runoff curve number = 90 was used to account for the higher level of urbanization. These values are included in the ***Eagle Point's Watershed Modeling Manual.*** Development of Runoff curve numbers is discussed in the Soil Conservation Service, Section 4 Hydrology, (2).

3.4 Rainfall Intensity

The point rainfall intensities used in the design of all stormwater drainage facilities in the Roma area were developed from the rainfall intensity equation $I = b/(t_c + d)^e$. The constants used in the rainfall intensity equation were obtained from the Texas Department of Transportation's (TxDOT) **Drainage Design Manual** (3) are summarized in Table 3.2 below. The t_c, the time of concentration in minutes which represents the time required for the runoff to flow from the most remote point in the watershed to the facility being designed, was based on an average velocity of

Table 3.2

Rainfall Intensity Equation Constants

Frequency	b	d	e
2-year	73	9.60	0.83
5-year	82	9.40	0.80
10-year	89	9.40	0.79
25-year	99	9.40	0.78
50-year	100	9.40	0.76
100-year	105	9.60	0.75

5 ft/sec. The HEC-RAS analyses developed in the evaluation of the alternatives indicated that this was a reasonable assumption.

3.5 Rainfall Data

Rainfall depths for storms are applied to the unit hydrograph to determine the resulting peak stormwater discharges produced by those storms. Rainfall data for the 5-, 10-, 25-, 50-, and 100-year frequency storms were derived from intensity-duration-frequency curves from the TxDot's **Drainage Design Manual** (3). A listing of the rainfall intensities used in the hydrologic models is presented in Table 3.3.

3.6 Precipitation Losses

Interception, depression storage and infiltration within each contributing drainage area are combined and handled as precipitation losses in the hydrologic models. Initial and hourly rainfall loss rates vary with storm frequency and soil type. Typically, storms with a lower return interval

Table 3.3

Rainfall Intensity-Duration Frequency

	5 min (in/hr)	15 min (in/hr)	30 min (in/hr)	60 min (in/hr)	6 hr (in/hr)	24 hr (in/hr)
2-year	7.87	5.10	3.43	2.10	0.47	0.14
5-year	9.58	6.27	4.26	2.65	0.65	0.21
10-year	10.79	7.11	4.87	3.10	0.81	0.27
25-year	12.36	8.19	5.64	3.60	0.93	0.31
50-year	13.24	8.88	6.17	4.00	1.10	0.39
100-year	14.06	9.51	6.65	4.45	1.39	0.53

(i.e., more frequent storms) will have higher initial and hourly loss rates. Clay soils typically have lower loss rates than sandy soils due to the lower permeability of clay soils. The initial and hourly loss rates used in this project are included in the SCS curve number for the soil type.

3.7 Lag Time

The lag time is the time interval between the center of the rainfall duration and the peak discharge. For the SCS unit hydrographs, the lag time is assumed to be equal to 0.6 times the time of concentration.

3.8 Hydrograph Routing

The Muskingum routing method, which is described in most standard hydrology and open channel textbooks, was used to route runoff hydrographs between design points. Linsey Kohler and Paulhus in Hydrology for Engineers (4) have expressed the storage in a reach of a stream as:

$$S = b/a\,[xI^{m/n} + (1 - x)O],$$

where *a* and *n* are constants from the mean stage-discharge relation for the reach, $q=ag^n$, and b and m are constants in the mean stage-storage relation for the reach, $S=bg^m$. The constant *x* expresses the relative importance of inflow and outflow in determining storage. For a simple reservoir, $x = 0$ (inflow has no effect). If inflow and outflow have an equal effect on stage, *x* would be 0.5. For most streams, *x* is between 0 and 0.3, with a mean value near 0.2. A value of 0.25 was used in these studies since improved channels are being considered.

In the Muskingum method, m/n is assumed equal to 1 and b/a is assumed to be a constant k.

$$S=K[xI+(1-x)O]$$

The constant *K*, known as the *storage constant,* is the ratio of storage to discharge and has the dimension of time. It is approximately equal to the travel time through the reach and, in the absence of better data, is sometimes estimated in this way. Sufficient historical data does not exist for the Roma area to compute a *K*. The *K* value has been approximated by dividing the travel distance by flow velocity of five feet per second. The HEC-RAS analyses developed in the evaluation of the alternatives indicated that this was a reasonable assumption.

3.9 Computed Peak Design Flows

The computed peak design flows for the 10-year, 50-year and 100-year frequency storms developed watershed conditions are summarized in Table 3.4. <u>These are the peak design flows that have been used to size the storm drainage and flood protection improvements.</u>

Table 3.4

Computed Peak Design Flows

Area No.	10-year Frequency (CFS)	50-year Frequency (CFS)	100-year Frequency (CFS)
ARa1	1,157	1,758	1,980
ARa2	906	1,243	1,366
ARa1+ARa2	1,557	2,319	2,602
ARb	873	1,218	1,344
ARb+area above	2,351	3,408	3,800
ARc	473	645	707
Arc+area above	2,669	3,854	4,294
ALMa	1,534	2,389	2,709
A11a	868	1,309	1,471
ALMa+A11a	1,835	2,869	3,258
ALMb	367	569	645
ALMb+area above	2,202	3,437	3,902
ALMc	794	1,199	1,349
ALMc+area above	2,860	4,355	4,937
A7	92	135	151
A8a	253	372	415
A8b	142	205	228
A8a+A8b			
A9a	233	333	369
A9b	290	438	492
A9a+A9b	367	554	622
A9c	197	285	317
A10a	167	242	269
A10b	374	547	610
A10a+A10b	496	722	805
A10c	55	85	96

Area No.	10-year Frequency (CFS)	50-year Frequency (CFS)	100-year Frequency (CFS)
A10c+area above			
A10d	303	450	503
A11b	224	330	368
A11c	120	186	211
A11b+A11c	275	411	461
A11d	317	462	515

4.0 Methods of Stormwater Management

4.1 Legal Considerations

The Flood Control and Insurance Act (Article 8280-14 of the Revised Civil Statutes of the State of Texas) authorizes Texas cities to develop stormwater management controls. The act provides for the development of a flood plain management program and the adoption and enforcement of permanent land use and control measures to aid in the implementation of the program.

The legal authority of the City of Roma to carry out a comprehensive program of stormwater management, and legal procedures for implementation of various funding methods must be carefully examined as the program strategy evolves. It is recommended that the City Attorney be consulted to provide a legal opinion on integrating the stormwater management program into the City process, especially as it relates to control of private drainage systems and the timing of program elements in light of financing implementation steps.

4.2 Structural Alternatives

Structural applications to control floodwater from a watershed may be divided into two fundamentally different approaches:

- the conveyance oriented approach, and
- storage oriented approach

Conveyance Oriented Approach: The conveyance concept, briefly stated, is the concept of providing provisions within the drainage system to transmit a given quantity of water within the confined limits of conduit or channel banks to **minimize** and/or **eliminate** damage and disruption through the adjacent areas. This technique is the more traditional stormwater management approach, and the system components consist of pipes, culverts, bridges, improved channels, and levees.

Conveyance describes the capacity of a conduit or channel section to transport stormwater runoff. The transmission capability of an improved conduit or channel varies with numerous factors such as the slope of the channel bed, channel width and depth, and smoothness of the channel walls and bottom. It is also necessary to understand that channel improvements must be sized to convey the selected storm frequency. The system that carries flooding for one storm will often be inadequate to carry the runoff from a larger frequency storm within the conduit or channel banks

An improved channel can greatly increase the conveyance capability provided by a typical natural channel. Depending upon conveyance needs, the improvements can include cleaning the clogged natural channel of vegetative growth, channel straightening which eliminates meandering and improves the slope, developing a new channel section to increase the flow area and maximize smoothness, or a combination of one or more of these. Compared to a typical natural channel, an improved straightened earth or grass lined channel having equal cross-sectional area can convey approximately 40 percent more water, and a concrete lined channel can convey more than three times the flow of a natural channel.

Because of the increased conveyance capability of the improved channel, stormwater can be rapidly and efficiently removed from a given area. Since the improved channel is more efficient in conveying water, it provides the benefit of minimizing the required channel area. Increasing channel efficiencies can also affect the overall watershed hydrology (i.e., hydrograph timing to create a peak on peak).

Within existing developments, the improved channel is very adaptable in controlling and removing stormwaters while requiring the minimum loss of right-of-way. In new developing areas, with proper planning, the improved channel can be combined with aesthetic amenities to provide efficient conveyance while minimizing the hard appearance that may be projected, for example, by a stark concrete lined channel.

Without question, the aesthetic quality of a natural tree-lined meandering creek or stream is very attractive and it becomes a desirable location for development. Roma is not unique in regard to development adjacent to many of the natural creeks meandering through the area. However, implementing stormwater control measures in some streams can possibly destroy or certainly diminish the natural aesthetic qualities with channel improvements, depending upon the conveyance requirements.

The advantages gained, from the increased conveyance capability of the improved channel, may be accompanied by loss of aesthetic quality. Another disadvantage sometimes associated with the improved channel is the possible increase in erosion due to higher velocities. There is also a potential for downstream flooding if the improved channel abruptly ends and allows water to stack up in an area of reduced channel conveyance.

Possible channel improvements and their respective advantages and disadvantages are summarized in Table 4.1. These typical improvements are basic and do not reflect the numerous variations to provide floodwater control within defined parameters or the myriad of aesthetic treatments to retain the natural look.

Table 4.1

Typical Channel Improvements

Type	Nature	Advantage	Disadvantage
Channel Clean Out	Selective removal of trees & under-brush to minimize clogging	Maintains maximum natural setting while improving conveyance	Destroys some Vegetation
Channel Straightening	Improved alignment by eliminating excessive mean-dering and increa-sing channel slope	Retains selected natural setting & improves the conveyance capability	Reduces aesthetic quality of natural swales depending upon extent of straigh-tening
Channel Enlargement	Complete modifi-cation of natural channel by straightening & widening	Provides significant increase in conveyance	Reduces aesthetic quality
Channel Lining	Maximum channel modification by providing lining (nor-mally concrete) to reduce right-of-way requirements	Provides maximum conveyance & minimizes land loss	Can project a hard appearance unless supple-mented with amenities

Storage Oriented Approach: This method of stormwater management provides for the control by means of storing water and releasing it at a predetermined rate which can be adequately conveyed by the downstream system. Traditionally, this method has been utilized on large streams and river systems to control major flooding and is an important function of many of the large dams existing on streams and rivers throughout Texas and the United States. In urban areas, detention is being used to **limit discharges** from developed properties to that of the pre-developed conditions.

The general application of this methodology for watershed management on smaller areas has seen increased use in recent years and many cities utilize this approach. Applications of this method are now applied to areas as small as two acres and can even be applied to individual lots. The only requirement to affect this concept, whether large or small, is provision of a storage area for stormwater collection. This storage can be done in parking areas, small ponds, or large areas requiring detailed engineering evaluation of the storage area and overflow spillway.

The storage concept may be divided into retention or detention facilities. The **retention storage** method assumes the continual retainage of a given quantity of water that may be used for aesthetic, recreational, irrigation or domestic purposes. The retention system, however, has the capacity to retain additional volumes of water for a short duration to regulate the maximum floodwater discharge flow rate. The stored stormwater is released downstream as rapidly or slowly as the receiving channels, creeks, or system will allow, consistent with a stormwater management program.

The **detention storage** method is similar to the retention system except no provision is made for continuous storage of water. Rather, the stored floodwaters are completely released in a time period consistent with a flow rate that will minimize or eliminate downstream flooding. Detention storage has as its major function the control of stormwaters, yet this requirement may be utilized on an infrequent basis. As a result, the detention storage area can very effectively provide multiple uses for such functions as park areas, playgrounds, or athletic fields.

The primary function of the retention/detention concept is elimination or reduction of downstream flooding by storing and controlling the released water. The prime advantage of this concept is the use of smaller conveyance systems downstream. Depending upon the available storage capacity, it may be possible for the natural creek or stream to convey the released waters and not cause flooding. This approach not only can reduce the capital cost for larger downstream facilities, but maximizes preservation of the aesthetic qualities of the natural stream area.

Multiple use of the storage area is also an advantage. New planning concepts generally encourage open space, parks, and other recreation areas within a development. The retention/detention areas are ideal for the development of water-related aesthetic or recreational facilities, or can be used for maintained green belts, parkways, or athletic fields, depending upon the storage area size.

An advantage associated with the retention/detention concept that has recently received considerable attention is the attenuation of stream pollutants. Inherent in the storage concept is rapid reduction of water velocity which allows the precipitation of water-conveyed sediments and other pollutants such as heavy metals, pesticides, and phosphorous, and thereby significantly reduces downstream pollution. Because urban stormwater has been observed as a major contributor to pollution of surface waters, the storage concept can be a very effective quality control facility. The periodic disposal of collected pollutants is another factor that should be considered in the planning of this type of facility.

Depending upon the upstream drainage area and the desired reduction of peak discharge, the loss of developable land can become significant. For this reason the application of the storage concept is generally restricted to new development that can incorporate the required storage area into desirable open space, park, or recreational areas. In existing developments, the open space requirements are generally prohibitive and the storage concept becomes difficult to apply.

The basic premise of the retention/detention concept is containment and storage of large inflow rates and the gradual release of smaller outflow rates to the downstream area. Due to this differential between inflow and outflow rates, an extended period of time is needed to release the stored volume of water. If the downstream conveyance system is inadequate and the peak flow reduction provided by the retention/detention system is limited, it is possible to extend a reduced flood stage problem over a longer period of time as opposed to the natural condition of higher stages of flooding for a shorter period of time. It is important in selection and design of retention/detention facilities to give adequate consideration to the downstream conveyance capabilities.

Construction of retention/detention facilities requires open land areas primarily in the upper regions of a watershed. Desirable sites will be those where existing depressions already exist, and the length of dam construction will be minimal and sufficient capacity exists. Since the study area is relatively flat, it may be necessary to excavate a storage area with a controlled overflow from the stream. The stored water would later be released downstream through a conduit with a flap gate as the water surface of the stream declines. Lack of property containing sufficient capacity within the watershed management program area may make this concept only viable in select areas without excavation.

A comparison of the two structural methods of watershed management, conveyance systems and retention/detention systems, is provided in Table 4.2. The conveyance and storage concepts are the current state-of-the art structural methods for stormwater management control. Either approach can be employed individually, but the best results will generally be achieved through a combination of the two concepts. The integrated system of improvements should consider each drainage basin as a whole to provide effective stormwater management control.

Federal Programs: Federal support for urban runoff control has been minimal, and limited primarily to program planning and research. The Section 208 program under the 1972 Clean Water Act (Public Law 92-500) invested heavily in evaluations of water quality programs resulting from urban runoff (4). The Soil Conservation Service (SCS) historically given technical assistance to local governments to control soil loss and provide water resource management in urban and rural areas. The types of controls the SCS has promoted reduce erosion/sediment, flow, and flooding problems. These controls often have another benefit, stormwater pollution control. The federal government has otherwise steered clear of urban runoff.

Table 4.2

Comparison of Conveyance and Storage Features

Conveyance	
Advantages	**Disadvantages**
1. Removes stormwater runoff rapidly and efficiently.	1. Reduces aesthetic quality, e.g., concrete lined channel.
2. Minimizes land loss by improved conveyance of stormwater.	2. Possible increase in erosion due to increased velocities.
4. Lowers maintenance cost compared to storage concept.	4. Possible increase in downstream flooding.
4. Can be applied to new or existing development.	
5. Generally the more accepted design analysis.	

Storage	
Advantages	**Disadvantages**
1. Reduces downstream flow therefore, smaller downstream conveyance system required.	1. Increased land loss.
2. Reduces downstream flow, allowing utilization of natural streams with minimum improvements while retaining aesthetic quality	2. Extends runoff period, bu at reduced peak.
4. Can be applied to new development limiting runoff to no more than natural conditions.	4. Generally restricted to new development.
4. Improves water quality by decreasing pollution through precipitation.	4. Collected sediment must be periodically removed which increases maintenance costs.
5. Has potential multipurpose application, e.g., recreation or aesthetic value.	
6. Can make use of existing depressions and abandoned caliche pits.	

Texas Legislation Related to Floodwater Management: Municipal floodwater management controls are authorized by Article 8280-14 of the Revised Civil Statutes of the State of Texas, commonly known as the "Flood Control and Insurance Act." The primary purpose of this Act is the "promotion of public interest by providing appropriate protection against the perils of flood losses and encouraging sound land use by minimizing exposure of property to flood losses." Subsection (5) of Section 5 provides for the development of a flood plain management program and the adoption and enforcement of permanent land use and control measures to aid in the implementation of the program.

Home Rule Authority: Any assessment of the legal considerations and requirements involved in providing an appropriate stormwater management program should include both the program functions and the financing options to properly balance the needs of the community with the authority and resources available to the City. A home rule city has a good deal of flexibility in organizing and financing municipal programs to meet the community's needs. The analysis of finance options addresses several innovative financing methods, many of which have not previously been widely used. These include establishing drainage as a utility and using impact or capital recovery fees.

The State of Texas has not specifically authorized cities to use the full range of possible drainage financing methods. It is fortunate that a home rule city has some latitude in using a variety of financing concepts. Home rule cities look to state law for limitations upon their powers, not for specific grants of power. Thus, home rule authority enables the City Council to enact funding methods which respond to the City's drainage needs without specific authorization at the state level.

However, restrictive court definitions of local taxing powers in Texas could impose limits on a city's flexibility.

From a practical standpoint, the program and financing strategy proposed for stormwater management must reflect the needs and attitudes in the local community and must be attractive to promote orderly growth. The options identified throughout this report have been developed in a manner that is intended to be consistent with reasonable public policies. The public will better understand drainage issues and the rationale underlying the strategies if the alternatives are clearly in tune with City policies on economic development, neighborhood revitalization, and environmental protection. Existing policies should not, however, foreclose opportunities to introduce new financing concepts or adjust existing policies.

4.4 Nonstructural Alternatives

Governmental Controls: Local governmental or administrative controls are means of providing control to sensitive areas such as the watershed and its floodplain. Such controls significantly broaden the scope of watershed management beyond the normal structural controls. Governmental controls take two forms: regulatory and non-regulatory.

Zoning and subdivision ordinances are effective regulatory control tools in stormwater management. New approaches to the control and management of land allow flexibility in the operation of flood plain land use controls.

The detailed specifications commonly found in zoning ordinances are generally inadequate when applied uniformly over an entire flood plain zone. The natural functions of the flood plain vary from site to site (1) due to local conditions, (2) how the site interacts with the surrounding natural features, (4) which conditions have a direct impact upon the site, and (4) whether the site is relatively pristine or is in the process of adjusting to surrounding disturbances.

An approach, that of controlling the impact of uses, represents a shift from zoning control of uses. Because of the shift in focus, this approach has caused some major changes in the operation of flood plain land use controls. This change can be characterized by a movement away from detailed specifications concerning construction techniques or site requirements and a movement toward performance criteria for land use.

One of the most commonly used methods of establishing performance type controls is the development of a series of policy guidelines that outline the community's expectations on the function of the land. The ensuing regulations are individualized, with each case being judged on its own merits as to how well it satisfies the policy guidelines. An alternate to this method is the use of performance standards. Using this type method, the community sets a specific measurable level at which the key functions of a development will meet these standards.

Subdivision control regulations are effective tools in watershed management. Unlike zoning ordinances which apply only within the city limits, subdivision control in Texas extends to areas within a city's extraterritorial jurisdiction (ETJ).

An effective method used in the establishment of a stormwater management program is the incorporation of runoff, erosion, water quality, and sedimentation controls into the City's subdivision ordinance performance specifications and design standards. This system allows for uniform application of a stormwater management program throughout the watershed, minimizing the possibility of inter-ordinance conflicts.

Non-regulatory controls take several forms. Annexation of areas which could potentially affect the flooding characteristics of the community is a viable method of increasing the effectiveness of stormwater regulatory controls. As discussed in the previous section, the subdivision ordinance and its platting requirements are essentially the only formal control the City has in regulating development in the ETJ. By annexing land, the City can use additional regulatory tools including the zoning ordinance, building code and the site plan review process.

Direct ownership through a fee simple purchase is one of the most effective means of preserving flood plains as open space areas, parks, existing caliche pits, or nature reserves within the City's corporate limits. Because of the direct expenditure of funds, there are fiscal limitations to this approach. However, some grant and loan programs are available to local governments through various public and private agencies for preservation and open space development within the City's corporate limits.

Purchase and/or dedication of flood easements is another option available for the control of flood hazard areas. This technique is usually implemented along drainage ways requiring regular maintenance and inspection so as to maximize accessibility.

The development of governmental policies that limit or discourage the extension of public services (i.e., roads, utilities, parks, etc.) into a flood prone areas are effective tools in the promotion of stormwater management. By not authorizing the extension of services to nonconforming developments, the City in conjunction with private utility companies, can encourage flood conscious design.

Municipal Drainage Regulations: The Roma Subdivision Regulations and Building Code Enforcement are the primary instruments used in the reduction of flood hazards within the city and its extraterritorial jurisdiction.

Drainage regulations to be developed for Roma should be designed to provide a stable foundation for a stormwater management program and provide effective measures for the prevention of flood damage to development. The regulations should outline concise performance standards for development inside and outside of the flood hazard areas, outlining at least a minimum level of performance for runoff will mitigate the long-term impact of development throughout the watersheds.

5.0 Description of Proposed Alternatives

5.1 Alternatives for Arroyo Roma

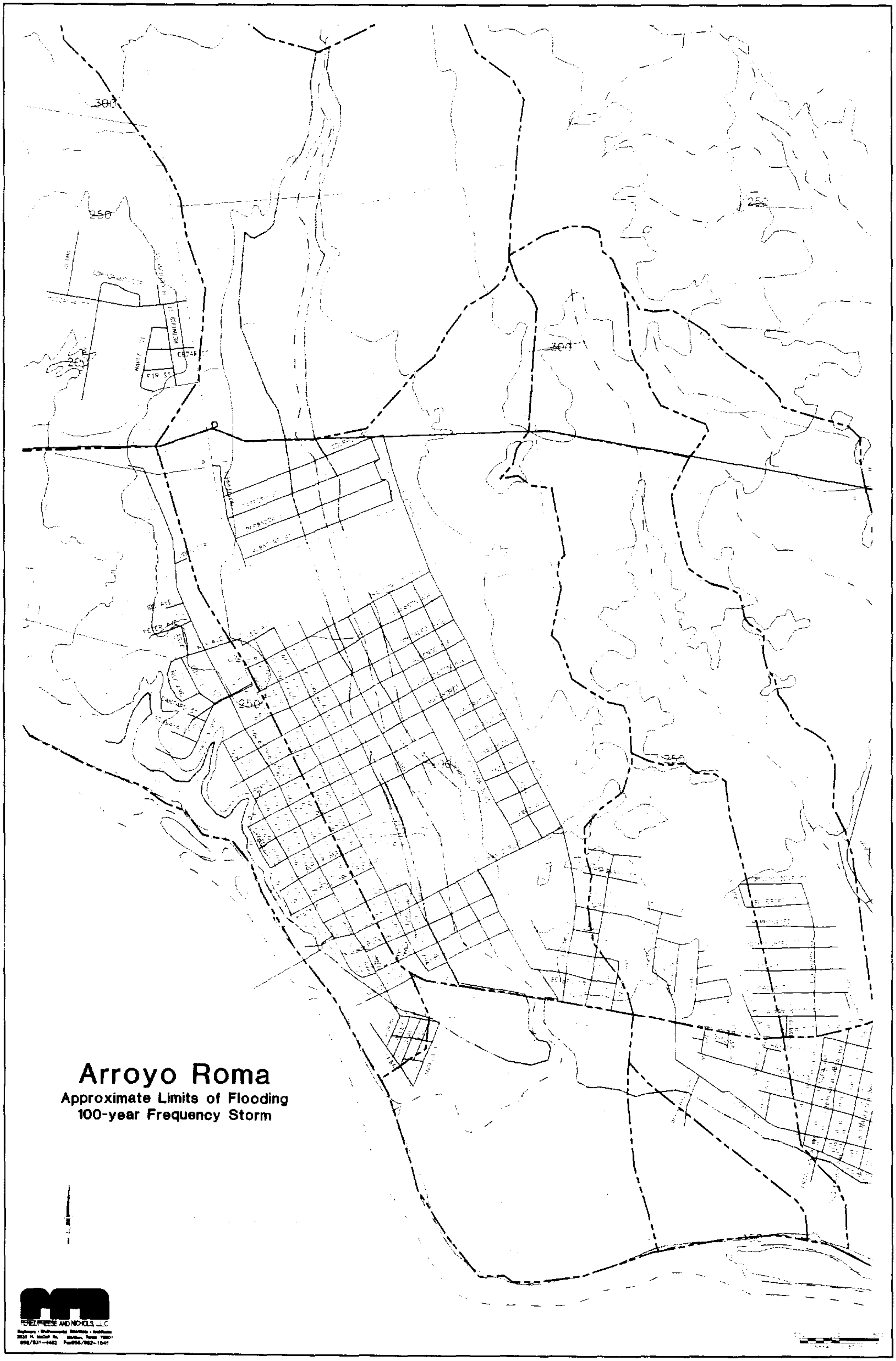
The approximate limits of flooding of the 100-year flood on Arroyo Roma are illustrated in Figure 5.1. A significant portion of the developed area of the City is affected by this flood. The flooding results from both the flood flows that are generated in the watershed and also from the spreading of the backwaters of the Rio Grande River as defined by FEMA maps.

The area inundated by the flood flows of the Rio Grande cannot be reduced by improvements within the City of Roma. The flood flows in the Rio Grande are controlled to a great extent by the spills from the Falcon-Amistad Reservoir System and by storm runoff from the uncontrolled drainage area below this reservoir system. Discussions have been conducted with representatives with the International Boundary and Water Commission (IBWC) on the magnitude and frequency of certain flow rates and water surface elevations in the vicinity of Roma. These flows and rating curves furnished by the IBWC have been used to define the starting water surface elevations for the flood flow water surface profile along Arroyo Roma. Based on the available information, the 100-year flood flow on the Rio Grande River in the vicinity of Roma would be at a water surface elevation of approximately 185 +/- feet msl. The conceptual alternatives do not provide protection from the 100-year flood on the Rio Grande.

The likelihood of the 100-year flood occurring on Arroyo Roma at the same time that a 100-year flood flow is occurring on the Rio Grande is very remote given the relative size of the two watersheds. Due to the control of the flows in this stretch of the Rio Grande by the Falcon-Amistad Reservoir system, a common peak flow rate as furnished by the IBWC is in the order of magnitude of 12,000 cfs to 15,000 cfs. The water surface elevation of the Rio Grande under these conditions is approximately 155+/- feet msl. This elevation has been used as the starting water surface elevation to establish the limits of backwater flooding on Arroyo Roma when the Rio Grande is not a major contributor to the limits of flooding.

With the extent of the flooding from the 100-year storm along Arroyo Roma, it is desirable to investigate potential improvements that could be constructed to remove some of the developed property from the flooded area. Described below are the alternatives that have been considered. A common improvement in all these alternatives is the construction of additional box culverts under U.S. Highway 83. Four-eight feet wide by eleven feet high boxes (4- 8'x11' RCBC) currently exist under U.S. Highway 83. Considering the limits of flooding immediately upstream of U.S. 83 as illustrated on Figure 5.1, it can be clearly seen that the limit is much wider upstream than it is on the downstream side of the highway. This condition is the result of the constriction caused by an insufficient opening under U.S. 83.

At the time the highway was constructed and subsequently widened, it is likely that the culvert was sized to meet the existing watershed conditions at the time using TxDOT design standards. Since the highway and culverts were constructed, additional urbanization has occurred upstream in the watershed. Also the TxDOT design frequencies are usually lower than the 100-year frequency protection that is considered appropriate for communities like Roma. According to the December 1985 edition of the TxDOT Bridge Division Hydraulic Manual, culverts under the main lanes of interstate and controlled access highways are designed for a **50-year frequency storm.** Culverts under other minor highways and frontage roads are designed for a minimum of a 5-year storm. The manual states that it is desirable to design these culverts for a 50-year frequency storm.



Arroyo Roma
Approximate Limits of Flooding
100-year Frequency Storm
300
250
PEREZ/FREESE AND NICHOLS, L.L.C.

In the development of the plans for improvements for the City of Roma, the assumption has been made that appropriate improvements will be made under U.S. Highway 83 by TxDOT. The hydraulic analyses of the limits of flooding on Arroyo Roma have been based on the assumption that from eight to ten culverts would exist under US 83. Making this assumption is not the most conservative approach, but one that appears appropriate given the impact of flooding on the City of Roma if the additional culverts are not installed. Certainly, the construction of the required modifications to U.S. 83 culverts should be of first priority.

Alternative 1 - Earthen Channel Improvements

A visit to the Arroyo Roma drainage ways reveals that much of the existing channel has been filled in and dwellings have been constructed that have impeded the natural flow. The earthen channel improvement approach, *a conveyance oriented approach*, involves the creation of an improved flow path through the flood plain. In planning conveyance oriented approach using earthen channels, consideration must be given to the velocity of the flow. The slope of the Arroyo Roma watershed is illustrated in Figure 5.2. As can be seen, the slope is fairly steep as compared to many other streams. This condition results from the watershed originating in the hill along the north side of the Rio Grande River.

The initial calculations indicated that if an earthen channel of adequate size is constructed at the existing slope, the resulting flow velocities would be of such a magnitude that major erosion of the channel and surrounding area would occur. The slope of the channel can be maintained flatter by constructing concrete drop structures at specific location thereby reducing flow velocities to acceptable levels so that the earthen erosion is minimized. The typical drop structure is designed to reduce the slope of the channel bottom and achieve the necessary drop in elevation at a controlled location to dissipate hydraulic energy. The locations for the proposed locations for the drop structures are illustrated on Figure 5.3 and their proposed height is illustrated on Figure 5.2.

The first drop structure is proposed near E. Morelos Ave. A second drop structure is located near Allende Ave. A third drop structure is proposed south Garfield Ave near the center of the school property. The fourth drop structure is proposed near Harrison Ave. Three drop structures are proposed south of U.S. Highway 83. The first is just downstream of the road embankment with the other two structures further downstream.

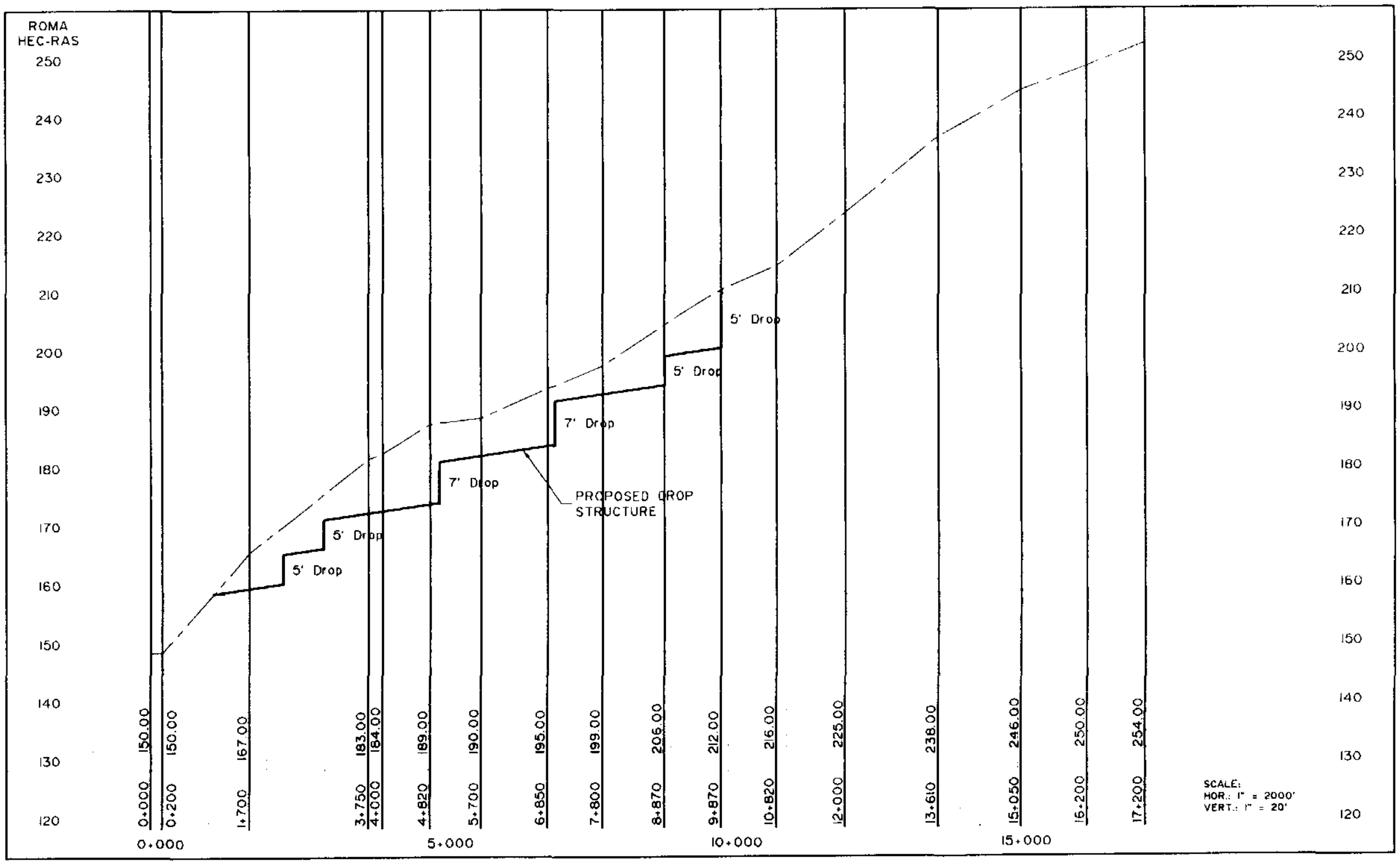
For the 100-year flood discharge of 3,800 cfs above U.S. Highway 83, in concept a channel with a 136-foot bottom width, 5-foot flow depth, and 2:1 side slopes is required. The bottom width and depth can be modified in the detailed design which is the case for all the alternatives. The 2:1 side slopes are relatively steep which creates a more difficult maintenance situation. Flatter side slopes should also be considered in the detailed design. Below U.S. 83 for the 100-year flood discharge of 4,100 cfs, a channel width of 147 feet is required. Under this alternative, the limits of the flooding from the 100-year flood would be **limited to the width of the earthen channel** between E. Morelos Ave. and the southern end of the channel near the Rio Grande.

To implement this alternative, numerous homes, vacant lots and open tracks of land would have to be acquired. The channel would divide the developed area and bridges would have to be constructed at strategic locations. Public safety would have to be considered and protective fencing would be included on both sides of the construction of the project. Cost estimates for this alternative are shown on Table 6.2.

Alternative 2 - Diversion Tunnel and Channel Improvements

The size of the improved channel can be decreased if a portion of the flow can be diverted

ARROYO ROMA PROFILE



PEREZ/FREESE AND NICHOLS, L.L.C.

Figure 5.2

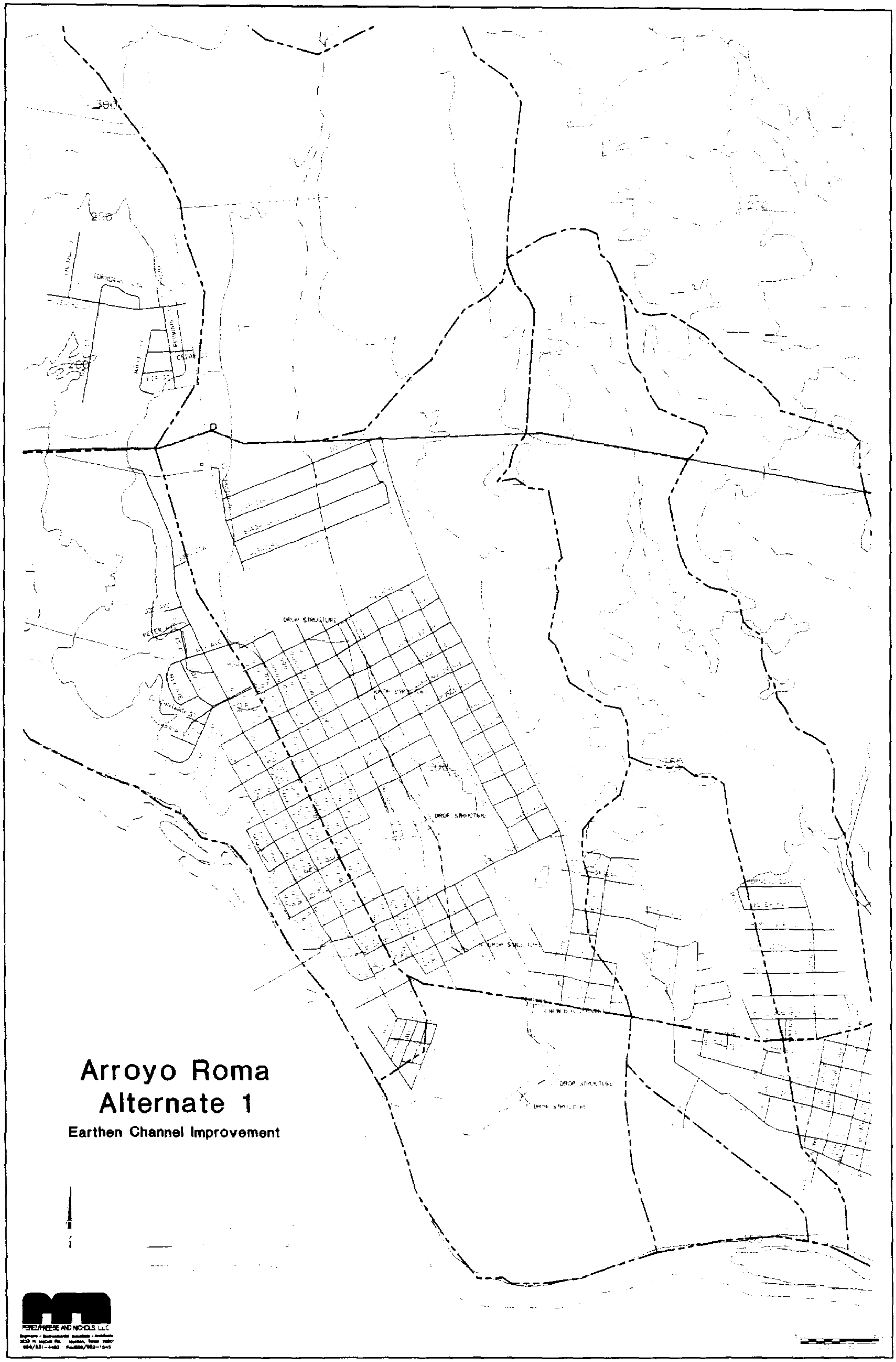

DROP STRUCTURE
DROP STRUCTURE
DROP STRUCTURE
DROP STRUCTURE
DROP STRUCTURE
NEW STRUCTURE
Arroyo Roma
Alternate 1
Earthen Channel Improvement
FREESE AND NICHOLS, LLC

Figure 5.3

prior to entering the current populated areas at East Morelos Avenue. The option for diversion involves construction of a tunnel from Arroyo Roma under the City to a small tributary of the Rio Grande River as illustrated on Figure 5.4. To divert a flow of approximately 2,200 cfs, the estimated 100-year flow at the diversion point, requires a **10-foot diameter tunnel**. The length of the tunnel would be approximately 1,100 feet.

Even with the construction of this diversion tunnel, an improved channel with drop structures would be required through the developed area of the city. The channel above U.S. Highway 83 for the estimated remaining flow of 1,600 cfs (100-year flow), would require a bottom width of 56 feet and 2:1 side slopes and a maximum 5-foot flow depth. Below U.S. 83, a 67-foot bottom width channel would be required for the estimated 1,900 cfs (100-year flow). Cost estimates for this alternative are shown on Table 6.3.

Alternative 3 - Detention Reservoir and Channel Improvements

An alternate structural approach is detention storage. A detention reservoir could be constructed above the area of the city that will be likely developed in the foreseeable future. The detention dam location is illustrated on Figure 5.5. The required dam would be approximately 45 feet high and have a crest length of approximately 2,715 feet at an elevation of 304.5 feet msl. A detention reservoir is designed to only detain flood flows and to make smaller releases over a longer period of time. The area within the reservoir storage basin could be used for recreation or agricultural purposes between storm events.

The storm flow from the drainage area below the detention reservoir plus the releases will also necessitate channel improvements through the developed area of the city. An earthen channel with a 99-foot bottom width and a 5-foot depth of flow and 2:1 side slopes is required to handle the

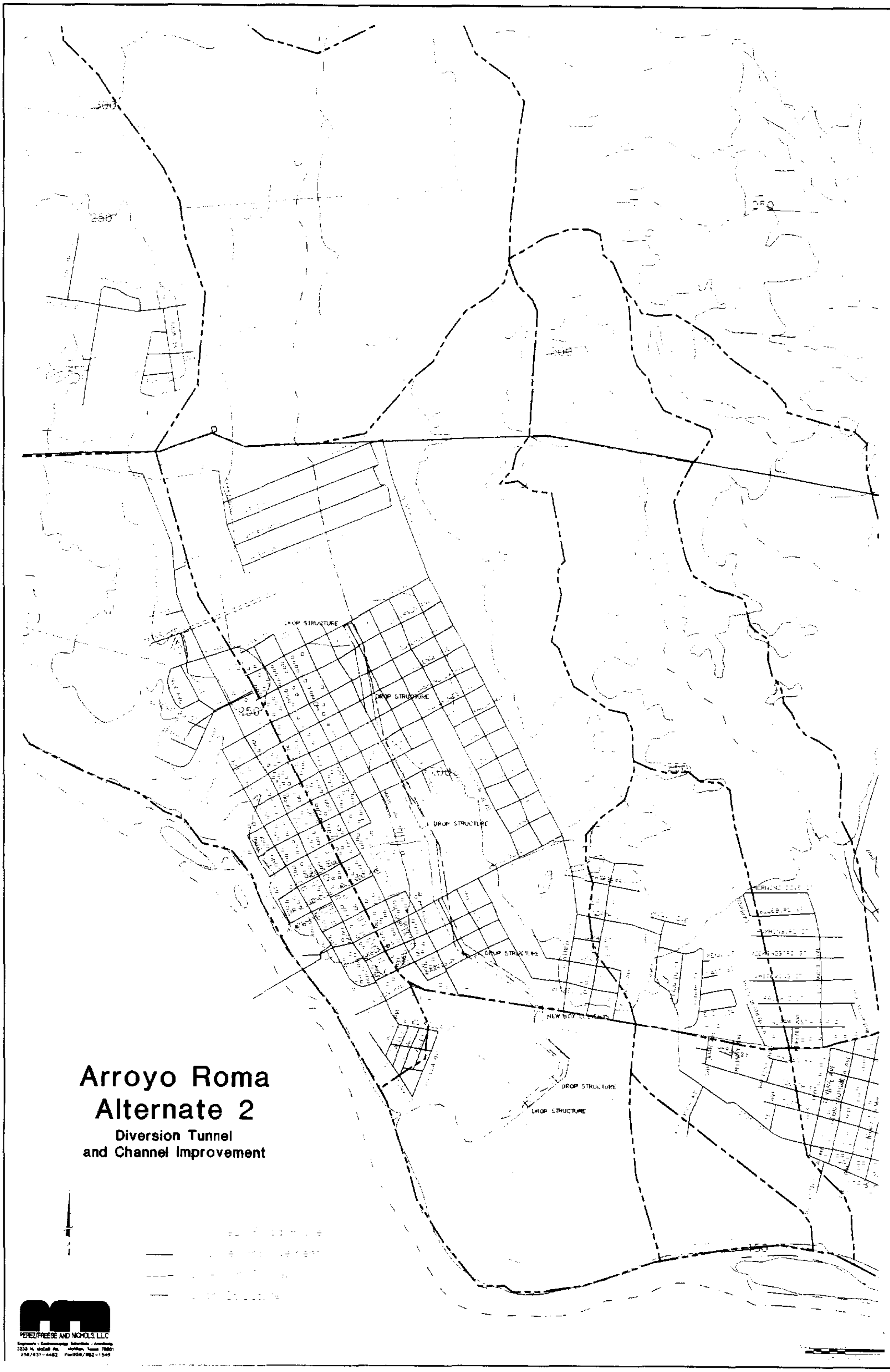

Arroyo Roma
Alternate 2
Diversion Tunnel
and Channel Improvement
DROP STRUCTURE
DROP STRUCTURE
DROP STRUCTURE
DROP STRUCTURE
NEW BOX CULVERTS
DROP STRUCTURE
DROP STRUCTURE
PEREZ/FREESE AND NICHOLS L.L.C.

Figure 5.

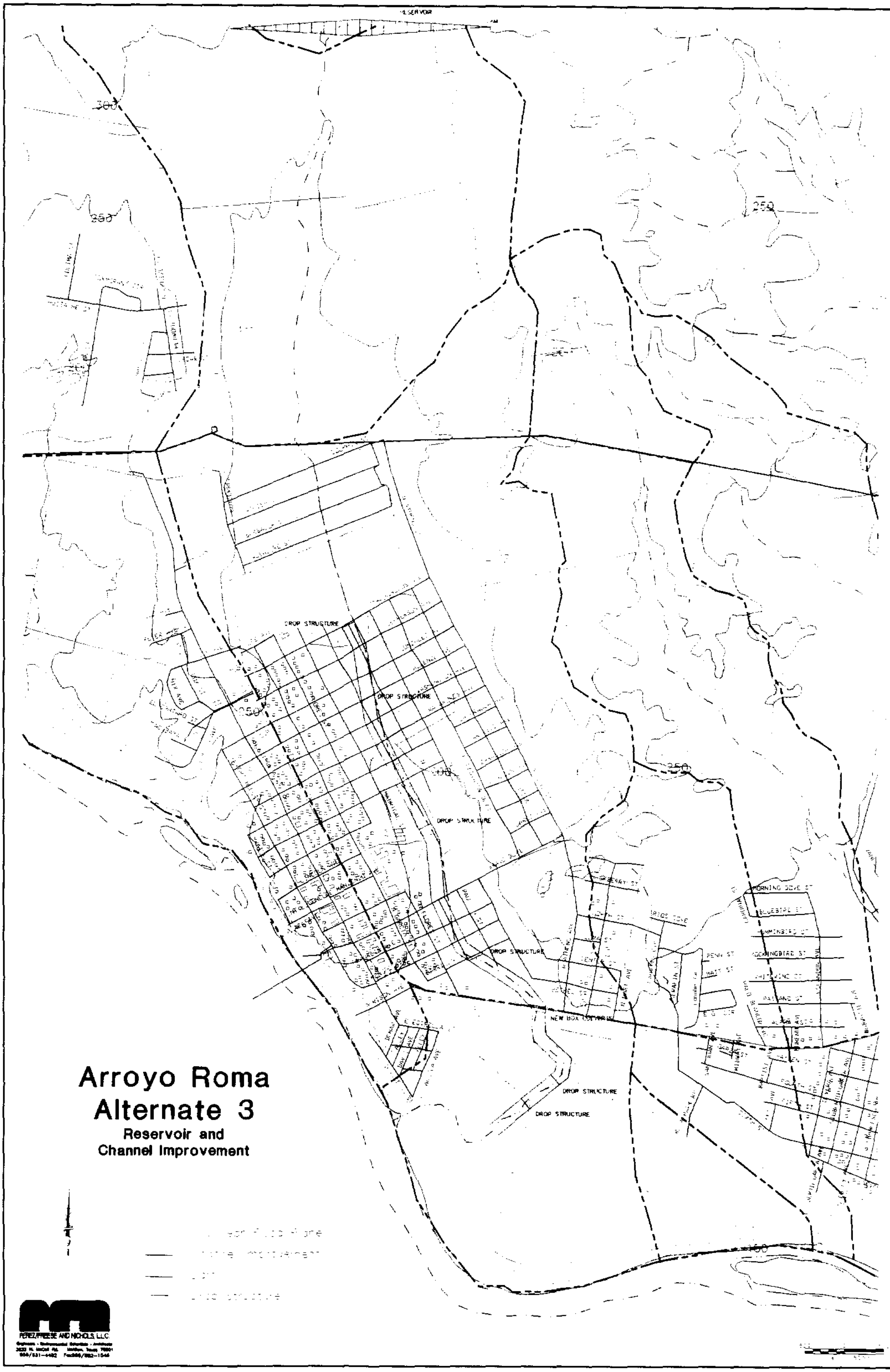

Arroyo Roma
Alternate 3
Reservoir and
Channel Improvement
DROP STRUCTURE
NEW BOX CULVERT
300
250
200
150

Figure 5.5

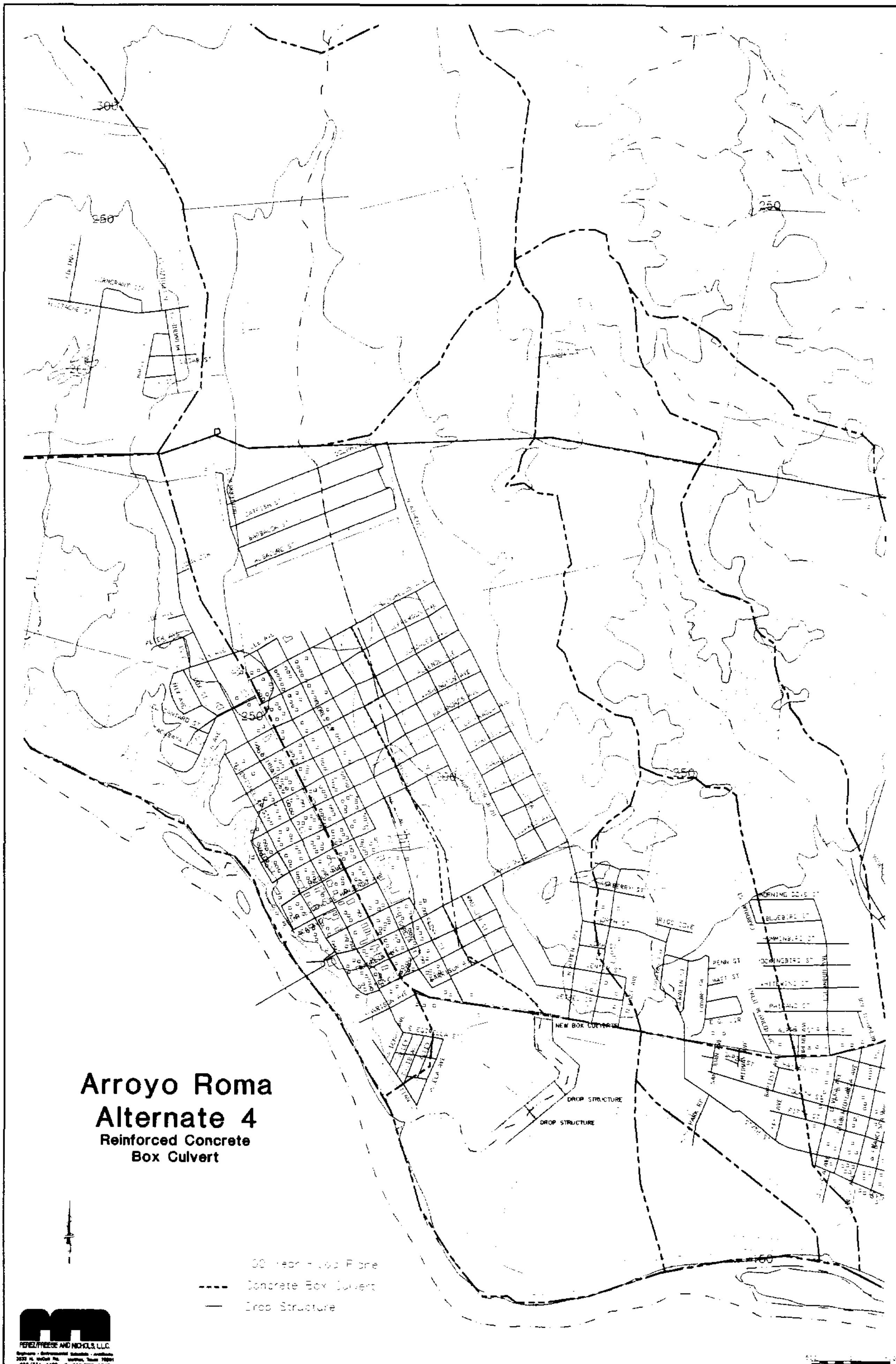

Arroyo Roma
Alternate 4
Reinforced Concrete
Box Culvert
100 Year Flood Plane
Concrete Box Culvert
Drop Structure
PEREZ/FREESE AND NICHOLS, L.L.C.
NEW BOX CULVERT
DROP STRUCTURE
DROP STRUCTURE
300
250
250
250
250
260
250
PENN ST
MARTI ST
BLUEBIRD ST
MORNING DOVE ST
MOCKINGBIRD ST
PHEASANT ST

Figure 5.6

culverts would allow traffic to travel east and west across Arroyo Roma. All other intersecting streets with the Arroyo would be dead ended and cul-de-sacs. All structures and dwellings, except school buildings would have to be demolished and removed. In order to avoid flooding to school buildings located north of Bravo Avenue, channelization would still have to be done as with "Alternative No. 1" to confine drainage waters to specific open channels. This work would be at the discretion of the Roma ISD and its costs are expected to be expended by the Roma I.S.D. and not quantified on Table 6.6.

5.2 Alternative for Los Saenz

Los Saenz area is a small watershed located between Arroyo Roma and Gongora Creek as illustrated in Figure 5.7. (For the purpose of this study we have named it "Arroyo Roma East"). Storm drainage culverts and inlets would be used to collect the storm runoff north of U.S. Highway 83. A box culvert would be constructed under U.S. 83. An improved channel to the Rio Grande River would be constructed south of U.S. 83 with a 10-foot channel bottom width, variable depth, 2:1 side slopes, and one 5-foot drop structure.

5.3 Alternatives for Arroyo Los Morenos

Two alternatives were considered to assist in the management of the flood flows in Arroyo Los Morenos watershed. The first alternative divides the watershed into sub-watersheds with part of the flow directed south through developed areas and the remainder directed to the east around the developed area. The second alternative diverts all the flood flow to the east around the developed area.

<u>Alternative 1 - East and West Channel Improvements</u>

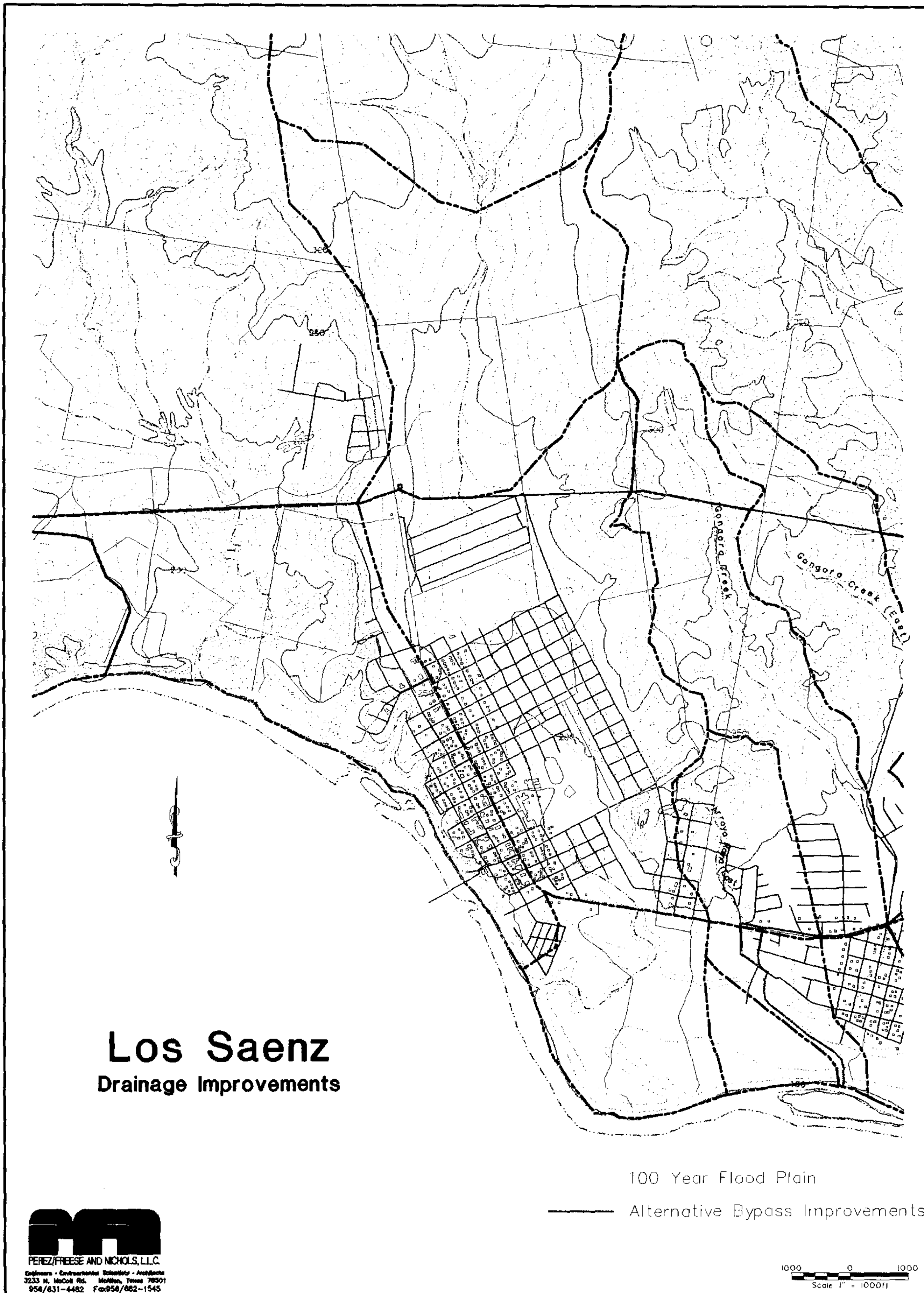
The first alternative involves the construction of drainage improvements for the Gongora

Creek watershed south through a sparsely developed area, then under U.S. 83 and then south to the Rio Grande as illustrated in Figure 5.8. The flood in the Arroyo Los Morenos watershed would be collected north of the currently partially developed area and diverted to the east. The improved channel for Gongora Creek above **N. Ebony Ave.** should have a 30-foot bottom width and below **N. Ebony Ave.** should have a 45-foot bottom width. The channel would be designed with 2:1 side slopes and a variable depth. Five new 8-foot by 10-foot box culverts would likely be required under U.S. Highway 83 for a total of nine.

The improved channel carrying the flood flows of Arroyo Los Morenos watershed to the east would begin at Arroyo Los Morenos - West with an improved channel with a 50-foot bottom width. The channel bottom would remain at the width until it reaches a point between **Soaring Dove St.** and **Evito Road** where the bottom width increases to 60 feet. The channel continues with a 60-foot bottom width until it reaches the Rio Grande. The improved channel is proposed with 2:1 side slopes and variable, but minimum flow depth of 5 feet.

Alternative 2 - Channel Improvements

This alternative begins at Gongora Creek near **N. Ebony Ave.** with a channel with a 20-foot bottom width. The bottom width increases to 30 feet where Gongora Creek - East enters the improved channel, to 75 feet where Arroyo Los Morenos - West enters the improved channel, and to 90 feet where Arroyo Los Morenos crosses Soaring Dove St. The channel width increases to 115 feet below U.S. Highway 83 and remains at that width until it reaches the Rio Grande. The channel is proposed with 2:1 side slopes and with a variable, but minimum of 5 feet, design flow. This alternative has been illustrated in Figure 5.9. Figure 5.9. also shows an alternate alignment south of U.S. 83 where it joins the Arroyo Grande (Garceno Creek). Costs for such diversion are not



Gongora Creek
Gongora Creek (East)
Arroyo Gongora Cat
Los Saenz
Drainage Improvements
100 Year Flood Plain
Alternative Bypass Improvements
PEREZ/FREESE AND NICHOLS, L.L.C.
1000 0 1000
Scale 1" = 1000ft

Figure 5.7

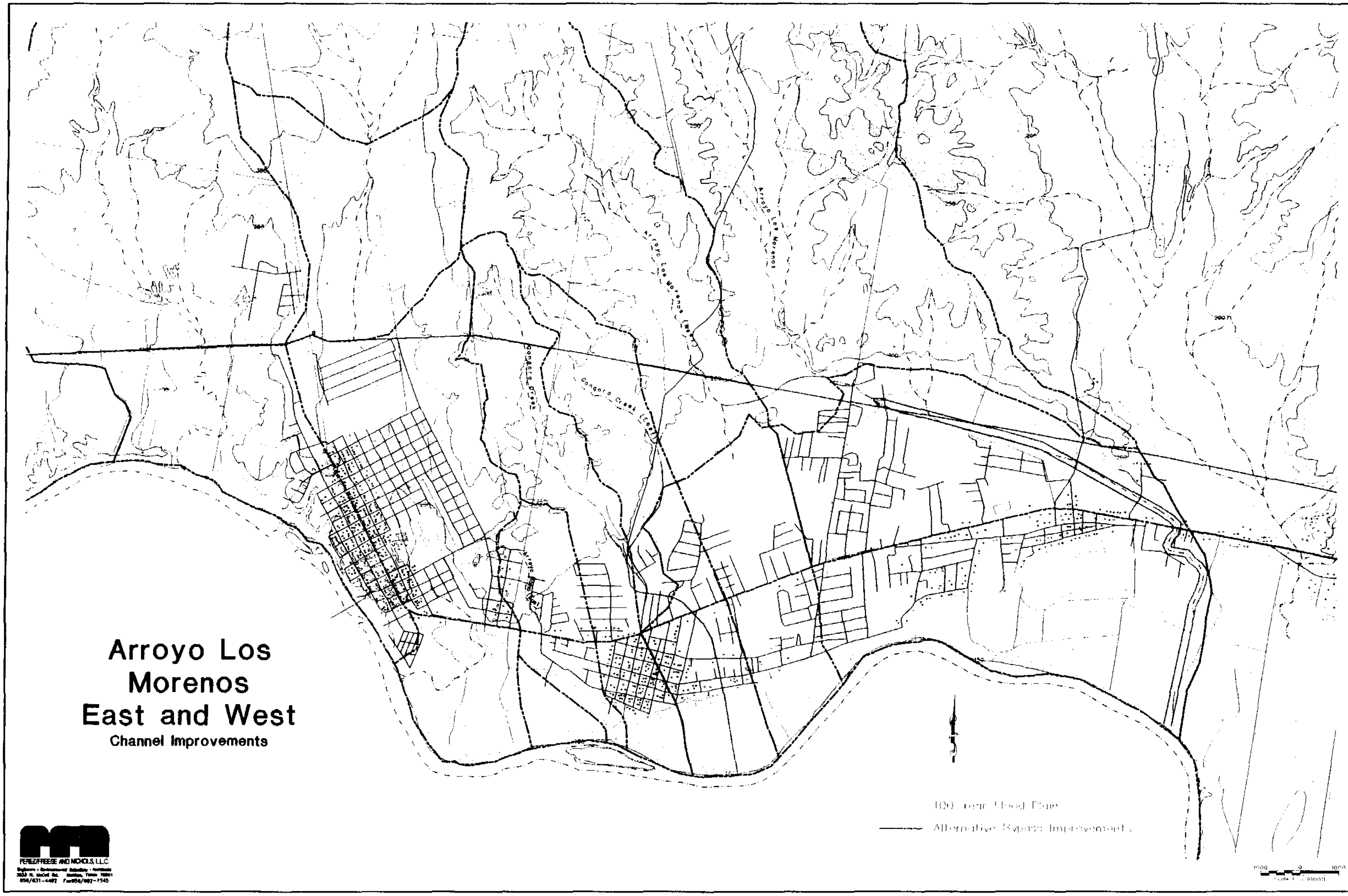

Arroyo Los
Morenos
East and West
Channel Improvements
Gongora Creek
Gongora Creek (East)
Arroyo Los Morenos (West)
Arroyo Los Morenos
100 year Flood Plain
Alternative Bypass Improvements
PEREZ/FREESE AND NICHOLS, L.L.C.

Figure 5.8

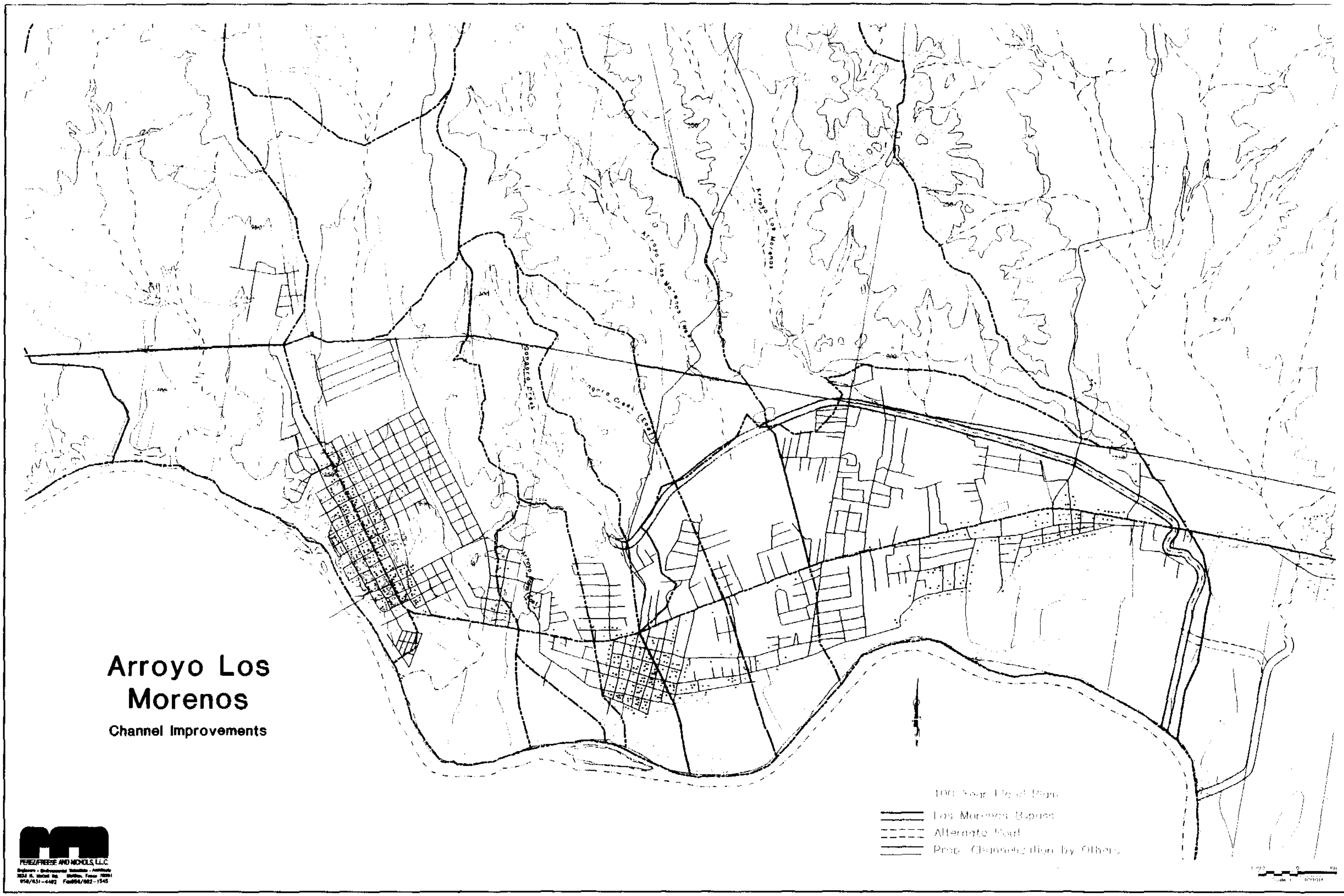

Arroyo Los Morenos
Channel Improvements
Arroyo Los Morenos
Arroyo Los Morenos (West)
Gongora Creek (East)
Gongora Creek
100 Year Flood Plain
Los Morenos Bypass
Alternate Road
Prop. Channelization by Others
PEREZ/FREESE AND NICHOLS, L.L.C.

Figure 5.9

considered in this report since this work is considered speculative and dependent of assistance by the Starr County Commissioners Court.

6.0 Detailed Construction Cost Estimates

The preliminary estimates of the probable construction costs for the alternatives described in Section 5 have been summarized in Table 6.1. The details of the estimates of the probable construction costs have been presented in Tables 6.2 through 6.9.

Reviewing the construction cost estimates for the alternatives for Arroyo Roma, it is clear that constructing two 8 feet by 11 feet box culverts from E. Morelos Ave. to new box culverts under U.S. Highway 83 and an improved channel below U.S. 83 to the Rio Grande River is the least costly approach. This approach would have the least impact on the amount of property that would have to be acquired for the construction.

For Arroyo Los Morenos, the construction of the improved channel from Gongora Creek to divert all the flood flows from the watershed around the East has the lowest estimate of probable construction costs. This alternative also has the least impact on developed areas.

For all the least costly alternatives, the total estimated probable construction cost is **$22,212,684.00**. These estimated costs **do** include the proposed box culvert improvements under U.S. Highway 83 which we feel should be constructed by the Texas Department of Transportation (TxDOT).

Table 6.1

SUMMARY OF OPINION OF PROBABLE COST
CITY OF ROMA MASTER DRAINAGE PLAN

WATERSHED	COST
Arroyo Roma Alternate No. 1 Earthen Channel Improvements (Table 6.2)	$12,546,690.00
Arroyo Roma Alternate No. 2 Diversion Tunnel and Channel Improvements (Table 6.3)	$10,735,530.00
Arroyo Roma Alternate No. 3 Detention Reservoir and Channel Improvements (Table 6.4)	$14,268,826.00
Arroyo Roma Alternate No. 4 **Reinforced Concrete Box Culvert** (Table 6.5)	**$9,394,580.00**
Arroyo Roma Alternate No. 5 Purchase Homes along 100 Yr. Flood plain (Table 6.6)	$15,358,200.00
Los Saenz **Storm Sewer and Channel Improvements** (Table 6.7)	**$730,028.00**
Arroyo Los Morenos - East and West Diversions Channel Improvements (Table 6.8)	$12,164,724.00
Arroyo Los Morenos **Channel Improvements - North** (Table 6.9)	**$12,088,076.00**

Note: The highlighted alternatives are the lowest cost and recommended. The total cost for all recommended improvements is **$22,212,684.00.**

Table 6.2

Arroyo Roma Alternate 1

Earthen Channel Improvements

Item	Description	Quantity	Unit	Unit Price	Total
1.	Purchase Property	22	ea.	$12,000.00	$264,000.00
2.	Purchase Dwellings	105	ea.	$40,000.00	$4,200,000.00
3.	Purchase Vacant Lots	60	ea.	$6,500.00	$390,000.00
4.	Site Preparation/Demolition	51	acre	$2,000.00	$102,000.00
5.	Channel Excavation	440,000	c.y.	$8.00	$3,520,000.00
6.	Conc. Drop Structures	6	ea.	$95,000.00	$570,000.00
7.	U.S. Hwy. 83 Culvert H.W.	2	ea.	$22,500.00	$45,000.00
8.	U.S. Hwy 83 Culverts	1	ea	$196,900.00	$196,900.00
9.	Drill Seeding	51	acre	$400.00	$20,400.00
10.	Barrier Fencing	11,000	ft.	$13.00	$143,000.00
11.	Utility Relocations	1	l.s.	$200,000.00	$200,000.00
Subtotal					$9,651,300.00
Engineering, Administration and Contingencies (30%)					$2,895,390.00
Total Project Cost					**$12,546,690.00**

Table 6.3

Arroyo Roma Alternate 2

Tunnel and Channel Improvements

Item	Description	Quantity	Unit	Unit Price	Total
1.	Purchase Property	13	acre	$1,000.00	$13,000.00
2.	Purchase Dwellings	60	ea.	$40,000.00	$2,400,000.00
3.	Purchase Vacant Lots	50	ea.	$6,500.00	$325,000.00
4.	10' Dia. Diversion Tunnel	1,100	l.f.	$2,400.00	$2,640,000.00
5.	Intake Structure	1	ea.	$75,000.00	$75,000.00
6.	Outlet Structure	1	ea.	$75,000.00	$75,000.00
7.	Site Preparation	23	acre	$2,000.00	$46,000.00
8.	Channel Excavation	220,000	c.y.	$8.00	$1,760,000.00
9.	Drop Structures	6	ea.	$55,000.00	$330,000.00
10.	U.S. Hwy. 83 Culvert H.W.	2	ea.	$22,500.00	$45,000.00
11.	Road "A" Box Culverts	1	ea.	$196,900.00	$196,900.00
12.	Drill Seeding	23	acre	$400.00	$9,200.00
13.	Barrier Fencing	11,000	l.f.	$13.00	$143,000.00
14.	Utility Relocations	1	l.s.	$200,000.00	$200,000.00
Subtotal					$8,258,100.00
Engineering, Administration and Contingencies (30%)					$2,477,430.00
Total Project Construction Cost					**$10,735,530.00**

Table 6.4

Arroyo Roma Alternate 3

Detention Reservoir and Channel Improvements

Item	Description	Quantity	Unit	Unit Price	Total
1.	Property for Detention Reservoir	253	acre	$3,000.00	$759,000.00
2.	Purchase Dwellings	60	ea.	$40,000.00	$2,400,000.00
3.	Purchase Vacant Lots	50	ea.	$6,500.00	$325,000.00
4.	Detention Reservoir Embankment	314,540	c.y.	$10.00	$3,145,400.00
5.	Detention Reservoir Spillway	1	ea.	$200,000.00	$200,000.00
6.	Property of Construction	17	acre	$12,000.00	$204,000.00
7.	Site preparation	39	acre	$2,000.00	$78,000.00
8.	Channel excavation	339,565	c.y.	$8.00	$2,716,520.00
9.	Drop Structure	6	ea.	$77,000.00	$462,000.00
10.	U.S. Hwy. 83 Culvert H.W.	2	ea.	$22,500.00	$45,000.00
11.	U.S. 83 Box Culverts	1	ea.	$196,900.00	$196,900.00
12.	Drill Seeding	253	acre	$400.00	$101,200.00
13.	Barrier Fencing	11,000	l.f.	$13.00	$143,000.00
14.	Utility Relocations	1	l.s.	$200,000.00	$200,000.00
Subtotal					$10,976,020.00
Engineering, Administration and Contingencies (30%)					$3,292,806.00
Total Project Cost					**$14,268,826.00**

Table 6.5

Arroyo Roma Alternate 4

Reinforced Concrete Box Culvert

Item	Description	Quantity	Unit	Unit Price	Total
1.	Purchase Property	13	acre	$12,000.00	$156,000.00
2.	2 - 10x'8' RCBC	5,800	l.f.	$1,000.00	$5,800,000.00
3.	Entrance Structure	1	ea.	$75,000.00	$75,000.00
4.	Outlet Structure	1	ea.	$75,000.00	$75,000.00
5.	10' Curb-Type Inlets	75	ea.	$1,500.00	$112,500.00
6.	24" RCP Connection Pipe	4,000	l.f.	$35.00	$140,000.00
7.	Pavement Patch	20,000	s.y.	$15.00	$300,000.00
8.	U.S. Hwy. 83 Culvert H.W.	2	ea.	$22,500.00	$45,000.00
9.	U.S. 83 Box Culvert	1	ea.	$196,900.00	$196,900.00
10.	Channel Excavation	4,000	c.y.	$8.00	$32,000.00
11.	Drop Structures	3	ea.	$95,000.00	$285,000.00
12.	Drill Seeding	23	acre	$400.00	$9,200.00
Subtotal					$7,226,600.00
Engineering, Administration and Contingencies (30%)					$2,167,980.00
Total Project Cost					**$9,394,580.00**

Table 6.6

Arroyo Roma Alternate 5

Purchase of Homes in Flooded Areas

Item	Description	Quantity	Unit	Unit Price	Total
1.	Purchase Dwellings	316	ea.	$40,000.00	$12,640,000.00
2.	Purchase Vacant Lots	60	ea.	$6,500.00	$390,000.00
3.	Demolition of Dwellings	316	ea.	$2,000.00	$632,000.00
4.	Roadway Culverts	5	ea.	$60,000.00	$300,000.00
Subtotal					$13,962,000.00
Engineering, Administration and Contingencies (10%)					$1,396,200.00
Total Project Cost					**$15,358,200.00**

Table 6.7

Los Saenz

Storm Sewer and Channel Improvements

Item	Description	Quantity	Unit	Unit Price	Total
1.	Purchase Property	7.4	acre	$12,000.00	$88,800.00
2.	Site Preparation	7.4	ea.	$2,000.00	$14,800.00
3.	Channel Excavation	16,000	c.y.	$8.00	$128,000.00
4.	U.S. 83 Box Culverts	1	ea.	$100,000.00	$100,000.00
5.	U.S. Hwy. 83 Culvert H.W.	2	ea.	$6,000.00	$12,000.00
6.	5-Foot Drop Structure	1	ea.	$50,000.00	$50,000.00
7.	Drill Seeding	7.4	acre	$400.00	$2,960.00
8.	Barrier Fencing	5,000	l.f.	$13.00	$65,000.00
9.	Utility Relocations	1	l.s.	$100,000.00	$100,000.00
Subtotal					$561,560.00
Engineering, Administration and Contingencies (30%)					$168,468.00
Total Project Cost					**$730,028.00**

Table 6.8

Arroyo Los Morenos - East and West

Channel Improvements

Item	Description	Quantity	Unit	Unit Price	Total
	Arroyo Morenos - East				
1.	Purchase Property	45.8	acre	$12,000.00	$549,600.00
2.	Site Preparation	45.8	acre	$2,000.00	$91,600.00
3.	Purchase Dwellings	15	ea.	$40,000.00	$600,000.00
4.	Purchase Vacant Lots	35	ea.	$6,500.00	$227,500.00
5.	Channel Excavation	530,000	c.y.	$8.00	$4,240,000.00
6.	Efren Ramirez Box Culverts	1	ea.	$85,600.00	$85,600.00
7.	H.W. Efren Ramirez Culverts	2	ea.	$13,500.00	$27,000.00
8.	Soaring Dove St. Box Culverts	1	ea.	$85,600.00	$85,600.00
9.	H.W. Soaring Dove Culverts	2	ea.	$13,500.00	$27,000.00
10.	Evito Road Box Culverts	1	ea.	$102,700.00	$102,700.00
11.	H.W. Evito Road Culverts	2	ea.	$15,000.00	$30,000.00
12.	Escobar Road Box Culverts	1	ea.	$102,700.00	$102,700.00
13.	H.W. Escobar Road Culverts	2	ea.	$15,000.00	$30,000.00
14.	U.S. 83 Box Culverts	1	ea.	$175,000.00	$175,000.00
15.	H.W. U.S. 83 Culverts	2	ea.	$20,000.00	$40,000.00
16.	Country Road Culverts	1	ea.	$102,700.00	$102,700.00
17.	H.W. Country Road Culverts	2	ea.	$15,000.00	$30,000.00
18.	Drill Seeding	45.8	acre	$400.00	$18,320.00
19.	Barrier Fencing	10,000	l.f.	$13.00	$130,000.00
20.	Utility Adjustments	1	l.s.	$100,000.00	$100,000.00
Subtotal - Morenos East					$6,795,320.00

Table 6.9

Arroyo Los Morenos

Channel Improvements

Item	Description	Quantity	Unit	Unit Price	Total
1.	Purchase Property	70.5	acre	$12,000.00	$846,000.00
2.	Site Preparation	70.5	acre	$2,000.00	$141,000.00
3.	Channel Excavation	777,940	c.y.	$8.00	$6,223,520.00
4.	N. Ebony Road Box Culverts	1	ea.	$34,200.00	$34,200.00
5.	Headwalls N. Ebony Road Box Culverts	2	ea.	$15,000.00	$30,000.00
6.	N. Efren Ramirez Box Culverts	1	ea.	$128,400.00	$128,400.00
7.	Headwalls N. Efren Ramirez Box Culverts	2	ea.	$17,500.00	$35,000.00
8.	Soaring Dove St. Box Cul	1	ea.	$128,400.00	$128,400.00
9.	Headwalls Soaring Dove St. Box Culverts	2	ea.	$17,500.00	$35,000.00
10.	Evito Road Box Culverts	1	ea.	$154,100.00	$154,100.00
11.	Headwalls Evito Road Box Culverts	2	ea.	$20,000.00	$40,000.00
12.	Escobar Road Box Culverts	1	ea.	$154,100.00	$154,100.00
13.	Headwalls Escobar Road Box Culverts	2	ea.	$20,000.00	$40,000.00
14.	U.S. 83 Box Culverts	1	ea.	$200,000.00	$200,000.00
15.	Headwalls for U.S. 83 Box Culverts	2	ea.	$22,500.00	$45,000.00
16.	Road "A" Box Culverts	1	ea.	$196,900.00	$196,900.00
17.	Headwalls Road "A" Box Culverts	1	ea.	$22,500.00	$22,500.00
18.	Drill Seeding	70.5	acre	$400.00	$28,200.00
19.	Barrier Fencing	47,400	l.ft.	$13.00	$616,200.00
20.	Utility Adjustments	1	Lump Sum	$200,000.00	$200,000.00
Subtotal					$9,298,520.00
Engineering, Administration and Contingencies (30%)					$2,789,556.00
Total Project Cost					**$12,088,076.00**

7.0 Financing Options

The lack of stable and adequate local financing is a major obstacle to implementation of any comprehensive, long-range stormwater management programs. Traditional municipal financing methods have proven to be ill-suited to funding major improvements to drainage systems, their maintenance and operation, and regulation of private sector activities which impact the systems. This section addresses major recent changes in watershed management financing, and describes some of the alternative and innovative approaches which can be considered. It briefly summarizes a range of financing concepts and suggests criteria for evaluating various financing alternatives. The range of financing option concepts available to the City of Roma includes those which are explicitly authorized by state legislation, those available under home rule authority, and methods which might require legislative authorization at the state level. Each of the options identified in this section has been used in one or more cities in the United States, though some have not been implemented in Texas. Their use in Roma could be subjected to legal challenge and judicial interpretation. Financing concepts used in other states cannot be assumed to be legal under Texas law, and methods held to be invalid in other applications should not necessarily be considered invalid for stormwater management.

Since both legislative and judicial actions may limit the application of the various methods of drainage financing, this list of options will require legal review by the City Attorney's Office. No legal evaluation was made during this analysis.

7.1 Summary of Financing Options

Traditionally, stormwater management has been financed using **general fund revenues** for annual operating expenses and a mix of revenue sources for capital improvements. The level of operational funding in most jurisdictions has only been sufficient to respond to the highest priority needs, and has not allowed comprehensive programs to be developed.

The range of financing option concepts presented herein is a contrast to the limited number of funding sources that have been used for stormwater management in the past. The options should be viewed as opportunities to broaden the base of support and balance financial participation in a stormwater management program, while also localizing costs when it is more appropriate than distributing them citywide

7.2 General Fund

The general fund of the City is the "base" of financing for municipal programs, with revenues from a number of sources including property taxes, excise and sales taxes, business licenses and taxes, utility taxes, and fees of several types. It supports wholly or partially those city functions which do not have other sources of funding such as service charges.

The City administration and City Commission have discretionary control of the general fund through the budget process. Identified municipal responsibilities and political realities tend to define how most of these revenues are spent, however. It has historically been difficult for programs which focus on long-term, capital intensive, public facilities construction and maintenance to complete effectively in an annual municipal budget process.

There are few explicit limitations on the use of general fund revenues. They can be spent on both operational and capital expenses, although most often they are used for annual operating costs. Capital outlays which are sometimes paid from the general fund include equipment and land acquisition, but only rarely major construction.

General fund revenues are often relatively susceptible to economic conditions in the community. Sales tax and excise tax receipts drop during a bad economic slump. Property values may decline leading to reduced tax assessments. Property tax delinquencies tend to increase during periods of recession and high interest rates. At the same time demand for many municipal services (especially police and social services) increases.

Insofar as drainage is concerned, financing through the general fund tends to create an imbalance of costs in comparison to contribution to drainage problems, benefit or services received. The complexity of drainage problems makes it difficult to accurately define who pays a disproportionate amount or receives more in benefit than they may be paying. It is clear, however, that there is no measurable basis of equity inherent in general fund financing of stormwater management.

7.3 Drainage Utility Service Charges

This financing method has been instituted in a number of cities and counties (particularly in the western United States) as an alternative to general fund financing for annual operating expenses. These "user" charges are analogous to water and sanitary sewer service charges, but dedicated for stormwater management. This approach requires that an enterprise fund utility be established for stormwater management.

The drainage utility is an innovative concept, but one which fits uniquely well with the program needs in most local stormwater management operations. The functions and costs for effectively managing drainage are similar to those needed to provide water supply and sanitary sewer programs. Since water and sewer have been financed through service charges for some time, it is not surprising that drainage utilities and service charges have been implemented in the same basic format.

The philosophy behind user charges for watershed management differs from those for water and sewer service in several ways. Unlike water supply, a measurable commodity is not delivered to the customer and sometimes its benefits are no shared by all contributors. The service provided is similar to sanitary sewers or solid waste disposal in that something is carried away and disposed of (i.e., stormwater) but quantified measurement is difficult and costly. The demand for the "service" is not comparable to the demand for water supply, since most properties drain onto downhill neighbors fairly effectively without any public system. A broader definition of benefit resulting from service is needed in the case of drainage than for other utilities. Finally, drainage programs are more oriented to solving or mitigating problems than are the other utility functions, which have focused on providing service to clients.

Unlike some of the other financing options, user charges can provide a true alternative to general fund financing for drainage, rather than just a supplement to it. The other options have a limited contributing group and will not generate sufficient revenue to fund all the necessary functions. User charges, on the other hand, spread the expense of the drainage program as broadly as possible throughout a community, resulting in a relatively low cost for each property owner.

Revenues derived from service charges can be used to pay for administration, planning, design, operations and maintenance, payment of revenue bonds for new construction and replacement of old systems, support services, regulatory functions, and virtually anything else required in a drainage program. Rate structures are flexible mechanisms which enable a city to tailor the cost distribution to fit the local program and be consistent with other local policies. Finally, drainage utility revenues remain in the utility fund if not spent, rather than reverting for redistribution in the next year's budget, an important factor in long-term program stability.

7.4 Interfund Loans to Drainage Utility

The legislative action establishing an enterprise utility necessarily precedes the imposition of service charges and collection of revenues. An interfund loan from another municipal fund(s) may be desirable for interim financing of stormwater management functions until revenues are generated by the drainage utility. An interfund loan of this type is normally repaid from the utility service charge revenues.

7.5 General Obligation Bonding Repaid by Property Taxes

Capital improvements are often too expensive to finance from operating revenues, especially when an activity is funded from the general fund. General obligation bonding is a form of municipal borrowing in which the full credit of the city is pledged to service the bond debt. These bonds require voter approval, and usually involve an added property tax levy. They have been used for many purposes in the past, though use of them for utility projects has diminished with greater acceptance of revenue bonds.

Because they are backed by the full credit of the local government, general obligation bonds normally receive the most attractive (lowest) interest rates of any municipal borrowing instrument. They can be issued with varying maturities and other provisions which may affect their marketability and the interest rate they must pay.

7.6 Revenue Bonding Repaid by Service Charge Revenues

Enterprise funds, such as utilities, which have a source of financing separate from the general fund can borrow money for capital improvements through bonds to be paid off with service charge revenues. These bonds do not require voted approval, but are usually subject to slightly higher interest rates than general obligation bonds because the full credit of the city is not pledged.

Revenue bonds do not authorize an increase in taxes, nor do they usually authorize a specific increase in utility service charges. If necessary to support the bonds, a rate increase is normally enacted separately. It is possible to use service charge revenues from throughout a service area to repay revenue bonds or to specify that only revenues from one area or even certain properties be used for the bond payments. In most cases, it is best to place few limitations within the bond ordinance which relate to revenue sources, while still being consistent with financing philosophies and local policies. This provides the bondholders with some assurance of payment, and may result in a lower interest rate.

Although typically the bonds are repaid from the regular service charge revenues, municipalities may also establish system development charges, hook up fees, and other financing methods and earmark those funds for repayment of the revenue bonds. This reduces the revenue required from the standard service charge by the amount generated by the special fees and charges, and ensures that developing properties help pay for the project.

7.7 Utility Tax Revenues

Utility taxes and franchise taxes are levied on utilities operating with a municipality, including one or more of the following in most jurisdictions: telephone, electricity, natural gas, water, sewer, solid waste, fuel oil, cable television, and drainage. In recent years, cities have used utility tax revenues to construct various kinds of capital improvements, including drainage system improvements. In general, communities have a high level of discretionary control of utility taxes and their uses.

7.8 Tax Increment Financing

Tax increment financing can be used to provide funds for an infrastructure in areas where development is desired but funding for public facilities are not otherwise available when needed. In this approach, increases in tax revenues that are realized as a result of new development in a specified area are earmarked for financing public improvements or services in that area.

Usually administered by a public agency, a district is defined with a specified "base line" tax base of existing development. Improvements within the area are financed from the general fund or from bonds, then repaid from increasing tax revenues generated by the new development. The new development in effect pays its own way, using the community's normal tax program as the mechanism for deriving revenues. The method does have the drawback of siphoning off all increases in revenues, even revenues attributable to increased value of existing development in the area, until the bonds are paid off.

7.9 State Funding

Community Development Block Grant Funds: These revenue sharing funds are intended for use in neighborhoods which have been targeted for improvement based on social-economic and physical condition criteria. The City has discretion in the use of the funds within broad guidelines. In Texas, CDBG funds are administered by the Texas Department of Commerce.

With pressures to balance the federal budget, the future of federal development funding is uncertain and the City should not depend on CDBG funds. In addition to the uncertainty surrounding revenue sharing funds, the program itself has substantially more applicants that funds available. Therefore, grants are generally awarded to those communities with highest priority needs, such as substandard housing, inadequate water and sewer systems, and a significant percentage of low/moderate income residents (8).

Texas Water Development Board Funding: The Texas Water Development Board (TWDB) administers state funds for financing flood control projects. TWDB funds are disbursed to eligible political entities, generally as loans. Using the state's excellent bond rating, TWDB sells Texas Water Development Bonds which are general obligations of the state and purchases the bonds of local political subdivisions.

Historically, use of the Texas Water Development Fund was reserved for "hardship" political entities (political subdivisions unable to sell bonds in the open market or political subdivisions unable to sell bonds at a reasonable interest rate). However, passage of House Bill 2 by the 69th Legislature and approval by voters in November 1987 expanded the program to allow TWDB to make loans without a finding of hardship for the construction of a regional water treatment facility, flood control project, and facilities designed for conversion from the use of ground water to surface water.

TWDB may provide loans from flood control funds for the following flood-control related projects: (1) construction of stormwater retention basins, (2) enlargement of stream channels, (3) modification or reconstruction of bridges, (4) the acquisition of floodplain land for use as a public open space, (5) acquisition and removal of buildings located in a floodplain, (6) relocation of residents of buildings removed from a floodplain, and (7) development of flood plain management plans. To determine if a project is eligible for loan funds, several points are considered including the needs and benefits of the project to the area to be served, the availability of revenue for repayment of the loan, and whether the political subdivision can reasonably finance the project without State assistance (hardship).

7.10 Fees and Charges

Cities have developed a variety of special administrative fees and charges to cover expenses which are associated with permits and other services for individuals. In most cases, an identifiable "client" is assessed the fee or special charge, which is often earmarked to support a specific function.

Plan Review and Inspection Fees: The City has specific design and construction standards which private drainage systems must meet. Development permits are issued only when the plans meet these standards, requiring that the staff check that plans. Field inspections are necessary to verify that the systems are installed as designed, since private drainage systems may have a direct impact on the function of public systems. Some cities attempt to make plan review and inspection financially self-sufficient through the fees, while others subsidized these functions partially out of general fund revenues to encourage development. The net effect of this type of fee is to have individuals with changes in land use bear some or all of the cost for improvement of public services impacted by their projects.

On-site Detention/Retention System Inspection Fees: The private drainage systems which are installed on private property are important components of the total drainage system. Public systems are often designed and operated on the assumption that the private systems will function properly. Experience has shown, however, that voluntary maintenance of private drainage systems is very lax. Annual inspections of private on-site facilities can identify needed maintenance before problems occur, but they are relatively expensive to carry out on a regular basis. These inspections can be billed to the property owner as a service charge if a drainage utility is established. It may be possible for the City to also levy such a charge without a utility, though an annual permit of some type may be needed.

Impact Fees: Impact fees are charges or assessments against new development to fund the cost of capital improvements or facility expansions necessitated by and attributable to the new development. As of June 1987, Texas cities are expressly authorized to assess impact fees for drainage facilities provided that the fees are directly **associated with actual impacts and earmarked to ensure they are used to mitigate those effects**. Further, the costs of oversizing facilities constructed prior to adoption of an impact fee ordinance may be recouped through the fees.

Impact fees began as a response to the realization that construction and land development may have significant impacts on a neighborhood or even an entire community. Rapid growth fostered a concern not only for the environmental effects of growth, but the economic implications as well. Increased urban runoff and pollution, congested highways, and larger water and sewer facilities often translate into higher property taxes to upgrade municipal systems in response to problems. Impact fees are perceived as a mechanism to make growth pay it's own way by participating in the cost of new facilities at the front end of a project rather than indirectly through long-term enhancement of the tax base and increased local employment.

While the recently enacted state legislation limits the use of the impact fee concept, the statute validates a funding process that has already passed judicial scrutiny. The new law requires that, prior to adoption of an ordinance establishing impact fees, a City must conduct several studies to determine the real impact of new development on the infrastructure. These studies include land use assumptions, establishment of service areas, a capital improvements plan, and analyses relating the costs of improvements to individual "service units." The statute also prescribes a definitive adoption procedure and requirements for earmarking and accounting, refunds, and assessment and collection of the fees. Prohibitions on the use of fees include "repair, operation or maintenance of existing or new capital improvements" and "administrative and operating costs" of the City.

Impact fees are sometimes confused with the other types of special fees and charges cited in this report. Care should be taken to differentiate between impact fees, which are associated specifically with the impact of a project, and the general needs for new facilities to serve the community.

Development Assessment Charges: As an alternative to requiring each new development to provide conveyance systems, on-site detention or retention to mitigate increases in peak runoff, the City could institute this type of charge as an option available to developers in some communities. Detention capacity and conveyance systems would be satisfied by regional public facilities, which the developers would be "buying into" and "contributing to" through the development assessment charge instead of building the on-site detention system on their site. Such fees are then earmarked to pay for **regional detention facilities**.

This approach will probably be enthusiastically welcomed in communities where developers have experience with building their own on-site detention systems. Not only are the developers relieved of the cost of design and responsibility of building the on-site facility, but they gain more flexibility in the efficient use of their property since an area need not be set aside for detention of stormwater.

Assessment fees are particularly useful when more than one type of drainage system would solve or mitigate a problem, but one approach would be privately financed while the other would be paid for from public funds. In some cases, the cities would prefer to have the type of system that would require public financing, yet do not want to forego the private investment which is justified. Assessment charges can offer the best of both options by allowing the most desirable system to be built while still ensuring private financial involvement.

System Development Charges (SDCs): These charges have been used by municipal utilities for a number of years as a method of financing improvements. They have been known by several titles other than system development charges, e.g., utility expansion charges and extension and improvement charges. System development charges differ from other similar charges, such as general facility charges, in that they are associated with **specific improvements** are constructed as a means of balancing financial participation.

Communities must frequently install suitable water, sewer, and drainage systems in anticipation of growth. System development charges enable communities to meet the increasing demands on systems which accompany growth pressures. The SDC resembles the latecomer's fee for developer extensions, which is explained below, in that the intent is to enable a community to achieve excess capacity improvements in advance of growth. At the same time, place an equitable portion of the cost on those properties which later develop and makes use of the extra capacity that was built into the system.

When revenue bonds (supported by drainage utility service charges) are used to finance drainage improvements, SDC's can ensure that all properties, adjacent to or within the watershed, equitably participate in the financing of the capital improvements. Major drainage improvements are normally sized with future development in mind and have a useful life at least two or three times as long as the bond maturity. One purpose of the SDC's concept is to ensure that the properties which develop after the bonds are sold also help to pay for the improvements. SDC's should be consistent with that amount paid by developed properties when the improvements were constructed.

The SDC provides a rational financing method which responds to the sensitive issue of who pays for over-sizing to accommodate future growth. Care must be taken, however not to place too much confidence on future growth as a revenue source. If the growth slows or does not occur, the existing developed properties might have to pay a larger service charge in the future to cover the shortfall of SDC revenue. Unanticipated increases in service charges due to SDC shortfalls can erode a utility's credibility with the public, and should be avoided through conservative projections.

General Facilities Charges: General facilities charges are similar to the SDC concept, although they are more often used for **overall improvement to a system**, or for maintenance or replacement than for specific capital improvements. This method of financing is most often used when improvements which will benefit an entire service area are involved.

If a community has sufficient drainage utility service charge revenues that improvements made to the drainage system can be paid for directly out of revenues rather than through bonding, general facilities charges can be used to balance the financial participation. For example, if all improvements to the drainage systems are oversized for future conditions, but the developed properties are not billed a service charge, the general facilities charge can be used to ensure that developing properties "buy into" the prior capital investment in the system. This type of financing works best when the newly developing properties must obtain a permit to hook up to the drainage system, similar to the case of water and sewer.

The general facilities charge is probably most appropriate when a simplified rate structure is used which lumps operating and capital expense into a uniform system of charges or an "equivalent residential unit" approach. In such cases, the costs of all elements of the drainage program are spread area-wide without a highly refined cost distribution formula.

The underlying philosophy of this approach is that the improvement serves everyone, or the system is viewed as a fairly uniform whole rather than as a number of discrete parts. There is usually no need to break down a general facilities charge into component parts, whereas a system development charge is often associated specifically with revenue bonds for individual improvements, which suggests that much closer accounting practices are justified.

Other terminology is used in different areas of the country for financing concepts quite similar to general facilities charges. Water and sanitary sewer "hook up" fees are often intended to help finance general improvements to the systems rather than simply cover the expenses related directly to the hook up itself. Some cities include general facility charges in building permit fees, or other municipal approvals associated with development. Regardless of what they are called, general facilities charges for drainage provide an additional revenue source which may fill in gaps in a utility rate structure. The gaps are often intentional and reflect the City's financing policies (e.g., undeveloped properties do not help finance utility systems), or occur because of billing system limitations.

Latecomer's Fees: These charges are especially useful in developing areas or where major **reconstruction or upgrading** of a drainage system is needed, public funds are limited or not available, and a private development is contingent on the improvement. Through a developer extension agreement, the City can allow the developer to construct the improved and oversized drainage facility in conjunction with the project.

Developer extensions are common for water and sewer systems in new developments, but have not been widely used for drainage systems. The latecomer's fee is usually only used for over sizing costs, for example in the case of sanitary sewer interceptors or to ensure fire flow capacity to other properties. This charge method may be applied to drainage systems as well.

Regardless of what these various fees and charges may be called, they typically have specified purposes, and are accounted for in a manner which allows the revenues to accumulate. Fees and charges dedicated for specific purposes can be carried forward, and reserves can accumulate if an enterprise utility fund is established for drainage which separates the revenues from the general fund.

Revenue which is not spent for several years may also require a special accounting treatment in municipalities in some state. Usually, the money must be accounted for in the budget, even if it is not intended to be spent during that year. For water, sewer, and solid waste, a utility expansion fund is often the reserve account for these revenues in a municipal budget. Drainage utilities can use the same accounting technique to make dedicated reserves less susceptible to application to other needs, a protection which may be important in differentiating fees from taxes.

Utilities are allowed to retain surplus funds, both as a reserve to respond to emergencies and as a natural function of long-term rate structures which are predicated on differing rates of change in expenditures and revenues over time. This reduces the frequency at which the rate structure must be changed, contributing to stability. Similar accounting practices allow revenue accounts for fees and charges in a utility to accumulate. It is important to clearly identify reserved funds in the annual budget and to maintain a proper audit trail to ensure that an accurate picture is given of the enterprise's balance sheet, including fee accounts.

7.11 Special Assessments

Several methods of levying special assessments on benefitted properties to pay for drainage improvements have been used around the country. In most cases, the projects have a demonstrable benefit to the properties included in the assessment area and the charges for each parcel are consistent with the relative benefit to each property. In Texas, special assessment options include drainage districts, which are special-purpose taxing districts with specific authority to deal with stormwater management (9), and special improvement districts, which are areas of the city where the majority of property owners have requested City Council to establish a district and collect assessments to fund levels of service and programs in excess of the existing levels (10).

7.12 Criteria for Evaluating Financing Options

Whenever an effort is made to develop a new drainage program and/or a new financing concept for a municipal function as complex as stormwater management, some basis must be established for judging the appropriateness of the various options. A financing strategy must provide a stable, adequate, and publicly acceptable source of funds which will support the entire program as efficiently and equitably as possible. Transition, growth, and future program requirements must be considered as well as immediate needs. Further, the financing strategy must be consistent with the community's perceptions and resources.

Based on experiences in cities which have implemented stormwater management programs, the following criteria were selected as qualitative measures of the financing options. It is unlikely that any single financing method will be judged best under this wide range of considerations, but the criteria should help identify the best mix of funding methods, and reconcile differences between program and financing strategies. Some of the criteria may be viewed as more important than others. The order does not imply a priority, although public acceptance based on perceived equity is essential for political success of any new stormwater financing proposal. No single criteria should outweigh the others to the extent that an option is selected or rejected solely on one consideration.

Perceived Equity and Public Acceptance: Public acceptance of a financing strategy and the mix of financing methods it incorporates is essential for a drainage program to be successful. It must be recognized that some members of the community will not wish to pay anything, through any financing method, to fund drainage control. In most cases, a larger segment of the population will understand the need for an adequate stormwater management program, and the necessity of paying for it. To these citizens the critical issue is usually equity. It is important to note that perfect equity is probably not achievable either technically or economically, and that public opinion will be based on "perceived equity" and an appearance of basic fairness in financing.

The key is to finance stormwater management in an understandable manner. This is the strength of classifying financing techniques according to purposes for which the technique typically is used. It presents a logical association between what is done (functions) and how to pay for it (financing). To achieve perceived equity and public acceptance this logic must be communicated to the general public through various public information concepts.

Flexibility: A great deal of change could occur in stormwater management programs during the next decade. More effective regulation and maintenance of systems could be required. Water quality may become as important a concern in the overall management of the drainage systems as flow control. A financing strategy should be responsive to the growth needs of the program and to the physical complexities of the drainage basins. It must provide a flexible approach which can grow incrementally with the program.

To gain this flexibility, a mix of financing methods is likely to be needed. Some methods may require authorizing legislative action at the state level, and the local government may have to substitute a second choice for funding some functions until such legislation is adopted. Care should be taken during the interim not to foreclose options which require legislative authorization. It is also possible that a financing strategy selected through this process will not fit the needs 10 or 20 years in the future, in which case the most flexible system might be the easiest to adjust to meet changing priorities.

Capacity: The financing methods should be carefully evaluated to determine if they can generate sufficient revenue now and in the future to meet program needs. The public's willingness to pay may have thresholds beyond which they will not support even the most equitable financing system for watershed management.

Perceived equity is a factor in the public's willingness to pay. Their willingness may increase with the strength of their perception of equity. However, emphasis on equity also carries with it a potential problem if the financing capacity of the most logical and equitable funding method is insufficient to accomplish the program.

Analysis of long-term financing capacity is important, and the equity criteria must be tempered with a degree of reasonableness. Inflation and other factors can render even the best estimates unreliable, which would suggest that the greatest emphasis be placed on short-term financing capacity (for not more than five to seven years).

Cost of Implementation: The bottom line to many of the criteria identified in this section is cost. A perfectly equitable financing method might be desirable and achievable except for the cost of development and maintenance. Compatibility with other programs and policies may be limited in a financing strategy to avoid the expense of an excessively complicated mix of financing methods, or to limit the complexity of needed rate structures.

The initial cost of implementation must be weighed against the financing capacity of the options and the program needs. A financing method which costs more to implement may be worth the added expense if the alternatives cannot generate sufficient revenue to fund the program. Another consideration is the source of revenue against which the implementation costs would be charged. One element of a financing strategy could be to delay the implementation of some financing methods until a drainage utility is formally established, making the subsequent implementation costs a utility expense rather than a general fund expense. The work might initially have to be funded from an interfund loan from another fund, but could be repaid later from utility revenues.

Finally, the cost of implementation must be weighed against the price of delay. Many segments of a drainage system may be in need of remedial repair or even replacement to prevent costly and dangerous failures. At least one year lead time is usually needed to prepare plans, designs, and bid documents to correct major drainage problems. Timely implementation may prove less costly in the long-run than the method with the lowest initial cost of implementation. Also, each month that a utility service charge concept is not in place, it means that the revenue is foregone.

Compatibility: Whenever possible, the financing methods for stormwater management should be compatible with existing policies, practices, and systems. This simplifies implementation and acceptance among City staff, and minimizes costs. Special emphasis should be given to ensuring compatibility between policies pertaining to the water and sewer utilities and those of a drainage utility, if one is established.

In some cases, financing methods may necessitate substantial changes in existing practices or systems. For example, use of drainage utility service charges might require that the utility billing system be altered to incorporate the additional billing. An effort should also be made to anticipate opportunities to improve existing systems during a changeover in the drainage program. Development of a master billing file for a utility service charge could provide the mechanism for assembling a parcel-based data system which would have spinoff benefits for land use planning, economic development, and other municipal programs. The incremental cost of generating additional data for management information systems is minimized if it can be piggybacked with the base file work being done for drainage or other related purposes. The City should also consider compatibility with programs in neighboring jurisdictions and special-purpose agencies.

Upkeep Requirements: The financing methods may have differing needs in terms of upkeep. Some require virtually no file or record maintenance, whereas others demand constant updates. Fee systems can be set up in a variety of ways which imply different upkeep procedures. Systems which minimize upkeep costs are desirable, but this must be weighed against both the equity and flexibility considerations.

This criterion is especially important with regard to drainage utility service charges. The upkeep requirements can be controlled through proper design of the data systems and processes that are used in the rate structure and for billing. The best reference, for evaluating the upkeep costs of drainage utility service charge financing options during the finance strategy phase, is the experience of the other cities which have implemented similar systems.

Balance: A financing strategy must be balanced in the terms of dependency placed on any single method of funding, the fit with the drainage program, and the resources of various sectors of the general public. A single source is likely to provide most of the money for annual operating expenses, i.e., either the general fund or a utility service charge. An effort should be made, however, to balance the dominant revenue source with complementary funds for special elements of the program. A municipality can control (to some degree) the balance the dominant revenue source with complementary funds for special elements of the program. A municipality can control (to some degree) the balance of revenue sources to ensure that the financing capacity is hedged against economic downturns and is responsive to economic improvements.

Drainage utility rate structures are relatively inelastic, and more stable than other utility rates that are based on consumption (e.g., water and electricity). Most drainage rates are based on how the use of property effects hydrology and/or water quality (with no charges assessed to unimproved property). These rates do not change in response to the economy. Delinquencies tend to increase during recessions, however, and a drainage utility is not totally immune from a revenue shortfall.

With so much emphasis placed on reconciling the financing strategy with the program strategy, that aspect of balance is usually well-assured initially. Care must be taken that the balance of the financing strategy remains consistent with the various stages in the development of the program, especially in light of the capacity of various financing methods. If the cumulative willingness to pay of the citizens in a neighborhood is fully tapped during the first two years by application of a variety of fees and charges, another element of the financing strategy might later be rejected. Also, no segment of the community should feel that the entire drainage program is being carried solely on their backs.

Timing: This consideration is most important in terms of the time required for implementation, and whether it fits with the desired timing of the program development process. If possible, charges should be initiated during the rainy season, when residents' recognition of drainage problems is highest. Some financing methods are highly dependent on timing for success. For example, special assessment districts should be proposed when the problems are fresh in the residents' minds and not during drought times.

Geographical and Jurisdictional Considerations: Unique geographical conditions should be incorporated into the evaluation, especially when there are numerous drainage basins, as the case in Roma. Over the long-term, demand for drainage services may be similar, but some areas might require replacement of inadequate or failing systems years before others.

Possibly the most important jurisdictional consideration is the difference in service level and design standards between neighboring local governments which share responsibility for drainage basins. The financing options should be evaluated on their suitability for bridging technical differences to support mutually desirable solutions to problems. The priorities which each local jurisdiction place on achieving its standards should also be reconciled with the opportunities afforded by financing options.

7.13 Summation

Experience has shown that implementation of numerous service charges, fees, and taxes cause confusion and misunderstanding in payment and funding allocations. In addition to an administrative fee charge for drainage plans review, a general drainage facilities charge, a base charge for the entire City similar to a utility charge but based upon land use, should be considered to supplement the existing fee structure. This charge would be designed to generate the additional revenue needed for program operations and allow the burden for generating revenue to be distributed equitably among all the citizens of Roma.

The City of Roma needs to review the financing options and adopt a combination that should provide adequate funding for a stormwater management program.

necessary right-of-ways and easements.

As important to the Arroyo Roma improvements, it would be prudent to consider work within the Los Saenz and Arroyo Los Morenos watersheds. Some of the recommended work that lies outside the City's limits and extra territorial jurisdiction will involve cooperation of Starr County. Some of the work within the lower reaches identified in this report in the Arroyo Los Morenos may be coordinated with the County Commissioner responsible for that area, combining the Arroyo Grande (Garceno) and Los Morenos, shown on Figure 5.9 as an alternate route. Appropriate channel alignments must be determined by performing detailed engineering and surveying studies. We anticipate and understand that routing of drainage outfalls from traditional waterways will be a difficult undertaking due to the sometimes unidentified clear waterways. It is important that deliberate and prudent negotiations be initiated with affected land owners to accomplish the goals contained in this report. Any legal opinions and considerations as to land acquisitions and drainage law should be addressed by the City Attorney.

To minimize the increase of future construction costs for drainage related projects, it is essential and imperative for the City, and in cases outside City limits, the County to **place a moratorium and stop any further development** in the identified floodplains and known flooded areas as well as in the vicinity of proposed routes of the improvements in the Arroyo Roma, Los Saenz and Arroyo Los Morenes watersheds. The development of a set of updated drainage ordinances, drainage requirements for development, and flood zone maps would greatly assist the city in reaching these objectives.

Three public meetings were conducted to discuss the study approach, the considered alternatives, and the recommended solutions. These meetings were conducted with the residents of the project area to determine how the most economical solution would impact social and environmental factors. The documentation of the comments of the public meetings included in Appendix B confirms the public consent for construction of flood control alternatives to serve the distressed areas.

9.0 Implementation and Phasing Recommendations

In order to accomplish all the work recommended within this Master Plan, it will be necessary to phase the required work into various sections and phases. Phasing of the projects will be essential given the City's budgetary and land/easement acquisition restrictions. The Arroyo Roma improvements are considered to be of the first priority and should be planned and implemented first since there exists potential danger to property and life due to flash flooding. This is not to say however, that other problem areas need immediate attention as well such as the Los Saenz (Police Station vicinity) problems. We feel that some of the work required to alleviate the flooding potential within the study area will have to be done with the assistance with the Texas Department of Transportation and such work will have to be programed into their budget. In Table 9.1 we have outlined the recommended phasing and scheduling of drainage improvements for all the watersheds contained in this study. Recommended improvements that require assistance from the Texas Department of Transportation (TxDOT) have been included with all other improvements, except culvert pipe required at Los Saenz from Escandon Avenue to 4th Street. These TxDOT improvements will be key essential in the development of the work contained in this report.

Table 9.1
PROJECT IMPLEMENTATION SCHEDULE
ARROYO ROMA

Year	Description of Work	Cost
1998	• Contact the Texas Department of Transportation for work at Arroyo Roma and U.S. 83 • Contract Engineering Services to prepare engineering drawings for all improvements • Contract Surveying Services to prepare land acquisition/easement surveys for proposed improvements	
1999	Obtain/Negotiate Drainage Easements and ROW for Arroyo Roma	
1999	Construction of Arroyo Roma channel improvements from the Rio Grande River to U.S. Highway 83	$424,060
	Construction of culvert improvements by TxDOT on Arroyo Roma at U.S. Highway 83	$314,470
	Subtotal 1999	$941,330
2000	Construction of Box Culvert and wingwalls at Arroyo Roma from U.S. Highway 83 to Bravo Avenue (School Property)	$2,518,100
2001	Construct Box Culvert from Bravo Avenue to Garfield Avenue	$2,990,000
2002	Construct Box Culvert improvements on Arroyo Roma from Garfield Avenue to East Morelos Avenue	$2,945,150
TOTAL		**$9,394,580**

Table 9.2
PROJECT IMPLEMENTATION SCHEDULE
ARROYO LOS MORENOS

Year	Description of Work	Cost
1998	• Contact the Texas Department of Transportation for work at Arroyo Roma, Los Morenos and 4th Street (San Juan Avenue - Los Saenz) • Contract Engineering Services to prepare engineering drawings for all improvements • Contract Surveying Services to prepare land acquisition/easement surveys for proposed improvements	
1999	Obtain/Negotiate Drainage Easements and ROW-for Arroyo Los Morenos	$1,099,800
	Construction of channel improvements for Arroyo Los Morenos from the Rio Grande River to U.S. highway 83	$2,695,550
	Construction of culvert improvements by TxDOT for Arroyo Los Morenos	$318,500
	Subtotal	$4,113,850
2000	Construction of channel improvements at Arroyo Los Morenos from U.S. 83 to Escobar Road	$1,218,126
2002	Construct channel improvements from Escobar Road to Evita Road on Arroyo Los Morenos	$901,550
2003	Construct channel improvements on Arroyo Los Morenos from Evita Road to Efren Ramirez Road	$2,924,090
2004	Construct channel improvements on Arroyo Los Morenos from Efren Ramirez Road to the end of the project	$2,930,460
TOTAL		**$12,088,076**

Table 9.3
PROJECT IMPLEMENTATION SCHEDULE
LOS SAENZ

Year	Description of Work	Cost
1998	Contact the Texas Department of Transportation for work at Arroyo Roma, Los Morenos and 4th Street (San Juan Avenue - Los Saenz) Contract Engineering Services to prepare engineering drawings for all improvements Contract Surveying Services to prepare land acquisition/easement surveys for proposed improvements	
1999	Obtain Drainage Easements and ROW for 4th Street Channel Improvements (Los Saenz) and Channel Downstream of U.S. 83 to Rio Grande River	$115,440
2000	Construction of Channel Improvements for the 4th Street Channel (Los Saenz)	$614,588
2001	Construct Culvert Pipe along north side U.S. 83 from Escandon Ave. (Los Saenz) to 4th Street Culvert at U.S. 83 (by TxDOT)	
Total		**$730,028**

APPENDIX A

List of References

LIST OF REFERENCES

(1) Eagle Point, Watershed Modeling, Third Edition, August 1994.

(2) Soil Conservation Service, U.S. Department of Agricultural, SCS National Engineering Handbook Section 4 Hydrology, August 1972.

(3) State Department of Highways and Public Transportation, State of Texas, Bridge Division, Hydraulic Manual, Third Edition, December 1985, p.2-14 and Table 6.

(4) Linsley, Ray K. Jr, Kohler, Max A., and Paulhaus, Joseph L.H., Hydrology for Engineers, p.228, McGraw-Hill Book Company, 1958.

(5) Texas Department of Community Affairs, City and County Assistance: Texas Community Development Program, Austin, 1987.

(6) Texas Advisory Commission on Intergovernmental Relations: Handbook of Governments in Texas, Austin, 1984.

(7) Harman, Douglas and Diveley, Ann Long, "Fort Worth Improvement District: A First in Texas," Texas Town and City, September 1987.

Appendix B

Minutes from Public Meetings

CITY OF ROMA
PUBLIC HEARING

The Board of Commissioners for the City of Roma conducted a public hearing on May 20, 1998 at 6:00 p.m. at the Roma Community Center.

The purpose of the public hearing was to discuss the ongoing current Drainage Master Plan Study of the Arroyo Roma and Los Morenos Watersheds. The study is being funded by the Texas Water Development Board, the City of Roma and Starr County. The public was invited to offer comments regarding social and environmental effects to the proposed alternate solutions to drainage and flood protection for the City of Roma and Los Morenos watersheds.

Mayor Fernando Peña was absent due to a meeting with Texas Water Development Board in Austin, Texas.

Persons attending the meeting were Commissioner Gabriel E. Recio, Mr. Jorge D. Perez, P.E. from Perez, Freese & Nichols, Mr. Anthony Reid, P.E. from Perez, Freese & Nichols, Mr. Rogelio Salinas, Director of Administration, Ms. Josie Hinojosa, City Secretary, Ms. Norma G. Martinez, Mr. Crisanto Salinas, City Planner, Mr. Jose H. Garcia, Chief of Police, Lieutenant Francisco Garcia,, Sergeant Emilio Montalvo, III., Mr. Joe Medrano, Mr. Salome Barrera, Sr. Mr. Salome Barrera, Sr., Mr. Leonel Gonzalez, Mrs. Rosa Ena Saenz, Mrs. Gloria Castañeda, Mrs. Belsa Alaniz, Mr. Domingo Sifuentes, Mr. Rene Gonzalez, Mr. Alex Gutierrez, Mr. Mario Barrera, Mr. Enrique Barrera, Mr. David Barrera, Mrs. Margarita C. Barrera, Dr. Jesus Menchaca, Mr. Luis O. Garcia, Mr. Manuel Angel Garcia, Mr. Gilberto Treviño, Mrs. Elia G. Lopez, Mr. Andres Olivarez, Mr. Reynaldo Garza and Mr. Eudocio Garza.

Mr. Jorge D. Perez, P.E. from Perez, Freese & Nichols gave a brief presentation on watersheds from Arroyo Roma and Los Morenos. Mr. Perez asked the public attending the meeting if they preferred to have the meeting in Spanish. The meeting, at the petition of the public, was conducted in Spanish. Mr. Perez presented various alternatives on the flooded areas. The following is a summary of the meeting.

1. Brief overview of the project.
   Funding sources.
2. Description of Arroyo Roma Watershed.
   Historical flooding experiences
   Previous projects
   Indiscriminant development on floodplain
   Illustrate current floodplain limits
3. Description of Los Morenos Watershed

4. Design criteria and constraints
   10 Year flood - fully developed or current development levels 100 year?
   If we design for current development limits, can we really expect future developers to provide detention facilities?

   Danger in by - passing watersheds (possible legal ramifications)
5. Design alternatives for Arroyo Roma
   Construct open channel through town
   Construct by pass tunnel north of populated areas
6. Design alternatives for Los Morenos Creek
   Are we following traditional flow directions or diverting flows?
7. Preliminary findings and facility sizing
   Approximate channel sizing

U.S. 83 Bridge at Arroyo Roma
U.S. 83 Bridge at Los Morenos Creek
Easement acquisition

8. Project cost estimates and funding
Future land development ordinances
Formation of drainage district for taxing purposes
drainage assessment on future development in watersheds.
9. Other possible funding sources.
10. Questions & Answers from the public.
11. Next meeting was announced to be approximately 4 weeks after this meeting.

After no further business, public hearing was adjourned.

Fernando Peña, Mayor

ATTEST:

Josie Hinojosa, City Secretary

May 20, 98 6:00 P.M.
Public Hearing
Flood Protection Planning

Salome' Barrera Ph. 849 [illegible] 14
Alben Flores Rd, Box 65-72
Salome Barrera
Obregon Con Mazatlan
Leonel Gonzalez
H.C. 1 Box 57 T
Rio Grande City

Rosa Ema Saenz 849-178[illegible]
Gloria Castaneda 849-2082
Belsa Alanis 849-1185
Domingo Cifuentes 849 1682
[illegible] 849-1348
[illegible] Garcia
[illegible]
[illegible]
Joe Medrano 849-2349
Abel [illegible] 849-1136
[illegible]
[illegible]
Mario Barrera 849-1978
Enrique Barrera
JORGE D. PEREZ Perez/Freese & Nichols 631-4482
J. Anthony Reid Perez/Freese & Nichols 631-4482
David Barrera
Margarita C. Barrera
[illegible] 849-1104
Luis O. Garza 849-0560
Manuel [illegible]
[illegible] Tamayo
Elia P. Lopez
Gabriel E. Recio
Norma Martinez
Rosie Hinojosa

Board of Commissioners:

Fer…do Peña, *Mayor*
Jos… Moraida, *Commissioner*
Gabriel E. Recio, *Commissioner*

CITY OF
ROMA
HISTORICAL CITY BY THE RIO GRANDE

NOTICE OF PUBLIC HEARING
FLOOD PROTECTION PLANNING
TEXAS WATER DEVELOPMENT BOARD

PROJECT NO. 96-483-160
DATE: July 1, 1998
TIME: 6:00 P.M.
LOCATION: ROMA COMMUNITY CENTER

The City of Roma is in the process of completing flood Protection Planning Study for the arroyo Roma and Arroyo Los Morenos watersheds. The study is funded by the City of Roma, Starr County, and the Texas Water Development Board. The study is nearing 50% completion and the comments from the residents of these two watersheds are needed to assist in the determination of the social and environmental factors of the proposed alternative solutions.

Information that will be shared includes:

Description of the proposed alternatives considered for the Arroyo Roma and the Arroyo Los Morenos Watersheds.

Existing and projected population affected by flooding and number of dwellings occupied and number of dwellings to be affected by flooding for possible relocation considerations.

Persons unable to attend the public hearing may submit their views at P.O. Box 947, Roma, Texas 78584. Accommodations for handicapped persons will be available; handicapped persons in need of special assistance for attending the meeting are encouraged to contact Mayor Fernando Peña at (956) 849-1411.

Fernando Peña, Mayor

2nd Public Hearing
Flood Protection Planning
Arroyo Roma-Los Morenos Creek Study
Roma, Texas
July 1, 1998 at 6:00 p.m.

A second Public Hearing was conducted on Wednesday, July 1, 1998 at 6:00 p.m. at the Roma Community Center.

Present were Mayor Fernando Peña, Mr. Rogelio Salinas, Director of Administration, Mr. Crisanto Salinas, Director of Planning, Ms. Josie Hinojosa, City secretary, Mr. Jorge D. Perez, Engineer from Perez Freese & Nichols, Mr. Anthony Reid, Engineer from Perez Freese & Nichols, Mrs. Maria D. Ramirez, Mrs. Rosa M. Ramirez, Mr. Domingo Sifuentes, Mr. Enrique Barrera, MR. Mario Barrera, Mr. David Barrera, Mrs. Norma Martinez, Mr. Ramon Vera, Mr. Gilbert R. Ward from Texas Water Development Board, Mrs. Antonieta Guzman, Mrs. Maria Guadalupe Garza, Mrs. Manuela Lopez, Mrs. Gloria Castañeda and Mrs. Maria dela Luz Garza.

Mrs. Norma Martinez read the public hearing advertisement inviting the general public to attend the public hearing.

Mayor Fernando Peña welcomed all persons attending the meeting and proceeded to introduce Mr. Gilbert R. Ward from Texas Water Development Board, Mr. Jorge D. Perez, Engineer from Perez, Freese & Nichols and Mr. Anthony Reid, Engineer from Perez, Freese & Nichols.

Mr. Jorge Perez Engineer from Perez, Freese & Nichols proceeded with the meeting. Mr. Perez gave an overview of the project showing the sections that are subject to flood.
The following is a list of existing dwellings and population affected by the 100-year flooding:

Watershed:	Dwellings:	Estimated Population:
Arroyo Roma	336	1,513
Rio Grande River	52	234
Los Morenos	1,033	4,650
Flood Special Zone	573	2,580
Total	1,994	8,977

Mr. Perez gave a summary of opinion of probable costs as follows:

Watershed:	Amount:
Arroyo Roma Alternate 1 Earthen Channel Improvements from E. Morelos Ave to U.S. Highway 83 and downstream to River	13,693,048.20
Arroyo Roma Alternate 2 Diversion Tunnel and Channel Improvements Diversion Tunnel Upstream and earthen Channel Improvements	12,538,415.50
Arroyo Roma Alternate 3 Detention Reservoir and Earthen Channel Improvements	18,523,562.81

Watershed:	Amount:
Arroyo Roma Alternate 4 Reinforced Concrete Box Culvert E. Morelos Avenue to U.S. Highway 83	9,236,857.50
Los Saenz Storm Sewer and Channel Improvements	901,485.00
Arroyo Los Morenos-East and west Channel Improvements Arroyo Los Morenos Interceptor Improvements	18,548,400.00

Mr. Perez asked the general public if they have questions.
There were no questions from the public. Mr. Perez stated that they will be available after the meeting for questions and answers. Also, there is a map available to review the flooding areas and the affected persons.

After no further business, public hearing was adjourned at 6:50 p.m.

Fernando Peña, Mayor

ATTEST:

Josie Hinojosa, City Secretary

July 1, 98 6:00 P.M
2nd Public Hearing
Flood Protection Planning

Maria D. Ramirez
Rosa M. Ramirez
Domingo Sifuente
Enrique Barrera
Moilo Barrera
David Barrera
[illegible]
[illegible]
J. Anthony Reid
Jorge D Perez

Gilbert Ward Texas Water Development Board

Norma Martinez
[illegible]
Antonieta Guzman
Maria Guadalupe Garza
Manuela Lopez
Gloria Castañeda
Maria de la Luz Garza Ramirez Garza
Josie Hinojosa

Board of Commissioners:

Fe do Peña, *Mayor*
Jose F. Moraida, *Commissioner*
Gabriel E. Recio, *Commissioner*

CITY OF ROMA
HISTORICAL CITY BY THE RIO GRANDE

NOTICE OF PUBLIC HEARING
FLOOD PROTECTION PLANNING
TEXAS WATER DEVELOPMENT BOARD
PROJECT NO. 96-483-160

DATE:	**Wednesday, November 4, 1998**
TIME:	**6:00 p.m.**
LOCATION:	**Roma Community Center**

The City of Roma will be conducting it's Final Public Meeting on Wednesday, November 4, 1998 to discuss the final draft of the Drainage Master Plan Study of the **ARROYO ROMA** and **LOS MORENOS** Watersheds. The Study is being funded by the Texas Water Development Board , the City of Roma and Starr County. The public is invited to offer comments regarding social and environmental effects of the proposed improvements for flood protection for the City of Roma and the Los Morenos Watersheds.

Information that will be presented includes:

Exhibits showing proposed alignments of the proposed drainage facilities;
Cost estimates for the recommended improvements and;
Proposed phasing of the work required.

Persons unable to attend the public hearing may submit their views at P.O. Box 947, Roma, Texas 78584. Accommodations for handicapped persons will be available; handicapped persons in need of special assistance for attending the meeting are encouraged to contact Mayor Fernando Peña at (956) 849-1411.

Fernando Peña, Mayor

P. O. BOX 947 ROMA, TEXAS 78584-0947 956-849-1411 FAX 956-849-3963

Final Public Hearing
Flood Protection Planning
Arroyo Roma-Los Morenos Creek Study
Roma, Texas
Project No: TWDB 96-483-160
Wednesday, November 4, 1998 at 6:00 P.M.
Roma Community Center

A Final Public Hearing was conducted on Wednesday, November 4, 1998 at 6:00 p.m. at the Roma Community Center with the following to wit:

Fernando Peña, Mayor (present)
Jose F. Moraida, Commissioner (present)
Gabriel E. Recio, Commissioner (present)

Also present were Mr. Jorge D. Perez, P.E. from Perez, Freese & Nichols, Mr. Gilbert R. Ward from Texas Water Development Board, Mr. Rogelio Salinas, Director of Administration, Mr. Crisanto Salinas, Director of Planning, Mr. Jorge L. Muñoz, Public Works Director, Ms. Josie Hinojosa, City Secretary, Mrs. Norma Martinez, Ms. Melva Lopez, Mrs. Belgica B. Muñoz, Mr. Sigifredo Galindo, Mrs. Minerva B. Gonzalez, Mr. Domingo Sifuentes, Mr. Manuel Garcia, Mr. Fernando Lopez, Mrs. Patricia Mendez, Mr. Keith Kindle, Project Manager for the City of Roma, Mrs. Manuela Lopez, Mr. Mario Barrera, Mr. Enrique Barrera, Mr. Manuel Garcia, Mr. Ricardo Peña, Mrs. Diana Peña, Mrs. Lesvia Alvarez, Mr. Jesus E. Alvarez, Mrs. Maribel Moreno, Mrs. Gloria Castañeda, Mrs. Maria Treviño, Mrs. Norma Benavides, Mr. Victor M. Benavides, Mrs. Elia Lopez and Mrs. Norma Garza.

Mrs. Norma Martinez read the Final Public Hearing advertisement inviting the general public to attend the public hearing.

Mayor Fernando Peña welcomed all persons attending the meeting and proceeded to introduce Mr. Gilbert R. Ward from the Texas Water Development Board and Mr. Jorge D. Perez, P.E. from Perez, Freese & Nichols.

Mr. Jorge D. Perez proceeded with the final public hearing and gave an overview of the project as follows:

1. Exhibits showing proposed alignments of the proposed drainage facilities.
2. Cost estimates for the recommended improvements.
3. Proposed phasing of the work required.

After the presentation, Mr. Jorge D. Perez was available to the public for questions.

After no further business, public hearing was adjourned.

Fernando Peña, Mayor

ATTEST:

Josie Hinojosa, City Secretary

Nov. 4, 1998 6:00 p.m.
PUBLIC Hearing (Final)
Flood Protection Planning

Jorge D. Perez — Perez/Freese & Nichols 631-4482
Gilbert Ward — Texas Water Development Bd (512) [illegible]
Velma Lopez — 956-849-[illegible]
[illegible] 849-24-20
[illegible] 849-10-39
[illegible] 849-47-33
Domingo [illegible] 849-16-82
Manuel A. Garcia 849-1782
Fernando Lopez Lopez 847-15-24
Patricia Mendez 849-2988 (max + Josie Gutierrez
[illegible] 418-5011
[illegible]
Manuela Lopez
[illegible]
Maribel Moreno
[illegible]
Gloria Castaneda
Norma A. Fernandez
Norma Martinez
Victor M. Benavides
Elia B. de Lopez
Norma [illegible]
Josie [illegible]
[illegible]
Mario Barrera
Enrique [illegible]
Manuel [illegible]
Ricardo Pena
Diana Pena
Leonila Alvarez
Jesus E. Alvarez
Jorge [illegible]
Gabriel E. Recio

APPENDIX C

Response to Comments From Texas Water Development Board on Draft Final Report

facsimile
TRANSMITTAL

to:	Jorge Perez
Company:	Freese & Nichols
fax #:	956-682-1545
re:	Review comments on Draft Final Report, TWDB Contract #96-483-160
date:	January 12, 1999
pages:	5, including cover sheet

Please see attached.

From the desk of...
Alicia Ramirez
Contract Specialist
Texas Water Development Board
1700 North Congress Avenue
Austin, Texas 78711-3231

(512) 463-8005
Fax: (512) 463-9893

TEXAS WATER DEVELOPMENT BOARD

January 12, 1999

The Honorable Fernando Peña
City of Roma
P.O. Box 947
Roma, Texas 78584-0947

Re: Review Comments for Draft Report Submitted by the City of Roma, entitled "City of Roma, Texas, Master Drainage Plan for Arroyo Roma and Arroyo Los Morenos Watersheds", TWDB Contract No. 96-483-160

Dear Mr. Peña:

Staff members of the Texas Water Development Board have completed a review of the draft report under TWDB Contract No. 96-483-160 and have found that specific tasks of the Scope of Work for this planning study have not been addressed. For those tasks, which were addressed and included in this draft report, Board staff offers comments shown in Attachment 1.

Results of Task Nos. 1D, 3, 6, and 8 have been identified as either nonexistent or incomplete. It will be necessary for the City to address these tasks in draft form to submit to the Board for comments. Please resubmit the draft report (2 copies) with your responses to the attached comments for our review.

The Board looks forward to receiving the draft report on the tasks identified above. Please contact Mr. Gilbert Ward, the Board's Contract Manager, at (512) 463-6418, if you have any questions about the Board's comments.

Sincerely,

Tommy Knowles
Deputy Executive Administrator
for Planning

ATTACHMENT 1
TEXAS WATER DEVELOPMENT BOARD
REVIEW COMMENTS FOR THE CITY OF ROMA
FLOOD PROTECTION PLANNING CONTRACT
CONTRACT NO. 96-483-160

Comments on the Master Drainage Plan:
The report presents hydrologic and hydraulic information on the study area and alternatives to manage storm water runoff and minimize recurrent flooding.

The Texas Water Development Board is allowed to provide loans from the Texas Water Development Funds to political subdivisions and nonprofit water supply corporations for both structural and non-structural projects, and development of floodplain management plans.

Selected alternatives appear feasible in scope and eligible for Board funding. Methodologies employed in the hydrologic and hydraulic analyses appear to be appropriate. The construction cost estimates provided appear reasonable. All engineering, legal, financial and environmental activities associated with the project would also be eligible for financing.

Enabling legislation (Texas Water Code Chapter 17.771-17.776) and Board rules (TAC 363.401-363.404) regarding loans for flood control require that basin-wide planning and considerations of the effect of the proposed project on surface water elevations within the watershed and any downstream watershed accompany applications for funding. If funding for any of the improvements identified in the study is requested from the Texas Water Development Board, all the findings required by statute and the demonstrations required by Board rules must be addressed. Work done in preparation of this flood study will be useful in this endeavor and may be incorporated into an engineering feasibility report that would accompany an application. An environmental assessment that meets the requirements of Chapter 363.14 of Board rules will be required. Flood control applications are not eligible for the Board's pre-design funding option.

Specific comments:

1. The following notes are referenced by a page number which has the format section-page, for example, section 1, page 2 would be page 1-2.

2. Throughout the report, portions of the text do not clearly state what the author intends to convey and/or contain poor grammar. Commas appear excessively and distract the reader rather than aid his understanding. The report needs to be proof read for grammar and spelling.

3. page 3-7: Please put the word "that" between "flows" and "have" on the second full paragraph in section 3.9. Change the word "bee" to "been" in the same sentence.

4. page 4-2: At the bottom of the page, there is a statement that says hydrograph timing to create a peak on peak. What is a peak on peak? Please clarify the statement

5. page 4-5: Second paragraph, third sentence. Change phrase "employed to" to "applied to". Also, in the fifth sentence, the writer says that storage can be done on rooftops. This is wrong. Water storage for detention or retention is never done on rooftops. Structural integrity comes into question. The only rooftop storage for water would be a cistern that is used to capture rain for drinking or watering lawns. Even then, they are fairly small. Please remove this statement from the report.

6. page 4-7: Second full paragraph, first line. The words "containment "and "storage" are redundant. Second sentence needs to have an "an" before the phrase "extended periods of time. Third full paragraph, fourth sentence - "flap gates" should be flap gate (singular).

7. page 4-8: Under the heading Federal Programs, the sentence that begins "The Soil Conservation Service should not be underlined, and the word "has" before the word historically should be removed, or the word " gives" should be "given".

8. page 5-1: What does 185 +/- feet msl mean? +/- what? One foot, two feet? This was done twice in the same section. On page two, they use the abbreviation M.S L. If they are going to use msl (mean sea level), then the abbreviation should be consistent.

9. page 5-2: Second full paragraph. Was the culvert a problem when highway 83 was constructed, or was it a problem after the highway was widened. Please clarify this paragraph. Also, if the TxDoT rainfall frequencies are not appropriate for communities like Roma, then why did they use the TxDoT rainfall frequency equation in Section 3.4 for their frequency calculation? Please explain.

10. page 5-3: In alternative one, they make a statement that Figure 5.2 clearly shows that the land surface slope is steeper than many other streams. First of all, the diagram was done with an exaggerated scale and you can't clearly see anything. There are no other stream slopes provided as comparison, therefore, nothing can be "clearly seen". Please provide a chart for comparison.

11. There is no documentation of consultation with residents of the project area to determine the most economical solution without overriding social or environmental factors, as stipulated in the Scope of Work, Item 3, nor documentation of public consent for construction of flood control alternatives to serve the distressed areas.

12. Scope of Work, Item 6: There is no comprehensive design data, only results. The calculation in this report cannot be verified. Please provide means for verification.

13. Scope of Work, Item 8: A detailed implementation schedule was not included, only brief milestone descriptions. Please include.

14. Scope of Work, Item 1.D.: Existing runoff flows are not included. Please provide.

15. The report does not give sufficient detail as to the computation of flood hydrographs. For instance, although lag time is stated as being 0.6 times the time of concentration (as per Equation 16.9 of the National Engineering Handbook's Section 4), none of the times of concentration are listed for any of the subdrainage areas listed in Table 3.1 of the report.

16. The report indicates that, in computing flood hydrographs for the subdrainage areas, a standard shape factor of 484 is used. However, the National Engineering Handbook states that this factor has been known to vary from 600 in steep terrain to 300 in very flat country. Since the channel slopes given for most of the subdrainage areas listed in Table 3.1 are one percent or less, it is questionable whether the shape factors could be as much as 484. Certainly to uniformly apply 484 to all subdrainage areas could be a mistake, since visual inspection of the subdrainage area bounds shown on the Watershed Key Map shows a wide variety in shape from area ALMb - which is very broad - to areas A10b and A9b which are extremely long and skinny. Please give detailed documentation on how the shape factors were chosen (e.g., did the consultant confer with the local office of National Resource Conservation Service?)

17. Please give detailed documentation on how the CN runoff curve numbers were chosen (e.g., give the data on land use, in tabular and/or map form, for each subdrainage area).

18. The scope of work also calls for run-off characteristics such as high velocity damage in certain areas to be analyzed, but the report does not give a velocity damage analysis as suggested in the scope. Is there a reason that high velocity damage analysis was not performed? The report mentions that "K" value in Muskingum's routing method equation has been approximated by dividing the travel distance by a velocity of 5 feet per second, but does not indicate whether this velocity has been assumed or computed. If this velocity has been computed, the report should indicate by what method (e.g.,TR-20 and HEC runs) and should give computed velocities in all stream reaches. If, however, 5 feet per second has been assumed, the assumption is poor, given the flat terrain. Incidentally, if a velocity of 5 feet per second did occur, then scouring would probably result, as velocities in this range will scour most soils to some degree.

19. The scope of work calls for existing and future development runoff flows to be analyzed; Table 3.4 of the report gives the peak design flows for developed watershed conditions, but the report does not contain an analogous table showing existing conditions flows - which should also be analyzed as specified by the scope of work. Please include the flows table.

Response to Comments from TWDB dated January 12, 1999

The editorial comments contained in comments 1, 2, 3, 5, 6, and 7 have been addressed as appropriate in the text.

Some of the comments are unclear. The comments are stated in such a manner that they appear to be addressed to someone internal to the TWDB. These have been addressed on the assumption that another TWDB staff person choose to furnish them to the consultant.

In general, there appears to be a difference in opinion on the amount of detail on the hydrologic and hydraulic analyses that should be provided in this report. Item 12 of the Scope of Work states "Prepare reports in accordance with Article III Section 4 of this contract." Article III Section 4 reads as follows:

> "The consultant will consider incorporating comments from the EXECUTIVE ADMINISTRATOR and other commentors on the draft final report into a final report. The CONSULTANT will include a copy of the EXECUTIVE ADMINISTRATOR's comments in the final report. The CONSULTANT will submit one (1) unbound camera ready original and nine (9) bound double-sided copies of the final report to the EXECUTIVE ADMINISTRATOR no later than the FINAL REPORT DEADLINE and four (4) bound double-sided copies of the final report to the CHIEF ELECTED OFFICIAL. The CONSULTANT will submit one (1) electronic copy of any computer programs or models and an operations manual developed under the terms of this Contract."

First, the contract does not contain specific language on what is to be included in the final report. If the TWDB wants specific information and a certain level of detail on certain areas, such as the hydrologic and hydraulic analyses included in the report, that should be specified in the detailed Scope of Work. Since that was not done in the existing contract, we would be pleased to provide a fee estimate for these additional services.

We are required to provide one electronic copy of any computer models developed under the terms of the contract. Since the last person identified in the Article III Section 4 prior to this requirement is the CHIEF ELECTED OFFICIAL, we assume this information is to be furnished to the city.

It is our opinion that in the development of a style for a report of this nature, it is most important to primarily consider the end-user, in this case the city officials and citizens of Roma. From the public meetings and discussions with the city officials, their primary concerns are (1) understanding the areas that will be subject to flooding and (2) what the cost will be to improve the problem. Including detailed discussions on all the hydrologic and hydraulic assumptions and analyses does not improve the quality of the answers to their primary concerns. If it is the desire of the TWDB to assure that certain methodologies and assumptions are made in the analyses, then it would be appropriate to define those in the detailed Scope of Work. Since that was not done in the existing contract, we would be pleased to provide a fee estimate for the additional services to provide the analyses using certain methodologies and assumptions specified by the TWDB.

4. Page 4-2: At the bottom of the page, there is a statement that says hydrograph timing to create a peak on peak. What is a peak on peak? Please clarify the statement.

The referenced sentence is making the point that improvements, such as increasing channel efficiencies through straightening or concrete lining, can cause an upstream peak to reach a downstream point more quickly. Potentially, when this peak is combined with the flow from a second watershed, the combined peak could be greater than under natural conditions. Under natural conditions, most of the second peak would have passed the point where the two flows are combined before the upstream peak arrives.

8. Page 5-1: What does 185+/-feet msl mean? +/- what? One foot, two feet? This was done twice in the same section. On page two, they use the abbreviation M.S. L. If they are going to use msl (mean sea level), then the abbreviation should be consistent.

The International Boundary and Water Commission is responsible for determining stage- discharge relationships at points on the Rio Grande. This relationship has not been defined at every point. A current specific relationship was not available at Roma. The water surface elevations for certain flows were estimated from available data. We did not want to imply a high level of accuracy in the water surface elevations levels so the +/- was included.

9. Page 5-2: Second full paragraph. Was the culvert a problem when highway 83 was constructed, or was it a problem after the highway was widened? Please clarify this paragraph. Also, if the TxDOT rainfall frequencies are not appropriate for communities like Roma, then why did they use the TxDOT rainfall frequency equation in Section 3.4 for their frequency calculation? Please explain.

We have not researched the records to determine the condition of the culvert before and after widening. We were concerned with the current condition.

The third sentence states the "**design frequencies**" are lower than what is considered appropriate. The "**rainfall intensities**" discussed in Section 3.4 are not the same thing and are considered appropriate. The tables in Section 3.4 contain a 100-year rainfall intensity which is the design frequency used to evaluate the flooding in Roma.

10. Page5-3: In alternative one, they make a statement that Figure 5.2 clearly shows that the land surface slope is steeper than many other streams. First of all, the diagram was done with an exaggerated scale and you can't clearly see anything. There are no other stream slopes provided as comparison, therefore, nothing can be "clearly seen." Please provide a chart for comparison.

First, the text does not include the statement "**clearly shows**." The text only states that "**As can be seen,....**" The statement was included in an attempt to develop in the reader's mind the concept of steepness to assist in understanding the necessity for the drop structures. A technical discussion on what constitutes a steep slope and a chart of comparison of slopes for streams with which the reader may not be familiar may not materially improve this understanding.

11. There is no documentation of consultation with residents of the project area to determine the most economical solution without overriding social or environmental factors, as stipulated in the Scope of work, Item 3. Nor documentation of public consent for construction of flood control alternatives to serve the distressed areas.

Comments from the three public meetings will be included in the report.

12. Scope of Work, Item 6: There is no comprehensive design data, only results. The calculation in this report cannot be verified. Please provide means for verification.

Scope of Work, Item 6 only concerns the "Comprehensive Hydraulic Design Data to be determined for feasibility of diverting the Arroyo Roma prior to entering the City of Roma." Please see the introductory discussion above on whether there is a contract requirement to include detailed information so that all calculations can be verified.

13. Scope of Work, Item 8: A detailed implementation schedule was not included, only brief milestone descriptions. Please include.

The Scope of Work does include the requirement of providing a detailed implementation schedule for designing, permitting, financing, and construction of the facilities. Until the funding mechanisms are defined, a detailed implementation schedule cannot be established. A generic detailed implementation schedule can be included to provide the reader with a general understanding of the time required concept to completion of construction.

14. Scope of Work, Item 1.D: Existing runoff flows are not included. Please provide.

The primary objective of the Master Drainage Plan was to identify the most cost effective improvements to will significantly reduce the impacts from flooding. This analysis is normally done assuming development in the watershed for a reasonable time in the future.

The SCS has developed a soil classification system that consists of four groups. Group C, which is representative of the Roma area, is described as "clay loams; shallow sandy loam; soils low in organic content; soils usually high in clay." The runoff curve number (CN) for Group C for land use conditions described as"poor conditions; grass cover on 50% or less of the area, is 86. The CN for "row houses, town houses, and residential with lot sizes 1/8 acre or less" is 90. Given the soil conditions and the nature of the development in the Roma area, it our opinion that the existing runoff flows and the future runoff flows will be essential the same. Although this is not standard procedure, we will clarify this conclusion in the report.

15. The report does not give sufficient detail as to the computation of flood hydrographs. For instance, although lag time is stated as being 0.6 times the time of concentration (as per Equation 16.9 of the National Engineering Handbook's Section 4), none of the times of concentration are listed for any of the subdrainage areas listed in Table 3.1 of the report.

Please see the introductory discussion above on whether there is a contract requirement to include detailed information so that all calculations can be verified.

16. The report indicates that, in computing flood hydrographs for the subdrainage areas, a standard shape factor of 484 is used. However, the National Engineering handbook states that this factor has been known to vary from 600 in steep terrain to 300 in very flat country. Since the channel slopes given for most of the subdrainage areas listed in Table 3.1 are one percent or less, it is questionable whether the shape factors could be as much as 484. Certainly to uniformly apply 484 to all subdrainage areas could be a mistake, since visual inspection of the variety in shape from area ALMb - which is very broad to areas A10b and A9b which are extremely long and skinny. Please give detailed documentation on how the shape factors were chosen (e.g., did the consultant confer with the local office of National Resource Conservation Service?)

The 484 is a constant used in the SCS triangular unit hydrograph method and it was adopted for use with the SCS curvilinear unit hydrograph method. The literature does indicate that the constant can be varied from 600 in steep terrain to 300 in very flat swampy country. There are no stream gaging stations in the study area, or in the vicinity of the study area, that would permit computations adjustment of this constant.

17. Please give detailed documentation on how the CN runoff curve numbers were chosen (e.g., give the data on land use, in tabular and/or map form, for each subdrainage area).

The SCS has developed a soil classification system that consists of four groups. Group C, which is representative of the Roma area, is described as "clay loams; shallow sandy loam; soils low in organic content; soils usually high in clay." The runoff curve number (CN) for Group C for land use conditions described as "poor conditions; grass cover on 50% or less of the area", is 86. The CN for "row houses, town houses, and residential with lot sizes 1/8 acre or less" is 90. Given the soil conditions and the nature of the development in the Roma, it our opinion that the existing runoff flows and the future runoff flows will be essential the same.

18. The scope of work also calls for run-off characteristics such as high velocity damage in certain areas to be analyzed, but the report does not give a velocity damage analysis as suggested in the scope. The report mentions that "K" value in Muskingum's routing method equation has been approximated by dividing the travel distance by a velocity of 5 feet per second, but does not indicate whether this velocity has been assumed or computed. If this velocity has been computed, the report should indicate by what method (e.g., TR-20 and HEC runs) and should give computed velocities *in all stream reaches. If, however 5 feet per second has been assumed, the assumption is poor, given the flat terrain. Incidentally, if a velocity of 5 feet per second did occur, then scouring would probably result, as velocities in this range will scour most soils to some degree.*

The average velocity of 5 feet per second is assumed. The HEC-RAS runs for the 100-year storm indicated that the average main channel velocity was 6.36 feet per second and the mean main channel velocity was 6.27 feet per second. We concur that some scouring would occur under these velocities.

19. The scope of work calls for existing and future development runoff flows to be analyzed. Table 3.4 of the report gives the peak design flows for developed water shed conditions, but the report does not contain an analogous table showing existing conditions flows - which should also be analyzed as specified by the scope of work. Please include the flows table.

The SCS has developed a soil classification system that consists of four groups. Group C, which is representative of the Roma area, is described as "clay loams; shallow sandy loam; soils low in organic content; soils usually high in clay." The runoff curve number (CN) for Group C for land use conditions described as"poor conditions; grass cover on 50% or less of the area, is 86. The CN for "row houses, town houses, and residential with lot sizes 1/8 acre or less" is 90. Given the soil conditions and the nature of the development in the Roma, it our opinion that the existing runoff flows and the future runoff flows will be essential the same. We will clarify this conclusion in the report.

PEREZ / FREESE • NICHOLS, L.L.C.

3233 N. McColl Road • McAllen, Texas 78501 • 956/631-4482 • Fax 956/682-1545

March 31, 1999

Mr. Tommy Knowles
Deputy Executive Administrator for Planning
Texas Water Development Board
P.O. Box 13231
Austin, Texas 78711-3231

RE: Flood Protection Planning Contract Between the Texas Water Development Board and the City of Roma, TWDB contract No. 96-483-160

Dear Mr. Knowles:

We are transmitting to you one (1) unbound camera-ready original and nine (9) bound double-sided copies of the Final Master Drainage Plan for the City of Roma as per the Planning Contract. With this notice, we are also transmitting four (4) copies of this Master Plan directly to the City of Roma.

Should you have any questions regarding this Master Plan, please contact me or Jorge D. Perez at 956/631-4482.

Sincerely,

PEREZ/FREESE AND NICHOLS, L.L.C.

T. Anthony Reid, P.E.
Executive Vice President

XC: Fernando Pena, Mayor, City of Roma

Master Drainage Plan

for

Arroyo Roma and
Arroyo Los Morenos Watersheds

City of Roma, Texas

March 24, 1999

STATE OF TEXAS
T. ANTHONY REID
33686
REGISTERED
PROFESSIONAL ENGINEER
3-24-99

Prepared by:

Perez/Freese and Nichols, L.L.C.
3233 North McColl Road
McAllen, Texas 78501

STATE OF TEXAS
JORGE D. PEREZ
34594
REGISTERED
PROFESSIONAL ENGINEER
3/24/99

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Roma, Texas

The Roma vicinity has grown in population and area at a very fast rate over the last 40 years. The increased population growth, together with unplanned development, has caused construction of residences and structures over historical floodways and floodplains of both Arroyo Roma and Arroyo Los Morenos and other tributaries within the study area. Flooding problems experienced in the Los Saenz area described in this study as "Special Flood Prone Areas" may be attributed to poor and/or blocked drainage caused by the construction of U.S. Highway 83 and it's subsequent widenings and improvements in recent years. It is estimated within our study area that approximately 9,000 residents may be affected by the 100-Year flood event caused by Arroyo Roma, Los Morenos, "Special Flood Prone Areas" and backwater from the Rio Grande River to varying degrees of damage. Based on historical and engineering evidence, and after reviewing this study, it can be seen that the potential 100-Year flood can be catastrophic in terms of life, health and property damage. The probability of the 100-Year event occurring simultaneously in the Arroyos Roma, Los Morenos and the Rio Grande River are considered to be of low probability. It is more likely that flooding may be experienced more frequently from the Arroyo Roma and Los Morenos. The cost to property damage associated with the 100-Year flood could easily reach the millions of dollars and could, additionally cause damages to the City's infrastructure; water treatment, wastewater treatment and collection, roads and bridges, etc.

This conceptual Master Drainage Plan has identified flood prone areas and has offered alternatives to help solve the potential for flood damage to the Roma Vicinity caused by Arroyo Roma and Arroyo Los Morenos as well as the Rio Grande River. This report has studied and analyzed five alternatives for flood control of the Arroyo Roma Floodplain, two alternatives for the Arroyo Los Morenos Floodplain, and one alternative for the Los Saenz "Special Flood Prone Area."

Summary of Alternatives

Arroyo Roma Watershed	
Alternative	**Cost**
Alternate No. 1 Construct earthen channel from the Rio Grande River to East Morelos Avenue with Reinforced Drop Structures	$12,546,690
Alternate No. 2 Construct Diversion Tunnel prior to East Morelos Avenue, and construction of smaller earthen channel and drop structures downstream to the Rio Grande River	$10,735,530
Alternate No. 3 Construct Detention Reservoir upstream of East Morelos Avenue and a smaller earthen channel and drop structures downstream to the Rio Grande River	$14,268,826
Alternate No. 4 **Construct a reinforced box culvert from East Morelos Avenue downstream to Madrigal Avenue, then an earthen channel downstream to the Rio Grande River**	***$9,394,580**
Alternate No. 5 Purchase homes and dwellings along entire 100-year flood plain along Arroyo Roma from East Morelos Avenue to Madrigal Avenue	$15,358,200
Arroyo Los Morenos Watershed	
Alternative	**Cost**
Alternate No. 1 Construct earthen channel diversions prior to populated areas and divert water westerly through the Los Saenz vicinity then southerly to the Rio Grande River and easterly to the traditional Los Morenos Arroyo, then to the Rio Grande River	$12,164,724
Alternate No. 2 **Construct earthen channel diversion from westerly contributing creeks to the Arroyo Los Morenos traditional floodway, then southerly to the Rio Grande River**	***$12,088,076**
Los Saenz (Special Flood Hazzard Areas)	
Construct reinforced concrete culvert pipe along north side of U.S. Highway 83 and construct new culvert under U.S. 83, and discharge to a proposed earthen channel, then flowing to the Rio Grande River	***$730,028**

* Recommended Alternatives

The least costly alternative for the Arroyo Roma floodway is recommended to include construction of 2-8'x11' reinforced concrete box culverts from East Morelos Avenue to U.S. Highway 83 and an open earthen channel downstream to the Rio Grande River. The estimated cost of these improvements, including channelization downstream of U.S. Highway 83 is $9.4 Million. The least costly alternative for the Arroyo Los Morenos floodway is $12.1 Million. This work would include earthen channelization of Arroyo Los Morenos with bottom widths ranging from 30 feet to 115 feet downstream of U.S. Highway 83. The Los Saenz least costly alternative is estimated to be $0.7 Million. The opinion of probable total costs for all improvements is **$22.2 Million**.

Included in the report is a suggested "Project Implementation Schedule" that breaks down the proposed recommended improvements of three separate watersheds into phases programed to be completed in the year 2004. The yearly expenditures average $3.7Million.

PROJECT IMPLEMENTATION SCHEDULE

ARROYO ROMA

Year	Description of Work	Cost
1998	• Contact the Texas Department of Transportation for work at Arroyo Roma and U.S. 83 • Contract Engineering Services to prepare engineering drawings for all improvements • Contract Surveying Services to prepare land acquisition/easement surveys for proposed improvements	
1999	Obtain/Negotiate Drainage Easements and ROW for Arroyo Roma	
1999	Construction of Arroyo Roma channel improvements from the Rio Grande River to U.S. Highway 83	$424,060
	Construction of culvert improvements by TxDot on Arroyo Roma at U.S. Highway 83	$314,470
	Subtotal 1999	$941,330
2000	Construction of Box Culvert and wingwalls at Arroyo Roma from U.S. Highway 83 to Bravo Avenue (School Property)	$2,518,100
2001	Construct Box Culvert from Bravo Avenue to Garfield Avenue	$2,990,000
2002	Construct Box Culvert improvements on Arroyo Roma from Garfield Avenue to East Morelos Avenue	$2,945,150
TOTAL		**$9,394,580**

PROJECT IMPLEMENTATION SCHEDULE
ARROYO LOS MORENOS

Year	Description of Work	Cost
1998	• Contact the Texas Department of Transportation for work at Arroyo Roma, Los Morenos and 4th Street (San Juan Avenue - Los Saenz) • Contract Engineering Services to prepare engineering drawings for all improvements • Contract Surveying Services to prepare land acquisition/easement surveys for proposed improvements	
1999	Obtain/Negotiate Drainage Easements and ROW for Arroyo Los Morenos	$1,099,800
	Construction of channel improvements for Arroyo Los Morenos from the Rio Grande River to U.S. highway 83	$2,695,550
	Construction of culvert improvements by TxDot for Arroyo Los Morenos	$318,500
	Subtotal	$4,113,850
2000	Construction of channel improvements at Arroyo Los Morenos from U.S. 83 to Escobar Road	$1,218,126
2002	Construct channel improvements from Escobar Road to Evita Road on Arroyo Los Morenos	$901,550
2003	Construct channel improvements on Arroyo Los Morenos from Evita Road to Efren Ramirez Road	$2,924,090
2004	Construct channel improvements on Arroyo Los Morenos from Efren Ramirez Road to the end of the project	$2,930,460
TOTAL		**$12,088,076**

PROJECT IMPLEMENTATION SCHEDULE
LOS SAENZ

Year	Description of Work	Cost
1998	Contact the Texas Department of Transportation for work at Arroyo Roma, Los Morenos and 4th Street (San Juan Avenue - Los Saenz) Contract Engineering Services to prepare engineering drawings for all improvements Contract Surveying Services to prepare land acquisition/easement surveys for proposed improvements	
1999	Obtain Drainage Easements and ROW for 4th Street Channel Improvements (Los Saenz) and Channel Downstream of U.S. 83 to Rio Grande River	$115,440
2000	Construction of Channel Improvements for the 4th Street Channel (Los Saenz)	$614,588
2001	Construct Culvert Pipe along north side U.S. 83 from Escandon Ave. (Los Saenz) to 4th Street Culvert at U.S. 83 (by TxDot)	
Total		**$730,028**

We acknowledge that construction of the proposed improvements will not be inexpensive. This report has listed several options for paying for the proposed improvements, including collection of revenues for construction from new development, grants, loans, force account work and drainage district tax revenues.

In order to stop further expenditures, it is recommended that the City of Roma and Strarr County limit construction within the identified floodways, floodplains and otherwise historical floodways either shown and contained in this report or not, until this Master Plan is incorporated into the City and County's ordinances and regulations. Limited development in hardship cases could be allowed only if detailed engineering studies show no additional future costs to the already programmed drainage improvements or that such improvements cause no significant impact to flooding (as defined by FEMA's regulations and guidelines). In these special cases, again only after engineering studies have satisfied no- impact, it is recommended that developers convey all necessary drainage easements and install all necessary drainage infrastructures within the limits of their subdivisions at the developer's expense and escrow monies for future construction deemed part of the Master Plan. In other areas within the watersheds and not mentioned in this study, care should be taken in allowing development without requiring a detailed engineering drainage analysis.

Master Drainage Plan for
Arroyo Roma and Arroyo Los Morenos Watersheds
City of Roma, Texas

1.0 Introduction

1.1 Basic Philosophy

Urbanizing (developing) watersheds contribute to downstream stormwater runoff problems because of the cumulative effects. In many cases, land development in upstream areas has occurred with little or no regard to the consequences to downstream areas. This is especially true in the Roma vicinity since portions of floodways and floodplains have been built-up without proper compensation of adverse effects downstream.

Local governments are autonomous entities primarily concerned with land use and stormwater runoff within their own boundaries. There are exceptions where municipalities receive water or sanitary sewer services from outside areas. Sometimes conflicts have arisen among adjoining communities, particularly over land use issues and its effect on the management of stormwater runoff. This situation has clearly occurred in the Roma vicinity since the majority of contributing watersheds of the Arroyo Roma and Los Morenos lie outside the City's jurisdiction.

The basic philosophy on the need for watershed management within urban areas has, over the past several decades, changed dramatically. Nationwide experience with the effects of inadequate past practices indicates that stormwater has not always been well managed. This experience has led to a major redirection in the way many communities perceive urban drainage and attempt to deal with it effectively.

The City of Roma has recognized the importance of addressing stormwater management and contracted with Perez/Freese and Nichols, L.L.C., in January 1998 to develop a **Master Drainage Plan for Arroyo Roma and Arroyo Los Morenos Watersheds** for the City and its surrounding areas. The study is funded in part through the Texas Water Development Board Flood Protection Planning Study, contract No. 96-483-160, the City of Roma and Starr County.

The basic scope of work is as follows:

A. An analysis and explanation of the problems and needs within the City area and the total planning area within the study limits:

   1. Description of the efforts that the City and resident have taken to provide necessary adequate facilities.

   2. Existing and projected population affected by flooding to be determined.

   3. Existing drainage facilities, storm sewer culverts, and channels to be analyzed for capacity & improvements determined.

   4 Existing and projected run-off flows and future development run-off flows to be analyzed hydraulically.

   5 Run-off characteristics such as high velocity damage in certain areas to be analyzed and resolution considered;

B. The identification, selection, and evaluation of alternatives, of not more than three, including preparation of a cost-effective analysis of the alternatives for providing adequate drainage in the City. The alternative evaluation will also consider facilities which will allow for greatest utilization of local labor during facility construction, operation and maintenance;

C. Documentation and Consultant with residents of the Project areas to determine the most economic solution without overriding social or environmental factors. Documentation of public consent for the construction of Flood Control to serve the distressed area;

D. Documentation and mapping of the number of dwellings occupied and number of dwellings to be affected by flooding for possible relocation consideration within the planning area.

E. A description of the proposed options, including an identification of any existing facilities to be acquired, replaced, enlarged, or improved;3

F. Comprehensive Engineering Hydraulic Design Data to be determined for feasibility of diverting the Arroyo Roma prior to entering the City of Roma;

G. Detailed Construction Cost Estimates for each segment of construction, estimates of the operation and maintenance costs for the recommended facilities. Separate costs for the dwelling relocation assistance, if any required.

H. Detailed implementation schedule for designing, permitting, financing, and constructing the facilities, and for any other major milestones. If the project is to be phased, major milestones, costs and descriptions of each component and segment of the project shall be provided;

I. A determination of the amount of funds available from federal, state, local and private organizations for plans and specifications, project construction, and operation of the recommended facilities;

J. Provide the City of Roma a monthly progress report on the first Thursday of each month;

K. Details or draft of any proposed interlocal agreement or other agreements or contracts needed to implement the project;

L. Prepare final report.

Stormwater is a difficult resource to manage primarily because drainage systems are constantly in a state of change. Even a natural drainage system is not static: streams meander, banks erode and lakes are filled by sediment after each rainfall. Urbanization and development compounds this problem because it increases the rate and quantity of runoff, and urban runoff is often polluted with chemicals and litter that is carried into the rivers and lakes. It is important to keep in mind that all development increases the stormwater runoff and contributes to the problems.

The combination of increased runoff, erosion and excess sediment and pollution threatens public safety and real properties and damages the habitat of plants and animals dependent on the streams.

A generally accepted concept is that real property within a city should contribute to the remedy of the problem caused by increased stormwater runoff. Two important principles underlie this stormwater management concept:

- First, that all real property within a city will be benefitted by the installation of an adequate storm drainage system;
- Second, that the cost of installing an adequate drainage system should therefore be assessed against the real property in a city.

These two principles are not easy for property owners to understand at first view, but they are the keys to an effective stormwater management effort. A property owner may not have a problem immediately on his property, but he contributes a proportionate share to problems downstream. A unified and safe drainage system is the benefit of the basin as a whole. Each property individual should contribute to the improvements necessary to solve the problem.

The problems that exist today will not go away, and the longer they are put off the more costly they will become to solve. Through advance planning, there will be fewer facilities and they will be larger and more strategically placed to minimize long-term maintenance costs and can be multipurpose in use (for open space, parks and recreation as well as for drainage).

Recognition that stormwater management includes much more than just flood control is important. Keeping streets open to emergency vehicle traffic, maintaining ponds and open channels so they do not become health and safety hazards, and promoting the use of drainage facilities for recreational purposes, all contribute to enhancing and maintaining the high and healthy quality of life for the entire community.

1.2 Statement of the Problem

The City of Roma, like many other cities, has reached a point of critical crises related to management of stormwater runoff from the watershed. A number of factors and conditions have merged together to pose a major challenge to the City. The growth and development of the community are manifested in a long-term, often subtle, and pervasive change in the City's drainage systems. Symptoms of the changes are evident in drainage system failures, localized flooding and escalating costs of control. Unfortunately, there is no single cause or simple cure for the problems of stormwater management.

We must ask; what are the factors which combine to make urban stormwater management a major challenge in Roma? They are a diverse group of problems, circumstances, and conditions. When considered separately, they do not fully indicate the seriousness of the situation. The seriousness is apparent, however, when they are considered together. The four most prominent factors in the present problems are changes in hydrology, resource conflicts, surrounding jurisdictions, and economics.

Changes in Hydrology: As the City has grown, impervious surfaces such as rooftops and pavements have covered over soils which were relatively pervious. An increasing proportion of the precipitation which had previously filtered through the soil to the groundwater has been repelled. Instead, it is diverted by roofs, streets and parking lots to channels and culverts, and carried to receiving streams in the most efficient manner, i.e., as quickly as possible in the smallest facility considered being adequate.

Although Roma may have some natural and manmade stormwater detention or retention facilities on developed sites and upper reaches of the watersheds, these systems are not coordinated to mitigate major storms. In many cases, the stock ponds used for agricultural uses are of unknown design parameters; as to whether they can withstand high amounts of rainfall, and can the dams resist flash flooding. The overall impact of urban development will result in large increases in runoff from smaller, more frequent storms which may not be effectively controlled by on-site detention systems designed for more severe events. The change in hydrology is a basic condition which must be recognized. The clearing of land, even for agricultural and cattle grazing use in the upper reaches can have adverse effects downstream.

Resource Conflicts: Urban levels of development are rarely achieved without conflicts in the use of the natural resources, especially when stormwaters impede potential uses of the land. Unfortunately, land development in general has not typically been achieved by solving the drainage problems. More often the symptoms, like flooding, have merely been moved to another location and passed on to the neighbor next door, or the neighbor downstream.

Urban runoff is a unique by-product of land development. The quantity and quality of stormwater runoff in Roma may pose major problems for the community in general. As new growth occurs in the area, resolution of short-term resource conflicts related to drainage control should be made with a better vision of long-term needs and impacts. The alternative consequence is that economic and social costs will continue to mount in the form of repetitive stormwater management problems.

Surrounding Jurisdictions: Stormwater runoff does not recognize established jurisdiction lines and close coordination with Starr County is essential for a successful master plan. The concept of a stormwater management in a watershed is not a new one. A coordinated effort can assist with the management of land within a watershed to enhance the well-being and quality of life of citizens within the watershed. Once a decision is reached to consider a coordinated watershed program, public meetings can be convened to help promote the need for comprehensive stormwater management planning and subsequent implementation. Ultimately, a regional stormwater management district may have to be considered given the difficulty for individual units of City government to act on development controls that aid in the stormwater management outside of it's borders and jurisdiction. Hence, a regional entity is often needed to implement, regulate and enforce a comprehensive stormwater management plan.

Economics: The problems cited above, which are primarily physical and structural, are compounded by economic factors which make solutions more difficult to achieve. Texas cities are in a period of a serious revenue shortfall in which programs of long-standing are being closely scrutinized, trimmed, and sometimes eliminated. This overriding revenue crunch further exaggerates what has always been a major obstacle to effective stormwater control: the lack of stable and adequate local financing upon which long-range programs can be based.

Lurking behind the immediate economic problems of local governments is an even more imposing potential problem. Existing infrastructure improvements of all types in the United States, both public and private, are collectively growing old and wearing out. Many will have to be rebuilt or they will fall apart within our lifetimes.

Regardless of what level of government will be responsible for rebuilding public systems, it will meet intense competition for limited capital resources to finance the reconstruction. Private industry faces many similar reinvestment needs, and many other costs of government are also rapidly rising.

The demand for financing to rebuild large public and private systems will likely keep the cost of money, in terms of interest rates, high throughout the next two decades. Even if federal policies regarding growth of the money supply change and interest rates remain somewhat low, it is likely that prices will inflate again. Inflation in the construction industry has historically been higher than average price inflation, driving the costs of public capital improvement projects up rapidly. This economic "Catch-22" may be the most serious of all the problems that Roma's drainage program must face.

Summation: The previously discussed factors create potentially serious situations as each drainage problem is compounded by the effect induced by changes in the other factors. This situation indicated the need to consider a comprehensive, balanced, and consolidated a stormwater management program through tough, enforceable ordinances and fiscal regulations imposed on any new development within the City's and County's jurisdiction.

2.0 Explanation of the Problems and Needs

2.1 Description of Known Flooded Areas

2.1.1 Arroyo Roma

Over the past 30 to 40 years, flash flooding has increasingly been prevalent in the Arroyo Roma area where school buildings and homes along its path and floodplain have experienced flood water damage. Before 1950, the floodways were mainly open natural wooded areas, some dedicated to grazing and other agricultural uses. Since that time, structures have been constructed within known flood plains and historic waterways and this situation has contributed to more frequent flood damage. During the past 15 years, Roma and it's study areas have experienced high rates of growth. Previous agricultural and open land has urbanized with little or no provisions for drainage and flood management. Subdivisions have developed over known waterways and floodplains, often blocking, diverting or hindering flow. This situation has significantly contributed to increased flood frequency for homes and structures along the Arroyo Roma, even for low frequency storms. Given the steep slopes of the upper reaches of the arroyos, flooding in the watersheds occur as flash floods, often with little or no warning. Over the recent past, loss of property and life have been reported in Arroyo Roma. Widespread flooding occurs in the populated areas of the city, from East Morelos Ave. downstream to U.S. Highway 83. The City of Roma has instituted a warning system to notify residents of low-lying areas of potential flooding. Warning signage is also posted warning of "Potential Flood Hazard Areas"

2.1.2 Arroyo Los Morenos

In the case of the Arroyo Los Morenos watershed, the lack of clear and concentrated waterways in the lower reaches means that flooding occurs as "sheet flow" over widely-spread developed areas. The upper reaches of the watershed are mainly open and used for agricultural purposes. Numerous livestock watering ponds line some of the arroyo's tributaries. Potentially, these ponds, during periods of high rainfall may breech, causing a catastrophic situation for residents downstream. Over the years, development of subdivisions, construction of roadways such as U.S. Highway 83, and other improvements have aggravated flooding by elimination and damming paths for flood water flows. Similar to the Arroyo Roma watershed, homes and other buildings have been constructed over water ways and flood plains. Barrier walls, earthen levees and other diversions have been constructed in the areas north and south of U.S. Highway 83, potentially causing additional localized flooding. Areas identified as flood-prone (under existing conditions) are shown in Exhibit 2.1. Areas north of U.S. Highway 83 in the Los Saenz vicinity have been designated in this study as ***"Special Flood Prone Areas"*** which are caused by the lack of an adequate outlet of storm water. This localized flooding situation has been aggravated by "dam-like" roadway construction of U.S. Highway 83. Flooding in these identified "Special Flood Prone Areas" has been observed in close proximity to U.S. Highway 83, behind the Police Service Building in Los Saenz, and flooding has been reported to depths of 3-4 feet, according to anecdotal information.

2.1.3 Rio Grande River

As within the Arroyo Roma and Los Morenos watersheds and floodways, homes and businesses have been constructed within the 100-year flood plain of the Rio Grande River (as delineated in current FEMA Flood Insurance Maps). Some base information for the Rio Grande River has been obtained from the International Boundary and Water Commission which show a 100-year base flood elevation of approximately 185 feet above Mean Sea Level. Data in the Roma gaging station from the IBWC is sparse especially since the construction of Falcon Dam approximately 15-20 miles upstream. According to IBWC officials, flood studies of the Rio Grande in the Roma area have not been conducted by the Commission. Anecdotal evidence however, indicates serious flooding along the Rio Grande's flood plain during Hurricane Bulah (1967). (This flood event has been estimated to be a 100-year event, occurring **after** the construction of Falcon Dam in 1953.)

Drainage Master Planning of the Roma vicinity should include the Rio Grande River's floodplain limits and backwaters. In addition to City and County regulations and ordinances that may result from suggestions of this Master Plan, regulations of Federal Agencies such as the U.S. Army Corps of Engineers, U.S. Coast Guard and the International Boundary and Water Commission are already in force and must be considered in any future development along the river and its backwater. Until further studies are conducted of the Rio Grande, the existing FEMA flood, prone maps should be used.

2.2 Description of Existing Storm Drainage Facilities

The majority of drainage facilities and improvements within the study limits have been concentrated in the Arroyo Roma watershed and have been constructed since 1965. These improvements have been financed mainly by State Grants with Local matching funds. Existing drainage improvements to Arroyo Roma from E. Morelos Avenue to U.S. Highway 83 were constructed in 1992 and include street improvements to Bethel Street upstream of the Roma School property and the installation of curb-type inlets to capture storm waters from north of East Morelos Ave., then flowing through a 48" diameter reinforced concrete pipe downstream to Bravo Avenue. From Bravo Avenue, the storm waters flow into a 4'x8' reinforced concrete box culvert downstream along Madrigal Street to Harrison Alley where it discharges into an improved earthen channel. The channel discharges into an existing 4 barrel 8'x11' reinforced concrete bridge at U.S. Highway 83. From that point, waters flow through natural channels and floodways to the Rio Grande. The design frequency for the improvements upstream of U.S. Highway 83 to East Morelos Avenue is seven (7) years, according to the Design Engineer for those projects.

Other drainage improvements include various box culverts and "equalizer" culvert pipes under U.S. Highway 83 constructed by the Texas Department of Transportation (TxDOT) in connection with roadway construction. Additionally, 2-24" drainage pipes downstream of an existing 2'x4' reinforced concrete box culvert on U.S. Highway 83 and Sixth Street have been installed by the City of Roma. These pipes discharge into an open earthen channel alongside of the Roma Community Center, the Wastewater Treatment Plant, then the Rio Grande River.

2.3 Existing and Projected Population Affected by Flooding

The 100-Year flood plain limits shown in this report is based on the existing development conditions, then using aerial photography taken in 1993 by the Texas Department of Transportation, overlays of the flood plains were made to estimate the existing number of dwellings affected by flooding. The estimated population was calculated assuming 4.5 persons per dwelling. Table 2.1 shows the approximate number of affected dwellings and buildings that currently exist. Population projections from 1993 to 1998 were estimated by counting the number of vacant lots still remaining in flood plains and estimating the percentage of those lots that would have been developed using Texas Water Development Board population projection rates of 1.57% per year. The estimated number of lots assumed to be developed between 1993 and 1998 was then multiplied by 4.5 persons per lot, and that population figure was then added to the 1993 estimates. The City of Roma is currently enforcing FEMA's **Flood Plain Development Standards** within their City Limits. Some of the areas in our study area are outside the City's jurisdiction, but we expect that either the City of Roma or Starr County (also a member of FEMA's program), will prudently enforce the regulations to prohibit further development in flood plains in the future thereby eliminating any population growth within the existing floodplains.

2.4 Location of Dwellings Affected by Flooding

The number of dwellings affected by flooding is shown in Table 2.1. Existing 100-Year flood conditions were used to determine the limits of the flood plains and the number of dwellings and buildings were estimated from the 1993 aerial photo obtained from the Texas Department of Transportation. As with the current population estimates, a 1.57% per year increase was made to the 1993 count in order to estimate the current number of dwellings. The severity of flooding for each dwelling will increase to its proximity to the low point of the floodway. Base maps obtained from the U.S. Geological Survey have been used to delineate the flood plains. Dwellings and other buildings are shown on these maps, but these maps are not up to date and were prepared in 1965.

Table 2.1

Existing Dwellings and Population Affected by the 100-Year Flooding

Watershed	Sub-Watershed	No. of Dwellings (1993)	No. of Dwellings *(Current)	No. of School Buildings	Est. Population (1993)	Est. Population *(Current)
Arroyo Roma						
(AR)	Arroyo Roma b	302	321	22	1,359	1,446
	Arroyo Roma c	14	15		63	67
Subtotal		316	336	22	1422	1,513
Rio Grande						
River	A7	0	0		0	0
	A8b	27	28		121.5	129
	A9c	8	9		36.0	38
	A10d	3	3		13.5	14
	A11d	11	12		49.5	53
Subtotal		49	52		220.5	234
Los Morenos						
(ALM)	ALMb	325	345		1,462.5	1,556
	ALMc	646	688		2,907.0	2,094
Subtotal		971	1,033		4,369.5	4,650
Flood Special						
Zone	A8a	98	104		441.0	469
	A9b	87	92		378.0	402
	A10c	204	217		918.0	977
	A11c	133	141		598.5	636
	ALMb	20	20		90.0	96
Subtotal		539	573		2,425.5	2,580
TOTAL		**1,875**	**1,944**	**22**	**8,437.5**	**8,977**

** Number of existing dwellings/population were estimated from a 1993 aerial photo, and projected at the rate of 1.57% per year according to the Texas Water Development Board population projections for the City of Roma, Texas updated 5/20/98 by J. Hoffmann.*

3.0 Development of Design Peak Flows

3.1 Study Area

The limits of the study area are illustrated on Figure 3.1. The Arroyo Roma study area extends from approximately two miles north of the City of Roma, through the city, to the Rio Grande River. The contributing drainage area is 2,730 acres. The Arroyo Los Morenos study area extends from approximately 0.8 miles north of U.S. Highway 83, through the developed area, to the Rio Grande. Its drainage area is 4,850 acres . A portion of the communities of Los Saenz and Escobares are located in the Arroyo Los Morenos watershed portion of the study area. The combined study areas represent approximately seven square miles of Starr County (4,500 acres). The flooding in the study area is affected by the type of development and general land uses in the watershed that extend north of the study area as illustrated on Figure 3.1.

The Scope of work included the analysis of both existing and future watershed conditions. The presently developed and future developed areas only represent a small portion of the total watershed areas. Also, the existing random urban development pattern will be filled and the impacts on the difference between the existing and future development conditions will be quite small. For these reasons, only one analysis was completed for this conceptual Master Plan Development

3.3 Contributing Drainage Areas

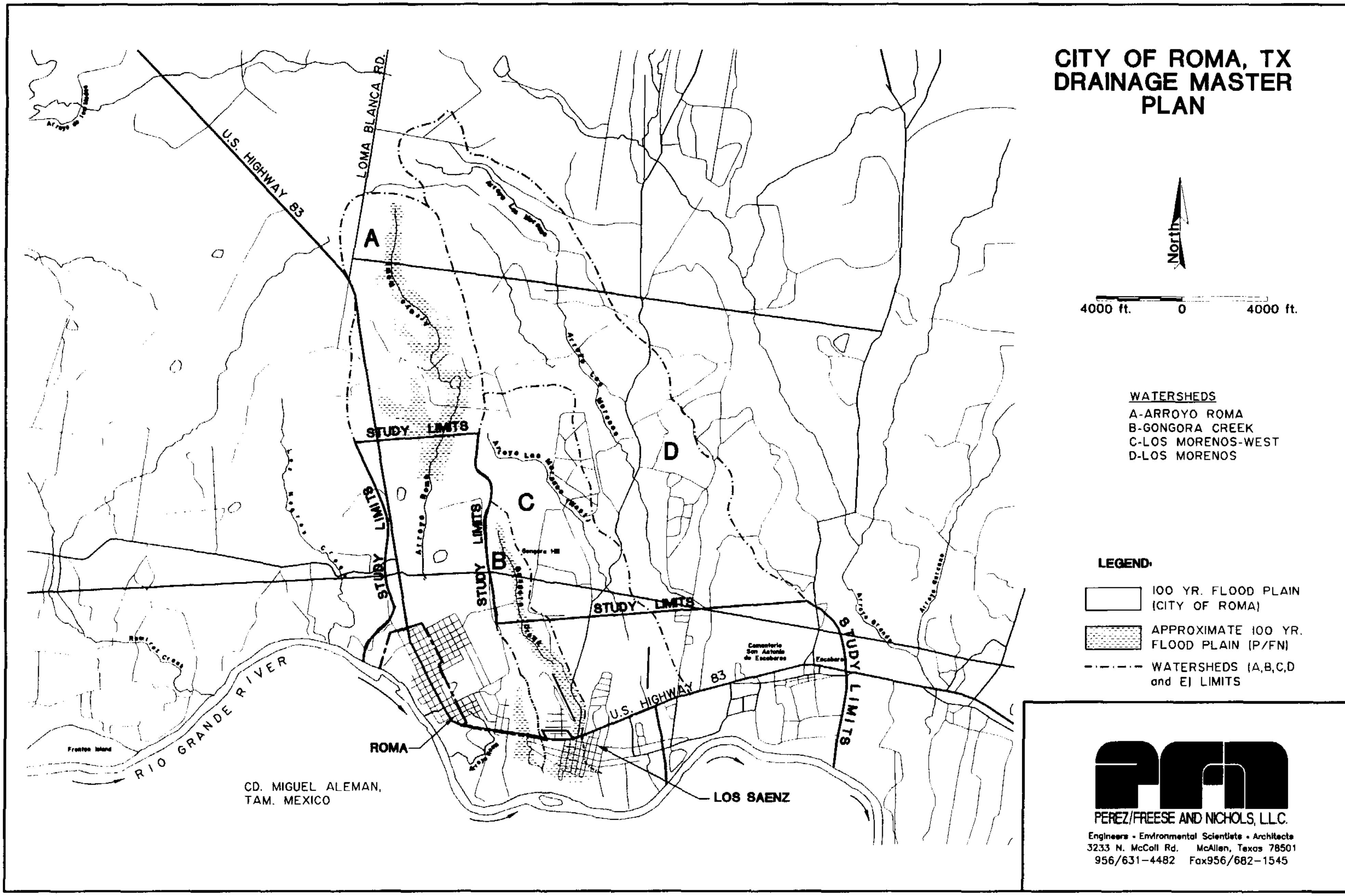
The City of Roma is located in a hilly portion of western Starr County on the northern bank of the Rio Grande across the river from Ciudad Miguel Aleman, Tamaulipas, Mexico. The City of Roma has developed along both sides of U.S. Highway 83 as illustrated on Figure 3.2. The limits of the principal drainage areas that cross the study area are defined on Figure 3.2. The two largest drainage areas are Arroyo Roma and Arroyo Los Morenos.

In each of these cases, the streams drain a relatively steep hilly area. When the streams arrive near the Rio Grande, they transition onto a fairly flat area, which is primarily the overbank floodplain of the Rio Grande. U.S. Highway 83 was constructed through this relatively flat floodplain area on an elevated fill. This fill acts as a dam and barrier to natural drainage paths. A series of culverts were constructed under U.S. Highway 83 to allow passage or equalization of stormwater from the north to reach the Rio Grande River. The conformation of the adequacy of these culverts to handle the flood flows will be an important element in the development of the Master Drainage Plan.

The drainage areas have been subdivided into smaller sections to permit a more detailed accounting of the watershed characteristics and to help for a better definition of the design flows where proposed improvements are anticipated. The physical characteristics of each contributing subdrainage area, as determined from the available U.S.G.S. Topographic Maps, are summarized in Table 3.1.

3.3 Storm Runoff Computations

Using standard engineering empirical design procedures, stormwater discharges produced by watersheds 200 acres or larger should be computed using a unit hydrograph method. Some of the watersheds listed in Table 3.1 have watershed areas less than 200 acres. The unit hydrograph method can be used for watershed with areas less than 200 acres, and this approach has been adopted for use in this analysis for consistency. There are two acceptable unit hydrograph methods for drainage system design in the City of Roma: *Snyder's Unit Hydrograph Method* and the *Soil Conservation Service Unit Hydrograph Method* (SCS Method). For this study, each contributing



CITY OF ROMA, TX
DRAINAGE MASTER
PLAN
North
4000 ft.
0
4000 ft.
WATERSHEDS
A-ARROYO ROMA
B-GONGORA CREEK
C-LOS MORENOS-WEST
D-LOS MORENOS
LEGEND:
100 YR. FLOOD PLAIN (CITY OF ROMA)
APPROXIMATE 100 YR. FLOOD PLAIN (P/FN)
WATERSHEDS (A,B,C,D and E) LIMITS
PEREZ/FREESE AND NICHOLS, L.L.C.
Engineers • Environmental Scientists • Architects
3233 N. McColl Rd. McAllen, Texas 78501
956/631-4482 Fax956/682-1545
U.S. HIGHWAY 83
LOMA BLANCA RD.
A
B
C
D
STUDY LIMITS
STUDY LIMITS
STUDY LIMITS
STUDY LIMITS
STUDY LIMITS
RIO GRANDE RIVER
ROMA
LOS SAENZ
CD. MIGUEL ALEMAN, TAM. MEXICO
U.S. HIGHWAY 83

Figure 3.1

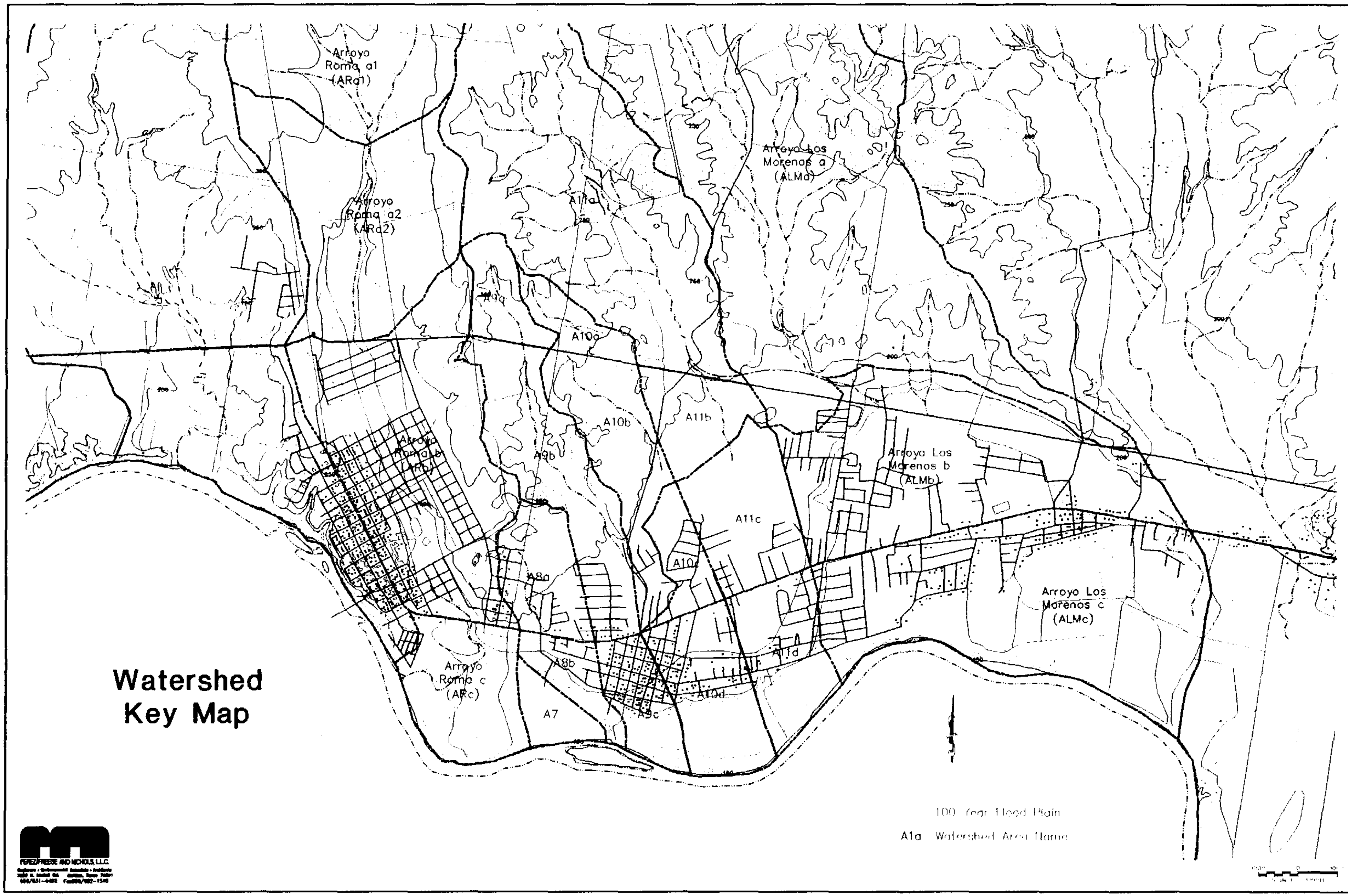

Arroyo Roma a1 (ARa1)
Arroyo Roma a2 (ARa2)
Arroyo Los Morenos a (ALMa)
A11a
A9a
A10a
A10b
A11b
A9b
Arroyo Roma b (ARb)
Arroyo Los Morenos b (ALMb)
A11c
A10c
A8a
Arroyo Los Morenos c (ALMc)
A11d
A8b
Arroyo Roma c (ARc)
A10d
A9c
A7
Watershed Key Map
100 Year Flood Plain
A1a Watershed Area Name
PEREZ/FREESE AND NICHOLS, L.L.C.

Figure 3.2

Table 3.1

Drainage Areas Characteristics

Area No.	Area (acres)	Sum of Areas (acres)	Channel Slope (feet/feet)	Flow Length (feet)
ARa1	1,386	1,386	0.0122	14,780
ARa2	522	1,908	0.0056	5,160
ARb	701	2,608	0.0051	8,062
ARc	240	2848	0.0089	3,826
ALMa	3,310	3,310	0.0083	28,213
ALMb	702	4,011	0.0020	9,792
ALMc	838	4,849	0.0036	5,555
A7	47	47	0.0125	2,810
A8a	144	144	0.0158	3,793
A8b	77	221	0.0121	3,310
A9a	87	87	0.0267	3,002
A9b	307	394	0.0077	8,457
A9c	112	506	0.0132	3,407
A10a	72	72	0.0210	3,335
A10b	229	301	0.0131	4,597
A10c	85	385	0.0006	3.272
A10d	210	596	0.0087	4,366
A11a	890	890	0.0133	12,029
A11b	130	1,020	0.0052	1,928
A11c	214	1,234	0.005	3,680
A11d	181	1,415	0.0106	3,590

watershed was modeled using the SCS Synthetic Unit Hydrograph method as contained in the ***Watershed Modeling*** (1) procedures in the ***Eagle Point*** computer software package. Hydrologic elements were used to compute runoff hydrographs at selected design points. The hydraulic models were used to determine storage-discharge relationships to route flood hydrographs in the hydrologic models. By definition, a unit hydrograph is a graphic representation of discharge versus time for a storm producing one inch of runoff resulting from 1 inch of effective rainfall generated uniformly over the basin area at a uniform rate during a specified period of time or duration. The curvilinear shape was used to compute the SCS unit hydrograph, and values were selected for the shape factor and the runoff curve number. The unit hydrographs were computed using a standard shape factor of 484, a constant runoff curve number = 80 for all subdrainage areas except Ara2, Arb, and Arc. For these three subdrainage areas a runoff curve number = 90 was used to account for the higher level of urbanization. These values are included in the ***Eagle Point's Watershed Modeling Manual***. Development of Runoff curve numbers is discussed in the Soil Conservation Service, Section 4 Hydrology, (2).

3.4 Rainfall Intensity

The point rainfall intensities used in the design of all stormwater drainage facilities in the Roma area were developed from the rainfall intensity equation $I = b/(t_c + d)^e$. The constants used in the rainfall intensity equation were obtained from the Texas Department of Transportation's (TxDOT) **Drainage Design Manual** (3) are summarized in Table 3.2 below. The t_c, the time of concentration in minutes which represents the time required for the runoff to flow from the most remote point in the watershed to the facility being designed, was based on an average velocity of

Table 3.2

Rainfall Intensity Equation Constants

Frequency	b	d	e
2-year	73	9.60	0.83
5-year	82	9.40	0.80
10-year	89	9.40	0.79
25-year	99	9.40	0.78
50-year	100	9.40	0.76
100-year	105	9.60	0.75

5 ft/sec. The HEC-RAS analyses developed in the evaluation of the alternatives indicated that this was a reasonable assumption.

3.5 Rainfall Data

Rainfall depths for storms are applied to the unit hydrograph to determine the resulting peak stormwater discharges produced by those storms. Rainfall data for the 5-, 10-, 25-, 50-, and 100-year frequency storms were derived from intensity-duration-frequency curves from the TxDot's **Drainage Design Manual** (3). A listing of the rainfall intensities used in the hydrologic models is presented in Table 3.3.

3.6 Precipitation Losses

Interception, depression storage and infiltration within each contributing drainage area are combined and handled as precipitation losses in the hydrologic models. Initial and hourly rainfall loss rates vary with storm frequency and soil type. Typically, storms with a lower return interval

Table 3.3

Rainfall Intensity-Duration Frequency

	5 min (in/hr)	15 min (in/hr)	30 min (in/hr)	60 min (in/hr)	6 hr (in/hr)	24 hr (in/hr)
2-year	7.87	5.10	3.43	2.10	0.47	0.14
5-year	9.58	6.27	4.26	2.65	0.65	0.21
10-year	10.79	7.11	4.87	3.10	0.81	0.27
25-year	12.36	8.19	5.64	3.60	0.93	0.31
50-year	13.24	8.88	6.17	4.00	1.10	0.39
100-year	14.06	9.51	6.65	4.45	1.39	0.53

(i.e., more frequent storms) will have higher initial and hourly loss rates. Clay soils typically have lower loss rates than sandy soils due to the lower permeability of clay soils. The initial and hourly loss rates used in this project are included in the SCS curve number for the soil type.

3.7 Lag Time

The lag time is the time interval between the center of the rainfall duration and the peak discharge. For the SCS unit hydrographs, the lag time is assumed to be equal to 0.6 times the time of concentration.

3.8 Hydrograph Routing

The Muskingum routing method, which is described in most standard hydrology and open channel textbooks, was used to route runoff hydrographs between design points. Linsey Kohler and Paulhus in Hydrology for Engineers (4) have expressed the storage in a reach of a stream as:

$$S = b/a\,[xI^{m/n} + (1 - x)O],$$

where *a* and *n* are constants from the mean stage-discharge relation for the reach, $q=ag^n$, and b and m are constants in the mean stage-storage relation for the reach, $S=bg^m$. The constant *x* expresses the relative importance of inflow and outflow in determining storage. For a simple reservoir, $x = 0$ (inflow has no effect). If inflow and outflow have an equal effect on stage, *x* would be 0.5. For most streams, *x* is between 0 and 0.3, with a mean value near 0.2. A value of 0.25 was used in these studies since improved channels are being considered.

In the Muskingum method, m/n is assumed equal to 1 and b/a is assumed to be a constant k.

$$S=K[xI+(1-x)O]$$

The constant *K*, known as the *storage constant,* is the ratio of storage to discharge and has the dimension of time. It is approximately equal to the travel time through the reach and, in the absence of better data, is sometimes estimated in this way. Sufficient historical data does not exist for the Roma area to compute a *K*. The *K* value has been approximated by dividing the travel distance by flow velocity of five feet per second. The HEC-RAS analyses developed in the evaluation of the alternatives indicated that this was a reasonable assumption.

3.9 Computed Peak Design Flows

The computed peak design flows for the 10-year, 50-year and 100-year frequency storms developed watershed conditions are summarized in Table 3.4. <u>These are the peak design flows that have been used to size the storm drainage and flood protection improvements.</u>

Table 3.4

Computed Peak Design Flows

Area No.	10-year Frequency (CFS)	50-year Frequency (CFS)	100-year Frequency (CFS)
ARa1	1,157	1,758	1,980
ARa2	906	1,243	1,366
ARa1+ARa2	1,557	2,319	2,602
ARb	873	1,218	1,344
ARb+area above	2,351	3,408	3,800
ARc	473	645	707
Arc+area above	2,669	3,854	4,294
ALMa	1,534	2,389	2,709
A11a	868	1,309	1,471
ALMa+A11a	1,835	2,869	3,258
ALMb	367	569	645
ALMb+area above	2,202	3,437	3,902
ALMc	794	1,199	1,349
ALMc+area above	2,860	4,355	4,937
A7	92	135	151
A8a	253	372	415
A8b	142	205	228
A8a+A8b			
A9a	233	333	369
A9b	290	438	492
A9a+A9b	367	554	622
A9c	197	285	317
A10a	167	242	269
A10b	374	547	610
A10a+A10b	496	722	805
A10c	55	85	96

Area No.	10-year Frequency (CFS)	50-year Frequency (CFS)	100-year Frequency (CFS)
A10c+area above			
A10d	303	450	503
A11b	224	330	368
A11c	120	186	211
A11b+A11c	275	411	461
A11d	317	462	515

4.0 Methods of Stormwater Management

4.1 Legal Considerations

The Flood Control and Insurance Act (Article 8280-14 of the Revised Civil Statutes of the State of Texas) authorizes Texas cities to develop stormwater management controls. The act provides for the development of a flood plain management program and the adoption and enforcement of permanent land use and control measures to aid in the implementation of the program.

The legal authority of the City of Roma to carry out a comprehensive program of stormwater management, and legal procedures for implementation of various funding methods must be carefully examined as the program strategy evolves. It is recommended that the City Attorney be consulted to provide a legal opinion on integrating the stormwater management program into the City process, especially as it relates to control of private drainage systems and the timing of program elements in light of financing implementation steps.

4.2 Structural Alternatives

Structural applications to control floodwater from a watershed may be divided into two fundamentally different approaches:

- the conveyance oriented approach, and
- storage oriented approach

Conveyance Oriented Approach: The conveyance concept, briefly stated, is the concept of providing provisions within the drainage system to transmit a given quantity of water within the confined limits of conduit or channel banks to **minimize** and/or **eliminate** damage and disruption through the adjacent areas. This technique is the more traditional stormwater management approach, and the system components consist of pipes, culverts, bridges, improved channels, and levees.

Conveyance describes the capacity of a conduit or channel section to transport stormwater runoff. The transmission capability of an improved conduit or channel varies with numerous factors such as the slope of the channel bed, channel width and depth, and smoothness of the channel walls and bottom. It is also necessary to understand that channel improvements must be sized to convey the selected storm frequency. The system that carries flooding for one storm will often be inadequate to carry the runoff from a larger frequency storm within the conduit or channel banks

An improved channel can greatly increase the conveyance capability provided by a typical natural channel. Depending upon conveyance needs, the improvements can include cleaning the clogged natural channel of vegetative growth, channel straightening which eliminates meandering and improves the slope, developing a new channel section to increase the flow area and maximize smoothness, or a combination of one or more of these. Compared to a typical natural channel, an improved straightened earth or grass lined channel having equal cross-sectional area can convey approximately 40 percent more water, and a concrete lined channel can convey more than three times the flow of a natural channel.

Because of the increased conveyance capability of the improved channel, stormwater can be rapidly and efficiently removed from a given area. Since the improved channel is more efficient in conveying water, it provides the benefit of minimizing the required channel area. Increasing channel efficiencies can also affect the overall watershed hydrology (i.e., hydrograph timing to create a peak on peak).

Within existing developments, the improved channel is very adaptable in controlling and removing stormwaters while requiring the minimum loss of right-of-way. In new developing areas, with proper planning, the improved channel can be combined with aesthetic amenities to provide efficient conveyance while minimizing the hard appearance that may be projected, for example, by a stark concrete lined channel.

Without question, the aesthetic quality of a natural tree-lined meandering creek or stream is very attractive and it becomes a desirable location for development. Roma is not unique in regard to development adjacent to many of the natural creeks meandering through the area. However, implementing stormwater control measures in some streams can possibly destroy or certainly diminish the natural aesthetic qualities with channel improvements, depending upon the conveyance requirements.

The advantages gained, from the increased conveyance capability of the improved channel, may be accompanied by loss of aesthetic quality. Another disadvantage sometimes associated with the improved channel is the possible increase in erosion due to higher velocities. There is also a potential for downstream flooding if the improved channel abruptly ends and allows water to stack up in an area of reduced channel conveyance.

Possible channel improvements and their respective advantages and disadvantages are summarized in Table 4.1. These typical improvements are basic and do not reflect the numerous variations to provide floodwater control within defined parameters or the myriad of aesthetic treatments to retain the natural look.

Table 4.1

Typical Channel Improvements

Type	Nature	Advantage	Disadvantage
Channel Clean Out	Selective removal of trees & under-brush to minimize clogging	Maintains maximum natural setting while improving conveyance	Destroys some Vegetation
Channel Straightening	Improved alignment by eliminating excessive mean-dering and increa-sing channel slope	Retains selected natural setting & improves the conveyance capability	Reduces aesthetic quality of natural swales depending upon extent of straigh-tening
Channel Enlargement	Complete modifi-cation of natural channel by straightening & widening	Provides significant increase in conveyance	Reduces aesthetic quality
Channel Lining	Maximum channel modification by providing lining (nor-mally concrete) to reduce right-of-way requirements	Provides maximum conveyance & minimizes land loss	Can project a hard appearance unless supple-mented with amenities

Storage Oriented Approach: This method of stormwater management provides for the control by means of storing water and releasing it at a predetermined rate which can be adequately conveyed by the downstream system. Traditionally, this method has been utilized on large streams and river systems to control major flooding and is an important function of many of the large dams existing on streams and rivers throughout Texas and the United States. In urban areas, detention is being used to **limit discharges** from developed properties to that of the pre-developed conditions.

The general application of this methodology for watershed management on smaller areas has seen increased use in recent years and many cities utilize this approach. Applications of this method are now applied to areas as small as two acres and can even be applied to individual lots. The only requirement to affect this concept, whether large or small, is provision of a storage area for stormwater collection. This storage can be done in parking areas, small ponds, or large areas requiring detailed engineering evaluation of the storage area and overflow spillway.

The storage concept may be divided into retention or detention facilities. The **retention storage** method assumes the continual retainage of a given quantity of water that may be used for aesthetic, recreational, irrigation or domestic purposes. The retention system, however, has the capacity to retain additional volumes of water for a short duration to regulate the maximum floodwater discharge flow rate. The stored stormwater is released downstream as rapidly or slowly as the receiving channels, creeks, or system will allow, consistent with a stormwater management program.

The **detention storage** method is similar to the retention system except no provision is made for continuous storage of water. Rather, the stored floodwaters are completely released in a time period consistent with a flow rate that will minimize or eliminate downstream flooding. Detention storage has as its major function the control of stormwaters, yet this requirement may be utilized on an infrequent basis. As a result, the detention storage area can very effectively provide multiple uses for such functions as park areas, playgrounds, or athletic fields.

The primary function of the retention/detention concept is elimination or reduction of downstream flooding by storing and controlling the released water. The prime advantage of this concept is the use of smaller conveyance systems downstream. Depending upon the available storage capacity, it may be possible for the natural creek or stream to convey the released waters and not cause flooding. This approach not only can reduce the capital cost for larger downstream facilities, but maximizes preservation of the aesthetic qualities of the natural stream area.

Multiple use of the storage area is also an advantage. New planning concepts generally encourage open space, parks, and other recreation areas within a development. The retention/detention areas are ideal for the development of water-related aesthetic or recreational facilities, or can be used for maintained green belts, parkways, or athletic fields, depending upon the storage area size.

An advantage associated with the retention/detention concept that has recently received considerable attention is the attenuation of stream pollutants. Inherent in the storage concept is rapid reduction of water velocity which allows the precipitation of water-conveyed sediments and other pollutants such as heavy metals, pesticides, and phosphorous, and thereby significantly reduces downstream pollution. Because urban stormwater has been observed as a major contributor to pollution of surface waters, the storage concept can be a very effective quality control facility. The periodic disposal of collected pollutants is another factor that should be considered in the planning of this type of facility.

Depending upon the upstream drainage area and the desired reduction of peak discharge, the loss of developable land can become significant. For this reason the application of the storage concept is generally restricted to new development that can incorporate the required storage area into desirable open space, park, or recreational areas. In existing developments, the open space requirements are generally prohibitive and the storage concept becomes difficult to apply.

The basic premise of the retention/detention concept is containment and storage of large inflow rates and the gradual release of smaller outflow rates to the downstream area. Due to this differential between inflow and outflow rates, an extended period of time is needed to release the stored volume of water. If the downstream conveyance system is inadequate and the peak flow reduction provided by the retention/detention system is limited, it is possible to extend a reduced flood stage problem over a longer period of time as opposed to the natural condition of higher stages of flooding for a shorter period of time. It is important in selection and design of retention/detention facilities to give adequate consideration to the downstream conveyance capabilities.

Construction of retention/detention facilities requires open land areas primarily in the upper regions of a watershed. Desirable sites will be those where existing depressions already exist, and the length of dam construction will be minimal and sufficient capacity exists. Since the study area is relatively flat, it may be necessary to excavate a storage area with a controlled overflow from the stream. The stored water would later be released downstream through a conduit with a flap gate as the water surface of the stream declines. Lack of property containing sufficient capacity within the watershed management program area may make this concept only viable in select areas without excavation.

A comparison of the two structural methods of watershed management, conveyance systems and retention/detention systems, is provided in Table 4.2. The conveyance and storage concepts are the current state-of-the art structural methods for stormwater management control. Either approach can be employed individually, but the best results will generally be achieved through a combination of the two concepts. The integrated system of improvements should consider each drainage basin as a whole to provide effective stormwater management control.

Federal Programs: Federal support for urban runoff control has been minimal, and limited primarily to program planning and research. The Section 208 program under the 1972 Clean Water Act (Public Law 92-500) invested heavily in evaluations of water quality programs resulting from urban runoff (4). The Soil Conservation Service (SCS) historically given technical assistance to local governments to control soil loss and provide water resource management in urban and rural areas. The types of controls the SCS has promoted reduce erosion/sediment, flow, and flooding problems. These controls often have another benefit, stormwater pollution control. The federal government has otherwise steered clear of urban runoff.

Table 4.2

Comparison of Conveyance and Storage Features

Conveyance	
Advantages	**Disadvantages**
1. Removes stormwater runoff rapidly and efficiently.	1. Reduces aesthetic quality, e.g., concrete lined channel.
2. Minimizes land loss by improved conveyance of stormwater.	2. Possible increase in erosion due to increased velocities.
4. Lowers maintenance cost compared to storage concept.	4. Possible increase in downstream flooding.
4. Can be applied to new or existing development.	
5. Generally the more accepted design analysis.	

Storage	
Advantages	**Disadvantages**
1. Reduces downstream flow therefore, smaller downstream conveyance system required.	1. Increased land loss.
2. Reduces downstream flow, allowing utilization of natural streams with minimum improvements while retaining aesthetic quality	2. Extends runoff period, bu at reduced peak.
4. Can be applied to new development limiting runoff to no more than natural conditions.	4. Generally restricted to new development.
4. Improves water quality by decreasing pollution through precipitation.	4. Collected sediment must be periodically removed which increases maintenance costs.
5. Has potential multipurpose application, e.g., recreation or aesthetic value.	
6. Can make use of existing depressions and abandoned caliche pits.	

Texas Legislation Related to Floodwater Management: Municipal floodwater management controls are authorized by Article 8280-14 of the Revised Civil Statutes of the State of Texas, commonly known as the "Flood Control and Insurance Act." The primary purpose of this Act is the "promotion of public interest by providing appropriate protection against the perils of flood losses and encouraging sound land use by minimizing exposure of property to flood losses." Subsection (5) of Section 5 provides for the development of a flood plain management program and the adoption and enforcement of permanent land use and control measures to aid in the implementation of the program.

Home Rule Authority: Any assessment of the legal considerations and requirements involved in providing an appropriate stormwater management program should include both the program functions and the financing options to properly balance the needs of the community with the authority and resources available to the City. A home rule city has a good deal of flexibility in organizing and financing municipal programs to meet the community's needs. The analysis of finance options addresses several innovative financing methods, many of which have not previously been widely used. These include establishing drainage as a utility and using impact or capital recovery fees.

The State of Texas has not specifically authorized cities to use the full range of possible drainage financing methods. It is fortunate that a home rule city has some latitude in using a variety of financing concepts. Home rule cities look to state law for limitations upon their powers, not for specific grants of power. Thus, home rule authority enables the City Council to enact funding methods which respond to the City's drainage needs without specific authorization at the state level.

However, restrictive court definitions of local taxing powers in Texas could impose limits on a city's flexibility.

From a practical standpoint, the program and financing strategy proposed for stormwater management must reflect the needs and attitudes in the local community and must be attractive to promote orderly growth. The options identified throughout this report have been developed in a manner that is intended to be consistent with reasonable public policies. The public will better understand drainage issues and the rationale underlying the strategies if the alternatives are clearly in tune with City policies on economic development, neighborhood revitalization, and environmental protection. Existing policies should not, however, foreclose opportunities to introduce new financing concepts or adjust existing policies.

4.4 Nonstructural Alternatives

Governmental Controls: Local governmental or administrative controls are means of providing control to sensitive areas such as the watershed and its floodplain. Such controls significantly broaden the scope of watershed management beyond the normal structural controls. Governmental controls take two forms: regulatory and non-regulatory.

Zoning and subdivision ordinances are effective regulatory control tools in stormwater management. New approaches to the control and management of land allow flexibility in the operation of flood plain land use controls.

The detailed specifications commonly found in zoning ordinances are generally inadequate when applied uniformly over an entire flood plain zone. The natural functions of the flood plain vary from site to site (1) due to local conditions, (2) how the site interacts with the surrounding natural features, (4) which conditions have a direct impact upon the site, and (4) whether the site is relatively pristine or is in the process of adjusting to surrounding disturbances.

An approach, that of controlling the impact of uses, represents a shift from zoning control of uses. Because of the shift in focus, this approach has caused some major changes in the operation of flood plain land use controls. This change can be characterized by a movement away from detailed specifications concerning construction techniques or site requirements and a movement toward performance criteria for land use.

One of the most commonly used methods of establishing performance type controls is the development of a series of policy guidelines that outline the community's expectations on the function of the land. The ensuing regulations are individualized, with each case being judged on its own merits as to how well it satisfies the policy guidelines. An alternate to this method is the use of performance standards. Using this type method, the community sets a specific measurable level at which the key functions of a development will meet these standards.

Subdivision control regulations are effective tools in watershed management. Unlike zoning ordinances which apply only within the city limits, subdivision control in Texas extends to areas within a city's extraterritorial jurisdiction (ETJ).

An effective method used in the establishment of a stormwater management program is the incorporation of runoff, erosion, water quality, and sedimentation controls into the City's subdivision ordinance performance specifications and design standards. This system allows for uniform application of a stormwater management program throughout the watershed, minimizing the possibility of inter-ordinance conflicts.

Non-regulatory controls take several forms. Annexation of areas which could potentially affect the flooding characteristics of the community is a viable method of increasing the effectiveness of stormwater regulatory controls. As discussed in the previous section, the subdivision ordinance and its platting requirements are essentially the only formal control the City has in regulating development in the ETJ. By annexing land, the City can use additional regulatory tools including the zoning ordinance, building code and the site plan review process.

Direct ownership through a fee simple purchase is one of the most effective means of preserving flood plains as open space areas, parks, existing caliche pits, or nature reserves within the City's corporate limits. Because of the direct expenditure of funds, there are fiscal limitations to this approach. However, some grant and loan programs are available to local governments through various public and private agencies for preservation and open space development within the City's corporate limits.

Purchase and/or dedication of flood easements is another option available for the control of flood hazard areas. This technique is usually implemented along drainage ways requiring regular maintenance and inspection so as to maximize accessibility.

The development of governmental policies that limit or discourage the extension of public services (i.e., roads, utilities, parks, etc.) into a flood prone areas are effective tools in the promotion of stormwater management. By not authorizing the extension of services to nonconforming developments, the City in conjunction with private utility companies, can encourage flood conscious design.

Municipal Drainage Regulations: The Roma Subdivision Regulations and Building Code Enforcement are the primary instruments used in the reduction of flood hazards within the city and its extraterritorial jurisdiction.

Drainage regulations to be developed for Roma should be designed to provide a stable foundation for a stormwater management program and provide effective measures for the prevention of flood damage to development. The regulations should outline concise performance standards for development inside and outside of the flood hazard areas, outlining at least a minimum level of performance for runoff will mitigate the long-term impact of development throughout the watersheds.

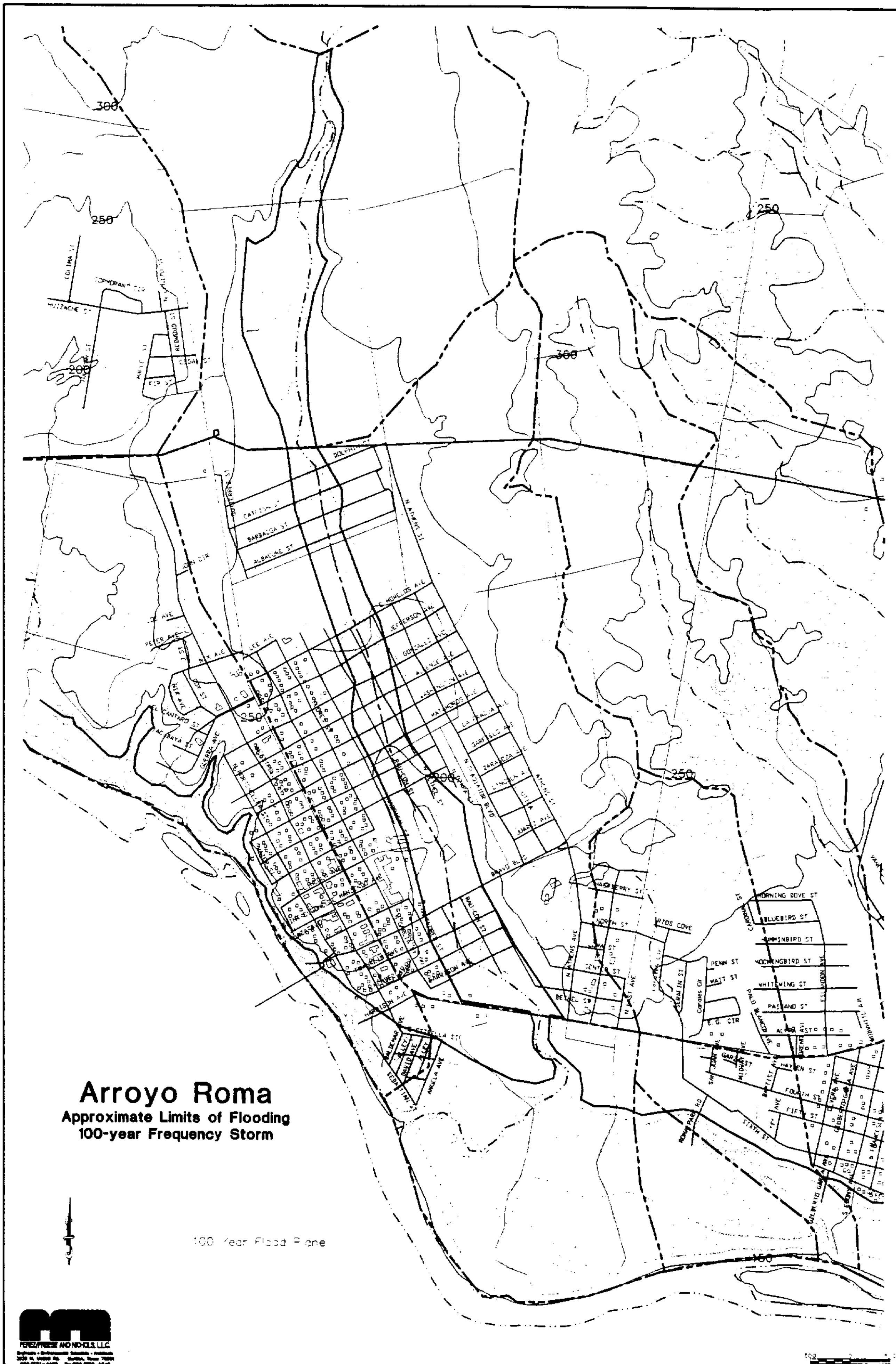
5.0 Description of Proposed Alternatives

5.1 Alternatives for Arroyo Roma

The approximate limits of flooding of the 100-year flood on Arroyo Roma are illustrated in Figure 5.1. A significant portion of the developed area of the City is affected by this flood. The flooding results from both the flood flows that are generated in the watershed and also from the spreading of the backwaters of the Rio Grande River as defined by FEMA maps.

The area inundated by the flood flows of the Rio Grande cannot be reduced by improvements within the City of Roma. The flood flows in the Rio Grande are controlled to a great extent by the spills from the Falcon-Amistad Reservoir System and by storm runoff from the uncontrolled drainage area below this reservoir system. Discussions have been conducted with representatives with the International Boundary and Water Commission (IBWC) on the magnitude and frequency of certain flow rates and water surface elevations in the vicinity of Roma. These flows and rating curves furnished by the IBWC have been used to define the starting water surface elevations for the flood flow water surface profile along Arroyo Roma. Based on the available information, the 100-year flood flow on the Rio Grande River in the vicinity of Roma would be at a water surface elevation of approximately 185 +/- feet msl. The conceptual alternatives do not provide protection from the 100-year flood on the Rio Grande.

The likelihood of the 100-year flood occurring on Arroyo Roma at the same time that a 100-year flood flow is occurring on the Rio Grande is very remote given the relative size of the two watersheds. Due to the control of the flows in this stretch of the Rio Grande by the Falcon-Amistad Reservoir system, a common peak flow rate as furnished by the IBWC is in the order of magnitude



Arroyo Roma
Approximate Limits of Flooding
100-year Frequency Storm
100 Year Flood Plane
300
250
200
150
JEFFERSON AVE
BRAVO BLVD
MORNING DOVE ST
BLUEBIRD ST
HUMMINGBIRD ST
MOCKINGBIRD ST
WHITEWING ST
PAISANO ST
PENN ST
MATT ST
RIOS COVE
NORTH ST
BETHEL ST
HAYDEN ST
FOURTH ST
SIXTH ST
PEREZ/FREESE AND NICHOLS, L.L.C.

Figure 5.1

of 12,000 cfs to 15,000 cfs. The water surface elevation of the Rio Grande under these conditions is approximately 155+/- feet msl. This elevation has been used as the starting water surface elevation to establish the limits of backwater flooding on Arroyo Roma when the Rio Grande is not a major contributor to the limits of flooding.

With the extent of the flooding from the 100-year storm along Arroyo Roma, it is desirable to investigate potential improvements that could be constructed to remove some of the developed property from the flooded area. Described below are the alternatives that have been considered. A common improvement in all these alternatives is the construction of additional box culverts under U.S. Highway 83. Four-eight feet wide by eleven feet high boxes (4- 8'x11' RCBC) currently exist under U.S. Highway 83. Considering the limits of flooding immediately upstream of U.S. 83 as illustrated on Figure 5.1, it can be clearly seen that the limit is much wider upstream than it is on the downstream side of the highway. This condition is the result of the constriction caused by an insufficient opening under U.S. 83.

At the time the highway was constructed and subsequently widened, it is likely that the culvert was sized to meet the existing watershed conditions at the time using TxDOT design standards. Since the highway and culverts were constructed, additional urbanization has occurred upstream in the watershed. Also the TxDOT design frequencies are usually lower than the 100-year frequency protection that is considered appropriate for communities like Roma. According to the December 1985 edition of the TxDOT Bridge Division Hydraulic Manual, culverts under the main lanes of interstate and controlled access highways are designed for a **50-year frequency storm**. Culverts under other minor highways and frontage roads are designed for a minimum of a 5-year storm. The manual states that it is desirable to design these culverts for a 50-year frequency storm.

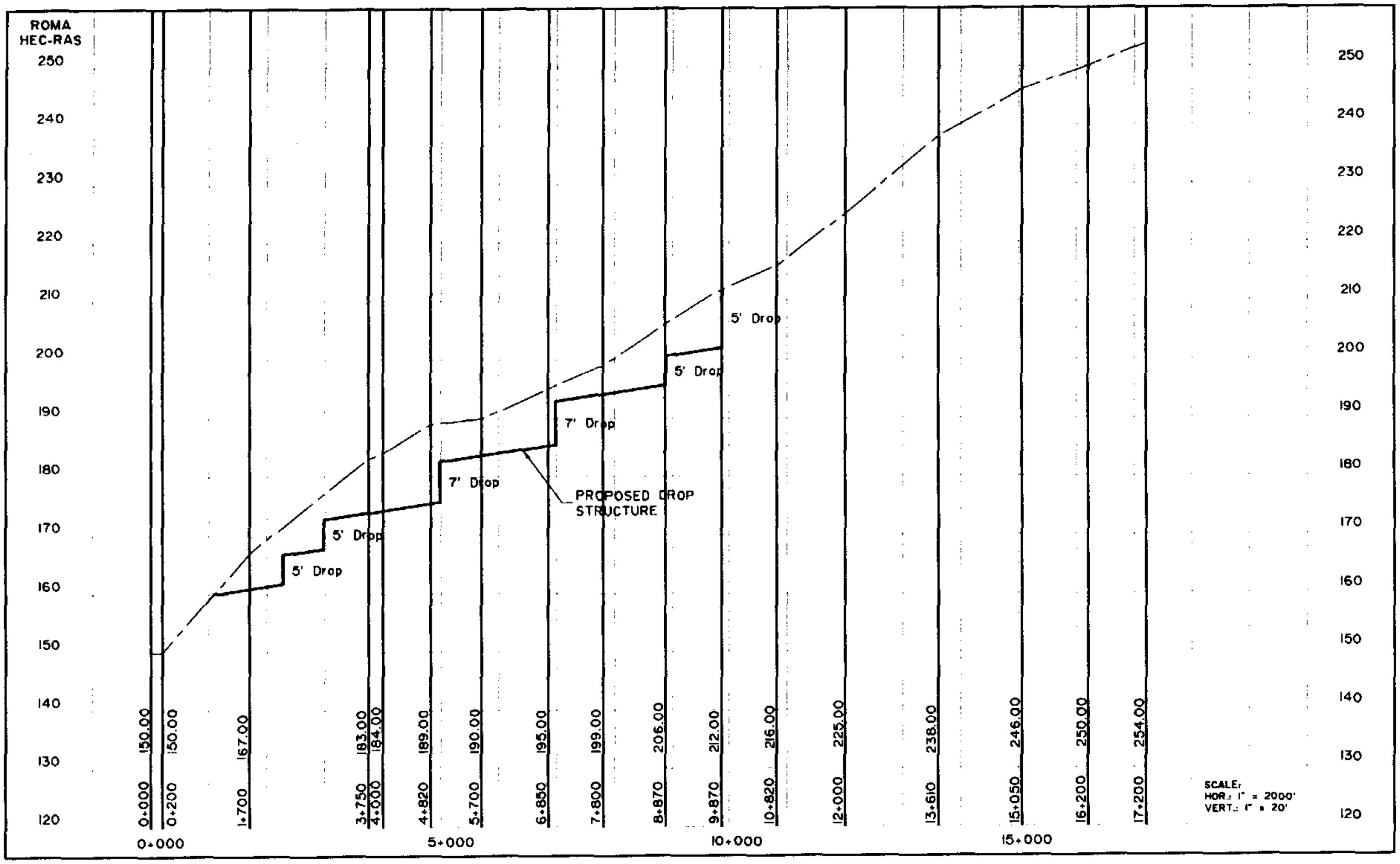
In the development of the plans for improvements for the City of Roma, the assumption has been made that appropriate improvements will be made under U.S. Highway 83 by TxDOT. The hydraulic analyses of the limits of flooding on Arroyo Roma have been based on the assumption that from eight to ten culverts would exist under US 83. Making this assumption is not the most conservative approach, but one that appears appropriate given the impact of flooding on the City of Roma if the additional culverts are not installed. Certainly, the construction of the required modifications to U.S. 83 culverts should be of first priority.

Alternative 1 - Earthen Channel Improvements

A visit to the Arroyo Roma drainage ways reveals that much of the existing channel has been filled in and dwellings have been constructed that have impeded the natural flow. The earthen channel improvement approach, *a conveyance oriented approach*, involves the creation of an improved flow path through the flood plain. In planning conveyance oriented approach using earthen channels, consideration must be given to the velocity of the flow. The slope of the Arroyo Roma watershed is illustrated in Figure 5.2. As can be seen, the slope is fairly steep as compared to many other streams. This condition results from the watershed originating in the hill along the north side of the Rio Grande River.

The initial calculations indicated that if an earthen channel of adequate size is constructed at the existing slope, the resulting flow velocities would be of such a magnitude that major erosion of the channel and surrounding area would occur. The slope of the channel can be maintained flatter by constructing concrete drop structures at specific location thereby reducing flow velocities to acceptable levels so that the earthen erosion is minimized. The typical drop structure is designed to reduce the slope of the channel bottom and achieve the necessary drop in elevation at a controlled

ARROYO ROMA
PROFILE



PEREZ/FREESE AND NICHOLS, L.L.C.

Figure 5.2

location to dissipate hydraulic energy. The locations for the proposed locations for the drop structures are illustrated on Figure 5.3 and their proposed height is illustrated on Figure 5.2.

The first drop structure is proposed near E. Morelos Ave. A second drop structure is located near Allende Ave. A third drop structure is proposed south Garfield Ave near the center of the school property. The fourth drop structure is proposed near Harrison Ave. Three drop structures are proposed south of U.S. Highway 83. The first is just downstream of the road embankment with the other two structures further downstream.

For the 100-year flood discharge of 3,800 cfs above U.S. Highway 83, in concept a channel with a 136-foot bottom width, 5-foot flow depth, and 2:1 side slopes is required. The bottom width and depth can be modified in the detailed design which is the case for all the alternatives. The 2:1 side slopes are relatively steep which creates a more difficult maintenance situation. Flatter side slopes should also be considered in the detailed design. Below U.S. 83 for the 100-year flood discharge of 4,100 cfs, a channel width of 147 feet is required. Under this alternative, the limits of the flooding from the 100-year flood would be **limited to the width of the earthen channel** between E. Morelos Ave. and the southern end of the channel near the Rio Grande.

To implement this alternative, numerous homes, vacant lots and open tracks of land would have to be acquired. The channel would divide the developed area and bridges would have to be constructed at strategic locations. Public safety would have to be considered and protective fencing would be included on both sides of the construction of the project. Cost estimates for this alternative are shown on Table 6.2.

Alternative 2 - Diversion Tunnel and Channel Improvements

The size of the improved channel can be decreased if a portion of the flow can be diverted

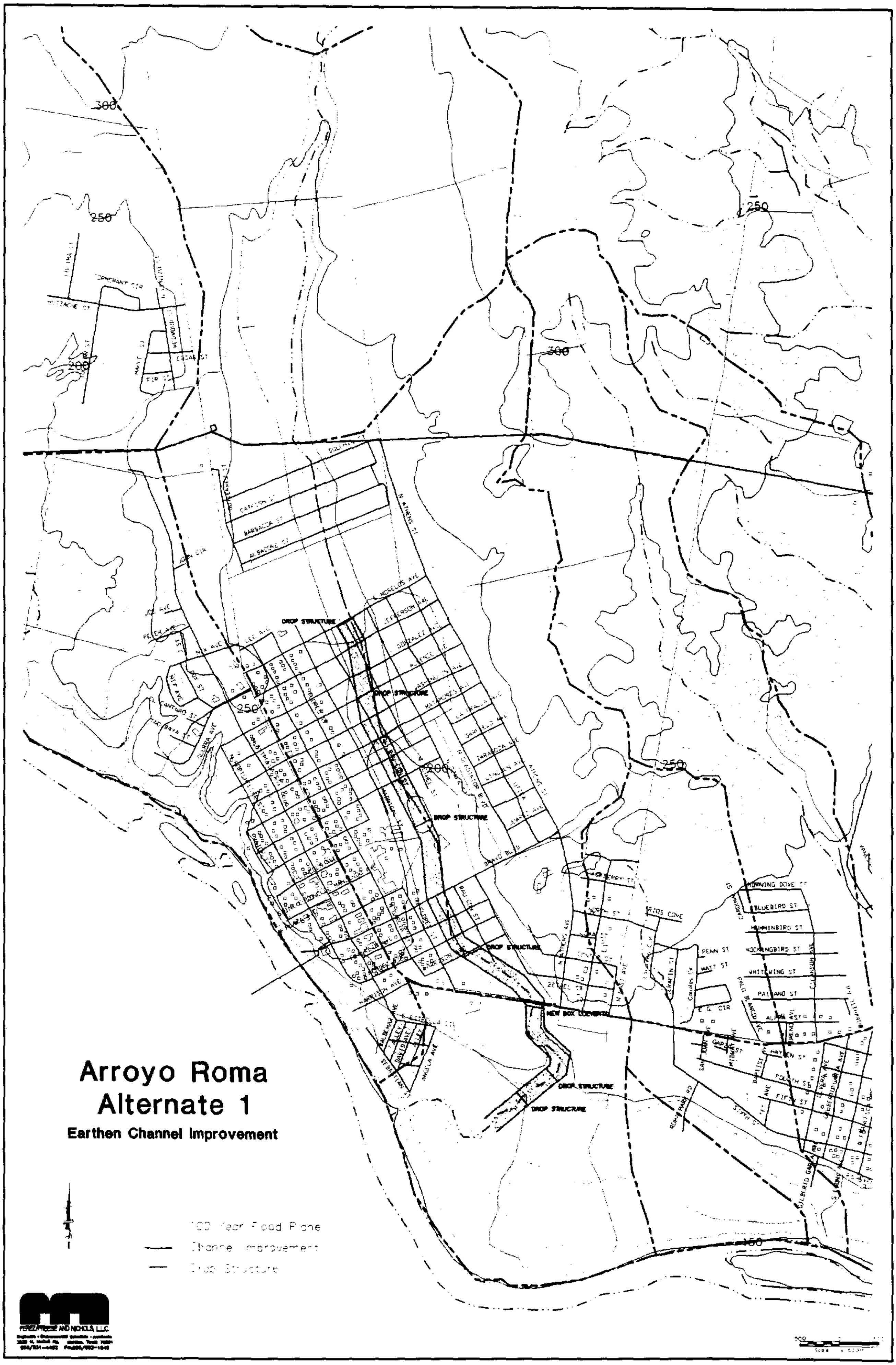

Arroyo Roma
Alternate 1
Earthen Channel Improvement
100 Year Flood Plane
Channel Improvement
Drop Structure
DROP STRUCTURE
NEW BOX CULVERT
300
250
200
150
PEREZ/FREESE AND NICHOLS, L.L.C.

Figure 5.3

prior to entering the current populated areas at East Morelos Avenue. The option for diversion involves construction of a tunnel from Arroyo Roma under the City to a small tributary of the Rio Grande River as illustrated on Figure 5.4. To divert a flow of approximately 2,200 cfs, the estimated 100-year flow at the diversion point, requires a **10-foot diameter tunnel**. The length of the tunnel would be approximately 1,100 feet.

Even with the construction of this diversion tunnel, an improved channel with drop structures would be required through the developed area of the city. The channel above U.S. Highway 83 for the estimated remaining flow of 1,600 cfs (100-year flow), would require a bottom width of 56 feet and 2:1 side slopes and a maximum 5-foot flow depth. Below U.S. 83, a 67-foot bottom width channel would be required for the estimated 1,900 cfs (100-year flow). Cost estimates for this alternative are shown on Table 6.3.

Alternative 3 - Detention Reservoir and Channel Improvements

An alternate structural approach is detention storage. A detention reservoir could be constructed above the area of the city that will be likely developed in the foreseeable future. The detention dam location is illustrated on Figure 5.5. The required dam would be approximately 45 feet high and have a crest length of approximately 2,715 feet at an elevation of 304.5 feet msl. A detention reservoir is designed to only detain flood flows and to make smaller releases over a longer period of time. The area within the reservoir storage basin could be used for recreation or agricultural purposes between storm events.

The storm flow from the drainage area below the detention reservoir plus the releases will also necessitate channel improvements through the developed area of the city. An earthen channel with a 99-foot bottom width and a 5-foot depth of flow and 2:1 side slopes is required to handle the

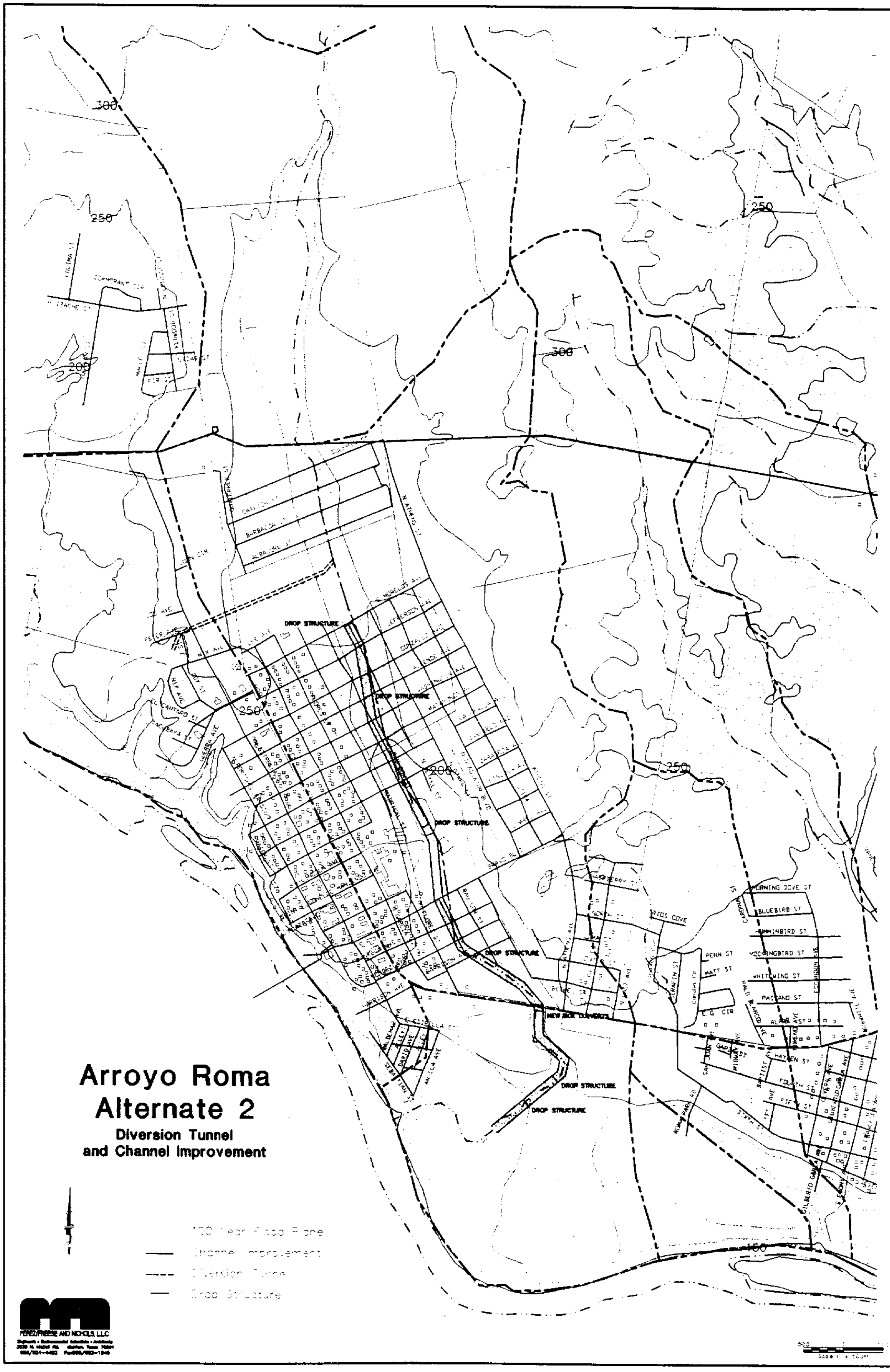
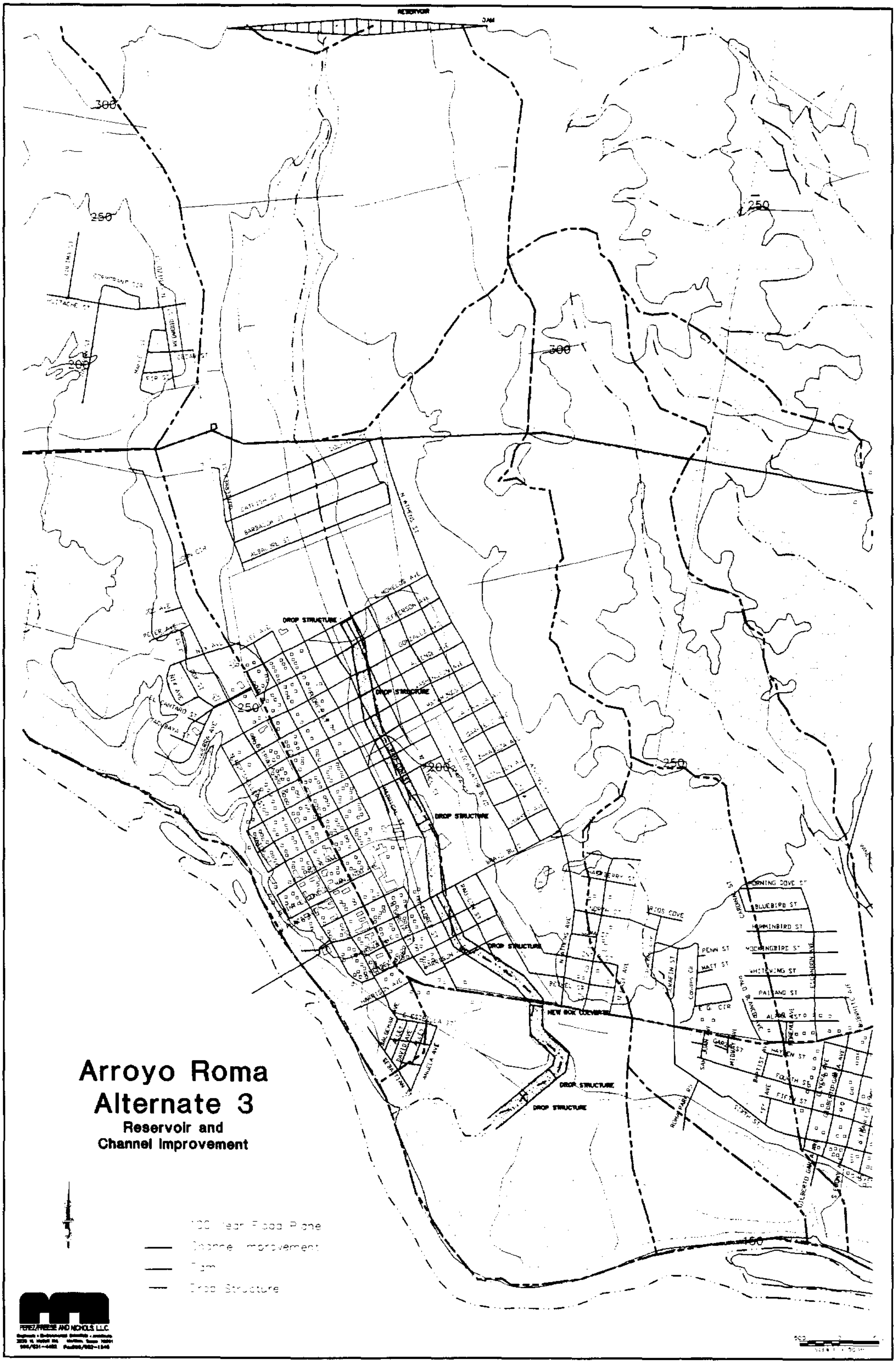

Arroyo Roma
Alternate 2
Diversion Tunnel
and Channel Improvement
100 Year Flood Plane
Channel Improvement
Diversion Tunnel
Drop Structure
DROP STRUCTURE
DROP STRUCTURE
DROP STRUCTURE
DROP STRUCTURE
DROP STRUCTURE
DROP STRUCTURE
NEW BOX CULVERTS
300
250
200
150
MORNING DOVE ST
BLUEBIRD ST
HUMMINBIRD ST
MOCKINGBIRD ST
WHITEWING ST
PAISANO ST
PENN ST
MATT ST
FOURTH ST
FIFTH ST
HAYDEN ST
GILBERTO GARZA
ALBACORE ST
BARRACUDA ST
N ATHENS ST
MORELOS AVE
JEFFERSON AVE
PEREZ/FREESE AND NICHOLS, LLC

Figure 5.4



Arroyo Roma
Alternate 3
Reservoir and
Channel Improvement
RESERVOIR
DAM
DROP STRUCTURE
DROP STRUCTURE
DROP STRUCTURE
DROP STRUCTURE
NEW BOX CULVERTS
DROP STRUCTURE
DROP STRUCTURE
300
250
200
300
250
250
200
250
150
100 Year Flood Plane
Channel Improvement
Dam
Drop Structure
PEREZ/FREESE AND NICHOLS L.L.C.

Figure 5.5

estimated 2,791 cfs 100-year flow above U.S. Highway 83. The bottom width would have to be increased to 116 feet below U.S. 83. Drop structures at the previously indicated locations would also be required. Cost estimates for this alternative are shown on Table 6.4.

Alternative 4 - Reinforced Concrete Box Culvert

The steep slope of Arroyo Roma can be used to the City's advantage by constructing a box culvert through the developed area with velocity dissipation structure at the lower end prior to returning to an earthen channel. A transition structure would also be required on the upper end to direct the flow to the box culvert structure under U.S. Highway 83. Storm drainage culverts and curb-type inlets in the crossing streets would be used to direct the local into the box culverts. This approach is illustrated on Figure 5.6.

As proposed, the two 8 feet by 11 feet box culverts (2-8'x11' RCBC) would extend from E. Morelos Ave. to the new U.S. 83 box culverts. If this alternative were adopted, the design and construction of channel box culverts should be coordinated with the design and construction of those under U.S. 83 by TxDOT. An improved 147-foot bottom width channel, 5-foot depth and 2:1 side slopes, with three drop structures would be required downstream below U.S. 83. This alternative would create less of a viable division in the middle of the city and the need for barrier fencing would be limited to the area below US 83. Cost estimates for this alternative are shown on Table 6.5.

Alternative 5- Purchase of Homes in Flooded Area

This alternative proposes the purchase of dwellings and vacant lots within the 100-year flood plain in the Arroyo Roma watershed from U.S. Highway 83, north to East Morelos Avenue. This alternative also includes the construction of five (5) culverts which would be constructed on strategic crossing locations at E. Morelos, Gonzalez, Matamoros, Bravo and Harrison Avenues. These

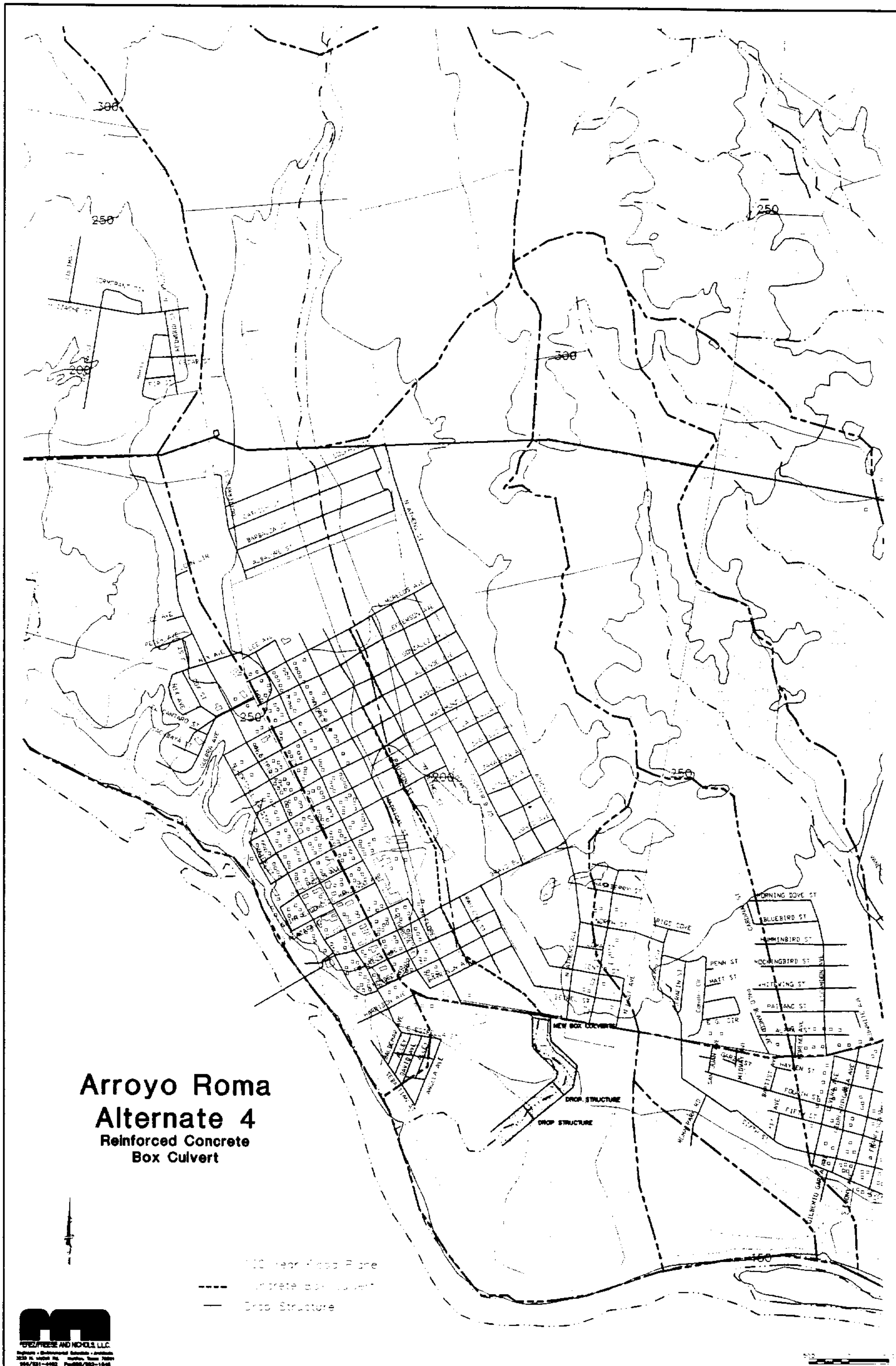

Arroyo Roma
Alternate 4
Reinforced Concrete
Box Culvert
300
250
200
150
NEW BOX CULVERTS
DROP STRUCTURE
DROP STRUCTURE
MORNING DOVE ST
BLUEBIRD ST
MOCKINGBIRD ST
PENN ST
MATT ST
HAYDEN ST
GARZA ST
HARRISON AVE
ANGELA AVE

Figure 5.6

culverts would allow traffic to travel east and west across Arroyo Roma. All other intersecting streets with the Arroyo would be dead ended and cul-de-sacs. All structures and dwellings, except school buildings would have to be demolished and removed. In order to avoid flooding to school buildings located north of Bravo Avenue, channelization would still have to be done as with "Alternative No. 1" to confine drainage waters to specific open channels. This work would be at the discretion of the Roma ISD and its costs are expected to be expended by the Roma I.S.D. and not quantified on Table 6.6.

5.2 Alternative for Los Saenz

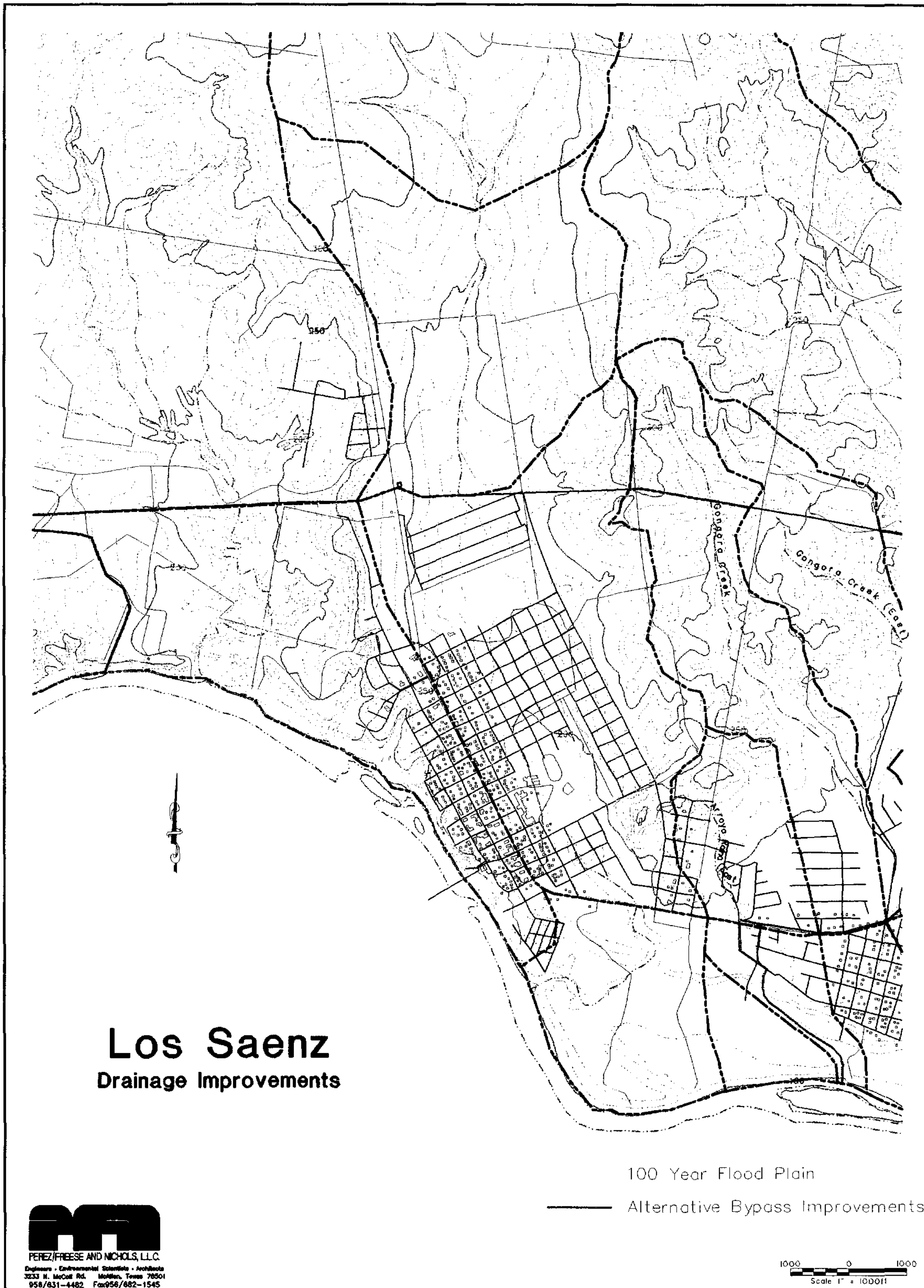
Los Saenz area is a small watershed located between Arroyo Roma and Gongora Creek as illustrated in Figure 5.7. (For the purpose of this study we have named it "Arroyo Roma East"). Storm drainage culverts and inlets would be used to collect the storm runoff north of U.S. Highway 83. A box culvert would be constructed under U.S. 83. An improved channel to the Rio Grande River would be constructed south of U.S. 83 with a 10-foot channel bottom width, variable depth, 2:1 side slopes, and one 5-foot drop structure.

5.3 Alternatives for Arroyo Los Morenos

Two alternatives were considered to assist in the management of the flood flows in Arroyo Los Morenos watershed. The first alternative divides the watershed into sub-watersheds with part of the flow directed south through developed areas and the remainder directed to the east around the developed area. The second alternative diverts all the flood flow to the east around the developed area.

Alternative 1 - East and West Channel Improvements

The first alternative involves the construction of drainage improvements for the Gongora



Los Saenz
Drainage Improvements
Gongora Creek
Gongora Creek (East)
250
100
100 Year Flood Plain
Alternative Bypass Improvements
PEREZ/FREESE AND NICHOLS, L.L.C.
958/631-4482 Fax956/682-1545
1000 0 1000

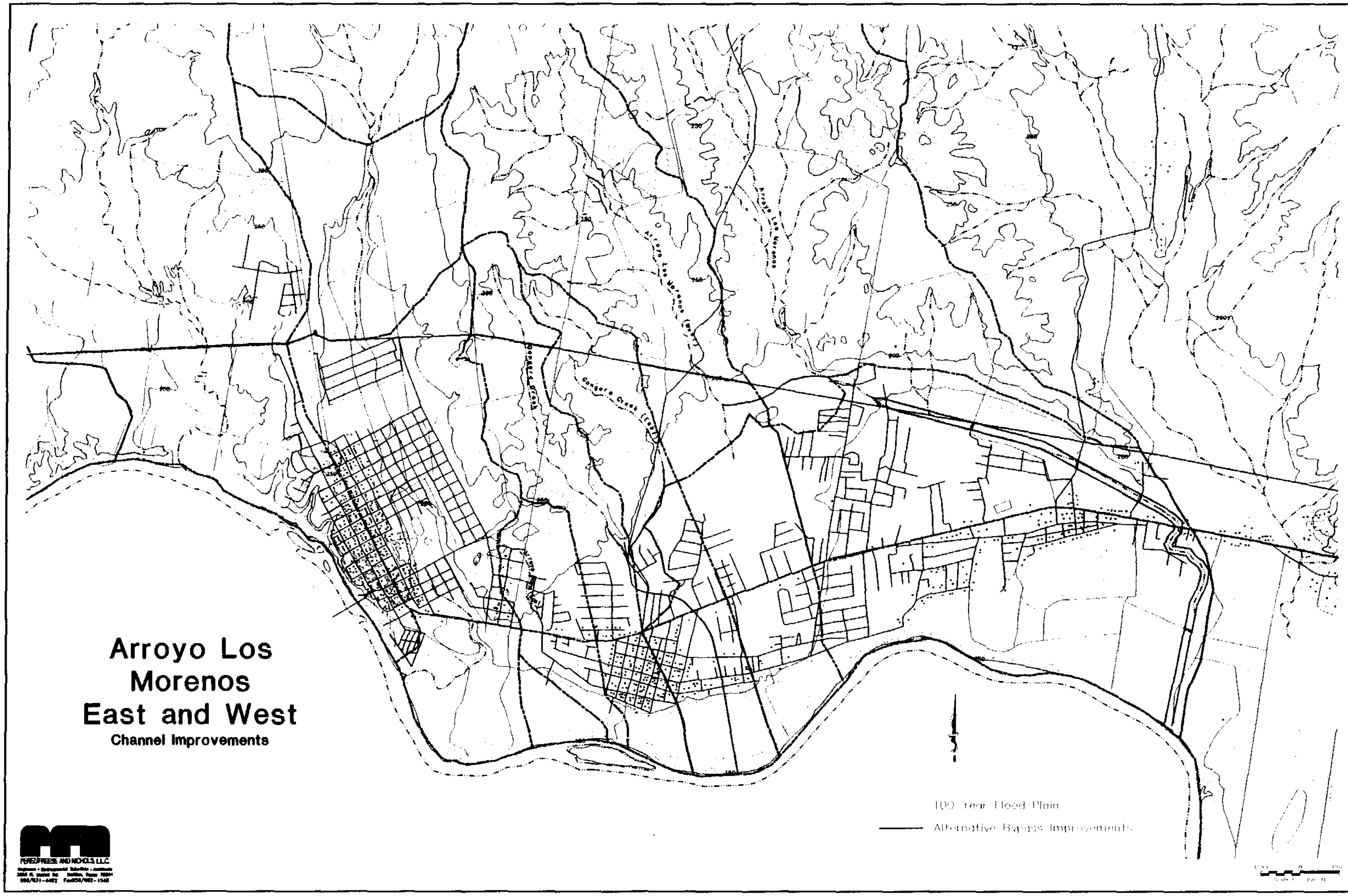
Figure 5.7

Creek watershed south through a sparsely developed area, then under U.S. 83 and then south to the Rio Grande as illustrated in Figure 5.8. The flood in the Arroyo Los Morenos watershed would be collected north of the currently partially developed area and diverted to the east. The improved channel for Gongora Creek above **N. Ebony Ave.** should have a 30-foot bottom width and below **N. Ebony Ave.** should have a 45-foot bottom width. The channel would be designed with 2:1 side slopes and a variable depth. Five new 8-foot by 10-foot box culverts would likely be required under U.S. Highway 83 for a total of nine.

The improved channel carrying the flood flows of Arroyo Los Morenos watershed to the east would begin at Arroyo Los Morenos - West with an improved channel with a 50-foot bottom width. The channel bottom would remain at the width until it reaches a point between **Soaring Dove St.** and **Evito Road** where the bottom width increases to 60 feet. The channel continues with a 60-foot bottom width until it reaches the Rio Grande. The improved channel is proposed with 2:1 side slopes and variable, but minimum flow depth of 5 feet.

Alternative 2 - Channel Improvements

This alternative begins at Gongora Creek near **N. Ebony Ave.** with a channel with a 20-foot bottom width. The bottom width increases to 30 feet where Gongora Creek - East enters the improved channel, to 75 feet where Arroyo Los Morenos - West enters the improved channel, and to 90 feet where Arroyo Los Morenos crosses Soaring Dove St. The channel width increases to 115 feet below U.S. Highway 83 and remains at that width until it reaches the Rio Grande. The channel is proposed with 2:1 side slopes and with a variable, but minimum of 5 feet, design flow. This alternative has been illustrated in Figure 5.9. Figure 5.9. also shows an alternate alignment south of U.S. 83 where it joins the Arroyo Grande (Garceno Creek). Costs for such diversion are not



Arroyo Los Morenos East and West
Channel Improvements
Arroyo Los Morenos
Gongora Creek
100 Year Flood Plain
Alternative Bypass Improvements
PEREZ/FREESE AND NICHOLS, L.L.C.

Figure 5.8

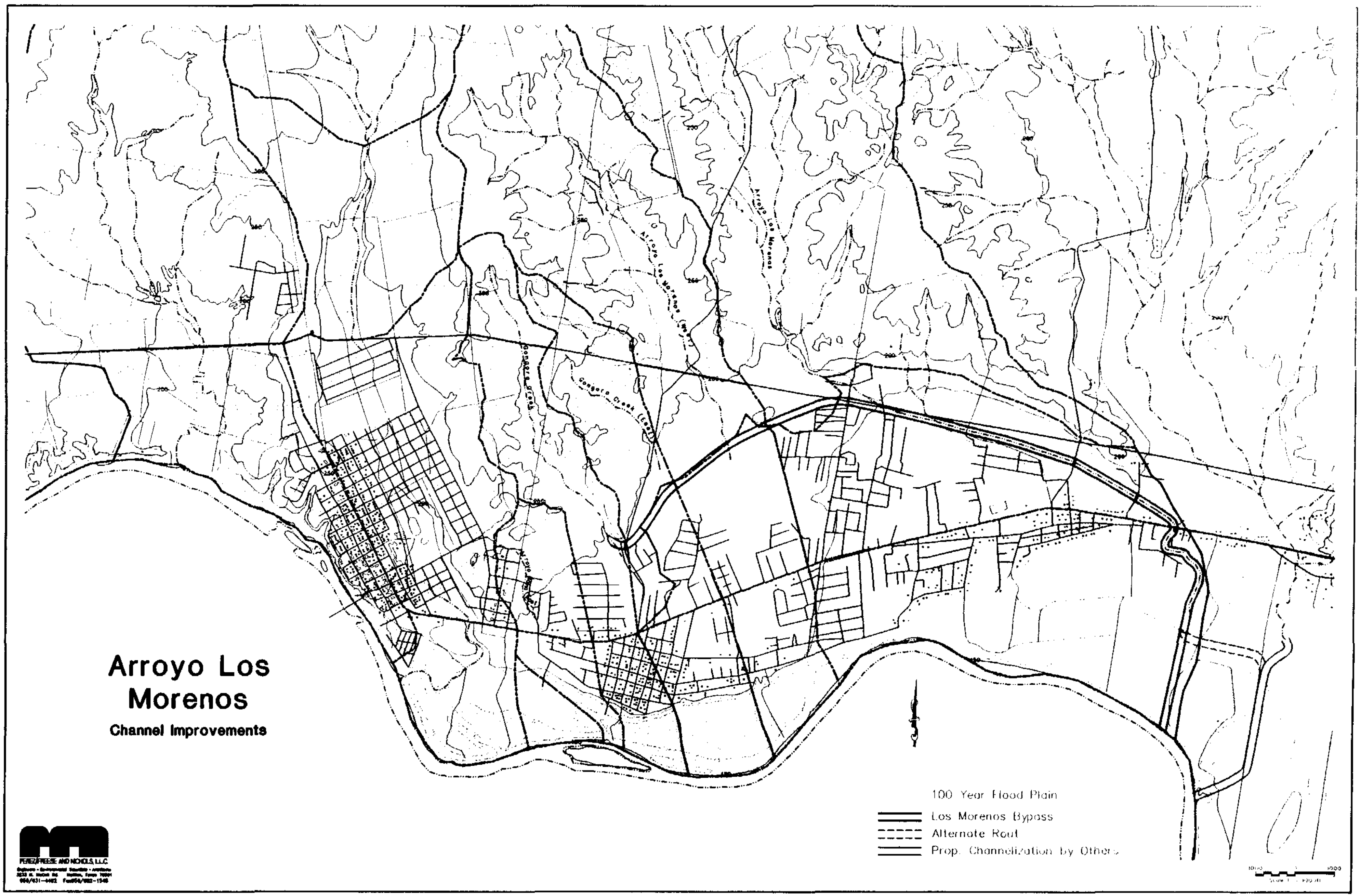

Arroyo Los Morenos
Channel Improvements
Arroyo Los Morenos
Arroyo Los Morenos (West)
Gongora Creek (East)
Gongora Creek
100 Year Flood Plain
Los Morenos Bypass
Alternate Rout
Prop. Channelization by Others
PEREZ/FREESE AND NICHOLS, L.L.C.

Figure 5.9

considered in this report since this work is considered speculative and dependent of assistance by the Starr County Commissioners Court.

6.0 Detailed Construction Cost Estimates

The preliminary estimates of the probable construction costs for the alternatives described in Section 5 have been summarized in Table 6.1. The details of the estimates of the probable construction costs have been presented in Tables 6.2 through 6.9.

Reviewing the construction cost estimates for the alternatives for Arroyo Roma, it is clear that constructing two 8 feet by 11 feet box culverts from E. Morelos Ave. to new box culverts under U.S. Highway 83 and an improved channel below U.S. 83 to the Rio Grande River is the least costly approach. This approach would have the least impact on the amount of property that would have to be acquired for the construction.

For Arroyo Los Morenos, the construction of the improved channel from Gongora Creek to divert all the flood flows from the watershed around the East has the lowest estimate of probable construction costs. This alternative also has the least impact on developed areas.

For all the least costly alternatives, the total estimated probable construction cost is **$22,212,684.00**. These estimated costs **do** include the proposed box culvert improvements under U.S. Highway 83 which we feel should be constructed by the Texas Department of Transportation (TxDOT).

Table 6.1

SUMMARY OF OPINION OF PROBABLE COST

CITY OF ROMA MASTER DRAINAGE PLAN

WATERSHED	COST
Arroyo Roma Alternate No. 1 Earthen Channel Improvements (Table 6.2)	$12,546,690.00
Arroyo Roma Alternate No. 2 Diversion Tunnel and Channel Improvements (Table 6.3)	$10,735,530.00
Arroyo Roma Alternate No. 3 Detention Reservoir and Channel Improvements (Table 6.4)	$14,268,826.00
Arroyo Roma Alternate No. 4 **Reinforced Concrete Box Culvert** (Table 6.5)	**$9,394,580.00**
Arroyo Roma Alternate No. 5 Purchase Homes along 100 Yr. Flood plain (Table 6.6)	$15,358,200.00
Los Saenz **Storm Sewer and Channel Improvements** (Table 6.7)	**$730,028.00**
Arroyo Los Morenos - East and West Diversions Channel Improvements (Table 6.8)	$12,164,724.00
Arroyo Los Morenos **Channel Improvements - North** (Table 6.9)	**$12,088,076.00**

Note: The highlighted alternatives are the lowest cost and recommended. The total cost for all recommended improvements is **$22,212,684.00.**

Table 6.2

Arroyo Roma Alternate 1

Earthen Channel Improvements

Item	Description	Quantity	Unit	Unit Price	Total
1.	Purchase Property	22	ea.	$12,000.00	$264,000.00
2.	Purchase Dwellings	105	ea.	$40,000.00	$4,200,000.00
3.	Purchase Vacant Lots	60	ea.	$6,500.00	$390,000.00
4.	Site Preparation/Demolition	51	acre	$2,000.00	$102,000.00
5.	Channel Excavation	440,000	c.y.	$8.00	$3,520,000.00
6.	Conc. Drop Structures	6	ea.	$95,000.00	$570,000.00
7.	U.S. Hwy. 83 Culvert H.W.	2	ea.	$22,500.00	$45,000.00
8.	U.S. Hwy 83 Culverts	1	ea	$196,900.00	$196,900.00
9.	Drill Seeding	51	acre	$400.00	$20,400.00
10.	Barrier Fencing	11,000	ft.	$13.00	$143,000.00
11.	Utility Relocations	1	l.s.	$200,000.00	$200,000.00
Subtotal					$9,651,300.00
Engineering, Administration and Contingencies (30%)					$2,895,390.00
Total Project Cost					**$12,546,690.00**

Table 6.3

Arroyo Roma Alternate 2

Tunnel and Channel Improvements

Item	Description	Quantity	Unit	Unit Price	Total
1.	Purchase Property	13	acre	$1,000.00	$13,000.00
2.	Purchase Dwellings	60	ea.	$40,000.00	$2,400,000.00
3.	Purchase Vacant Lots	50	ea.	$6,500.00	$325,000.00
4.	10' Dia. Diversion Tunnel	1,100	l.f.	$2,400.00	$2,640,000.00
5.	Intake Structure	1	ea.	$75,000.00	$75,000.00
6.	Outlet Structure	1	ea.	$75,000.00	$75,000.00
7.	Site Preparation	23	acre	$2,000.00	$46,000.00
8.	Channel Excavation	220,000	c.y.	$8.00	$1,760,000.00
9.	Drop Structures	6	ea.	$55,000.00	$330,000.00
10.	U.S. Hwy. 83 Culvert H.W.	2	ea.	$22,500.00	$45,000.00
11.	Road "A" Box Culverts	1	ea.	$196,900.00	$196,900.00
12.	Drill Seeding	23	acre	$400.00	$9,200.00
13.	Barrier Fencing	11,000	l.f.	$13.00	$143,000.00
14.	Utility Relocations	1	l.s.	$200,000.00	$200,000.00
Subtotal					$8,258,100.00
Engineering, Administration and Contingencies (30%)					$2,477,430.00
Total Project Construction Cost					**$10,735,530.00**

Table 6.4
Arroyo Roma Alternate 3
Detention Reservoir and Channel Improvements

Item	Description	Quantity	Unit	Unit Price	Total
1.	Property for Detention Reservoir	253	acre	$3,000.00	$759,000.00
2.	Purchase Dwellings	60	ea.	$40,000.00	$2,400,000.00
3.	Purchase Vacant Lots	50	ea.	$6,500.00	$325,000.00
4.	Detention Reservoir Embankment	314,540	c.y.	$10.00	$3,145,400.00
5.	Detention Reservoir Spillway	1	ea.	$200,000.00	$200,000.00
6.	Property of Construction	17	acre	$12,000.00	$204,000.00
7.	Site preparation	39	acre	$2,000.00	$78,000.00
8.	Channel excavation	339,565	c.y.	$8.00	$2,716,520.00
9.	Drop Structure	6	ea.	$77,000.00	$462,000.00
10.	U.S. Hwy. 83 Culvert H.W.	2	ea.	$22,500.00	$45,000.00
11.	U.S. 83 Box Culverts	1	ea.	$196,900.00	$196,900.00
12.	Drill Seeding	253	acre	$400.00	$101,200.00
13.	Barrier Fencing	11,000	l.f.	$13.00	$143,000.00
14.	Utility Relocations	1	l.s.	$200,000.00	$200,000.00
Subtotal					$10,976,020.00
Engineering, Administration and Contingencies (30%)					$3,292,806.00
Total Project Cost					**$14,268,826.00**

Table 6.5

Arroyo Roma Alternate 4

Reinforced Concrete Box Culvert

Item	Description	Quantity	Unit	Unit Price	Total
1.	Purchase Property	13	acre	$12,000.00	$156,000.00
2.	2 - 10x'8' RCBC	5,800	l.f.	$1,000.00	$5,800,000.00
3.	Entrance Structure	1	ea.	$75,000.00	$75,000.00
4.	Outlet Structure	1	ea.	$75,000.00	$75,000.00
5.	10' Curb-Type Inlets	75	ea.	$1,500.00	$112,500.00
6.	24" RCP Connection Pipe	4,000	l.f.	$35.00	$140,000.00
7.	Pavement Patch	20,000	s.y.	$15.00	$300,000.00
8.	U.S. Hwy. 83 Culvert H.W.	2	ea.	$22,500.00	$45,000.00
9.	U.S. 83 Box Culvert	1	ea.	$196,900.00	$196,900.00
10.	Channel Excavation	4,000	c.y.	$8.00	$32,000.00
11.	Drop Structures	3	ea.	$95,000.00	$285,000.00
12.	Drill Seeding	23	acre	$400.00	$9,200.00
Subtotal					$7,226,600.00
Engineering, Administration and Contingencies (30%)					$2,167,980.00
Total Project Cost					**$9,394,580.00**

Table 6.6

Arroyo Roma Alternate 5

Purchase of Homes in Flooded Areas

Item	Description	Quantity	Unit	Unit Price	Total
1.	Purchase Dwellings	316	ea.	$40,000.00	$12,640,000.00
2.	Purchase Vacant Lots	60	ea.	$6,500.00	$390,000.00
3.	Demolition of Dwellings	316	ea.	$2,000.00	$632,000.00
4.	Roadway Culverts	5	ea.	$60,000.00	$300,000.00
Subtotal					$13,962,000.00
Engineering, Administration and Contingencies (10%)					$1,396,200.00
Total Project Cost					**$15,358,200.00**

Table 6.7

Los Saenz

Storm Sewer and Channel Improvements

Item	Description	Quantity	Unit	Unit Price	Total
1.	Purchase Property	7.4	acre	$12,000.00	$88,800.00
2.	Site Preparation	7.4	ea.	$2,000.00	$14,800.00
3.	Channel Excavation	16,000	c.y.	$8.00	$128,000.00
4.	U.S. 83 Box Culverts	1	ea.	$100,000.00	$100,000.00
5.	U.S. Hwy. 83 Culvert H.W.	2	ea.	$6,000.00	$12,000.00
6.	5-Foot Drop Structure	1	ea.	$50,000.00	$50,000.00
7.	Drill Seeding	7.4	acre	$400.00	$2,960.00
8.	Barrier Fencing	5,000	l.f.	$13.00	$65,000.00
9.	Utility Relocations	1	l.s.	$100,000.00	$100,000.00
Subtotal					$561,560.00
Engineering, Administration and Contingencies (30%)					$168,468.00
Total Project Cost					**$730,028.00**

Table 6.8

Arroyo Los Morenos - East and West

Channel Improvements

Item	Description	Quantity	Unit	Unit Price	Total
	Arroyo Morenos - East				
1.	Purchase Property	45.8	acre	$12,000.00	$549,600.00
2.	Site Preparation	45.8	acre	$2,000.00	$91,600.00
3.	Purchase Dwellings	15	ea.	$40,000.00	$600,000.00
4.	Purchase Vacant Lots	35	ea.	$6,500.00	$227,500.00
5.	Channel Excavation	530,000	c.y.	$8.00	$4,240,000.00
6.	Efren Ramirez Box Culverts	1	ea.	$85,600.00	$85,600.00
7.	H.W. Efren Ramirez Culverts	2	ea.	$13,500.00	$27,000.00
8.	Soaring Dove St. Box Culverts	1	ea.	$85,600.00	$85,600.00
9.	H.W. Soaring Dove Culverts	2	ea.	$13,500.00	$27,000.00
10.	Evito Road Box Culverts	1	ea.	$102,700.00	$102,700.00
11.	H.W. Evito Road Culverts	2	ea.	$15,000.00	$30,000.00
12.	Escobar Road Box Culverts	1	ea.	$102,700.00	$102,700.00
13.	H.W. Escobar Road Culverts	2	ea.	$15,000.00	$30,000.00
14.	U.S. 83 Box Culverts	1	ea.	$175,000.00	$175,000.00
15.	H.W. U.S. 83 Culverts	2	ea.	$20,000.00	$40,000.00
16.	Country Road Culverts	1	ea.	$102,700.00	$102,700.00
17.	H.W. Country Road Culverts	2	ea.	$15,000.00	$30,000.00
18.	Drill Seeding	45.8	acre	$400.00	$18,320.00
19.	Barrier Fencing	10,000	l.f.	$13.00	$130,000.00
20.	Utility Adjustments	1	l.s.	$100,000.00	$100,000.00
Subtotal - Morenos East					$6,795,320.00

Table 6.8 Cont.					
Item	Description	Quantity	Unit	Unit Price	Total
	Arroyo Morenos - West				
1.	Purchase Property	23.4	acre	$12,000.00	$280,800.00
2.	Site Preparation	23.4	acre	$2,000.00	$46,800.00
3.	Channel Excavation	180,000	c.y.	$8.00	$1,440,000.00
4.	N. Ebony Ave. Culverts (upper)	1	ea.	$51,400.00	$51,400.00
5.	H.W. N. Ebony Ave. Culverts (upper)	2	ea.	$10,000.00	$20,000.00
6.	N. Ebony Ave. Culverts (lower)	1	ea.	$51,400.00	$51,400.00
7.	H.W. N. Ebony Ave. Culverts (lower)	2	ea.	$10,000.00	$20,000.00
8.	Jesus Sanchez Ave. Culverts	1	ea.	$77,000.00	$77,000.00
9.	H.W. Jesus Sanchez Ave. Culverts	2	ea.	$12,000.00	$24,000.00
10.	U.S. 83 Box Culverts	1	ea.	$150,000.00	$150,000.00
11.	H.W. for U.S. Box Culverts	2	ea.	$25,000.00	$50,000.00
12.	Fourth St. Culverts	1	ea.	$77,000.00	$77,000.00
13.	H.W. Fourth St. Culverts	2	ea.	$12,000.00	$24,000.00
14.	Drill Seeding	23.4	acre	$400.00	$9,360.00
15.	Barrier Fencing	23.4	acre	$6,000.00	$140,400.00
16.	Utility Adjustments	1	l.s.	$100,000.00	$100,000.00
Subtotal - Morenos West					**$2,562,160.00**
Subtotal - Morenos East and West					$9,357,480.00
Engineering, Administration and Contingencies (30%)					$2,807,244.00
Total Project Cost					**$12,164,724.00**

Table 6.9

Arroyo Los Morenos
Channel Improvements

Item	Description	Quantity	Unit	Unit Price	Total
1.	Purchase Property	70.5	acre	$12,000.00	$846,000.00
2.	Site Preparation	70.5	acre	$2,000.00	$141,000.00
3.	Channel Excavation	777,940	c.y.	$8.00	$6,223,520.00
4.	N. Ebony Road Box Culverts	1	ea.	$34,200.00	$34,200.00
5.	Headwalls N. Ebony Road Box Culverts	2	ea.	$15,000.00	$30,000.00
6.	N. Efren Ramirez Box Culverts	1	ea.	$128,400.00	$128,400.00
7.	Headwalls N. Efren Ramirez Box Culverts	2	ea.	$17,500.00	$35,000.00
8.	Soaring Dove St. Box Cul	1	ea.	$128,400.00	$128,400.00
9.	Headwalls Soaring Dove St. Box Culverts	2	ea.	$17,500.00	$35,000.00
10.	Evito Road Box Culverts	1	ea.	$154,100.00	$154,100.00
11.	Headwalls Evito Road Box Culverts	2	ea.	$20,000.00	$40,000.00
12.	Escobar Road Box Culverts	1	ea.	$154,100.00	$154,100.00
13.	Headwalls Escobar Road Box Culverts	2	ea.	$20,000.00	$40,000.00
14.	U.S. 83 Box Culverts	1	ea.	$200,000.00	$200,000.00
15.	Headwalls for U.S. 83 Box Culverts	2	ea.	$22,500.00	$45,000.00
16.	Road "A" Box Culverts	1	ea.	$196,900.00	$196,900.00
17.	Headwalls Road "A" Box Culverts	1	ea.	$22,500.00	$22,500.00
18.	Drill Seeding	70.5	acre	$400.00	$28,200.00
19.	Barrier Fencing	47,400	l.ft.	$13.00	$616,200.00
20.	Utility Adjustments	1	Lump Sum	$200,000.00	$200,000.00
Subtotal					$9,298,520.00
Engineering, Administration and Contingencies (30%)					$2,789,556.00
Total Project Cost					**$12,088,076.00**

7.0 Financing Options

The lack of stable and adequate local financing is a major obstacle to implementation of any comprehensive, long-range stormwater management programs. Traditional municipal financing methods have proven to be ill-suited to funding major improvements to drainage systems, their maintenance and operation, and regulation of private sector activities which impact the systems. This section addresses major recent changes in watershed management financing, and describes some of the alternative and innovative approaches which can be considered. It briefly summarizes a range of financing concepts and suggests criteria for evaluating various financing alternatives. The range of financing option concepts available to the City of Roma includes those which are explicitly authorized by state legislation, those available under home rule authority, and methods which might require legislative authorization at the state level. Each of the options identified in this section has been used in one or more cities in the United States, though some have not been implemented in Texas. Their use in Roma could be subjected to legal challenge and judicial interpretation. Financing concepts used in other states cannot be assumed to be legal under Texas law, and methods held to be invalid in other applications should not necessarily be considered invalid for stormwater management.

Since both legislative and judicial actions may limit the application of the various methods of drainage financing, this list of options will require legal review by the City Attorney's Office. No legal evaluation was made during this analysis.

7.1 Summary of Financing Options

Traditionally, stormwater management has been financed using **general fund revenues** for annual operating expenses and a mix of revenue sources for capital improvements. The level of operational funding in most jurisdictions has only been sufficient to respond to the highest priority needs, and has not allowed comprehensive programs to be developed.

The range of financing option concepts presented herein is a contrast to the limited number of funding sources that have been used for stormwater management in the past. The options should be viewed as opportunities to broaden the base of support and balance financial participation in a stormwater management program, while also localizing costs when it is more appropriate than distributing them citywide

7.2 General Fund

The general fund of the City is the "base" of financing for municipal programs, with revenues from a number of sources including property taxes, excise and sales taxes, business licenses and taxes, utility taxes, and fees of several types. It supports wholly or partially those city functions which do not have other sources of funding such as service charges.

The City administration and City Commission have discretionary control of the general fund through the budget process. Identified municipal responsibilities and political realities tend to define how most of these revenues are spent, however. It has historically been difficult for programs which focus on long-term, capital intensive, public facilities construction and maintenance to complete effectively in an annual municipal budget process.

There are few explicit limitations on the use of general fund revenues. They can be spent on both operational and capital expenses, although most often they are used for annual operating costs. Capital outlays which are sometimes paid from the general fund include equipment and land acquisition, but only rarely major construction.

General fund revenues are often relatively susceptible to economic conditions in the community. Sales tax and excise tax receipts drop during a bad economic slump. Property values may decline leading to reduced tax assessments. Property tax delinquencies tend to increase during periods of recession and high interest rates. At the same time demand for many municipal services (especially police and social services) increases.

Insofar as drainage is concerned, financing through the general fund tends to create an imbalance of costs in comparison to contribution to drainage problems, benefit or services received. The complexity of drainage problems makes it difficult to accurately define who pays a disproportionate amount or receives more in benefit than they may be paying. It is clear, however, that there is no measurable basis of equity inherent in general fund financing of stormwater management.

7.3 Drainage Utility Service Charges

This financing method has been instituted in a number of cities and counties (particularly in the western United States) as an alternative to general fund financing for annual operating expenses. These "user" charges are analogous to water and sanitary sewer service charges, but dedicated for stormwater management. This approach requires that an enterprise fund utility be established for stormwater management.

The drainage utility is an innovative concept, but one which fits uniquely well with the program needs in most local stormwater management operations. The functions and costs for effectively managing drainage are similar to those needed to provide water supply and sanitary sewer programs. Since water and sewer have been financed through service charges for some time, it is not surprising that drainage utilities and service charges have been implemented in the same basic format.

The philosophy behind user charges for watershed management differs from those for water and sewer service in several ways. Unlike water supply, a measurable commodity is not delivered to the customer and sometimes its benefits are no shared by all contributors. The service provided is similar to sanitary sewers or solid waste disposal in that something is carried away and disposed of (i.e., stormwater) but quantified measurement is difficult and costly. The demand for the "service" is not comparable to the demand for water supply, since most properties drain onto downhill neighbors fairly effectively without any public system. A broader definition of benefit resulting from service is needed in the case of drainage than for other utilities. Finally, drainage programs are more oriented to solving or mitigating problems than are the other utility functions, which have focused on providing service to clients.

Unlike some of the other financing options, user charges can provide a true alternative to general fund financing for drainage, rather than just a supplement to it. The other options have a limited contributing group and will not generate sufficient revenue to fund all the necessary functions. User charges, on the other hand, spread the expense of the drainage program as broadly as possible throughout a community, resulting in a relatively low cost for each property owner.

Revenues derived from service charges can be used to pay for administration, planning, design, operations and maintenance, payment of revenue bonds for new construction and replacement of old systems, support services, regulatory functions, and virtually anything else required in a drainage program. Rate structures are flexible mechanisms which enable a city to tailor the cost distribution to fit the local program and be consistent with other local policies. Finally, drainage utility revenues remain in the utility fund if not spent, rather than reverting for redistribution in the next year's budget, an important factor in long-term program stability.

7.4 Interfund Loans to Drainage Utility

The legislative action establishing an enterprise utility necessarily precedes the imposition of service charges and collection of revenues. An interfund loan from another municipal fund(s) may be desirable for interim financing of stormwater management functions until revenues are generated by the drainage utility. An interfund loan of this type is normally repaid from the utility service charge revenues.

7.5 General Obligation Bonding Repaid by Property Taxes

Capital improvements are often too expensive to finance from operating revenues, especially when an activity is funded from the general fund. General obligation bonding is a form of municipal borrowing in which the full credit of the city is pledged to service the bond debt. These bonds require voter approval, and usually involve an added property tax levy. They have been used for many purposes in the past, though use of them for utility projects has diminished with greater acceptance of revenue bonds.

Because they are backed by the full credit of the local government, general obligation bonds normally receive the most attractive (lowest) interest rates of any municipal borrowing instrument. They can be issued with varying maturities and other provisions which may affect their marketability and the interest rate they must pay.

7.6 Revenue Bonding Repaid by Service Charge Revenues

Enterprise funds, such as utilities, which have a source of financing separate from the general fund can borrow money for capital improvements through bonds to be paid off with service charge revenues. These bonds do not require voted approval, but are usually subject to slightly higher interest rates than general obligation bonds because the full credit of the city is not pledged.

Revenue bonds do not authorize an increase in taxes, nor do they usually authorize a specific increase in utility service charges. If necessary to support the bonds, a rate increase is normally enacted separately. It is possible to use service charge revenues from throughout a service area to repay revenue bonds or to specify that only revenues from one area or even certain properties be used for the bond payments. In most cases, it is best to place few limitations within the bond ordinance which relate to revenue sources, while still being consistent with financing philosophies and local policies. This provides the bondholders with some assurance of payment, and may result in a lower interest rate.

Although typically the bonds are repaid from the regular service charge revenues, municipalities may also establish system development charges, hook up fees, and other financing methods and earmark those funds for repayment of the revenue bonds. This reduces the revenue required from the standard service charge by the amount generated by the special fees and charges, and ensures that developing properties help pay for the project.

7.7 Utility Tax Revenues

Utility taxes and franchise taxes are levied on utilities operating with a municipality, including one or more of the following in most jurisdictions: telephone, electricity, natural gas, water, sewer, solid waste, fuel oil, cable television, and drainage. In recent years, cities have used utility tax revenues to construct various kinds of capital improvements, including drainage system improvements. In general, communities have a high level of discretionary control of utility taxes and their uses.

7.8 Tax Increment Financing

Tax increment financing can be used to provide funds for an infrastructure in areas where development is desired but funding for public facilities are not otherwise available when needed. In this approach, increases in tax revenues that are realized as a result of new development in a specified area are earmarked for financing public improvements or services in that area.

Usually administered by a public agency, a district is defined with a specified "base line" tax base of existing development. Improvements within the area are financed from the general fund or from bonds, then repaid from increasing tax revenues generated by the new development. The new development in effect pays its own way, using the community's normal tax program as the mechanism for deriving revenues. The method does have the drawback of siphoning off all increases in revenues, even revenues attributable to increased value of existing development in the area, until the bonds are paid off.

7.9 State Funding

Community Development Block Grant Funds: These revenue sharing funds are intended for use in neighborhoods which have been targeted for improvement based on social-economic and physical condition criteria. The City has discretion in the use of the funds within broad guidelines. In Texas, CDBG funds are administered by the Texas Department of Commerce.

With pressures to balance the federal budget, the future of federal development funding is uncertain and the City should not depend on CDBG funds. In addition to the uncertainty surrounding revenue sharing funds, the program itself has substantially more applicants that funds available. Therefore, grants are generally awarded to those communities with highest priority needs, such as substandard housing, inadequate water and sewer systems, and a significant percentage of low/moderate income residents (8).

Texas Water Development Board Funding: The Texas Water Development Board (TWDB) administers state funds for financing flood control projects. TWDB funds are disbursed to eligible political entities, generally as loans. Using the state's excellent bond rating, TWDB sells Texas Water Development Bonds which are general obligations of the state and purchases the bonds of local political subdivisions.

Historically, use of the Texas Water Development Fund was reserved for "hardship" political entities (political subdivisions unable to sell bonds in the open market or political subdivisions unable to sell bonds at a reasonable interest rate). However, passage of House Bill 2 by the 69th Legislature and approval by voters in November 1987 expanded the program to allow TWDB to make loans without a finding of hardship for the construction of a regional water treatment facility, flood control project, and facilities designed for conversion from the use of ground water to surface water.

TWDB may provide loans from flood control funds for the following flood-control related projects: (1) construction of stormwater retention basins, (2) enlargement of stream channels, (3) modification or reconstruction of bridges, (4) the acquisition of floodplain land for use as a public open space, (5) acquisition and removal of buildings located in a floodplain, (6) relocation of residents of buildings removed from a floodplain, and (7) development of flood plain management plans. To determine if a project is eligible for loan funds, several points are considered including the needs and benefits of the project to the area to be served, the availability of revenue for repayment of the loan, and whether the political subdivision can reasonably finance the project without State assistance (hardship).

7.10 Fees and Charges

Cities have developed a variety of special administrative fees and charges to cover expenses which are associated with permits and other services for individuals. In most cases, an identifiable "client" is assessed the fee or special charge, which is often earmarked to support a specific function.

Plan Review and Inspection Fees: The City has specific design and construction standards which private drainage systems must meet. Development permits are issued only when the plans meet these standards, requiring that the staff check that plans. Field inspections are necessary to verify that the systems are installed as designed, since private drainage systems may have a direct impact on the function of public systems. Some cities attempt to make plan review and inspection financially self-sufficient through the fees, while others subsidized these functions partially out of general fund revenues to encourage development. The net effect of this type of fee is to have individuals with changes in land use bear some or all of the cost for improvement of public services impacted by their projects.

On-site Detention/Retention System Inspection Fees: The private drainage systems which are installed on private property are important components of the total drainage system. Public systems are often designed and operated on the assumption that the private systems will function properly. Experience has shown, however, that voluntary maintenance of private drainage systems is very lax. Annual inspections of private on-site facilities can identify needed maintenance before problems occur, but they are relatively expensive to carry out on a regular basis. These inspections can be billed to the property owner as a service charge if a drainage utility is established. It may be possible for the City to also levy such a charge without a utility, though an annual permit of some type may be needed.

Impact Fees: Impact fees are charges or assessments against new development to fund the cost of capital improvements or facility expansions necessitated by and attributable to the new development. As of June 1987, Texas cities are expressly authorized to assess impact fees for drainage facilities provided that the fees are directly **associated with actual impacts and earmarked to ensure they are used to mitigate those effects**. Further, the costs of oversizing facilities constructed prior to adoption of an impact fee ordinance may be recouped through the fees.

Impact fees began as a response to the realization that construction and land development may have significant impacts on a neighborhood or even an entire community. Rapid growth fostered a concern not only for the environmental effects of growth, but the economic implications as well. Increased urban runoff and pollution, congested highways, and larger water and sewer facilities often translate into higher property taxes to upgrade municipal systems in response to problems. Impact fees are perceived as a mechanism to make growth pay it's own way by participating in the cost of new facilities at the front end of a project rather than indirectly through long-term enhancement of the tax base and increased local employment.

While the recently enacted state legislation limits the use of the impact fee concept, the statute validates a funding process that has already passed judicial scrutiny. The new law requires that, prior to adoption of an ordinance establishing impact fees, a City must conduct several studies to determine the real impact of new development on the infrastructure. These studies include land use assumptions, establishment of service areas, a capital improvements plan, and analyses relating the costs of improvements to individual "service units." The statute also prescribes a definitive adoption procedure and requirements for earmarking and accounting, refunds, and assessment and collection of the fees. Prohibitions on the use of fees include "repair, operation or maintenance of existing or new capital improvements" and "administrative and operating costs" of the City.

Impact fees are sometimes confused with the other types of special fees and charges cited in this report. Care should be taken to differentiate between impact fees, which are associated specifically with the impact of a project, and the general needs for new facilities to serve the community.

Development Assessment Charges: As an alternative to requiring each new development to provide conveyance systems, on-site detention or retention to mitigate increases in peak runoff, the City could institute this type of charge as an option available to developers in some communities. Detention capacity and conveyance systems would be satisfied by regional public facilities, which the developers would be "buying into" and "contributing to" through the development assessment charge instead of building the on-site detention system on their site. Such fees are then earmarked to pay for **regional detention facilities**.

This approach will probably be enthusiastically welcomed in communities where developers have experience with building their own on-site detention systems. Not only are the developers relieved of the cost of design and responsibility of building the on-site facility, but they gain more flexibility in the efficient use of their property since an area need not be set aside for detention of stormwater.

Assessment fees are particularly useful when more than one type of drainage system would solve or mitigate a problem, but one approach would be privately financed while the other would be paid for from public funds. In some cases, the cities would prefer to have the type of system that would require public financing, yet do not want to forego the private investment which is justified. Assessment charges can offer the best of both options by allowing the most desirable system to be built while still ensuring private financial involvement.

System Development Charges (SDCs): These charges have been used by municipal utilities for a number of years as a method of financing improvements. They have been known by several titles other than system development charges, e.g., utility expansion charges and extension and improvement charges. System development charges differ from other similar charges, such as general facility charges, in that they are associated with **specific improvements** are constructed as a means of balancing financial participation.

Communities must frequently install suitable water, sewer, and drainage systems in anticipation of growth. System development charges enable communities to meet the increasing demands on systems which accompany growth pressures. The SDC resembles the latecomer's fee for developer extensions, which is explained below, in that the intent is to enable a community to achieve excess capacity improvements in advance of growth. At the same time, place an equitable portion of the cost on those properties which later develop and makes use of the extra capacity that was built into the system.

When revenue bonds (supported by drainage utility service charges) are used to finance drainage improvements, SDC's can ensure that all properties, adjacent to or within the watershed, equitably participate in the financing of the capital improvements. Major drainage improvements are normally sized with future development in mind and have a useful life at least two or three times as long as the bond maturity. One purpose of the SDC's concept is to ensure that the properties which develop after the bonds are sold also help to pay for the improvements. SDC's should be consistent with that amount paid by developed properties when the improvements were constructed.

The SDC provides a rational financing method which responds to the sensitive issue of who pays for over-sizing to accommodate future growth. Care must be taken, however not to place too much confidence on future growth as a revenue source. If the growth slows or does not occur, the existing developed properties might have to pay a larger service charge in the future to cover the shortfall of SDC revenue. Unanticipated increases in service charges due to SDC shortfalls can erode a utility's credibility with the public, and should be avoided through conservative projections.

General Facilities Charges: General facilities charges are similar to the SDC concept, although they are more often used for **overall improvement to a system**, or for maintenance or replacement than for specific capital improvements. This method of financing is most often used when improvements which will benefit an entire service area are involved.

If a community has sufficient drainage utility service charge revenues that improvements made to the drainage system can be paid for directly out of revenues rather than through bonding, general facilities charges can be used to balance the financial participation. For example, if all improvements to the drainage systems are oversized for future conditions, but the developed properties are not billed a service charge, the general facilities charge can be used to ensure that developing properties "buy into" the prior capital investment in the system. This type of financing works best when the newly developing properties must obtain a permit to hook up to the drainage system, similar to the case of water and sewer.

The general facilities charge is probably most appropriate when a simplified rate structure is used which lumps operating and capital expense into a uniform system of charges or an "equivalent residential unit" approach. In such cases, the costs of all elements of the drainage program are spread area-wide without a highly refined cost distribution formula.

The underlying philosophy of this approach is that the improvement serves everyone, or the system is viewed as a fairly uniform whole rather than as a number of discrete parts. There is usually no need to break down a general facilities charge into component parts, whereas a system development charge is often associated specifically with revenue bonds for individual improvements, which suggests that much closer accounting practices are justified.

Other terminology is used in different areas of the country for financing concepts quite similar to general facilities charges. Water and sanitary sewer "hook up" fees are often intended to help finance general improvements to the systems rather than simply cover the expenses related directly to the hook up itself. Some cities include general facility charges in building permit fees, or other municipal approvals associated with development. Regardless of what they are called, general facilities charges for drainage provide an additional revenue source which may fill in gaps in a utility rate structure. The gaps are often intentional and reflect the City's financing policies (e.g., undeveloped properties do not help finance utility systems), or occur because of billing system limitations.

Latecomer's Fees: These charges are especially useful in developing areas or where major **reconstruction or upgrading** of a drainage system is needed, public funds are limited or not available, and a private development is contingent on the improvement. Through a developer extension agreement, the City can allow the developer to construct the improved and oversized drainage facility in conjunction with the project.

Developer extensions are common for water and sewer systems in new developments, but have not been widely used for drainage systems. The latecomer's fee is usually only used for over sizing costs, for example in the case of sanitary sewer interceptors or to ensure fire flow capacity to other properties. This charge method may be applied to drainage systems as well.

Regardless of what these various fees and charges may be called, they typically have specified purposes, and are accounted for in a manner which allows the revenues to accumulate. Fees and charges dedicated for specific purposes can be carried forward, and reserves can accumulate if an enterprise utility fund is established for drainage which separates the revenues from the general fund.

Revenue which is not spent for several years may also require a special accounting treatment in municipalities in some state. Usually, the money must be accounted for in the budget, even if it is not intended to be spent during that year. For water, sewer, and solid waste, a utility expansion fund is often the reserve account for these revenues in a municipal budget. Drainage utilities can use the same accounting technique to make dedicated reserves less susceptible to application to other needs, a protection which may be important in differentiating fees from taxes.

Utilities are allowed to retain surplus funds, both as a reserve to respond to emergencies and as a natural function of long-term rate structures which are predicated on differing rates of change in expenditures and revenues over time. This reduces the frequency at which the rate structure must be changed, contributing to stability. Similar accounting practices allow revenue accounts for fees and charges in a utility to accumulate. It is important to clearly identify reserved funds in the annual budget and to maintain a proper audit trail to ensure that an accurate picture is given of the enterprise's balance sheet, including fee accounts.

7.11 Special Assessments

Several methods of levying special assessments on benefitted properties to pay for drainage improvements have been used around the country. In most cases, the projects have a demonstrable benefit to the properties included in the assessment area and the charges for each parcel are consistent with the relative benefit to each property. In Texas, special assessment options include drainage districts, which are special-purpose taxing districts with specific authority to deal with stormwater management (9), and special improvement districts, which are areas of the city where the majority of property owners have requested City Council to establish a district and collect assessments to fund levels of service and programs in excess of the existing levels (10).

7.12 Criteria for Evaluating Financing Options

Whenever an effort is made to develop a new drainage program and/or a new financing concept for a municipal function as complex as stormwater management, some basis must be established for judging the appropriateness of the various options. A financing strategy must provide a stable, adequate, and publicly acceptable source of funds which will support the entire program as efficiently and equitably as possible. Transition, growth, and future program requirements must be considered as well as immediate needs. Further, the financing strategy must be consistent with the community's perceptions and resources.

Based on experiences in cities which have implemented stormwater management programs, the following criteria were selected as qualitative measures of the financing options. It is unlikely that any single financing method will be judged best under this wide range of considerations, but the criteria should help identify the best mix of funding methods, and reconcile differences between program and financing strategies. Some of the criteria may be viewed as more important than others. The order does not imply a priority, although public acceptance based on perceived equity is essential for political success of any new stormwater financing proposal. No single criteria should outweigh the others to the extent that an option is selected or rejected solely on one consideration.

Perceived Equity and Public Acceptance: Public acceptance of a financing strategy and the mix of financing methods it incorporates is essential for a drainage program to be successful. It must be recognized that some members of the community will not wish to pay anything, through any financing method, to fund drainage control. In most cases, a larger segment of the population will understand the need for an adequate stormwater management program, and the necessity of paying for it. To these citizens the critical issue is usually equity. It is important to note that perfect equity is probably not achievable either technically or economically, and that public opinion will be based on "perceived equity" and an appearance of basic fairness in financing.

The key is to finance stormwater management in an understandable manner. This is the strength of classifying financing techniques according to purposes for which the technique typically is used. It presents a logical association between what is done (functions) and how to pay for it (financing). To achieve perceived equity and public acceptance this logic must be communicated to the general public through various public information concepts.

Flexibility: A great deal of change could occur in stormwater management programs during the next decade. More effective regulation and maintenance of systems could be required. Water quality may become as important a concern in the overall management of the drainage systems as flow control. A financing strategy should be responsive to the growth needs of the program and to the physical complexities of the drainage basins. It must provide a flexible approach which can grow incrementally with the program.

To gain this flexibility, a mix of financing methods is likely to be needed. Some methods may require authorizing legislative action at the state level, and the local government may have to substitute a second choice for funding some functions until such legislation is adopted. Care should be taken during the interim not to foreclose options which require legislative authorization. It is also possible that a financing strategy selected through this process will not fit the needs 10 or 20 years in the future, in which case the most flexible system might be the easiest to adjust to meet changing priorities.

Capacity: The financing methods should be carefully evaluated to determine if they can generate sufficient revenue now and in the future to meet program needs. The public's willingness to pay may have thresholds beyond which they will not support even the most equitable financing system for watershed management.

Perceived equity is a factor in the public's willingness to pay. Their willingness may increase with the strength of their perception of equity. However, emphasis on equity also carries with it a potential problem if the financing capacity of the most logical and equitable funding method is insufficient to accomplish the program.

Analysis of long-term financing capacity is important, and the equity criteria must be tempered with a degree of reasonableness. Inflation and other factors can render even the best estimates unreliable, which would suggest that the greatest emphasis be placed on short-term financing capacity (for not more than five to seven years).

Cost of Implementation: The bottom line to many of the criteria identified in this section is cost. A perfectly equitable financing method might be desirable and achievable except for the cost of development and maintenance. Compatibility with other programs and policies may be limited in a financing strategy to avoid the expense of an excessively complicated mix of financing methods, or to limit the complexity of needed rate structures.

The initial cost of implementation must be weighed against the financing capacity of the options and the program needs. A financing method which costs more to implement may be worth the added expense if the alternatives cannot generate sufficient revenue to fund the program. Another consideration is the source of revenue against which the implementation costs would be charged. One element of a financing strategy could be to delay the implementation of some financing methods until a drainage utility is formally established, making the subsequent implementation costs a utility expense rather than a general fund expense. The work might initially have to be funded from an interfund loan from another fund, but could be repaid later from utility revenues.

Finally, the cost of implementation must be weighed against the price of delay. Many segments of a drainage system may be in need of remedial repair or even replacement to prevent costly and dangerous failures. At least one year lead time is usually needed to prepare plans, designs, and bid documents to correct major drainage problems. Timely implementation may prove less costly in the long-run than the method with the lowest initial cost of implementation. Also, each month that a utility service charge concept is not in place, it means that the revenue is foregone.

Compatibility: Whenever possible, the financing methods for stormwater management should be compatible with existing policies, practices, and systems. This simplifies implementation and acceptance among City staff, and minimizes costs. Special emphasis should be given to ensuring compatibility between policies pertaining to the water and sewer utilities and those of a drainage utility, if one is established.

In some cases, financing methods may necessitate substantial changes in existing practices or systems. For example, use of drainage utility service charges might require that the utility billing system be altered to incorporate the additional billing. An effort should also be made to anticipate opportunities to improve existing systems during a changeover in the drainage program. Development of a master billing file for a utility service charge could provide the mechanism for assembling a parcel-based data system which would have spinoff benefits for land use planning, economic development, and other municipal programs. The incremental cost of generating additional data for management information systems is minimized if it can be piggybacked with the base file work being done for drainage or other related purposes. The City should also consider compatibility with programs in neighboring jurisdictions and special-purpose agencies.

Upkeep Requirements: The financing methods may have differing needs in terms of upkeep. Some require virtually no file or record maintenance, whereas others demand constant updates. Fee systems can be set up in a variety of ways which imply different upkeep procedures. Systems which minimize upkeep costs are desirable, but this must be weighed against both the equity and flexibility considerations.

This criterion is especially important with regard to drainage utility service charges. The upkeep requirements can be controlled through proper design of the data systems and processes that are used in the rate structure and for billing. The best reference, for evaluating the upkeep costs of drainage utility service charge financing options during the finance strategy phase, is the experience of the other cities which have implemented similar systems.

Balance: A financing strategy must be balanced in the terms of dependency placed on any single method of funding, the fit with the drainage program, and the resources of various sectors of the general public. A single source is likely to provide most of the money for annual operating expenses, i.e., either the general fund or a utility service charge. An effort should be made, however, to balance the dominant revenue source with complementary funds for special elements of the program. A municipality can control (to some degree) the balance the dominant revenue source with complementary funds for special elements of the program. A municipality can control (to some degree) the balance of revenue sources to ensure that the financing capacity is hedged against economic downturns and is responsive to economic improvements.

Drainage utility rate structures are relatively inelastic, and more stable than other utility rates that are based on consumption (e.g., water and electricity). Most drainage rates are based on how the use of property effects hydrology and/or water quality (with no charges assessed to unimproved property). These rates do not change in response to the economy. Delinquencies tend to increase during recessions, however, and a drainage utility is not totally immune from a revenue shortfall.

With so much emphasis placed on reconciling the financing strategy with the program strategy, that aspect of balance is usually well-assured initially. Care must be taken that the balance of the financing strategy remains consistent with the various stages in the development of the program, especially in light of the capacity of various financing methods. If the cumulative willingness to pay of the citizens in a neighborhood is fully tapped during the first two years by application of a variety of fees and charges, another element of the financing strategy might later be rejected. Also, no segment of the community should feel that the entire drainage program is being carried solely on their backs.

Timing: This consideration is most important in terms of the time required for implementation, and whether it fits with the desired timing of the program development process. If possible, charges should be initiated during the rainy season, when residents' recognition of drainage problems is highest. Some financing methods are highly dependent on timing for success. For example, special assessment districts should be proposed when the problems are fresh in the residents' minds and not during drought times.

Geographical and Jurisdictional Considerations: Unique geographical conditions should be incorporated into the evaluation, especially when there are numerous drainage basins, as the case in Roma. Over the long-term, demand for drainage services may be similar, but some areas might require replacement of inadequate or failing systems years before others.

Possibly the most important jurisdictional consideration is the difference in service level and design standards between neighboring local governments which share responsibility for drainage basins. The financing options should be evaluated on their suitability for bridging technical differences to support mutually desirable solutions to problems. The priorities which each local jurisdiction place on achieving its standards should also be reconciled with the opportunities afforded by financing options.

7.13 Summation

Experience has shown that implementation of numerous service charges, fees, and taxes cause confusion and misunderstanding in payment and funding allocations. In addition to an administrative fee charge for drainage plans review, a general drainage facilities charge, a base charge for the entire City similar to a utility charge but based upon land use, should be considered to supplement the existing fee structure. This charge would be designed to generate the additional revenue needed for program operations and allow the burden for generating revenue to be distributed equitably among all the citizens of Roma.

The City of Roma needs to review the financing options and adopt a combination that should provide adequate funding for a stormwater management program.

8.0 Recommended Master Plan Improvements

The most urgent master drainage improvement needs for the City of Roma are improvement plans for Arroyo Roma due to its potential for damage to property and life. The construction of a double 8-foot by 11-foot box culverts (2-8'x11' RCBC) along the Arroyo Roma waterway between E. Morelos Avenue and U.S. Highway 83, has been identified in this study as the least costly solution.

Two recommended first steps would include:

- Entering into an engineering and surveying contract with a scope of services that would permit the preparation of right-of-way/easement studies and surveys and preliminary plans for the construction projects contained in the report. A revised estimate of the probable construction cost and land acquisition cost would then be developed and prepared.
- Initiate preliminary and detailed discussions with the Texas Department of Transportation (TxDOT) over plans for the construction of the identified culvert improvements under U.S. Highway 83 at Arroyo Roma, Los Saenz, and at Arroyo Los Morenos.

With the base hydraulic information determined from engineering and surveying studies, more detailed construction and funding plans could be developed for the construction of the proposed box culvert improvements in Arroyo Roma. One year to eighteen months could be required to complete this work depending on how quickly land acquisition agreements can be reached on the final alignment. Another year would probably be required to obtain funding and to acquire the necessary right-of-ways and easements.

As important to the Arroyo Roma improvements, it would be prudent to consider work within the Los Saenz and Arroyo Los Morenos watersheds. Some of the recommended work that lies outside the City's limits and extra territorial jurisdiction will involve cooperation of Starr County. Some of the work within the lower reaches identified in this report in the Arroyo Los Morenos may be coordinated with the County Commissioner responsible for that area, combining the Arroyo Grande (Garceno) and Los Morenos, shown on Figure 5.9 as an alternate route. Appropriate channel alignments must be determined by performing detailed engineering and surveying studies. We anticipate and understand that routing of drainage outfalls from traditional waterways will be a difficult undertaking due to the sometimes unidentified clear waterways. It is important that deliberate and prudent negotiations be initiated with affected land owners to accomplish the goals contained in this report. Any legal opinions and considerations as to land acquisitions and drainage law should be addressed by the City Attorney.

To minimize the increase of future construction costs for drainage related projects, it is essential and imperative for the City, and in cases outside City limits, the County to **place a moratorium and stop any further development** in the identified floodplains and known flooded areas as well as in the vicinity of proposed routes of the improvements in the Arroyo Roma, Los Saenz and Arroyo Los Morenes watersheds. The development of a set of updated drainage ordinances, drainage requirements for development, and flood zone maps would greatly assist the city in reaching these objectives.

Three public meetings were conducted to discuss the study approach, the considered alternatives, and the recommended solutions. These meetings were conducted with the residents of the project area to determine how the most economical solution would impact social and environmental factors. The documentation of the comments of the public meetings included in Appendix B confirms the public consent for construction of flood control alternatives to serve the distressed areas.

9.0 Implementation and Phasing Recommendations

In order to accomplish all the work recommended within this Master Plan, it will be necessary to phase the required work into various sections and phases. Phasing of the projects will be essential given the City's budgetary and land/easement acquisition restrictions. The Arroyo Roma improvements are considered to be of the first priority and should be planned and implemented first since there exists potential danger to property and life due to flash flooding. This is not to say however, that other problem areas need immediate attention as well such as the Los Saenz (Police Station vicinity) problems. We feel that some of the work required to alleviate the flooding potential within the study area will have to be done with the assistance with the Texas Department of Transportation and such work will have to be programed into their budget. In Table 9.1 we have outlined the recommended phasing and scheduling of drainage improvements for all the watersheds contained in this study. Recommended improvements that require assistance from the Texas Department of Transportation (TxDOT) have been included with all other improvements, except culvert pipe required at Los Saenz from Escandon Avenue to 4th Street. These TxDOT improvements will be key essential in the development of the work contained in this report.

Table 9.1
PROJECT IMPLEMENTATION SCHEDULE
ARROYO ROMA

Year	Description of Work	Cost
1998	• Contact the Texas Department of Transportation for work at Arroyo Roma and U.S. 83 • Contract Engineering Services to prepare engineering drawings for all improvements • Contract Surveying Services to prepare land acquisition/easement surveys for proposed improvements	
1999	Obtain/Negotiate Drainage Easements and ROW for Arroyo Roma	
1999	Construction of Arroyo Roma channel improvements from the Rio Grande River to U.S. Highway 83	$424,060
	Construction of culvert improvements by TxDOT on Arroyo Roma at U.S. Highway 83	$314,470
	Subtotal 1999	$941,330
2000	Construction of Box Culvert and wingwalls at Arroyo Roma from U.S. Highway 83 to Bravo Avenue (School Property)	$2,518,10 0
2001	Construct Box Culvert from Bravo Avenue to Garfield Avenue	$2,990,00 0
2002	Construct Box Culvert improvements on Arroyo Roma from Garfield Avenue to East Morelos Avenue	$2,945,15 0
TOTAL		**$9,394,58 0**

Table 9.2
PROJECT IMPLEMENTATION SCHEDULE
ARROYO LOS MORENOS

Year	Description of Work	Cost
1998	• Contact the Texas Department of Transportation for work at Arroyo Roma, Los Morenos and 4th Street (San Juan Avenue - Los Saenz) • Contract Engineering Services to prepare engineering drawings for all improvements • Contract Surveying Services to prepare land acquisition/easement surveys for proposed improvements	
1999	Obtain/Negotiate Drainage Easements and ROW for Arroyo Los Morenos	$1,099,800
	Construction of channel improvements for Arroyo Los Morenos from the Rio Grande River to U.S. highway 83	$2,695,550
	Construction of culvert improvements by TxDOT for Arroyo Los Morenos	$318,500
	Subtotal	$4,113,850
2000	Construction of channel improvements at Arroyo Los Morenos from U.S. 83 to Escobar Road	$1,218,126
2002	Construct channel improvements from Escobar Road to Evita Road on Arroyo Los Morenos	$901,550
2003	Construct channel improvements on Arroyo Los Morenos from Evita Road to Efren Ramirez Road	$2,924,090
2004	Construct channel improvements on Arroyo Los Morenos from Efren Ramirez Road to the end of the project	$2,930,460
TOTAL		**$12,088,076**

Table 9.3
PROJECT IMPLEMENTATION SCHEDULE
LOS SAENZ

Year	Description of Work	Cost
1998	Contact the Texas Department of Transportation for work at Arroyo Roma, Los Morenos and 4th Street (San Juan Avenue - Los Saenz) Contract Engineering Services to prepare engineering drawings for all improvements Contract Surveying Services to prepare land acquisition/easement surveys for proposed improvements	
1999	Obtain Drainage Easements and ROW for 4th Street Channel Improvements (Los Saenz) and Channel Downstream of U.S. 83 to Rio Grande River	$115,440
2000	Construction of Channel Improvements for the 4th Street Channel (Los Saenz)	$614,588
2001	Construct Culvert Pipe along north side U.S. 83 from Escandon Ave. (Los Saenz) to 4th Street Culvert at U.S. 83 (by TxDOT)	
Total		**$730,028**

LIST OF REFERENCES

(1) Eagle Point, Watershed Modeling, Third Edition, August 1994.

(2) Soil Conservation Service, U.S. Department of Agricultural, SCS National Engineering Handbook Section 4 Hydrology, August 1972.

(3) State Department of Highways and Public Transportation, State of Texas, Bridge Division, Hydraulic Manual, Third Edition, December 1985, p.2-14 and Table 6.

(4) Linsley, Ray K. Jr, Kohler, Max A., and Paulhaus, Joseph L.H., Hydrology for Engineers, p.228, McGraw-Hill Book Company, 1958.

(5) Texas Department of Community Affairs, City and County Assistance: Texas Community Development Program, Austin, 1987.

(6) Texas Advisory Commission on Intergovernmental Relations: Handbook of Governments in Texas, Austin, 1984.

(7) Harman, Douglas and Diveley, Ann Long, "Fort Worth Improvement District: A First in Texas," Texas Town and City, September 1987.

Appendix B

Minutes from Public Meetings

CITY OF ROMA
PUBLIC HEARING

The Board of Commissioners for the City of Roma conducted a public hearing on May 20, 1998 at 6:00 p.m. at the Roma Community Center.

The purpose of the public hearing was to discuss the ongoing current Drainage Master Plan Study of the Arroyo Roma and Los Morenos Watersheds. The study is being funded by the Texas Water Development Board, the City of Roma and Starr County. The public was invited to offer comments regarding social and environmental effects to the proposed alternate solutions to drainage and flood protection for the City of Roma and Los Morenos watersheds.

Mayor Fernando Peña was absent due to a meeting with Texas Water Development Board in Austin, Texas.

Persons attending the meeting were Commissioner Gabriel E. Recio, Mr. Jorge D. Perez, P.E. from Perez, Freese & Nichols, Mr. Anthony Reid, P.E. from Perez, Freese & Nichols, Mr. Rogelio Salinas, Director of Administration, Ms. Josie Hinojosa, City Secretary, Ms. Norma G. Martinez, Mr. Crisanto Salinas, City Planner, Mr. Jose H. Garcia, Chief of Police, Lieutenant Francisco Garcia,, Sergeant Emilio Montalvo, III., Mr. Joe Medrano, Mr. Salome Barrera, Sr. Mr. Salome Barrera, Sr., Mr. Leonel Gonzalez, Mrs. Rosa Ena Saenz, Mrs. Gloria Castañeda, Mrs. Belsa Alaniz, Mr. Domingo Sifuentes, Mr. Rene Gonzalez, Mr. Alex Gutierrez, Mr. Mario Barrera, Mr. Enrique Barrera, Mr. David Barrera, Mrs. Margarita C. Barrera, Dr. Jesus Menchaca, Mr. Luis O. Garcia, Mr. Manuel Angel Garcia, Mr. Gilberto Treviño, Mrs. Elia G. Lopez, Mr. Andres Olivarez, Mr. Reynaldo Garza and Mr. Eudocio Garza.

Mr. Jorge D. Perez, P.E. from Perez, Freese & Nichols gave a brief presentation on watersheds from Arroyo Roma and Los Morenos. Mr. Perez asked the public attending the meeting if they preferred to have the meeting in Spanish. The meeting, at the petition of the public, was conducted in Spanish. Mr. Perez presented various alternatives on the flooded areas. The following is a summary of the meeting.

1. Brief overview of the project.
   Funding sources.
2. Description of Arroyo Roma Watershed.
   Historical flooding experiences
   Previous projects
   Indiscriminant development on floodplain
   Illustrate current floodplain limits
3. Description of Los Morenos Watershed

4. Design criteria and constraints
   10 Year flood - fully developed or current development levels 100 year?
   If we design for current development limits, can we really expect future developers to provide detention facilities?

   Danger in by - passing watersheds (possible legal ramifications)
5. Design alternatives for Arroyo Roma
   Construct open channel through town
   Construct by pass tunnel north of populated areas
6. Design alternatives for Los Morenos Creek
   Are we following traditional flow directions or diverting flows?
7. Preliminary findings and facility sizing
   Approximate channel sizing

U.S. 83 Bridge at Arroyo Roma
U.S. 83 Bridge at Los Morenos Creek
Easement acquisition

8. Project cost estimates and funding
Future land development ordinances
Formation of drainage district for taxing purposes
drainage assessment on future development in watersheds.

9. Other possible funding sources.

10. Questions & Answers from the public.

11. Next meeting was announced to be approximately 4 weeks after this meeting.

After no further business, public hearing was adjourned.

Fernando Peña, Mayor

ATTEST:

Josie Hinojosa, City Secretary

May 20, '98 6:00

Public Hearing

Flood Protection Planning

Salome' Barrera Ph. 849 B 14
Alben Flores Rd, Box 65-72
Salome Barrera
Obregon Con Mazatlan
Leonel Gonzalez
H.C. 1 BOX 57 J
Rio Grande City

Rosa Ena Sainz 849-178
Gloria Castañeda 849-2082
Belsa Alanis 849-1185
Domingo Sifuentes 849 1682
[illegible] 849-1348
Jose A. Garcia
[illegible]
[illegible]
Joe Medrano 849-2349
Abel Gutierrez 849-1136
[illegible]
[illegible]
Mario Romero 849-1978
Enrique Ramirez
JORGE D. PEREZ Perez/Freese & Nichols 631-4482
J. Anthony Reid Perez/Freese & Nichols 631-4482
David Barrera
Margarita C. Barrera
[illegible] M. [illegible] D.V.M. 849-1104
Luis O. Garza 849-0560
Manuel [illegible]
[illegible] Treviño Tanguma
Elia B Lopez
Gabriel E Rico
Norma Martinez
Josie Hinojosa

STATE OF TEXAS — CITY OF ROMA

CITY OF ROMA
HISTORICAL CITY BY THE RIO GRANDE

NOTICE OF PUBLIC HEARING
FLOOD PROTECTION PLANNING
TEXAS WATER DEVELOPMENT BOARD

PROJECT NO. 96-483-160
DATE: July 1, 1998
TIME: 6:00 P.M.
LOCATION: ROMA COMMUNITY CENTER

The City of Roma is in the process of completing flood Protection Planning Study for the arroyo Roma and Arroyo Los Morenos watersheds. The study is funded by the City of Roma, Starr County, and the Texas Water Development Board. The study is nearing 50% completion and the comments from the residents of these two watersheds are needed to assist in the determination of the social and environmental factors of the proposed alternative solutions.

Information that will be shared includes:

Description of the proposed alternatives considered for the Arroyo Roma and the Arroyo Los Morenos Watersheds.

Existing and projected population affected by flooding and number of dwellings occupied and number of dwellings to be affected by flooding for possible relocation considerations.

Persons unable to attend the public hearing may submit their views at P.O. Box 947, Roma, Texas 78584. Accommodations for handicapped persons will be available; handicapped persons in need of special assistance for attending the meeting are encouraged to contact Mayor Fernando Peña at (956) 849-1411.

Fernando Peña, Mayor

2nd Public Hearing
Flood Protection Planning
Arroyo Roma-Los Morenos Creek Study
Roma, Texas
July 1, 1998 at 6:00 p.m.

A second Public Hearing was conducted on Wednesday, July 1, 1998 at 6:00 p.m. at the Roma Community Center.

Present were Mayor Fernando Peña, Mr. Rogelio Salinas, Director of Administration, Mr. Crisanto Salinas, Director of Planning, Ms. Josie Hinojosa, City secretary, Mr. Jorge D. Perez, Engineer from Perez Freese & Nichols, Mr. Anthony Reid, Engineer from Perez Freese & Nichols, Mrs. Maria D. Ramirez, Mrs. Rosa M. Ramirez, Mr. Domingo Sifuentes, Mr. Enrique Barrera, MR. Mario Barrera, Mr. David Barrera, Mrs. Norma Martinez, Mr. Ramon Vera, Mr. Gilbert R. Ward from Texas Water Development Board, Mrs. Antonieta Guzman, Mrs. Maria Guadalupe Garza, Mrs. Manuela Lopez, Mrs. Gloria Castañeda and Mrs. Maria dela Luz Garza.

Mrs. Norma Martinez read the public hearing advertisement inviting the general public to attend the public hearing.

Mayor Fernando Peña welcomed all persons attending the meeting and proceeded to introduce Mr. Gilbert R. Ward from Texas Water Development Board, Mr. Jorge D. Perez, Engineer from Perez, Freese & Nichols and Mr. Anthony Reid, Engineer from Perez, Freese & Nichols.

Mr. Jorge Perez Engineer from Perez, Freese & Nichols proceeded with the meeting. Mr. Perez gave an overview of the project showing the sections that are subject to flood.
The following is a list of existing dwellings and population affected by the 100-year flooding:

Watershed:	Dwellings:	Estimated Population:
Arroyo Roma	336	1,513
Rio Grande River	52	234
Los Morenos	1,033	4,650
Flood Special Zone	573	2,580
Total	1,994	8,977

Mr. Perez gave a summary of opinion of probable costs as follows:

Watershed:	Amount:
Arroyo Roma Alternate 1 Earthen Channel Improvements from E. Morelos Ave to U.S. Highway 83 and downstream to River	13,693,048.20
Arroyo Roma Alternate 2 Diversion Tunnel and Channel Improvements Diversion Tunnel Upstream and earthen Channel Improvements	12,538,415.50
Arroyo Roma Alternate 3 Detention Reservoir and Earthen Channel Improvements	18,523,562.81

Watershed:	Amount:
Arroyo Roma Alternate 4 Reinforced Concrete Box Culvert E. Morelos Avenue to U.S. Highway 83	9,236,857.50
Los Saenz Storm Sewer and Channel Improvements	901,485.00
Arroyo Los Morenos-East and west Channel Improvements Arroyo Los Morenos Interceptor Improvements	18,548,400.00

Mr. Perez asked the general public if they have questions.
There were no questions from the public. Mr. Perez stated that they will be available after the meeting for questions and answers. Also, there is a map available to review the flooding areas and the affected persons.

After no further business, public hearing was adjourned at 6:50 p.m.

Fernando Peña, Mayor

ATTEST:

Josie Hinojosa, City Secretary

July 1, 98 6:00 P.M
2nd Public Hearing
Flood Protection Planning

Maria D. Ramirez
Rosa M. Ramirez
Domingo Sifuente
Enrique Barrera
Moilo Barrera
David Barrera
[illegible]
[illegible]
J. Anthony Reid
Jorge D Perez
Gilbert Ward Texas Water Development Board
Norma Martinez
[illegible]
Antonieta Guzman
Maria Guadalupe Garza
Manuela Lopez
Gloria Castaneda
Maria de la Luz Garza Romero Garza
Josie Hinojosa

Board of Commissioners:

Fernando Peña, *Mayor*
Jose F. Moraida, *Commissioner*
Gabriel E. Recio, *Commissioner*

STATE OF TEXAS · CITY OF ROMA

CITY OF ROMA
HISTORICAL CITY BY THE RIO GRANDE

NOTICE OF PUBLIC HEARING
FLOOD PROTECTION PLANNING
TEXAS WATER DEVELOPMENT BOARD
PROJECT NO. 96-483-160

DATE: Wednesday, November 4, 1998
TIME: 6:00 p.m.
LOCATION: Roma Community Center

The City of Roma will be conducting it's Final Public Meeting on Wednesday, November 4, 1998 to discuss the final draft of the Drainage Master Plan Study of the **ARROYO ROMA** and **LOS MORENOS** Watersheds. The Study is being funded by the Texas Water Development Board , the City of Roma and Starr County. The public is invited to offer comments regarding social and environmental effects of the proposed improvements for flood protection for the City of Roma and the Los Morenos Watersheds.

Information that will be presented includes:

Exhibits showing proposed alignments of the proposed drainage facilities;
Cost estimates for the recommended improvements and;
Proposed phasing of the work required.

Persons unable to attend the public hearing may submit their views at P.O. Box 947, Roma, Texas 78584. Accommodations for handicapped persons will be available; handicapped persons in need of special assistance for attending the meeting are encouraged to contact Mayor Fernando Peña at (956) 849-1411.

Fernando Peña, Mayor

P. O. BOX 947 ROMA, TEXAS 78584-0947 956-849-1411 FAX 956-849-3963

Final Public Hearing
Flood Protection Planning
Arroyo Roma-Los Morenos Creek Study
Roma, Texas
Project No: TWDB 96-483-160
Wednesday, November 4, 1998 at 6:00 P.M.
Roma Community Center

A Final Public Hearing was conducted on Wednesday, November 4, 1998 at 6:00 p.m. at the Roma Community Center with the following to wit:

Fernando Peña, Mayor (present)
Jose F. Moraida, Commissioner (present)
Gabriel E. Recio, Commissioner (present)

Also present were Mr. Jorge D. Perez, P.E. from Perez, Freese & Nichols, Mr. Gilbert R. Ward from Texas Water Development Board, Mr. Rogelio Salinas, Director of Administration, Mr. Crisanto Salinas, Director of Planning, Mr. Jorge L. Muñoz, Public Works Director, Ms. Josie Hinojosa, City Secretary, Mrs. Norma Martinez, Ms. Melva Lopez, Mrs. Belgica B. Muñoz, Mr. Sigifredo Galindo, Mrs. Minerva B. Gonzalez, Mr. Domingo Sifuentes, Mr. Manuel Garcia, Mr. Fernando Lopez, Mrs. Patricia Mendez, Mr. Keith Kindle, Project Manager for the City of Roma, Mrs. Manuela Lopez, Mr. Mario Barrera, Mr. Enrique Barrera, Mr. Manuel Garcia, Mr. Ricardo Peña, Mrs. Diana Peña, Mrs. Lesvia Alvarez, Mr. Jesus E. Alvarez, Mrs. Maribel Moreno, Mrs. Gloria Castañeda, Mrs. Maria Treviño, Mrs. Norma Benavides, Mr. Victor M. Benavides, Mrs. Elia Lopez and Mrs. Norma Garza.

Mrs. Norma Martinez read the Final Public Hearing advertisement inviting the general public to attend the public hearing.

Mayor Fernando Peña welcomed all persons attending the meeting and proceeded to introduce Mr. Gilbert R. Ward from the Texas Water Development Board and Mr. Jorge D. Perez, P.E. from Perez, Freese & Nichols.

Mr. Jorge D. Perez proceeded with the final public hearing and gave an overview of the project as follows:

1. Exhibits showing proposed alignments of the proposed drainage facilities.
2. Cost estimates for the recommended improvements.
3. Proposed phasing of the work required.

After the presentation, Mr. Jorge D. Perez was available to the public for questions.

After no further business, public hearing was adjourned.

Fernando Peña, Mayor

ATTEST:

Josie Hinojosa, City Secretary

Nov. 4, 1998 6:00 p.m.
PUBLIC Hearing (Final)
Flood Protection Planning

Jorge D. Perez — Perez/Freese & Nichols — 631-4482
Gilbert Ward — Texas Water Development Bd (512) 463-[illegible]
[illegible] Lopez — 956-849-[illegible]
[illegible] B. [illegible] — 849-24-20
[illegible] — 849-10-39
[illegible] B [illegible] — 849-47-33
Domingo [illegible] — 849-16-82
Manuel A. Garcia — 849-1782
Fernando Lopez Lopez — 847-15-24
Patricia Mendez — 849-2988 (max + Josie Gutierrez)
[illegible] — 418-5011
[illegible]
Manuela Lopez
[illegible]
Maribel Moreno
[illegible]
Gloria Castaneda
Norma Fernandez
Norma Martinez
Victor M Benavidez
Elia B de Lopez
Norma [illegible] Garza
Josie [illegible]
[illegible]
Mario Bornera
Enrique Ramirez
Manuel Garcia
Ricardo Pena
Diana Pena
Lesma Alvarez
Jesus E. Alvarez
Jorge [illegible] [illegible]
Gabriel E Recio
[illegible]

APPENDIX C

Response to Comments From Texas Water Development Board on Draft Final Report

facsimile
TRANSMITTAL

to:	Jorge Perez
Company:	Freese & Nichols
fax #:	956-682-1545
re:	Review comments on Draft Final Report, TWDB Contract #96-483-160
date:	January 12, 1999
pages:	5, including cover sheet

Please see attached.

From the desk of...
Alicia Ramirez
Contract Specialist
Texas Water Development Board
1700 North Congress Avenue
Austin, Texas 78711-3231

(512) 463-8005
Fax: (512) 463-9893

TEXAS WATER DEVELOPMENT BOARD

January 12, 1999

The Honorable Fernando Peña
City of Roma
P.O. Box 947
Roma, Texas 78584-0947

Re: Review Comments for Draft Report Submitted by the City of Roma, entitled "City of Roma, Texas, Master Drainage Plan for Arroyo Roma and Arroyo Los Morenos Watersheds", TWDB Contract No. 96-483-160

Dear Mr. Peña:

Staff members of the Texas Water Development Board have completed a review of the draft report under TWDB Contract No. 96-483-160 and have found that specific tasks of the Scope of Work for this planning study have not been addressed. For those tasks, which were addressed and included in this draft report, Board staff offers comments shown in Attachment 1.

Results of Task Nos. 1D, 3, 6, and 8 have been identified as either nonexistent or incomplete. It will be necessary for the City to address these tasks in draft form to submit to the Board for comments. Please resubmit the draft report (2 copies) with your responses to the attached comments for our review.

The Board looks forward to receiving the draft report on the tasks identified above. Please contact Mr. Gilbert Ward, the Board's Contract Manager, at (512) 463-6418, if you have any questions about the Board's comments.

Sincerely,

Tommy Knowles
Deputy Executive Administrator
for Planning

ATTACHMENT 1
TEXAS WATER DEVELOPMENT BOARD
REVIEW COMMENTS FOR THE CITY OF ROMA
FLOOD PROTECTION PLANNING CONTRACT
CONTRACT NO. 96-483-160

Comments on the Master Drainage Plan:
The report presents hydrologic and hydraulic information on the study area and alternatives to manage storm water runoff and minimize recurrent flooding.

The Texas Water Development Board is allowed to provide loans from the Texas Water Development Funds to political subdivisions and nonprofit water supply corporations for both structural and non-structural projects, and development of floodplain management plans.

Selected alternatives appear feasible in scope and eligible for Board funding. Methodologies employed in the hydrologic and hydraulic analyses appear to be appropriate. The construction cost estimates provided appear reasonable. All engineering, legal, financial and environmental activities associated with the project would also be eligible for financing.

Enabling legislation (Texas Water Code Chapter 17.771-17.776) and Board rules (TAC 363.401-363.404) regarding loans for flood control require that basin-wide planning and considerations of the effect of the proposed project on surface water elevations within the watershed and any downstream watershed accompany applications for funding. If funding for any of the improvements identified in the study is requested from the Texas Water Development Board, all the findings required by statute and the demonstrations required by Board rules must be addressed. Work done in preparation of this flood study will be useful in this endeavor and may be incorporated into an engineering feasibility report that would accompany an application. An environmental assessment that meets the requirements of Chapter 363.14 of Board rules will be required. Flood control applications are not eligible for the Board's pre-design funding option.

Specific comments:

1. The following notes are referenced by a page number which has the format section-page, for example, section 1, page 2 would be page 1-2.

2. Throughout the report, portions of the text do not clearly state what the author intends to convey and/or contain poor grammar. Commas appear excessively and distract the reader rather than aid his understanding. The report needs to be proof read for grammar and spelling.

3. page 3-7: Please put the word "that" between "flows" and "have" on the second full paragraph in section 3.9. Change the word "bee" to "been" in the same sentence.

4. page 4-2: At the bottom of the page, there is a statement that says hydrograph timing to create a peak on peak. What is a peak on peak? Please clarify the statement

5. page 4-5: Second paragraph, third sentence. Change phrase "employed to" to "applied to". Also, in the fifth sentence, the writer says that storage can be done on rooftops. This is wrong. Water storage for detention or retention is never done on rooftops. Structural integrity comes into question. The only rooftop storage for water would be a cistern that is used to capture rain for drinking or watering lawns. Even then, they are fairly small. Please remove this statement from the report.

6. page 4-7: Second full paragraph, first line. The words "containment "and "storage" are redundant. Second sentence needs to have an "an" before the phrase "extended periods of time. Third full paragraph, fourth sentence - "flap gates" should be flap gate (singular).

7. page 4-8: Under the heading Federal Programs, the sentence that begins "The Soil Conservation Service should not be underlined, and the word "has" before the word historically should be removed, or the word " gives" should be "given".

8. page 5-1: What does 185 +/- feet msl mean? +/- what? One foot, two feet? This was done twice in the same section. On page two, they use the abbreviation M.S L. If they are going to use msl (mean sea level), then the abbreviation should be consistent.

9. page 5-2: Second full paragraph. Was the culvert a problem when highway 83 was constructed, or was it a problem after the highway was widened. Please clarify this paragraph. Also, if the TxDoT rainfall frequencies are not appropriate for communities like Roma, then why did they use the TxDoT rainfall frequency equation in Section 3.4 for their frequency calculation? Please explain.

10. page 5-3: In alternative one, they make a statement that Figure 5.2 clearly shows that the land surface slope is steeper than many other streams. First of all, the diagram was done with an exaggerated scale and you can't clearly see anything. There are no other stream slopes provided as comparison, therefore, nothing can be "clearly seen". Please provide a chart for comparison.

11. There is no documentation of consultation with residents of the project area to determine the most economical solution without overriding social or environmental factors, as stipulated in the Scope of Work, Item 3, nor documentation of public consent for construction of flood control alternatives to serve the distressed areas.

12. Scope of Work, Item 6: There is no comprehensive design data, only results. The calculation in this report cannot be verified. Please provide means for verification.

13. Scope of Work, Item 8: A detailed implementation schedule was not included, only brief milestone descriptions. Please include.

14. Scope of Work, Item 1.D.: Existing runoff flows are not included. Please provide.

15. The report does not give sufficient detail as to the computation of flood hydrographs. For instance, although lag time is stated as being 0.6 times the time of concentration (as per Equation 16.9 of the National Engineering Handbook's Section 4), none of the times of concentration are listed for any of the subdrainage areas listed in Table 3.1 of the report.

16. The report indicates that, in computing flood hydrographs for the subdrainage areas, a standard shape factor of 484 is used. However, the National Engineering Handbook states that this factor has been known to vary from 600 in steep terrain to 300 in very flat country. Since the channel slopes given for most of the subdrainage areas listed in Table 3.1 are one percent or less, it is questionable whether the shape factors could be as much as 484. Certainly to uniformly apply 484 to all subdrainage areas could be a mistake, since visual inspection of the subdrainage area bounds shown on the Watershed Key Map shows a wide variety in shape from area ALMb - which is very broad - to areas A10b and A9b which are extremely long and skinny. Please give detailed documentation on how the shape factors were chosen (e.g., did the consultant confer with the local office of National Resource Conservation Service?)

17. Please give detailed documentation on how the CN runoff curve numbers were chosen (e.g., give the data on land use, in tabular and/or map form, for each subdrainage area).

18. The scope of work also calls for run-off characteristics such as high velocity damage in certain areas to be analyzed, but the report does not give a velocity damage analysis as suggested in the scope. Is there a reason that high velocity damage analysis was not performed? The report mentions that "K" value in Muskingum's routing method equation has been approximated by dividing the travel distance by a velocity of 5 feet per second, but does not indicate whether this velocity has been assumed or computed. If this velocity has been computed, the report should indicate by what method (e.g.,TR-20 and HEC runs) and should give computed velocities in all stream reaches. If, however, 5 feet per second has been assumed, the assumption is poor, given the flat terrain. Incidentally, if a velocity of 5 feet per second did occur, then scouring would probably result, as velocities in this range will scour most soils to some degree.

19. The scope of work calls for existing and future development runoff flows to be analyzed; Table 3.4 of the report gives the peak design flows for developed watershed conditions, but the report does not contain an analogous table showing existing conditions flows - which should also be analyzed as specified by the scope of work. Please include the flows table.

Response to Comments from TWDB dated January 12, 1999

The editorial comments contained in comments 1, 2, 3, 5, 6, and 7 have been addressed as appropriate in the text.

Some of the comments are unclear. The comments are stated in such a manner that they appear to be addressed to someone internal to the TWDB. These have been addressed on the assumption that another TWDB staff person choose to furnish them to the consultant.

In general, there appears to be a difference in opinion on the amount of detail on the hydrologic and hydraulic analyses that should be provided in this report. Item 12 of the Scope of Work states "Prepare reports in accordance with Article III Section 4 of this contract." Article III Section 4 reads as follows:

> "The consultant will consider incorporating comments from the EXECUTIVE ADMINISTRATOR and other commentors on the draft final report into a final report. The CONSULTANT will include a copy of the EXECUTIVE ADMINISTRATOR's comments in the final report. The CONSULTANT will submit one (1) unbound camera ready original and nine (9) bound double-sided copies of the final report to the EXECUTIVE ADMINISTRATOR no later than the FINAL REPORT DEADLINE and four (4) bound double-sided copies of the final report to the CHIEF ELECTED OFFICIAL. The CONSULTANT will submit one (1) electronic copy of any computer programs or models and an operations manual developed under the terms of this Contract."

First, the contract does not contain specific language on what is to be included in the final report. If the TWDB wants specific information and a certain level of detail on certain areas, such as the hydrologic and hydraulic analyses included in the report, that should be specified in the detailed Scope of Work. Since that was not done in the existing contract, we would be pleased to provide a fee estimate for these additional services.

We are required to provide one electronic copy of any computer models developed under the terms of the contract. Since the last person identified in the Article III Section 4 prior to this requirement is the CHIEF ELECTED OFFICIAL, we assume this information is to be furnished to the city.

It is our opinion that in the development of a style for a report of this nature, it is most important to primarily consider the end-user, in this case the city officials and citizens of Roma. From the public meetings and discussions with the city officials, their primary concerns are (1) understanding the areas that will be subject to flooding and (2) what the cost will be to improve the problem. Including detailed discussions on all the hydrologic and hydraulic assumptions and analyses does not improve the quality of the answers to their primary concerns. If it is the desire of the TWDB to assure that certain methodologies and assumptions are made in the analyses, then it would be appropriate to define those in the detailed Scope of Work. Since that was not done in the existing contract, we would be pleased to provide a fee estimate for the additional services to provide the analyses using certain methodologies and assumptions specified by the TWDB.

4. Page 4-2: At the bottom of the page, there is a statement that says hydrograph timing to create a peak on peak. What is a peak on peak? Please clarify the statement.

The referenced sentence is making the point that improvements, such as increasing channel efficiencies through straightening or concrete lining, can cause an upstream peak to reach a downstream point more quickly. Potentially, when this peak is combined with the flow from a second watershed, the combined peak could be greater than under natural conditions. Under natural conditions, most of the second peak would have passed the point where the two flows are combined before the upstream peak arrives.

8. Page 5-1: What does 185+/- feet msl mean? +/- what? One foot, two feet? This was done twice in the same section. On page two, they use the abbreviation M.S. L. If they are going to use msl (mean sea level), then the abbreviation should be consistent.

The International Boundary and Water Commission is responsible for determining stage- discharge relationships at points on the Rio Grande. This relationship has not been defined at every point. A current specific relationship was not available at Roma. The water surface elevations for certain flows were estimated from available data. We did not want to imply a high level of accuracy in the water surface elevations levels so the +/- was included.

9. Page 5-2: Second full paragraph. Was the culvert a problem when highway 83 was constructed, or was it a problem after the highway was widened? Please clarify this paragraph. Also, if the TxDOT rainfall frequencies are not appropriate for communities like Roma, then why did they use the TxDOT rainfall frequency equation in Section 3.4 for their frequency calculation? Please explain.

We have not researched the records to determine the condition of the culvert before and after widening. We were concerned with the current condition.

The third sentence states the "**design frequencies**" are lower than what is considered appropriate. The "**rainfall intensities**" discussed in Section 3.4 are not the same thing and are considered appropriate. The tables in Section 3.4 contain a 100-year rainfall intensity which is the design frequency used to evaluate the flooding in Roma.

10. Page5-3: In alternative one, they make a statement that Figure 5.2 clearly shows that the land surface slope is steeper than many other streams. First of all, the diagram was done with an exaggerated scale and you can't clearly see anything. There are no other stream slopes provided as comparison, therefore, nothing can be "clearly seen." Please provide a chart for comparison.

First, the text does not include the statement "**clearly shows**." The text only states that "**As can be seen,....**" The statement was included in an attempt to develop in the reader's mind the concept of steepness to assist in understanding the necessity for the drop structures. A technical discussion on what constitutes a steep slope and a chart of comparison of slopes for streams with which the reader may not be familiar may not materially improve this understanding.

11. There is no documentation of consultation with residents of the project area to determine the most economical solution without overriding social or environmental factors, as stipulated in the Scope of work, Item 3. Nor documentation of public consent for construction of flood control alternatives to serve the distressed areas.

Comments from the three public meetings will be included in the report.

12. Scope of Work, Item 6: There is no comprehensive design data, only results. The calculation in this report cannot be verified. Please provide means for verification.

Scope of Work, Item 6 only concerns the "Comprehensive Hydraulic Design Data to be determined for feasibility of diverting the Arroyo Roma prior to entering the City of Roma." Please see the introductory discussion above on whether there is a contract requirement to include detailed information so that all calculations can be verified.

13. Scope of Work, Item 8: A detailed implementation schedule was not included, only brief milestone descriptions. Please include.

The Scope of Work does include the requirement of providing a detailed implementation schedule for designing, permitting, financing, and construction of the facilities. Until the funding mechanisms are defined, a detailed implementation schedule cannot be established. A generic detailed implementation schedule can be included to provide the reader with a general understanding of the time required concept to completion of construction.

14. Scope of Work, Item 1.D: Existing runoff flows are not included. Please provide.

The primary objective of the Master Drainage Plan was to identify the most cost effective improvements to will significantly reduce the impacts from flooding. This analysis is normally done assuming development in the watershed for a reasonable time in the future.

The SCS has developed a soil classification system that consists of four groups. Group C, which is representative of the Roma area, is described as "clay loams; shallow sandy loam; soils low in organic content; soils usually high in clay." The runoff curve number (CN) for Group C for land use conditions described as"poor conditions; grass cover on 50% or less of the area, is 86. The CN for "row houses, town houses, and residential with lot sizes 1/8 acre or less" is 90. Given the soil conditions and the nature of the development in the Roma area, it our opinion that the existing runoff flows and the future runoff flows will be essential the same. Although this is not standard procedure, we will clarify this conclusion in the report.

15. The report does not give sufficient detail as to the computation of flood hydrographs. For instance, although lag time is stated as being 0.6 times the time of concentration (as per Equation 16.9 of the National Engineering Handbook's Section 4), none of the times of concentration are listed for any of the subdrainage areas listed in Table 3.1 of the report.

Please see the introductory discussion above on whether there is a contract requirement to include detailed information so that all calculations can be verified.

16. The report indicates that, in computing flood hydrographs for the subdrainage areas, a standard shape factor of 484 is used. However, the National Engineering handbook states that this factor has been known to vary from 600 in steep terrain to 300 in very flat country. Since the channel slopes given for most of the subdrainage areas listed in Table 3.1 are one percent or less, it is questionable whether the shape factors could be as much as 484. Certainly to uniformly apply 484 to all subdrainage areas could be a mistake, since visual inspection of the variety in shape from area ALMb - which is very broad to areas A10b and A9b which are extremely long and skinny. Please give detailed documentation on how the shape factors were chosen (e.g., did the consultant confer with the local office of National Resource Conservation Service?)

The 484 is a constant used in the SCS triangular unit hydrograph method and it was adopted for use with the SCS curvilinear unit hydrograph method. The literature does indicate that the constant can be varied from 600 in steep terrain to 300 in very flat swampy country. There are no stream gaging stations in the study area, or in the vicinity of the study area, that would permit computations adjustment of this constant.

17. Please give detailed documentation on how the CN runoff curve numbers were chosen (e.g., give the data on land use, in tabular and/or map form, for each subdrainage area).

The SCS has developed a soil classification system that consists of four groups. Group C, which is representative of the Roma area, is described as "clay loams; shallow sandy loam; soils low in organic content; soils usually high in clay." The runoff curve number (CN) for Group C for land use conditions described as "poor conditions; grass cover on 50% or less of the area", is 86. The CN for "row houses, town houses, and residential with lot sizes 1/8 acre or less" is 90. Given the soil conditions and the nature of the development in the Roma, it our opinion that the existing runoff flows and the future runoff flows will be essential the same.

18. The scope of work also calls for run-off characteristics such as high velocity damage in certain areas to be analyzed, but the report does not give a velocity damage analysis as suggested in the scope. The report mentions that "K" value in Muskingum's routing method equation has been approximated by dividing the travel distance by a velocity of 5 feet per second, but does not indicate whether this velocity has been assumed or computed. If this velocity has been computed, the report should indicate by what method (e.g., TR-20 and HEC runs) and should give computed velocities *in all stream reaches. If, however 5 feet per second has been assumed, the assumption is poor, given the flat terrain. Incidentally, if a velocity of 5 feet per second did occur, then scouring would probably result, as velocities in this range will scour most soils to some degree.*

The average velocity of 5 feet per second is assumed. The HEC-RAS runs for the 100-year storm indicated that the average main channel velocity was 6.36 feet per second and the mean main channel velocity was 6.27 feet per second. We concur that some scouring would occur under these velocities.

19. The scope of work calls for existing and future development runoff flows to be analyzed. Table 3.4 of the report gives the peak design flows for developed water shed conditions, but the report does not contain an analogous table showing existing conditions flows - which should also be analyzed as specified by the scope of work. Please include the flows table.

The SCS has developed a soil classification system that consists of four groups. Group C, which is representative of the Roma area, is described as "clay loams; shallow sandy loam; soils low in organic content; soils usually high in clay." The runoff curve number (CN) for Group C for land use conditions described as"poor conditions; grass cover on 50% or less of the area, is 86. The CN for "row houses, town houses, and residential with lot sizes 1/8 acre or less" is 90. Given the soil conditions and the nature of the development in the Roma, it our opinion that the existing runoff flows and the future runoff flows will be essential the same. We will clarify this conclusion in the report.