### Attachment I

Executive Summary from 1996 Flood Plain Management Study

# **EXECUTIVE SUMMARY**

# SKUNK RIVER/SQUAW CREEK FLOOD PLAIN MANAGEMENT STUDY



## Prepared For: CITY OF AMES, STORY COUNTY, IOWA STATE UNIVERSITY, IOWA DOT April 12, 1996



**CONSULTING ENGINEERS & PLANNERS** 

**SNYDER & ASSOCIATES, INC.** 

# EXECUTIVE SUMMARY

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#### A. INTRODUCTION

The City of Ames, Iowa and surrounding portions of Story County have numerous structures located immediately adjacent the Skunk River and Squaw Creek floodplains. In recent years, these structures have experienced repeated flooding from the two basins with Squaw Creek accounting for the majority of the flood damage. The major floods in Ames have occurred in 1965, 1975, 1990 and twice in 1993. The largest of these occurrences in terms of damage, depth of water, and discharge was July 8th/9th, 1993, which resulted in a storm water runoff frequency greater than 500 years and rainfall frequency of approximately 50 years.

Within the City of Ames, the areas sustaining the most damage during the 1993 flood were Iowa State University, South Riverside Avenue, South Duff Avenue and property adjacent to US 30. The total estimated damage to structures within the City of Ames and adjacent areas was approximately \$10.5 million which is summarized as follows:

#### 1. IOWA STATE UNIVERSITY

a.	Hilton Coliseum	\$ 2,137,000
b.	Scheman Building	\$ 900,000
c.	Maple-Willow-Larch	\$ 983,000
d.	Recreation/Athletic Center	\$ 115,900
e.	University Village	\$ 159,400
f.	Other Locations (Golf Course, Olsen	
	Building, utilities, etc.)	<u>\$ 2,204,700</u>
	Subtotal	\$ 6,500,000
THI	E CITY OF AMES PUBLIC PROPERTY	\$ 830,000
PRI	VATE PROPERTY	
a.	South Duff Avenue from Squaw Creek Bridge	
	north to near 3rd Street.	\$ 1,800,000
Ъ.	South 5th Street	\$ 233,000
c.	South 4th Street near Riverside Manor	\$ 95,000
d.	Dayton Ave. north of US 30	\$ 100,000
e.	East Lincoln Way	\$ 235,000
f.	Arrasmith Trail	\$ 85,000
g.	Meadow Lanes Mobile Home Park	\$ 62,000
ĥ.	Shady Grove Mobile Home Park	<u>\$    542,880</u>
	Subtotal	\$ 3,152,880
	GRAND TOTAL	\$10,482,880

2.

3.

As a result of the floods of 1993, the City of Ames, Iowa State University, Story County, and the Iowa Department of Transportation formed a Flood Review Task Force to complete the following:

- Identification of factors contributing to the recent flooding.
- Development of an updated HEC-2 model for flood profiles and integration of the model with the flood warning system being developed by members of the Flood Task Force.
- Determination of the impacts of existing structures on flood water surface elevations.
- Identification and analysis of a list of potential flood mitigation alternatives, development of a short list of approved alternatives, and the development of benefit/cost analysis on the short listed alternatives.
- Facilitate a public input process.

In the fall of 1994, Snyder & Associates, Inc. of Ankeny, Iowa was retained to develop a Squaw Creek/Skunk River Flood Plain Management Plan with the task of completing the above listed items. Numerous meetings were held with the task force and with the general public to received input and discuss possible solutions.

#### B. SKUNK RIVER/SQUAW CREEK FLOOD PLAIN CHARACTERISTICS

#### 1. SKUNK RIVER BASIN

The Skunk River Basin has a drainage area of approximately 329 square miles to the north of the City of Ames. This represents approximately 60% of the Skunk River/Squaw Creek Basin. The upper portion of the basin commences just north of Williams, Iowa and proceeds south approximately 40 miles to near S. 16th Street in Ames where it meets Squaw Creek. The majority of the basin is farm ground and contains eight communities including the City of Ames. The characteristics of the floodplain is its ability to hold considerable amounts of water in the main channel and has a very small increase in depth as the discharge increases substantially. The average depth of floodwater near Ames upstream of the confluence for the new 100-year discharge is approximately 12 feet and approximately 13 feet for the new 500-year discharge.

#### 2. SQUAW CREEK BASIN

The Squaw Creek Basin has a drainage area of approximately 227 square miles. The basin starts just north of Stanhope and proceeds south to Ames a distance of approximately 30 miles. The majority of land use in the basin is farm ground except for the communities of Stanhope, Stratford, Gilbert, and on the west side of the City of Ames. Throughout the majority of the basin, the floodplain is relatively constant in width at a quarter of a mile. The Squaw Creek Basin is considerably different in character than the Skunk River basin. The flood plain is relatively narrow and has very little storage capacity for flood waters. Because of its narrow flood plain, the depth raises sharply as discharge increases compared to Skunk River. The average depth of floodwater near Ames for the new 100-year discharge is approximately 14 feet and for the new 500-year is approximately 19 feet.

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#### C. 1993 RAINFALL AND RUNOFF

Between April 23 and September 1, 1993, there were only 13 days without measurable rainfall somewhere in Iowa. This was a result of a stationary weather pattern which caused substantial rainfall. On Squaw Creek at Lincoln Way gage, the peak flood elevation occurred approximately 9 a.m. on July 9, 1993. This was approximately 6 hours after the end of the rainfall that recorded a discharge of 24,300 cfs which was nearly twice as high as the previous record flood of 1990 in which 12,500 cfs occurred.

Regarding the Skunk River, two peak discharges occurred.

1. Upper Gage - Upstream of Squaw Creek confluence. Peak discharge of 11,200 cfs occurred at approximately 1 p.m. on July 9th or some 10 hours after the rainfall.

2. Lower Gage - Below Squaw Creek confluence. The peak discharge of 26,500 cfs occurred approximately 2 p.m. on July 9th or near 11 hours after the rainfall ended.

## D. US GEOLOGICAL SURVEY/CORPS OF ENGINEERS HYDROLOGICAL ANALYSIS

Both the USGS and Corps of Engineers completed a revised hydrological analysis of all three Ames gages. Both agencies used the US Water Resources Bulletin No. 17B to complete their analysis. Bulletin 17B is a nationally accepted method for completing hydrologic studies. As a result of their analysis, the USGS and Corps of Engineers obtained different results particularly on Squaw Creek. The USGS had a 100-year discharge of 13,455 cfs on Squaw Creek. This agency is a statistical agency and does not make interpretations of the data. The Corps of Engineers had a 100-year discharge of 16,200 cfs for Squaw Creek. This agency is a regulation and construction oriented agency. Since the purpose of the 100-year flood is for the protection of the City of Ames and Story County, the Task Force believed the higher Corps of Engineers' value would be more appropriate. Therefore, the Corps of Engineers' discharges were used throughout the remainder of this study in the evaluation of the effects of alternatives for the 100- and 500-year floods. The selected discharges require Iowa DNR and FEMA approval prior to becoming official values. Jack Riessen with the Iowa DNR stated in a February 15, 1995 letter to Shirley Johnson with the COE, both the USGS and COE discharges are "technically defensible". In selecting the higher COE discharges, the Ames Flood Task Force will be required to provide justification for this selection during the Iowa DNR/FEMA approval process.

#### E. CORPS OF ENGINEERS' MODEL CALIBRATION

As part of the project study, Snyder & Associates, Inc. updated the hydraulic (HEC-2) model for Skunk River and Squaw Creek. This model was used to determine both the effects of previous constructed structures and flood reduction alternatives. Once initial model parameters were determined and the preliminary model was developed, the model required adjustments to accurately develop water surface profiles. This process is called model calibration. During the calibration process, Snyder & Associates, Inc. discovered

the Corps of Engineers was developing a model of the entire Skunk River/Squaw Creek basin for the Iowa DNR. As a result of close contact between Snyder & Associates and the COE, a final hydraulic model agreeable to both parties was developed and calibrated.

#### F. RUNOFF EFFECTS FROM PREVIOUS DEVELOPMENT

#### 1. LAND USE CHANGES

Over a 30 year period of time, 1960 to 1990, the City of Ames experienced a population growth of approximately 20,000 persons (27,003 to 47,198). A comparison of a 1965 aerial flight and a 1993 flight over the City of Ames was used to determine land use changes within the Squaw Creek/Skunk River flood plains.

Regarding Squaw Creek, the majority of development has been commercial and public facilities. Two areas, in particular, showed substantial growth. First, South Duff Avenue had a concentration of commercial development in the Squaw Creek Flood plain. The second area of increased growth was the development of the ISU Center facilities within the Squaw Creek flood plain north and south of Lincoln Way.

Regarding Skunk River, development had not been as extensive as along Squaw Creek. The majority of development had taken place near the north end of the City limits and the south edge of the City near US 30 and Dayton Avenue.

#### 2. CITY OF AMES STORM RUNOFF

Storm runoff from these newly developed areas as a result of previous floods had little impact on the flooding that occurred in 1993. The discharges developed from within the City limits had moved downstream when the peak discharges from Squaw Creek and Skunk River passed through the City. Therefore, the peak discharges were caused by the large volume of upstream runoff and not localized runoff. This is supported by the fact the City of Ames is approximately 25 square miles and the areas developed in the last 30 years are approximately 8 square miles. This is less than 1.5% of the total 556 square miles of the two basins. The rainfall amounts within the City of Ames were substantial and could account for localized flooding. Localized flooding is not part of the scope of this project.

#### 3. IMPACTS OF DEVELOPMENT RESTRICTIONS ON BACKWATER

An analysis of impact locations was completed to determine if bridges, roadways, and land development restrictions caused substantial upstream water surface elevation increases (backwater). Fifteen different sites were selected throughout the Skunk River and Squaw Creek basins. The analysis concluded the three potential restrictions, bridges, roadways, and development, had a very small effect on the backwater within the City.

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The Code of Iowa and FEMA state one foot of maximum backwater is allowed for 100-year flood (regulatory flood). The hydraulic analysis for the basin was for the 1993 flood which was approximately a 500-year. Even with utilizing the 500year flood, the bridges, roadways, and development restrictions all were within the one foot allowance with the exception of Interstate 35 and Stange Road. This includes Elwood Drive and Iowa State Center. Stange Road bridge for the 1993 flood had 14 inches of backwater and Interstate 35 had 19 inches of backwater. When checking the 100 year discharge for both of these bridges, the backwater was less than the allowable amount.

#### G. FLOOD MITIGATION ALTERNATIVES

A wide range of potential alternatives were analyzed to determine the feasibility of reducing the impact of flooding within the two basins. The alternatives considered were

- 1. Channel Widening
- 2. Channel Straightening
- 3. Bridge Channel Clearing
- 4. Upstream Detention (2 reservoirs)
- 5. Levee Construction
- 6. Floodproofing

#### 1. PUBLIC INVOLVEMENT

Several meetings concerning proposed alternatives were held with individual property owners. Property owners in the US 30/Dayton Avenue area expressed valid concerns on the consequences of continued flooding on their homes, businesses, and land. They also furnished valuable information concerning past flooding history. This information was used in the development of the hydraulic models.

The owner of Riverside Manor nursing home at 1204 S. 4th Street commented on the problem of flow overtopping S. 4th Street east of the bridge and running into the nursing home and apartments. He asked Snyder & Associates to investigate the potential for placing a levee across the ground where the City bought out several homes on the north side of S. 4th Street. The levee alignment would keep floodwaters from overtopping S. 4th Street east of the bridge. Floodwater would still overflow the roadway west of the bridge.

The analysis was completed using the calibrated HEC-2 model for Squaw Creek. The results of this analysis indicate the upstream water surface elevations would increase as a result of the levee. The 100-year flood elevations would increase approximately 0.2' while the 500-year flood elevations would increase approximately 0.3'.

The Ames Flood Plain Ordinance states an improvement must cause not greater than 0.1' of water surface elevation increase upstream from the improvement site. The S. 4th Street levee in the location proposed does not meet this requirement. Individual site flood protection measures such as an earthen berm or building floodproofing could diminish the threat of flood damage for the affected structures without causing increases in upstream water surface elevations.

#### 2. RECOMMENDED ALTERNATIVES

Alternatives 1 through 4 were considered to be cost prohibitive, environmentally harmful, or publicly unacceptable. The decrease in water surface elevation for Alternatives 1 through 3 for the 500-year flood discharge were only 2" to 6" in depth. Alternative 4 (upstream detention) did reduce flood water depths, but cost \$36 million and had previously been rejected by the public.

It is proposed that the elevation of the top of levee and floodproofing be based on the COE 100-year flood water surface profile plus 2.5 feet of freeboard. This makes the top of the protection at the 500-year flood water surface profile. The 500-year water surface profile is approximately equivalent to the 1993 flood water surface profile. As a result of the analysis and public input, specific locations of levee construction and floodproofing were considered viable for further analysis.

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#### H. BENEFIT/COST ANALYSIS OF SHORT LISTED ALTERNATIVES

As a result of the alternative analysis, the following four areas were short listed by the Ames City Council for further consideration and for the development of benefit/cost ratios. The evaluation of Iowa State University facilities was completed in the 1994 Flood Mitigation Study.

	Area	Alternatives	B/C Ratio	Conclusions
CI	Y OF AMES/STORY COUN	TY		
1.	S. Duff Ave. and S. 5th St.	• Levee	0.8	Levee is not cost effective
2.	S. Duff Ave./S. 5th St.	• Floodproofing	1.2 Total 3.4 Partial	Develop program for floodproofing
3.	Arrasmith Trail	• Levee Repair	0.7	Additional Study*
4.		• Regulation	N/A	Update FIS. Modify flood plain ordinance.
IO	IOWA STATE UNIVERSITY			
1.	Hilton Coliseum	• Floodproofing	5.7	Install floodproofing
2.	Scheman Building	• Floodproofing	5.8	Install floodproofing
3.	Maple-Willow-Larch Resident Hall	• Levee	1.5	As funding allows, consider site levee
4.	Recreation/Athletic Facility	• Floodproofing (interior)	0.7	Floodproofing not cost effective

\* While this value in itself does not indicate the project is economically justified, other indirect factors not considered in the analysis, such as lost wages and disruptions in transportation services, indicate this alternative should be reviewed further by Story County.

#### I. REGULATORY FLOOD

Through the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973, the Federal Insurance Administration (FIA) developed the Flood Insurance Study (FIS) to aid in the investigation of the existence and severity of flood hazards. The result was the creation of the Flood Insurance Rate Maps (FIRM) for flood prone areas around the country. In 1979, the flood mapping for the City of Ames was accepted and published in July of 1980.

The Federal Emergency Management Agency (FEMA) restricts construction in the floodway fringe so that construction will not raise the water surface during the regulatory 100-year base flood by more than one foot. This one foot restriction has been adopted by the Iowa Administrative Code for the State of Iowa as the maximum allowable. The City of Ames has revised this to a 0.1 foot maximum increase. It is the basis for floodplain management programs. Construction in the main channel, referred to as the floodway, is not allowed.

Based on historical data, flood discharges were developed by FEMA along with corresponding flood profiles. As a result of the 1990 and 1993 floods, the 100-year and 500-year runoff discharges and flood profiles were increased as a result of this study and the study completed by the Army Corps of Engineers. The discharges are shown below.

DATE	SKUNK RIVER		SQUAW CREEK
	UPPER GAGE LOWER GAGE		LINCOLN WAY GAGE
	DISCHARGE (cfs)	DISCHARGE (cfs)	DISCHARGE (cfs)
100-YEAR*	9,780	20,200	16,200
500-YEAR	12,100	26,400	25,100

#### 1994 COE DISCHARGES

\* Recommend new 100-year regulatory discharge.

The 100- and 500-year flood boundaries are shown in Figures 1 to 6.













#### J. FINAL RECOMMENDATIONS

#### 1. FLOODPROOFING

The floodproofing of individual buildings, particularly residences, outside of the S. Duff Avenue/S. 5th Street area and the Iowa State Center facilities may or may not prove to be cost effective. A individual benefit/cost analysis would be required for each structure. The following is a compiled listing of all structures with floodwater entry elevations below the 100-year water surface profile and between the 100- and 500-year water surface profiles.

	AREA	NUMBER OF BUILDINGS Between 100-		
		Below 100-Year	and 500-year	<u>TOTAL</u>
a.	South Duff Area	17	18	35
b.	S. 5th Street	11	7	18
с.	S. 4th Street at Squaw Creek	6	2	8
d.	Dayton Avenue	3	3	6
e.	Iowa State University	4	1	5
f.	E. Lincoln Way	б	3	9
g.	Arrasmith Trail TOTAL	<u>2</u> 49	$\frac{2}{36}$	<u>4</u> 85

The City of Ames may want to develop an incentive program to encourage existing structures within a flood prone area to have some type of floodproofing. Floodproofing should be completed on a case-by-case basis at the discretion of the property owner. Incentive programs could be developed that include low interest loans to meet preset criteria, education on floodproofing measures and corresponding costs, and the enforcement of current and future floodplain regulations. The criteria to obtain a loan could include documentation of previous flood damage, a detailed engineering analysis of the buildings to determine the most applicable floodproofing measure, and the cost to construct the improvements.

#### 2. BRIDGES

All bridges in the study area should be regularly inspected to determine if any debris has built up causing a flow restriction. This is especially critical for the Stange Road Bridge and S. Duff Avenue Bridge over the Squaw Creek and the US 30 Bridge over the Skunk River.

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As new bridges are built across Squaw Creek and Skunk River, or old bridges are reconstructed, the historical flood elevation (1993) plus one foot of freeboard to low steel concrete should be utilized in the design where feasible. These bridges should be sized according to the most recent design standards.

#### 3. DAYTON AVENUE

The existence of Dayton Avenue does not eliminate the potential for flooding east of Dayton Avenue. The internal drainage on the east side of Dayton Avenue cannot easily be drained away during flood events. These flood waters may pond and cause flood damage to businesses and mobile homes along the area. A larger culvert with an outlet control gate could be constructed under US 30 to alleviate this problem. This gate would require yearly maintenance to assure proper function during a flood event. The flood control outlet of the culvert is critical since the flood waters on the south side of US 30 would back through the culvert and cause flooding without the gate. Snyder & Associates, Inc. recommends sandbagging the low point of Dayton Avenue at US 30. This low point was created during the construction of the new Dayton interchange. Approximately 6 inches of additional flood protection could be obtained with these sandbags by eliminating premature roadway overtopping.

#### 4. IOWA STATE CENTER AND MAPLE-WILLOW-LARCH

Iowa State University completed a Study of Flood Mitigation measures for the Iowa State Center and Maple-Willow-Larch Residence Complex in June of 1994. As funding becomes available, floodproofing as described in the report should be completed.

Until funds can be allocated to install the proposed on-site levee system around the Maple-Willow-Larch, special consideration should be given to protecting the complex as much as possible. The complex is a masonry wall structure with glass curtain walls and cannot hold back flood waters. Sand bagging the structure would not be practical since they would have to be 3 feet high for a distance of 1,400 feet. Based on the new 100-year flood elevation, Maple-Willow-Larch would be considered to be in Zone A by FEMA even though physically, the 100-year is held back by Elwood Drive and College Creek. However, FEMA does not recognize these as approved levee systems.

The complex is actually within Zone B or between the 100- and 500-year flood elevations. The complex did flood in 1993. The flood action plan developed for the complex has assumed that the site levee system would be in place. Until the levee system is completed the complex does not have an adequate flood protection level above the 100-year level. The finish floor elevations are as follows:

Larch Hall - 897.27 Commons - 897.38 Willow Hall - 897.42

The 1993 flood elevation was 900.4 (approximately the 500-year) with the new 100-year flood elevation of Squaw Creek at 897.5.

5. ARRASMITH TRAIL

The Arrasmith Trail Levee is located north of Ames. This levee protects approximately six buildings. The 1993 flood damage estimated \$85,000 with repair costs of \$100,000. Based on analyzed cost, the benefit/cost ratio is 0.7. While this value in itself does not indicate the project is economically justified, other indirect factors not considered in the analysis, such as lost wages and disruptions in transportation services, indicate this alternative should be reviewed further by Story County. Therefore, it is recommended Story County meet with the property owners in this area to discuss repair cost and funding alternatives.

#### 6. **REGULATORY**

a. City of Ames Floodplain Zoning Regulations

The City of Ames and Story County should adopt the new 1994 Corps of Engineers 100-year and 500-year flood discharges for floodplain management. The timing of the adoptions must coincide to when the FIA requires the restudy of the changes to the floodplain, floodways, and flood elevations along with the redistribution of the new National Flood Insurance Program (NFIP) maps. It should be noted that the City is responsible for submitting data to the Federal Emergency Management Agency (FEMA) reflecting revised flood hazard information so the NFIP maps can be revised accordingly. The City of Ames should consider adopting the higher regulatory standards as an interim requirement prior to Iowa DNR/FEMA approval.

According to the City of Ames and Snyder & Associates, Inc. discussions on April 4, 1996, with Iowa DNR and FEMA in Kansas City, Missouri, the procedure to start the notice is to send Iowa DNR a copy of this report for review and concurrence. The review process will take approximately three to four weeks. Once this is accomplished, the next step is to submit the required forms, maps and changes under FEMA requirements. Because of the magnitude of the changes in the flood plains, floodways and flood elevations a Physical Map Revision (PMR) will probably be required. The review and printing process by FEMA may take one to 1½ years. The City should modify its ordinance to allow for a maximum of one foot of water surface increase in the floodway fringe from the new 100-year flood. This would eliminate the current water surface increase of no more than 0.1 foot. One foot of water surface increase matches FEMA requirements. Current modeling methods used do not develop water surface profiles accurate to 0.1 foot. One foot would be more user-friendly for regulatory purposes.

Flood Insurance Rate Maps are established to show the 100-year and 500-year flood elevations and corresponding risk zones. Zone A is a special flood hazard area inundated by the 100-year flood. Zone B is a special flood hazard area between the limits of the 100year flood and the 500-year flood. Zone C are areas of minimal flooding. It is recommended that all new buildings with high risk of flood damage be constructed at or above the 1993 flood level (above Zone B) where economically feasible. This would eliminate damage to these structures should an event similar to 1993 occur in the future. At times, this is not economically feasible and therefore, any new building allowed to be built within Zone B should incorporate structural floodproofing to the 500-year level. In all cases, FEMA requirements should be followed which provides that all buildings within Zone A be constructed with the lowest building elevation 1' above the 100-year flood elevation. All floodproofing must be certified by a structural engineer.

Mobile Home Parks

Meadow Lane Mobile Home Park adjacent to Squaw Creek and Shady Grove Mobile Home Park adjacent to the Skunk River have the following number of mobile homes below the 100-year flood elevation and between the 100- 500-year flood elevations which are as follows:

	•	Between 100-
Mobile Home Park	Below 100-Year	and 500-year
Meadow Lane	0	84
Shady Grove	23	17

Snyder & Associates, Inc. recommends the continued enforcement of Section 9.5.2.d of the Ames Flood Plain Ordinance requiring all mobile homes to be securely anchored to resist floatation, collapse, or lateral movement. This section also requires the permanent foundation of the structure to be elevated one foot above the 100year flood elevation. Where possible, it is recommended each structure within the flood plain be elevated above the 500-year flood elevation. b. Flood Action Plans/Warnings System

Currently, the Ames Flood Task Force is developing a flood warning system for both the Skunk River and Squaw Creek. This system will contain rain and elevation gages along each channel. This system will integrate the gages with the hydrologic models being developed by Iowa State University. Due to the relatively fast rise of the floodcrest on Squaw Creek and Skunk River, the plan is to maximize the warning time to homes and businesses along both basins.

Currently, the City of Ames and Iowa State University have flood action plans. The City of Ames is entitled "Disaster Response Time For Flood" that was updated after the 1993 event. Iowa State University completed a flood action plan for the Iowa State Center and adjacent university property when they completed the June, 1994 flood mitigation measure report.

Based on the above the following is recommended:

- The tables developed in Chapter 9 showing the flood water entry elevations for buildings within the floodplain should be incorporated into the City and ISU flood warning systems and flood action plans. It is recommended that once the discharge is known through the modeling by ISU, the City notify the landowners one discharge level lower than predicted.
- It is recommended the Iowa DOT and Story County develop a written flood action plan that can be incorporated with the City of Ames and ISU. The county does have a new communication system to help in the coordination of road closures and excavation procedures. Iowa DOT basically operates in the same manner during flood events, in that their primary concern is with road closures and control of traffic on the primary roads.
- The City of Ames should periodically re-calibrate the HEC-2 computer model to assure proper function. This is especially true after major flood events. The City should attempt to obtain as much real time high water information as possible during future flood events for model re-calibration purposes.

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# SUMMARY OF ALTERNATIVES

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ALTERNATIVE	PROTECTION EFFECTIVE ASSESSMENT
CHANNEL WIDENING	LOW
CHANNEL STRAIGHTENING	LOW
BRIDGE CHANNEL CLEARING	LOW
UPSTREAM DETENTION	LOW
UNIVERSITY VILLAGE APARTMENTYS LEVEE	LOW
SOUTH DUFF AVENUE LEVEE	MEDIUM
ARRASMITH TRAIL LEVEE	MEDIUM
REGULATION	HIGH
FLOODPROOFING - FLOODWALL	HIGH

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