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DEPARTMENT OF
PUBLIC WORKS

CITY OF SACRAMENTO
CALIFORNIA

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November 1, 1988

916-449-5283

Budget and Finance/Transportation and Community Development Committees
Sacramento, California

Honorable Members in Session:

SUBJECT: Flood Control Status Report

SUMMARY

Attached is an informational report on the status of flood control facilities which protect the City. The report describes existing flood control facilities, the level of protection currently provided and details the status of the planning efforts being performed by various agencies to identify improvements and modifications necessary to increase the level of protection.

As indicated in the report, the total cost to construct facilities and improvements to provide 200-year flood protection throughout the City is estimated at \$400 to \$500 million. If these improvements are included as part of a federally sponsored project, the federal government would pay approximately 75 percent of that cost. The remaining \$100 to \$125 million would be shared among the local interests, including the State.

RECOMMENDATION

The report is submitted for Committee information.

Respectfully submitted,

Melvin H. Johnson
MELVIN H. JOHNSON
Director Public Works

Approved for Committee
Information:

Solon Wisham, Jr.
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November 1, 1988
ALL DISTRICTS

FLOOD.TCD

TECO / BCF 11/1/88

CITY OF SACRAMENTO
FLOOD CONTROL STATUS
REPORT

PREPARED BY
DEPARTMENT OF PUBLIC WORKS
FLOOD CONTROL AND SEWER DIVISION

OCTOBER 1988

PREFACE

The risks of exceeding a flood event of estimated magnitudes which are set forth in the report in percentage predictions are based on the Sacramento District, Corps of Engineers (Corps) Chart of November 1987. The chart is reprinted on pages 13, 20 and 23 of this report. The underlying criteria, data and assumptions on which the Corps relies in support of the risk predictions in the chart are not the City's. Those risk estimates are used in this report only for general informational purposes to merely indicate a perspective on risk projections. This perspective is not the only possible method on risk estimates.

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SUMMARY

This report presents an overview of the flood control facilities protecting the City and greater Sacramento area. Included is a description of the existing flood control facilities, a discussion as to the level of protection provided by these facilities and a status report of the planning that is currently being performed, by various governmental agencies, to identify improvements or operation modifications to increase, as required, the level of protection.

Generally speaking, the flood control facilities include a comprehensive system of dams, levees, overflow weirs, drainage pumping plants and flood control by-pass channels located at strategic locations on the American and Sacramento Rivers and Morrison Creek. Such facilities, in short, harness the flood flows by regulating the amount of water passing through a particular reach of the river. The American River flood control system was designed with an objective release at Folsom Dam of 115,000 cubic feet per second (cfs). The Sacramento River flood control system was designed to hold the maximum flow of the river, between the American River and Courtland, at 110,000 cfs.

When completed these flood control facilities were believed to provide a high degree of protection (in excess of 100 year level). However, recent studies by the Corps of Engineers have revealed that the American River and the Sacramento River facilities only provide a 70 year and 90 year level of protection, respectively. The Morrison Creek system provides varying degrees of protection starting with a 40 year level and going up to over a 100 year level. Consequently, improvements and/or operation modification of the flood control system protecting the City are necessary.

The Corps has estimated that the cost of the improvements and new facilities needed to provide a 200 year level of protection would be \$400-\$500 million. Improvements identified to date include structural modification to the levees and additional upstream storage at the Auburn Dam site.

If the improvements and dam facilities are constructed as part of the federal project, the federal government will pay approximately 75% of the cost. The remaining 25% must be absorbed by the local interest and, more than likely, will require an additional source of revenue. Under the federal 75/25 cost sharing formula and the States new guidelines of recently adopted SB502, the local interest (City, County and Special District) will be required to pay approximately \$34 million.

INTRODUCTION

Description of Flood Control System

Sacramento River System

Project Description: The Sacramento Flood Control System consists of a number of dams, levees, overflow weirs and bypass channels extending from Shasta Dam to Collinsville. Approximately 980 miles of levee are included in the project and provide flood protection to about 800,000 acres of highly productive agricultural lands and to the cities of Marysville and Sacramento and numerous smaller communities.

Elements of this system that provide direct protection to the City during a major storm are shown on Figure I, page 5 of this report and include the:

1. Fremont Weir
2. Sacramento Weir
3. Yolo By-Pass Channel
4. Sacramento By-Pass Channel

Levees in the Sacramento River system which also provide immediate protection to the City include those along the Sacramento River, Lower American River, Natomas East Main Drainage Canal (NEMDC), Arcade Creek, Natomas Cross Canal and the Yolo By-Pass Channels.

Design Capacity: The design flow of the Sacramento River System from Fremont Weir to the Sacramento Weir is 107,000 cfs and downstream of the American River is 110,000 cfs. The levees along both sides of the Sacramento River were designed to carry these flows with at least three feet of freeboard. Excess flood waters are discharged through the Fremont and Sacramento Weirs and into the Sacramento and/or Yolo By-Pass Channels.

Status of Project: Construction of this system by the Corps of Engineers was initiated in fiscal year 1918 and completed between 1952 and 1958. Since completion, maintaining the stability of the levees has been a continuing problem.

Several studies are currently being conducted by the Corps of Engineers to identify deficiencies and recommend solutions. These studies have found the levees to be unstable and/or to lack sufficient freeboard, and, consequently, provide the City of Sacramento with only a 70 to 90 year level of protection. This report will discuss those deficiencies and solutions in general terms.

INTRODUCTION

Description of Flood Control System (cont.)

American River System

Project Description: The American River System consists of a 340 foot high concrete-earthfill dam on the main stem of the American River near the town of Folsom, one auxiliary dam at Mormon Island and 8 earthfill dikes. These facilities created a 1,000,000 acre-foot multipurpose reservoir for flood control, irrigation, municipal water supply, and power.

Additionally, the system includes Nimbus Dam located 7 miles downstream of Folsom Dam and approximately 4 miles of levee improvements on the north bank of the American River. The levee improvements extend from the high ground at Howe Avenue east of Cal Expo to the foot of Arden Way.

Design Capacity: The American River System was designed with an objective release from Folsom of 115,000 cubic foot per second (cfs). The levee system downstream of Folsom was designated to accommodate 115,000 cfs with 5 feet of freeboard.

Status of Project: Construction of this system by the Corps of Engineers was initiated in October 1948 and completed in May 1956. When completed, Folsom and Nimbus Dams were turned over to the Bureau of Reclamation to operate and maintain in conjunction with other Central Valley Project facilities.

Several studies by the Corps of Engineers are underway and have concluded that the existing system only provides the City of Sacramento with a 70 year level of protection. These studies identified levee improvements and additional upstream storage as the best alternative to increasing the level of protection provided by the American River System. This report will discuss those needed levee improvements and additional upstream storage requirements.

INTRODUCTION

Description of Flood Control System (cont.)

Morrison Creek System

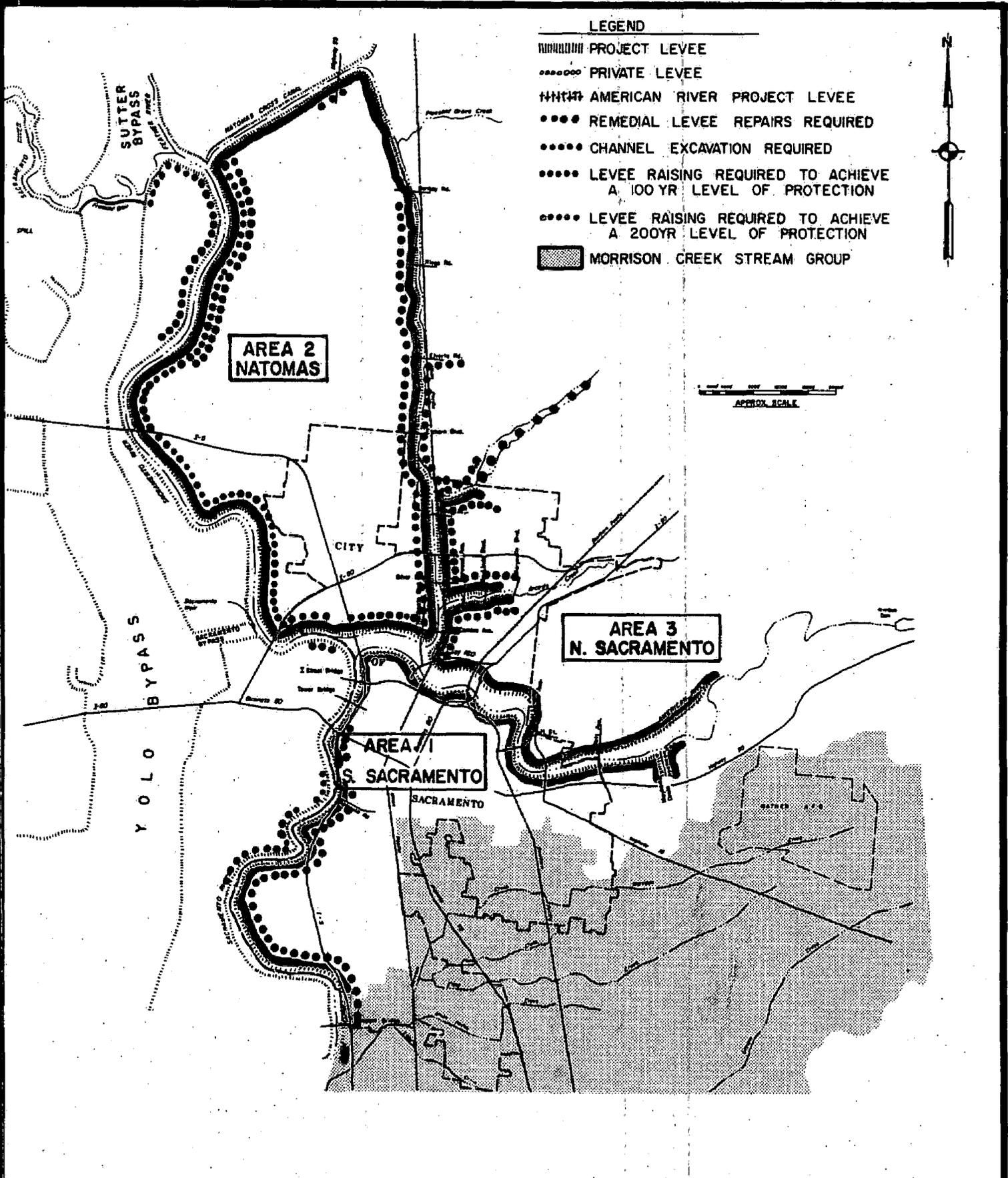
Project Description: The Morrison Creek System consists of a combination of natural streams, improved channels, constructed levees, and drainage pump stations that ultimately discharge into the Beach Lake natural drainage basin. The total system is composed of Morrison, Elder, Unionhouse and Laguna Creek and smaller tributaries that provide drainage for portions of the City of Sacramento; the communities of Florin, Elk Grove, Franklin, Point Pleasant and Hood; the Sacramento Army Depot; and Mather Air Force Base. Approximately 15,000 acres of City lands are drained by the Morrison Creek System.

Design Capacity: The design capacity of the Morrison Creek system varies. According to the latest FEMA map, the upper reaches of the system have a 100 year level of protection while the lower reaches have less than a 100 year level of protection. The lower reaches provide less than 100 year protection due to the back water condition of Beach Lake and/or their lack of levee freeboard.

Status of Project: Construction of this system has been somewhat piecemeal over the years. Some portions of the system have been constructed privately as development occurred and other portions have been constructed by the City as part of an assessment district. In 1986 a channelization project on Morrison Creek was completed in the vicinity of the Army Depot. More recent is the on-going channel improvement project on Laguna Creek which is being constructed as part of the Laguna Assessment District.

Several studies by the Corps of Engineers have been completed within the last 15 years and have identified a more systematic and uniform approach to channel and levee improvement. The first report was completed in 1972, updated in 1976 and the report "Advance Engineering and Design, Morrison Creek Stream Group, California," was published March 1987.

Currently the Corps is re-evaluating the Morrison Creek Stream Group under their Small Project Authority at the request of the City. Their reconnaissance level report should be completed early 1989. This report will discuss the findings of the Corps past reports along with tentative results of this on-going reconnaissance study.



**FIGURE 1
FLOOD CONTROL
SYSTEM PROTECTING
CITY OF SACRAMENTO**

DISCUSSION

Flood Control System Problems

General Description of Problems: During the 1986 flood, several reaches of the Garden Highway levees which protect the Natomas area almost failed. Additionally, the flood waters backing up into the Natomas East Main Drainage Canal came within inches of overtopping the west levees. The east levees did, in fact, overtop at Main Avenue.

Prompted by these facts, the Corps of Engineers began several investigations to determine what level of protection was provided by, and what improvements were necessary to increase the level of protection of, the American and Sacramento flood control systems. Two of these investigations completed by the Corps in 1988 indicate that the Sacramento and American River flood control systems do not provide as high a level of protection as previously thought.

The reconnaissance report, "American River Watershed Investigation, January 1988" concluded that Folsom Dam and the American River levees are only capable of handling a 70 year flood event. Both inadequate levee height and a lack of upstream storage were the main reasons why the American River flood control system was credited with such a low level of protection. The report, "Sacramento River System Evaluation, June 1988" revealed that the levees on both the Sacramento and American Rivers had freeboard and/or stability problems.

The Corps' report, "Advanced Engineering and Design, Morrison Creek Stream Group" was published 1987 and indicated that the channels and/or levees lacked adequate capacity to handle the 100 year storm. This conclusion was later reinforced by the FEMA floodplain maps which became effective February 1988 and showed a larger portion of the lower reaches of the Morrison Stream group to lie within the 100 year floodplain.

The following paragraphs will discuss the site-specific stability and freeboard problems of the levee systems and the need for additional storage on the American River. Included in the discussion will be the solutions identified in the Corps' investigations for the American, Sacramento and Morrison Creek flood control systems.

In an effort to make the discussion more meaningful, the levee problems and their respective solutions will be addressed separately from the additional storage requirements and solutions. Additionally, the levee problems and solutions will be discussed in reference to the area they protect. Finally, the flood control systems will be treated as a whole and discussion of particular levee problem will be irrespective of whether the levee is located in the American or Sacramento River flood control system.

DISCUSSION

Levee Problems

Area 1 - South Sacramento

Levee Problems: Figure I, page 5 of this report highlights the levees with respect to the areas they protect. The protected areas for discussion purposes are identified as follows:

| <u>Area</u> | <u>Name</u> |
|-------------|-------------------------|
| 1 | South Sacramento/Pocket |
| 1A | Morrison Creek |
| 2 | Natomas |
| 3 | North Sacramento |

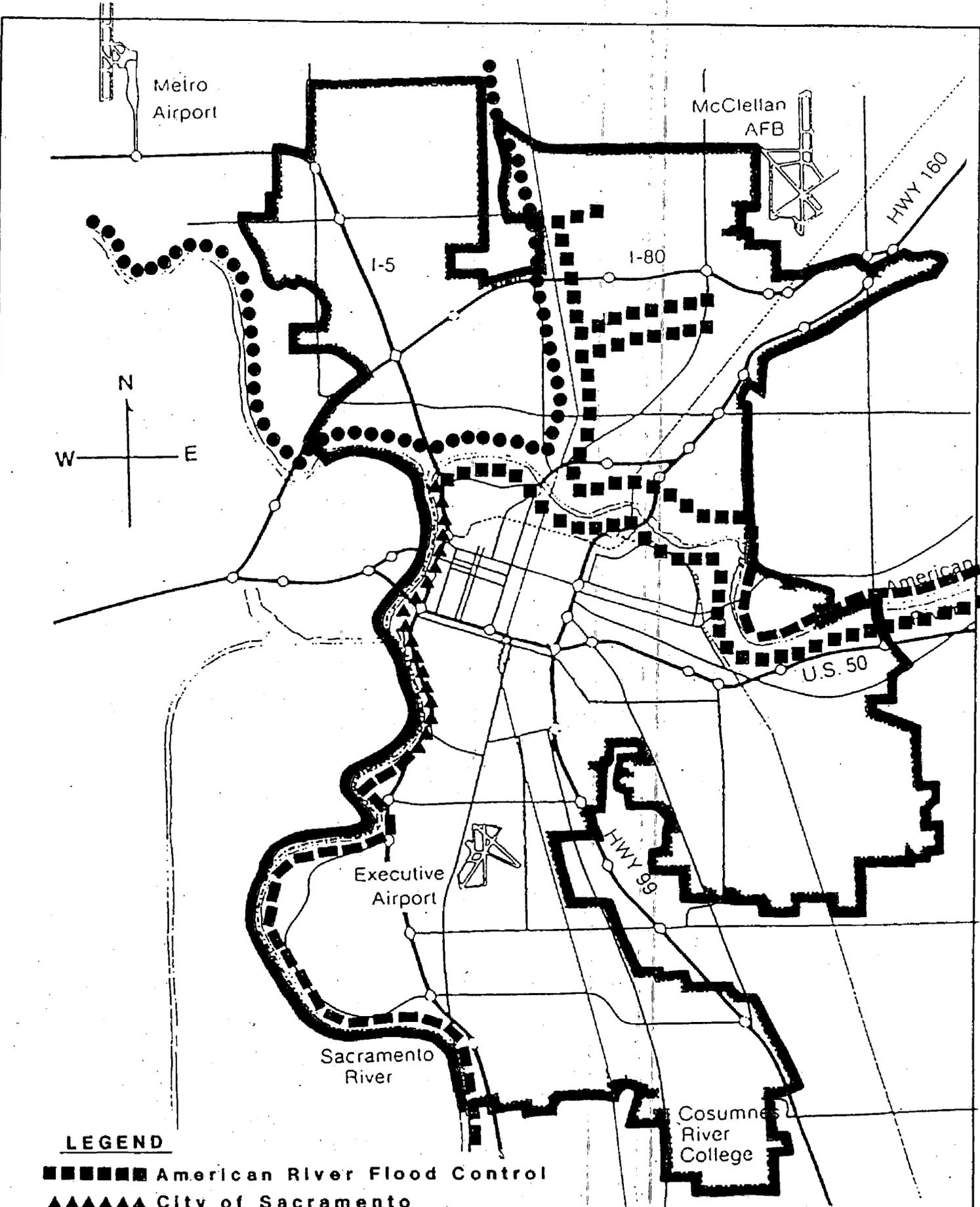
General Description of Area: This area is basically bounded to the north by the American River, to the west by the Sacramento River and to the south and east by the City limits. Included within this area would be those areas of the City commonly known as Original, East Central and South Sacramento/Pocket. This area contains approximately 38,500 acres, has a population of approximately 237,000, is 80 percent developed and included \$11.5 billion worth of public and private property located in the 200 year floodplain based on October 1987 prices.

Levee Responsibility: The area is protected from major flooding by levees operated and maintained by the:

1. American River Flood Control District
2. City of Sacramento
3. State of California

The division of levee responsibility is shown on Figure II, page 8 of this report.

Location of Problems and Solutions: The reach of levee identified in the Corps studies needing remedial repair to restore stability is shown on Figure I, page 5 of this report and extends from Miller Park to the town of Freeport, a distance of approximately 11 miles. The repair consists of a slurry trench impervious cut-off wall or some variation of a slurry trench cut-off wall that would cut off seepage water through the levee. (See Figure III).



LEGEND

- ■ ■ ■ ■ American River Flood Control
- ▲ ▲ ▲ ▲ City of Sacramento
- ● ● ● Reclamation District No. 1000
- ▣ ▣ ▣ ▣ State of California C.C.C.
- ▬ CITY LIMITS

| | |
|---|----------|
| FLOOD CONTROL & SEWER DIVISION | |
| LEVEE OWNERSHIP MAP | |
| SCALE: NONE | 10/21/88 |

DISCUSSION

Levee Problems

Area 1 - South Sacramento

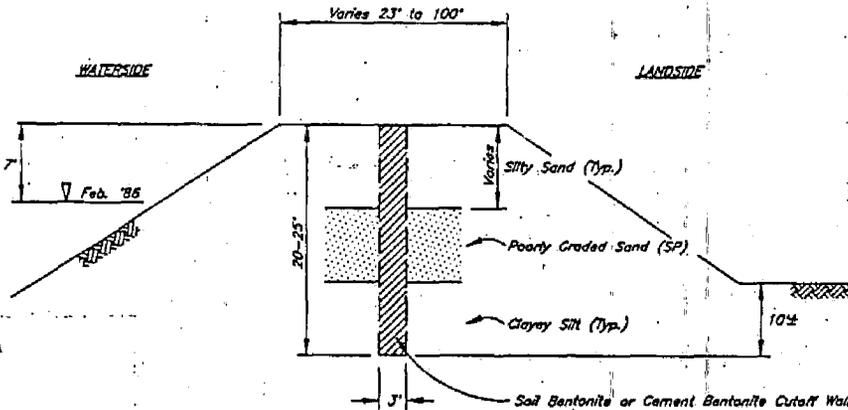


FIGURE III

Cost and Benefits: The cost to construct these 11 miles of levee improvements has been estimated at \$8.62 million using May 1988 dollars. The average annual reduction in damages with the improvements is estimated at \$2.1 million. The annual cost of the improvements is \$940,000. Consequently the benefit to cost ratio is 2.23 to 1.0.

Schedule and Degree of Risk: According to the Corps' latest schedule, the remedial levee improvements should be completed in early 1993, or approximately five years (See Figure IV). If we assume the maximum discharge down the American River is 115,000 cubic foot per second, when completed, these improvements should restore the level of protection for the area to a 200 year level or greater. Since the estimated level of protection is about 90 years, the risk of exceeding a flood event of that magnitude for each year is approximately 1.4 percent.

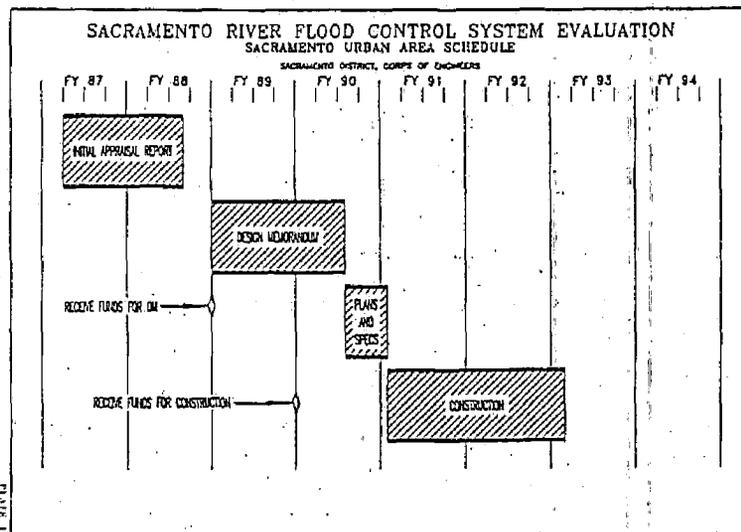


FIGURE IV

DISCUSSION

Levee Problems

Area 1A - Morrison Creek

General Description of Area: This area includes all those lands lying within the Morrison Creek Stream Group Watershed boundaries, as shown on Figure I, page 5 of this report. The watershed upstream of I-5 contains approximately 115,000 acres, of which 1600 acres lie within the City limits. The area in the City is 80% developed and has \$1.9 billion worth of damageable public and private property in the 200 year floodplain based on 1987 prices. Included within this area are portions of the City commonly known as East and South Sacramento.

Levee/Channel Responsibility: The levees, channels and pump stations protecting the City are maintained by the Flood Control and Sewer Division of the Public Works Department. These facilities protect the southern portion of the City from flooding from Morrison, Elder, Unionhouse and Laguna Creeks.

Area 1A - Morrison Creek

Location of Problems and Solutions: The main problem with the Morrison Creek System is that the lower reaches of the channels and levees cannot contain the 100 year flood event and satisfy the minimum freeboard requirement of the Federal Emergency Management Agency (FEMA). When FEMA learned of these problems in early 1980, the agency contracted with the Corps of Engineers to remap the floodplains. This remapping work was completed in February 1988 and resulted in a larger portion of the City, which was previously out of the floodplain, being included within the newly defined floodplain.

The main reason the floodplain changed so drastically was new hydrology, better topography data and new federal regulations that require a channel/levee system to have a minimum freeboard board of three feet when passing the 100 year flow. Since development is on the fast track in the newly defined floodplains, considerable disruption to the development community has resulted. Consequently, a resolution of the issue is in order and is currently being developed by the Corps of Engineers at the request of the City.

The latest report by the Corps has tentatively concluded that the most economical way to provide 100 year flood protection consists of about 25 miles of channel improvements and modification of the Lambert Road outlet structure. The recommended channel improvements are shown on Figure V and the Lambert Road structure modifications are shown on Figure VI, page 11 of this report.

DISCUSSION

Levee Problems

Area 1A - Morrison Creek System

Location of Problems and Solutions (cont.)

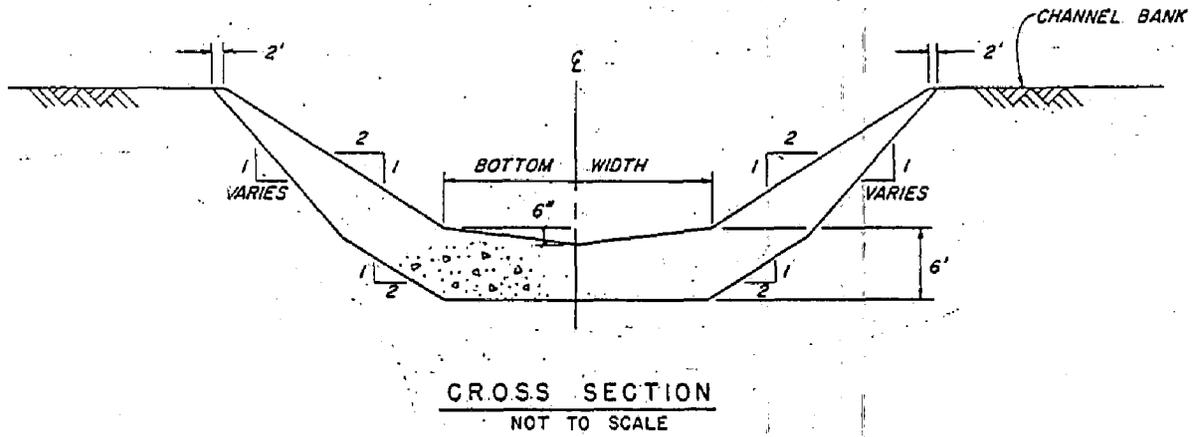


FIGURE V

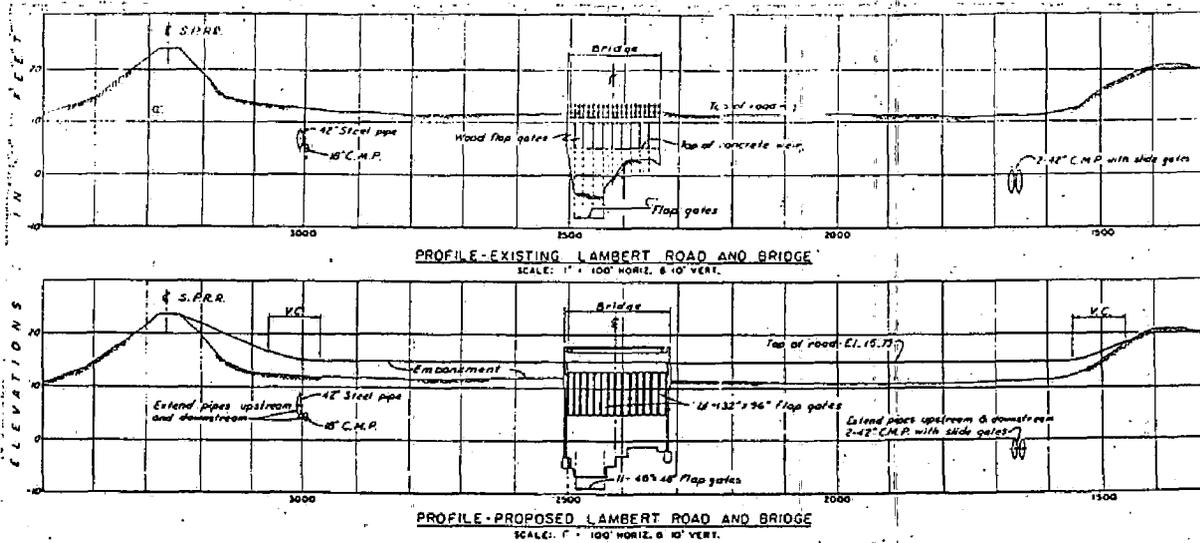


FIGURE VI

DISCUSSION

Levee Problems

Area 1A - Morrison Creek System

Location of Problems and Solutions (cont.)

These recommended improvements and modifications should remove most of the area within the Morrison Creek Basin from the floodplain by increasing the capacity of the channels and by stopping the flow of water north from the Consumnes River.

Cost and Benefits: The preliminary estimate of cost to construct the necessary channel improvements and modify the Lambert Road structure is \$30 million to provide a 100 year and \$35 million to provide a 500 year level of protection. The annual cost and benefits with corresponding benefit cost ratios are shown in Table I.

TABLE I

| LEVEL OF PROTECTION | ANNUAL COST (x 1,000) | ANNUAL BENEFIT (x 1,000) | B/C |
|---------------------|--------------------------|-----------------------------|---------|
| 100 | 2,525 | 5,148 | 2.0/1.0 |
| 500 | 2,840 | 5,449 | 1.9/1.0 |

* This benefit to cost ratio does not include any benefits attributed to Beach Stone Lake area.

It should be pointed out that approximately 65 percent of these improvements lie within the City limits. Additionally the City has completed channel improvement since the \$30 million estimate was made that subtracted from the overall cost. As a result, the maximum cost of the needed improvements in the City is estimated now at \$15 million.

Schedule and Degree of Risk: The reconnaissance study presently being conducted by the Corps should be completed early 1989. According to the Corps' latest estimate, the needed levee improvements could be completed in 4-6 years.

DISCUSSION

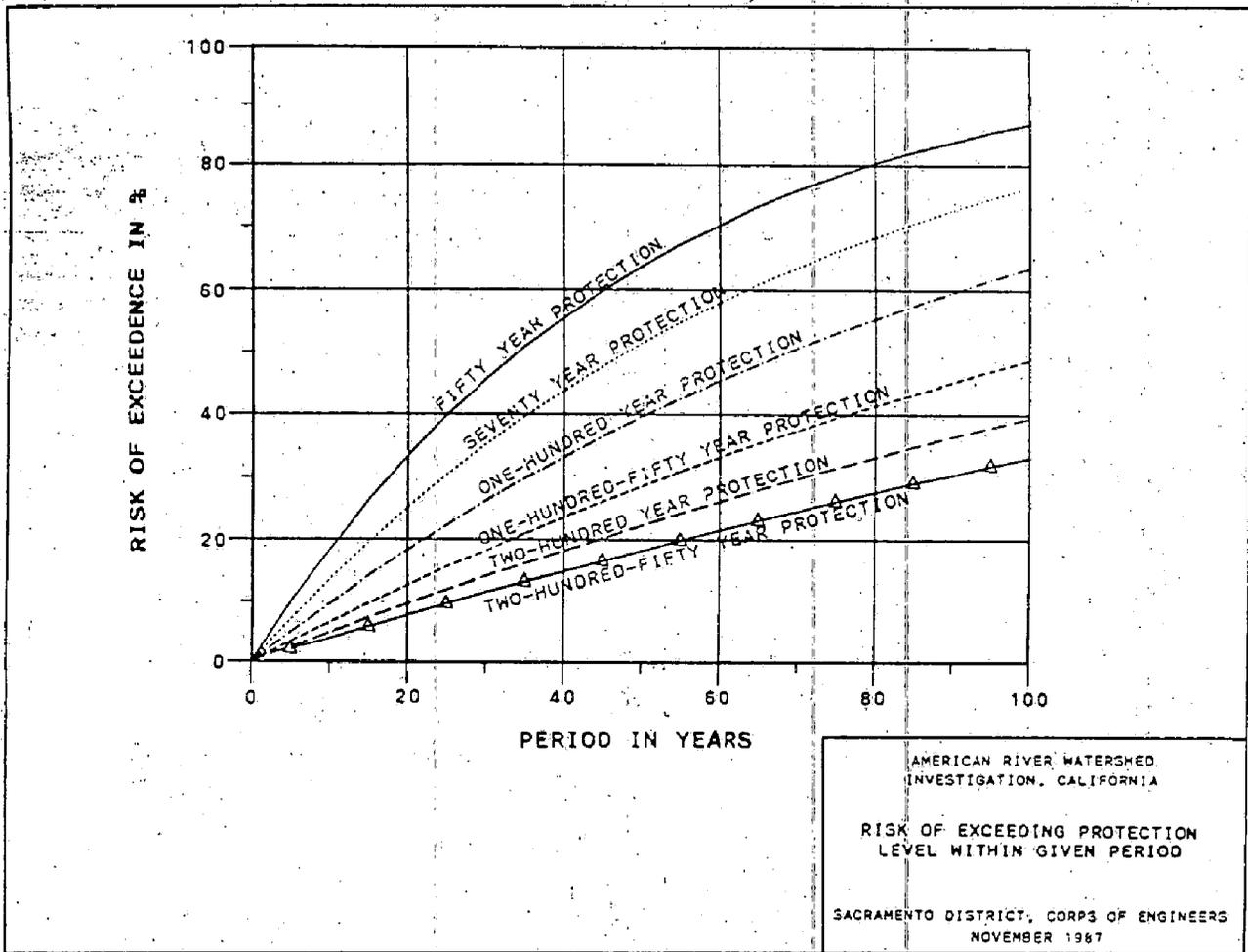
Levee Problems

Area 1A - Morrison Creek System

Location of Problems and Solutions (cont.)

Estimates of the level of protection provided by the existing system have been made and vary depending on location. They began at a 40 year level and go up. Consequently the risk of exceeding a flood event of 40 years for each year is approximately 2.8 percent.

It should be pointed out these estimates of the level of protection were made prior to the build up of the delta levees and new estimates will be made as a part of the study currently being performed by the C.O.E.



DISCUSSION

Levee Problems

Area 2 - Natomas

General Description of Area: This area is basically bounded to the west by the Sacramento River, to the north by the Cross Canal, to the east by the Natomas East Main Drainage Canal and to the south by the American River. Included within these boundaries are the South Natomas and North Natomas areas of the City, the Sacramento Metropolitan Airport and portions of Sacramento and Sutter Counties. Of the 43,000 acres lying within this area 11,500 acres lie within the City limit of which 2,600 have been developed. The 1985 population of the area is 22,000. The estimate of public and private damageable property located in the 200 year floodplain is \$1.15 billion using October 1987 dollars.

Levee Responsibility: This area, for the most part, is surrounded by 43 miles of levees that are operated and maintained by Reclamation District 1000. These levees protect the Natomas area from potential flooding from the Sacramento River, the Natomas East Main Drainage Canal and the American River.

Location of Problems and Solutions: The reaches of levee identified in the Corps' Study needing remedial repairs to restore stability and needing to be raised to increase freeboard are shown on Figure I, page 5 of this report. The total length of remedial repairs is approximately 15 miles of Garden Highway levees (approximately 2 miles were repaired in 1986 under PL84-99). The recommended repair includes the placement of a chimney drain over a portion of the landside levee slope with a horizontal drainage blanket extending beyond the levee toe (See Figure VII).

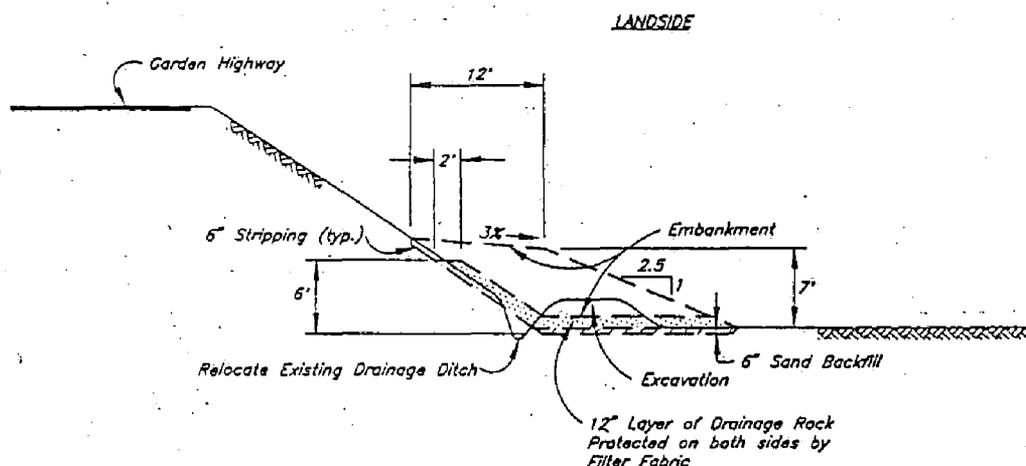


FIGURE VII

DISCUSSION

Levee Problems

Area 2 - Natomas

Location of Problems and Solutions (cont.)

This drainage blanket would be protected by an overlaying stabilizing berm. This repair scheme restores stability by reducing the potential for water to seep through the levee and providing additional mass to resist lateral movement. The additional berm also decreased the potential for piping near the levee toe.

Remedial repairs to restore stability also include relocating 1.3 miles of an irrigation ditch located immediately adjacent to the Natomas Cross Canal. The relocation work would begin at Highway 99 and extend west (See Figure VIII).

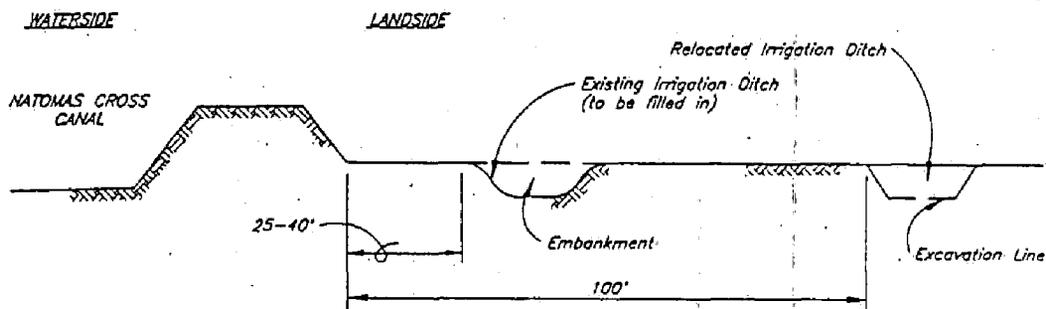


FIGURE VIII

An alternate solution to relocating the irrigation ditch would be to place a large diameter irrigation pipe in the existing ditch and backfill around the pipe.

The remaining levees protecting this area do not need any remedial repair, except for a 100 foot reach on the west bank of the Natomas East Main Drainage Canal. The reach is located between Silver Eagle Road and El Camino Avenue.

In addition to the remedial repairs needed for stability, approximately 50 miles of levee need to be raised to provide adequate freeboard. The reaches needing additional height are shown on Figure I, Page 5 of this report and described as follows:

Construct a gated embankment (earthen) structure at the mouth of the Natomas Cross Canal and install a high volume pump station (about 2,500 cfs for 100-year and 3,500 cfs for 200-year protection).

DISCUSSION

Levee Problems

Area 3 - Natomas

Location of Problems and Solutions (cont.)

Raise the west NEMDC levee 1-3 feet (4 feet for 200-year) from the mouth of American River to Sankey Road.

Raise the east Sacramento River levee about 1 foot from the Natomas Cross Canal to Elverta Road.

Raise or replace the Highway 99 bridge across the Natomas Cross Canal and all bridges along the NEMDC except Silver Eagle and I-80.

The gated earthen structure at the mouth of the Natomas Cross Canal proved to be the most economical way of providing 100 year protection in Pleasant Grove and surrounding areas. The structures will prevent the Sacramento River from backing up the Natomas Cross Canal and flooding the areas east of the Natomas East Main Drainage Canal.

During high flows, the levee improvements would result in induced flooding in the Dry and Arcade Creek areas, increased likelihood for levee breaks along the Sacramento River and Yolo Bypass, and erosion in the Sacramento Bypass. To offset these impacts, the following measures were included in this alternative:

- Raise the east levee of the NEMDC from the mouth of the American River to Dry Creek.
- Construct about 4 miles of new levee approximately 15 feet high along the east bank of the NEMDC from near Elverta Road to the confluence of Dry Creek and continuing upstream along the north side of Dry Creek to near Marysville Boulevard.
- Extend the existing south levee along Dry Creek to the Magpie Diversion Canal.
- Excavate and widen about 3 miles of channel in Dry Creek from near Marysville Boulevard up the south side of Cherry Island.
- Raise the north levee along Arcade Creek from the NEMDC to Marysville Boulevard 2 feet.
- Construct 0.4 miles of new levees on both sides of Arcade Creek upstream from Marysville Boulevard to a height of about 3 feet.

DISCUSSION

Levee Problems

Area 2 - Natomas

Location of Problems and Solutions (cont.)

- Raise or replace the bridges over Dry Creek at Elkhorn Boulevard, Rio Linda Boulevard and Dry Creek Road.
- Raise or replace the bridges over Arcade Creek at Norwood Avenue and Marysville Boulevard. (The bridge at Rio Linda Boulevard is being replaced by the City of Sacramento.)
- Raise and modify the north levee of the American River for about 1 mile downstream of the NEMDC.

Cost and Benefits: The cost to construct the levee improvements, the pump station and the associated mitigation improvements is summarized in Table II.

TABLE II

SUMMARY DISPLAY
NATOMAS AREA ALTERNATIVES^{1/}

| Alternatives | Modify/Construct levees with gated structure and pumping facilities at mouth of Natomas Cross Canal | | Modify/Construct levees along with cross levee at: | | | |
|---|---|--------|--|--------|--------------|--------|
| | | | Del Paso Road | | Elverta Road | |
| Level of Protection | 100-Yr | 200-Yr | 100-Yr | 200-Yr | 100-Yr | 200-Yr |
| Features | | | | | | |
| Levee Construction (mi)-Primary ^{2/} | 0 | 0 | 6 | 6 | 6.5 | 6.5 |
| -Secondary ^{3/} | 5 | 5 | 5 | 5 | 5 | 5 |
| Levee Modification (mi)-Primary | 17 | 20 | 12 | 14 | 13 | 15 |
| -Secondary | 30 | 30 | 23 | 25 | 23 | 25 |
| Pumping Capacity (cfs) | 2,500 | 3,500 | - | - | - | - |
| Area Protected (acres) | 60,000 | 63,000 | 25,000 | 25,000 | 36,000 | 36,000 |
| Costs (\$1,000,000) | | | | | | |
| Investment | | | | | | |
| Levee and Channels -Primary | 31 | 40 | 64 | 76 | 65 | 79 |
| -Secondary | 56 | 75 | 52 | 57 | 53 | 59 |
| Gated Structure and Pumping Facilities | 18 | 26 | - | - | - | - |
| Env. Mitigation Allowance ^{4/} | 10 | 14 | 12 | 13 | 12 | 14 |
| Total | 115 | 155 | 128 | 146 | 130 | 152 |
| Annual Cost | | | | | | |
| Interest Cost and Amortization, O, M, and R | 10.2 | 13.8 | 11.4 | 13.0 | 11.5 | 13.5 |
| Total | 0.5 | 0.7 | 0.1 | 0.2 | 0.1 | 0.2 |
| | 10.7 | 14.5 | 11.5 | 13.2 | 11.6 | 13.7 |
| Benefits (\$1,000,000) | | | | | | |
| Annual Benefits | | | | | | |
| Flood Control ^{5/} | 32.0 | 35.0 | 30.0 | 33.0 | 31.0 | 34.0 |
| Net Annual Benefits | 21.3 | 20.5 | 18.5 | 19.8 | 19.4 | 20.3 |
| Benefit-Cost Ratio (to one) | 3.0 | 2.4 | 2.6 | 2.5 | 2.7 | 2.5 |

^{1/} Assumes structural stability of all levee reaches.

^{2/} Primary = work required to protect Natomas area.

^{3/} Secondary = work believed necessary to offset induced flow impacts.

^{4/} Mitigation cost assumed at 10 percent of first cost.

^{5/} Does not include location benefits. If included, total project benefits would substantially increase for plan protecting entire area, moderately increase for Elverta cross levee plan, and increase somewhat for Del Paso Road plan.

DISCUSSION

Levee Problems

Area 2 - Natomas

Cost and Benefits (cont.)

As can be seen, several alternatives and levels of protection are considered. However, for purposes of this report, the 200-year alternative protecting the largest area (63,000 acres) will be used. It should be pointed out that this alternative seems to be the most promising, since a local drive to muster a consensus on the location of a cross levee failed earlier this year.

The cost to construct the remedial repairs to solve the stability problems, using May 1988 dollars, has been estimated at \$11,180,000. The total cost to construct remedial repairs and to raise the levees is approximately \$166 million. The initial construction cost, the annual cost and the annual benefits are summarized in Table III.

TABLE III

| FEATURE | CONSTRUCTION COST (\$ million) | ANNUAL COST (\$ million) | ANNUAL BENEFIT (\$ million) |
|---------------------------------|-----------------------------------|-----------------------------|--------------------------------|
| Remedial Repairs (stability) | 11.2 | 1.92 | 6.2 |
| Raise Levees (freeboard) | 155.0 | 14.5 | 35.0 |
| TOTALS | 166.2 | 16.42 | 41.2 |

Consequently, the overall benefit to cost ratio is 2.50 to 1.0.

Schedule and Degree of Risk: According to the Corps' latest schedule, the remedial repairs should be completed in early 1993, (See schedule Figure IV, page 9 of this report). Increasing the levee height, however, will not be completed until early 1995. Authorization to raise the levees might be received as early as 1991, or sooner, depending on congressional actions.

If we assume the maximum discharge down the American River is 115,000 cfs, these improvements should restore the level of protection for the Natomas area to a 200-year level. Since the estimated level of protection is about 50 years, the risk of exceeding a flood event for each year is approximately 2 percent.

DISCUSSION

Levee Problems

Area 3 - North Sacramento

General Description of Area: This area is basically bounded to the west by the Natomas East Main Drainage Canal, to the south by the American River and to the east and north by the City limits. Included within the area would be those areas of the City commonly known as Campus Commons and North Sacramento. This area contains approximately 12,000 acres, has a population of 56,000, is 75% developed and has \$2.88 billion worth of damageable public and private property in the 200 year floodplain based on October 1987 prices.

Levee Responsibility: This area is protected by levees operated and maintained by the American River Flood Control District (ARFCD). The levees protect the area from potential flooding from the American River, Arcade Creek, Dry Creek and the Natomas East Main Drainage Canal.

Location of Problems and Solutions: The levees protecting this area are currently considered stable for objective releases from Folsom Dam of 115,000 cubic feet per second. Consequently no structural fixes are necessary. The levees, however, for the most part, need to be raised to provide either a 100 year or a 200 year level of protection. The length of levees needing to be raised is 47 miles for the 100 year and 50 miles for the 200 year level of protection. Those reaches needed to be raised are shown on Figure I, page 5 of this report.

In addition to the requirement to raise these levees, the Arcade Creek channel needs to be excavated and widened for about 3 miles. The reach of the channel needing to be widened extends from Marysville Boulevard to Cherry Island as shown on Figure I of this report.

Cost and Benefits: The May 1988 cost to raise the levees and to excavate and widen Dry Creek is approximately \$40 million. It should be pointed out that this cost has also been included in the \$75 million mitigation cost of strengthening and raising the levees surrounding Area 2-Natomas. (See Table II, page 16 of this report)

Assuming an annual benefit for flood control of \$26 million, as determined by the Corps, and an annual cost of improvements at \$3.5 million yields a benefit to cost ratio of 7.4 to 1.

Schedule and Degree of Risk: According to the Corps latest schedule, the needed levee improvements and channel work should be completed in early 1995 or approximately 6 years. Authorization of the needed work might be as early as 1991, or sooner, depending on Congressional actions.

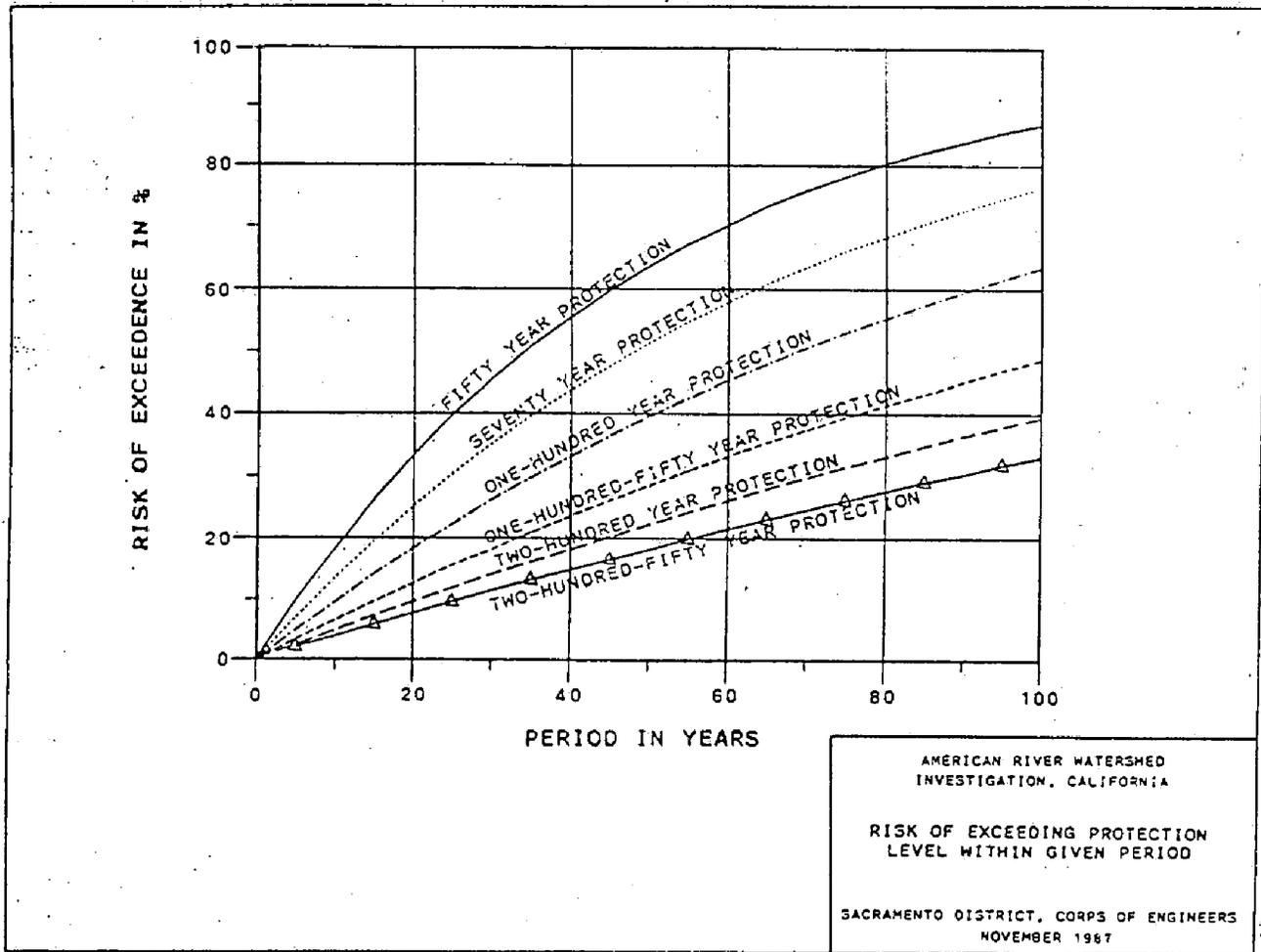
DISCUSSION

Levee Problems

Area 3 - North Sacramento

Schedule and Degree of Risk (cont.)

If we assume the maximum discharge down the American River is 115,000 cfs, these improvements should restore the level of protection for the North Sacramento area to a 200 year level. Since the estimated level of protection is about 70 years, the risk of exceeding a flood event for each year is approximately 1.3 percent.



DISCUSSION

Storage Problems

Area 1-3 Sacramento

General Description of Area: This area includes all of the City of Sacramento and the greater Sacramento area. The City contains approximately 62,000 acres of which 75% have been developed. The 1987 population for the City was 327,000. The estimate of damageable property located in the 200 year floodplain is \$16 billion, using 1987 dollars.

Dam and Storage Facilities Responsibility: The area is protected from major flooding from the American River by Folsom and Nimbus Dams operated and maintained by the Bureau of Reclamation. These facilities regulate the maximum flow passing down the river and protect the City from flooding that would result from levee failure or overtopping.

Problems and Solutions: The reconnaissance report, "American River Watershed Investigation" states:

In February 1986, major storms in northern California caused record floodflows in the American River Basin. Prior to this time, it was believed that Folsom Dam and Reservoir could control flows along the lower river to 115,000 cubic feet per second (cfs) for events having return periods of about once in 120 years, on the average. However, recent studies of Folsom Reservoir flood operation and flow-frequency relationships have shown that the facility is capable of controlling only about the 63-year flood to 115,000 cfs. The outflows from Folsom Dam capable of causing major flood damages along the river are expected to occur significantly more often than previously believed.

The investigation studied various alternatives to increase the level of protection provided by the existing system and concluded:

Along the American River, 100 to 150 year levels of protection can be economically achieved through various combinations of Folsom Dam modification and downstream levee and channel modifications.

Levels of protection in excess of 150 years along the lower American River can be economically achieved by constructing new storage upstream from Folsom Reservoir.

The cost to construct the necessary storage facilities for 200 year protection and the price tag for the most promising combinations of Folsom Dam modification with downstream levee improvements for 100 year protection are summarized in Table IV.

DISCUSSION

Storage Problems

Area 1-3 Sacramento

Cost and Benefits (cont.)

TABLE IV

SUMMARY DISPLAY
COMBINATION ALTERNATIVES^{1/}

| Level of Protection | 100-Yr | | 200-Yr |
|---|--|--|---|
| Alternative | Increase Folsom Objective Release and Construct Natomas Improvements | Increase Folsom F.C. Storage Lower Spillway and Construct Natomas Improvements | Construct New Storage (Single-Purpose Reservoir) and Natomas Improvements |
| Features | | | |
| Reservoir Storage (ac-ft) | | | |
| Folsom Reservoir F.C. | 400,000 | 650,000 | 400,000 |
| New Reservoir | - | - | 570,000 |
| Total | - | - | 540,000 |
| Flood Control | | | |
| Folsom Objective Release (cfs) | 100,000 | 115,000 | 115,000 |
| Lower Folsom Spillway (ft) | - | 15 | - |
| Levee Modification (mi) | | | |
| American River | - | 0 | 0 |
| Natomas Area - Primary ^{3/} | 15 | 14 | 21 |
| Other Areas - Secondary ^{4/} | 31 | 30 | 30 |
| Natomas Cross Canal | | | |
| Pump Capacity (cfs) | 2,500 | 2,500 | 3,500 |
| Costs (\$1,000,000) | | | |
| Investment | | | |
| Levees and Channels | | | |
| American River - Primary | 93 | - | - |
| Natomas Area - Primary | 24 | 18 | 22 |
| Other Areas - Secondary | 56 | 48 | 60 |
| Folsom Dam Modification | - | 28 | - |
| New Dam and Related | - | - | 272 |
| Gated Structure and Pumping Facilities | | | |
| Env. Mitigation Allowance ^{5/} | 18 | 18 | 26 |
| Subtotal | 38 | 11 | 38 |
| Interest During Construction | 229 | 123 | 418 |
| Total | - | 3 | 23 |
| Total | 229 | 126 | 441 |
| Annual Cost | | | |
| Interest and Amortization | 20.3 | 11.2 | 39.1 |
| O, M, and R | 1.0 | .9 | 1.8 |
| Total | 21.3 | 12.1 | 40.9 |
| Benefits (\$1,000,000) | | | |
| Annual Benefits | | | |
| Flood Control | 55.9 | 56.3 | 96.9 |
| Water Supply | - | -5.9 ^{6/} | - |
| Hydropower | - | -3.7 ^{7/} | - |
| Auburn Dam Savings | - | - | 5.0 |
| Total | 55.9 | 46.7 | 101.9 |
| Net Annual Benefits | 34.6 | 34.6 | 61.0 |
| Benefit-Cost Ratio (to one) | 2.6 | 3.8 | 2.5 |

^{1/} Assumes structural stability of all levee reaches.

^{2/} See Primary work items in Table 12.

^{3/} Primary = work required to protect Natomas Area.

^{4/} Secondary = work believed necessary to offset induced-flow impacts.

^{5/} Mitigation costs for (1) levee modification along American River assumed at 30 percent and

(2) other areas assumed at 10 percent of first cost for the other items.

^{6/} Value of firm water supply Folsom assumed to be \$200/ac-ft.

^{7/} Value of power supply foregone assumed to be 100 mills/kWh.

Schedule and Degree of Risk: Currently the Corps is fast tracking their study for additional upstream storage on the American and according to their latest schedule a flood control project providing a 200 year level of protection could be completed as early as 1999. At the same time the Corps is investigating ways to provide an interim 100 year level of protection. A study on the reallocation of the flood control space in Folsom has just been started and should be completed October 1989.

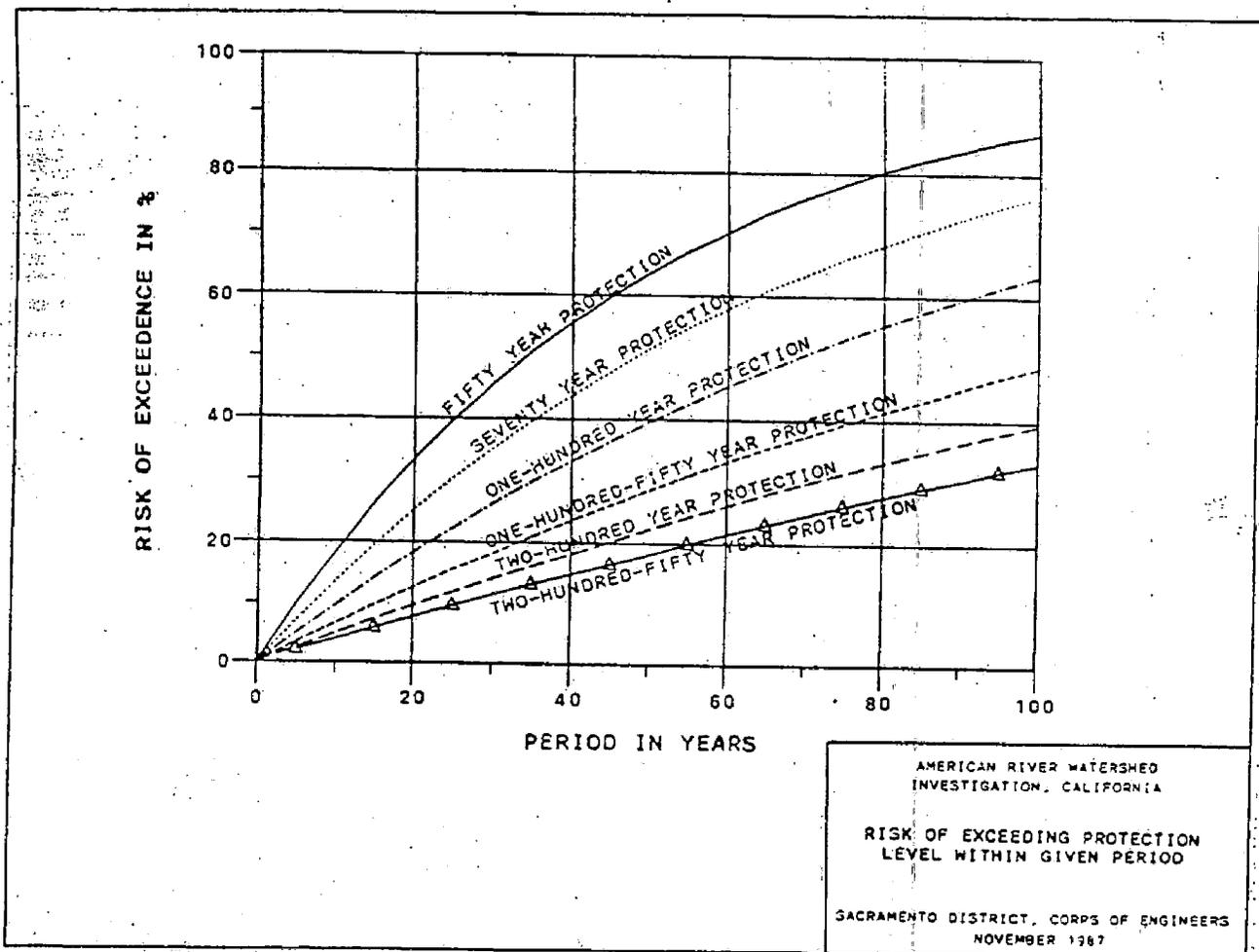
DISCUSSION

Storage Problems

Area 1-3 Sacramento

Cost and Benefits (cont.)

Since the existing level of protection has been estimated at 63 years, the risk of exceeding the capacity of the American River flood control for each year is approximately 1.7 percent.



FINANCIAL IMPACTS

Total Cost of Improvements: The total cost to construct the remedial repairs, raise the levees and provide additional upstream storage is \$461.8 million as summarized on Table V.

TABLE V
COST OF NEED IMPROVEMENTS
200 YEAR PROTECTION

| AREA | NAME AREA | LEVEES | | STORAGE | TOTAL LEVEE AND STORAGE |
|--------|----------------|-----------|-----------|---------|----------------------------|
| | | STABILITY | FREEBOARD | | |
| 1 | So. Sacramento | 8.6 | | | 8.6 |
| 1A | Morrison Creek | | 15.0 | | 15.0 |
| 2 | Natomas | 11.2 | 125.0 | | 136.2 |
| 3 | No. Sacramento | | 30.0 | | 30.0 |
| | | | | 272.0 | 272.0 |
| TOTALS | | 19.8 | 170.0 | 272.0 | 461.8 |

If we assume the needed improvements and the additional storage requirements are constructed as part of a Federal project, then the allocation of cost would be roughly as shown on Table VI.

TABLE VI
COST ALLOCATIONS
NEEDED IMPROVEMENTS
(Cost in millions)

| AREA NAME | CONSTRUCTION COST | LERR | RELOCATIONS | FEDERAL | STATE | LOCAL | TOTAL |
|-------------------------|-------------------|------|-------------|---------|--------|-------|--------|
| Levees | | | | | | | |
| So. Sacramento | | | | | | | |
| Stability | 8.62 | | | 6.465 | 1.509 | 0.646 | 8.62 |
| Freeboard | | | | | | | |
| Morrison Creek | | | | | | | |
| Stability | 11.0 | 1.0 | 3.0 | 8.25 | 4.73 | 2.02 | 15.0 |
| Freeboard | | | | | | | |
| Natomas | | | | | | | |
| Stability | 7.18 | 2.0 | 2.0 | 5.38 | 4.06 | 1.74 | 11.18 |
| Freeboard | 115.0 | 2.0 | 5.0 | 86.25 | 25.02 | 10.73 | 122.0 |
| No. Sacramento | | | | | | | |
| Stability | 25.0 | 3.0 | 5.0 | 18.75 | 9.98 | 4.27 | 33.0 |
| Freeboard | | | | | | | |
| Total Levee | 166.8 | 8.0 | 15.0 | 125.08 | 45.29 | 19.41 | 189.78 |
| Storage | | | | | | | |
| Sacramento | 252.0 | | 20.0 | 189.0 | 68.0 | 15.0 | 272.0 |
| Total Storage | 252.0 | 0 | 20.0 | 189.0 | 68.0 | 15.0 | 272.0 |
| Total Levee and Storage | 418.8 | 8.0 | 35.0 | 314.08 | 113.29 | 34.41 | 461.78 |

FINANCIAL IMPACTS

Total Cost of Improvements (cont.)

The above cost allocation are based on the new sharing percentages of SB502.

CONCLUSION

Recent studies by the Corps' have revealed that the American River, Sacramento River and Morrison Creek flood control system only provides a 70, 90 and 40 year level of protection, respectively. In order to increase the level of protection, levee improvements and additional storage on the American River are necessary.

The most recent estimate of cost to provide a 200 year level of protection is \$461.8 and is summarized according to the area protected on Table V, page 24 of the report. The annual benefits exceed the annual cost of the improvements and additional storage as shown on Table VII of this report.

TABLE VII
COST OF NEED IMPROVEMENTS
200 YEAR PROTECTION
(cost in millions)

| AREA | NAME OF AREA | LEVEES | | STORAGE | TOTAL LEVEE AND STORAGE | ANNUAL COST | ANNUAL BENEFIT | B/C RATIO |
|--------|----------------|-----------|-----------|---------|----------------------------|----------------|-------------------|--------------|
| | | STABILITY | FREEBOARD | | | | | |
| 1 | So. Sacramento | 8.6 | | | 8.6 | .94 | 2.1 | 2.23/1 |
| 1A | Morrison Creek | | 15.0 | | 15.0 | 2.84 | 5.45 | 1.90/1 |
| 2 | Natomas | 11.2 | 125.0 | | 136.2 | | | |
| 3 | No. Sacramento | | 30.0 | | 30.0 | 16.42 | 41.2 | 2.50/1 |
| | Storage | | | 272.0 | 272.0 | 40.9 | 101.9 | 2.50/1 |
| TOTALS | | 19.8 | 170.0 | 272.0 | 461.8 | | | |

* Overall benefit of Natomas and North Sacramento

Since the benefit cost ratios are greater than 1.0, a federal interest is somewhat assured. According to the federal 75/25 cost sharing formula for flood control projects and the newly adopted guidelines (SB502) for the States subvention program, the local interest can anticipate a future bill of approximately \$34 million (see Table VI, page 24 of this report).

CONCLUSION (cont'd)

Since the cost used in this report are taken from the preliminary Corps' studies they should be considered preliminary and subject to change. The \$34 million price tag, however, would indicate a definite need for the local interest to begin developing a means of financing this local share. Financing these improvements could be by revenues generated from a beneficial assessment, an increase in rate fees or some form of bond financing. According to City Council direction, City staff, in the future, will start to develop an acceptable funding mechanism and report back to council accordingly.

RECOMMENDATION

It is recommended that the Council receive and file this report.