CHAPTER 5 - ASSUMPTIONS AND METHODOLOGY USED IN PLANNING

This chapter describes several assumptions made by the basin plan about future development and land use activities, in order to predict the impacts of development and identify the top priority water resource problems. Some assumptions quantify the types and intensity of development for use in the hydrologic computer model. Other assumptions concern the relative degree of water quality and habitat degradation, based on field observations.

5.1 EXISTING CONDITIONS ASSUMPTIONS

The basin plan used a continuous hydrologic model which predicts stream flows in the basin resulting from rainfalls of various intensities. The stream flow estimates for given rainfall events depend on the assumptions about land cover, soils, and slope in the basin. Future stream flow predictions depend on assumptions about how future development will change the land cover, soils and slope.

The model was calibrated for existing conditions based on observed rainfall and stream flows. Continuous-recording stream flow gauges collected data from several stations on both creeks for two years, and precipitation gauges measured corresponding rainfall. The model was adjusted to match the predicted stream flows with the two years of observed stream flows.

The observed precipitation data in the basin was equated mathematically with precipitation data collected at the National Weather Service station at the Olympia Airport. Thirty-five years of rainfall data for the basin was synthesized from the historical data collected at the airport, to account for differences in precipitation between the basin and the airport and provide a better basis for checking the model.

The existing land cover conditions in the basin were interpreted and mapped from aerial photographs of the basin taken in 1987, which were the most recent aerial photographs at the time the model was developed. Soils and slopes were taken from the *Soil Survey of Thurston County, Washington* (U.S. Department of Agriculture 1990). The model requires land cover to be categorized according to "percent of effective impervious area", which is the proportion of land that cannot infiltrate rainfall and is hydrologically connected to a drainage way. The model also requires soil types to be categorized according to the rate at which they infiltrate rainfall. The model made the following assumptions:

Land cover was sorted into six classes of imperviousness, divided into forested and non-forested segments, and assisgned a percentage of effective impervious area. The hydrologic model recognizes a maximum of six land cover categories. The imperviousness of each category was taken from other modeling of similar soils in south Puget Sound, and refined to reflect local conditions. Significant deviations from the assumed land cover classes would have resulted in different predicted runoff than what was actually observed.

Impervious areas not connected to any drainage way (called "non-effective impervious areas") were assumed to infiltrate into the surrounding soils. The hydrologic model calculates stream flows from runoff. If all impervious areas, including those in closed depressions, were assumed to drain directly to a surface water course, the model would have predicted artificially high stream flow peaks.

Runoff from upland till soils not directly connected to a stream was assumed to drain to the first outwash soils downslope from the till soils. Till soils infiltrate poorly and cause high runoff which increases stream flow peaks if it drains directly to a stream. However, runoff from till soils that drains downslope into porous outwash soils infiltrates into the ground and reaches the stream much more slowly. This assumption insured that till soils did not cause the model to overestimate peak flows.

Till and saturated soils were treated identically, because rainfall does not infiltrate readily through either soil type. Saturated soils typical of wetlands occur frequently in the basin. These soils may appear to infiltrate runoff when dry, but they are often too wet to absorb any additional runoff. When rain falls on these soils, the water level in the soils rises and any excess water runs off into the nearest drainage. This assumption caused the model to recognize the limitations of saturated soils, and prevented the model from over-estimating the ability of saturated soils to store runoff.

The process of calibrating the model involved entering the recorded precipitation into the model, comparing the resulting flows with actual observed flows in the creek, adjusting the model assumptions to improve the model's behavior, and repeating the process. The more observed data to compare to, the better the final calibration. The calibration assures that the assumptions are accurate enough to produce reliable results. The Woodland and Woodard Creek basin model was calibrated against two years of observed flow data. The model was run 59 times and produced a calibration with plus or minus 2% of observed flows.

5.2 FUTURE LAND USE ASSUMPTIONS

In the 1980s, over 41% of the new housing construction in the county occurred in the Woodland Creek and Woodard Creek basins (Thurston Regional Planning Council 1991). The local jurisdictions have planned for continued residential growth and extensive commercial and industrial development in the basins. The model was used to predict the consequences about future development, after the existing conditions were developed and calibrated. The future conditions were modeled assuming that all developable land in the basin will be developed to the maximum density allowed by current zoning. This "build-out" condition could occur at any time; the model did not assume any specific time frame for reaching build-out.

The population forecasts developed by Thurston Regional Planning Council and adopted by the local jurisdictions (see chapter 3) predict that the older, more developed urban core of

Lacey and the east side of Olympia will be fully developed by the year 2015, but substantial capacity will remain in the unincorporated urban growth areas.

The hydrologic model made the following assumptions for the build-out condition:

- All currently undeveloped, developable lands will be developed to the maximum density allowed under current zoning as of June, 1994.
- Land currently developed at a lower density than the maximum allowed will not be converted to a higher density, except in the mostly-undeveloped sub-basins.
- 20% of all undeveloped land will be preserved undeveloped outside the UGMA.
- All new development will provide drainage facilities according to the standards contained in the 1994 Drainage Design and Erosion Control Manual.
- Existing wetland and in-channel storage will be preserved, regardless of the underlying zoning.

These assumptions directly affect the hydrologic model's predictions about future stream flows, which form the rationale for several recommendations. The assumptions provide a realistic worst-case assessment of the watershed. Changes to the basin's zoning, wetland regulations, or drainage standards would affect the predicted impacts to the stream system, and could alter the plan's recommendations. In the southern Woodland Creek sub-basins, for example, modeling indicates that the wetlands are storing most of the runoff, and consequently, new development will not substantially increase stream flows there. However, if wetland regulations were changed to allow significant development of those wetlands, the modeling predictions would not be valid and additional measures might be needed to prevent downstream impacts.

Building density also significantly influences stream flows. For instance, if lands are developed less densely than the model assumes, the actual runoff would be lower than the predicted runoff and the actual peak stream flows could be lower than the predicted peak stream flows. Conversely, if the model assumed low density development and the land was developed at a higher density, actual runoff could increase more than the model predicted, and the recommended measures might not be sufficient to mitigate the impacts of development. The model's assumption that undeveloped land will be developed to the maximum density allowed by law provides a safety margin against future flooding problems.

Maps 14 and 15 depict the future land use conditions used to develop the build-out scenario. Appendix C contains additional details about the hydrologic model.

5.3 OTHER ASSUMPTIONS

The basin plan makes a number of other assumptions about the future of the basin, some of which affect the predictions of the hydrologic model, and others of which are not directly related to stream flows. The assumptions influence the plan's ability to meet the stated water

quality goals, so failure to implement these measures could decrease the potential for meeting those goals without additional measures. The assumptions include:

- The Fones Road ditch stormwater treatment project will be built (completed November 1994).
- The regional nonstructural recommendations will be implemented. Staff and resources will be provided to enforce ordinances, inform the public about drainage issues, monitor water quality, preserve wetlands, etc, at some level.

Assumptions used to determine the cost of structural solutions include:

- Land will be acquired at 125% of 1994 assessed value
- The volume of material to be removed for pond construction will be the same as volume of pond needed
- All the excavated material will need to be disposed

The plan made several assumptions about future actions when planning first began. Many of these actions have since come to pass, including:

- The recommended changes to drainage design standards were adopted in 1994.
- The city of Lacey built the Woodland Creek Stormwater Treatment Facility in 1991.
- St. Peters Hospital upgraded their stormwater system to eliminate all discharge from the 100-year storm.
- Local jurisdictions adopted new Critical Areas Ordinances in 1993 and 1994.
- Thurston County adopted the Nonpoint Source Pollution Control Ordinance in 1993.
- Rural zoning was revised in 1993.

Chapter 4 explains the consequences of increased stream flows on aquatic habitat. The basin plan makes predictions about the results of various future stream flows on aquatic habitat. In general, the plan assumes that increased stream flows predicted by the hydrologic modeling will have the following effects:

- Increased stream bank erosion.
- Reduced in-stream refuge habitat.
- Increased sedimentation of spawning gravels.
- Increased fish passage problems at culverts.

The plan also assumes that urban development will continue to add to the problems which have already been observed in urban stretches of the creek, such as removal of woody debris from the stream and consequent reduction in the number of pools, increased nonpoint pollution from lawn and landscape maintenance practices, decreased water quality from road runoff, and sedimentation from road runoff.

The plan assumes that current regulations will prevent new local flooding and fish passage problems in the future. The plan also assumes that existing critical areas ordinances will at least partially protect stream side and wetland vegetation from the impacts of future development.

CHAPTER 6 - LEVEL OF SERVICE ALTERNATIVES

This chapter begins by describing the current stormwater management program and the need for additional action to protect water resources, then describes two alternatives for increased levels of service in the Woodland and Woodard Creek basins. Each level of service includes a set of goals, a program of activities to meet the goals, and an explanation of the predicted impacts. The goals cover flooding, water quality and stream habitat. The activities range from public education to regulations to facilities construction, operation and maintenance. A table at the end of the chapter summarizes the impacts of each service level. Chapters 7 and 8 describe the specific recommendations and costs under service levels 1 and 2.

- The current program includes limited construction of stormwater treatment facilities, periodic maintenance of public drainage facilities, and partial implementation of the regional nonstructural management program.

- Service level 1 would expand construction of stormwater treatment facilities, begin construction of regional detention facilities to prevent further stream degradation, complete implemention of the regional nonstructural management program, resolve fish passage problems and reduce existing local flooding problems.

- Service level 2 would expand construction of stormwater treatment facilities to the maximum possible extent, develop other opportunities to reduce pollution sources, construct regional detention facilities to reduce the current level of stream degradation, restore degraded habitat, and bring all existing local flooding problem sites into compliance with the standards for new development.

6.1 CURRENT PROGRAM AND NEED FOR ADDITIONAL ACTION

Water quality and habitat degradation accelerated dramatically in the Woodland and Woodard Creek basins over the past twenty years. Concern over loss of fish in the streams and shellfish in Henderson Inlet led to the development and adoption of the *Henderson Inlet Watershed Action Plan* (Thurston County Planning Department 1989), and subsequent development of this basin plan. Stormwater management activities have failed to keep pace with the level of development in the basin, and water quality continues to deteriorate.

The local jurisdictions stepped up stormwater management activities in the early 1990s, attempting to curb the rapid deterioration of water quality and fish habitat. The current management program includes stormwater facilities, either completed or under development, for several of the worst discharges. Several septic system surveys and farm plans have been completed throughout the basin. Public education and involvement activities have increased substantially.

These activities have benefited individual sites along the creek system. Recent evidence indicates that the rate of water quality deterioration may have slowed down. A watershed report concluded that "the water quality of Henderson Inlet appears to show neither a positive

or negative trend" (Hofstad 1993). However, this can be attributed only partially to improved management of the basin. Development in the basin also slowed down substantially, which has reduced the rate of water quality degradation. Also, the data that indicate a reduced rate of degradation were collected during drought years and probably understate the true pollutant loading levels (personal communication with L. Hofstad 1994).

The stream system continues to show signs of severe habitat degradation. Peak winter stream flows, more than double the natural flows, continue to scour out gravels, erode the banks, and wash out habitat features. In the summer, a two mile reach of Woodland Creek dries up completely.

In sum, the current stormwater management program has reduced, but not stopped, the rate of water quality and habitat degradation. Without additional action, more sites are likely to violate water quality standards, shellfish resources will probably become more threatened, and fish runs which are already declining could disappear completely.

6.1.1 Current Nonstructural Measures

The local stormwater management programs include several "nonstructural" measures such as design standards, education programs, and monitoring. Some of these activities were recommended by the regional nonstructural management program (included in appendix G), which was adopted by Lacey, Olympia and Thurston County in 1992. Table 6-1 shows the current status of the regional program recommendations that have not been fully implemented yet. The current nonstructural program includes:

Drainage Design and Erosion Control Manual The drainage design manual was amended in 1994 to reflect some of the recommendations of the regional nonstructural management program. The new drainage design standards reduce, but do not eliminate, increases in stream flow peaks caused by new development.

Critical Areas Ordinances Lacey, Olympia and Thurston County adopted new critical areas ordinances in 1993/94, in order to comply with state growth management requirements. The new ordinances partially fulfill regional recommendations on habitat and critical areas protection. The county ordinance prohibits most new construction in the floodplain, as recommended by the regional nonstructural management program, but the Lacey and Olympia ordinances do not contain this provision.

Nonpoint Source Pollution Control Ordinance Thurston County adopted this ordinance in 1992, fulfilling a recommendation of the regional nonstructural management program. The nonpoint ordinance regulates agricultural animal waste in runoff and disposal of small amounts of hazardous waste and petroleum products.

Table 6-1 Regional Nonstructural Recommendations Remaining To Be Implemented

RECOMMENDATION[1]	IMPLEMENTATION STATUS
R-1: Implement a maintenance program for all public and private facilities	Currently under various stages of development by each jurisdiction.
R-2: Identify public and private stormwater facilities that can be upgraded	Partially accomplished in basin plans.
R-3: Protect critical areas through regulation	Small wetlands are not protected, and several types of wetland conversions are allowed.
R-4: Provide assistance for private parties pursuing open space preservation.	Not implemented (recent grant proposal for this recommendation failed).
R-9: Require new homes and remodels which increase impervious areas to manage the new runoff on-site	Not implemented (certain homes and remodels are still exempt from Drainage Manual requirements).
R-11: Restrict new development in the floodplain	Implemented by county but not by cities.
R-14: Establish uniform standards for land clearing within the UGMA.	Not implemented.
R-19: Establish a community grants program	Olympia has stormwater grants for schools. Lacey has community grants, but not targeted at stormwater.
R-22: Create a Stream Team naturalist program	Some Stream Team members have done naturalist activities, but not in a coordinated program.
R-28: Investigate incentives for schools to incorporate water resources curricula	Olympia's grant program does this.
R-29: Create a citizen Stream Patrol program.	Not implemented.
R-31: Install watershed boundary signs.	Not implemented.
R-33: Create a computer data base for volunteer data	The regional public education committee (ETAC) is working on this recommendation.
R-35: Establish a position to assist jurisdictions with developing funding for basin plans	Jurisdictions currently doing this separately.
R-36: Establish a 5-year strategy for improving coordination of water resource management in the UGMA	Jurisdictions have begun on-going dialogue with citizen committees on how to coordinate water resources management.

[1] The number preceding each recommendation refers to the recommendation in the full text of the regional nonstructural management program, contained in Appendix G.

Public Involvement and Education All the local jurisdictions offer a variety of surface water public education and involvement activities. The regional Stream Team volunteer program, designed to foster a sense of stewardship for local streams, is the centerpiece of the local stormwater public involvement programs. Stream Team programs install a few small-scale restoration projects on local creeks every year. The current programs fulfill some, but not all, of the regional recommendations for public education.

Monitoring The local jurisdictions participate in a coordinated ambient monitoring program for water quality, stream flows and precipitation, and new regional stormwater facilities always include a monitoring component. These activities fulfill the regional recommendations regarding monitoring. Thurston County and Olympia are also beginning a program to monitor habitat conditions in local streams.

Maintenance Each jurisdiction has a different program for maintaining stormwater facilities. Thurston County currently cleans out roadside ditches and catch basins located in the public right-of-way on a scheduled basis, and cleans out vaults and oil/water separators as needed. An expanded maintenance program is under development, that will address maintenance of facilities outside the public right-of-way.

Olympia's stormwater maintenance section has 6.5 full time employees responsible for maintaining all the stormwater pipes, culverts, catch basins, and publicly-owned stormwater facilities in the city. They also operate the regional vactor waste facility located at the city's maintenance center.

Lacey maintains street drainage facilities such as catch basins, culverts and drainage pipes, and the city is currently evaluating maintenance options for privately-owned residential and commercial facilities.

6.1.2 Current Structural Measures

Lacey constructed the Woodland Creek Stormwater Treatment Facility in 1991 to treat the worst outfall in Woodland Creek basin. Lacey began designing a facility for the College Street outfall on Woodland Creek in 1992, but the project was tabled because the land for the project site was not available. Lacey has also developed a preliminary design to treat the Ruddell Road/Hicks Lake stormwater outfall. Thurston County is currently designing a treatment facility for the Woodland Creek outfall at Martin Way East. None of the projects in the development stage have secured construction funding. Lacey and Olympia completed the Fones Road Ditch Treatment Facility in 1994. Thurston County, Tumwater, Lacey, and Olympia jointly developed a new vactor waste treatment facility in 1992, to treat the waste material pumped out of catch basins.

The current program does not include any projects in the Woodland and Woodard Creek basin to reduce peak stream flows, or improve fish passage. Structural projects to control

flooding are limited to projects which can be solved through routine maintenance, and projects to resolve problems which pose an immediate public health threat.

6.1.3 Impacts of the Current Program

Flooding Impacts The current program does not address any of the existing flooding problems identified in chapter 4. For many sites that experience frequent flooding, this results in periodic damage to homes and roads, and reduced or obstructed access to homes and businesses. Chronic flooding in these areas reduces propert values and decreases the tax base. Flooding also aggravates water quality problems. The cumulative impacts of future development could cause increases in flooding problems in the future.

Water Quality Impacts Currently, increases to fecal coliform contamination of the receiving waters in Henderson Inlet appear to have slowed down, compared to levels measured in the 1980s. Fecal coliform contamination led to restrictions on commercial shellfish harvesting in 1983, which have not been lifted. Data collected from 1989 through 1992 appear to indicate that fecal coliform levels have stabilized. Woodland Creek was the only Henderson Inlet stream to meet part one of the state fecal coliform standards during that time period. Overall, "Henderson Inlet's data appear to show that water quality is stable," despite increased population and development (Hofstad 1993). However, the data were collected during unusually dry periods when fecal coliform contamination would be expected to drop, and the data collected during major storms indicate continuing problems (L. Hofstad, personal communication 1994). Woodland Creek and Henderson Inlet continue to be listed as "water quality limited" under section 303(d) of the federal Clean Water Act (Washington Department of Ecology 1994).

The indications of a possible water quality stabilizing trend may be due partly to stormwater management activities, including implementation of the drainage manual and construction of the Woodland Creek Stormwater Treatment Facility in 1991. Nearly all new commercial property must attempt to infiltrate runoff instead of discharging it off-site, and any stormwater discharge must be treated. New public road projects now include treatment for all runoff before discharging to a stream. The nonpoint ordinance is being actively enforced, which has probably reduced some pollution in the streams.

However, storage and treatment requirements for runoff from paved surfaces do not apply to new developments with less than 5,000 square feet of impervious surfaces, or to existing developments. Also, treated runoff still causes degraded water quality because treatment facilities do not remove 100% of all contaminants. Under the current program, water quality degradation continues to occur from the existing problem outfalls identified in chapter 4.

Future urbanization at the level predicted in the build-out condition would probably cause additional water quality degradation from other nonpoint sources of pollution which current programs do not address adequately. Additional homes, lawns, pets and automobiles would

all contribute to nonpoint pollution. Similar urbanizing areas in other parts of Puget Sound exhibit problems with fecal coliform contamination and high nutrient levels.

Stream Habitat Impacts The current program results in the stream peak flow and low flow return frequencies depicted in figures 3-1 through 3-4. The existing stream peak flows have significantly degraded salmon spawning habitat in lower Woodland Creek. The existing low flows have cut off prime rearing habitat on Woodland Creek from mile 3.3 at Martin Way to the lakes in the upper basin. Development in Woodard Creek basin has also increased the stream peak flows, and habitat degradation is evident, though less severe than in Woodland Creek. Figures 4-1 through 4-4 depict predicted future stream flows under build-out conditions, with the current program. The expected effects of these flows on habitat include:

- channel shape will change and stream bank erosion will increase, especially at sharp bends and in steep reaches of the creeks.
- sediment will be deposited on spawning gravels and in Henderson Inlet.
- refuge habitat in the streams will decline sharply during peak flows.
- the number and frequency of pools will decrease.
- fish passage at culverts will deteriorate during peak flows.

Other impacts to stream habitat from the current program include: erosion and diminished habitat due to clearing of the stream channel and banks by property owners; and poor conditions for fish due to deteriorating water quality. Stream Team restoration projects partially mitigate the effects of some of the vegetation clearing. However, the impact from increased stream flows would probably be the most severe impacts to stream resources.

6.2 SERVICE LEVEL 1

This level of service would reduce the severity of the most frequent local flooding problems, improve the water quality of stormwater runoff, and prevent further deterioration of fish habitat. Water quality treatment facilities would be constructed to address known hot spots and future peak flows would be limited as closely as possible to existing peak flows. However, the effects of stormwater treatment on the creeks' water quality cannot be predicted accurately, and the effects of development on receiving waters can never be mitigated totally. For example, peak flows might be held to lower levels, but they would last longer because the total volume of runoff would have increased.

6.2.1 SERVICE LEVEL 1 GOALS

Flood Control Service level 1 would install drainage system improvements at the sites with the most frequent, chronic flooding problems caused by publicly owned drainage facilities. The goal of this service level would be to improve public health and safety and reduce property damage. In order to reach this goal, flooding problems would be evaluated and prioritized according to the following criteria:

- Existing public drainage systems which flood buildings from the 10-year or more frequent storm events would be prioritized for remedial action.
- Eligible drainage systems which flood multiple structures or roads would receive higher priority.
- Drainage system upgrades would attempt to accommodate the 25-year storm, if possible.

Water Quality Protection Service level 1 would install treatment on contaminated outfalls with documented water quality problems, and continue education programs directed at reducing nonpoint pollution sources. The goal of this service level would be to prevent further degradation of receiving waters. In order to reach this goal, existing stormwater discharges would be evaluated and prioritized according to the following criteria:

- Existing stormwater discharges with documented water quality problems would be prioritized for treatment.
- Contaminated discharges that present a public health hazard would receive higher priority.
- Treatment systems would be designed to treat the 6-month rainfall event.

Stream Habitat Preservation Service level 1 would prevent increases in peak stream flows, protect riparian and in-stream habitat, improve fish access to critical habitat, and restore fish habitat at a few sites through the existing Stream Team program. In order to reach this goal, stream habitat projects would be evaluated and prioritized according to the following criteria:

- Future stream peak flows would be held to existing levels.
- Culverts that do not meet Department of Fisheries standards would be replaced or improved, in prioritized order from downstream to upstream.
- Existing fish habitat in areas which are accessible to fish would receive higher priority for preservation.

6.2.2 Nonstructural Measures of Service Level 1

Service level 1 would fully implement the regional nonstructural management program described in appendix G. Table 6-1 describes the major recommendations which remain to be fully implemented.

Service level 1 would also implement the following nonstructural measures:

- Maintenance frequency would be increased for certain facilities, and remedial maintenance would be scheduled for some failing facilities.
- Direct stormwater discharges which have not been tested would be sampled for water quality.
- The fish habitat in both creeks would be monitored periodically.

- Volunteers would conduct fish habitat restoration projects.

Chapter 7 describes the Service level 1 recommendations in detail.

6.2.3 Structural Measures of Service Level 1

Service Level 1 would include structural measures to correct flooding, water quality and stream habitat problems. Chapter 7 describes these projects in detail. Generally, flood mitigation projects would involve replacing, rebuilding, or augmenting existing stormwater facilities that meet the criteria described above. The problem systems would be prioritized and included in the local jurisdiction's capital facilities plans or added to remedial maintenance programs.

Projects to address known water quality problems would generally involve building constructed wetland treatment facilities, swales, or wet vaults to treat stormwater discharges that meet the criteria described above. Constructed wetlands would be designed to remove sediments, nutrients, and heavy metals. Oil-water separators would be installed on these facilities. Constructed wetlands have proven effective for stormwater treatment in the Puget Sound area.

Projects to improve stream habitat would include two types of projects: fish passage improvements, and regional stormwater detention ponds. Fish passage improvements would consist of replacing, or installing baffles or fish ladders on culverts that meet the service level 1 criteria. Culvert improvements would proceed upstream from the mouths of the creeks, except where scheduled road improvements offer economical opportunities to improve the culverts.

New developments would be required to meet the service level 1 goals, which would prevent cumulative increases in the peak stream flows. Developments would prevent peak flow increases by installing larger detention systems, preserving larger forested areas, participating in regional detention projects, or some combination of these options. Regional detention systems would capture runoff and release it to the streams in a pattern that mimics the streams' natural hydrology as closely as possible, as predicted by the basin hydrologic model. Regional detention ponds would include treatment for water quality in their designs.

6.2.4 Impacts of Service Level 1

Flooding Impacts Service level 1 would reduce flooding at all the problem sites identified in chapter 4 where public drainage systems cause the 10-year storm to damage buildings or block emergency services. Additional engineering studies would be required to determine which problem sites would be addressed by this service level. The cost estimates provided in chapter 7 assume the worst-case scenario, that all the problem sites would require action. That scenario is highly unlikely. Sites where the 10-year storm does not threaten structures or block emergency services would continue to experience flooding.

Water Quality Impacts Recent data collected for the Henderson Inlet watershed (described in section 6.1.4) appear to indicate that aggressive stormwater management actions, combined with additional remediation of septic systems and implementation of agricultural BMPs, have the potential to halt declines in water quality. Results from the Woodland Creek Stormwater Treatment Facility indicate that constructed wetlands can significantly improve runoff water quality. First year monitoring of that facility under normal rainfall conditions demonstrated pollutant removal rates of 50% - 90% for a broad range of contaminants.

Based on those observations, service level 1 would probably bring problem outfall sites into compliance with most state water quality standards and help prevent further cumulative water quality degradation of the creeks. Sediment pollutant levels would probably remain high, but increased maintenance and new facilities would prevent accumulated sediments from entering the streams through storm drains.

Gains in water quality would be partly offset by new impervious surfaces that treatment can only partially mitigate, and increased nonpoint pollution from sources such as automobiles, household hazardous materials, pet waste, lawn fertilization, septic systems, etc. Service level 1 would increase public education programs targeted at nonpoint pollution sources. Public education is often the only practical method for reducing nonpoint pollution, but the benefits are difficult to predict and quantify.

Overall, gains from installing treatment on existing discharges would probably be offset by degraded runoff from new developments which cannot be completely treated to remove 100% of contaminants. The net effect would probably be the stabilization of water quality at current levels.

Stream Habitat Impacts Peak stream flows for most flood events would remain about the same as they are today. However the duration and volume of runoff would increase. Increased flood durations and volumes could have a negative effect on habitat, but this impact cannot be predicted accurately. Hydrological analysis of stream habitat indicates that refuge habitat for fish in one segment of Woodard Creek has declined by 25% or more from natural conditions (see appendix H). Spawning habitat has also declined from natural conditions because of sedimentation of gravel beds, but the extent is difficult to quantify. Increased flood durations would probably cause continued erosion and sedimentation, and would extend the periods of reduced refuge in the stream.

Habitat losses from peak flows would be partially offset by stream restoration projects designed to provide habitat under the altered flow conditions. Restoration efforts would also stem some of the erosion problems. Habitat has declined more in Woodland Creek than in Woodard Creek, because it is more urbanized and the hydrology has changed even more from natural conditions. Woodland Creek would probably experience less significant habitat

losses than Woodard Creek under service level 1, because Woodland Creek has already lost more habitat.

Service level 1 could improve summer low flows in the creeks by infiltrating more winter runoff into the ground, where it would move more slowly through the subsurface, toward the creeks. This effect is impossible to predict. Fish passage would be improved on both creeks, in full compliance with the state Hydraulics Code. Improved fish passage would benefit the fisheries of both creeks.

6.3 SERVICE LEVEL 2

Service level 2 would provide measures to correct virtually all known flooding problems from publicly-owned drainage systems. Habitat degradation would be reduced significantly, and additional steps would be taken in an attempt to meet water quality standards. This level of service differs from service level 1 primarily in that additional actions would be taken to reduce peak flows to below current levels. In addition, extensive retrofitting of stormwater systems and increased education and regulation may be necessary to meet the water quality goals of service level 2.

6.3.1 SERVICE LEVEL 2 GOALS

Flood Control Service level 2 flood control measures would attempt to reduce flooding at most sites with flooding problems caused by public drainage facilities which do not meet today's standards for new construction. In order to reach this goal, flooding problems caused by public drainage facilities would be evaluated and prioritized according to the following criteria:

- Existing public drainage systems which flood buildings from the 25-year or more frequent storm events would be prioritized for remedial action.
- Drainage systems which flood multiple structures or roads would receive higher priority.
- Drainage system upgrades would attempt to accommodate the 100-year storm, if possible.

Water Quality Protection Service level 2 would improve the water quality of stormwater runoff by installing treatment on all direct discharges, and continuing education programs directed at reducing nonpoint pollution sources. The goal of this service level would be to improve the quality of receiving waters. In order to reach this goal, existing stormwater discharges would be evaluated and prioritized according to the following criteria:

- All existing stormwater discharges that drain directly to a surface water body would be prioritized for treatment.
- Contaminated discharges that present a public health hazard would receive higher priority.

- Additional source control measures would be developed if needed to meet state standards. Likely measures include increased education, regulation and enforcement.
- Treatment systems would utilize additional technologies to maximize pollutant removal efficiency.

Stream Habitat Preservation Service level 2 would improve fish habitat by: reducing peak stream flows to below current levels; protecting riparian and in-stream habitat; providing for fish access to critical habitat; and implementing comprehensive fish habitat restoration projects through partnerships between agencies, landowners, students and volunteers. A comprehensive fish habitat restoration and management plan would be developed for both creeks. The plan would identify and prioritize the limiting habitat factors for both creeks, and incorporate the following criteria:

- Future stream peak flows would be reduced to below existing levels.
- Culverts that do not meet Department of Fisheries standrads would be replaced or improved, in prioritized order from downstream to upstream.
- Existing fish habitat in areas which are accessible to fish would receive higher priority for preservation.
- All active erosion sites would be remediated using native vegetation. Sites would be prioritized and incorporated into a comprehensive restoration plan based on the severity of the erosion.

The plan would also recommend additional habitat standards for designing projects, based on a review of current research. Potential standards include pool:riffle ratio, large woody debris per stream segment, maximum water temperature, etc.

6.3.2 Nonstructural Measures of Service Level 2

Service level 2 would include the nonstructural measures proposed in service level 1, including full implementation of the Regional Nonstructural Management Program contained in appendix G. In addition, zoning would be changed to require clustered development that preserves forested open space outside the UGMA. Clustered development would further reduce future peak flows in the streams, which are predicted to increase because of clearing of forested areas on the poor soils north of the UGMA. The drainage standards would also be doubled for Woodland basin, to further reduce the impact of future development on stream peak flows.

Additional actions would be proposed to meet state water quality standards, if future monitoring indicates the need. The effectiveness of the proposed nonstructural measures would be monitored and evaluated, and potential additional measures would include expanded education and regulation efforts.

The fish habitat restoration plan would probably identify additional nonstructural measurements designed to help restore fish habitat in both streams.

6.3.3 Structural Projects of Service Level 2

The proposed structural measures in service level 2 include all the measures in service level 1 to remediate known flooding, water quality and habitat problems. Service level 2 would also include capital construction and remedial maintenance projects to bring many public drainage facilities up to current standards for new construction.

Water quality treatment facilities would be installed on all stormwater discharges that drain directly to surface water bodies. Treatment facilities would be designed with larger capacity and additional features to reduce contaminant levels. Additional actions would be proposed in order to meet state water quality standards if future monitoring indicates the need. The effectiveness of the proposed structural measures would be monitored and evaluated, and potential additional measures would include all known and available technologies.

Service level 2 would include capital facilities designed to store floodwaters in order to reduce peak stream flows to levels below current peak flows. Chapter 8 describes these projects in detail. Fish habitat improvements designed to accommodate projected stream flows would be constructed in both creeks, and most eroding streambanks would be stabilized using bioengineering techniques that utilize native vegetation and create fish habitat.

6.3.4 Impacts of Service Level 2

Flooding Impacts Service level 2 would reduce or eliminate known flooding problems which affect buildings and roads during the 25-year storms. Public health and safety would improve and flood-related property damage would decline. Water quality degradation from flooding would be reduced.

Water Quality Impacts Increased storage and drainage system improvements would improve water quality slightly by infiltrating more runoff and reducing major discharges, compared to service level 1. Additional treatment of stormwater discharges would improve water quality. Water quality would be monitored for compliance with state water quality standards, and additional measures would be proposed in order to bring the creeks into compliance.

Stream Habitat Impacts Service level 2 would reduce future peak stream flows to below current levels at all locations on Woodland Creek and at all locations except the mouth on Woodard Creek, resulting in reduced erosion and improved fish habitat. Future habitat conditions would improve. Increased peak flows are the most significant habitat threat to Woodard Creek, and service level 2 would reduce this threat substantially.

Comprehensive restoration would result in significantly improved fish habitat, which would probably increase fish populations in both creeks. Fish blockages would also be eliminated,

and passage would be improved under this service level, enabling the streams' fish populations to take full advantage of increased habitat.

6.4 COMPARISON OF SERVICE LEVELS

The tables below compare the current management program with the proposed goals for service levels 1 and 2, and compare the impacts of the current program with the two alternatives.

Table 6-2 Comparison of service level goals

Category	Current Management Program	Service Level 1	Service Level 2
Flooding	New drainage systems: • convey the 10-year storm • minor road flooding OK from 25-year storm inside UGMA • minor road flooding OK from 100-year storm outside UGMA • detain/retain the 100-year storm No standards for upgrading existing drainage systems	New drainage systems: • same as current program Upgrade existing drainage systems: • drainage systems that flood buildings during the 10-year storm will be upgraded to prevent flooding from the 25-storm, if possible • road drainage will be upgraded to insure emergency vehicle access during the 100-year storm	New drainage systems: • same as current program Upgrade existing drainage systems: • drainage systems that flood buildings from the 25-year storm will be upgraded to prevent flooding from the 100-year storm, if possible • Roads: same as service level 1
Water Quality	Current program fails to meet state water quality standards	• No further degradation of water quality in the future • Treatment installed on all contaminated direct discharges	• Improve existing degraded water quality to meet state standards • Treatment installed on all direct discharges
Stream Habitat	Current program fails to meet state Hydraulic Code requirements, and allows increased future peak stream flows	• No fish blockages (comply with Hydraulic Code) • No further loss of riparian vegetation (comply with Critical Areas ordinance) • No future increases in stream peak flows	• No fish blockages • No further loss of riparian vegetation • Decrease future stream peak flows below existing conditions • Improve fish habitat

Table 6-3 Comparison of the impacts of current and proposed stormwater service levels

PROBLEM AREA	LEVEL OF SERVICE		
	Current Program	Service Level 1	Service Level 2
Fish Habitat Degradation	Stream velocities would increase. Flood damage would increase in a few areas such as at Long Lake down from the outlet. Erosion of stream channels would increase dramatically. No fish passage barriers would be removed.	Stream velocities would remain about the same. High flows would be of longer duration. Erosion and stream channel incision may increase modestly because of longer duration of high flows. Fish migration barriers would be removed. Riparian habitat may improve slightly.	Stream velocities would be reduced but duration of high flows may be longer. Erosion and stream channel incision would be reduced from existing condition. Fish migration barriers would be removed. Habitat would be significantly restored, and fish populations would probably increase.
Water Quality Degradation	Water quality would continue to deteriorate.	Water quality would probably remain stable. Increased population increases risk of spills and dumping.	Water quality would probably remain stable or might improve. Increased population would increase risk of spills and dumping.
Flooding	Local spot flooding would not be addressed.	Some flooding of roads and buildings would be reduced.	Most flooding of roads and buildings would be reduced.