

CHAPTER 5

FLOOD CONTROL MANAGEMENT OPTIONS AND ALTERNATIVES

Skagit County has many flood control options to choose from to mitigate the impacts of flooding. Due to the complex nature of the flooding, several methods of flood control are understandably necessary to accomplish a desirable measure of protection. The County has used several different flood control methods throughout its history and has been successful in controlling flood damages. This chapter discusses the flood control management options, both structural and non-structural, available to the County, noting the practices that have been used in the past, and those which may be viable today.

STRUCTURAL MEASURES

Structural measures for flood control management are measures which attempt to modify the flooding itself. Typically the control is in-stream or very nearby. Options for mitigating damage through structural measures include levees and dikes, coastal control, flood storage, channel maintenance and modifications, and control of contributing runoff areas. Each option has different capital expenditure and maintenance needs, and is best applied under certain conditions.

Levees and Dikes

Levees and dikes protect a specific portion of the flood plain from flooding by placing a barrier between the flood waters and the protected lands. These structures are usually earth filled, have sloped sides, and are protected from erosion by rip rap or revegetation. Existing levees and dikes in Skagit County vary in height from 5 to 10 feet, with a top width of 3 to 12 feet.

Levees and dikes are effective structural measures of protecting large areas of land and property. They remove a relatively small amount of land from otherwise beneficial uses and have few impacts on natural resources. The capital and maintenance costs are higher than other control measures, but the benefits are substantial if the project protects a large area.

New levees have the potential of increasing flood heights elsewhere by reducing the amount of flood plain available for flood storage. By concentrating flood waters in a smaller channel, the water velocities are increased and can aggravate

erosion problems unless mitigated with a good bank maintenance program. Drainage pumps are normally used to remove storm water that collects behind the levees, which have ongoing operational and maintenance costs as well.

Levees have been constructed in the lower reaches of the Skagit river since the early 1890s. In the beginning the levees were low and some areas were unprotected. The levees have since been raised and expanded to confine floods with a 8- to 25-year frequency to the river channel. More than 80 miles of levees and dikes are now in existence along saltwater bays and channels, along the main river channels between Skagit and Padilla Bays and Burlington. Eleven diking districts maintain the levee system which protects about 45,000 acres of land.

Additional levees could probably be used upstream of Burlington, where little flood protection currently exists. Additional levees could increase flood levels in unprotected areas, though. The entire existing levee system could be strengthened and raised to achieve the desired 25-year flood frequency level of control. To provide for emergency repair and services access, many of the levees need raising and widening.

Coastal Control

Saltwater flooding problems can be controlled by the use of dikes, flood walls and bulkheads, or tide gates. Dikes are constructed out of river materials and are earth filled. Flood walls and bulkheads are vertical sided structures usually made out of reinforced concrete, but can also be wood pilings. Large rip rap can also be used to construct a bulkhead. Breakwaters can be built to protect these structures from excessive wave damage. Flood gates (or tide gates) allow storm drainage to pass into the bays through the saltwater dikes. The gate prevents saltwater from traveling upstream during high tide and allows passage of storm water at low tide. Drainage pumps may assist the removal of water from behind the dikes. Each of these structures serve to protect the upland from the highest book tides.^a

Almost the entire westerly boundary of the County is salt-water diked. Most of the dikes have been rock rip-rapped. The dikes are constructed to accommodate book tides only, and when high winds and low barometer readings accompany the high tides, overtopping occurs in several places, including LaConner and Edison. The dikes could be strengthened and raised. The break waters, tidegates and drainage pumps require continual maintenance, and may require removal and replacement.

^aA book tide refers to the tide predicted from tidal charts for the location.

Flood Storage

Flood water storage is the most direct means of flood water control. It is also the most versatile as the approach reduces the flood flow rate and peak rate, reduces the area inundated, and controls the duration of the flood. The degree of protection is dependent on the type of flood storage device and the storage capacity. Flood control storage can be attained with dams and reservoirs, holding ponds or sedimentation basins, or property acquisition of inundated lands.

Dams and Reservoirs. Hydropower projects on upper reaches of the river offer multi-use facilities for power, water supply and flood storage capacity. There are currently three dams on the Skagit river (Ross, George and Diablo) and two on the Baker River, which is a tributary to the Skagit. The dams provide a total of 193,000 acre-feet of flood storage, and control about 30 percent of the Skagit basin's runoff. It is estimated that since 1953 when the first dam was installed that flood crests at Sedro Woolley have been reduced by about 10 percent.

Additional large scale dams and reservoirs are no longer a flood control option for Skagit County. Sites have been proposed for the Suiattle and Sauk Rivers, but the Wild and Scenic Rivers Act placed limitations on construction and modification of these river systems, effectively prohibiting additional storage projects from being constructed. Environmental and economic concerns present almost insurmountable problems.

Holding Ponds--Settling Basins. Feeder streams have the tendency to leave the stream channels and flow over nearby fields at the point where the stream gradient is reduced as it approaches the flood plain of the river. Silt and debris are deposited as the velocities are reduced. A basin with a controlled outlet constructed at the point of gradient change can control the flooding and debris problems.

The holding ponds serve three purposes: the velocity of the stream is reduced, allowing the gravels and silt to settle out in a controlled area; energy is dissipated, which helps keep the stream in the channel downstream, and; some flood storage can be provided. The amount of flood storage offered by the facility would depend on its size.

The County has constructed two holding ponds at Coal Creek and Warner Creek to control stream bed deposits which contribute to flooding problems. The ponds have been successful in controlling the sediment problems, and have the benefit that they can be maintained in non-emergency periods. The material removed yearly from the ponds is available for use by the community as fill material.

Opportunity to use this method of flood control avails itself at several other feeder streams, including Hansen and Muddy Creeks. The facilities could also be sized to offer some limited flood storage capacity, if the siting and situation warrants it. Settlement basins are a relatively new approach to flood control within the County. The biggest problem with this option is setting up an authority to maintain and operate these structures. Final decisions are at the discretion of local property owners, and their desires determine the feasibility of the project.

Floodway Acquisition. Areas which experience frequent inundation and cannot economically be protected with flood control works may be candidates for acquisition. These lands would continue to act as a natural storage area for floods. The land can then be used as public parks or recreational facilities. Structures within the area would need to be removed or flood-proofed.

The Nookachamps area currently is unprotected by levees from flooding. This area of about 5000 acres floods during high Skagit River flows, and provided 34,000 acre-feet of storage in the 1951 flood. This added natural storage has given some relief to lower Skagit flooding.

Other areas within the meander belt of the Skagit River between Burlington and Marblemount are often inundated during high water. The feasibility of protecting these areas is low as they are in the almost direct run of the river. Some of these areas could be acquired if additional action is required.

Channel Maintenance and Modification

The purpose of channel modification and maintenance is to preserve or increase the flood capacity of a specific stream reach. Maintaining and enhancing existing flow patterns keeps flooding from occurring in new areas and helps to convey the flow as efficiently as possible. Many techniques can be used to enhance channel performance including bank stabilization, debris removal, realignment and removal of restrictions, flow diversions or bypass, and enlargement or dredging.

Bank Stabilization and Erosion Control. The natural tendency of the river in the flood plain is to meander, which causes erosion in some areas and depositing of those materials in other areas. High flows during flood events within the channel area have increased velocities and tend to erode more material away. Structures such as roads and levees along the river's edge need to be protected from extensive erosion which might cause a levee failure, channel change or road collapse.

Several materials can and have been used by the County to control erosion on the stream embankments. Rock rip-rap is the most common. It is an abundant supply up the river, is natural looking and does an excellent job in maintaining the banks. Revegetation is used in moderation; sod and grasses are placed and maintained on all the levees and dikes, but plants which have a potential to become dislodged during a flood event or are very difficult to maintain are avoided. Revetments and piling have been used in the past, but are capital intensive to build and difficult to repair once deteriorated. Gabions and vegetative cover would not perform well in high velocity flows experienced in the Skagit River, but may have merit on a smaller stream. The use of rubble or asphalt as bank stabilization is not allowed by the County.

Debris Removal. Log jams, snags and stumps have a tendency to collect at restrictions, bends, or anywhere else there might be an corner or high spot in the river to become lodged against. High velocity flows through a debris accumulation can cause serious erosion problems, and the back waters created by the capacity reduction can be substantial. The County has and will continue to remove debris in areas that have flood damage potential. Non-threatening natural debris is retained so as to maintain shade and organic material for the fisheries resources.

Realignment or Removal of Restrictions. At times the natural meandering of the river encroaches on existing structures. Realigning the channel can prevent damage on the short-term at that location. Channel straightening counteracts the natural tendency for gradient reductions in the stream. It will increase velocities through the section, which will tend to make downstream erosion problems worse. For this reason the County does not undertake realignment projects and this option will not be considered further.

The removal of restrictions has the benefit of increasing channel capacity and reducing the tendency of debris accumulations. Often the restrictions are bridges, which take major expenditures to modify. The restriction on a small feeder stream may be misaligned or undersized culvert, which in comparison, can be remedied fairly inexpensively.

Flow Diversion or Bypass. High flow diversions typically direct flood flows around developed areas and from a main channel into natural or artificial secondary channels or conduits. Physical opportunities for flow diversion are often limited by the lack of appropriate lands through which to divert the flows.

Although no flow diversions have been constructed in the Skagit Basin, the option has been considered. The Flood Control Act of 1936 authorized the Avon Bypass Project for the partial control of floods in the lower Skagit Valley. The proposed bypass

channel would divert excess Skagit River flows from Burlington to Padilla Bay, a distance of about five miles. The project has not been undertaken as Skagit County has not been able to meet local participation requirements. Substantial costs would be involved in the relocation of transportation facilities and the acquisition of right of way. Still, this is an option open to the County. The Avon bypass will not be considered further in this plan as the project study reports (Corps of Engineers, 1963) contain the necessary impact and alternative analysis, and can be referenced if desired.

Old meander ways can also be used for high flow diversions and flood storage. Gages Slough is probably an old channel of the Skagit River and could be used to help remove water from Burlington once a flood started to recede. Currently, the sloughs effectiveness in carrying flood waters is in question as it has been neglected, abused and has undersized outlet capacity. The slough could be improved as a drainage way and flood way.

Enlargement and Dredging. Enlargement of a stream section can increase flow capacity and in-stream storage. Dredging is often used to accomplish this purpose, removing aggradation materials from the river bed. Enlargements efforts usually have short lived effectiveness, as materials removed during low flow periods are replaced during winter peak flows.

Dredging is used by the County to remove gravel accumulations that have built up to the point where a major channel change could occur. Dredging has occurred more frequently on the feeder streams. Gravel deposits occur at the point of gradient and velocity reductions, causing buildups and restrictions. Dredging the material removes the problem buildups and prevents it from travelling downstream.

Control of Contributing Area

Control of the runoff from contributing areas into the basin can mitigate flooding problems by decreasing the rate and amount of storm runoff, and by allowing quick and efficient removal of the water. Methods of controlling runoff include measures that affect infiltration, storage and conveyance of the flows.

Increase Infiltration. An increase in the ground's capacity to soak up the water reduces the amount of excess surface water runoff available to cause flooding. Optimizing the infiltration usually includes measures to maximize the retention of vegetation, particularly forests, and minimize the development of impervious surfaces such as buildings and roads. Land treatment is most effective in small basins or headwaters, and has the biggest impact on low level flooding.

The forested areas within the County have the largest impact on the runoff peaks and volumes. The sudden decrease in infiltration when a forested area is harvested causes increased flow and erosion problems. The State regulates the forest practices through the Forest Practices Act, and requires mitigation measures in harvesting areas. The County has little additional control over the hydrologic impacts of harvesting.

Drainage ordinances can influence the infiltration within urban or developing areas. In suitable areas, drain tiles or rock pits could be used to put the storm runoff into the ground, versus conveying it into a storm drain. Grass-lined detention ponds, pervious surfaces for parking lots, and terracing slopes can improve infiltration and reduce storm runoff. The County could consider including such measures in a drainage ordinance, if the necessity arose.

On-Site Detention. On-site storm water detention has become a standard practice in many urban areas for the purpose of moderating the effect of flood flows up to the 10 to 25 year storm; on-site detention of larger storms becomes increasingly difficult and costly. On-site detention provides temporary storage of storm water for delayed release, thus reducing peak flows.

Skagit County Water Drainage and Erosion/Sedimentation Control Ordinance requires retention/detention facilities for substantial developments, unless it can be demonstrated that no adverse impact will result without it. The purpose of the facility is to regulate the discharge rate at or below the existing design storm's peak discharge. As the ordinance provides for runoff control through on-site detention, no additional consideration of this alternative is required.

Conveyance. Localized flooding problems are created when the storm water is not carried away at the same rate that it accumulates. Undersized or poorly maintained facilities not only create localized problems, but can cause increased duration of the problems if the flows are not conveyed before the river rises in height.

Conveyance systems are maintained to reduce local flooding problems. Conduits, channels (natural or lined), ditches, and culverts may be used to improve parts of the conveyance system. Existing storm drains, culverts and ditches can be cleaned and improved within the County to improve drainage and flooding potential.

Summary of Structural Alternatives

The methods of controlling floods through in-stream control are many and diverse. The County has used nearly all of the measures, with the exception of floodway acquisition. Almost all of the measures described are consistent with regulations and policies governing flood control work, and are still viable options open to the County. Those options that will not be considered due to regulation conflicts, ineffectiveness, or adequate existing regulation are dams, realignment, and on-site detention.

NON-STRUCTURAL ALTERNATIVES

Non-structural flood control measures attempt to modify the effect of flooding, rather than modifying the flooding itself. The primary focus of non-structural measures is to modify human actions and behaviors which will reduce flood damages. Non-structural measures include modification of development policies and land use regulations, risk management in flood prone areas, enhancing flood plain management, and improving emergency response systems. These measures can be used alone, or in conjunction with the structural measures previously discussed.

Development Policies and Land Use Regulation

Policies and regulations can be developed to prevent or discourage people from unwise actions or land uses in flood prone areas. These measures usually affect one or two structures at a time as they are being developed and limit the location and type of development that can occur. Many of the County's policies and regulations discussed have been responses to state laws on policies regarding actions in the flood plain.

Flood Plain Management Regulations. Management of the flood plain is necessary, not only for the locations that experience flooding, but for the welfare of the entire state. For that reason, several state laws have been enacted which manage activities in the flood plain. One such law is the Flood Plain Management Act (Chapter 86.16 RCW). The act regulates construction and planning within the floodways and flood plain.

The Federal Emergency Management Agency (FEMA), and the National Flood Insurance Program (NFIP) are national agencies and programs which effect flood plain management. In order to have flood insurance coverage made available from the NFIP, the County had to adopt flood plain management regulations consistent with FEMA requirements. The County adopted its Flood Damage Prevention

Ordinance #11216 in 1986 to comply with the regulations. This ordinance has the effect of a building code for flood plain construction and preserves the natural function of streams.

The County's compliance with the NFIP, and the other state policies concerning flood plain management, form a complete regulatory framework that helps protect the County from increases in flood damage. No additional flood plain management regulations need be considered.

Drainage Ordinance. Storm water from the urbanized areas which contributes to flooding problems must also be controlled. Control of urban storm water can be accomplished through the use of a drainage ordinance. The drainage ordinance would require permitting of larger developments, ensuring proper handling of storm run-off.

The County adopted its Water Drainage and Erosion/Sedimentation Control Ordinance #9763 in 1983. It is complete in its approach to flood control within the urban areas. The ordinance can be updated as necessary and could be made more restrictive. No need for additional updating is anticipated, so the alternative does not need further consideration.

Shoreline Management Program. Development on or nearby the shorelines can have an effect on the amount of damages incurred and can modify the flood characteristics. The state Shorelines Management Act (SMA, Chapter 10.58 RCW) mandated local development of shoreline master programs to manage and regulate uses of the shorelines. Skagit County adopted its Shoreline Management Master Program in 1976 in compliance with the Act. As described in Chapter 4, the program includes protection and use of the river for flood control work. No additional consideration of this option is necessary, as the County is in compliance with the regulations.

Risk Management

All flood control management can be seen as risk management, but for the purposes of this plan, risk management is taken to address personal risks. An individual's ability to take responsibility for the risks associated with the flood prone area can be enhanced through several measures. The measures include flood proofing, public information programs, and other preparedness measures that can abate flood damages to the residents of the flood plain.

Flood Proofing. Buildings within the flood plain can be protected from flood damage. Buildings can be elevated and windows and doors can be fitted with water tight seals. Water resistant building materials can be used, and utilities such as sewers and electricity can be protected from damage.

Skagit County has addressed flood proofing in the Flood Damage Prevention Ordinance. Flood proofing is required by FEMA for flood insurance purposes, and the ordinance upholds all of the FEMA requirements. The ordinance acts as a type of building code for structures within the flood plain. As flood proofing is required, no additional analysis of this alternative is necessary.

Public Information Programs. An informed community can better respond to flooding problems and can better manage the personal risks that they will bear. An education program could focus on general flood plain awareness, and preparatory actions they might need to take in the case of a flood emergency. Giving seminars to school children or civic groups about the flood plain and distributing information on emergency services and procedures are some of the public information options available. Public interest is high when a serious event has recently occurred. Interest and concern diminish very rapidly.

Typically, a general education program would be designed and implemented by a local emergency services agency. In general, these general programs have limited effect when no danger is perceived by residents. If desired, the County could cooperate with a local agency in sponsoring a general education program, but further consideration of such as a flood control option is not warranted.

Specialized public information programs have also been used by the County to abate flood damages. Public officials have met with citizens of localized areas which experience frequent flooding. The citizens were provided information about flood danger and possible mitigating measures. Certain communities have taken the information and have developed plans to warn each other about an impending flood and help each other with preparedness plans. A localized public information program can be effective when it is timely and the need exists. The County may continue to pursue this flood control option.

Enhanced Flood Plain Management

A coordinated management effort applicable throughout the entire County can enhance equitability or integrity of flood control protection. Individual efforts at controlling flooding and drainage problems can be piece-meal and have damaging downstream effects. A consistent, systematic process for flood control measures that is designed to best serve public and private concerns, as well as maintaining hydraulic control over the flood control being accomplished should be part of a flood plain management effort.

The County has in effect ordinances and permitting processes to manage flood plain activities. Yet the control of the facilities has been delegated to locality of the problems through

diking and drainage districts. The diking and drainage districts have the responsibility for maintaining the diking and drainage systems, and funding within their boundaries. The revised code of Washington Chapters 85 and 86 regulate the actions of the districts. Permit application and review procedures are required to prevent piece-meal flood control projects. The County has a good relationship with the districts and will encourage the development of additional districts as necessary. Formalized coordination and cooperation between the districts could be beneficial also.

Emergency Response Measures

In the event of an actual flood, measures can be taken to reduce risks and public and private losses. As soon as the flood warning is announced, preparedness plans can be implemented, sand bagging crews can be stationed, and evacuations could take place in specified locations.

Skagit County emergency services is responsible for the development and implementation of the flood emergency plan. Preparedness plans are distributed to all residents and businesses as well as emergency response agencies. The agencies are contacted in the case of an impending flood and required actions are taken to implement the plans.

The County trains sand bagging crews through the local fire departments and also has cooperation from military in combatting rising river heights. The city of Mt. Vernon has not experienced damage in recent years due to the efforts of these flood fighting teams.

Evacuations in some areas are necessary during the floods. Currently, evacuation of the upper valley floodplains begins at the 10-year flood frequency, and the lower floodplain areas where a levee failure is imminent at a 20-year flood frequency or greater. Permanent evacuations of areas that are flooded frequently may be the only option available if protection by other measures is economically unfeasible. The costs incurred for this type of project include moving damageable property, paying for new sites and demolishing old ones, and reimbursing losses.

Emergency preparedness and response are necessary actions to deal with flooding. Skagit County implements and successfully carries out emergency services at high water periods. These measures are not viewed as flood control options by the County. It is unwise to depend upon emergency action teams for protection given the types of things that can go wrong. FEMA does not recognize flood fighting as an adequate measure and will not reduce flood insurance rates for areas that are protected by flood fighting. This plan will not consider emergency response measures as a flood control option.

Summary of Non-Structural Alternatives

Skagit County, throughout its history, has had to mitigate flood damages and has implemented all of the possible policy and non-structural alternative measures that can control flood damages. As necessary, the policies and procedures should be updated. The County could engage in a public information program in coordination with a local agency to enhance awareness. Otherwise, the only non-structural alternative to consider further is updated flood plain management, formation of new drainage and diking districts, localized public information programs, and permanent evacuations. Floodway acquisition will also be investigated as a means of flood storage.