

CHAPTER 7

EVALUATION OF FLOODING PROBLEMS AND CONTROL ACTIONS

Skagit County has many and varied flooding issues and has numerous options for flood control, each with its unique benefits, impacts, and costs. These alternatives must be evaluated for their appropriateness in solving the flooding problems in the County. Once solutions are determined for each problem area, they must be prioritized in order of severity and importance to the County overall. This chapter provides alternative analyses for each problem area and develops a list of preferred alternatives for the County to pursue.

ALTERNATIVE ANALYSIS

The evaluation of flood control problems and alternatives is best approached over a reach of the watershed, rather than by specific problem location, due to the widespread and varied nature of the problems. Separate areas of the county have similar problems and needs, and specific control measures are appropriate for each different area. The floodplain can be divided into five areas: leveed areas (lower valleys), coastal areas, urban/rural areas, upper Skagit/Samish valleys, and feeder streams. A definition of each area, a description of the problems, and needs of the general area are presented first, followed by an alternative analysis in Tables 7-1 through 7-5, and is concluded with a list of preferred alternatives for each area.

Leveed Areas

This area encompasses land immediately adjacent to and including the existing lower Skagit and Samish Valley levees, and includes sloughs and other ditches that have levees near them. Areas farther from the levees are addressed under the urban/rural alternative.

General Problems. Flood problems within the leveed areas generally relate to maintaining the levees and routing water from one side of the levee to the other. The channelized stream at flood stage has a higher velocity than the non-leveed river would have, and the erosion capabilities are much higher. Thus, the levees are exposed to these high eroding velocities, and must be

continually maintained. Maintenance includes bank stabilization, with riprap or vegetation, and repairing sections, which have sloughed and need replacement.

Drainage that is prevented from flowing naturally into the river due to the levees must be conveyed properly. Existing drainage pumps must be maintained, replaced as necessary, and additional pumps and/or channels and conduits must be installed to prevent and relieve flooding behind the levees.

Sand boiling can also be a problem. When the hydraulic head of the river is above the surrounding ground elevation during flood stage, areas of sand material can quicken and boil, allowing flow to pass under the levee to the other side. These sand boils must also be detected and remedied to prevent major levee failure. Sand boiling is most frequent at the Avon Bend.

Another issue during flood stage in the floodplain is emergency access. If a major levee failure were to occur, entire areas would be inundated, including roads which emergency crews need to use to administer aid and to repair the damage. Existing levees can be enhanced through widening and raising, to allow vehicles to be able to drive along the top of them.

Specific Problems. Some specific problems associated with levees, as described in Chapter 2, include: area No. 6-- maintenance of big ditch underpass under Fisher Creek; and area No. 7--repair sloughed levee on the left bank of North Fork Skagit River. Continuing flood control projects also include all the existing levees, pumps, and riprapped areas adjacent to the leveed areas.

Assumptions Used for Evaluation Purposes. Because the area is defined as existing leveed areas and related problems, several of the alternative solutions do not apply. Coastal control and control of contributing area fall under other area categories and are covered in another section. Under the discussion of new structural alternatives, additional levees is listed. Since most of the area in the Lower Skagit/Samish area is leveed already, this alternative will not be applicable in most cases. Flood storage is not practical in the lower reaches of the river system, as there would be too much volume flow to control. The area is completely divided into drainage and diking districts, so no new ones need to be formed. The levees provide sufficient protection so that permanent evacuation is neither necessary or politically possible.

Channel maintenance is a good control measure, but a distinction must be made between channel maintenance and existing flood control works maintenance. Within this area it will be assumed that levee maintenance includes bank stabilization and removal of debris and related constrictions. It also includes

Table 7-1

Skagit Comprehensive Flood Control Management Plan
Evaluation of Alternatives

Leveed Areas

OBJECTIVE

| ALTERNATIVE | reduce threat | reduce damage | protect economy | provide effective emergency response | maintain existing flood control | enhance existing flood control | maintain in-stream uses and resources | maintain safe transportation | equitable, county-wide protection | maintain local control | efficient use of public dollars | overall effectiveness | | |
|---------------------------------------|---------------|---------------|-----------------|--------------------------------------|---------------------------------|--------------------------------|---------------------------------------|------------------------------|-----------------------------------|------------------------|---------------------------------|-----------------------|---|---|
| Maintain existing flood control works | ✓ | ✓ | ✓ | - | + | • | ✓ | ✓ | ✓ | + | + | ✓ | + | |
| Enhance existing flood control works | ✓ | + | ✓ | + | ✓ | + | ✓ | + | • | ✓ | + | ✓ | + | |
| New Structural Alternatives: | | | | | | | | | | | | | | |
| Levees | ✓ | ✓ | ✓ | ✓ | • | • | ~ | ✓ | • | - | ✓ | * ^a | ✓ | - |
| Flood storage | ~ | ✓ | • | - | ~ | • | ✓ | ✓ | - | ✓ | - | - | - | |
| Channel Maintenance: | | | | | | | | | | | | | | |
| Flow diversion | ✓ | ✓ | ~ ^b | ✓ | ✓ | • | ✓ | ~ | - | • | - | ✓ | • | |
| Enlargement/dredging | • | • | • | • | ✓ | • | ✓ | • | • | ✓ | • | * ^a | • | |
| New bank stabilization | ✓ | ✓ | ✓ | • | • | • | ✓ | • | ✓ | ✓ | • | ✓ | ✓ | |
| Non-Structural Alternatives: | | | | | | | | | | | | | | |
| Enhanced flood plain management. | • | ✓ | • | ✓ | • | • | ✓ | • | ✓ | + | + | + | ✓ | |
| Specific public information programs | • | • | ✓ | ✓ | • | • | ✓ | ✓ | • | ✓ | + | + | ✓ | |

- Legend:
- + benefit
 - ✓ positive impact
 - neutral or non applicable
 - negative impact
 - * impact depends on project
 - ~ mixed impacts

a. cost depends on size of project, amount of protection

b. flow diversion could have negative impacts on economy through routed area.

Table 7-2

Skagit Comprehensive Flood Control Management Plan
Evaluation of Alternatives

Coastal Area

| ALTERNATIVE | OBJECTIVE | | | | | | | | | | | |
|---------------------------------------|---------------|---------------|-----------------|--------------------------------------|---------------------------------|--------------------------------|---------------------------------------|------------------------------|-----------------------------------|------------------------|---------------------------------|-----------------------|
| | reduce threat | reduce damage | protect economy | provide effective emergency response | maintain existing flood control | enhance existing flood control | maintain in-stream uses and resources | maintain safe transportation | equitable, county-wide protection | maintain local control | efficient use of public dollars | overall effectiveness |
| Maintain Existing flood control works | ✓ | ✓ | ✓ | ● - | + | ● | ✓ | ✓ | ✓ + | ✓ | + | ✓ + |
| Enhance Existing flood control works | ✓ + | ✓ | ✓ | ✓ | + | + | ✓ | ✓ | ● - | ✓ | + | ✓ + |
| New Structural Alternatives: | | | | | | | | | | | | |
| Dikes | ✓ | ✓ | ✓ | ✓ | ● | ● | ~ | * | - | ✓ | * | ✓ |
| Tidegates | ✓ | ✓ | ✓ | ✓ | ● | ● | - | ● | - | ✓ | ✓ | ✓ |
| Non-Structural Alternatives: | | | | | | | | | | | | |
| Specific public education | ● | ✓ | ● | ✓ | ● | ● | ✓ | ● | ✓ | + | + | ✓ |

- Legend:
- + benefit
 - ✓ positive impact
 - neutral or non applicable
 - negative impact
 - * impact depends on project
 - ~ mixed impacts

Table 7-3

Skagit Comprehensive Flood Control Management Plan
Evaluation of Alternatives

Urban/Rural Areas

| ALTERNATIVE | OBJECTIVE | | | | | | | | | | | |
|---|---------------|---------------|-----------------|--------------------------------------|---------------------------------|--------------------------------|---------------------------------------|------------------------------|-----------------------------------|------------------------|---------------------------------|-----------------------|
| | reduce threat | reduce damage | protect economy | provide effective emergency response | maintain existing flood control | enhance existing flood control | maintain in-stream uses and resources | maintain safe transportation | equitable, county-wide protection | maintain local control | efficient use of public dollars | overall effectiveness |
| Maintenance of existing flood control works | ✓ | ✓ | ✓+ | ✓ | + | • | ✓• | ✓ | ✓ | o | + | + |
| Enhance existing flood control works | ✓ | ✓+ | ✓+ | ✓+ | + | + | ✓• | ✓+ | • | o | ✓ | ✓+ |
| New Structural Alternatives: | | | | | | | | | | | | |
| Levees | ✓ | ✓ | ✓ | ✓ | • | • | ✓ | ✓ | - | o | ~ | ✓ |
| Flood Storage: | | | | | | | | | | | | |
| Detention systems | ~ | ✓ | ~ | • | •- | • | • | • | - | - | ~ | •- |
| Control of contributing area | | | | | | | | | | | | |
| Increase infiltration | ✓• | ✓• | • | • | • | • | ✓• | • | ✓• | - | - | • |
| Conveyance | ✓ | ✓ | ✓ | ✓ | • | • | ✓• | ✓+ | ✓ | o | ✓ | ✓ |
| Flow diversion | ✓• | ✓• | ✓ | ✓• | • | • | ✓+ | • | •- | o | - | ✓- |
| Non-Structural Alternatives: | | | | | | | | | | | | |
| Specific public information program | • | ✓ | ✓ | ✓• | • | • | ✓• | ✓ | ✓ | + | + | ✓+ |
| Form new drainage districts | ✓ | ✓ | ✓ | ✓• | ✓ | • | • | ✓ | ✓+ | + | + | ✓+ |

- Legend:
- + benefit
 - ✓ positive impact
 - neutral or non applicable
 - negative impact
 - * impact depends on project
 - ~ mixed impacts

a. There is local control only if the area is within a drainage/diking district.

Table 7-4

Skagit comprehensive Flood Control Management Plan
Evaluation of Alternatives

Upper Skagit/Samish Valleys

OBJECTIVE

| ALTERNATIVE | reduce threat | reduce damage | protect economy | provide effective emergency response | maintain existing flood control | enhance existing flood control | maintain in-stream uses and resources | maintain safe transportation | equitable, county-wide protection | maintain local control ^c | efficient use of public dollars | overall effectiveness |
|--|---------------|---------------|-----------------|--------------------------------------|---------------------------------|--------------------------------|---------------------------------------|------------------------------|-----------------------------------|-------------------------------------|---------------------------------|-----------------------|
| Maintain existing flood control works | ✓ | ✓ | ✓ | ✓• | + | • | ✓ | ✓ | ✓ | c | + | ++ |
| Enhance/Improve existing flood control works | ✓ | ✓ | ✓ | ✓ | + | + | ✓ | ✓ | •✓ | c | + | ✓+ |
| New Structural Alternatives: | | | | | | | | | | | | |
| Levees ^b | ~ | ~ | ~ | • | • | • | ~ | ✓ | - | - | * | ~ |
| Flood Storage: | | | | | | | | | | | | |
| Floodway acquisition | ✓• | ✓ | • | • | • | • | ✓ | • | •- | - | ~ | ~ |
| Dam/reservoir ^a | + | + | + | + | • | • | ≡ | ✓ | + | - | * | - |
| Channel maintenance & modification: | | | | | | | | | | | | |
| Bank stabilization | ✓+ | ✓+ | ✓ | ✓• | • | • | ✓ | ✓+ | ✓• | - | ✓+ | ✓+ |
| Debris removal | ✓ | ✓ | ✓ | • | • | • | ✓ | ✓ | ✓• | - | ✓ | ✓ |
| Removal of restrictions | ✓ | ✓ | ✓• | ✓• | • | • | ✓ | ✓+ | - | - | * | ✓ |
| Flow diversion | ✓• | ✓• | •- | •- | • | • | ✓+ | • | - | - | ~ | •- |
| Dredging | ✓+ | ~ | ✓ | • | • | • | ✓• | ✓• | ✓ | - | ✓ | ✓ |
| Non-Structural Alternatives: | | | | | | | | | | | | |
| Evacuation | ✓ | ✓+ | • | + | • | • | ✓ | •- | - | - | ✓ | - |
| Specific public information program | • | ✓ | • | ✓ | • | • | ✓ | • | ✓ | + | ++ | ✓ |
| New diking and drainage districts | • | • | ✓ | • | • | • | ✓ | • | ✓ | ++ | + | ✓ |

- Legend:
- + benefit
 - ✓ positive impact
 - neutral or non applicable
 - negative impact
 - * impact depends on project
 - ~ mixed impacts

- a. Illegal due to Wild and Scenic Rivers Act
- b. Additional levees in the Upper Skagit Valley would help in some areas, and would worsen flooding problems in other areas.
- c. Local control is maintained if area is within drainage/diking district.

Table 7-5

Skagit Comprehensive Flood Control Management Plan
Evaluation of Alternatives

Feeder Streams

OBJECTIVE

| ALTERNATIVE | reduce threat | reduce damage | protect economy | provide effective emergency response | maintain existing flood control | enhance existing flood control | maintain in-stream uses and resources | maintain safe transportation | equitable, county-wide protection | maintain local control | efficient use of public dollars | overall effectiveness |
|---------------------------------------|---------------|---------------|-----------------|--------------------------------------|---------------------------------|--------------------------------|---------------------------------------|------------------------------|-----------------------------------|------------------------|---------------------------------|-----------------------|
| Maintain existing flood control works | ✓ | ✓ | ✓ | ✓• | + | • | ✓ | ✓ | ✓ | o | + | ++ |
| Enhance existing flood control works | ✓ | ✓ | ✓ | ✓ | + | + | ✓ | ✓ | o | ✓ | + | |
| New Structural Alternatives: | | | | | | | | | | | | |
| Levees | ✓ | ✓ | ✓ | ✓ | • | • | ✓ | ✓ | ✓- | o | ✓ | ✓ |
| Flood storage: | | | | | | | | | | | | |
| Holding ponds | ✓ | ✓ | ✓+ | ✓+ | ✓ | • | ✓ | ✓ | ✓• | o | ✓- | ✓ |
| Detention storage | ✓ | ✓ | ✓ | ✓+ | ✓ | • | ✓ | ✓ | ✓+ | o | ✓- | ✓ |
| Floodway acquisition | ✓ | • | • | ✓ | • | • | ✓ | •- | •- | •- | ✓+ | ✓ |
| Channel maintenance: | | | | | | | | | | | | |
| Bank stabilization | ✓ | ✓ | ✓ | ✓• | • | • | ✓ | ✓+ | ✓ | - | ✓+ | ✓ |
| Debris removal | ✓ | ✓ | ✓• | • | • | • | ✓ | ✓ | ✓• | - | ✓ | ✓ |
| Flow diversion | ✓• | ✓• | •- | •- | • | • | ✓+ | • | - | o | ✓- | • |
| Dredging | ✓• | ✓ | ✓ | ✓• | ✓ | • | ✓ | • | ✓• | - | ✓ | ✓ |
| Non-Structural Alternatives: | | | | | | | | | | | | |
| Evacuation | ✓ | ✓+ | • | + | • | • | ✓ | • | - | - | ✓ | - |
| Specific public information programs | • | ✓ | • | ✓ | • | • | ✓ | • | ✓ | + | ++ | ✓ |
| New drainage/diking districts | • | • | ✓ | ✓• | • | • | ✓ | • | ✓ | ++ | + | ✓ |

Legend: + benefit
 ✓ positive impact
 • neutral or non applicable
 - negative impact
 * impact depends on project
 ~ mixed impacts

o. local control is maintained only where there are existing drainage districts or sub-flood control zones.

maintenance of pumping facilities which route contributing flow from other areas, and riprap which has been placed on the levee banks for stabilization. Additional channel maintenance would consist of enlargement and/or dredging and flow diversion.

Enhancement of existing flood control work would include raising the heights to increase flood protection, and to widen the levees to provide for emergency vehicle movement. Increasing pump capacity and increasing integrity of riprapped areas would also be included.

Preferred Alternatives. Given the definition of the Lower Skagit/Samish leveed areas, the preferred solutions as determined from Table 7-1 are maintaining and enhancing existing flood control works. These solutions best meet the County's goals. If additional work is required, additional levees and riprap bank stabilization seem to be the best solution alternatives. Flow diversion and dredging are neutral at best, and their effectiveness would depend on the type of problem and amount of increased protection they would offer. Flood storage is probably not a feasible type of flood control option in the lower reaches of the Skagit.

The preferred solution for specific problem areas 6 and 7 is maintenance and repair of the existing flood control works.

Coastal Areas

Coastal areas are defined as those areas that have contact with salt water, are adjacent to saltwater dikes, or are otherwise affected by tidal influences. The entire westerly boundary of the county, plus areas extending up the mouths of the sloughs and rivers that are affected by tides are included.

General Problems. General problems in the coastal area consist primarily of maintaining, repairing, and enhancing the existing dike network. Nearly the entire westerly boundary of the county is diked, and sections are in various states of disrepair. Dikes have the same problems as levees, in that during high tides, storm drainage tends to pond behind them and the water must be pumped out if flooding problems occur. Tide gates must also be maintained to ensure proper working and flow passage.

Most of the dikes in the county have been designed to accommodate book tides only, and overtop if high tides are accompanied by high winds and low barometric pressure. Specific problem areas cited include area No. 8--repair of the Padilla dike, and general maintenance of existing dikes, pumping stations, and tide gates.

Assumptions Used for Evaluation Purposes. Coastal areas require both coastal control measures and non-structural measures to mitigate flood damages. Other structural control (levees, flood storage, channel modifications, and control of contributing area) either do not apply to coastal areas or will be covered in another section. Maintenance of existing facilities includes stabilizing and maintaining all existing dikes, pumping stations, and tide gate structures. Any new diking or flood gates that would be installed would include necessary pumps, flap gates, and other conduits necessary to pass storm water during non-coastal periods.

Preferred Alternatives. Again, maintenance and increasing integrity of existing measures are the most goal-achieving methods of mitigating flood damages along the coast, according to Table 7-2. Depending on the problem and potential flood damage in specific areas, additional dikes, pumps, and flood gates could be used with generally equal preference. The solution in specified problem area of the Padilla dike should be repair and replacement of the dike.

Urban and Rural Areas

This area is defined as the area within the floodplain that is not included in one of the other areas. Generally, this includes agricultural and urban lands removed from the adjacent river, creek, or levee, but still within the floodplain area.

General problems within this area consist of localized drainage and flooding problems. Poorly maintained, broken, and misaligned pipes and culverts create ponding and localized flooding during heavy rains. Increases in development will magnify runoff peaks and volumes, and additional flows will need to be conveyed efficiently to the river to prevent localized flooding. These areas are also generally protected from the main river by a levee or embankment. In the case of a major flood, with levees overtopped or failed, excess flood waters would need to be efficiently removed.

An existing problem specified within this area is Gages Slough (Area 12) which can be improved as a drainage and floodway. Conveyance problems would generally occur within this urban/rural area.

Assumptions Used for Evaluation Purposes. The urban and rural areas are defined to be those areas removed from the main river or creek, but still within the floodplain. Therefore, maintenance or attention to the main stream channel will not fall under this category.

Existing flood control within the urban/rural areas would consist of all existing drainage, conveyance, and detention systems, including channels, conduits, culverts, outlet and inlet structures, and any drainage pumps and detention storage. Maintenance of these items would include cleaning and repairing broken and misaligned pipes and culverts, removing debris, clearing weeds, and removing restrictions.

Any new construction of conveyance systems would include channel construction, installation of conduits, culverts, inlet and outlet structures, and necessary drainage pumps.

The responsibility of maintaining conveyance systems belongs to the owner of the system, be it a city, town, private citizens, or a drainage district. Additional drainage districts could be formed to take responsibility of this. Specific public information programs would be addressed to some of these groups or agencies.

Preferred Alternatives. Maintaining the existing conveyance system is the best method of meeting the County's goals, as noted in Table 7-3. The formation of new drainage districts where none currently exist is essential for financing and overseeing maintenance and capital improvement projects. As most projects will be instituted between various groups (cities, individuals, and drainage districts) specialized public information programs that would enhance coordination and inform of perceived problems and alternative solutions is also a good option. Other methods, such as adding to the conveyance systems or installing berms and levees could be used where necessary. Detention systems and increased infiltration do help control runoff rates and volumes, but contribute little during major storm events when flooding occurs, and are not highly recommended flood control options. Flow diversion would be a specialized option applicable only to certain situations, and would need to be carefully evaluated in the pre-engineering planning stage. For problem area No. 12 (Gages Slough), enhancing the natural drainageway would be the preferred alternative

Upper Skagit/Samish Valleys

This area is defined as those along the main river which are within the floodplain and are not adequately protected by levees. This would include Nookachamps Creek area and the entire Skagit floodplain to the east of Burlington and unleveed areas of the Samish River. Floodplains of tributaries to those rivers will be discussed in the next section.

General Problems. This area experiences major flooding damage, as it is in the floodway and is generally unprotected. Debris and point bar accumulations due to normal river processes could cause major channel change during high velocity flows in a

flood period. Erosion on the outer bank during high flow periods endangers existing structures and can cause a major channel change.

Many areas within the Upper Skagit Valley are listed as problem areas in Chapter 2. Potential areas of channel change due to erosion and point bar accumulations are in problem area Nos. 2, 3, 4, and 11 near Gilligan's Creek, Lyman, Van Horn, and Burlington. Erosion is encroaching on existing structures in area No. 5 (Cape Horn Road) and area No. 10 (Highway 9 bridge at Sedro Woolley). Cockreham Island (area No. 13), Hamilton (area No. 14), and the Nookachamps Creek area are completely inundated during a major flood event.

Assumptions Used for Evaluation Purposes. As the feeder streams are addressed in the next section, the alternative evaluation applies only to the areas within the main floodplain of the upper river valleys. Holding ponds and storage are not appropriate in this area, as flows are too great to be contained. Dredging would be used to remove point bar accumulations, debris accumulations would refer to logs and other material that might be impeding flow.

Existing flood control works include riprap along some bank segments and the Cockreham Island levee.

Preferred Alternatives. Table 7-4 shows that many alternatives are available in the upper valley areas, as little flood protection currently exists in this area. Maintenance of the existing bank stabilization and installing new bank stabilization would be most effective at protecting the county from further flood damage and would meet the County's goals. Dredging and debris removal are also good alternatives, and could be considered equal with bank stabilization if they are considered to be maintenance alternatives within the river. Restriction removal would be effective, although there are no known restrictions in the area. Although public information programs and new districts within these areas may not reduce threat and damage, both are non-structural and offer some local control of protection to the area.

Floodway acquisition and additional levees are less desirable alternatives. New levees, especially near Burlington, could offer protection to the north areas, but would cause an increase in flood depths in the Nookachamps Creek area. Flow velocities and volumes farther upstream are such that a new levee would need extra reinforcement and height to withstand flood conditions, and would not be allowed with the proposed state floodplain regulations. Floodway acquisition would maintain natural flood storage in the upper valley for the benefit of the lower river areas at the expense of the existing property owners.

Permanent evacuation of frequently inundated areas would prevent further damage, but is highly undesirable from the point of view of persons who want to live within those areas.

An alternative that could solve flooding problems in both the upper and lower valleys would be the construction of a dam or reservoir on the Sauk or Suiattle Rivers. This is not possible, though, due to its illegality based on the Wild and Scenic Rivers Act.

Flows diversion is not a viable option in the Upper Valley. The natural processes of the river change the course so much that the diversion may become obsolete and unusable in time as the river moves away from it, or the river may use it as a path of least resistance and may cause a major channel change.

Preferred alternatives for problem areas 2, 3, 4, and 11 would be dredging to remove point bar accumulations. Erosion areas 5 and 10 should receive bank stabilization. Areas 13 and 14 which are subject to complete inundation are candidates for specific education programs, if not floodway acquisition or permanent evacuation.

Feeder Streams

The feeder stream areas are defined as the designated floodplains not associated with the main river. These streams generally have steeper gradients through the mountainous areas which flatten out as the streams approach the main river.

General problems along the feeder streams include maintaining the stream within the channel area, controlling debris accumulations, preventing erosion, and channel maintenance. Logging practices in the upper basins have a large affect on the problems the stream causes where the stream gradient flattens out.

Specific problems noted in Chapter 2 with this area include area No. 1 (Friday Creek erosion), Area No. 9 (Hansen Creek deposits, and area No. 15 (Grandy Creek restriction and debris accumulations).

Assumptions Used for Evaluation Purposes. Maintenance of existing flood control structures in this area consists of riprap for bank stabilization and a holding pond. Logging practices have the greatest effect on the flooding of these areas, so the exact location of the problems is dependent on which areas are being logged.

Preferred Alternatives. Again, Table 7-5 shows that maintaining the existing holding ponds and rock riprap are the best methods for flood control in this area. Several other

methods can also be used to further reduce flood damages. Further stabilization of the banks and improvements of the holding ponds are also highly feasible solutions.

The remainder of the alternatives for this area meet the goals and objectives equally well, and a preferred use would depend entirely on the specifics of the problem and project. A holding pond is effective at reducing sediment and gravel load, and can be sized for detention storage to also regulate flow rates downstream. Bank stabilization should improve the chances of the stream staying within the appropriate channel. Dredging and debris removal should occur where accumulations have severely restricted the stream's channel. Shallow levees may be appropriate to keep a stream which has the tendency to veer from its course from traveling through a nearby field. Properties which experience frequent inundation could be acquired and developed into parks.

Although specific education programs and additional districts would not in themselves lessen the flood hazards, they are cost-effective options that meet the goal of having local control. Flow diversion could have mixed results; it could be a major benefit in some areas, while in others it would only move the problem or create new ones. Evacuation in this area is probably unnecessary and would be highly unpopular.

A holding pond/detention basin is a preferred alternative for problem area 9, Hansen Creek deposits. Grandy Creek restriction (Area 15) is candidate for debris removal, and additional study could be made of the feasibility of removing the restriction. Friday Creek (Area 1) should have some bank stabilization installed.

Summary

Table 7-6 lists the preferred alternative for each problem area within the County. For each problem area, the alternative which best met the County's goals is maintenance of existing flood control works. This alternative is eligible for Flood Control Assistance (FCAAP) funding, is equitable for the entire County, and maintains local control, as most existing projects are within a drainage or diking district. Although bank stabilization is included as maintenance of existing flood control works in several of the areas, it is restated in the preferred alternative table for completeness. Additional structural flood control work is necessary in the upper Skagit Valley and in the tributary feeder streams, as these areas experience frequent problems, and little has been done in the past to mitigate damage in these areas. Bank stabilization and debris removal are overall preferred alternatives for these areas, and are also eligible for FCAAP funding.

Other non-structural alternatives could be combined with the preferred alternatives to help meet the County goals better.

Additional drainage and diking districts can be formed in areas where none exist now, to give local control over the flood control works. Specific education to localized areas which are experiencing problems can only help residents become informed and participate in mitigating flood damages.

Table 7-6. Preferred Flood Control Alternatives by Area

| Area | Alternative | | | | |
|---------------------------------|---------------------------------------|--------------------|----------------|--------------|--------------------|
| | Maintain existing flood control works | Bank stabilization | Debris removal | Holding pond | Specific education |
| Leveed area | ✓ | ✓ | | | |
| Coastal | ✓ | ✓ | | | |
| Urban/rural | ✓ | ✓ | | | |
| Upper Skagit/ Samish Valleys | ✓ | ✓ | ✓ | | ✓ |
| Feeder streams | ✓ | ✓ | ✓ | ✓ | |