FLOOD CONTROL PLANNING STUDY

ON

CHIGGER AND COWARTS CREEKS

IN AND FOR

THE CITY OF FRIENDSWOOD, TEXAS

AND

THE TEXAS DEPARTMENT OF WATER RESOURCES

AUGUST 1985

PREPARED BY

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TABLE OF CONTENTS

D. Table 3 "Cowarts Creek 100 Year Flood Elevations"
E. Computer Program Printout--Water Surface Profile--"Chigger Creek (Existing Conditions)"
F. Computer Program Printout--"Water Surface Profile - Chigger Creek (Improved Conditions)"
G. Computer Program Printout--"Water Surface Profile--Cowarts Creek (Existing Conditions)"
H. Computer Program Printout--"Water Surface Profile--Cowarts Creek (Improved Conditions)"
I. Plans & Profiles -- Chigger and Cowarts Creeks

J. Overall Plan of Chigger and Cowarts Creeks

I. INTRODUCTION

A. Authorization

This report was prepared in accordance with the contract between the City of Friendswood, Texas and COENCO, Inc., Consulting Engineers and dated October 17, 1983. That contract was in accordance with a contract and agreement made between the Texas Department of Water Resources and the City of Friendswood, Texas. This project is authorized under Chapter 355 of the Texas Water Code.

B. Purpose

The purpose for the undertaking of this project is a joint effort between the Texas Department of Water Resources and the City of Friendswood to conduct Flood Control Planning Studies for Chigger and Cowarts Creeks in the City of Friendswood, said creeks being in the Clear Creek watershed. As defined in Chapter 355 of the Texas Water Code, flood control planning is a developing of mechanisms to provide the most cost effective flood protection by means of structual and non-structual measures to abate flood hazard. In the past 10 years, and more particularly since July of 1979, floods and flooding have resulted in millions of dollars of damages to homes and property in the City of Friendswood. The need then is an overall plan to abate these flood hazards and thereby reduce the millions of dollars of damages in homes and other property in the City of Friendswood.

C. Project Scope

The scope of the project services was defined in the contract between the Texas Department of Water Resources and the City of Friendswood, and subsequently in the contract between the City of Friendswood and COENCO, Inc., and is as follows:

1. Establish formal and direct liaison with appropriate project directors of the U.S. Army Corps of Engineers and U.S. Soil Conservation Service for the purpose of coordinating the work of this planning study and to acquire available data pertinent to this study planning effort.

2. Conduct on the ground field surveys of Chigger and Cowarts Creeks within the City of Friendswood.

3. Using existing stream bed and bank elevations and projected flood water surface elevation profiles, develop proposed channelizations for Cowarts and Chigger Creeks within the City of Friendswood.

4. Develop flood control channel preliminary designs for containing one or more low frequency flood events on each of Chigger and Cowarts Creeks in the City of Friendswood.

5. All design flood events shall be compatible with flood designs developed by the U.S. Army Corps of Engineers Study of the Clear Creek Watershed reported in May 1982.

6. Identify and consider flood control alternatives in addition to stream channelization. These alternatives should include flood water retention or detention basins and non-structural flood control measures.

7. Specifications will be made for the engineering design and cost estimates for the potential flood control measures based upon current prices.

8. Compute estimates of the flood protection benefits that may be expected from the various flood protection alternatives evaluated.

9. Submit a final report which shall include as a minimum, detailed survey results, preliminary design and cost of flood control structures, estimates of flood protection benefits, and specifications of further work needed to complete and implement the flood control plan for Chigger and Cowarts Creeks in the City of Friendswood.

II. THE PROBLEM

A. Urbanization

Urban hydrology has been defined as interdisciplinary science of water and its interrelationships with urban man. It is a relatively young science and the bulk of its knowledge has accumulated since the early 1960's. L. B. Leopold in his "Hydrology for Urban Land Planning- a Guide Book on the Hydrologic Effects of Urban Land Use" says of all the land use changes effecting the hydrology of an area, urbanization is by far the most forceful. In 1970, 73.5% of the population of the United States lived in an urbanized area (U.S. Department of Commerce 1972). Each year urban expansion claims another 420,070 acres (U.S. Department of State 1971). Many studies have shown that urbanization causes an increase in flooding and drastic changes in water quality. Larger floods increase the risk of property damage and/ or injury to residents.

Before urbanization of the area became so intense, vegetation as well as small depressions detained significant quanities of water, actually storing the moisture and delaying its flow and allowing some rain water to reevaporate into the atmosphere. This surface storage, or detention in its natural state, increased the amount of infiltration in an area. Rain falling on a natural area of forest and meadows is intercepted by the leaves and branches of trees and smaller plants.

When the vegetation cover becomes saturated, the subsequent rain water begins to drip on to the ground penetrating the soil. Runoff may be defined as stream flow, or the sum of surface runoff and subsurface runoff. Surface runoff equals precipitation minus the sum of surface storage and infiltration. In other words, when the surface storage and soil becomes saturated, infiltration ceases and subsequent rainfall becomes surface runoff.

Urbanization begins with the occupancy of rural lands by small, concentrated communities with close grouping of homes, schools, churches and commercial facilities. Further growth comes along and results in large residential subdivisions, additional schools, shopping centers and an enlarged network of streets and sidewalks. Then the central business districts evolve containing large stores and offices and often cultural and civic centers. The process continues until homes, apartment complexes, commercial and industrial buildings, streets, parking lots, and sidewalks occupy all or most of the former rural land area. As the land surface is developed for urban use, a region is transformed from the natural state to a totally manmade state. New structures add large amounts of impervious areas to the watershed, which in general increase slopes and considerably diminish the water storage capability. All of this increases the runoff rate and the runoff amount.

Drainage in most urban areas is facilitated by storm sewers. In one study it was shown that improvements of the drainage system may reduce lagtime to 1/8 of that of natural channels. This lagtime reduction, combined with an increased storm runoff resulting from impervious surfaces, increases the flood peaks by a factor that ranges from 2 to nearly 8.

B. Planning Lagtime

In addition to the urbanization, the lag in proper planning to compensate for urbanization is also part of the problem. In man's haste to build communities, homes, shopping centers and other parts of urbanization he fails to properly plan for the increased runoff of the storm waters. With long range foresight, cities, planning commisions, and drainage districts could control the increased runoff rate of storm waters with the proper type of planning. This does not necessarily mean just widening, deepening and straightening out the creek and drainage channels to take more runoff from the urbanization. Various other methods will be discussed in a later section of this report.

Major rainfall events have occurred in the watershed of this planning study over the past 50 or so years. In July of 1979, tropical storm Claudette deposited in excess of 26 to 28 inches of rain in parts of this watershed resulting in flood damages estimated to be many millions of dollars. In September of that same year another storm classified as probably a 100 year frequency storm brought even more flooding to the area. In 1981 another major storm again flooded many of the homes in the Friendswood area. Very little has been accomplished in the past years in the way of flood prevention planning or actual construction due to the lack of funds to provide the planning. These storms and the increased flooding alerted the citizens to the fact that they needed something done to prevent further flooding and destruction of property.

III. LOCATION AND DESCRIPTION

In Galveston County, Friendswood has 4 major creeks in the watershed. The largest of these is Clear Creek, and studies by the U.S. Army Corps of Engineers and others have been made on Clear Creek. Mary's Creek has had engineering studies and engineering design and construction of the major portion of it in Friendswood. The two larger remaining creeks are Cowarts Creek and Chigger Creek. Cowarts Creek, Chigger Creek, and Mary's Creek all empty into Clear Creek in the Friendswood area. Approximately 35,800 linear feet of Chigger Creek exist in the City of Friendswood. Across the county line in Brazoria County approximately 22,200 linear feet of Chigger Creek exist. This means that 61.7% of the length of Chigger Creek is in Friendswood with the remainder in Brazoria County. The area in Friendswood drained by Chigger Creek is 5,252 acres with a total drainage area including the Brazoria County area of approximately 8,176 acres. This situation is reversed for Cowarts Creek as 20,100 linear feet of Cowarts Creek exist in the City of Friendswood, but 41,700 linear feet exist in Brazoria County. The total area in Friendswood drained by Cowarts Creek is approximately 1900 acres with an additional 10,230 acres in Brazoria County making a total drainage area for Cowarts Creek of 12,130 acres. Both of these creeks together drain approximately 20,300 acres. Due to the fact that these creeks enter Clear Creek in Friendswood, their size and the quantity of water carried is the largest in their lower reaches in the City of Friendswood. The topography varies from an elevation of approximately 8 to 10 feet to approximately 40 feet. This area is in the very most north end of Galveston County and joins Brazoria County on the west and Harris County on the north and northeast.

For over 15 years the U.S. Corps of Engineers have been making studies on Clear Creek, and periodically revising those studies. In 1984 and 1985 Bernard Johnson Engineers made a study on a portion of Clear Creek for some modifications in the total study, mostly due to an additional outlet at Clear Lake. The results of these studies and their corresponding backwater profile elevations have been used and coordinated in this study of Cowarts and Chigger Creeks.

The soil characteristics in the watershed studied are comprised of clays, silts and some localized sandy pockets. The clays and silts have high shrink-swell protential, low bearing capacity, high moisture content and low permeability. The climate in the area studied has historical weather records obtained from the Alvin weather station of average temperatures ranging from 54°F. to 80°F. and above in the summer. The average annual precipitation in this watershed is approximately 47 to 48 inches.

IV. EXISTING CONDITIONS

A. General

In the early stage of a Flood Control Planning Study, the existing conditions of the streams under study and their watershed are investigated and established. Some type of overall topographical maps of the entire watershed must be used in order to delineate the actual watershed of any particular creek or stream at any particular point. Obtaining such data in the initial phase of the planning study provides a basis for comparison between the existing conditions and the area after improved conditions are established. These can then be compared as to the cost benefit ratio for the proposed flood control improvements. It is important in this phase to obtain good data and accurate data if the study or analysis is to be very conclusive.

B. Field Surveys

1. Horizontal

Field surveys were performed on the ground along Chigger Creek and Cowarts Creek in order to locate horizontally the existing stream bed and banks and all objects or structures that might have an influence on the flow of the water or the widening, realignment, or deepening of the creek itself.

All bridge structures were carefully measured and located accurately, including the piers, abutments and other portions that would influence the flow of the water going through or over the structure. All fences up and down the streams were located and any houses or other buildings that were within a distance considered important in the final analysis of the relocation of the creek. All pipe lines were located and identified.

2. Vertical

Vertical control was then established from known bench marks in the area. These bench marks had been updated so that the elevation used was on the latest adjusted datum. From these known elevations at these bench marks, temporary bench marks were established up the length of Chigger Creek and Cowarts Creek. Bench mark loops were run on these and closed out to assure that they were accurate. Then from these temporary bench marks, elevations were taken where needed on the creek flow line of the bridges, on the elevations of the roadway and the bottoms of the girders of the bridges and all other needed elevations. Cross sections of the creek and out each side from the centerline were run to a point where an elevation was obtained that matched the elevation given on FEMA maps in the Friendswood City Public Works Department for 100 year flood elevations. These cross sections were taken at intervals of from 200 to 500 feet as the need existed. These were then plotted up in the office to be used in modeling the existing conditions of the two creeks.

C. Hydrology

1. Computer Model

The Chigger Creek and Cowarts Creek watersheds were modeled utilizing the Hydropac computer program by Holguin & Associates, Inc. and authored by Jefferson A. Rampy. This computer package will generate runoff hydrographs using a number of methods. The one chosen for this study was the Soil Conservation Service (SCS) method which had been taken from the SCS National Engineering Handbook, Section 4, Chapter 16 and SCS Technical Release 55. This was chosen because the program had the proper modifications and assumptions to use the soil-cover-complex method described in NEH-4 to compute runoff from urban areas. The variables used in this method apply to runoff from both agriculture and urban watersheds, which this study encompasses. With the proper experience in the selection of some of the variables used, excellent results are obtained.

2. Basic Parameters

Some of the parameters needed in modeling this watershed for this program are the time of concentration, the precipitation, and of course the acreage encompossed. In this particular method curve numbers must be selected for the area. These curve numbers can be modified or be a composite, because of the different land use and the different hydrologic soil groups based on the slope of the land, the type of cover, and other factors of experience in the area. Further in this report is an exhibit entitled "Overall Plan of Chigger and Cowarts Creeks". This plan shows the watershed areas of both Chigger Creek and Cowarts Creek and denotes points along each creek where flows have been calculated. Along Chigger Creek these are denoted with a capital J and followed by a number such as J-20 or J-14, etc. On Cowarts Creek these are denoted by a capital C and followed by a number such as C-26 or C-25, etc. The time of concentration was calculated for each point. The precipitation used in this method was taken from TP 40 and was the 24 hour precipitation given for the various 4 storms modeled. These 4 storms were the 10 year, 25 year, 50 year and 100 year.

3. Computation of Flows

Using the method described in the previous paragraphs with the parameters as discussed, the computation of the various flows at the different points on Chigger and Cowarts Creeks was accomplished. The watershed of Chigger Creek in Friendswood encompasses 8.2 square miles of a total watershed of Chigger Creek of 12.78 square miles. The watershed of Cowarts Creek in Friendswood is 2.97 square miles out of a total watershed in Friendswood and Brazoria County for Cowarts Creek of 18.95 square miles. The flows were computed and are given in Table 1 further in this report. The precipitation used for a 10 year storm was 8.6 inches, and for a 25 year storm was 10.0 inches, and for a 50 year storm was 11.6 inches, and for a 100 year storm was 13.2 inches. As stated previously these were obtained from the National Weather Bureau Techinical Paper 40.

D. Hydraulics

1. Computer Model

The computer model used for this portion of the study is by Coherent Systems 2200 WSP2 (Water Surface Profile 2) computer program. The original WSP2 program was developed by the Engineering Division of the U.S.D. Soil Conservation Service (SCS). That particular version is explained fully in SCS Technical Release No. 61. Another version, the Lisle version, was developed by the Lisle, Illinois office of the

SCS. Coherent Systems 2200 WSP2 is based on the Lisle version and is considered to produce more accurate results. It allows actual measured data to be input for each reach of a river or stream. This program can compute water surface profiles and open channels, and can also estimate head losses at restrictive sections, including roadways with either bridge openings or culverts.

2. Input Data

The input data required to run the water surface profiles using this computer program is the starting conditions, namely a discharge relationship at the starting section. Also needed are channel lengths, flood lengths and drainage areas. Cross section profiles are needed at valleys and roads with Manning's 'n' value changes along any given profile. Road data needed is the type of road opening, either culvert or bridge. Also the skew angle which is the angle of flow in degrees with the perpendicular to the centerline of the roadway. Likewise the girder points and the type of culvert or bridge. The flow data needed for this is obtained from the previous discussion on hydrology and the computation of flows obtained there. The starting water surface elevations where Chigger Creek and Cowarts Creek enter Clear Creek were obtained from the U.S. Corps of Engineers Study. The cross sections and measurements of bridges and structures were obtained as discussed previously by on the ground field surveys. Roughness coefficients (Mannings 'n') for Chigger and Cowarts Creek were estimated by inspection of the area and experience from previous work. Values used varied from 0.04 upwards to 0.09.

3. Water Surface Profiles

Using the computer program described and the input data, the water surface profiles were computed for a 10 year frequency, a 25 year frequency, a 50 year frequency and a 100 year frequency storm for both Chigger Creek and Cowarts Creek. Copies of these computer runs are enclosed as a part of this report. Table 2 of this report gives the elevations obtained from these water surface profile runs for Chigger Creek for a 100 year flood at various locations up Chigger Creek. Table 3 gives the same information for Cowarts Creek.

V. PROPOSED IMPROVEMENTS

A. General

The Clear Creek Drainage District, which controls drainage in new subdivision developed in the City of Friendswood, requires that all new subdivisions have detention systems, so that their runoff from the development after improvements are in and houses are built will not be any faster from a 25 year storm than the runoff from that same area of land in the undeveloped state. The Brazoria County Drainage District No. 4 controls the drainage for any new developments that can be built on the upper reaches of Chigger and Cowarts Creeks. This drainage district is now requiring that all new developments from 5 acres and up have detention systems built in that will not allow the developed runoff to be any faster from a 100 year storm than the undeveloped area would generate from that same storm. Therefor, in evaluating the improvements for Chigger and Cowarts Creek, it is not deemed necessary to provide for new developments in the future and additional runoff from these new developments. Therefore, the proposed improvements of this study are for what is now developed and no additional capacity is anticipated beyond what is needed at this time.

B. Preliminary Designs

1. Realignment of Channels

As can be seen from the plan and profiles incorporated with this study, Chigger and Cowarts Creek wind around and have many oxbows in their alignment. Therefor one of the first proposed improvements is to realign the channels and cut out unnecessary bends and oxbows in these channels. This proposed new alignment or realignment is shown on the enclosed plan and profiles of these two creeks. The existing length of Chigger Creek in Friendswood is some 35,863 feet. The proposed length with the realignment of the channel is 31,060 feet, or a reduction in channel length of 4,803 feet. The existing length of Cowarts Creek in the City of Friendswood is 20,090 feet. The proposed channel length of Cowarts Creek in Friendswood is 16,111 feet, or a reduction in channel length of 3,979 feet. Without any further improvements, the realignment of these channels and the reduction in their length would mean a better grade for the creeks and a smoother flow which would result in more flow being able to be carried in the same size channel. The citizens living along these creeks do not particularly care for the realignment of the creeks in their property, but as many of them have been flooded in the past, most of them are working with the Clear Creek Drainage District in an effort to reduce the flooding and are thereby inclined to give right-of-way for widening and realignment as needed in order to reduce the flooding conditions.

2. Sizing Channels

The channels as they exist are very much undersized to carry the existing flow that comes down these creeks in times of severe floods. Therefor the second proposed improvement would be to enlarge the channels and to correct the grade of the flow line of the channels. The channels can be deepened somewhat due to the realignment and still maintain a good grade. The field surveys showed that the channels as they exist have a flow line that is not consistant and goes up and down, and in some cases has a reverse grade. Working with the water surface profiles and the quantity of water that these creeks need to carry in a 100 year storm, the channels have been sized accordingly. The bottoms vary according to the location in each creek and how much flow would occur at that point. Further in this report some typical channel sections are shown. As these indicate the proposed channel would be trapezoidal shaped with 3 to 1 side slopes. The 100 year storm frequency is the one required for federal insurance. Therefor in order to obtain proper insurance in this area the proposed channels have been sized to carry the 100 flood water.

3. Bridges

As shown in the computer printouts, the bridges were analyzed in running the water surface profiles. In most cases the bridges can carry the flow of water with some dredging out of the channel beneath the bridge and concrete lining along and underneath the bridges. This lining is proposed to go only on the sides and not the bottom of the creek channel. This lining would extend out and rap around the side slopes just outside of the bridge itself. With this type of improvement, the bridges would carry the 100 year flow. Several of these bridges have been recently built and designed so that they would carry the flow before this study was made. Two of these are the bridge over Cowarts Creek at Sunset and the bridge over Chigger Creek at Greenbriar.

C. Alternatives

1. Upstream Detention

In this study, detention near the county line either in Friendswood or in Brazoria County was considered. As an example, detention was considered on Chigger Creek just across the county line in Brazoria County. Various sized detention reservoirs were studied, and in order to reduce the channel of Chigger Creek appreciably, the detention computed to be approximately 735 acre feet needed. At the position mentioned in Brazoria County, the depth of Chigger Creek would allow this detention reservoir to be approximately 7-1/2 to 8 feet deep. This then means that in order to have the 735 acre feet, there would need to be purchased a 100 acre tract to build this detention reservoir. When all costs were in including the cost of the land for the detention reservoir and balanced against the savings in the construction of the channel down stream and the acquisition of land for said channel, the upstream detention did not prove to be cost effective. Land in that area was found to cost approximately $6,000 to $7,000 per acre. This would mean the cost of the land alone would range between $600,000 and $700,000. The only cost saving downstream due to this would be the actual cost of excavation for the larger channel against the cost of excavation for the smaller channel. The drainage district is working very well with downstream property owners to acquire the additional land for larger channelization without cost. If this were not true and the land cost of the additional width of the channel all the way below the detention reservoir had to be added, then this method would prove a cost effective alternative. Without the land cost below, the savings in the excavation of the smaller channel would be approximately 60 to 70 percent of the cost of the land for the detention reservoir.

2. Small Dispersed Detention

Another alternative instead of large detention reservoirs would be small dispersed detention throughout the watershed area. This again would mean the acquisition of small tracts at various locations on tributaries into Chigger Creek and Cowarts Creek. The cost of this land acquisition proves prohibitive at this time. If done in subdivisions as a part of the required drainage improvements, this is a very viable alternative. As stated previously in this report, this is being done both in Friendswood and in the Brazoria County Drainage District No. 4 area. This keeps the flow from increasing due to development, but does not correct the drainage problem as it exists, which is too much flow for the size of the channels at this time.

3. Roof Top Storage

As the open area is developed, there are many houses in the subdivisions, buildings in office complexes and industrial parks and other structures where storage of storm water can be held on properly designed roofs. This is an additional alternative for future drainage, but proves non-cost effective to try to install that type of storage on existing roofs and structures.

4. Porous Pavement

There are a number of types of porous pavement that can be used for parking lots and for streets. Some of these are asphaltic and some are concrete. Porous pavement usually works well in an area where the soil is more porous beneath it than in the area of study in this case. In this area studied, the soil is more of the clay and gumbo type which is very tight and does not allow much infiltration into it after the initial wetting from the rain. Therefor porous pavements do not work nearly as well in this area as they would in some other localities.

5. Parking Lot Detention

Parking lot detention or parking lot storage is another measure that can be used in subdivisions, office complexes, industrial parks or commercial and industrial parcels. A certain amount of storage of the storm water can be detained in properly designed parking areas. This is an economical solution for the storage for detention of storm water as the land is still being put to some use other than just for detention of storm waters. This again is an alternative for a preventative measure for future development.

6. Swales

An alternative to curbs and gutters is grassed depressions with a subsurface drain or swales to carry the water along side of paved streets and roads rather than putting the water in curbs and gutters and then into storm sewers. The curbs and gutters in storm sewers do not allow for much infiltration or detention, whereas the grassed depressions or swales will slow the flow of the water and allow for more infiltration and more evaporation. The swales in place of curbs and gutters generally increase the amount of right-of-way needed for a street in order to get the proper drainage. In many cases this is advisable and will work quite well and as stated, decrease the flow and slow down the flow so that the time of concentration is lengthened and thereby in effect, the flow into the creeks is slowed down. This is another alternative that can be used in future subdivisions and building of streets, but would be expensive to attempt to change any existing street with curbs and gutters.

7. Dutch Drains

Dutch drains are simply gravel filled ditches that may have an optional drainage pipe in the bottom. This type of a drainage ditch could replace the grassed swale or the curb and gutter. It would not take as much right-of-way as the grass swale and would carry more water for the amount of land that it required. The result would be reducing the volume of storm runoff and thereby reducing flood peaks and increasing ground infiltration.

8. Parks and Recreation Areas

A final type of alternative studied was the use of parks and recreational areas in low lying land that could be within the 100 year flood plain and its uses would be restricted. Parks create little runoff of their own, but provide excellent storage potential. Using parks as storage areas can reduce the total urban system cost by combining capital requirements and maintenance requirements into multiple-purpose facilities. Storage can also be combined with recreation areas. Open space areas can be utilized for the temporary detention of the storm runoff with a minimum effect on their primary function. Recreational areas, such as soccer or football fields, generally have a substantial area of grass cover which often has a good infiltration rate. Storm runoff from such fields is generally minimal. This is a highly recommended alternative, as more parks and recreational areas are needed and this would serve both purposes exceptionally well.

VI. CONCLUSIONS

This report indicates the following conclusions:

A. The difference in the acreage that is under the 100 year flood in its existing condition and the acreage that is in the 100 year flood after the improvements are made is a total of approximately 847 acres. This land should be considered as reclaimed land and the value increased.

B. As shown in Tables 2 and 3, the construction of the proposed improvements will result in lowering the 100 year flood from approximately 2 feet in some cases to a maximum in excess of 7 feet. This is contingent upon the construction of the proposed improvements in the Bernard Johnson Flood Study of a portion of Clear Creek.

C. The estimated construction cost of all the proposed improvements in this study is $2,229,417. The increased value of the acreage removed from the 100 year flood plain is approximately $12,705,000. This would indicate a net benefit of $10,475,583. The Federal Emergency Management Agency reports show that claims of damage in the Friendswood area from 1978 through 1984 amounted to $31,028,532. There appears no accurate way to determine how much of the 1979 claims of $29,511,041 were due to the July flood that year that was termed a 500 year flood. It is considered a good estimate that at least 70% were probably due to the 500 year flood and the remainder would have been flooded without the July flood. Therefor, this still leaves $10,370,803 in damages over these years. The proposed construction improvements should alleviate approximately 40% of the homes damaged due to 100 year floods or less. Forty percent of the damages for those years amounts to $4,148,321. If this is added to the increased land value for reclaimed 100 year flood plain as stated previously, the total net benefit would be $14,623,904. It should be remembered that this benefit is predicated on the 10 year frequency channel improvement on Clear Creek with its resulting lowering of the water surface profile of Clear Creek.

VII. RECOMMENDATIONS

A. It is recommended that the preliminary designs noted in this report, namely the realignment of the channels and the increased size of the channels with the bridge repairs be constructed. There are several locations where pipe culverts need to be enlarged. On Chigger Creek, the culvert at St. Cloud needs an additional 6' pipe. Just upstream a long 5' diameter pipe exists under part of the golf course. An additional 5.5' diameter pipe needs to be installed. On Cowarts Creek between Greenbriar Drive and Baker Road there is an oil trap built right into the creek. This trap is causing about a 2.5' difference in water surface elevation just for a 25 year frequency storm. In other words it is causing the water surface upstream of it to be about 2.5 feet higher for a 25 year frequency flood than it should. It is recommended that this structure be removed. The water flows over it from less than a 10 year storm and would wash over any oil trapped, thereby defeating its purpose. As shown previously the above proposed improvements have a very good cost benefit ratio.

B. It is further recommended that the Planning Commission of Friendswood and the Clear Creek Drainage District continue to require some type of detention in most new developments of 5 acres and above, unless it can be clearly shown by engineering drainage analysis that the development as proposed will not adversely affect any downstream area. This does not mean simply subdivisions but developments of commercial areas also. The required detention can be of the detention pond, the detention in swales, the detention by dutch drains, the detention by the use in parks and recreation areas, roof top storage, or parking lot detention. The goal would be that no increase in runoff would come from developed areas more then what comes from them in the undeveloped state for a minimum of a 25 year storm, and preferably a 100 year storm.

PRELIMINARY
CONSTRUCTION COST ESTIMATE
(100 Year Channel)

1.	Channel Excavation: 1,020,078 C.Y. @ $1.50	=	$1,530,117
2.	Pipeline Lowering: 16 Ea. @ $30,000	=	480,000
3.	Concrete Slope Paving under Bridges: 1,660 S.Y. @ $45	=	74,700
4.	Clearing & Grubbing: Lump Sum	=	44,600
5.	Miscellaneous	=	100,000
	TOTAL ESTIMATED PRELIMINARY COST---------------		$2,229,417

TABLE 1

CHIGGER AND COWARTS CREEKS

100 YEAR FLOW

SECTION NO.	APPROX. LOCATION	DRAINAGE AREA IN ACRES TO THIS POINT	100 YR. TOTAL FLOW, CFS
	County Line	596	519
J-4B	In Sunmeadow	825	684
J-9		2,924	2,336
J-10		3,438	2,690
J-11		3,793	2,870
J-12		4,017	2,952
J-13		4,304	3,068
J-14	Greenbriar Bridge	4,575	3,177
J-15	F.M. 528 Bridge	4,705	3,204
J-16	Upstream of Tributary	4,740	3,220
J-17	Tributary Only	1,733	1,658
J-18	Downstream of Tributary	6,473	4,401
J-19	F.M. 518 Bridge	6,640	4,397
J-20	Oak St. Bridge	6,746	4,400
J-21	At Tributary	7,640	4,942
J-22		7,849	4,986
J-23	At Clear Creek	8,176	5,094
C-20	County Line	10,231	6,225
C-21	Greenbriar Dr.	10,862	6,367
C-22	Sunset Bridge	11,127	6,475
C-23		11,300	6,468
C-24		11,571	6,559
C-25	Castlewood Bridge	11,711	6,582
C-26	Winding Way	11,866	6,626
C-27	At Clear Creek	12,129	6,557

TABLE 2
CHIGGER CREEK
100 YEAR FLOOD ELEVATIONS

OLD STATION	LOCATION	EXISTING CONDITIONS	IMPROVED CONDITIONS
26 + 50	Approx. .5 Mile Upstream from Clear Ck.	17.3	12.6
52 + 43	Approx. 1.0 Miles Upstream	17.7	12.9
60 + 89	At Oak St. Bridge Downstream	17.9	13.0
79 + 40	At F.M. 518 Bridge Downstream	18.9	13.9
104+ 91	Approx. 2.0 Miles Upstream	20.4	14.8
126+ 49	At F.M. 528 Bridge Downstream	21.0	15.1
142+ 56	Just Downstream of Greenbriar Bridge	23.4	16.6
161+ 90	3.07 Miles Upstream	25.5	18.1
181+ 41	3.4 Miles Upstream	27.0	19.2
213+ 56	4.04 Miles Upstream	29.7	22.8
230+ 34	4.36 Miles Upstream	30.9	25.0
261+ 77	4.96 Miles Upstream	33.1	29.2
271+ 70	5.15 Miles Upstream	33.9	30.3
278+ 24	5.28 Miles Upstream	34.2	31.0
284+ 70	5.40 Miles Upstream	34.3	31.5
288+ 80	5.48 Miles Upstream	34.6	31.7
293+ 48	5.57 Miles Upstream	34.9	32.1
298+ 63	5.66 Miles Upstream	35.0	32.4
305+ 12	5.79 Miles Upstream	35.1	32.5
309+ 72	5.87 Miles Upstream	35.1	32.5
315+ 68	5.99 Miles Upstream	35.2	32.6
320+ 12	6.07 Miles Upstream	35.4	32.7

TABLE 2 (CONT'D.)
CHIGGER CREEK
100 YEAR FLOOD ELEVATIONS

OLD STATION	LOCATION	EXISTING CONDITIONS	IMPROVED CONDITIONS
323+ 18	At St. Cloud Culvert	35.48	34.37
325+ 51	6.17 Miles Upstream	35.5	34.4
328+ 04	6.22 Miles Upstream	35.5	34.4
330+ 77	6.27 Miles Upstream	35.5	34.5
336+ 44	6.38 Miles Upstream	35.6	34.6
341+ 55	6.48 Miles Upstream	35.9	34.7
348+ 45	6.61 Miles Upstream	36.4	34.8
352+ 46	6.68 Miles Upstream	36.6	34.9
358+ 63	6.80 Miles Upstream (Near County Line)	36.8	35.0

TABLE 3
COWARTS CREEK
100 YEAR FLOOD ELEVATIONS

OLD STATION	LOCATION	EXISTING CONDITIONS	IMPROVED CONDITIONS
9 + 20	C-27	22.0	18.2
15 + 50		22.1	18.2
19 + 20		22.2	18.2
23 + 70		22.3	18.3
29 + 10		22.4	18.4
34 + 15		22.5	18.4
35 + 20	F.M. 518 Bridge	22.63	18.38
36 + 70		22.7	18.4
41 + 42		22.9	18.5
46 + 40		22.9	18.5
51 + 32		23.1	18.6
56 + 57		23.3	18.7
66 + 25		23.6	18.8
73 + 60		23.9	18.8
76 + 40	Castlewood Bridge	24.54	20.04
77 + 80		24.5	20.1
99 + 00	C-24	24.8	20.6
113+ 90	C-23	25.3	21.3
123+ 87		25.5	21.6
125+ 15	Sunset Bridge	25.89	22.25
137+ 90		27.3	22.9
146+ 65		28.2	23.7
153+ 67	C-21 Greenbriar	29.0	24.2

TABLE 3 (CONT'D)
COWARTS CREEK
100 YEAR FLOOD ELEVATIONS

OLD STATION	LOCATION	EXISTING CONDITIONS	IMPROVED CONDITIONS
159+ 20		29.8	24.7
168+ 65		30.1	25.5
169+ 05	Oil Trap	29.96	26.77
181+ 40		31.3	27.6
192+ 15		32.5	28.5
194+ 65	Baker Road Bridge	33.05	29.87
200+ 90	C-20	33.4	30.2

80/80 LIST OF INPUT DATA

1	WSP2					
2	TITLE	FLOOD CONTROL PLANNING STUDY				
3	TITLE	CHIGGER CREEK				
4	COMMENT	(EXISTING CONDITIONS)				
5	DISCHARGE	-1.0	10	25	50	100
6	STARTE	541	13.9	15.3	16.2	17.1
7	OUTPUT	PS				
8	REACH	541	1	00	00	00
9	FLOW-FREQ	541	5094	4131	3218	2453
10	REACH	810	1	269	269	269
11	FLOW-FREQ	810	5090	4130	3217	2452
12	REACH	1061	1	251	251	251
13	FLOW-FREQ	1061	5088	4129	3216	2451
14	REACH	1398	1	337	337	337
15	FLOW-FREQ	1398	4955	4017	3129	2384
16	REACH	1568	1	170	170	170
17	FLOW-FREQ	1568	4920	3989	3106	2367
18	REACH	1840	1	272	272	272
19	FLOW-FREQ	1840	4886	3960	3084	2350
20	REACH	2049	1	209	209	209
21	FLOW-FREQ	2049	4851	3932	3062	2333
22	REACH	2347	1	298	298	298
23	FLOW-FREQ	2347	4817	3903	3040	2315
24	REACH	2650	1	303	303	303
25	FLOW-FREQ	2650	4782	3875	3017	2298
26	REACH	2981	1	331	331	331
27	FLOW-FREQ	2981	4747	3847	2995	2281
28	REACH	3268	1	287	287	287
29	FLOW-FREQ	3268	4712	3818	2973	2264
30	REACH	3483	1	215	215	215
31	FLOW-FREQ	3483	4678	3790	2950	2247
32	REACH	3887	1	404	404	404
33	FLOW-FREQ	3887	4511	3653	2843	2164
34	REACH	4550	1	663	663	663
35	FLOW-FREQ	4550	4497	3642	2834	2157
36	REACH	4731	1	181	181	181
37	FLOW-FREQ	4731	4483	3630	2826	2150
38	REACH	4953	1	222	222	222
39	FLOW-FREQ	4953	4469	3619	2817	2143
40	REACH	5243	1	290	290	290
41	FLOW-FREQ	5243	4456	3608	2808	2137
42	REACH	5642	1	399	399	399
43	FLOW-FREQ	5642	4442	3596	2799	2130
44	REACH	5881	1	239	239	239
45	FLOW-FREQ	5881	4428	3585	2790	2123

--------------------------------80/80 LIST OF INPUT DATA--------------------------------

46	REACH	6103	1	222	222	222	
47	FLOW-FREQ	6103	4414	3574	2781	2116	
48	SEGMENT	541	1	N	751		
49	NVALUE	0.09					
50	SEGMENT	541	2	C	791		
51	NVALUE	0.05					
52	SEGMENT	541	3	N	1300		
53	NVALUE	0.09					
54	SECTION	541					
55		0	18.4	100	20.6	200	21.7
56		300	21.9	400	20.9	500	17.9
57		600	14.8	609	14.2	645	11.0
58		678	7.8	700	6.0	737	2.0
59		751	1.4	753	-0.4	760	-3.3
60		771	-5.1	780	-2.4	790	-1.1
61		791	1.6	800	1.9	886	1.4
62		900	2.4	960	4.9	1000	8.2
63		1040	10.0	1086	10.7	1100	10.3
64		1143	9.9	1200	5.7	1300	8.8
65	ENDTABLE						
66	SEGMENT	810	1	N	949		
67	NVALUE	0.09					
68	SEGMENT	810	2	C	996		
69	NVALUE	0.05					
70	SEGMENT	810	3	N	1500		
71	NVALUE	0.09					
72	SECTION	810					
73		0	22.1	100	22.7	200	22.8
74		300	22.8	400	22.2	500	21.1
75		600	19.3	700	16.8	800	13.7
76		820	13.4	842	11.7	859	8.6
77		873	6.8	900	5.0	928	2.6
78		949	1.6	951	0.2	955	-0.4
79		965	-2.9	974	-5.7	980	-5.8
80		994	-1.3	996	1.3	1000	2.2
81		1010	3.1	1039	1.6	1075	1.6
82		1087	2.6	1097	2.6	1100	3.2
83		1119	3.7	1163	6.2	1200	8.2
84		1251	10.0	1281	9.7	1293	10.6
85		1300	10.5	1336	10.5	1371	11.3
86		1400	11.1	1452	8.7	1500	7.2
87	ENDTABLE						
88	SEGMENT	1061	1	N	958		
89	NVALUE	0.09					
90	SEGMENT	1061	2	C	995		

------------------------------80/80 LIST OF INPUT DATA------------------------------

91	NVALUE	0.05						
92	SEGMENT	1061	3	N	1700			
93	NVALUE	0.09						
94	SECTION	1061						
95		0	23.4	100	22.8	200	22.5
96		300	21.9	400	20.1	500	18.5
97		600	16.6	656	15.3	700	11.4
98		757	11.3	800	8.7	819	7.2
99		895	2.2	900	1.9	958	1.9
100		959	-0.4	967	-4.6	977	-5.3
101		986	-4.5	994	-0.6	995	1.8
102		1000	2.2	1058	3.4	1067	4.7
103		1100	6.2	1200	9.9	1247	11.3
104		1300	11.0	1400	11.7	1500	10.9
105		1600	10.4	1700	9.9		
106	ENDTABLE						
107	SEGMENT	1398	1	N	856		
108	NVALUE	0.09					
109	SEGMENT	1398	2	C	896		
110	NVALUE	0.05					
111	SEGMENT	1398	3	N	1700		
112	NVALUE	0.09					
113	SECTION	1398					
114		0	23.3	100	22.9	200	22.4
115		300	21.6	400	20.1	500	18.5
116		600	16.5	611	16.0	700	12.4
117		752	11.6	800	8.3	822	6.6
118		844	3.0	856	1.8	857	-0.7
119		865	-3.1	875	-4.2	885	-3.8
120		895	-0.8	896	2.4	900	2.2
121		922	3.1	953	1.7	1000	1.3
122		1028	1.7	1100	5.4	1200	10.7
123		1300	12.3	1400	13.7	1500	14.1
124		1600	14.7	1700	14.5		
125	ENDTABLE						
126	SEGMENT	1568	1	N	656		
127	NVALUE	0.09					
128	SEGMENT	1568	2	C	695		
129	NVALUE	0.05					
130	SEGMENT	1568	3	N	1300		
131	NVALUE	0.09					
132	SECTION	1568					
133		0	18.7	100	17.3	200	16.5
134		300	15.9	400	14.5	478	13.6
135		500	13.4	529	9.3	656	1.9

------------------------------80/80 LIST OF INPUT DATA------------------------------

136		657	-0.8	665	-4.3	675	-4.1
137		685	-2.8	694	0.5	695	2.2
138		700	2.6	710	3.7	747	2.7
139		795	2.1	800	2.3	849	5.5
140		862	7.5	900	9.1	954	12.5
141		1000	12.8	1100	14.0	1200	14.5
142		1300	14.8				
143	ENDTABLE						
144	SEGMENT	1840	1	N	862		
145	NVALUE	0.09					
146	SEGMENT	1840	2	C	892		
147	NVALUE	0.05					
148	SEGMENT	1840	3	N	1300		
149	NVALUE	0.09					
150	SECTION	1840					
151		0	18.4	100	17.6	200	17.5
152		300	15.5	392	14.1	400	12.8
153		500	12.7	548	10.8	600	10.6
154		700	7.2	767	3.3	800	2.4
155		862	2.8	863	-0.9	875	-4.9
156		885	-2.9	891	-0.9	892	2.3
157		900	2.6	936	6.9	968	9.9
158		1000	11.2	1065	13.7	1100	14.5
159		1200	14.7	1300	14.6		
160	ENDTABLE						
161	SEGMENT	2049	1	N	759		
162	NVALUE	0.09					
163	SEGMENT	2049	2	C	794		
164	NVALUE	0.05					
165	SEGMENT	2049	3	N	1400		
166	NVALUE	0.09					
167	SECTION	2049					
168		0	15.6	100	13.6	200	14.2
169		300	13.9	400	13.8	411	12.8
170		500	13.7	600	13.0	664	9.6
171		700	7.4	759	2.5	760	-0.9
172		765	-2.9	775	-4.1	785	-2.7
173		793	-1.1	794	2.5	800	3.3
174		822	1.7	853	2.7	900	5.4
175		958	9.0	1000	10.8	1060	13.4
176		1100	14.1	1200	15.4	1300	17.0
177		1400	17.9				
178	ENDTABLE						
179	SEGMENT	2347	1	N	562		
180	NVALUE	0.09					

-80/80 LIST OF INPUT DATA-

181	SEGMENT	2347	2	C	591			
182	NVALUE	0.05						
183	SEGMENT	2347	3	N	1300			
184	NVALUE	0.09						
185	SECTION	2347						
186		0	20.4	100	20.1	200	19.4	
187		300	18.5	400	17.3	408	16.1	
188		452	14.0	470	11.7	500	0.4	
189		506	1.0	528	2.0	540	4.6	
190		548	5.8	561	7.2	562	9.7	
191		568	12.9	575	13.4	585	11.9	
192		590	10.5	591	7.0	600	6.6	
193		624	4.6	668	4.2	700	3.0	
194		730	2.9	800	3.9	900	7.3	
195		1000	11.2	1100	14.1	1200	15.3	
196		1245	16.2	1255	16.7	1300	17.4	
197	ENDTABLE							
198	SEGMENT	2650	1	N	464			
199	NVALUE	0.09						
200	SEGMENT	2650	2	C	495			
201	NVALUE	0.05						
202	SEGMENT	2650	3	N	1100			
203	NVALUE	0.09						
204	SECTION	2650						
205		0	20.1	100	19.0	164	17.7	
206		200	15.7	300	9.0	433	1.8	
207		442	3.0	464	2.6	465	-1.1	
208		477	-3.3	484	-4.3	494	-1.3	
209		495	2.4	500	2.9	508	3.4	
210		533	3.1	600	6.7	700	10.7	
211		737	11.6	800	13.0	900	15.0	
212		1000	16.3	1100	17.3			
213	ENDTABLE							
214	SEGMENT	2981	1	N	667			
215	NVALUE	0.09						
216	SEGMENT	2981	2	C	693			
217	NVALUE	0.05						
218	SEGMENT	2981	3	N	1100			
219	NVALUE	0.09						
220	SECTION	2981						
221		0	20.0	100	19.2	200	18.2	
222		300	15.0	400	10.7	500	8.6	
223		564	6.2	600	4.7	626	3.6	
224		667	2.6	668	-2.2	678	-4.4	
225		684	-3.0	692	-0.4	693	2.2	

------------------------------80/80 LIST OF INPUT DATA------------------------------

226		700	2.7	744	4.2	765	6.6
227		800	9.1	900	14.9	1000	17.1
228		1100	19.1				
229	ENDTABLE						
230	SEGMENT	3268	1	N	772		
231	NVALUE	0.09					
232	SEGMENT	3268	2	C	791		
233	NVALUE	0.05					
234	SEGMENT	3268	3	N	1200		
235	NVALUE	0.09					
236	SECTION	3268					
237		0	19.5	100	18.7	200	17.9
238		300	16.8	400	15.4	500	13.9
239		600	9.6	700	4.7	745	3.9
240		753	3.1	772	2.5	774	-0.3
241		778	-3.5	781	-4.6	789	-1.3
242		791	2.4	800	3.3	804	3.4
243		830	9.5	900	11.0	1000	13.9
244		1100	16.8	1128	18.2	1200	19.3
245	ENDTABLE						
246	SEGMENT	3483	1	N	670		
247	NVALUE	0.09					
248	SEGMENT	3483	2	C	693		
249	NVALUE	0.05					
250	SEGMENT	3483	3	N	1100		
251	NVALUE	0.09					
252	SECTION	3483					
253		0	20.3	100	19.3	200	18.4
254		300	17.4	400	16.0	500	14.6
255		663	3.4	670	3.3	672	-2.5
256		680	-3.9	687	-3.9	692	-2.6
257		693	2.2	700	3.3	761	3.2
258		800	4.8	838	6.9	900	11.6
259		961	14.5	1000	15.8	1100	17.6
260	ENDTABLE						
261	SEGMENT	3887	1	N	872		
262	NVALUE	0.09					
263	SEGMENT	3887	2	C	893		
264	NVALUE	0.05					
265	SEGMENT	3887	3	N	1200		
266	NVALUE	0.09					
267	SECTION	3887					
268		0	19.6	100	19.0	200	18.3
269		300	17.5	400	16.6	453	16.2
270		500	13.1	521	11.0	534	9.6

------------------------------80/80 LIST OF INPUT DATA------------------------------

271		569	9.2	573	8.0	600	6.3
272		615	4.9	700	4.9	800	5.2
273		838	5.0	863	3.4	872	3.6
274		873	0.1	877	-2.3	880	-2.9
275		885	-3.4	892	-1.6	893	3.2
276		900	4.0	927	3.9	957	4.2
277		1000	12.4	1046	15.8	1067	16.9
278		1100	17.4	1200	19.0		
279	ENDTABLE						
280	SEGMENT	4550	1	N	672		
281	NVALUE	0.09					
282	SEGMENT	4550	2	C	693		
283	NVALUE	0.05					
284	SEGMENT	4550	3	N	1000		
285	NVALUE	0.09					
286	SECTION	4550					
287		0	20.6	100	20.3	200	19.0
288		290	17.6	300	15.2	372	10.2
289		400	8.4	460	5.8	500	5.5
290		519	4.9	600	6.6	610	7.3
291		642	6.5	657	5.7	672	4.5
292		673	1.8	676	0.4	682	-2.6
293		687	-1.8	692	0.0	693	5.1
294		700	5.4	709	5.8	716	6.7
295		741	9.1	770	11.7	800	14.5
296		848	17.1	900	18.4	1000	20.3
297	ENDTABLE						
298	SEGMENT	4731	1	N	673		
299	NVALUE	0.09					
300	SEGMENT	4731	2	C	694		
301	NVALUE	0.05					
302	SEGMENT	4731	3	N	1300		
303	NVALUE	0.09					
304	SECTION	4731					
305		0	19.7	100	19.1	200	18.4
306		300	17.6	400	17.1	500	14.6
307		600	12.1	635	9.8	656	7.3
308		666	5.4	673	2.6	674	-2.0
309		680	-3.1	683	-3.4	688	-2.9
310		693	-0.9	694	2.9	700	3.5
311		710	4.0	722	5.5	763	4.4
312		800	5.1	826	6.8	873	9.3
313		900	11.3	934	12.0	955	14.3
314		1000	16.5	1100	18.3	1200	19.1
315		1300	20.0				

------------------------------80/80 LIST OF INPUT DATA------------------------------

316	ENDTABLE						
317	SEGMENT	4953	1	N	771		
318	NVALUE	0.09					
319	SEGMENT	4953	2	C	790		
320	NVALUE	0.05					
321	SEGMENT	4953	3	N	1400		
322	NVALUE	0.09					
323	SECTION	4953					
324		0	19.2	100	18.5	200	17.7
325		300	16.8	400	14.6	500	13.9
326		510	13.5	544	10.8	571	9.5
327		600	7.7	622	6.3	700	5.4
328		726	4.6	771	1.7	772	-0.5
329		777	-2.5	781	-2.2	784	-2.2
330		789	-0.9	790	2.5	800	4.0
331		837	5.2	869	8.6	900	10.5
332		933	12.3	990	14.8	1000	15.4
333		1065	16.4	1100	16.5	1200	16.5
334		1300	17.8	1400	19.6		
335	ENDTABLE						
336	SEGMENT	5243	1	N	823		
337	NVALUE	0.09					
338	SEGMENT	5243	2	C	859		
339	NVALUE	0.05					
340	SEGMENT	5243	3	N	1400		
341	NVALUE	0.09					
342	SECTION	5243					
343		0	20.2	100	19.9	200	18.5
344		300	18.5	400	17.7	500	16.7
345		600	16.1	700	13.7	723	12.2
346		758	8.3	800	5.3	815	3.1
347		823	1.7	824	-0.1	830	-0.9
348		840	-1.3	851	-1.0	858	-1.1
349		859	2.1	900	4.2	988	3.8
350		1000	7.0	1077	13.6	1100	14.5
351		1200	16.5	1300	18.8	1400	19.7
352	ENDTABLE						
353	SEGMENT	5642	1	N	964		
354	NVALUE	0.09					
355	SEGMENT	5642	2	C	980		
356	NVALUE	0.05					
357	SEGMENT	5642	3	N	1400		
358	NVALUE	0.09					
359	SECTION	5642					
360		0	20.0	100	19.7	200	18.9

-----80/80 LIST OF INPUT DATA-----

361		300	18.2	400	17.5	500	17.0
362		600	16.9	700	15.5	708	15.5
363		800	12.0	869	7.4	900	5.6
364		948	4.2	964	3.0	965	-0.1
365		967	-1.9	971	-1.8	975	-1.1
366		979	-0.2	980	3.6	1000	4.5
367		1068	5.8	1094	9.2	1100	9.1
368		1140	12.9	1200	15.4	1300	18.1
369		1400	19.7				
370	ENDTABLE						
371	SEGMENT	5881	1	N	779		
372	NVALUE	0.09					
373	SEGMENT	5881	2	C	795		
374	NVALUE	0.05					
375	SEGMENT	5881	3	N	1300		
376	NVALUE	0.09					
377	SECTION	5881					
378		0	20.1	100	19.8	200	19.2
379		300	18.4	400	17.8	500	17.4
380		600	16.1	679	13.7	700	11.1
381		751	6.1	779	4.3	780	-1.8
382		783	-2.8	786	-2.4	790	-1.6
383		794	-0.8	795	3.2	800	3.8
384		819	5.6	900	6.0	1000	11.7
385		1100	16.8	1200	18.2	1300	19.2
386	ENDTABLE						
387	SEGMENT	6103	1	N	869		
388	NVALUE	0.09					
389	SEGMENT	6103	2	C	887		
390	NVALUE	0.05					
391	SEGMENT	6103	3	N	1300		
392	NVALUE	0.09					
393	SECTION	6103					
394		0	20.2	100	19.9	200	18.9
395		300	18.4	400	16.7	500	16.1
396		525	15.8	600	12.1	651	8.8
397		678	6.7	700	6.4	800	6.5
398		858	4.6	869	2.9	870	0.2
399		873	-0.7	877	-1.5	881	-0.8
400		886	-0.2	887	4.6	900	5.1
401		905	5.1	984	10.4	1000	10.4
402		1100	12.1	1200	15.4	1300	18.9
403	ENDTABLE						
404	COMPUTE	541	6103	541			

-----END OF 80/80-----

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COMPUTE            541      6103      541

----------------------------STARTING DATA FROM GIVEN ELEVATION----------------------------
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RATING TABLE FOR SECTION 541 DA= 1.0

	NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
	0	5.0	0.0	0.0						
BANK FULL		1.4	171.5	839.2	0.00	0.00	0.00			
ZERO DAMG		8.8	2194.6	1794.6	0.00	0.00	0.00			
	1	13.9	5373.7	2453.0	0.00	0.00	0.00	10.00	2.5	0.00004
	2	15.3	6356.4	3218.0	0.00	0.00	0.00	25.00	2.9	0.00004
	3	16.2	7011.9	4131.0	0.00	0.00	0.00	50.00	3.3	0.00005
	4	17.1	7694.2	5094.0	0.00	0.00	0.00	100.00	3.8	0.00006

*****************************PROFILE NO 1 EXCEEDS SURVEY DATA*****************************

SEGMENT TABLE FOR SECTION 541

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2453.	300.	721.	1432.
2453.	VELOCITY FPS	0.67	0.34	1.08	0.37
2	DISCHARGE CFS	3218.	391.	857.	1970.
3218.	VELOCITY FPS	0.71	0.35	1.19	0.43
3	DISCHARGE CFS	4131.	500.	1042.	2589.
4131.	VELOCITY FPS	0.82	0.39	1.38	0.52
4	DISCHARGE CFS	5094.	624.	1222.	3248.
5094.	VELOCITY FPS	0.91	0.43	1.54	0.60
1	ELEV 13.9 KD	410525.	50164.	121363.	238998.
2	ELEV 15.3 KD	519958.	63302.	138876.	317780.
3	ELEV 16.2 KD	595917.	72057.	150633.	373226.
4	ELEV 17.1 KD	677470.	82915.	162765.	431790.

RATING TABLE FOR SECTION 810 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	CHANNEL	NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	5.7	0.0	0.0						
BANK FULL	1.3	199.3	883.3	0.00	0.00	0.00			
ZERO DAMG	7.2	1427.0	1617.4	0.00	0.00	1.66			
1	13.9	5034.6	2452.0	0.29	0.00	4.07	10.00	2.3	0.00004
2	15.3	6056.1	3217.0	0.29	0.00	4.35	25.00	2.8	0.00004
3	16.2	6751.7	4130.0	0.29	0.00	4.53	50.00	3.4	0.00005
4	17.1	7474.4	5090.0	0.29	0.00	4.73	100.00	3.8	0.00006

******************************PROFILE NO 1 EXCEEDS SURVEY DATA******************************

SEGMENT TABLE FOR SECTION 810

CSM		TOTAL	SEG NO 1 N	2 C	3 N
1	DISCHARGE CFS	2452.	322.	934.	1196.
2452.	VELOCITY FPS	0.78	0.34	1.18	0.36
2	DISCHARGE CFS	3217.	416.	1100.	1700.
3217.	VELOCITY FPS	0.82	0.35	1.28	0.42
3	DISCHARGE CFS	4130.	547.	1325.	2259.
4130.	VELOCITY FPS	0.93	0.39	1.47	0.51
4	DISCHARGE CFS	5090.	693.	1540.	2857.
5090.	VELOCITY FPS	1.02	0.43	1.63	0.58
1	ELEV 13.9 KD	388344.	51098.	148084.	189163.
2	ELEV 15.3 KD	493958.	63900.	169177.	260881.
3	ELEV 16.2 KD	569862.	75357.	183339.	311167.
4	ELEV 17.1 KD	651795.	88539.	197957.	365298.

RATING TABLE FOR SECTION 1061 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	5.2	0.0	0.0						
BANK FULL	1.8	199.3	905.4	0.00	0.00	0.01			
ZERO DAMG	9.9	2300.1	1938.4	0.00	0.00	2.52			
1	13.9	5757.2	2451.0	0.21	0.00	5.71	10.00	1.6	0.00004
2	15.3	7211.6	3216.0	0.21	0.00	5.86	25.00	3.2	0.00004
3	16.2	8181.8	4129.0	0.21	0.00	6.04	50.00	3.7	0.00005
4	17.1	9172.5	5088.0	0.21	0.00	6.29	100.00	4.1	0.00005

*****************************PROFILE NO 1 EXCEEDS SURVEY DATA******************************

SEGMENT TABLE FOR SECTION 1061

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2451.	736.	775.	940.
2451.	VELOCITY FPS	0.74	0.38	1.20	0.30
2	DISCHARGE CFS	3216.	935.	856.	1426.
3216.	VELOCITY FPS	0.71	0.40	1.22	0.34
3	DISCHARGE CFS	4129.	1161.	1006.	1962.
4129.	VELOCITY FPS	0.77	0.44	1.37	0.41
4	DISCHARGE CFS	5088.	1383.	1152.	2553.
5088.	VELOCITY FPS	0.83	0.47	1.50	0.47
1	ELEV 13.9 KD	372959.	112471.	119162.	141326.
2	ELEV 15.3 KD	505794.	147436.	135491.	222866.
3	ELEV 16.2 KD	598090.	168829.	146480.	282782.
4	ELEV 17.1 KD	696760.	189488.	157812.	349461.

RATING TABLE FOR SECTION 1398 DA= 1.0

	NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
	0	4.1	0.0	0.0						
BANK FULL		1.8	215.2	788.7	0.00	0.00	0.46			
	1	13.9	4745.9	2384.0	0.00	0.00	5.92	10.00	2.5	0.00005
ZERO DAMG		14.5	5283.6	2684.3	0.00	0.00	6.71			
	2	15.3	6107.3	3129.0	0.31	0.00	7.91	25.00	3.0	0.00006
	3	16.2	7091.8	4017.0	0.31	0.00	8.19	50.00	3.3	0.00007
	4	17.2	8102.0	4955.0	0.31	0.00	8.45	100.00	3.7	0.00007

*****************************PROFILE NO 2 EXCEEDS SURVEY DATA*****************************

SEGMENT TABLE FOR SECTION 1398

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2384.	249.	880.	1256.
2384.	VELOCITY FPS	0.85	0.31	1.31	0.38
2	DISCHARGE CFS	3129.	397.	1063.	1669.
3129.	VELOCITY FPS	0.91	0.36	1.46	0.39
3	DISCHARGE CFS	4017.	530.	1214.	2274.
4017.	VELOCITY FPS	0.96	0.40	1.59	0.45
4	DISCHARGE CFS	4955.	667.	1354.	2934.
4955.	VELOCITY FPS	0.99	0.43	1.69	0.51
1	ELEV 13.9 KD	327860.	34113.	121013.	172733.
2	ELEV 15.3 KD	407023.	51611.	138340.	217073.
3	ELEV 16.2 KD	492225.	64816.	150046.	277363.
4	ELEV 17.2 KD	590509.	79501.	162124.	348884.

RATING TABLE FOR SECTION 1568 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	4.2	0.0	0.0						
BANK FULL	1.9	179.8	804.5	0.00	0.00	0.01			
1	13.9	4069.1	2367.0	0.00	0.00	2.38	10.00	3.1	0.00006
ZERO DAMG	14.8	4777.6	2819.2	0.00	0.00	3.14			
2	15.3	5235.9	3106.0	0.15	0.00	3.60	25.00	3.7	0.00008
3	16.3	6170.5	3989.0	0.15	0.00	4.03	50.00	4.0	0.00009
4	17.2	7182.4	4920.0	0.15	0.00	4.41	100.00	4.4	0.00010

*****************************PROFILE NO 2 EXCEEDS SURVEY DATA******************************

SEGMENT TABLE FOR SECTION 1568

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2367.	477.	941.	949.
2367.	VELOCITY FPS	0.97	0.41	1.45	0.42
2	DISCHARGE CFS	3106.	632.	1191.	1283.
3106.	VELOCITY FPS	1.10	0.42	1.69	0.43
3	DISCHARGE CFS	3989.	785.	1382.	1822.
3989.	VELOCITY FPS	1.18	0.42	1.87	0.51
4	DISCHARGE CFS	4920.	995.	1542.	2382.
4920.	VELOCITY FPS	1.21	0.43	1.99	0.58
1	ELEV 13.9 KD	295545.	59609.	117473.	118464.
2	ELEV 15.3 KD	350249.	71354.	134420.	144476.
3	ELEV 16.3 KD	418146.	82595.	145884.	189667.
4	ELEV 17.2 KD	499507.	100475.	157710.	241322.

RATING TABLE FOR SECTION 1840 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	4.8	0.0	0.0						
BANK FULL	2.3	152.6	896.9	0.00	0.00	0.00			
1	14.0	3900.9	2350.0	0.00	0.00	4.78	10.00	3.6	0.00009
ZERO DAMG	14.6	4347.8	2681.4	0.00	0.00	5.60			
2	15.4	5083.4	3084.0	0.19	0.00	5.98	25.00	4.0	0.00009
3	16.3	6002.0	3960.0	0.19	0.00	6.30	50.00	4.5	0.00010
4	17.2	6970.2	4886.0	0.19	0.00	6.59	100.00	4.9	0.00011

******************************PROFILE NO 2 EXCEEDS SURVEY DATA******************************

SEGMENT TABLE FOR SECTION 1840

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2350.	1236.	824.	290.
2350.	VELOCITY FPS	1.05	0.48	1.64	0.35
2	DISCHARGE CFS	3084.	1712.	939.	432.
3084.	VELOCITY FPS	1.05	0.52	1.72	0.35
3	DISCHARGE CFS	3960.	2191.	1086.	684.
3960.	VELOCITY FPS	1.10	0.57	1.90	0.42
4	DISCHARGE CFS	4886.	2698.	1202.	986.
4886.	VELOCITY FPS	1.13	0.62	2.01	0.50
1	ELEV 14.0 KD	243934.	127553.	86075.	30305.
2	ELEV 15.4 KD	319508.	178173.	98452.	42884.
3	ELEV 16.3 KD	388017.	214914.	106850.	66252.
4	ELEV 17.2 KD	466590.	258019.	115475.	93096.

RATING TABLE FOR SECTION 2049 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	4.0	0.0	0.0						
BANK FULL	2.5	197.3	851.6	0.00	0.00	0.18			
1	14.0	3524.7	2333.0	0.00	0.00	4.29	10.00	3.2	0.00010
2	15.4	5029.8	3062.0	0.00	0.00	5.51	25.00	3.8	0.00010
ZERO DAMG	15.6	5280.6	3264.5	0.00	0.00	5.63			
3	16.3	6158.5	3932.0	0.17	0.00	5.85	50.00	4.4	0.00011
4	17.2	7297.0	4851.0	0.17	0.00	6.14	100.00	4.9	0.00011

******************************PROFILE NO 3 EXCEEDS SURVEY DATA******************************

SEGMENT TABLE FOR SECTION 2049

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2333.	315.	1008.	1010.
2333.	VELOCITY FPS	1.20	0.29	1.73	0.55
2	DISCHARGE CFS	3062.	673.	1153.	1236.
3062.	VELOCITY FPS	1.18	0.33	1.83	0.53
3	DISCHARGE CFS	3932.	1120.	1291.	1520.
3932.	VELOCITY FPS	1.21	0.41	1.95	0.55
4	DISCHARGE CFS	4851.	1604.	1427.	1820.
4851.	VELOCITY FPS	1.18	0.47	2.05	0.58
1	ELEV 14.0 KD	234566.	31689.	101365.	101513.
2	ELEV 15.4 KD	307052.	66656.	116067.	124329.
3	ELEV 16.3 KD	378182.	104548.	126056.	147579.
4	ELEV 17.2 KD	470577.	159343.	136348.	174885.

RATING TABLE FOR SECTION 2347 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	0.4	0.0	0.0						
BANK FULL	7.0	1058.1	1121.8	0.00	0.00	2.55			
1	14.0	4541.8	2315.0	0.00	0.00	4.32	10.00	4.7	0.00007
2	15.4	5550.2	3040.0	0.00	0.00	5.11	25.00	5.0	0.00008
3	16.3	6292.5	3903.0	0.00	0.00	5.57	50.00	5.3	0.00010
4	17.3	7075.5	4817.0	0.00	0.00	5.90	100.00	5.6	0.00011

SEGMENT TABLE FOR SECTION 2347

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2315.	503.	21.	1792.
2315.	VELOCITY FPS	0.51	0.55	0.37	0.50
2	DISCHARGE CFS	3040.	621.	53.	2367.
3040.	VELOCITY FPS	0.55	0.57	0.55	0.54
3	DISCHARGE CFS	3903.	776.	87.	3040.
3903.	VELOCITY FPS	0.62	0.63	0.71	0.62
4	DISCHARGE CFS	4817.	944.	125.	3747.
4817.	VELOCITY FPS	0.68	0.68	0.84	0.68
1	ELEV 14.0 KD	274488.	59742.	2209.	212536.
2	ELEV 15.4 KD	342687.	70106.	5748.	266832.
3	ELEV 16.3 KD	399773.	79560.	8750.	311463.
4	ELEV 17.3 KD	469400.	92101.	12202.	365097.

RATING TABLE FOR SECTION 2650 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	4.2	0.0	0.0						
BANK FULL	2.4	162.1	839.8	0.00	0.00	0.16			
1	14.0	4010.8	2298.0	0.00	0.00	4.15	10.00	3.7	0.00007
2	15.4	4963.2	3017.0	0.00	0.00	4.87	25.00	4.1	0.00007
3	16.4	5686.8	3875.0	0.00	0.00	5.52	50.00	4.6	0.00009
4	17.3	6482.0	4782.0	0.00	0.00	6.03	100.00	5.0	0.00010

SEGMENT TABLE FOR SECTION 2650

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2298.	848.	726.	724.
2298.	VELOCITY FPS	0.88	0.50	1.41	0.40
2	DISCHARGE CFS	3017.	1135.	860.	1021.
3017.	VELOCITY FPS	0.93	0.56	1.54	0.43
3	DISCHARGE CFS	3875.	1472.	1041.	1362.
3875.	VELOCITY FPS	1.04	0.64	1.77	0.48
4	DISCHARGE CFS	4782.	1787.	1200.	1795.
4782.	VELOCITY FPS	1.12	0.70	1.95	0.54
1	ELEV 14.0 KD	278024.	102567.	87964.	87493.
2	ELEV 15.4 KD	352907.	132808.	100747.	119352.
3	ELEV 16.4 KD	406705.	154502.	109498.	142705.
4	ELEV 17.3 KD	469925.	176110.	118452.	175363.

RATING TABLE FOR SECTION 2981 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	4.3	0.0	0.0						
BANK FULL	2.2	125.8	815.5	0.00	0.00	0.03			
1	14.1	3614.6	2281.0	0.00	0.00	4.10	10.00	4.2	0.00009
2	15.5	4460.2	2995.0	0.00	0.00	4.67	25.00	4.7	0.00009
3	16.4	5086.7	3847.0	0.00	0.00	5.21	50.00	5.2	0.00011
4	17.3	5784.1	4747.0	0.00	0.00	5.76	100.00	5.7	0.00013

SEGMENT TABLE FOR SECTION 2981

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2281.	1013.	677.	591.
2281.	VELOCITY FPS	0.96	0.50	1.56	0.51
2	DISCHARGE CFS	2995.	1415.	795.	785.
2995.	VELOCITY FPS	1.00	0.56	1.69	0.54
3	DISCHARGE CFS	3847.	1881.	963.	1003.
3847.	VELOCITY FPS	1.12	0.65	1.95	0.59
4	DISCHARGE CFS	4747.	2380.	1115.	1252.
4747.	VELOCITY FPS	1.21	0.72	2.15	0.63
1	ELEV 14.1 KD	243121.	107686.	72452.	62983.
2	ELEV 15.5 KD	311607.	146990.	82955.	81663.
3	ELEV 16.4 KD	359626.	175657.	90194.	93775.
4	ELEV 17.3 KD	414072.	207323.	97581.	109169.

RATING TABLE FOR SECTION 3268 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	4.5	0.0	0.0						
BANK FULL	2.4	86.0	847.5	0.00	0.00	0.03			
1	14.1	2780.0	2264.0	0.00	0.00	3.36	10.00	5.1	0.00018
2	15.5	3617.5	2973.0	0.00	0.00	4.26	25.00	5.6	0.00019
3	16.5	4267.2	3818.0	0.00	0.00	4.90	50.00	6.1	0.00022
4	17.4	5038.5	4712.0	0.00	0.00	5.57	100.00	6.6	0.00024

SEGMENT TABLE FOR SECTION 3268

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2264.	1192.	660.	411.
2264.	VELOCITY FPS	1.29	0.71	2.14	0.52
2	DISCHARGE CFS	2973.	1537.	772.	664.
2973.	VELOCITY FPS	1.32	0.71	2.31	0.59
3	DISCHARGE CFS	3818.	1962.	915.	941.
3818.	VELOCITY FPS	1.43	0.77	2.59	0.68
4	DISCHARGE CFS	4712.	2409.	1026.	1277.
4712.	VELOCITY FPS	1.48	0.80	2.77	0.76
1	ELEV 14.1 KD	168250.	88861.	49354.	30036.
2	ELEV 15.5 KD	217230.	112529.	56727.	47974.
3	ELEV 16.5 KD	257970.	132622.	61863.	63484.
4	ELEV 17.4 KD	306436.	156851.	67084.	82501.

RATING TABLE FOR SECTION 3483 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	3.8	0.0	0.0						
BANK FULL	2.2	119.6	760.1	0.00	0.00	0.01			
1	14.1	3134.8	2247.0	0.00	0.00	2.09	10.00	4.3	0.00010
2	15.5	3837.3	2950.0	0.00	0.00	2.66	25.00	4.8	0.00012
3	16.5	4439.0	3790.0	0.00	0.00	3.22	50.00	5.3	0.00016
4	17.4	5109.5	4678.0	0.00	0.00	3.77	100.00	5.7	0.00018

SEGMENT TABLE FOR SECTION 3483

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2247.	484.	642.	1121.
2247.	VELOCITY FPS	1.01	0.53	1.63	0.61
2	DISCHARGE CFS	2950.	629.	793.	1529.
2950.	VELOCITY FPS	1.11	0.53	1.86	0.69
3	DISCHARGE CFS	3790.	850.	978.	1962.
3790.	VELOCITY FPS	1.28	0.58	2.18	0.77
4	DISCHARGE CFS	4678.	1101.	1143.	2434.
4678.	VELOCITY FPS	1.39	0.62	2.44	0.85
1	ELEV 14.1 KD	220979.	47485.	63277.	110216.
2	ELEV 15.5 KD	268605.	57274.	72224.	139107.
3	ELEV 16.5 KD	303533.	67865.	78468.	157200.
4	ELEV 17.4 KD	345918.	81270.	84807.	179841.

RATING TABLE FOR SECTION 3887 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	3.3	0.0	0.0						
BANK FULL	3.2	111.4	813.2	0.00	0.00	0.05			
1	14.2	4271.8	2164.0	0.00	0.00	4.81	10.00	5.0	0.00005
2	15.6	5066.1	2843.0	0.00	0.00	5.20	25.00	5.5	0.00006
3	16.5	5662.4	3653.0	0.00	0.00	5.88	50.00	5.8	0.00007
4	17.5	6328.0	4511.0	0.00	0.00	7.27	100.00	6.0	0.00010

SEGMENT TABLE FOR SECTION 3887

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2164.	1384.	377.	403.
2164.	VELOCITY FPS	0.62	0.46	1.11	0.43
2	DISCHARGE CFS	2843.	1861.	453.	529.
2843.	VELOCITY FPS	0.68	0.52	1.23	0.47
3	DISCHARGE CFS	3653.	2398.	570.	685.
3653.	VELOCITY FPS	0.79	0.60	1.46	0.53
4	DISCHARGE CFS	4511.	2924.	724.	863.
4511.	VELOCITY FPS	0.92	0.65	1.77	0.59
1	ELEV 14.2 KD	302144.	193036.	52832.	56275.
2	ELEV 15.6 KD	379937.	248498.	60760.	70679.
3	ELEV 16.5 KD	425536.	279355.	66355.	79826.
4	ELEV 17.5 KD	448867.	290959.	72055.	85853.

RATING TABLE FOR SECTION 4550 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	2.5	0.0	0.0						
BANK FULL	4.5	107.7	910.1	0.00	0.00	0.02			
1	14.2	3261.6	2157.0	0.00	0.00	7.03	10.00	6.5	0.00010
2	15.6	3975.8	2834.0	0.00	0.00	7.64	25.00	6.8	0.00010
3	16.6	4495.9	3642.0	0.00	0.00	7.97	50.00	7.1	0.00012
4	17.6	5042.1	4497.0	0.00	0.00	8.77	100.00	7.4	0.00014

SEGMENT TABLE FOR SECTION 4550

CSM	TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1 DISCHARGE CFS	2157.	1463.	459.	235.
2157. VELOCITY FPS	0.85	0.60	1.47	0.47
2 DISCHARGE CFS	2834.	1968.	536.	330.
2834. VELOCITY FPS	0.90	0.66	1.57	0.50
3 DISCHARGE CFS	3642.	2560.	638.	445.
3642. VELOCITY FPS	1.00	0.77	1.76	0.56
4 DISCHARGE CFS	4497.	3167.	755.	575.
4497. VELOCITY FPS	1.11	0.85	1.98	0.60
1 ELEV 14.2 KD	214907.	145751.	45748.	23407.
2 ELEV 15.6 KD	281148.	195193.	53257.	32699.
3 ELEV 16.6 KD	333777.	234486.	58632.	40658.
4 ELEV 17.6 KD	381458.	268697.	64143.	48618.

RATING TABLE FOR SECTION 4731 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	3.3	0.0	0.0						
BANK FULL	2.6	103.8	731.2	0.00	0.00	0.00			
1	14.2	2578.8	2150.0	0.00	0.00	1.76	10.00	5.5	0.00015
2	15.7	3264.5	2826.0	0.00	0.00	2.10	25.00	5.9	0.00016
3	16.6	3813.8	3630.0	0.00	0.00	2.49	50.00	6.4	0.00019
4	17.6	4416.7	4483.0	0.00	0.00	3.07	100.00	6.8	0.00023

SEGMENT TABLE FOR SECTION 4731

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2150.	209.	685.	1256.
2150.	VELOCITY FPS	1.26	0.43	1.97	0.72
2	DISCHARGE CFS	2826.	357.	795.	1674.
2826.	VELOCITY FPS	1.29	0.48	2.10	0.78
3	DISCHARGE CFS	3630.	522.	961.	2147.
3630.	VELOCITY FPS	1.43	0.53	2.41	0.88
4	DISCHARGE CFS	4483.	704.	1142.	2636.
4483.	VELOCITY FPS	1.58	0.56	2.73	0.96
1	ELEV 14.2 KD	172597.	16445.	55342.	100810.
2	ELEV 15.7 KD	224449.	27841.	63459.	133149.
3	ELEV 16.6 KD	261174.	37323.	69267.	154583.
4	ELEV 17.6 KD	295130.	46366.	75199.	173565.

RATING TABLE FOR SECTION 4953 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	2.4	0.0	0.0						
BANK FULL	1.7	62.2	536.5	0.00	0.00	0.00			
1	14.3	3216.3	2143.0	0.00	0.00	2.62	10.00	5.1	0.00011
2	15.7	4078.1	2817.0	0.00	0.00	3.31	25.00	5.7	0.00012
3	16.7	4866.9	3619.0	0.00	0.00	4.42	50.00	6.1	0.00015
4	17.6	5810.6	4469.0	0.00	0.00	5.41	100.00	6.6	0.00017

SEGMENT TABLE FOR SECTION 4953

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2143.	1099.	520.	524.
2143.	VELOCITY FPS	0.98	0.57	1.73	0.53
2	DISCHARGE CFS	2817.	1462.	623.	732.
2817.	VELOCITY FPS	1.03	0.59	1.90	0.57
3	DISCHARGE CFS	3619.	1990.	769.	860.
3619.	VELOCITY FPS	1.18	0.68	2.22	0.54
4	DISCHARGE CFS	4469.	2457.	887.	1126.
4469.	VELOCITY FPS	1.25	0.72	2.43	0.56
1	ELEV 14.3 KD	202076.	103629.	49008.	49439.
2	ELEV 15.7 KD	255687.	132716.	56544.	66427.
3	ELEV 16.7 KD	291001.	159692.	61985.	69324.
4	ELEV 17.6 KD	338340.	186704.	67552.	84084.

RATING TABLE FOR SECTION 5243 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1.2	0.0	0.0						
BANK FULL	1.7	93.9	411.0	0.00	0.00	0.00			
1	14.3	3073.1	2137.0	0.00	0.00	2.55	10.00	4.4	0.00008
2	15.7	3773.3	2808.0	0.00	0.00	3.48	25.00	4.7	0.00010
3	16.7	4380.1	3608.0	0.00	0.00	4.47	50.00	5.1	0.00012
4	17.7	5150.8	4456.0	0.00	0.00	5.46	100.00	5.4	0.00014

SEGMENT TABLE FOR SECTION 5243

CSM	TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1 DISCHARGE CFS	2137.	315.	826.	996.
2137. VELOCITY FPS	1.03	0.42	1.51	0.56
2 DISCHARGE CFS	2808.	446.	1063.	1299.
2808. VELOCITY FPS	1.18	0.44	1.78	0.60
3 DISCHARGE CFS	3608.	573.	1338.	1697.
3608. VELOCITY FPS	1.38	0.46	2.11	0.68
4 DISCHARGE CFS	4456.	780.	1566.	2110.
4456. VELOCITY FPS	1.50	0.48	2.34	0.74
1 ELEV 14.3 KD	243103.	35784.	93981.	113337.
2 ELEV 15.7 KD	287959.	45721.	109073.	133165.
3 ELEV 16.7 KD	323516.	51379.	120050.	152086.
4 ELEV 17.7 KD	372096.	64541.	131261.	176294.

RATING TABLE FOR SECTION 5642 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1.8	0.0	0.0						
BANK FULL	3.0	63.1	641.8	0.00	0.00	0.01			
1	14.4	2720.6	2130.0	0.00	0.00	3.86	10.00	5.9	0.00016
2	15.8	3416.0	2799.0	0.00	0.00	4.84	25.00	6.3	0.00017
3	16.8	4046.1	3596.0	0.00	0.00	6.31	50.00	6.7	0.00022
4	17.8	4800.0	4442.0	0.00	0.00	8.37	100.00	7.0	0.00027

SEGMENT TABLE FOR SECTION 5642

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2130.	832.	455.	843.
2130.	VELOCITY FPS	1.05	0.66	1.86	0.70
2	DISCHARGE CFS	2799.	1117.	551.	1130.
2799.	VELOCITY FPS	1.12	0.68	2.06	0.75
3	DISCHARGE CFS	3596.	1401.	686.	1509.
3596.	VELOCITY FPS	1.28	0.70	2.42	0.85
4	DISCHARGE CFS	4442.	1676.	825.	1942.
4442.	VELOCITY FPS	1.41	0.68	2.76	0.95
1	ELEV 14.4 KD	168802.	65848.	36153.	66801.
2	ELEV 15.8 KD	212562.	84847.	41968.	85747.
3	ELEV 16.8 KD	242207.	94552.	46264.	101391.
4	ELEV 17.8 KD	272359.	102548.	50642.	119169.

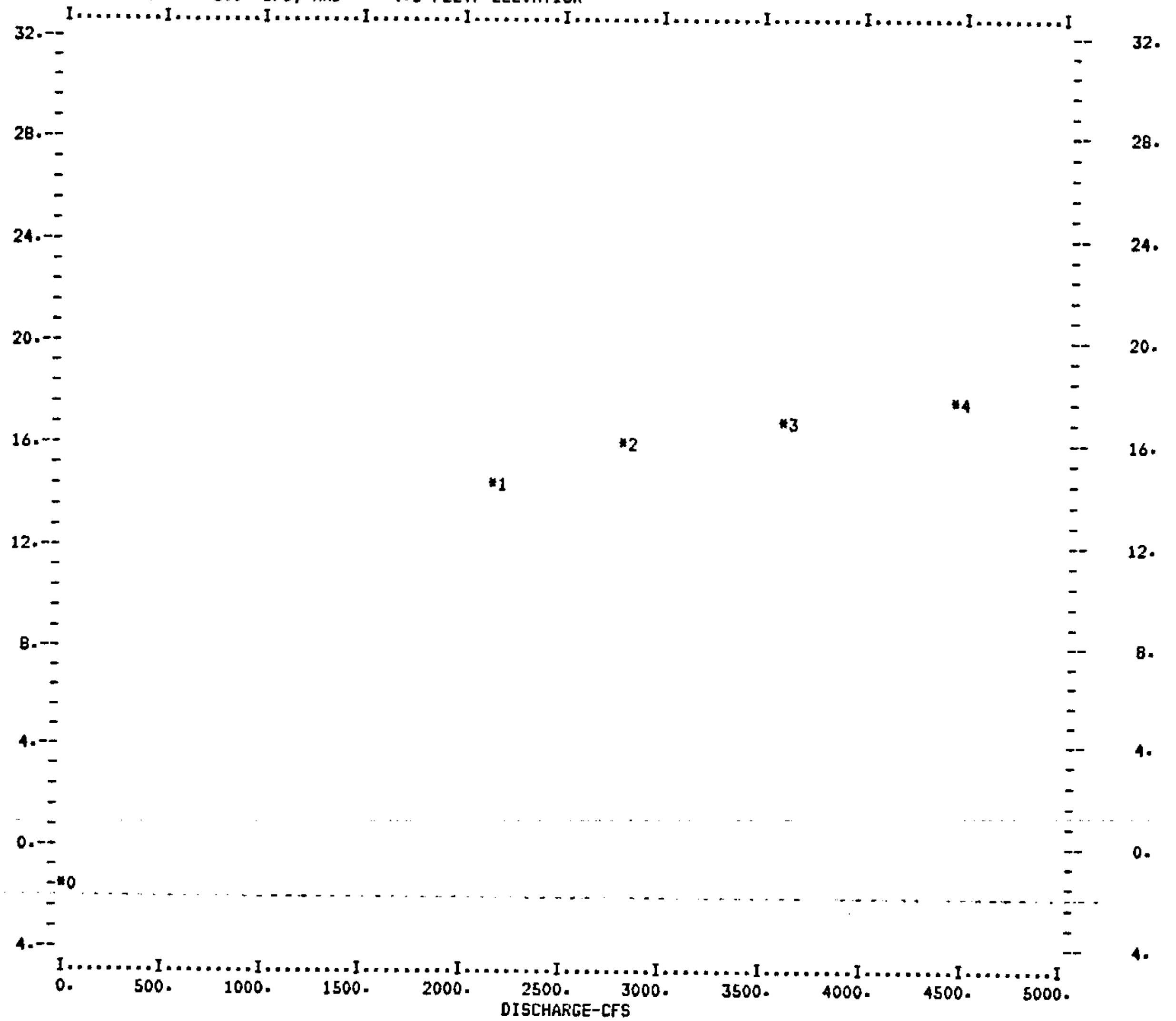
COHERENT SYSTEMS, INC.
2200 WSP2, RELEASE 3.0
BASED ON LISLE, ILLINOIS VERSION

FLOOD CONTROL PLANNING STUDY
CHIGGER CREEK

XEQ 09/24/84
REV 03/11/74

CROSS SECTION 5642

SCALES ARE 1 INCH = 500. CFS, AND 4.8 FEET/ ELEVATION



RATING TABLE FOR SECTION 5881 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	2.7	0.0	0.0						
BANK FULL	3.2	76.7	740.4	0.00	0.00	0.01			
1	14.4	2433.2	2123.0	0.00	0.00	2.09	10.00	6.5	0.00020
2	15.8	3059.7	2790.0	0.00	0.00	2.56	25.00	6.9	0.00020
3	16.9	3571.4	3585.0	0.00	0.00	3.01	50.00	7.3	0.00024
4	17.9	4263.4	4428.0	0.00	0.00	4.24	100.00	7.7	0.00030

SEGMENT TABLE FOR SECTION 5881

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2123.	410.	506.	1207.
2123.	VELOCITY FPS	1.17	0.67	1.98	0.77
2	DISCHARGE CFS	2790.	535.	594.	1661.
2790.	VELOCITY FPS	1.22	0.65	2.13	0.85
3	DISCHARGE CFS	3585.	688.	713.	2183.
3585.	VELOCITY FPS	1.35	0.67	2.42	0.97
4	DISCHARGE CFS	4428.	873.	864.	2690.
4428.	VELOCITY FPS	1.50	0.65	2.78	1.03
1	ELEV 14.4 KD	150874.	29137.	36127.	85610.
2	ELEV 15.8 KD	194927.	37393.	41688.	115846.
3	ELEV 16.9 KD	230247.	44210.	45823.	140214.
4	ELEV 17.9 KD	256207.	50496.	50040.	155670.

RATING TABLE FOR SECTION 6103 DA= 1.0

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	CSM	CRIT ELEV	FRICTION SLOPE
0	1.4	0.0	0.0						
BANK FULL	2.9	61.2	584.1	0.00	0.00	0.00			
1	14.4	3487.0	2116.0	0.00	0.00	3.06	10.00	6.7	0.00011
2	15.9	4445.8	2781.0	0.00	0.00	3.65	25.00	7.0	0.00011
3	16.9	5221.4	3574.0	0.00	0.00	4.26	50.00	7.3	0.00013
4	17.9	6125.3	4414.0	0.00	0.00	4.71	100.00	7.6	0.00013

SEGMENT TABLE FOR SECTION 6103

CSM		TOTAL	SEG NO 1 N	SEG NO 2 C	SEG NO 3 N
1	DISCHARGE CFS	2116.	1200.	407.	509.
2116.	VELOCITY FPS	0.83	0.59	1.52	0.43
2	DISCHARGE CFS	2781.	1509.	477.	795.
2781.	VELOCITY FPS	0.85	0.59	1.62	0.49
3	DISCHARGE CFS	3574.	1852.	581.	1141.
3574.	VELOCITY FPS	0.94	0.63	1.86	0.58
4	DISCHARGE CFS	4414.	2285.	652.	1478.
4414.	VELOCITY FPS	0.97	0.66	1.97	0.63
1	ELEV 14.4 KD	206040.	117017.	39821.	49202.
2	ELEV 15.9 KD	269475.	146839.	46404.	76232.
3	ELEV 16.9 KD	314619.	163054.	51349.	100216.
4	ELEV 17.9 KD	380912.	197208.	56403.	127301.

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------------------------------ 80/80 LIST OF INPUT DATA        ------------------------------
 405    ENDJOB

******************************NORMAL END OF JOB******************************
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------------------------------ 80/80 LIST OF INPUT DATA      ------------------------------
 406    ENDRUN
******************************NORMAL END OF RUN******************************
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COHERENT SYSTEMS, INC.                                                       PAGE   1
2200 WSP2, RELEASE 3.0                                                       XEQ 05/29/85
BASED ON LISLE, ILLINOIS VERSION                                             REV 03/11/74

-------------------------- 80/80 LIST OF INPUT DATA --------------------------
 1   WSP2
 2   TITLE         FLOOD CONTROL PLANNING STUDY
 3   TITLE         CHIGGER CREEK
 4   COMMENT        (EXISTING CONDITIONS)
 5   DISCHARGE     -1.0      10       25       50       100
 6   STARTE        6089      14.4     15.9     16.9     17.9
 7   OUTPUT        S
 8   REACH         6089      1        00       00       00
 9   FLOW-FREQ     6089      4414     3574     2781     2116
10    REACH        6330      1        241      241      241
11    FLOW-FREQ    6330      4402     3564     2774     2111
12    ROAD         OAK       2.7      65       65       65
13    REACH        6460      1        65       65       65
14    FLOW-FREQ    6460      4400     3563     2772     2109
15    REACH        6577      1        117      117      117
16    FLOW-FREQ    6577      4400     3563     2772     2108
17    REACH        6858      1        281      281      281
18    FLOW-FREQ    6858      4400     3563     2772     2108
19    REACH        7066      1        208      208      208
20    FLOW-FREQ    7066      4399     3563     2769     2103
21    REACH        7298      1        232      232      232
22    FLOW-FREQ    7298      4399     3563     2769     2103
23    REACH        7729      1        431      431      431
24    FLOW-FREQ    7729      4399     3563     2769     2103
25    REACH        7940      1        211      211      211
26    FLOW-FREQ    7940      4397     3563     2766     2096
27    ROAD         F.M.518   2.7      102      102      102
28    REACH        8299      1        257      257      257
29    FLOW-FREQ    8299      4397     3563     2766     2096
30    REACH        8556      1        257      257      257
31    FLOW-FREQ    8556      4397     3563     2766     2096
32    REACH        8858      1        302      302      302
33    FLOW-FREQ    8858      4397     3563     2766     2096
34    REACH        9257      1        399      399      399
35    FLOW-FREQ    9257      4397     3563     2766     2096
36    REACH        9594      1        337      337      337
37    FLOW-FREQ    9594      4397     3563     2766     2096
38    REACH        9973      1        379      379      379
39    FLOW-FREQ    9973      4397     3563     2766     2096
40    REACH        10241     1        268      268      268
41    FLOW-FREQ    10241     4397     3563     2766     2096
42    ROAD         MANISON   2.8      59       59       59
43    REACH        10491     1        191      191      191
44    FLOW-FREQ    10491     4397     3563     2766     2096
45    REACH        10749     1        258      258      258
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------------------------------80/80 LIST OF INPUT DATA------------------------------

46	FLOW-FREQ	10749	4397	3563	2766	2096	
47	REACH	11147	1	398	398	398	
48	FLOW-FREQ	11147	4400	3555	2762	2100	
49	REACH	11758	1	611	611	611	
50	FLOW-FREQ	11758	3220	2607	2026	1539	
51	REACH	12118	1	360	360	360	
52	FLOW-FREQ	12118	3220	2607	2026	1539	
53	REACH	12430	1	312	312	312	
54	FLOW-FREQ	12430	3220	2607	2026	1539	
55	REACH	12649	1	219	219	219	
56	FLOW-FREQ	12649	3220	2607	2026	1539	
57	SEGMENT	6089	1	N	869		
58	NVALUE	0.09					
59	SEGMENT	6089	2	C	887		
60	NVALUE	0.05					
61	SEGMENT	6089	3	N	1300		
62	NVALUE	0.09					
63	SECTION	6089					
64		0	20.2	100	19.9	200	18.9
65		300	18.4	400	16.7	500	16.1
66		525	15.8	600	12.1	651	8.8
67		678	6.7	700	6.4	800	6.5
68		858	4.6	869	2.9	870	0.2
69		873	-0.7	877	-1.5	881	-0.8
70		886	-0.2	887	4.6	900	5.1
71		905	5.1	984	10.4	1000	10.4
72		1100	12.1	1200	15.4	1300	18.9
73	ENDTABLE						
74	SEGMENT	6330	1	N	200		
75	NVALUE	0.07					
76	SEGMENT	6330	2	C	284.5		
77	NVALUE	0.04					
78	SEGMENT	6330	3	N	485		
79	NVALUE	0.07					
80	SECTION	6330					
81		0	20.8	100	20.3	200	19.9
82		201	16.85	203.5	15.87	207	14.43
83		210.5	12.84	213.5	10.9	218	8.3
84		222	6.8	226.5	5.9	230.5	5.3
85		235	3.8	239.5	2.6	242.5	0.3
86		246.5	0.2	251.5	0.9	253.5	3.8
87		259	1.9	264.5	7.6	268.5	10.0
88		271	11.9	272.5	13.4	277	14.9
89		280	16.3	283.5	16.9	284.5	19.0
90		385	20.0	485	21.1		

------------------------------80/80 LIST OF INPUT DATA------------------------------

91	ENDTABLE						
92	BPR	OAK	A	1	3		
93	PIER	9.05	1.2	2.45	2.4	10.05	1.2
94	GIRDER	19.75	19.55	00	0.8	2.6	
95		200	20.81	284.5	20.81		
96	ENDTABLE						
97	SECTION	OAK					
98		0	20.8	100	20.3	200	20.81
99		200	19.88	201	18.4	203.5	16.0
100		207	14.2	210.5	12.8	213	11.1
101		218	8.3	222	6.7	226	5.9
102		231	5.1	234.5	3.4	239	1.8
103		242.5	0.5	246.5	0.2	251.5	1.2
104		259	6.0	262.5	7.9	269	11.0
105		273.5	13.6	278	15.3	281	16.5
106		284	18.3	284.5	19.55	284.5	20.81
107		385	20.0	485	21.1		
108	ENDTABLE						
109	SEGMENT	6460	1	N	200		
110	NVALUE	0.07					
111	SEGMENT	6460	2	C	284.5		
112	NVALUE	0.04					
113	SEGMENT	6460	3	N	486		
114	NVALUE	0.07					
115	SECTION	6460					
116		0	21.1	100	20.6	200	20.1
117		201	17.9	203	16.4	205	15.4
118		207	14.0	211	11.6	215	9.8
119		219.5	7.5	221	6.6	226	5.8
120		231	4.8	234	3.0	236	1.2
121		238.5	1.0	242.5	0.7	249	1.1
122		251.5	1.5	255	4.7	257	6.9
123		259	7.3	261	8.1	266	10.4
124		270	12.0	274.5	13.8	278.5	15.6
125		282	16.7	284.5	17.5	286	18.5
126		386	20.0	486	21.4		
127	ENDTABLE						
128	SEGMENT	6577	1	N	676		
129	NVALUE	0.09					
130	SEGMENT	6577	2	C	691		
131	NVALUE	0.05					
132	SEGMENT	6577	3	N	1100		
133	NVALUE	0.09					
134	SECTION	6577					
135		0	20.0	100	19.7	200	19.5

------------------------------80/80 LIST OF INPUT DATA------------------------------

136		300	18.7	400	17.9	500	15.0
137		573	10.6	600	8.8	618	7.7
138		650	6.0	670	6.0	676	4.8
139		677	-0.4	680	-1.6	683	-1.6
140		687	-1.1	690	-0.1	691	5.4
141		700	5.7	712	6.3	794	9.4
142		800	9.0	818	8.4	850	17.3
143		900	17.3	1000	19.5	1100	19.9
144	ENDTABLE						
145	SEGMENT	6858	1	N	378		
146	NVALUE	0.09					
147	SEGMENT	6858	2	C	395		
148	NVALUE	0.05					
149	SEGMENT	6858	3	N	900		
150	NVALUE	0.09					
151	SECTION	6858					
152		0	20.7	100	19.8	200	18.3
153		300	16.7	340	15.5	350	11.7
154		361	7.0	370	5.1	378	5.4
155		379	2.0	384	0.7	386	0.7
156		390	1.3	394	1.7	395	5.2
157		400	5.7	410	6.5	462	6.7
158		500	9.6	600	14.6	700	16.9
159		800	19.5	900	20.8		
160	ENDTABLE						
161	SEGMENT	7066	1	N	470		
162	NVALUE	0.09					
163	SEGMENT	7066	2	C	490		
164	NVALUE	0.05					
165	SEGMENT	7066	3	N	800		
166	NVALUE	0.09					
167	SECTION	7066					
168		0	20.2	100	19.1	200	16.8
169		213	16.4	300	12.4	358	8.3
170		385	6.8	400	6.4	470	5.6
171		471	0.5	475	0.3	480	-1.4
172		484	-1.7	489	-1.2	490	5.7
173		500	6.4	505	6.6	600	15.7
174		618	16.5	700	18.9	800	20.6
175	ENDTABLE						
176	SEGMENT	7298	1	N	358		
177	NVALUE	0.09					
178	SEGMENT	7298	2	C	391		
179	NVALUE	0.05					
180	SEGMENT	7298	3	N	800		