than 20 years ago The channel cross-section may have changed considerably in 20 years as a result of siltation To update the channel characteristics, the Cities of Portland and Gresham resurveyed each bridge spanning the creek and surveyed typical cross-sections (at approximately 500-foot intervals) up to river mile 22 during the summer of 1993 The updated bridge and channel cross-sections were used to develop new hydrologic and hydraulic models of the Johnson Creek watershed.

HEC-1 (the hydrologic model) is used to determine how rainfall during a storm becomes runoff to the creek It uses physical properties of a watershed, such as soil characteristics, amount of impermeable surface, and slope, to calculate how much of the rainfall infiltrates into the soil and how much runs off as surface flow Together with data on the intensity and distribution of the rainfall during the storm, the program calculates a "hydrograph" or picture of the amount of creek flow with time The maximum amount of creek flow or "peak" of the hydrograph is the value usually reported as the magnitude of the flood The shape of the hydrograph and the duration of flood flows are also important in determining how damaging a flood may be and how effective detention basins and other flood management strategies will be in reducing flood damages

For the RMP modeling effort, the Johnson Creek watershed was subdivided into approximately 90 sub-basins which were assumed to have the same physical properties HEC-1 was calibrated by comparing the results of the modeling effort with measured flows at the two USGS gaging stations The calibration confirms that the properties assumed for the sub-basins are accurate enough to use the model to predict runoff and creek flow for rainfall events which have not been recorded, such as the 50- and 100-year floods

HEC-2 (the hydraulics model) is used to predict the water surface elevation of creek flow HEC-2 uses the physical properties of the creek channel and its flood plain, including channel shape and size, the hydraulic properties of bridges and culverts, and the resistance to flow in the creek channel, usually called the roughness (expressed as Manning's "n" value) The roughness takes account of the combined effect of the channel material, vegetation, sinuosity, and sudden changes in channel shape

It is obviously important that the HEC-2 model accurately predicts water surface elevations Checking the accuracy of a model is typically difficult due to the lack of information on large floods Large floods are infrequent events, when they do occur city staff are usually preoccupied with emergency relief and are rarely available to measure the water surface elevations or creek flows Very few water surface elevations or creek flows are available among the records of earlier floods on Johnson Creek Fortuitously, from the point-of-view of the hydrologic studies, a 5-year return period flood occurred on February 24, 1994, enabling water surface elevations to be measured accurately at many locations. HEC-2 was calibrated by comparing predicted water surface elevations with those measured during the February 24, 1994, flood This calibration confirmed that the channel cross-sections and roughness values are accurate enough to use the model to predict water surface elevations during future floods

PREDICTED FUTURE FLOOD FLOWS

Table 14 shows estimated peak flows at the Sycamore and Milport gages under different land use conditions The unusual hydrologic characteristics of the watershed are illustrated by a comparison of peak flows at the two gages under the existing land use condition In most watersheds peak flow increases substantially as a flood moves downstream As a flood moves down a stream channel, larger and larger areas contribute water to the flood This effect is lessened somewhat by the tendency of peak flow to decline in a downstream direction as the stream channel broadens.

TABLE 14

Predicted Flood Discharges on Johnson Creek Under Different Land Use Conditions

Flood Return Period (yrs)	Streamflow (cfs) Pre-Development[1]	Existing Land Use	Planned Future Land Use[2]	2040 Plan Land Use[3]	Watershed Buildout[4]
Sycamore Gage (river mile 10.8)					
2	880	1340	1380	1480	–
5	1220	1760	1800	1920	–
10	1440	2030	2080	2210	3600
25	1740	2400	2450	2600	–
50	2050	2790	2840	3000	–
100	2410	3220	3280	3420	5200
500	3200	4060	4110	4260	–
Milport Gage (river mile 0.5)					
2	1030	1500	1530	1670	–
5	1390	1790	1820	1930	–
10	1540	1870	1890	2250	2700
25	1790	2350	2370	2480	–
50	1930	2530	2550	2630	–
100	2370	2690	2700	2800	3000
500	2720	2880	2920	3240	–

Note

1 Assumes watershed to be forested

2 Planned future land use conditions that reflect current comprehensive planning within existing urban growth boundary and some reduction in development intensity due to natural resource area conflicts

3 Assumes urban reserve areas in Metro's 2040 plan are converted to urban uses

4 Assumes conversion of entire watershed to urban and suburban land uses

During small floods in the Johnson Creek watershed, the peak flow at the Milport gage, near the creek mouth, is slightly higher than the peak flow at the Sycamore gage, near the watershed's midpoint The difference between peak flows at the two gages is not great, however, because the western portion of the watershed contributes so little runoff As noted earlier, much of the rainfall over the western end of the watershed either percolates into the ground or is diverted away from the creek by the Portland combined sewer system Also, the watershed is long and narrow, characteristics that tend to prevent the development of large peak flows Stormwater from the western end of the watershed discharges rapidly to the Willamette River long before flood waters from the upper basin arrive in the lower reaches of the creek

On the other hand, during larger floods, peak flows at Milport are lower than those at Sycamore This counter-intuitive phenomenon is a result of a portion of the flood flow being diverted into storage in the Lents area Most of the flow remains in the stream channel and is recorded by the Sycamore gage but, in the Lents area, a considerable proportion overflows the creek banks and is temporarily stored As a consequence, only a fraction of the flow reaches the Milport gage during the height of the flood

Estimated peak flows for three future land use conditions are also shown in Table 14 The planned future land use condition is based on current city and county comprehensive plans and reflects the fact that development is currently limited to within the Urban Growth Boundary (about two-thirds of the watershed lies within the Urban Growth Boundary) The estimated peak flows under the planned future land use condition are only about two percent greater than for the existing land use This is a result of the unusual hydrologic characteristics of the watershed, as described above, and the limited areal extent of new development Much of the currently planned development involves expansion on the fringes of existing communities and redevelopment and densification of existing developed areas

It is expected that the population of the Portland metropolitan area will increase by about one million by the year 2040 METRO, the regional planning agency for the four-county Portland metropolitan area, recently approved a plan to accommodate an expected population increase of 1 1 million by the year 2040 The 2040 plan does not envisage any immediate changes to the urban growth boundary in the Johnson Creek watershed Instead, new residents would be accommodated by denser development of lands within the present urban growth boundary However, the 2040 plan does identify lands south and east of Gresham as "urban reserve" or lands that could be included in the urban growth boundary at some future time If these lands are developed then peak flows are estimated to be as shown under the 2040 condition in Table 14 It is apparent that the increase in development allowed under the 2040 plan has only a modest effect on peak stream flow

Although there are no plans to develop the Johnson Creek watershed beyond the levels noted above, the effects of more intensive development were investigated A future land use condition referred to as "watershed buildout" was modeled Under this condition it was assumed that the watershed becomes fully developed in approximate proportion to the current mix of urban land uses Peak flows in Johnson Creek as recorded at the Sycamore gage would increase by about 70 percent In this, and the other land use conditions modeled, it was assumed that floodwater detention in new development either does not exist, or is ineffective

FLOODING PATTERNS

An overall picture of how flooding occurs in the Johnson Creek watershed can be constructed from observations of past floods and model-generated predictions of future flooding Table 15 shows flood-prone areas along the creek

TABLE 15
Floodprone Areas Along Johnson Creek

River Mile	Location	Remarks
0 61	South of Milport	Overbank flooding in five-year storm, some damage in February 1994 storm
0 79-0 86	Between Milport and Portland Traction trestle	Overbank flooding in two-year storm
1 29-1 51	Johnson Creek Park and vicinity	Overbank flooding in two-year storm
2 47-2 59	Tideman Johnson Park	Overbank flooding in two-year storm, no structures involved
3 18-3 27	Johnson Creek Boulevard at 45th	Overbank flooding in two-year storm
4 35-4 43	Linwood crossing and vicinity	Overbank flooding in two-year storm
4 71-4 82	Bell Station and vicinity	Overbank flooding in two-year storm, some damage in February 1994 storm
5 24-5 41	Luther and 76th	Overbank flooding in two-year storm
5 72	82nd Avenue crossing	Overbank flooding in five-year storm
6 99	100th Avenue	Overbank flooding in five-year storm
7 45-8 98	106th Avenue to 120th Avenue	Continuous overbank flooding in five-year storm, overbank flooding in two-year storm around 112th Avenue Considerable damage in February 1994 storm
9 27-9 87	Leach Botanical Garden and vicinity	Overbank flooding in two-year storm, no structures involved
10 66-10 83	148th Avenue and vicinity	Overbank flooding in two-year storm
11 24	158th Avenue	Overbank flooding in two-year storm

The most flood-vulnerable reach of the creek is in the Lents area along S E Foster Road between S E 106th Street and S.E 112th Street Historic maps indicate that, before development, much of the area was a wetland Beggars-tick Marsh is a remnant of the wetland The creek in this reach has a gentle slope and meanders considerably The capacity of the creek channel in this area is approximately 900 cfs An existing 72-inch bypass pipe, installed earlier to relieve flooding, increases total capacity to approximately 1,200 cfs. This is less than the peak flow associated with a 2-year return period flood Thus, flooding in this area can be expected to occur every other year on average.

During floods that exceed channel capacity, water leaves Johnson Creek near S E 112th Street and flows across S E Foster Road A portion of the flow is intercepted by the Springwater Trail Corridor fill and routed back toward S.E Foster Road near S.E 106th Street, where it crosses the road and re-enters the creek channel on the Freeway Land Company property The creek channel on the Freeway Land Company property has a considerably higher capacity than the reaches of the creek just upstream Another portion of the flow continues north into Beggars-tick Refuge If the flood is large enough, two other low-lying areas begin to fill with floodwater These are the Holgate Lake area to the north and east of the refuge and the resident neighborhoods to the west of the marsh In both of these areas a relatively large number of structures are vulnerable to flooding

Several other areas downstream of Lents are subject to flooding in relatively-frequent small storms (2- to 5-year return period storms) They include S E Umatilla Street (river mile 1 5), S.E. 45th Avenue, just upstream of the WPA-constructed fish ladder (river mile 3.2), Bell Station (river mile 4.7) and S E Luther Road (river mile 5 4) Relatively small numbers of structures are vulnerable at each of these locations

If flow becomes great enough, properties in the vicinity of Crystal Springs Creek become vulnerable to flooding In storms greater than the 50-year event, the path of floodwaters splits upstream of the S E Tacoma Street bridge One flow path continues to follow Johnson Creek, while the other crosses Eastmoreland Golf Course and S E McLoughlin Boulevard, and joins Crystal Springs Creek in Westmoreland Park The combined flows in Crystal Springs Creek exceed channel capacity, making properties lining the creek vulnerable to flooding

A few areas upstream of Lents are also vulnerable to frequent flooding They are in the vicinity of S.E 151st Avenue and S E 158th Avenue Only a handful of structures are vulnerable in small storms In large storms (25-year return period and greater) about 50 structures could be affected in Portland and a few more in Gresham

FLOOD DAMAGES

A post-flood damage survey was conducted after the 1964 flood, when approximately 1,500 structures were affected It was concluded that the total cost of the damages was $500,000, expressed in 1964 dollars Adjusting for inflation, the economic damage of such a flood today, would be $3,000,000, or about $2,000 per structure.

In their 1990 reconnaissance study report, the Corps estimated the value of damage that would be caused by floods of various sizes The Corps used an estimation method developed by the Federal Emergency Management Agency (FEMA) The information developed by the Corps was adjusted to take account of the new estimates of flood frequency made by KAI Table 16 shows the estimated damages associated with various return period floods

After the recent flood in February, the City of Portland estimated the value of damages to be about $375,000 This is 45 percent higher than the estimate of $210,000 extrapolated from Corps of Engineers data It is not clear whether the Corps' estimates undervalue damage that might occur in more severe and less frequent floods

TABLE 16
Predicted Costs of Flood Damages Under Existing Land Use Conditions
(1994 dollars)

Flood Frequency (years)	Estimated Damage ($ Million)		
	Below Lents	At Lents	Total
2	0	0 05	0 06
5	0 02	0 18	0 26
10	0 05	5 11	5 4
25	0 06	10 22	10 8
50	0 11	11 92	12 6
100	0 13	13 87	15 1
500	0 92	14 6	16 3

Note Damage estimates are based on the relationship between flood water levels and damage value established by the U S Army Corps of Engineers and the new estimates of flood frequency and peak flow made by Kurahashi and Associates Actual damage estimates for the 5-year return period flood that occurred on February 24, 1994 are approximately $375,000 Thus, it is possible that predicted damages in larger floods are also underestimated

Flood Reduction Strategy

The conventional approach to flood control in the urban environment has been to make improvements to channels so that they can accommodate higher flows This was the approach taken by the Works Progress Administration when it widened and rock-lined Johnson Creek in the 1930s Followed to its ultimate conclusion, the approach results in the conversion of natural streams to concrete-lined channels, the Los Angeles River is a notable example

Two of the goals of the RMP established by the Johnson Creek Corridor Committee are to ensure "flood impacts are minimized," and "natural areas are preserved and restored." If the conventional approach to flood control were adopted, the two goals would be mutually exclusive because conventional channel improvements are entirely incompatible with the preservation of natural areas Thus, to satisfy both of the JCCC's goals, flood control on Johnson Creek cannot rely heavily on conventional channel improvements Two major consequences follow from this conclusion First, and most obviously, flood reduction on Johnson Creek must primarily rely on measures other than conventional channel improvements Less obviously, it must include measures to halt or slow the increase in peak flows that result from development Without control of peak flows from new development, channel improvements or large-scale acquisition of flood plan lands could become virtually unavoidable at some time in the future Instead of channel improvements, the flood reduction strategy must rely on measures such as on- and off-stream floodwater storage, that serve to offset the adverse effects of development and allow the channel to remain in a more natural state Acquisition of the most vulnerable properties would also be desirable

Plan Objectives and Actions

The first of the objectives listed below addresses the control of future peak flows from increased development of the watershed The second objective addresses the need to minimize flood damage to existing structures Table 17 lists the objectives and actions, identifies the party responsible for each action, and includes an estimate of the cost of each action

OBJECTIVE FM-1
Minimize Post-Development Peak Flows.

As discussed earlier, urban development typically results in an increase in peak flows and total runoff volume As indicated in Table 15, development of the Johnson Creek watershed has increased peak flows by approximately 40% compared to the undeveloped condition Futher development or significant redevelopment would lead to increases in runoff volume, but the increases in peak flows are not likely to be great However, if, as seems likely, the Urban Growth Boundary is modified at some time in the future, to allow urban development in the upper Johnson Creek watershed, peak flows could increase by up to 70 percent Higher peak flows will exacerbate downstream flooding and impose flood control costs on Portland and Milwaukie that are attributable to development upstream Furthermore, the need to provide flood protection from increased peak flows could force downstream communities to consider channelization, a flood control measure that is inherently incompatible with protection of natural resources and fisheries enhancement

The only way to prevent or minimize future increases in peak flow is to build individual or regional stormwater detention facilities into all new development In this way the monetary and environmental costs of flood control are imposed on those who cause the increase in peak flows, rather than on those who are simply subjected to them

Three government agencies in the watershed have already adopted development standards that require some form of stormwater detention in new development The existing standards are as follows

TABLE 17
Summary of Flood Management Plan Element

Objectives and Actions	Implementing Agency/ Responsible Party	Estimated Cost of Action	Portion of Estimated Annual Cost of Action Attributable to JCRMP	Priority
Objective FM-1. Minimize Future Post-Development Peak Flows				
Action FM-1-1 Establish comprehensive and effective basin-wide stormwater drainage regulations for new developments[1]	Cities and Counties (intergovernmental committee)	$45,000 (One-time cost)	$45,000 (One-time cost)	B
Action FM-1-2 Implement basin-wide development standards for stormwater drainage[2]	Cities, Counties, and Developers	Not estimated	Not estimated	B
Objective FM-2. Reduce Flood Damage to Existing Structures				
Action FM-2-1 Construct flood reduction facilities	Cities and Counties	$14,000,000 (One-time cost) $75,000 (annual cost)	$14,000,000 (One-time cost) $75,000 (annual cost)	A
Action FM-2-2 Draft and adopt "Balanced Cut and Fill Standard" for the 100-year flood plain[3]	Cities and Counties	$15,000 (One-time cost)	$15,000 (One-time cost)	B
Action FM-2-3 Redefine FEMA 100-year flood plain[4]	Cities and Counties	$50,000 (One-time cost)	$50,000 (One-time cost)	A
Action FM-2-4 Establish channel maintenance practices handbook	Cities and Counties (intergovernmental committee)	$30,000 (One-time cost)	$30,000 (One-time cost)	B
Action FM-2-5 Maintain channel according to channel maintenance practices handbook[5]	Cities and Counties/ volunteers	$83,000 (annual cost)	$83,000 (annual cost)	B
Action FM-2-6 Establish emergency response team and procedures to minimize flood damage	Portland and Milwaukie	$25,000 (one-time cost)	$25,000 (One-time cost)	A
Action FM-2-7 Acquire properties vulnerable to frequent flooding as they become available	Cities and Counties	Not estimated	Not estimated	C

1 Related action Action PP-2-3
2 No increase in public cost to implement modified standards Increased development costs to comply with standards
3 No increase in public cost to implement standards Increased development costs to comply with standards Some lots become unbuildable
4 Action would reduce flood insurance costs and lead to appreciation of property values
5 Assumes silt and large debris removed by City and Counties at 3-year intervals Volunteers and homeowners trim vegetation

- **City of Portland.** Limits the volume of stormwater runoff from new development in the Johnson Creek basin to 110 percent of the volume under pre-development conditions for the 10-year storm event Also prohibits an increase in downstream peak flow

- **City of Gresham.** Runoff during a 25-year storm shall not exceed the pre-development rate of runoff released during a 10-year storm

- **County of Clackamas.** Detention for new developments (except single family residences) should be constructed for 25-year storms and release rates from the detention should not exceed the runoff rate from the pre-developed site during a 5-year storm

The existing hydrologic development standards suffer from several disadvantages Firstly, they are imposed uniformly within a political subdivision without regard for hydrologic considerations This can produce the opposite of the effect intended In most watersheds flooding can be prevented by ensuring that peak flows from different parts of the watershed do not arrive simultaneously at a single point In a long and narrow watershed like the Johnson Creek watershed, this can best be accomplished by delaying the release of flood flows from the upper watershed until the lower reaches of the creek have drained to the Willamette River Floodwater detention in the upper basin clearly serves a useful purpose while floodwater detention in the lower basin may simply decelerate draining of the lower reaches and thus increase peak flow and the severity of flooding

A second disadvantage is illustrated by the inconsistent nature of each community's hydrologic development standards The differing standards reflect the lack of agreement among engineers on how they should be drafted As part of the work in support of the RMP a survey was made of hydrologic development standards used in different parts of the United States The results are contained in Technical Memorandum No 2 entitled "Summary of Land Use Regulations for Minimizing Hydrologic Impacts"

It is clear from the results of the survey that the lack of agreement on the best way to limit the adverse hydrologic effects of development is not confined to the Johnson Creek watershed A number of technical and institutional issues remain unresolved Many jurisdictions seek to limit post-development runoff to its pre-development value However, there is no general agreement on how pre- and post-development runoff should be calculated or how the required detention facilities should be designed In the Pacific Northwest some engineers believe that the conventional practice of designing detention facilities based on single, isolated storms may not provide the desired level of protection during the back-to-back storms common in the region If they are correct, and a different runoff calculation method is appropriate, the required detention facilities could be much larger and more costly than they have been in the past

Stormwater detention facilities can be constructed at each new development, or regional facilities can be built In general, regional facilities are preferable because they are more likely to be properly designed and maintained However, in already urbanized areas, suitable sites may be difficult to locate Requiring all developers to provide stormwater detention is administratively simple and imposes less of a burden on public agencies than provision of regional storage Some agencies, the Unified Sewerage Agency of Washington County for example, allow developers to contribute to a regional detention fund rather than build their own on-site detention facilities The Unified Sewerage Agency also takes responsibility for maintenance of all private detention facilities

It is important that the requirements for control of stormwater flow or quantity are coordinated with the requirements for control of stormwater quality As part of their stormwater management plans, the cities of Portland and Gresham, and Clackamas County are developing standards and guidance documents for water quality control facilities for new developments It is likely that these jurisdictions will require treatment of stormwater, probably sedimentation in vegetated basins Thus, any standards for detention basins should take account of the need to control peak flow and the quality of discharged stormwater

Action FM-1-1

Establish comprehensive and effective basin-wide stormwater drainage regulations for new developments

It is clear from the discussion above that the establishment of a comprehensive set of standards to minimize the adverse hydrologic effects of development is technically complex An intergovernmental committee will be established to consider the options and recommend an effective and equitable set of regulations for adoption by all jurisdictions within the watershed (see Action WS-1-1) The new standards will address

- Runoff calculation methods
- The characteristics and size of the design storm
- Coordination of design criteria for control of stormwater quantity and quality
- Differences in hydrologic development standards for different parts of watershed

HEC-1 hydrologic model developed as part of the RMP will be useful in testing the effectiveness of different standards

Action FM-1-2

Implement basin-wide development standards for stormwater drainage

Jurisdictions within the watershed will adopt the development standards established in Action FM-1-1 and incorporate them into their zoning and development regulations

OBJECTIVE FM-2

Reduce Flood Damage to Existing Structures.

The actions discussed above would limit future increases in peak flow, but would not reduce the flood risk to currently vulnerable properties To develop a flood management plan to protect vulnerable properties, the study consultants and the Flood Management

Task Group met regularly over a six month period Before proceeding with the development of specific flood control measures, two general issues were addressed by the consultants, the task group and the JCCC The first issue revolved around whether the displacement of existing homes and businesses should be considered as part of the flood management plan The Corps of Engineers have estimated that about 2,000 structures lie within the 100-year flood plain in the Johnson Creek watershed This is a result of past government practices that allowed construction in the flood plain For the last several decades local governments have prohibited or greatly restricted construction in flood plains as a way of preventing damaging floods. Consequently there are few vulnerable properties in Gresham, because much of that community's growth has occurred in the last 20 years when controls on development in the flood plain were in place Although flood damages could be greatly reduced by the public acquisition and removal of flood-vulnerable properties, the JCCC concluded that the compulsory purchase of homes and businesses should not be a part of the RMP The possibility of purchase of flood-vulnerable properties from willing sellers, as they become available, was retained and is described in Action FM-2-7

The second general issue considered was what level of flood protection the plan should provide It was becoming clear from early work by the consultants that provision of protection from very large floods, the 100-year flood for example, was not practically possible Protection from the 100-year flood could be provided by extensive channel improvements, construction of very large floodwater storage reservoirs, or by large-scale acquisition of vulnerable properties None of these approaches were deemed acceptable by the JCCC Also their cost would be very great, for example, the City of Portland estimates that the cost of acquiring all property in the flood plain within its city limits would be several hundred million dollars To further explore this issue, the study consultants held a series of meetings with local residents and neighborhood associations in the watershed During these meetings, local residents, particularly those living in the Lents neighborhood, indicated that their primary concern was the frequent floods which cause damage on a regular basis (i e , the 2- and 5-year floods) If flood reduction measures could prevent the more frequent floods, residents could accept the damage caused by larger, more infrequent floods Based on these views, the consultants developed a flood control strategy to address the more frequent floods

The first step in developing the strategy involved the analysis and prioritization of available flood control measures The measures which were considered are listed below in order of applicability to conditions in Johnson Creek and compatibility with other elements of the RMP, that is, the highest priority measures are listed first

- *On-stream Detention Basin* An embankment is built across the creek to form an on-stream detention basin No vegetation is removed in the detention area upstream of the embankment, it is left in its current natural condition Dry-weather flows and flows associated with small storm events pass through a culvert under the embankment without being detained During larger storm events (e g , 2-year or larger storms), the capacity of the culvert would be exceeded and excess water would accumulate in the detention basin

Floodwater would be temporarily stored in detention basins built on Johnson Creek and its tributaries in the upper watershed By delaying flow from the upper watershed, peak flows would be reduced in downstream reaches of the creek, including those currently subject to frequent flooding On average the on-stream detention basins would contain water for a day or two once every 2 to 5 years A sketch of an on-stream detention basin is shown in Figure 20

- *Off-stream Detention Basin* Off-stream detention basins consist of normally dry basins connected to the creek by weirs or culverts If creek flows exceed a certain value, excess water would flow over the weir into the detention basin Floodwater stored in the detention basin would be slowly released back to the creek after the flood has passed Peak flows would be reduced downstream of the detention basins Off-stream detention basins can be located at any point along the creek where adequate space is available Off-stream detention basins are more expensive than on-stream basins because they involve more complex and extensive earthwork and control structures

- *High-flow Bypass* Flooding occurs when the capacity of a creek channel is not large enough to convey the flow A high-flow bypass provides a second channel or conduit, thus increasing the total flow capacity During dry-weather flows and flows associated with smaller storm events, the creek remains in its original channel and the bypass channel is dry. During large storm events, both channels convey flow High-flow bypasses can be very effective in reducing localized flooding Their primary disadvantage is that they may simply transfer the problem downstream to another creek section where capacity may also be limited

- *Modification of Structures.* Bridges or other structures in the creek may constrict flow and cause or worsen upstream flooding The structures may be removed or modified, however, this may only transfer flooding problems downstream.

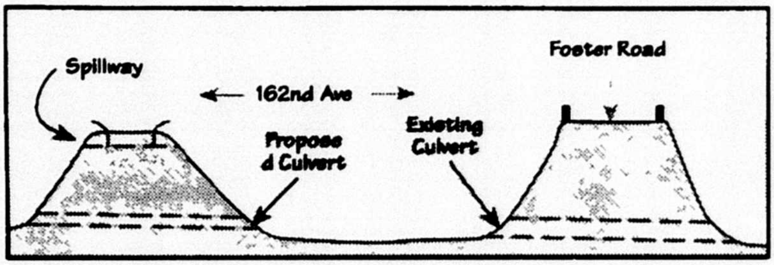
- *Dry Well Injection* Dry wells operate by discharging stormwater or flood waters directly into the ground There is some evidence to suggest that construction of large dry wells in the Lents area could relieve local flooding Excavations have shown that a thick layer of cobbles, ten to thirty feet thick, lies four to ten feet below the surface Dry wells could be used to inject overflow from Johnson Creek into this very permeable layer

One additional flood control measure, floodproofing, was also considered, but not included in the above list for several reasons Floodproofing is a method of modifying structures, currently subject to flooding, to eliminate or reduce damage Floodproofing includes raising structures on their foundations and sealing doorways and windows with temporary dams Floodproofing large numbers of structures is rarely cost-effective. Minor floodproofing may be appropriate when only a handful of structures are involved

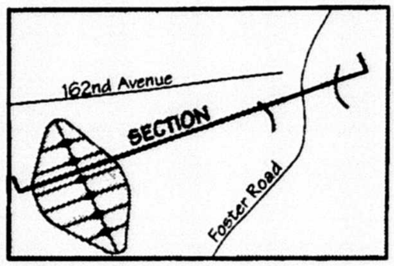
FIG 20

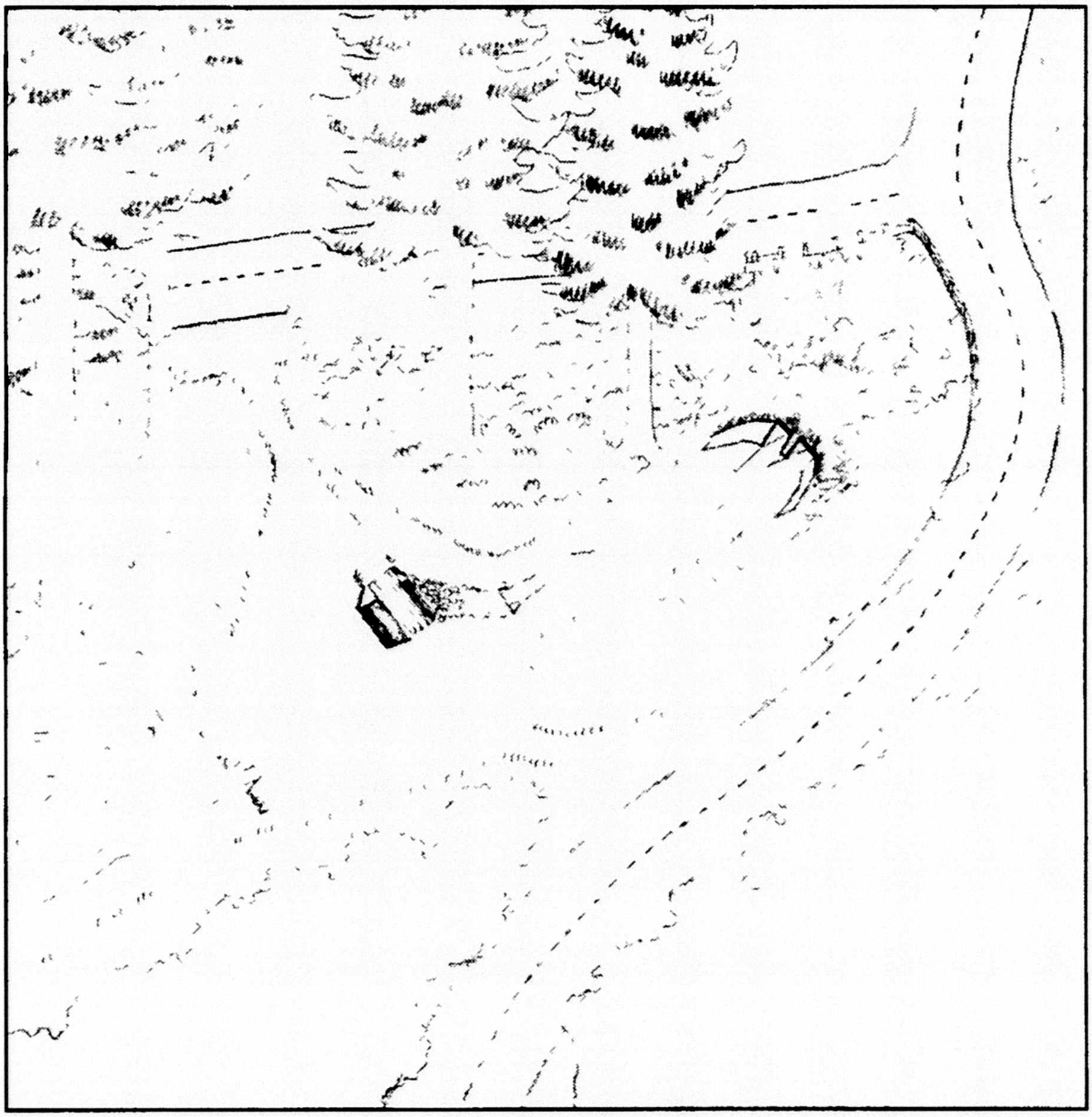
Perspective Sketch of Detention Structure

SECTION



LOCATION





Of the five options listed above, three, on- and off-stream detention basins and high flow by-passes, appear to be the most promising for the Johnson Creek watershed Dry well infiltration in the Lents area could play a part in a flood reduction plan, but it is currently unproven Although there is evidence that a very permeable layer of gravel lies just below the surface of the soil to the north of the creek in the Lents area, it is not clear whether this layer is hydraulically connected to Johnson Creek Also, it is not known whether groundwater levels rise in this permeable layer during wet periods, to the extent that drainage of flood water would be impossible or limited Preliminary studies by the City of Portland suggest this option is unpromising

Initially, it was thought that modification of bridge structures might reduce flooding on Johnson Creek substantially The HEC-2 hydraulic model was used to examine the effect of bridges on flood flow in the reach of the creek below river mile 12 The model showed that while some bridges are contributing to local flooding problems, they are not a major cause of widespread flooding Modification of some bridges would relieve local flooding here and there, and would reduce transportation disruption, but would not solve the more serious flooding problems The study consultants identified ten bridges that cause a local increase in water surface elevation of at least one foot in a 10-year return frequency storm Five structures were assigned the highest priority for action and the City of Portland is proceeding with plans to modify them They are the private bridge near S E Luther Avenue, the Portland Traction Company trestle near S E Ochoco Street, the S.E Ochoco Street bridge itself, the S E Stanley Street bridge and the S E Johnson Creek Boulevard bridge at S.E 45th Avenue

Action FM-2-1

Construct flood reduction facilities

The various flood reduction measures described above were assembled into several alternative flood reduction schemes The alternatives attempt to achieve a reasonable level of flood protection for existing structures, while retaining as much of the appearance and benefits of a natural creek as possible All alternatives would include the modification of the five bridge structures noted above, and minor channel improvements The minor channel improvements would involve clearing and trimming of mostly non-native vegetation to increase channel capacity in some reaches of the creek (see Actions FM-2-4 and FM-2-5)

- ALTERNATE A Construction of on-stream detention basins in the upper watershed with a total storage capacity of approximately 400 acre-feet Potential locations for detention basins are shown in Figures 21 through 24 The capacity of each detention basin is shown in Table 18

- ALTERNATE B. Construction of Alternative A, together with a flood relief channel in the Lents neighborhood east of Interstate 205 The relief channel would route a portion of the floodwaters around the most flood-vulnerable area The preferred location for the channel would convey floodwater across S E Foster Road to Beggars-tick Refuge, convey it in an open unlined channel along the edge of the Springwater Corridor, and return it to Johnson Creek under Foster

TABLE 18
Characteristics of On-stream Detention Basins*

Site	Maximum Water Surface Elevation (ft MSL)	Height of Structure (feet)	Storage Volume (ac-ft)
Kelley Creek above S E 162nd, lower site	295	30	84 5
Kelley Creek above S E 190th	440	35	38 5
Tributary below Hogan Rd , lower site	360	25	43 6
Tributary below Hogan Rd , middle site (existing Cedar Lake)	368	27	26 5
Tributary below Hogan Rd , upper site	395	25	50 0
Tributary near Hillview	440	15	145 0
	TOTAL VOLUME		**426.2**

Note Final sites for the on-stream detention basins have not been selected The sites listed in the table would provide the required volume of storage These sites, and others, continue to be evaluated

Road As a less-desirable alternative, the capacity of the existing culvert pipe, which runs along Foster Road from S E 112th Avenue to S.E 108th Avenue, could be increased and its outfall relocated beyond S.E. 106th Avenue

- ALTERNATE C1. Construction of all elements of Alternatives A and B, together with off-stream storage in the Lents neighborhood, east of Interstate 205 The off-stream storage facilities would have a capacity of 660 acre-feet They would be located on the Freeway Land Company site The storage facilities would be designed for multiple use, combining flood reduction with wildlife habitat and recreation facilities

- ALTERNATE C2. Alternative C2 would be the same as Alternative C1, except that the off-stream storage facilities would have a capacity of 200 to 600 acre-feet. They would be located on several parcels north of the creek, in the vicinity of Beggars-tick Refuge, and south of the creek near Brookside Drive and on portions of the Freeway Land Company property

- ALTERNATE D. Alternative D would include the same upstream storage facilities as Alternative A, and the same off-stream storage facilities as Alternative C2 It would not include a flood relief channel at Lents

The effects of each of the alternatives were examined using the hydrologic and hydraulic models Alternative A offers the advantage that it provides a moderate level of flood protection to all downstream areas It produces some reduction in flood flows along the entire length of the stream channel downstream of the detention basins. In no instance does it produce an increase in flow relative to the no action condition.

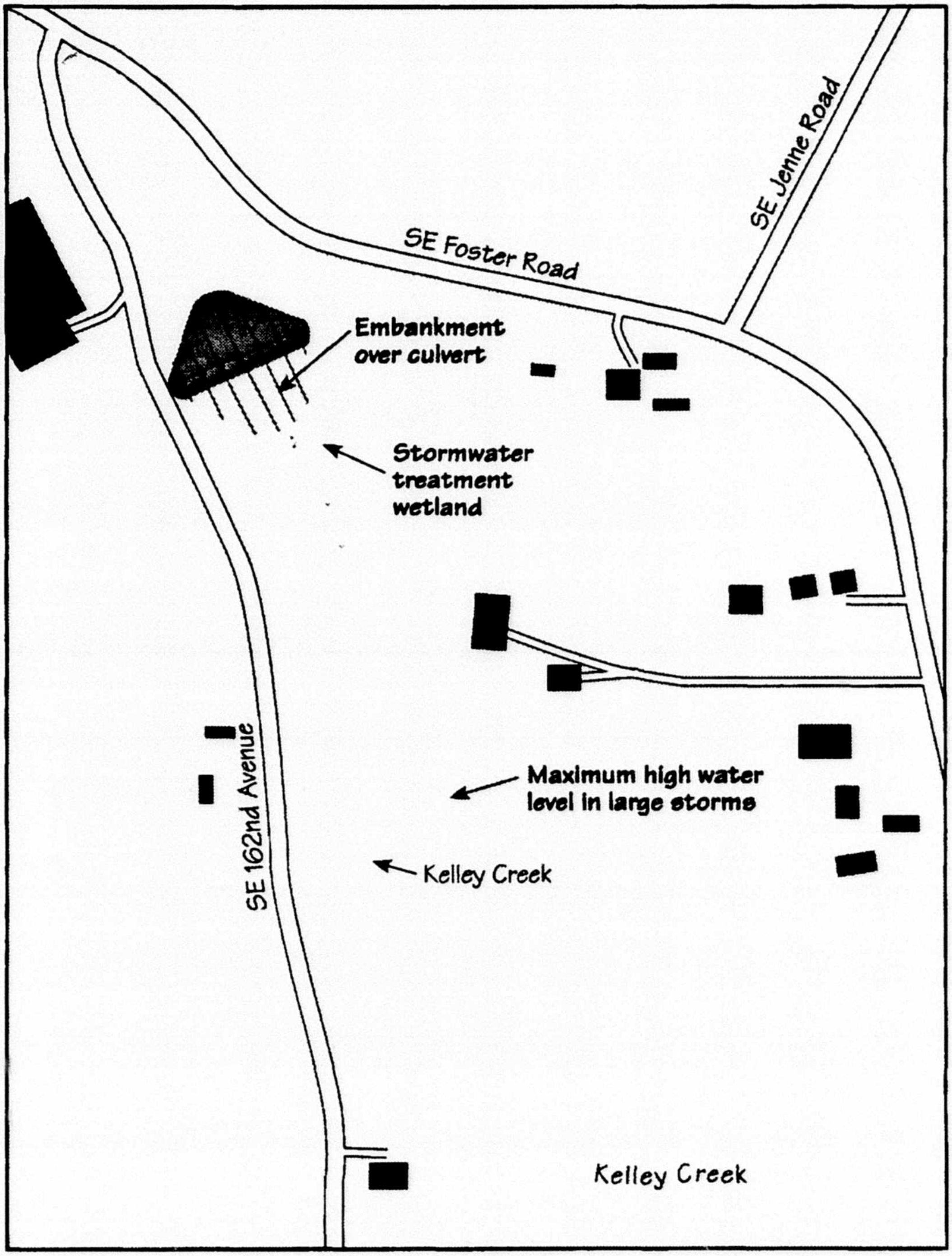
Alternative B would provide a greater level of flood protection to the Lents neighborhood upstream of Interstate 205 than would Alternative A. The flood relief channel at Lents would route a portion of flood flow around a reach of the creek which has very limited capacity. Alternative B would provide less flood relief to areas downstream of Lents than Alternative A. This is because the flooding that currently occurs in the Lents area protects downstream areas from flooding (see earlier discussion of historic flooding). The flood relief channel would prevent some of the floodwater from going into storage in the Lents area and would route it rapidly downstream. Under Alternative B, and viewed from the perspective of the areas downstream of Lents, the beneficial effects of upstream storage would be partly cancelled out by the effects of the flood relief channel in small- and medium-sized storms During large storms, 50-year return period and larger, the effects of the flood relief channel would more than cancel out the beneficial effects of upstream storage, downstream flow would be increased above the no project condition

Alternative C includes the components of Alternative B and off-stream storage at Lents. It is similar to Alternative B in that it provides a greater level of flood protection to Lents, but it also seeks to offset the adverse downstream effects of Alternative B by providing additional storage The off-stream storage at Lents would replace some of the inadvertent flood storage that now occurs in the same general area, and would wholly, or partly, counteract the effects of the flood relief channel Two versions of this alternative were developed. Alternative C1 includes sufficient off-stream storage capacity, 660 acre-feet, to wholly counteract the effect of the flood relief channel The only single site in the Lents area that can accommodate such a large storage facility is the Freeway Land Company site However, use of the Freeway Land Company site for floodwater storage is in conflict with the Outer Southeast Community Plan The Outer Southeast Community Plan reflects the community's desire to use the site for employment generation. Because the feasibility of Alternative C1 is in doubt, Alternative C2 was developed Under Alternative C2, the off-stream storage at Lents would be located at a number of smaller sites It is not clear how much storage can be developed in this way. For the purposes of the analysis, it was assumed that a minimum of 200 acre-feet could be developed at four or five sites. Modelling indicates that the storage included in Alternative C2 would partly counteract the effects of the flood relief channel However, during large storms (50-year return period and greater), Alternative C2 would still increase flows downstream of Lents relative to the no project condition, but by a smaller margin than Alternative B

The fact that Alternatives B and C2 result in increases in downstream flood flows may make them impossible to implement Even though the increases are relatively small, they could raise difficult-to-resolve legal liability issues Like Alternative C1, Alternative D was devised to provide increased flood protection in the Lents area without increasing downstream flood flows. It is similar to Alternative C2, except that it does not include a flood relief channel Like Alternative A, it would produce flood reduction benefits along the entire length of the stream. Flood protection in Lents would be enhanced by routing some flood waters to local off-stream storage, but no attempt would be made to by-pass flow around the area.

FIG 21

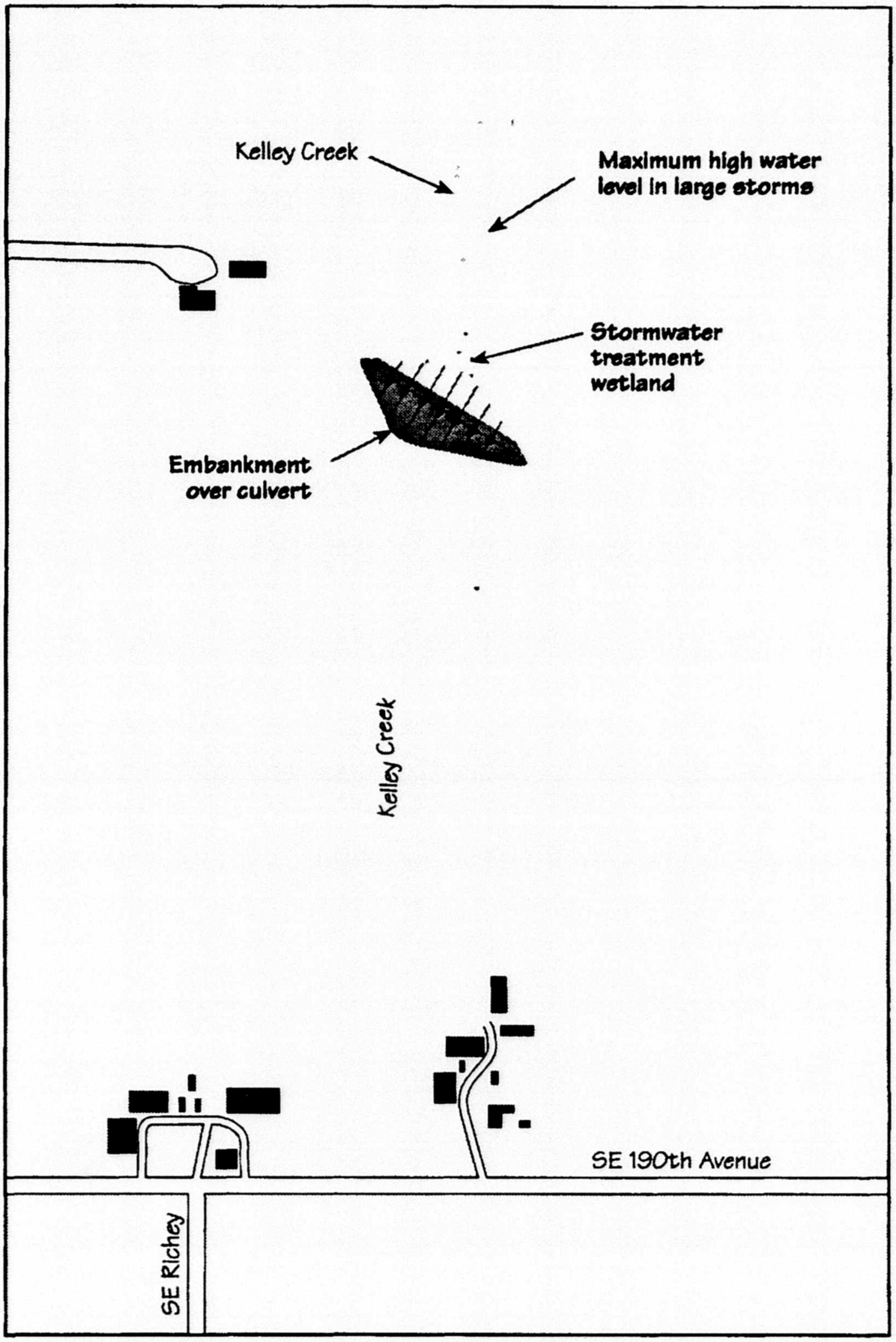
Detention Site on Kelley Creek Between 162nd Avenue and Foster Road



Note Detention basins will only fill during storms larger than the two-year return period event

FIG 22

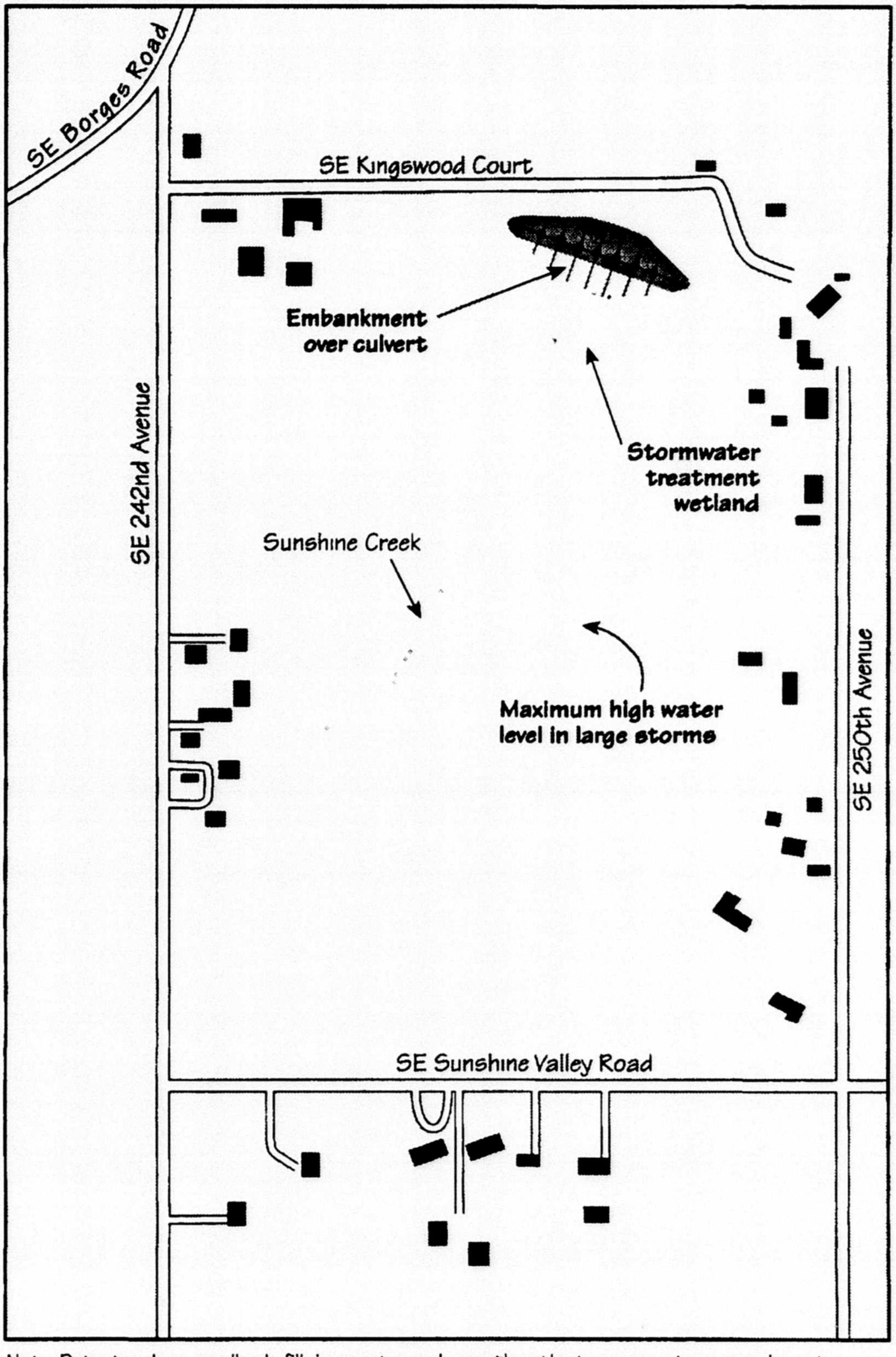
Detention Site on Kelley Creek at 190th Avenue



Note Detention basins will only fill during storms larger than the two-year return period event

FIG 23

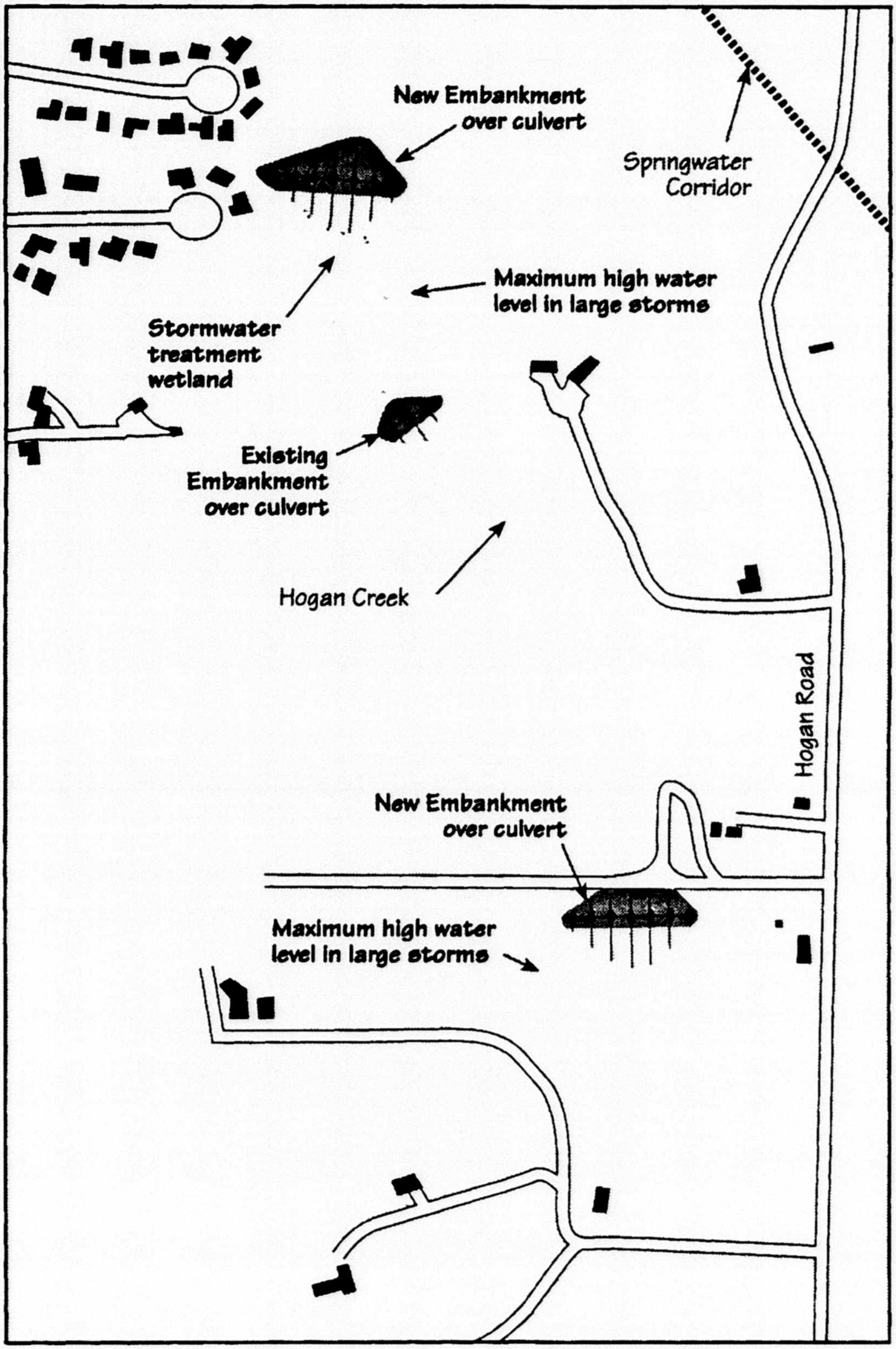
Detention Site at Hillview



Note Detention basins will only fill during storms larger than the two-year return period event

FIG 24

Detention Site at Hogan Road



Note Detention basins will only fill during storms larger than the two-year return period event

An alternative was considered that included off-stream storage and a flood relief channel at Lents, but no upstream storage. It was not evaluated in detail because of the difficulties in obtaining sufficient storage at Lents to counter the effect of the flood relief channel on downstream properties

The monetary costs and benefits associated with the flood reduction alternatives are shown in Table 19. Alternative A would cost $7 million and would reduce flood damage costs over a 50-year period by approximately $28 million. It is clear that, over a 50-year life, Alternative A would return benefits considerably in excess of its costs. The benefits of Alternative B are more difficult to estimate but they, too, clearly exceed costs Under Alternative B, flood damage downstream of Lents would be slightly greater than under Alternative A On the other hand, flood damage at Lents would be decreased by an indeterminate amount The benefit-cost ratio for Alternative B is clearly positive

The benefit-cost ratios for both Alternative C2 and Alternative D are close to one. However, the benefits are underestimated somewhat, and so both alternatives would be expected to yield a positive benefit-cost ratio.

The flood reduction alternatives would produce some non-monetary benefits. The upstream detention basins that are a part of all alternatives would serve multiple purposes in that they would reduce flooding, improve water quality and preserve open space A disadvantage of the detention basins is that property would be removed from the tax rolls Also some believe that the dams would represent a barrier to migration of fish and other animals using the stream corridor Others believe that problems associated with wildlife migration can be solved by careful design of the structures. The off-stream detention basins would also serve multiple purposes Depending on the

TABLE 19

Costs and Benefits of Flood Management Alternatives[a]

Alternative	Estimated Capital Cost ($ million)	Avoided Damages[b] ($ million)	Benefit/Cost Ratio[c]
A	7	28	1 7
B	8	>28	>1 6
C2	14	>28	>1 0
D	13	>28	>1 0

Note

a Information in this table is based on conceptual level facility plans

b For 50-year period

c Based on present value of cost and benefits assuming a 50-year useful life for flood reduction facilities and a four-percent discount rate design ultimately chosen, the off-stream basins would benefit water quality, wildlife habitat and recreation

After thoroughly reviewing the alternatives, the JCCC selected Alternative C2, with the qualification that it be built in stages. The storage components of the alternative will be built first The flood relief channel will not be built until it is clear that it will not increase downstream flood damage. This assurance would be provided by developing sufficient storage in the Lents area to prevent an increase in downstream peak flow, or by property acquisition and flood proofing in the flood-vulnerable downstream areas.

Action FM-2-2

Draft and adopt "balanced cut and fill" standard

Current FEMA regulations define two flood zones. the floodway and the floodway fringe. A floodway is the part of the 100-year flood plain which must be kept clear of fill or other obstructions in order to convey the 100-year flood without an excessive increase in flood elevations. The floodway fringe is the portion of the 100-year flood plain outside of the floodway which may be developed if the fill does not cause the 100-year flood elevation in the floodway to rise more than one foot (Figure 25). If a developer or creekside resident can show that fill in the floodway fringe will not increase the upstream 100-year flood elevation more than one foot, then development is allowed.

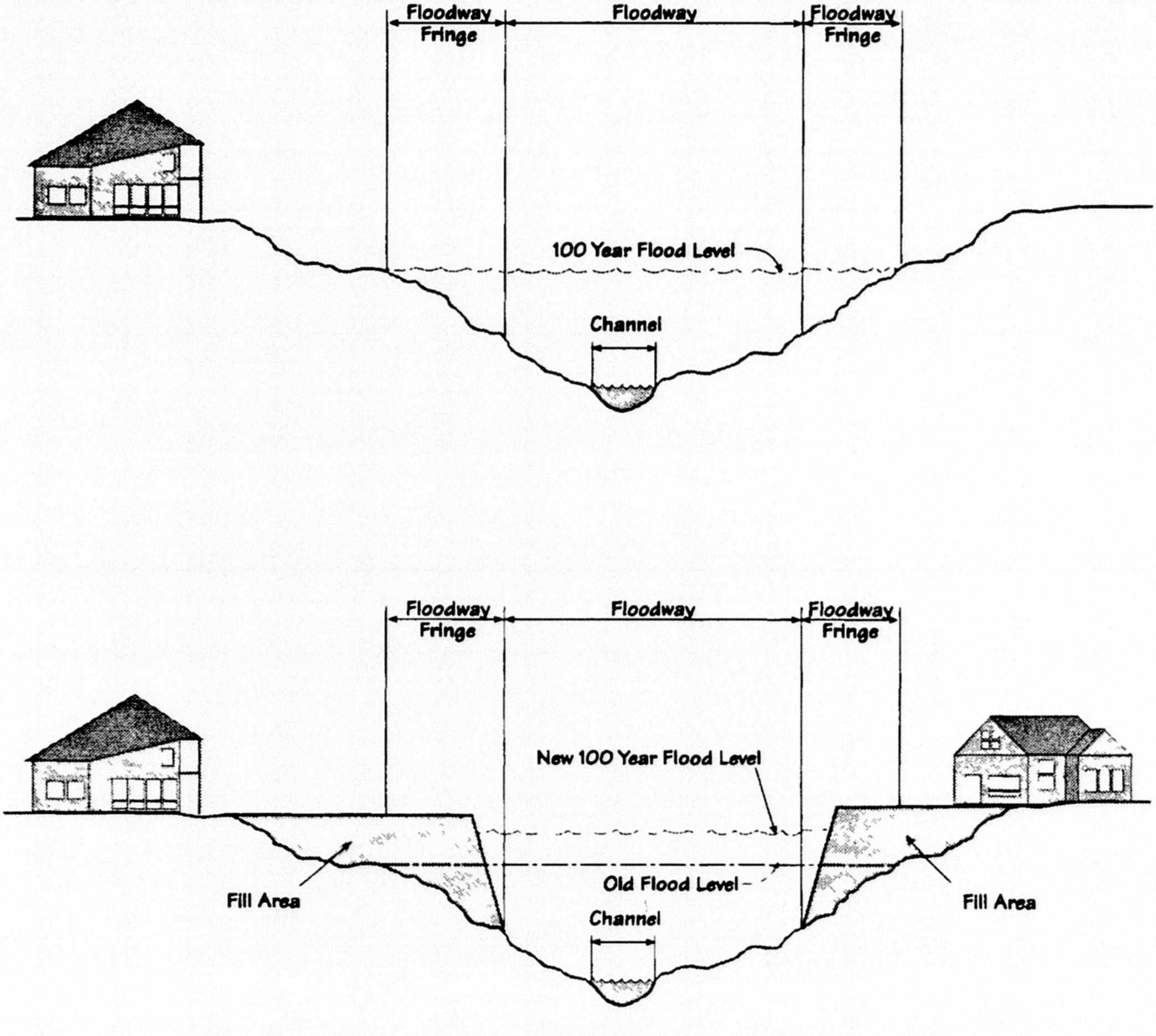
In the Johnson Creek watershed, a considerable amount of fill and development has occurred within the 100-year flood plain Although each individual occurrence may have met the requirements under FEMA regulations, the cumulative effect has been to increase flood elevations to unacceptable levels because fill displaces floodwater storage which in turn increases local flood water levels and downstream peak flows.

Due to similar concerns that FEMA regulations may allow unacceptable increases in peak flows and flood elevations, the Unified Sewerage Agency (USA) of Washington County has already adopted modified flood plain design standards Referred to as the "Balanced Cut and Fill Standard," USA requires that all fill placed on a parcel within the 100-year flood plain is balanced by an equal amount of soil removal from the 100-year flood plain on the same parcel No net fill within the 100-year flood plain is allowed Restrictions are placed on location, areal extent, and grade of the excavation and its depth in relation to the winter "low water" elevation. For each proposed "cut and fill," the location of the cut, its effectiveness for offsetting the amount of fill, and its environmental impacts need to be carefully considered The balanced cut and fill rule would not apply to properties destroyed by fire, flood, or other similar cause.

Immediate implementation of a new rule similar to USA's would have minor effects in the Johnson Creek watershed except in the Lents-Powellhurst neighborhood There are many undeveloped lots in the 100-year flood plain, as currently defined, in the Lents-Powellhurst neighborhood A new "Balanced Cut and Fill" rule would make many of these lots unbuildable.

FIG 25

Flood Plain Before and After Filling Floodway Fringe



The 100-year flood plain in the Lents area was mapped by the Corps of Engineers as part of the 1980 Multnomah County Flood Insurance study The mapping was based on a relatively crude hydraulic model of Johnson Creek The more refined hydraulic model now available indicates that water surface elevations in a 100-year flood would not be as high as predicted by the Corps In addition, filling that has occurred since 1980 has altered some of the drainage patterns in the area. It is now apparent that the 100-year flood plain at Lents is smaller than predicted by the Corps. Thus, to avoid unjustified restrictions on certain lots, the new "Balanced Cut and Fill" rule should not be imposed until the 100-year flood plain is remapped

The cities and counties within the watershed will adopt a "Balanced Cut and Fill Standard," similar to USA's standard, to prevent further fill and development within a redefined 100-year flood plain. Until the flood plain is redefined, Portland will carefully review all proposals to build in the floodway fringe in the Lents area to ensure that the proposals will not increase flood water levels

Action FM-2-3

Redefine 100-year flood plain

To change the 100-year flood plain it is necessary to file an application with FEMA The hydrologic and hydraulic information that is the basis for the change must be detailed and must follow a prescribed format The cities and counties in the watershed will conduct the necessary studies and request changes in the 100-year flood plain The changes are most urgent in the city of Portland because many properties lie within the 100-year flood plain in that jurisdictions

Simply remapping the flood plain in the Lents-Powellhurst area could have considerable economic benefits It is likely that some homes and unbuilt lots will no longer be in the 100-year flood plain. This will result in reduced insurance costs and appreciation in property values.

Action FM-2-4

Establish channel maintenance practices handbook

The proposed flood management facilities will only be effective if the hydraulic capacity of the creek is maintained Channel maintenance practices must be designed to meet the multiple objectives of the RMP flood management, water quality improvement, and fish and wildlife habitat improvement In order to achieve a reasonable balance between these needs, channel maintenance needs to be performed carefully.

The principle of conducting maintenance based on performance is that maintenance will not be required as long as adequate channel capacity is maintained For each section of Johnson Creek, a target range of channel capacities, with an upper and lower limit, will be determined using HEC-2 (the hydraulic model). The lower limit will be based on potential flood damages, the upper limit on compatibility with fish and wildlife habitat Maintenance will be performed on a section of the creek when the hydraulic capacity reaches the lower limit of the target range Channel maintenance will be limited to only those low impact practices required to achieve the upper limit of the target capacity range. The section then will be allowed to evolve and mature naturally until the lower limit of the target capacity range is again reached.

An evaluation of channel performance will be conducted annually to determine when and where channel maintenance is necessary The annual inspection team will include a hydrologist, an ecologist, wildlife and fisheries biologists, and a representative of the WMO. The annual evaluation will consist of updating the channel cross-sections in HEC-2 with visual observations (to update estimated roughness) and surveying significant sediment deposits. The photographs of each typical section taken by the surveyors during the summer of 1993 will be useful for updating the estimated roughness of each section Based on the updated cross-sections, HEC-2 will be used to determine the current capacity of each section of the creek The schedule for channel maintenance will be determined in consultation with the fisheries and wildlife biologists to minimize disturbance during important migratory or nesting seasons for fish and wildlife.

Where unacceptable decreases in hydraulic capacity of the creek have been identified, channel maintenance will be conducted according to the following guidelines.

1. Labor intensive methods will be used to thin and remove vegetation and to remove channel obstructions.

2. The use of herbicides for vegetation management will be minimized

3. Riparian trees on the top of both banks will be allowed to grow to maturity to provide maximum shading of the creek channel and to reduce the density of understory vegetation.

4 Sediment removal will be performed only when thinning or removal of vegetation is insufficient to reach the upper range of the target channel capacity. Access to the creek channel, if needed, will be made from the north bank to minimize destruction of shading. Access points will be a maximum of 25 feet wide. Replanting of the disturbed vegetation with native species identified in Actions FW-2-1 and FW-2-2 in the Fish and Wildlife Habitat Improvement Plan Element will be required If direct crossing of the creek channel occurs, the creek bed will be repaired based on standards provided by the fisheries biologist.

5. Routine maintenance will be limited to the removal of inorganic debris and garbage

Initial costs for channel maintenance based on performance criteria will be higher than traditional channel maintenance practices, however, the long-term goal is to significantly reduce costs associated with channel management. To reduce costs associated with the above practices, vegetation management and routine removal of debris and garbage will be coordinated with volunteer efforts as described in Watershed Stewardship Plan Element, Action WS-2-3 (Support Volunteer Creek

Improvement Projects). The cities and counties could provide the equipment and means of disposal while the volunteers could perform the labor

An intergovernmental committee will be established to develop a channel maintenance practices handbook for the watershed.

Action FM-2-5

Maintain channel according to channel maintenance practices handbook.

The jurisdictions within the watershed will adopt the channel maintenance practices handbook developed in Action FM-2-4. They will also request private landowners to maintain the channel on their land in accordance with the handbook or provide the cities and counties with easements so that the latter can maintain the channel.

Action FM-2-6

Establish emergency response team and procedures to minimize flood damage

During the flood event which occurred on February 24, 1994, the City of Portland provided sand and sandbags to residents in the Lents and Powellhurst neighborhoods for use in protecting their homes and businesses from floodwater Although the sand and sandbags were helpful, delivery was delayed due to an uncertain decision-making process and the need for mobilization time In order to speed up the response time during future flood events, a multi-jurisdictional emergency response team will be organized During a flood event, the emergency response team will coordinate the activities of city or county personnel

Specific procedures will be developed for the emergency response team. The emergency response plan could include.

- Prompt notification of potential flood conditions for residents in flood prone areas (e.g , announcements on local radio stations, police PA announcements)

- Storage of materials for emergency response near flood-prone areas for immediate availability (e g , sand and sandbags for temporary floodproofing of homes and businesses)

- Closure of flooded streets by police to prevent joyriding in four-wheel drive vehicles which increases damage to flooded properties

Action FM-2-7

Acquire properties vulnerable to frequent flooding as they become available

Current thinking in engineering and planning circles is that construction within the 100-year flood plain should be avoided if possible This approach reduces the risk of flood damage and avoids the need for construction of expensive and environmentally damaging flood reduction facilities It is the approach adopted by the City of Gresham, where the bulk of the 100-year flood plain is in public ownership and construction within it is prohibited Because the westerly portions of the watershed were developed

many years ago, they reflect an earlier planning philosophy that allowed development in the flood plain and assumed that residents would either tolerate periodic flooding or that any problems could be corrected by drainage improvements.
Currently there are about 2,000 homes and businesses in the 100-year flood plain of Johnson Creek downstream of S E 158th Avenue (The number may be reduced somewhat when the 100-year flood plain is redrawn as discussed in Actions FM-2-3 and FM-2-4.) The measures proposed in Action FM-2-2 of this plan will greatly reduce the vulnerability of existing structures to frequent flooding However, for several reasons, it may be in the public interest to gradually acquire land and property within the flood plain Public ownership of the flood plain would allow the demolition of existing structures and the setting aside of the land for flood conveyance purposes. It would also allow a more comprehensive restoration of wildlife habitat within and adjacent to the riparian corridor. Furthermore, the recreational value of the Springwater Corridor Trail would be enhanced by its proximity to more natural areas.

The Johnson Creek Corridor Committee has decided against condemnation as a means of implementing the RMP. Acquisition of property by public agencies within the flood plain will only be considered where there is a willing seller Properties most vulnerable to flooding, that is, those within the 10-year flood plain, should be given the highest priority for acquisition Properties acquired by public agencies in residential neighborhoods should be properly managed to avoid neighborhood blight as a result of unoccupied property. Eventually, when sufficient property has been acquired, the flood plain could be restored to a natural condition

FISH AND WILDLIFE HABITAT ENHANCEMENT PLAN ELEMENT

INTRODUCTION

Waterways play a key role in the natural environment The number of species found in and around rivers and streams far exceeds those found in the neighboring uplands Stream corridors and associated uplands contain a diversity of micro-environments that provide habitat for birds, mammals, reptiles, amphibians and fish Some of these species live permanently in the stream corridor while others visit it periodically for food, water, and cover. Because of the stream corridor's importance to fish and wildlife, its pollution or degradation can have a disproportionately serious effect on the ecology of an entire watershed One of the primary goals of the RMP is to improve fish and wildlife habitat in the Johnson Creek corridor within the broader context of watershed-wide habitat improvement

Development of the Johnson Creek watershed has had a profoundly adverse effect on the creek system, the riparian corridor, and associated uplands. The downstream or lower reaches of the creek channel were rock-lined in the 1930s to reduce flooding The rock-lining project not only destroyed streamside vegetation, but also confined the stream within a channel eliminating its ability to wander within the floodplain and destroying the aquatic and riparian habitats created by the stream's sinuosity Although lack of maintenance of the channel has allowed some vegetation to become established on the streambanks, it is far from a fully functional natural environment Clearing and development of upland areas have reduced the extent and value of wildlife habitat, accelerated soil erosion and diminished summertime stream flow. The stream itself has been subject to siltation and water pollution limiting its value as habitat for fish and other aquatic life

Despite these great changes, Johnson Creek and its watershed remain important for wildlife Enough streamside vegetation exists to provide a corridor for wildlife movement, a remnant salmonid fish population still persists, beaver flourish and a few mink inhabit the least developed stream reaches, and frogs and salamanders take advantage of side channels and ponds In the uplands, forested buttes continue to provide homes for birds and mammals. However, it is not clear whether what remains can be preserved in the face of continuing development pressures Without decisive action the wildlife habitat value of the creek corridor and uplands is likely to slip away, bit by bit, as new homes displace natural areas. The purpose of this element of the RMP is to change this trend, to stop the progressive deterioration and loss of wildlife habitat and to begin its gradual restoration.

Wildlife habitat enhancement provides benefits to humankind as well as wildlife Shady riparian corridors provide a quiet place for passive recreation Forested uplands lower ambient air temperatures and provide privacy for people living nearby Tree and shrub roots stabilize steep slopes and reduce soil erosion and landslide potential Wetlands filter pollutants from stormwater runoff and allow flood waters to spread across the flood plain without causing damage. And many people enjoy the opportunity to observe wild birds and animals close to home

A three step process was used to develop the fish and wildlife habitat enhancement element of the RMP First, an assessment was made of the current condition of fish and wildlife habitat within the watershed, next, the factors that limit the value of the habitat were identified and analyzed, and finally, a plan was developed to improve habitat quality. The terrestrial and aquatic environments, although obviously functionally-linked, are discussed separately below

VEGETATION AND WILDLIFE

Vegetation, wildlife habitat and wildlife populations in the Johnson Creek watershed have been greatly altered since the beginnings of European settlement in the mid-nineteenth century Extensive old growth coniferous forests were cut for timber and the fertile lowlands cleared for agriculture. Later, small residential communities were established along a commuter railroad, ultimately growing to form the present urban and suburban communities Today, the watershed is a mosaic of agricultural lands, urban and suburban landscapes, upland forest, riparian woodland and wetlands. Remnants of pre-development vegetation are rare and consist mainly of isolated mature trees scattered throughout the watershed. Vegetation in undeveloped areas is primarily at a relatively early stage of recovery from disturbance It remains far from the condition that might prevail in a stable, undisturbed natural vegetative community

HISTORIC LANDSCAPE AND WILDLIFE

Prior to European settlement of Multnomah and Clackamas counties in the mid-19th century, the landscape was a mixture of terrestrial and aquatic habitats including upland and wetland forests, prairies and shrublands, creeks, rivers, and marshes The Johnson Creek watershed was dominated by extensive stands of mature and old growth conifer and mixed conifer-deciduous forests Overstory trees in the uplands included western hemlock, Douglas-fir, grand fir, western red cedar in the wetter sites, big-leaf maple, and oaks on south-facing slopes Vegetation occurred in several layers and included young conifer trees (mostly hemlock and cedar which are shade tolerant), shrubs, such as hazel, vine maple, rose, and huckleberry, and herbaceous plants, such as oxalis, bunchberry, inside-out flower, fringe cup, and others Where floods or fire had formed natural openings in the forest canopy, Douglas-fir, big-leaf maple, huckleberry, salal, thimbleberry, and bracken fern would have been the likely early colonizers Red alder, big-leaf maple, willows, red-osier dogwood, vine maple, salmonberry, and sword fern would have colonized the riparian areas providing nutrients and soil for the conifer stands that would succeed them.

The broader lowland areas, typically defined in modern terms as the 100-year return period floodplain, supported black cottonwood forests, which often included dense understories of willows. Oregon ash/slough sedge wetland forests were also found in the flatter streamside areas where water was seasonally perched and flows were sluggish

Early survey maps show an extensive marsh system located along the lower three miles of Johnson Creek and throughout the Crystal Springs basin The marsh system was likely a mixture of cover types with skunk cabbage wetlands in places, scrub/shrub willow habitat, cottonwood/willow stands, and open water The marsh habitat likely supported rich and varied wildlife populations Abundant insects provided a prey base for amphibians (spotted and red-legged frogs), reptiles (western pond and painted turtles), and resident and anadromous fish, such as cutthroat trout, sculpins, salmon and steelhead Ducks and geese nested and overwintered in these food rich habitats, and predators such as fox, coyote, and raccoon would hunt there. Marshes and wetland forests likely existed in other flat areas such as the broad floodplain area south of Powell Butte

Trees killed by lightning or disease or other natural causes would fall into creeks and wetlands providing instream protective cover for fish and egg laying habitat for frogs and salamanders Downed logs within the forests provided habitat for insects and salamanders, denning places for foxes and bobcat, and foraging places for pileated woodpecker and raccoons Standing dead trees provided cavities for nesting woodpeckers and other birds, insects for wildlife food, and perches for large birds of prey, such as red-tailed hawk and bald eagle.

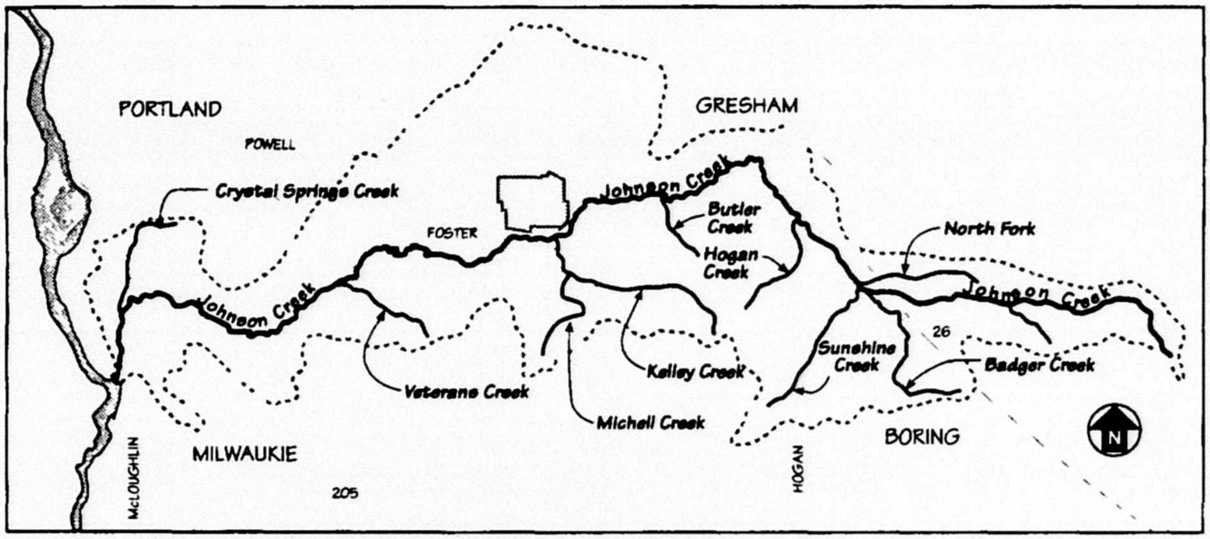
The mixture of terrestrial and aquatic habitats within the watershed supported the necessary functions of reproduction, rearing, territory, and travel for a variety of wildlife species. Bear, elk, deer, muskrat, beaver, otter, mink, cougar, bobcat, gray wolf, salmon, steelhead, cutthroat trout, and lamprey probably all existed in the watershed prior to 1900. The first habitats to be lost were timbered lands, cleared for shipping and farming Creeks and marshes were initially avoided by the early European settlers because they lacked the technology to drain them Consequently, these habitats were still plentiful until about 1920 By the mid-1930s, most of the marsh land within the watershed was drained for housing and agricultural development Of the estimated thirty or more large and small creek systems and their attendant marshes identified by the early surveyors within Multnomah County, less than a dozen still remain in an above-ground, free flowing or partially free flowing state

EXISTING VEGETATION AND WILDLIFE

Several natural resources surveys of Johnson Creek have been made in the last five years They include wildlife and vegetation inventories to determine the presence of local and migratory wildlife and to identify habitat types The surveys were conducted for METRO's Greenspaces Program and for the City of Portland Planning Bureau, among other jurisdictions They, together with new surveys conducted as part of the RMP process, provided the informational basis for the description that follows (see Technical Memorandum No. 7 for a complete description of survey methods and results) A map of the creek and its major tributaries is shown in Figure 26.

FIG 26

Johnson Creek and Tributaries



Currently, streamside, or riparian, vegetation along Johnson Creek and its tributaries, is dominated by red alder, big leaf maple, western red cedar, and hawthorn with black cottonwood, Oregon ash, and willows in the wetter sites Douglas-fir is common in the uplands adjacent to the creek. Common native shrubs include snowberry, elderberry, Indian plum, hawthorn, and red osier dogwood, but introduced species, such as Himalayan blackberry and holly, overwhelm natives in many sections of the creek Herbaceous vegetation includes native species such as lady fern, sword fern, trailing blackberry, small-fruited bulrush and introduced species such as English ivy, thistles and various grasses Lawns and crops often extend to the creek bank. Some wet areas have been colonized by the very invasive non-native reed canary grass.

■ MAINSTEM OF JOHNSON CREEK

Long sections of the mainstem of Johnson Creek from its mouth at the Willamette River to S E 158th Avenue were rock-lined in the 1930s The rock-work has not been maintained, but remains in good condition, for the most part Although vegetation has grown over and through it in many places, the rock-work continues to exert a profound influence on creek bank vegetation

From its mouth to the S.E Tacoma Street bridge at river mile 1 6, the creek flows through densely developed industrial, commercial and residential areas. In some sections, riparian vegetation is completely lacking, having been replaced by buildings or parking lots Where trees exist, the remnant riparian forest is dominated by red alder saplings with few shrubs Himalayan blackberry occurs as a dominant shrub within forested habitat and in monocultural stands where trees are wholly lacking. Stream shade is limited and the creek corridor is subject to much human disturbance A short section of creek, near the confluence with Crystal Springs Creek and within Johnson Creek Park, is not rock-lined.

Just east of the S.E. Tacoma Street Bridge, the creek enters a lightly-developed canyon which includes Tideman Johnson Park at its easterly end   Most of this section of the channel is not rock-lined   The corridor of riparian and upland forest is broader here and dominant trees include Douglas-fir, western red cedar, big-leaf maple, with a shrub layer of both native and non-native species. Native herbaceous (non-woody) plants also exist in these broader forested areas and include such species as piggyback plant, spring beauty, and ducksfoot.

Upstream of S.E Johnson Creek Boulevard at river mile 3 2, the creek traverses an area of mixed residential, commercial and industrial land uses that extend to Interstate 205 at river mile 6 4   Although the area is less densely developed than the downstream reaches, the creek is largely bordered by landscaped yards, parking lots and buildings. Vegetation is generally sparse, shade is lacking and the banks of the creek are almost continuously rock-lined. There is, however, a small forested area adjacent to the creek at S E. 86th Avenue.

East of Interstate 205, there is a greater variety of habitat types   Just east of the highway, at the partially-developed Freeway Land Company site, habitats include emergent wetland, upland shrub/scrub and wetland and upland forests. Native trees, shrubs, and herbs are present together with the ubiquitous Himalayan blackberry, in both open and forested areas. The creek banks themselves are covered with blackberry and willow   East of the Freeway Land Company site, the creek meanders through a flat residential area where the riparian corridor is narrow and bordered by landscaped yards

At S.E. 112th Avenue (river mile 8 1) the creek enters a canyon where the tree canopy broadens and the creek banks are not rock-lined   Although trees are numerous in the canyon, lawns and cleared areas still exist in the understory   Dominant trees here include large and older western red cedar, big-leaf maple, western hemlock, grand fir, and larger red alder   Native plants are fairly common, interspersed with introduced landscaping trees such as ornamental cherry. Snag trees, suitable for hole-nesting birds, are present and the creek is joined by a number of small feeder streams that connect the riparian corridor to other densely-vegetated uplands   The canyon extends through Leach Botanical Gardens to near the intersection of S E Foster Road and Barbara Welch Road. From this intersection to S.E 158th Avenue, the creek follows S E Foster Road and the northerly toe of a densely-vegetated hillside   Rural homes, some on large lots with pastures, border this section of the creek   Although riparian trees are numerous, much of the understory has been cleared   This section of the creek is the last of the rock-lined sections   Creek banks are largely natural upstream of S E 158th Avenue (river mile 11.3).

Upstream of Johnson Creek's confluence with Kelley Creek at river mile 11 4, the valley bottom between Powell Butte and the highlands to the south becomes wider   The creek passes through an area of large rural lots and small farms   In some places, upland shrub/scrub and wet meadow habitats exist, vegetated by native willows and a mixture of native and non-native grasses and flowering plants   Himalayan blackberry and reed canary grass are the non-native dominants in these habitats. Pastures of non-native grasses extend to the top of the creek bank in some locations. As a whole, the area lacks structural diversity and, consequently, its wildlife habitat value is low

From Jenne Road at river mile 12.0 east to Highland Road at river mile 13.0, the mainstem creek corridor passes through or near several types of habitats At river mile 12.0, the creek corridor consists of a narrow band of sapling alder trees with scattered shrubs of wild rose and Himalayan blackberry with open grassy areas to the creek At the S E 174th Street crossing, the creek passes through upland shrub/scrub habitat and a wet meadow area. Himalayan blackberry dominates in both habitat types, but some areas possess native red osier dogwood and Pacific ninebark shrubs Grasses include reed canary grass and other exotic plants. While this area may be dominated by several non-native plants, it is linked to the creek and other upland habitats in several directions, improving its overall value to wildlife.

From Highland Road at about river mile 13 0 to the Pleasant View Avenue crossing at river mile 13, streamside vegetation includes an upland forest of Douglas-fir and western red cedar that are mostly 60 to 75 years old Some trees may be approaching 100 years of age. The shrub layer contains many native species, such as snowberry and Indian plum and is generally well developed, although Himalayan blackberry and English ivy exist throughout the area At Cedarville Park, shrubs are mostly absent, but there are several snag trees which provide nesting and foraging habitat for birds

From just east of the Pleasant View Street crossing to river mile 13 9, just beyond the mouth of Butler Creek, the streamside vegetation changes to a wetland forest consisting mostly of 15- to 20-year-old alder and extensive stands of Himalayan blackberry. From here upstream to Towle Road at river mile 14.8, the creek corridor is vegetated by an upland forest of 60-year-old alder with some cedars. This area of the Johnson Creek riparian corridor is linked to other upland habitats and small feeder streams on the south side of the creek

From Towle Road to about river mile 15.3, both sides of the creek are vegetated by upland shrub/scrub habitat which is dominated by Himalayan blackberry. The area is very disturbed and weedy with little connection to other habitats Upstream of river mile 15 3, the riparian vegetation changes first to upland meadow and then to wetland forest that extends to the east end of Gresham Main Park The upland meadow consists of Himalayan blackberry and fescue grass, with reed canary grass in localized wet spots It appears to be a former pasture and is bordered by a red osier dogwood/willow/Himalayan blackberry wetland forest This forest has a moderate wildlife habitat value because it has not recently been disturbed Its value is increased by its linkage to the meadow and to an upland forest strip to the south of the creek.

At Gresham Main Park (river mile 16.1), the creek swings southeast around the toe of Walter's Hill and follows the Springwater Corridor Trail to Regner Road at river mile 16 9 The vegetation along Johnson Creek and the Springwater Trail at Walter's Hill provides excellent nesting and foraging habitat for warblers, flycatchers and other birds that migrate from the tropics The site is also connected to upland forested habitat which is vegetated mostly by big-leaf maple, Douglas-fir and alder with a shrub layer of hazelnut and blackberry. Wildlife habitat value is high because of the native plant species diversity.

From Regner Road to the Telleford Road crossing at river mile 19 6, streamside vegetation is mostly closed canopy upland forest The upland forest is dominated by alder and cedar 50 to 60 years old with salmonberry and swordfern present in the shrub and herbaceous layers. Snag trees are common in some areas and larger, older trees are scattered through the forest A small area of wetland forest occurs within the upland forest at about river mile 18.5. The wetland forest consists primarily of Oregon ash interspersed with large cottonwoods. Wild rose and slough sedge are found in association with these trees

East of Highway 26 at about river mile 20, the creek runs through agricultural lands which are principally used for grazing and nursery operations. From river mile 20.3 to Orient Road at river mile 22, the creek area is vegetated by a wetland forest dominated by alder and ash with some cottonwood Generally, the shrub layer is underdeveloped and impacted by grazing West of Orient Road to the headwaters, the riparian corridor is mostly vegetated by a closed canopy upland forest of alder, western red cedar, big-leaf maple, and Douglas-fir For the most part, a well-developed shrub layer is lacking due to grazing or lawns extending to the stream bank. At Pleasant Home Road, the riparian corridor includes a wetland forest of alder and Oregon ash with a mix of blackberry and red osier dogwood in the shrub layer The southern branch of the headwaters runs through a series of agricultural fields and nurseries. There is no riparian vegetation along this stretch of creek Within the summer and fall of 1993, the cottonwood forest at the headwaters was logged

■ CRYSTAL SPRINGS AND REED CREEKS

Crystal Springs Creek flows into Johnson Creek from the north at river mile 1.2. It, and its tributary Reed Creek, are fed by perennial springs. Crystal Spring Creek originates from springs within the Crystal Springs Rhododendron Gardens Reed Creek originates from springs on the Reed College campus Historically, the springs fed a marshy area, interspersed with uplands trees, that drained slowly to Johnson Creek via the two creeks Today, the former wetlands are occupied by landscaped gardens, a lake, small farms and the Eastmoreland Golf Course A dam on Crystal Springs Creek forms Crystal Springs Lake. The lake is shallow and offers little cover for fish or nesting habitat for waterfowl It is surrounded by landscaped grounds and golf fairways. Downstream of the dam, Crystal Springs Creek crosses the golf course in a broad channel to its confluence with Reed Creek.

Reed Creek flows into Reed Lake which is surrounded by a remnant Douglas-fir and western red cedar forest The lake is formed by a small dam and provides prime breeding and rearing habitat for amphibians and salmonid fish. Downstream of the dam and upstream of S.E 28th Street, the creek flows through a section of original creek channel where conifer and deciduous forest canopy and shrubs provide good cover and food for aquatic and terrestrial wildlife After entering Eastmoreland Golf Course, the creek meanders through fairways to Crystal Springs Creek. Within the golf course, streamside vegetation along both creeks consists of introduced overstory trees, mainly weeping willow, with no developed shrub layer. Leaving the golf course, Crystal Springs Creek enters an area of homes on small lots. The riparian corridor is narrow with trees limited to exotic landscape species or entirely lacking Wildlife habitat value is generally low for

Crystal Springs and Reed Creeks, with the exception of Reed Canyon where native vegetation still dominates and the creek and lake are well shaded

■ KELLEY AND MITCHELL CREEKS

Kelley Creek joins Johnson Creek at river mile 11.4, near S E Foster Road and S.E. 162nd Avenue. Kelley Creek and its principal tributary, Mitchell Creek, are mostly vegetated by upland closed canopy forest consisting of Douglas-fir, western red cedar, big-leaf maple, alder, and black cottonwood Shrub layer development is scattered in some areas with native plants dominating the stream corridor overall Certain localities are dominated by Himalayan blackberry. Immediately east of Foster Road, there is an approximately one mile stretch of Kelley Creek which is an open canopied wetland forest dominated by cottonwood and alder with some very large (100') cottonwood trees Generally, the wildlife habitat value is considered as low to moderate because of the mix of native and non-native vegetation, and a mostly reduced shrub layer resulting from residential lawns

Mitchell Creek is a major tributary entering Kelley Creek from the east Mitchell Creek is vegetated by an upland closed canopied forest dominated by 60- to 80-year old alder and cedar Salmonberry and blackberry dominate the shrub layer and trailing blackberry dominates the herb layer

Two unnamed tributaries enter Kelley Creek The first tributary enters Kelley Creek just upstream of Mitchell Creek and is vegetated by an upland closed canopied forest dominated by Douglas-fir and cedar with blackberry making up the principal shrub component. Springs may be present along this tributary The second unnamed tributary enters Kelley Creek at the Pleasant Valley School This area appears to be an old meander of Kelley Creek and is dominated by a wetland forest of alder and ash with a mixture of native and non-native shrubs, including snowberry and blackberry. Springs may also exist along this tributary. Habitat value for both these unnamed tributaries is considered as medium because of the native/non-native mix and the encroachment of invasive plants

■ BUTLER CREEK

Butler Creek enters Johnson Creek at river mile 13.9 Its headwaters are located on a forested hill south of Johnson Creek. The headwaters forest is composed mostly of alder and cedar with openings in the canopy where housing developments and lawns have cleared vegetation to creekside. Where it is forested, native plants remain, such as Oregon hazel and salmonberry in the wet areas Swordfern dominates the herb layer Several artificial lakes have been created on Butler Creek

■ HOGAN CREEK

Hogan Creek enters Johnson Creek just east of the brick factory where Hogan Road and the Springwater Trail intersect (river mile 18.6). The creek corridor is generally forested and surrounded by a mosaic of agricultural lands and undeveloped upland forests. Forested areas are dominated by red alder and big-leaf maple, with Douglas-fir and other conifers present in the mid-reaches. At the headwaters, west of Hogan Road, the creek flows through a sand and gravel operation where the riparian corridor has been narrowed to an open canopy strip of deciduous and conifer trees. The Hogan Creek drainage still retains some larger blocks of upland and riparian forested habitat which are important for interior forest nesting birds and mammals

■ NORTH FORK JOHNSON CREEK

The north fork of Johnson Creek enters the mainstem at about river mile 19.3 The riparian corridor is a narrow strip of forested land, primarily alders and maple, surrounded by rural housing and agricultural developments Highway 26 separates the north fork riparian corridor from the mainstem, limiting opportunities for wildlife movement. Riparian habitat in the upper reaches is connected to a few forested areas and open pastures or meadows

■ SUNSHINE CREEK

Sunshine Creek enters Johnson Creek near Telleford Road at river mile 20.6 The forest along the creek varies from wetland alder/willow woods to an upland alder-dominated forest. Blackberry is present in both forest types as a dominant shrub. Beaver sign is abundant and, according to local residents, beaver are very active within the creek

■ UNNAMED TRIBUTARY AT SE 282nd AVENUE

This tributary to the mainstem Johnson Creek is located on the south side of Johnson Creek at 282nd and Stone roads. The area is vegetated by an upland closed canopied forest dominated by big-leaf maple and cedar. The shrub layer is lacking and swordfern dominates the herb layer.

■ UPLANDS

Upland habitats in the Johnson Creek watershed include small parcels of forest and other habitats that are located adjacent to, but outside, the creek corridors Uplands also include larger blocks of habitat found in city and county parks (e g , Tideman Johnson Park), the 86th Avenue forest, and the forested buttes east of Interstate 205, including Kelly Butte, Powell Butte, Jenne Butte, Mount Scott, the Willamette Cemetery hill, the Barbara Welch uplands, Walter's Hill, and the unnamed butte at the headwaters of Sunshine Creek (part of the Boring Lava Hills) The larger upland areas are mostly forested with 80-year old, second growth Douglas-fir, in association with big-leaf maple, red alder, western red cedar, grand fir, and western hemlock Native shrubs and herbs are often present, but in the more developed areas, non-native trees and shrubs can be found Small streams and ephemeral drainages within the uplands contribute to their overall wildlife habitat value Some of the upland areas are directly connected to each other and to the Johnson Creek riparian corridor, allowing free movement of wildlife, others are not.

■ WETLANDS

Wetland habitats are scattered throughout the watershed, either connected to the creek or within the watershed boundary These include remnant wet meadows at the Freeway

Land Company site, Beggars-tick Refuge, S.E Brookside Drive, and at the north edge of Jenne Butte. Beggars-tick Refuge also includes emergent marsh Wet meadows and emergent wetland areas are a mixture of wetland dependent species such as rushes and sedges, often associated with willows and having snag trees. Wet shrub/scrub habitat is located at Jenne Butte and eastward to Walter's Hill and is dominated by willow, alder, and in many cases, Himalayan blackberry Wetland forests are located mostly in the upper watershed in agricultural lands. They occur north of the mouth of Butler Creek, along the north and east borders of Walter's Hill, and in a few scattered locations east of Highway 26 Wetland forests may be a combination of alder and ash trees, or the more rare Oregon ash/slough sedge habitat (one site is located at Palmblad Road).

Many wetland forests in the upper basin have been drained for agriculture or rural housing Himalayan blackberry is also encroaching at the cleared edges of these forests and upland forests throughout the upper watershed. Habitat value for the wetland forests, especially those interspersed with upland forest and scrub/shrub habitats along Walter's Hill and into the upper tributary areas, is medium to high The single most limiting factor for habitat value here is the lack of dead wood habitat for birds and amphibians.

■ WILDLIFE

Overall, the diversity of wildlife species in the watershed has been reduced since pre-European settlement Large mammals which were once common, such as black bear, bobcat, cougar, wolf, fox, elk, and coyote either no longer exist within the watershed, are restricted to the upper basin, or their numbers are reduced. Black-tailed deer are likely the only large mammal that can be found in or near the remaining forested areas. Opossum, raccoon and skunk have learned to adapt to human development and remain common. Herpetofauna also show declines in species variety The last record for spotted frog is dated sometime in the 1930s, red-legged frog exists in remnant wetland and creek habitat and the Pacific tree frog is likely the most plentiful amphibian today within the basin. Birds are the most abundant wildlife form living in urban and rural areas within the watershed. Although there is a marked decline in interior forest habitat (large continuous blocks of woodland), bird species that winter in the tropics, such as Swainson's thrush, flycatchers, and warblers, can still be found in sufficient numbers to sustain local breeding populations During migration, and in winter, birds from higher elevations and more northerly latitudes can be seen. These include species such as evening grosbeak and varied thrush, which will frequent backyard feeders, and small raptors such as Cooper's hawks

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FACTORS LIMITING WILDLIFE HABITAT VALUE

The wildlife habitat value of the Johnson Creek watershed has been greatly reduced by development In this context, wildlife habitat is more than just vegetation It includes rocks for sunning and cover, and suitable soils for harboring prey and creating dens It includes trees in various states of decay, standing or down, which provide a home for insects and the opportunity for carving out cavities in which birds and small animals can roost, sleep, or raise their young And it also includes decaying leafy debris that provides hiding places for salamanders and food for insects as well as the ingredients for future soils.

Many different factors influence and generally reduce wildlife habitat values. In order to devise a strategy for improvement, the most important factors reducing wildlife habitat values were identified, based on the results of field surveys and interpretation of aerial photographs Important limiting factors include

- A general lack of species and structural diversity within all habitat types in the riparian corridors (e g., few tree species and no shrub layer)
- A narrow and degraded riparian corridor, often less than 20 ft wide, lacking in shrub layers and having thin (<30 percent) canopy closures
- A lack of dead wood, either standing as snag trees, or down as woody debris.
- Limited connection or linkage between riparian habitats and upland habitats.
- Very limited interior forest habitat, defined as blocks of habitat of a size that would allow songbirds and other neotropical migrant species to have secure nesting territories (often defined as habitat blocks 600 feet from a road or break in tree canopy)
- Fragmentation of habitat, that is, breaks in vegetation that subject wildlife to predation and disturbance
- Disturbance due to the proximity of housing, domestic animals, and recreational trails
- Encroachment of non-native vegetation which out competes native species and reduces wildlife habitat value
- Lack of habitat diversity, especially in the lower reaches

The goal of wildlife habitat enhancement is to minimize the adverse effects of these limiting factors, and to maximize species and habitat diversity

WILDLIFE HABITAT IMPROVEMENT STRATEGIES

Restoring wildlife habitats to their pre-development condition is obviously an unrealistic goal Urban and agricultural development has produced irreversible changes in land use and vegetative cover. Further changes can be expected as the population of the watershed grows. A practical goal for an urbanizing watershed is to arrest, and perhaps reverse, the decline in wildlife habitat values that accompanies development This goal can be accomplished by protecting valuable habitats that remain, enhancing the value of those that have been degraded, and restoring, to the extent practicable, native plant communities This approach is both expedient and consistent with practices adopted elsewhere in the United States

The fish and wildlife habitat improvement plan element sets out to minimize the effect of the factors, described earlier, that limit wildlife habitat value in the watershed. Effects of the limiting factors will be minimized by a combination of protection, enhancement and restoration strategies Unique or very high value habitats, such as ash wetlands, will be protected Protection could be accomplished by land purchase, conservation easements, zoning and development standards, management changes on public land, and cooperative management agreements with private landowners. Habitats for which protection would be the priority include areas that now possess the best habitat and support populations of native species of concern, floodplains, riparian corridors, wetland forest, meadows or marshes, interior forest habitat, and areas that link stream corridors with uplands and upland habitats to each other

Enhancement would involve modifying existing habitat to increase its value to wildlife Areas targeted for enhancement already have some value to wildlife which can be increased by judicious intervention. An example might be a riparian area with a mature canopy of large trees but where heavy livestock grazing has eliminated the shrub and herb layers. Limitation of livestock access to the stream corridor and replanting with natives shrubs would increase structural diversity and wildlife habitat value in the riparian area and in the associated aquatic habitat. Another example might be a wet area created when a stream was rerouted around a housing development The wet area could be improved to become a fully functional wetland habitat.

Restoration would be applied to sites that have very little or no vegetation, or mostly non-native plants Restoration would include revegetating a site with native trees, shrubs, and herbaceous plants to approximate the historic vegetative assemblage Once planted, the vegetation would be allowed to succeed naturally over time. Other habitat components such as downed wood may be added during early planting phases to improve habitat value faster than normal succession. An example of restoration would be the replacement of the extensive monocultural stands of Himalayan blackberry prevalent in the lower reaches of the creek with native trees, shrubs, and grasses

Obviously, enhancing wildlife habitat in the Johnson Creek riparian corridor will not always be simple. Both public and private landowners have uses for streamside lands that they may consider more important than wildlife habitat In some cases, land uses incompatible with wildlife habitat extend to the very edge of the stream, severely limiting opportunities for wildlife habitat improvement The rock-lining that occurred in the 1930s limits revegetation of the creek banks themselves. To succeed, habitat improvement efforts will have to be practical and will have to balance wildlife values with human needs.

The approach taken in this plan is to establish an improvement goal for each reach of the creek and its tributaries. The goal specifies the type of vegetation that would be desirable and the extent of revegetation that should occur in about 10 years, and then in 50 years In establishing the improvement goals for a particular stream reach, various factors were taken into account including capacity of the channel to pass flood flows, probable historic vegetation type, presence or absence of rock-lining, orientation to the sun (where the creek runs east/west conifers would be planted on the south side to provide stream shade quickly), land ownership and the compatibility of adjacent land uses with a natural stream corridor.

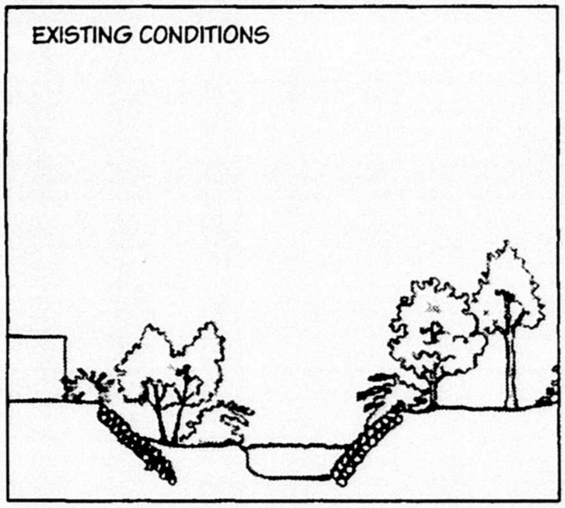
Figures 27 through 34 show the improvement goals for the riparian area in various reaches of the creek. The improvement goals are stated generally in the form of creek cross-sections. They cannot usually be attained uniformly through the designated creek reaches because of the natural variability of the channel form and encroachment of structures into the stream corridor However, they do provide an overall framework for vegetation restoration within which planting plans for specific sites can be developed. Additional guidance on wildlife habitat improvements by river mile is included in Appendix B.

The revegetated sections would need to be maintained to ensure that adequate stream flow capacity was retained (See discussion of channel maintenance practices in Action FM-2-4) Trees that mature and become unsafe will be dealt with on a case-by-case basis In some instances, trees may have to be cut down Where possible, cut trees will be laid down in the upland area to provide denning and foraging habitat Alternatively they could be secured in the stream channel or bank to provide cover for fish

Restoration and enhancement goals for upland habitats, and wetland habitats not directly associated with the principal riparian corridors, will also focus on revegetation, especially for the larger habitat blocks and those areas that would provide linkages to other habitats The most important upland and wetland habitats within the watershed may require protection by purchase, easement, or land management changes

All habitat improvement projects will require specific site assessment, site plans, and evaluation and monitoring Guidelines for site planning and attendant processes to be implemented under this plan can be found in Technical Memorandum No. 17

FIG 27 Vegetation Restoration Goal - Millport Street

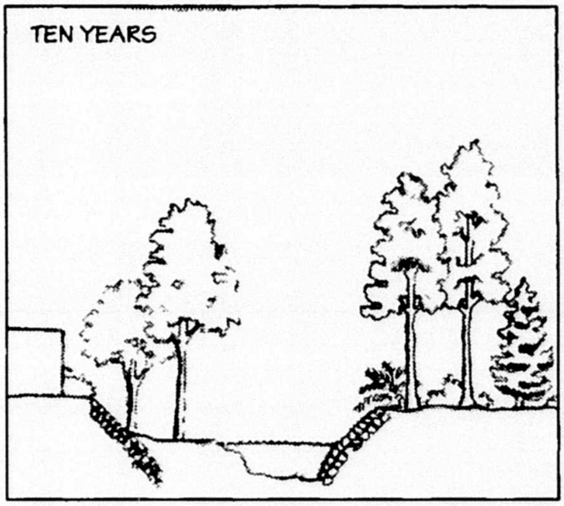


VEGETATION

- Tree layer is mostly sapling alder with 1) no understory shrub layer or 2) an understory of mostly Himalayan blackberry, trees and shrubs located on the banks and in the channel where sediments have been deposited
- Small areas may have larger trees, in other areas there are only grasses and weeds with buildings or parking lots to bank edge

PROPOSED PLANTINGS/TREATMENT

- Remove in channel vegetation to accommodate the minimum flood flow and bio-engineer the new bank to provide stabilization
- Add native shrubs and herbs to diversify habitat conditions, widen riparian area to accommodate additional vegetation, where possible
- Plant Douglas-fir seedlings or saplings in open areas to provide long-term shading and structure
- Add big-leaf maple seedlings interspersed with alder to provide larger quick-growing trees for stream shading

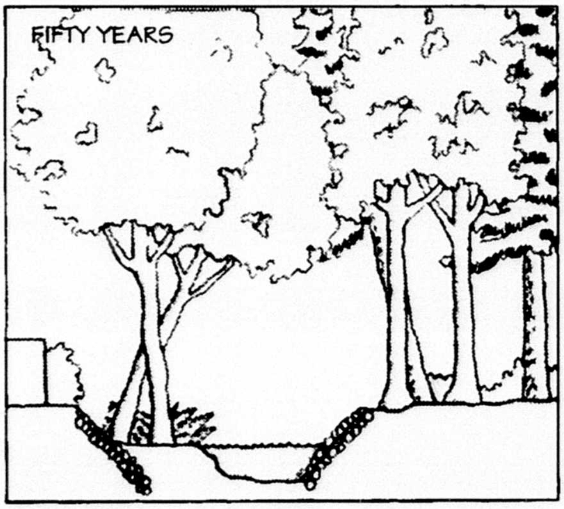


VEGETATION

- Alder saplings are now about 30-40 ft tall providing better stream shade
- Big-leaf maple are about 25-30 ft. tall with fairly open crowns
- Douglas fir seedlings are now about 10-15 ft. tall adding to shrub layer structure
- Shrub and herb layer should be well developed

PROPOSED PLANTINGS/TREATMENT

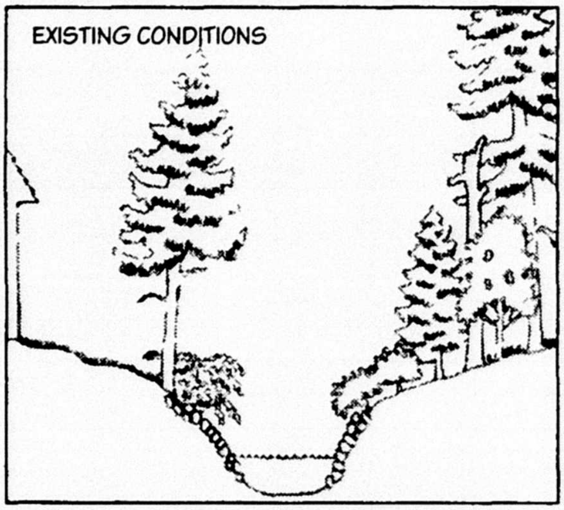
- Add western red cedar in appropriate areas



VEGETATION

- Alder may be up to 130 ft. tall with well-developed crowns
- Big-leaf maple will be about 50 ft tall with crowns that shade over the creek
- Shrub layer may be scattered due to additional shading from developed tree layer
- Douglas-fir should be about 70-90 ft tall with good sized crowns

Vegetation Restoration Goal - Canyon Area FIG 28

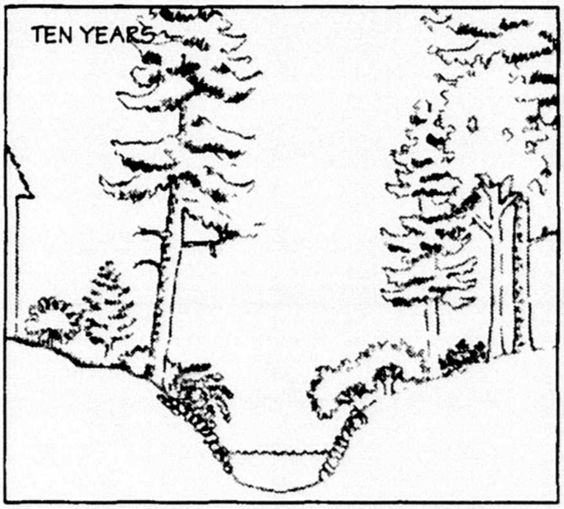


VEGETATION

- Suburban housing borders most creek areas with lawns and landscaping plants to creek
- Native tree layer in places with Douglas-fir trees 70-80 ft tall, large western red cedar, and mature big-leaf maple
- Shrubs include native Oregon grape, salal, rose and others, Himalayan blackberry, English holly, and exotic weed species encroaching in some areas

PROPOSED PLANTINGS/TREATMENT

- Allow trees to succeed naturally
- Replace Himalayan blackberry and other exotic species with native shrubs
- Remove yard and other debris
- Avoid use of lawn chemicals, replace lawn at creekside with low shrubs to provide bank stability and habitat

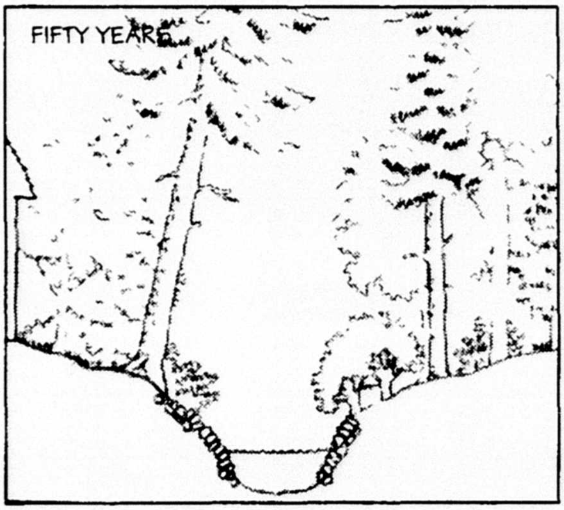


VEGETATION

- Shrub layer has become established in places, Himalayan blackberry still exists in areas not treated or has colonized into other areas in forest openings and along backyards
- Conifers (cedar and fir) have matured and may now be 80-85 ft. tall

PROPOSED PLANTINGS/TREATMENT

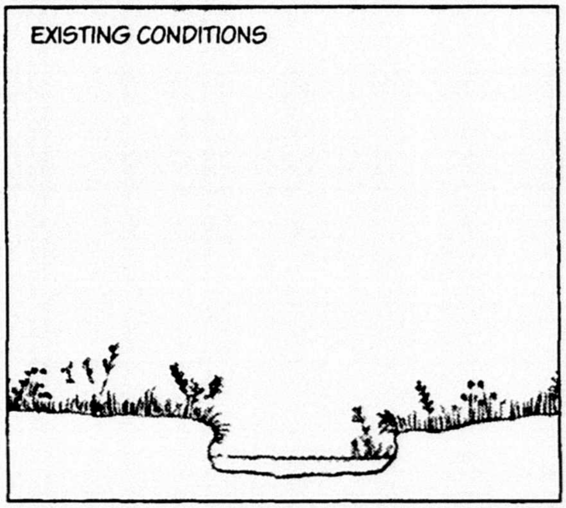
- Older or diseased trees that need to be cut down for safety or other reasons should be dropped in place within riparian zone to provide wildlife habitat
- Continue replacement of non-native shrubs and herbs and replant with natives



VEGETATION

- The forest is now composed of mature trees ranging from 50 to over 200 feet tall with mostly closed canopy which covers the stream providing shade and wildlife habitat
- The shrub layer is scattered and has thinned out in the more shaded areas but is mostly native species and is providing structural diversity to the habitat

FIG 29 Vegetation Restoration Goal - Agricultural/Rural Housing Areas (Upper Watershed)

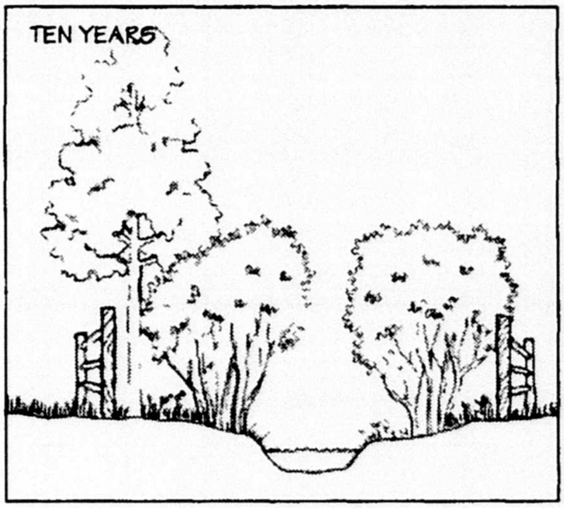


VEGETATION

- There is no tree layer but may be widely scattered willow or alder saplings in places, mostly pasture grasses with some scattered sedges or rushes in seepy areas
- The predominant land use is grazing with some hay fields, there is some rural housing with small pastures
- The stream channel may be severely undercut where cattle cross or loaf in the stream

PROPOSED PLANTINGS/TREATMENT

- Plant willow and alder seedlings or saplings
- Plant sedges and rushes in wet areas
- Fence riparian corridor to ensure re-establishment of riparian vegetation
- Avoid use of chemicals which may impact the aquatic environment

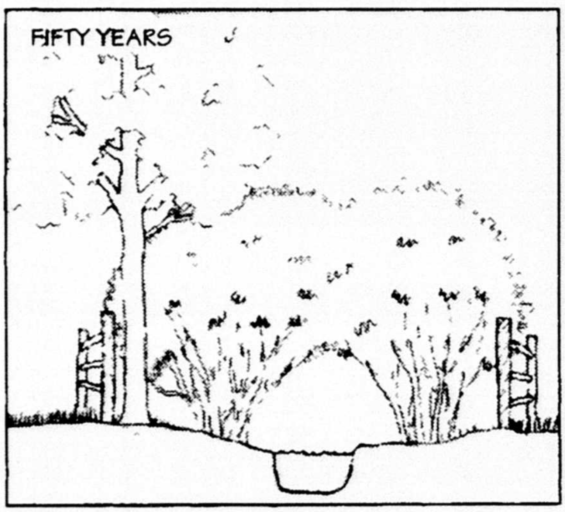


VEGETATION

- Alder seedlings now about 25 ft tall, saplings about 40-50 ft. tall providing stream shade
- Willows will be about 8-10 ft tall in dense clumps
- Stream channel may have some integrity and be narrow, flow may have become perennial

PROPOSED PLANTINGS/TREATMENT

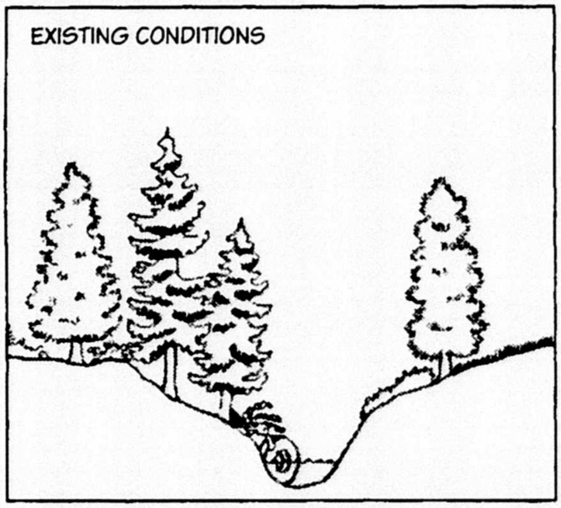
- Remove any exotic species, such as Himalayan blackberry that may be encroaching in riparian vegetation
- Allow plantings to succeed naturally, replant areas where initial plantings did not take or where new plantings are needed



VEGETATION

- Alder may be up to 130 ft tall and willow should be at full growth, about 15 ft tall in dense clumps, stream will be fully shaded
- Stream channel has narrowed and is deeper; there may be perennial surface flow

Vegetation Restoration Goal - Kelley and Mitchell Creeks FIG 30

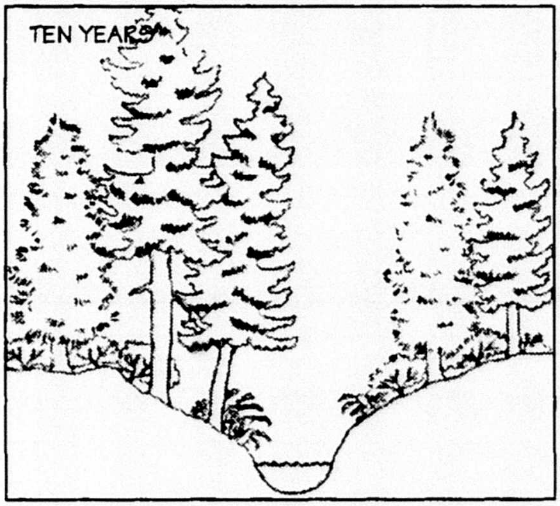


VEGETATION

- Creeks flow through natural channel of rock and mud, suburban housing and some rural housing borders creeks with lawn, pasture or landscaping to bank edge
- Native tree layer in places with Douglas-fir trees 70-80 ft tall, large western red cedar, and mature big-leaf maple
- Shrub layer is mostly native plants with encroachment of lawn grasses and blackberry
- Creeks have yard and other debris in stream channel

PROPOSED PLANTINGS/TREATMENT

- Allow tree canopy to succeed naturally Plant native trees in areas where they are lacking
- Replace Himalayan blackberry and other exotic species with native shrubs
- Remove yard and other debris
- Avoid use of lawn chemicals, replace lawn at creekside with low shrubs

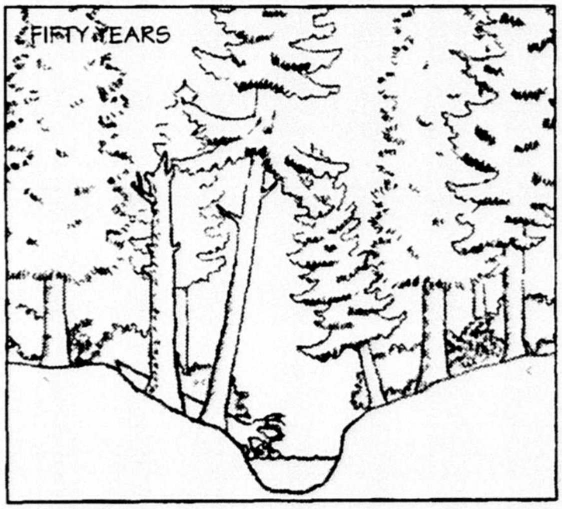


VEGETATION

- Tree canopy will fill in as native trees mature
- Natural succession of forest may occur as native plants seed area where exotics have been removed

PROPOSED PLANTINGS/TREATMENT

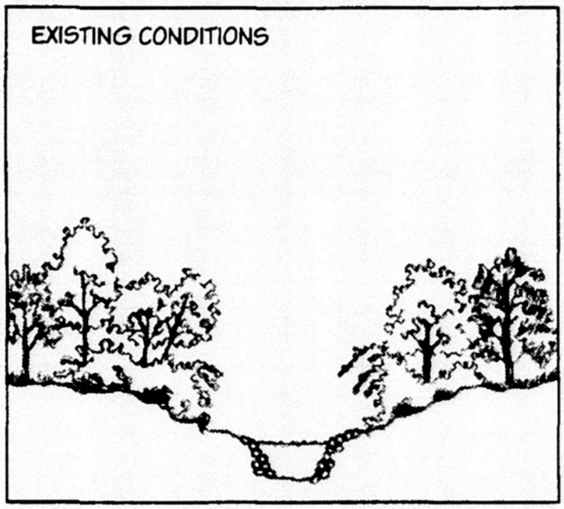
- Where needed control exotic plants and replant with native species This process will be repeated as needed to establish native plants



VEGETATION

- Over time large trees will die and either remain standing as snags or fall as downed logs providing dead wood habitat for several species of wildlife, including mammals and amphibians If exotic plant encroachment has been controlled, the forested habitat will likely reflect historic vegetative characteristics

FIG 31 Vegetation Restoration Goal - Bell Station

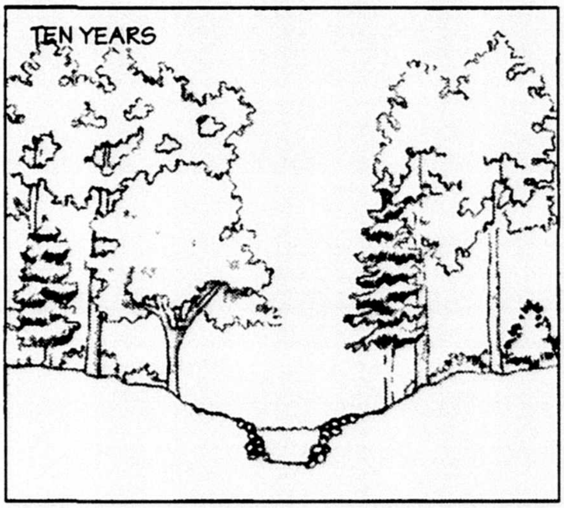


VEGETATION

- Stream bank is mostly rock walls with sapling and larger alder trees along upper banks and in channel where sediments have been deposited on one bank
- Shrub layer is mostly Himalayan blackberry
- Exotic grasses dominate herb layer

PROPOSED PLANTINGS/TREATMENT

- Remove in channel vegetation to accommodate the minimum flood flow goal and bio-engineer the new bank to provide stabilization
- Allow existing alder to succeed naturally and plant additional alder to increase tree layer, widen riparian area to accommodate more vegetation, where possible
- Plant Douglas-fir seedlings in open areas or, where necessary, clear small areas, for these trees
- Plant big-leaf maple saplings close to the creek to provide stream shade
- Begin removal of Himalayan blackberry

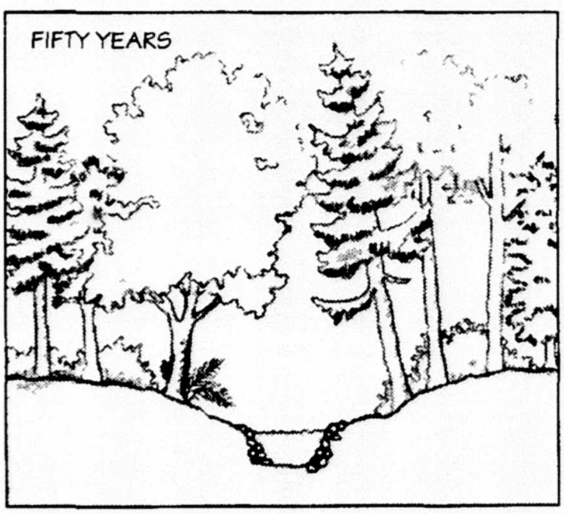


VEGETATION

- Alder are about 30-40 ft tall providing good shade at leaf on
- Big-leaf maples now average about 25-30 ft providing shade and vegetative structure
- Douglas-fir saplings are now about 10-12 ft. tall
- Where shade has increased, Himalayan blackberry may be reduced

PROPOSED PLANTINGS/TREATMENT

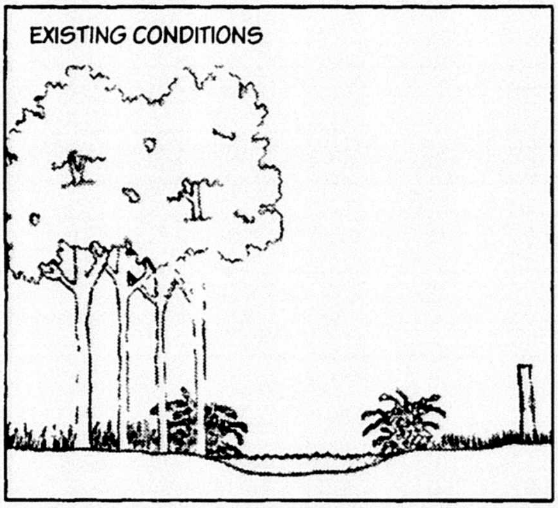
- Remove blackberry roots and plants and revegetate with native shrubs
- Add western red cedar, grand fir, and western hemlock where appropriate to increase overstory tree canopy and shade value for creek



VEGETATION

- Big-leaf maple and alder have matured and range from 50 to 130 ft tall respectively, providing good shade to stream and shading out Himalayan blackberry where it was once established
- Douglas-fir and other conifers are now 40-50 years old and stand anywhere from 50-80 ft tall The forest shows good diversity both vegetatively and structurally
- Shrub layer is scattered having thinned out in the more well shaded areas
- The stream is 70-100% shaded at noon

Vegetation Restoration Goal - Wetland and Forests Found in Broader Floodplains **FIG 32**

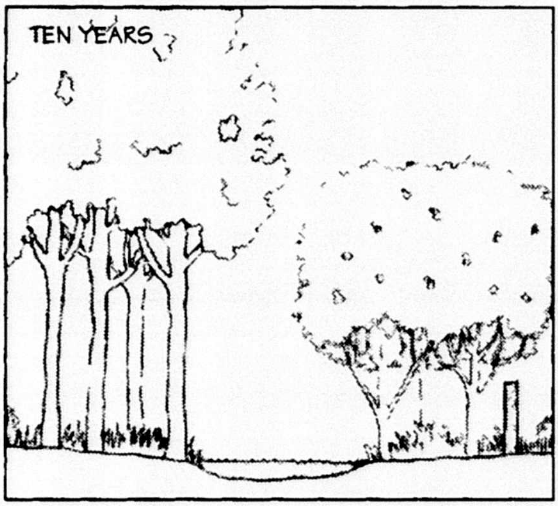


VEGETATION

- Dominant trees may be Oregon ash, red alder, or black cottonwood
- In cottonwood forests, willows may be the dominant shrub, in Oregon ash forests, slough sedge may be dominant and shrubs may be absent or along the periphery
- Often one bank is forested and the other bank is vegetated with exotic grasses or Himalayan blackberry, which may encroach into the wetland forest on the other bank
- Flow in these areas may spread out of the normal stream channel and into the broader floodplain and be sluggish

PROPOSED PLANTINGS/TREATMENT

- Remove Himalayan blackberry and other exotics
- Plant non-forested area with native trees and shrubs, including ash, cottonwood, alder, wild rose, willow and various rushes and sedges
- Where needed, fence riparian zone to protect existing forest and new plantings from livestock and human disturbance

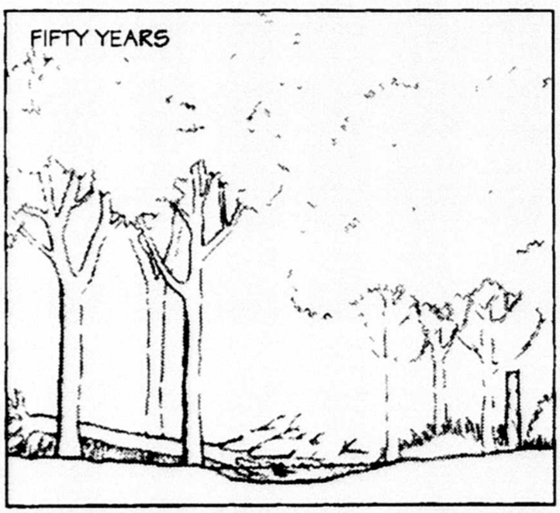


VEGETATION

- Alder may be about 30 ft tall, ash about 15-20 ft tall, and cottonwood about 30-35 ft tall, willows and other shrubs will be well established as well as ground cover plants

PROPOSED PLANTINGS/TREATMENT

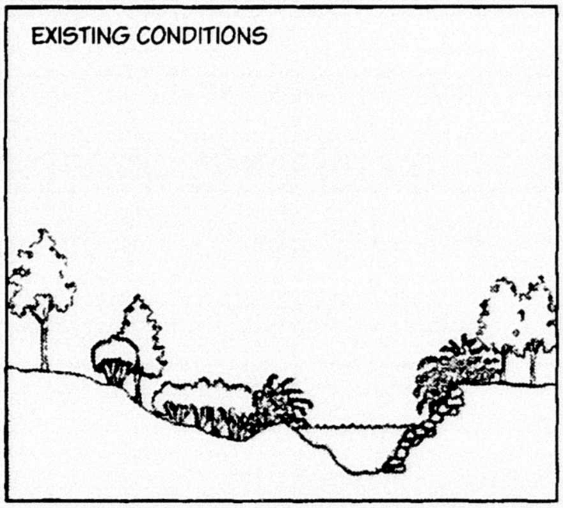
- Continue to remove exotic plants and maintain fences
- Replant where necessary or add new plantings where openings allow



VEGETATION

- Willow and other shrubs have reached maximum height
- Trees range from 40 ft to 70 ft tall, depending upon species present, some trees have already died and have fallen, providing habitat for fish and aquatic wildlife
- Slough sedge and other wetland plants dominate the ground layer and shrubs may be present where light penetrates the forest canopy or along the forest periphery
- The wetland forests are now providing areas that distribute flood waters, catch sediment, and support additional wildlife species

FIG 33 Vegetation Restoration Goal - Circle Drive

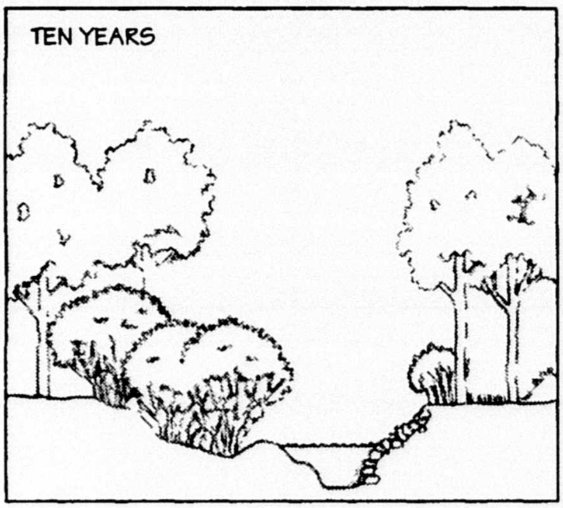


VEGETATION

- Willows have become established in sediment deposits within stream channel along one bank, scattered alder saplings are located within and adjacent to the willow and in established sapling stands on the opposite bank
- In some areas Himalayan blackberry dominates the shrub layer

PROPOSED PLANTINGS/TREATMENT

- Allow willow and alder to naturally succeed
- Add conifers in appropriate places on higher stream bank
- Begin to replace Himalayan blackberry with native shrubs and herbs

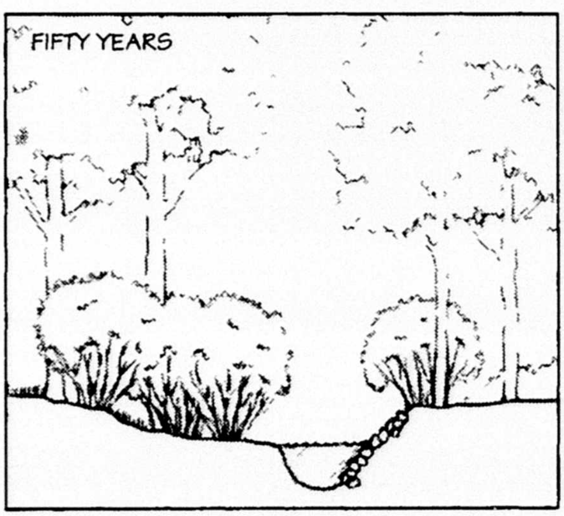


VEGETATION

- Willow remains in dense stands, alder have matured on both sides of the creek providing additional stream shade

PROPOSED PLANTINGS/TREATMENT

- Continue with removal of Himalayan blackberry and replace with native shrubs or trees
- Fence riparian area, if necessary, to ensure establishment of new vegetation



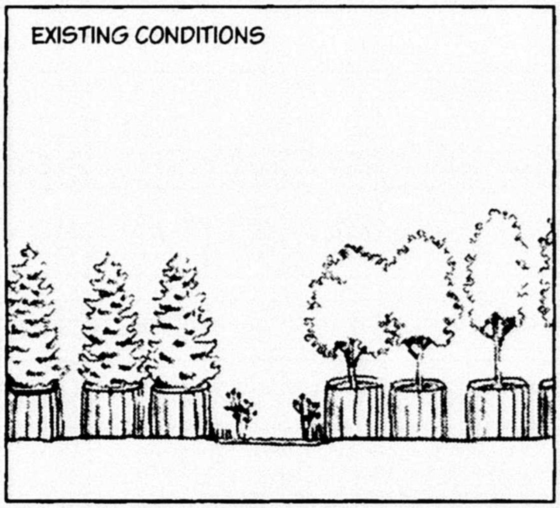
VEGETATION

- The sediment caught by willow shrubs has provided a new channel which is narrower and deeper than fifty years ago
- Douglas-fir trees are about 70-90 ft tall and about 16-20 inches diameter at breast height providing large structure and stream shade

PROPOSED PLANTINGS/TREATMENT

- Continue to remove exotic plants and maintain fences
- Replant where necessary or add new plantings where openings allow

Vegetation Restoration Goal - Agricultural Areas and Container Nurseries FIG 34



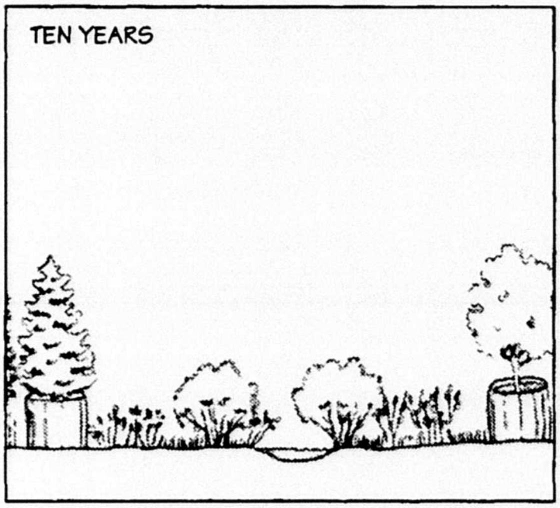
EXISTING CONDITIONS

VEGETATION

- The creek shows no defined drainage but usually appears as a broad wet area in pastures or between containers
- Trees are absent, shrubs may include common rush or other rush type plant, ground cover is usually pasture grasses

PROPOSED PLANTINGS/TREATMENT

- Widen riparian area by setting back containers or fencing off livestock
- Plant wet area with shrubs, such as willow and wild rose, and other wetland types ground covers, such as rushes and sedges
- Where possible, in broader floodplain areas, plant alder and cottonwood trees to reestablish creek channels and provide stream cover
- Control pesticide use within riparian and adjacent areas



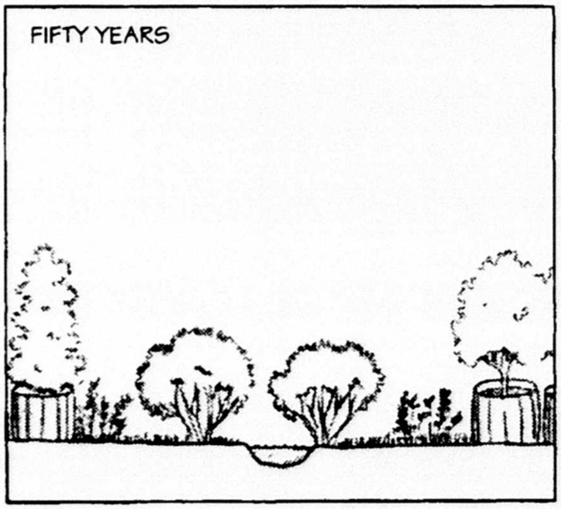
TEN YEARS

VEGETATION

- Trees may be 15-40 ft tall and willows will be about 8-10 ft. tall
- Wetland plants should be well established, if area has been fenced to exclude livestock
- Stream channel has begun to form and may be only 6-8 inches wide, water flow has likely improved

PROPOSED PLANTINGS/TREATMENT

- Allow plantings to succeed naturally, plant or replant where necessary
- Continue to control pesticide use in and adjacent to riparian area



FIFTY YEARS

VEGETATION

- Trees willows and other plants have achieved maximum growth and channel may be 6-10 inches deep

PROPOSED PLANTINGS/TREATMENT

- Protect area and allow to succeed naturally

PLAN OBJECTIVES AND ACTIONS

The objectives and actions summarized in Table 20 are designed to improve wildlife habitat. They are based on the the wildlife habitat improvement strategy described above, and include protection, enhancement and restoration components

Certain actions elsewhere in the RMP may result in some minor loss of wildlife habitat. Principal among them is the construction of on-stream detention basins for flood reduction Some wetlands will be lost as a result of dam construction Because the losses are expected to be small (less than five acres), the wildlife habitat enhancing actions in this plan element are expected to more than compensate for the losses

Objective FW-1.
Protect Existing Wildlife Habitat

Action FW-1-1.
Protect critical wildlife habitats

Certain lands in the watershed are particularly important as wildlife habitat. Examples are remnants of vegetation that existed before European settlement, lands that connect the riparian corridor with adjacent uplands, lands that abut spawning and rearing habitat for native fish, habitat types under-represented in the watershed, such as forested and emergent wetlands, seeps and springs, and the habitats of special status plants or animals The protection of these lands may be best accomplished by acquiring them, obtaining conservation easements or executing land management agreements with landowners

A list of general candidate sites for protection has been compiled as part of the RMP A special purpose wildlife habitat subcommittee of the WMO will develop the list in more detail, assign priorities and devise protection strategies. (See Action WS-1-4.) Because funds for public land acquisition are always limited, it may be desirable to protect wildlife habitat as much as possible by conservation easements and management agreements rather than by outright acquisition

In May, 1995, Metro is seeking voter approval to sell bonds to finance the public purchase of open space throughout the Portland metropolitan area. The Open Space, Parks and Streams Bond Measure asks voters to approve the expenditure of $135.6 million to acquire, protect and improve valuable lands for fish and wildlife habitat, as well as for recreational opportunities If approved, this measure will protect and preserve over 6,000 acres of open space Funds will be used to acquire stream corridors, critical wildlife habitat and land near existing parks and trails, to create and improve trail corridors, and to increase opportunities for walking, jogging and biking

Eighty-nine projects are proposed, 14 of which lie within the Johnson Creek watershed. Approximately 340 acres would be acquired in the Johnson Creek watershed at the locations listed in Table 21. About one-half of the proposed acquisitions would benefit fish and wildlife.

TABLE 20
Wildlife Habitat Enhancement Plan Element

Objectives and Actions	Implementing Agency/ Responsible Party	Estimated Cost of Action	Portion of Estimated Annual Cost of Action Attributable to JCRMP	Priority
Objective FW-1. Protect Existing Wildlife Habitat (JCCC Goals 2, 4, and 12)				
Action FW-1-1 Protect critical wildlife habitats	Cities, Counties, Land Trusts	Not estimated	Not estimated	A
Action FW-1-2 Protect other existing wildlife habitats through land use regulation[1]	Cities, Counties, Land Trusts	Included in Action WS-3-1	Included in Action WS-3-1	A
Objective FW-2. Enhance and Restore Streamside Vegetation (JCCC Goals 2, 4, and 12)				
Action FW-2-1 Enhance and restore riparian corridor on public lands	Cities and Counties (one-time cost)	$400,000 (one-time cost)	$400,000	A
Action FW-2-2 Enhance and restore riparian corridor on private lands[2]	Private property owners	$1,400,000 (one-time cost)	$1,400,000 (one-time cost)	A
Action FW-2-3 Provide artificial habitat structures	Cities, Counties, Private property owners	Minor Not estimated	Minor Not estimated	B
Action FW-2-4 Connect upland and wetland habitats with riparian areas	Cities, Counties, Private property owners	Not Estimated	Not Estimated	B
Objective FW-3. Enhance and Restore Uplands and Wetlands Outside Creek Corridor (JCCC Goals 2, 4, and 12)				
Action FW-3-1 Enhance and restore publicly-owned uplands	Cities and Counties	Not estimated	Not estimated	B
Action FW-3-2 Enhance and restore privately-owned uplands	Private property owners	Not estimated	Not estimated	B

NOTE

1 Related actions WS-3-1, WS-3-2, and WS-3-3
2 Cost estimate assumes basic revegetation with small native plants Property owners may choose to spend more to accelerate achievement of mature landscaping

watershed hydrology attributable to development. Before development a greater proportion of rainfall percolated into the ground than it does today. Summertime flow is sustained by groundwater Objective FW-3 addresses the need to maintain a minimum flow in the creek year-round in order to support aquatic life

Much of Johnson Creek is confined within a rock-lined channel This prevents the creek from evolving naturally, eroding banks, building bars and altering its course over the years. The lack of a natural, dynamic stream channel reduces the diversity of habitats for fish and fish food organisms Allowing the creek a degree of freedom to move within its flood plain would benefit the fishery Objective FW-4 addresses this issue

Although the RMP seeks to make Johnson Creek function more naturally than it does today, it would be unrealistic to expect that it can be returned to its predevelopment state. The creek will remain largely an urban waterway, compromises will always have to be struck between the desire for a natural channel and the need to minimize flood hazard As a result of these compromises, Johnson Creek will have to be actively managed. Natural forces cannot be allowed to take their course unhindered Intervention is necessary to prevent flooding and some of the actions taken will be deleterious to fish and wildlife Compensatory management actions will be needed to tilt the scale back in favor of fish and wildlife Unlike a stream in an undeveloped watershed that creates fish habitat as it evolves, Johnson Creek will have to be actively managed to create and maintain fish habitat

■ SHORT-TERM IMPROVEMENTS TO FISH HABITATS

A number of actions can be taken that will improve fish habitat immediately In Reach 1 the lack of deep pool habitat, in-stream cover and suitable spawning gravel is a limiting factor for steelhead and chinook Pools can be created artificially using a number of different techniques. Instream cover can be increased by adding large rocks and secured logs to the stream channel. The increased channel complexity produced in this way will naturally result in improved retention of gravel suitable for spawning Gravel recruitment can be further increased by directly adding suitable gravel in strategic locations

In Reach 2, lack of pool habitat and suitable spawning gravels are limiting factors for steelhead Pools could be created artificially in this reach Gravel accumulation could be accelerated by removing the rock walls on the outside of bends This would allow gravel bearing strata to be eroded naturally. Obviously this approach would only be applicable where bank erosion poses no hazard Alternatively suitable gravel could be added directly to the stream channel Steelhead success in Reach 2 is also limited by summer low flow. Some habitat improvement might be obtained by artificially creating meanders in the low flow channel The meanders would lengthen the channel and deepen it by concentrating flow rather than spreading it across the entire channel These improvements could also allow chinook salmon to better access the lower part of Reach 2.

Options for coho salmon habitat enhancement include improvement of winter refuge habitat and creation of off-stream rearing ponds. Reach 5 offers the best opportunity for development of alcoves and protected side channels for winter refuge Sections of Reach 5 have a relatively broad, well forested flood plain, where high quality off-stream refuge habitat could be constructed. Reach 5 is also a preferred reach because it is the closest mainstem reach to the headwater tributaries where most of the coho salmon spawning and rearing habitat is located Juvenile fish moving downstream out of the headwater streams could readily find refuge areas along Reach 5 Opportunities for development of refuge habitat in reaches further downstream may also exist, particularly in relatively undeveloped Reach 2.

Construction of off-stream rearing ponds for year-round rearing of juvenile coho may be possible at a few locations in the Johnson Creek watershed These ponds would be constructed along small spring-fed tributaries with sufficient flow to maintain cool water conditions throughout the summer. The ponds would be located close to potential spawning areas so that small juvenile fish, in their first summer of life, would be able to access the ponds The ponds would substantially increase rearing habitat for coho in the watershed Water temperature and flow in the spring-fed tributaries are more suitable for year-round rearing than in the mainstem of Johnson Creek.

The best opportunity for improving runs of coho salmon in the Johnson Creek watershed is habitat enhancement in Crystal Springs Creek. Crystal Springs Creek has a constant flow of cool spring water and has consistently supported a small run of coho salmon for several years This is despite the fact that fish habitat is severely degraded The section of Crystal Springs Creek that flows through the Eastmoreland Golf Course is wide and straight and its bed is laden with silt. Reconstruction of the channel in this area would provide habitat for coho and steelhead. The channel could be narrowed and a number of tight meanders constructed to create a diversity of pool and riffle habitat The new channel configuration should allow gravel beds to be kept free of silt naturally, although it may be desirable to mechanically remove already-accumulated silt from this reach of Crystal Springs Creek when the channel modifications are made

Many of the enhancements described above will also benefit cutthroat trout Removal of barriers to upstream migration in the small tributary streams is probably the best short-term habitat improvement that could be provided for cutthroat trout

■ SUPPLEMENTARY FISH HABITAT IMPROVEMENT OPPORTUNITIES

As development along streams continues, opportunities to include fish habitat improvements as part of development should be taken In some cases where public or private developments encroach on the stream corridor mitigation measures may be necessary Potential mitigation measures might include construction of side channels for juvenile fish rearing or in-stream structural improvements Opportunities of this kind will be identified as part of the WMO's review of development proposals (Action WS-3-3).

Citizen interest in fishery restoration is high. Individuals or groups should be encouraged to undertake small-scale habitat improvement projects throughout the creek Some projects could serve as educational tools or demonstrations of new techniques. These types of citizen-initiated projects should be coordinated with other fish habitat improvements occurring in the watershed (see Action FW-2-1).

PLAN OBJECTIVES AND ACTIONS

Objectives and actions, most of which are associated with short-term improvements to fish habitat, are shown in Table 22 Recommended short-and long-term improvements are listed, by reach, in Table 23

OBJECTIVE FW-4.
Improve Habitat to Foster the Reestablishment of Self-sustaining Native Salmonids and other Desirable Fish Stocks.

Successful reestablishment of naturally-reproducing wild salmonid populations in Johnson Creek will require the implementation of a carefully designed management plan coupled with both short-term and long-term habitat enhancement programs. Oregon Department of Fish and Wildlife has the responsibility for development of the management plan Development of the plan is underway, but new information is needed regarding the present composition (wild versus hatchery-reared) of the remnant salmonid runs before it can be completed

As noted above fish habitat restoration has long-term and short-term components The long-term components are intended to gradually recreate a stream environment that is well-suited to native salmonid fish over a period of 5 to 50 years Objectives FW-1, FW-3 and FW-4 and many of the actions in the other plan elements are designed to bring about such a result The actions included under this objective, Objective FW-2, are designed to produce an immediate improvement in fish habitat (that is, within 5 years), and to obtain the information necessary to complete a plan for restoration of native fish stocks.

Action FW-4-1.
Complete fisheries management plan for Johnson Creek

The Oregon Department of Fish and Wildlife is responsible for developing a fisheries management plan for Johnson Creek It will address artificial propagation and angling regulations Information gathered under Actions FW-2-5 and FW-2-6 will provide the basis for plan development with respect to reestablishment of a native salmonid fishery.

Action FW-4-2.
Develop off-channel rearing ponds and refugia for coho salmon and other fish.

The limiting factor analysis for anadromous salmonids (Technical Memorandum No 16) revealed that summer water temperature conditions in mainstem Johnson Creek are well above the levels considered suitable for rearing of juvenile coho salmon Headwater tributaries and spring fed pond habitats are the only areas in the watershed where suitable rearing temperature conditions are presently found. Most of the headwater tributaries suffer from moderate to severe sediment deposition, low summer flow and from a general lack of overwintering habitat (deep pools or off-channel backwater areas) Improvement of rearing conditions in the tributary streams will be a

TABLE 22
Fish Habitat Enhancement Plan Element

Objectives and Actions	Implementing Agency/ Responsible Party	Estimated Cost of Action	Portion of Estimated Annual Cost of Action Attributable to JCRMP	Priority
Objective FW-4. Restore Salmonid Fish Habitat (JCCC Goals 2 and 4)				
Action FW-4-1. Complete fisheries management plan	Oregon Department of Fish & Wildlife	Already budgeted	0	A
Action FW-4-2 Develop off-stream rearing ponds and refugia for coho salmon	City of Portland and private landowners	$100,000 (one-time cost)	$100,000 (one-time cost)	B
Action FW-4-3 Construct in-stream habitat improvements[1]	Cities, Counties, WMO, Volunteers	$140,000 (one-time cost)	$140,000 (one-time cost)	A
Action FW-4-4 Construct a trap for upstream migrating salmonids	Volunteers/Oregon Dept of Fish & Wildlife	$5,000 (one-time cost)	$5,000 (one-time cost)	A
Action FW-4-5. Construct a trap for downstream migrating salmonids	Volunteers/Oregon Department of Fish and Wildlife	$5,000 (one-time cost)	$5,000 (one-time cost)	B
Action FW-4-6 Protect habitat for cutthroat trout	WMO	Included in WS-1-4	0	B
Objective FW-5. Maintain a Minimum In-Stream Flow (JCCC Goals 2 and 4)				
Action FW-5-1 Update information on water rights and active diversions	WMO/Oregon Water Resources Department	$25,000 (one-time cost)	$25,000 (one-time cost)	A
Action FW-5-2 Eliminate illegal diversions	Oregon Water Resources Department	$20,000 (one-time cost)	$20,000 (one-time cost)	A
Action FW-5-3 Establish and obtain rights to minimum in-stream flow	Oregon Departments of Water Resources and Fish and Wildlife	Not estimated	Not estimated	A
Action FW-5-4 Obtain water to meet in-stream flow[2]	WMO	$25,000 (one-time cost)	$25,000 (one-time cost)	A
Action FW-5-5 Investigate potential sources of supplemental water	WMO	$25,000 (one-time cost)	$25,000 (one-time cost)	B
Objective FW-6. Protect and Restore Natural Stream Processes				
Action FW-6-1 Promote low environmental impact road crossing[3]	Cities and Counties	Not estimated	Not estimated	B

NOTE

1 Related actions FW-2-1 and FW-2-2
2 Estimate only includes investigation cost
3 Minor costs would be associated with environmental features

TABLE 23
Fish Habitat Improvements by Streams Reach

Reach	Short-term Improvements	Long-term Improvements
1	In-stream structure, creek clean-up	Riparian corridor revegetation
2	Off-stream refugia, clean-up	Riparian corridor revegetation, control of urban runoff
3	Creek clean-up	Riparian corridor revegetation, natural channel formation, control of urban runoff
4	Creek clean-up	Riparian corridor revegetation, natural channel formation, control of urban runoff
5	Off-stream refugia	Riparian corridor revegetation, control of siltation
Crystal Springs Creek	In-stream structure, creek clean-up	Riparian corridor revegetation
Other Tributaries	Removal of barriers to fish movement	Riparian corridor revegetation, control of siltation

long-term process that will require control of sediment input, bank stabilization, improved summer flow conditions and enhancement of the riparian vegetation corridors

In the interim, opportunities for production of coho salmon will be limited to a few locations where the juveniles can utilize spring-fed pond environments for year-round rearing Coho salmon planted in appropriate pond environments in other areas have been shown to grow rapidly and have relatively high survival in comparison to those stocked into stream environments Our surveys of the Johnson Creek watershed indicate that a few existing ponds and several pond sites could be developed for year-round rearing of juvenile coho salmon However, because the RMP goal is a self-sustaining native fishery, only those pond sites which can be used by naturally produced coho will be developed. Consequently, the proximity of existing or potential spawning habitat will be a criterion for pond development The off-stream rearing ponds will need to be connected to the creek by unobstructed outlet channels There will need to be sufficient flow in the outlet channel to allow juvenile fish access to the ponds year-round Initially, some artificial propagation probably will be required to establish runs to these sites. Any such stocking will be conducted in accordance with the long-term goal of re-establishing native fish runs

The criteria for an appropriate rearing pond environment include. (1) perennial springwater input in sufficient volume to maintain summer water temperatures below 18°C and preferably below 15°C, (2) dissolved oxygen concentrations near saturation, (3) absence of other fish predators and/or competitors, (4) an abundant natural food supply, and (5) cover A few existing spring-fed ponds, where temperature conditions may be satisfactory for annual rearing of coho salmon juveniles, have been identified in the upper watershed Other suitable ponds may be present in the watershed, but have not yet been identified. Most of these ponds are on private property and will require landowner cooperation for their use. Some of the ponds would require modifications to their outlets to allow juvenile coho access and egress. Temporary draining of some ponds may be necessary to remove unwanted fish species, to remove accumulations of sediment or to allow excavation for additional depth Enhancement of cover conditions also would be necessary in most of the ponds Figure 38 shows a cross-section of a coho rearing pond with the physical features recommended for food production and protection from predators.

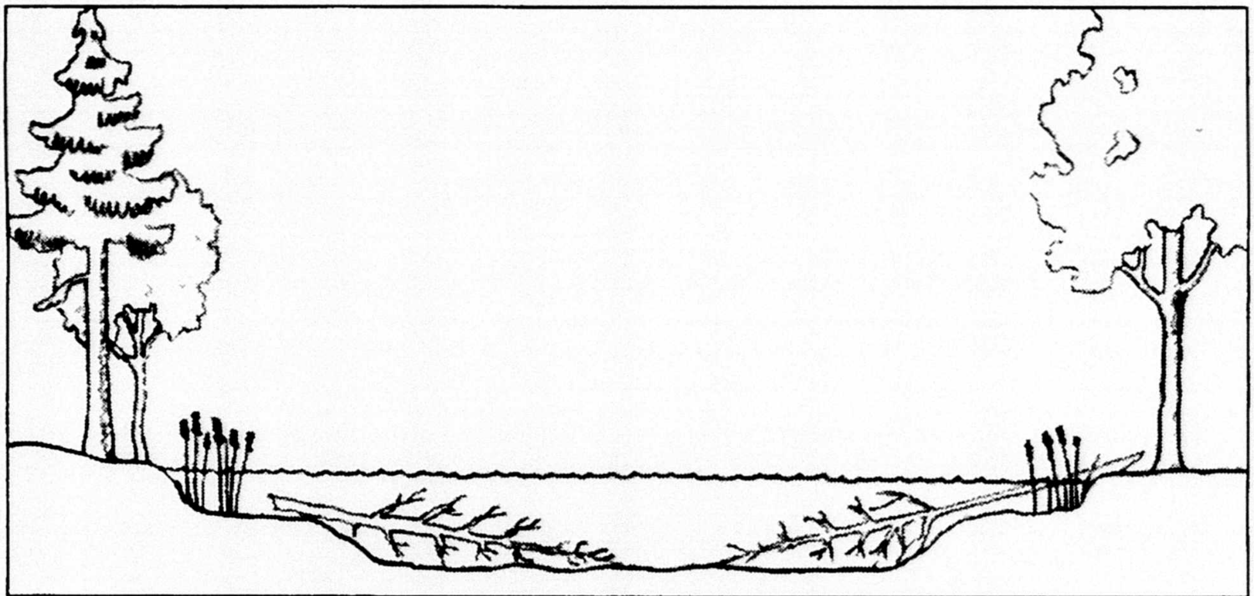
The most promising known sites for coho rearing are in the upper watershed, although there may be additional as-yet-unidentified sites further downstream. Several downstream pond sites in the vicinity of Tideman-Johnson Park were considered, but, while they may be suitable for coho rearing, they lack adjacent spawning habitat, and thus could not support a self-sustaining run of fish

Two of the sites considered could be developed as refuges for fish, amphibians and other life forms that prefer the kind of quiet backwaters that are rare along Johnson Creek. One of the sites is located on undeveloped publicly-owned land, just upstream of Tideman-Johnson Park A series of small, interconnected ponds similar to Figure 38 would be excavated and connected to the creek by a channel allowing fish movement year-round The water table at this location is at the surface and a number of springs and seeps enter the area from higher ground to the north It is likely that sufficient groundwater flow would be intercepted by the ponds to keep the ponds cool and to provide a small outflow to smolts to Johnson Creek It is noteworthy that the site is located in an area of the Springwater Trail corridor that has a variety of interest points for visitors (e g , WPA fish ladder and rock work, Springwater trail head, etc.) The development of a fish refuge area would be an additional point of interest (see Figure 45) The other site lies south of Tideman-Johnson Park on property owned by a JCCC member willing to devote a portion of the site to a pond or fish refuge area

In addition to off-stream pond development, Crystal Springs Lake, adjacent to the Eastmoreland Golf Course, is being considered for coho rearing Crystal Springs Lake receives a large input of spring water and may be cool enough (at least in the immediate area of the spring inputs) to support coho juveniles throughout the year. Temperature data are not available for Crystal Springs Lake and would be collected prior to any attempt to establish rearing in the lake Crystal Springs Lake is shallow and presently has little cover that would allow juvenile coho to escape predators, such as fish eating ducks, blue heron, and kingfisher. Underwater brush piles and/or trees with branches would need to be placed at various locations throughout the lake to provide

FIG 38

Cross Section of Typical Coho Rearing Pond



cover Potential spawning habitat for coho salmon is available where the springs enter the lake. Currently, movement of fish in and out of the lake is blocked by a small dam at the lake outlet. A short fish ladder at the outlet would permit access and possibly allow the establishment of a naturally reproducing run of coho salmon Reed Lake, on the Reed College campus, is spring-fed and also may have potential as coho rearing habitat, if water temperatures are suitable and access problems can be solved

Action FW-4-3.

Construct in-stream habitat improvements

In addition to the off-channel ponds discussed in FW-4-2, the limiting factor analysis (Technical Memorandum No 16) indicated that Reach 1 (lower mile of Johnson Creek) and sections of Crystal Springs Creek could benefit in the near-term from instream habitat enhancement The other reaches of mainstem Johnson Creek suffer from problems associated with low summer flows, high water temperatures and excessive sediment inputs that should be controlled before extensive instream habitat enhancement is considered

REACH 1 OF JOHNSON CREEK

In Reach 1, quality of pool habitat and high water temperatures during smolt development were identified as limiting factors Most of the pool habitat in Reach 1 is shallow and contains little cover. This condition is largely due to the channel straightening and bank rocking done during the 1930s by the WPA as a flood control measure The lower end of Johnson Creek historically meandered over a wide flood plain and undoubtedly had a much more complex channel structure. Re-establishment of some of the complex habitat structure needed to support anadromous salmonids can be accomplished through the use a variety of in-channel habitat structures that are designed to modify the low flow channel characteristics In designing the instream habitat enhancements a balance had to be achieved between optimization of fish habitat and flood control. Therefore, the intensity of habitat enhancement proposed is lower than would be recommended, if flooding was not a concern

A variety of in-stream structures are recommended to create additional pool habitat and increase channel complexity. All of the structures recommended are low in profile and are designed to minimize the accumulation of debris that could increase the chance of flooding The structures include the following.

- Rock single-wing deflectors
- Rock double-wing deflectors
- Digger logs
- Boulder/root wad combinations
- Boulder clusters
- Single boulder placements

Preliminary selection of locations for these structures was accomplished by walking Reach 1 and noting areas that appeared to be appropriate for each treatment Before the final location of the enhancement structures is determined, additional survey work will be required to evaluate their potential effects on flood sensitive areas, potential impacts on stream bank stability and access for heavy equipment. A general description of each of the improvements and their purpose is provided below. Locations of improvements in Reach 1 are shown in Table 24

TABLE 24
Location of Fish Habitat Improvements in Reach 1

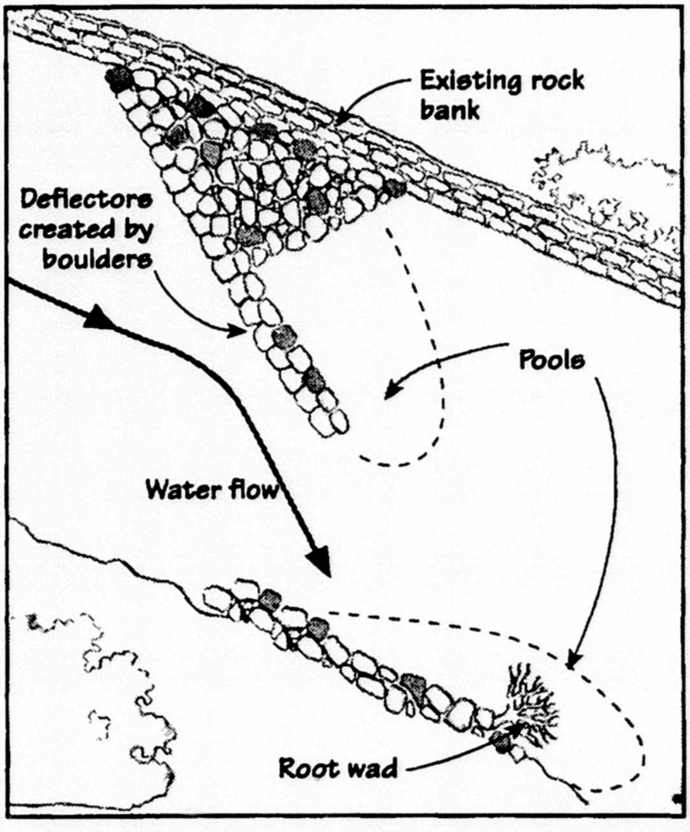
Type of Improvement	No	Location (River Miles)
Single-wing flow deflectors	24	0 20, 0 29, 0 31, 0 32, 0 50, 0 53, 0 61, 0 62, 0 63, 0 67, 0 70, 0 76, 0 79, 0 ,82, 0 91, 0 93, 0 95, 0 96, 0 98, 1 00, 1 09, 1 13, 1 23, 1 24
Double-wing flow deflectors	2	0 59, 0 84
Digger log	3	0 38, 0 55, 0 87

Flow deflectors (Figure 39) are recommended to create a meandering flow pattern in the low flow channel Pools are created where the deflected water strikes the opposite bank and to some extent on the downstream side of the deflector. Through the use of a series of deflectors the low flow channel can be forced to meander back and forth across the straightened existing channel, creating a series of riffles, runs and pools where only shallow riffle and run habitat presently exists. Deflectors also tend to trap gravel and increase the amount of spawning substrate Both rock and log deflectors have been used in stream habitat enhancement work However, minimizing the use of logs for enhancement of Reach 1 is recommended due to the concern for potential wash out of the structures and the effect a resulting log jam could have on flooding

Rocks used for constructing the upstream edge of a wing deflector should be large enough to protrude 8 to 18 inches above the water surface during low flow conditions Rocks 18 to 24 inches in diameter with about 1/3 of their diameter keyed into the streambed are recommended for construction of the primary deflector wing. To be effective the deflectors should narrow the low flow channel by as much as 70 to 80 percent. The deflector wing should be placed at an angle of 30° to 35° to the stream bank The purpose of the deflector is to guide the water rather than block it It is important to fill the downstream side of the wing deflector with rock as shown in Figure 39. This configuration directs overtopping water away from the bank and reduces the potential for bank erosion at the base of the deflector. Where possible, the single-wing deflectors will be located to direct water toward natural cover such as complex root mats that have developed from trees growing along the low flow stream channel. The force of the water directed toward these areas will cause under cut bank habitat with overhanging roots which can be used as cover by juvenile salmonids

FIG 39

Single-Wing Deflectors Constructed of Boulders



Where natural cover is not present, large boulders with root wads attached by cable can be placed on the bank opposite the deflector and provide complex habitat similar to natural cover.

In areas of Reach 1 where single-wing deflectors are not appropriate due to concerns for bank erosion or other channel constraints, double-wing deflectors are recommended (Figure 40) Double-wing deflectors concentrate the water in a narrow channel and cause scouring to occur near the downstream apex of the deflector in the center of the stream Placement of large boulders immediately downstream of a double-wing deflector is recommended to add additional complexity to the channel and to create additional small pools for rearing juvenile salmonids

Installation of several digger logs is recommended to create additional pool habitat in the alluvial bottom material present throughout most of Reach 1 Digger logs create pools by increasing the water velocity in the area of the log which results in removal of alluvial gravel and rubble deposits underneath and somewhat downstream of the log (Figure 41). A natural digger log, created by the roots and partial trunk of a large fallen tree, is located in the upper end of Reach 1 and has created one of the few deep pools in the reach Additional digger logs could be established by burying approximately eight to ten feet of an 18-24 inch diameter log into the stream bank and extending the

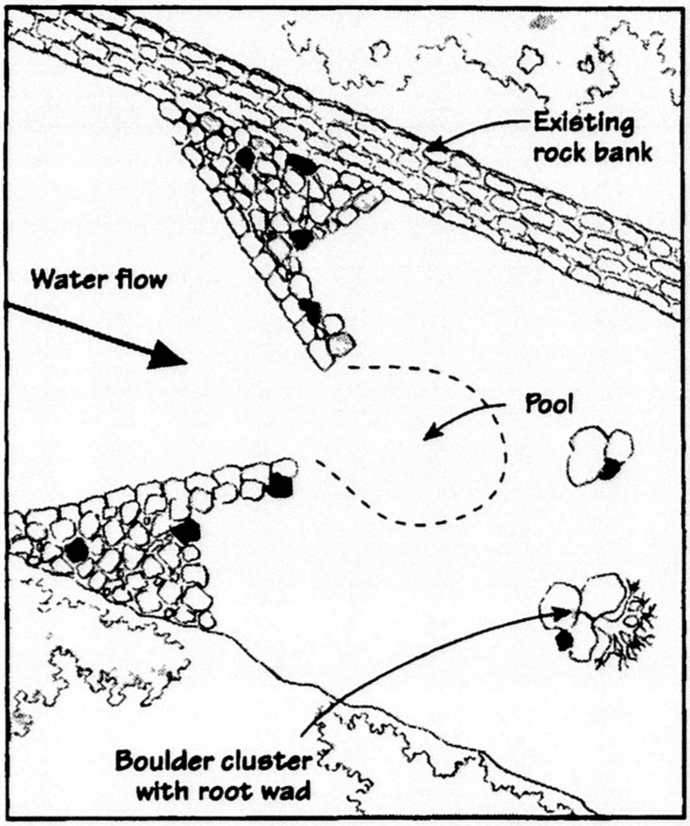
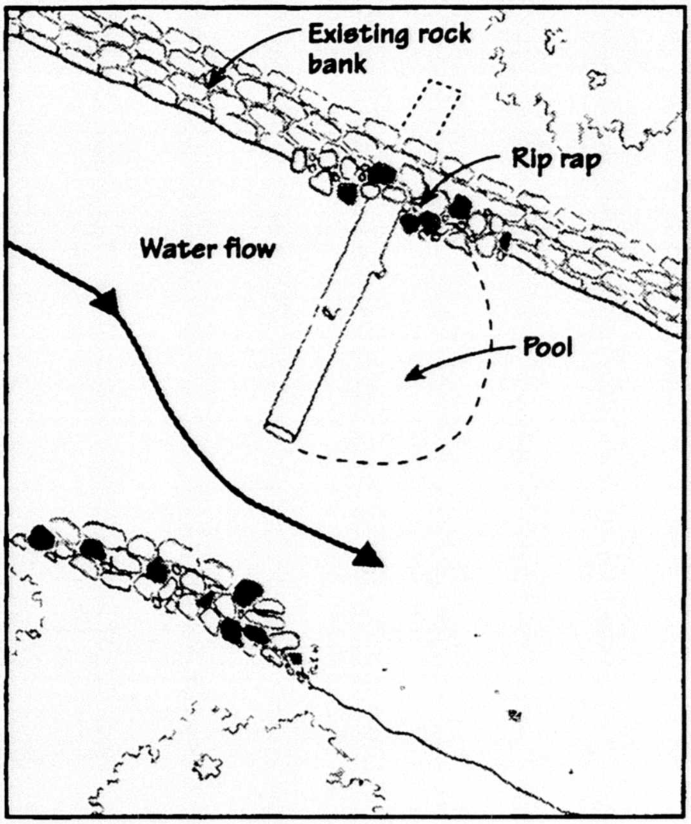


FIG 40

Double-Wing Deflectors Constructed of Boulders

FIG 41

Pool Created by Placement of Digger Log

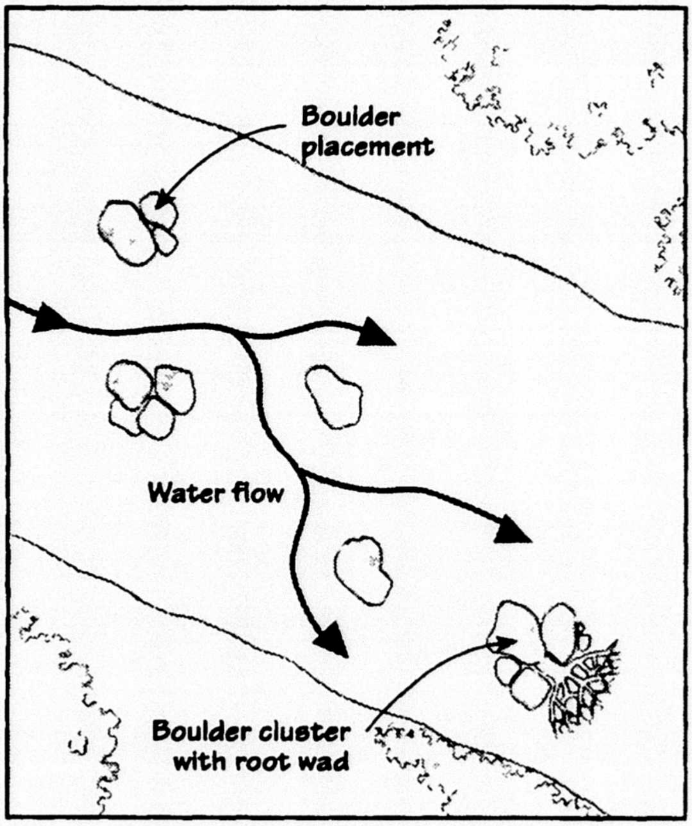


exposed portion approximately one half the distance across the channel at the level of the substrate surface These structures work best where the channel is relatively narrow Placement of several large boulders on the opposite bank would constrict the low flow channel and increase the efficiency of the digger log As indicated in Figure 41, large rocks should be placed around the log in the area where it enters the bank and the continuity of the existing rock wall should be reestablished above the log to prevent erosion Digger logs have a low profile in the stream channel and do not accumulate debris that could influence flood capacity of the channel A fan of gravel suitable for spawning is often created immediately downstream of the pool created a digger log Three of these structures are recommended for Reach 1

Placement of large boulders both individually and in clusters is another enhancement technique that is recommended for improving rearing conditions in shallow riffle and run habitats Boulders provide cover and midchannel feeding areas for juvenile salmonids The turbulence around boulders creates small pools which provide shelter from high water velocities Clusters of three large boulders generally provide more structural diversity and cover than single boulder placements However, both single boulders and boulder clusters can be effective, if properly located in the channel Boulders 2.5 to 3.5 feet in diameter are recommended for Reach 1. A typical placement pattern, including both clusters and single is boulders, is shown in Figure 43.

FIG 42

Boulder Clusters



Root wads provide excellent cover for juvenile salmonids and will be used in conjunction with boulder clusters at selected locations in Reach 1 (e g., Figures 39, 40, and 42). Root wads tend to be scour structures in the channel and keep bed load from accumulating around boulders However, root wads need to be tightly cabled to boulders to avoid floating up during high flow periods or their effectiveness as cover elements diminishes significantly

CRYSTAL SPRINGS CREEK

The limiting factors in Crystal Springs Creek appear to be associated with channel straightening and widening that has occurred throughout most of it length Due to the low gradient and relatively constant flow conditions in Crystal Springs Creek most of the substrate is blanketed with a thick layer of fine silt. Electrofishing surveys indicated that juvenile salmonids were only present in areas where water velocities are sufficient to scour the sediment and expose gravel and rubble substrate To remove silt accumulations water velocity over the substrate needs to be substantially increased. This can be accomplished by narrowing the stream channel and creating tight meanders that create numerous scour points in the channel Installation of a series of single-wing rock deflectors (Figure 43) is recommended as the appropriate treatment to create the desired habitat conditions The best location for such treatment is on the Eastmoreland Golf Course Because flow conditions are nearly constant year round in Crystal Springs Creek the rock deflectors could be covered with topsoil and revegetated with shrubs and grasses Sediment would gradually fill in on the downstream side of the deflectors and also could be revegetated The end result would be a much narrower meandering stream channel with much improved conditions for steelhead trout and coho salmon rearing and spawning.

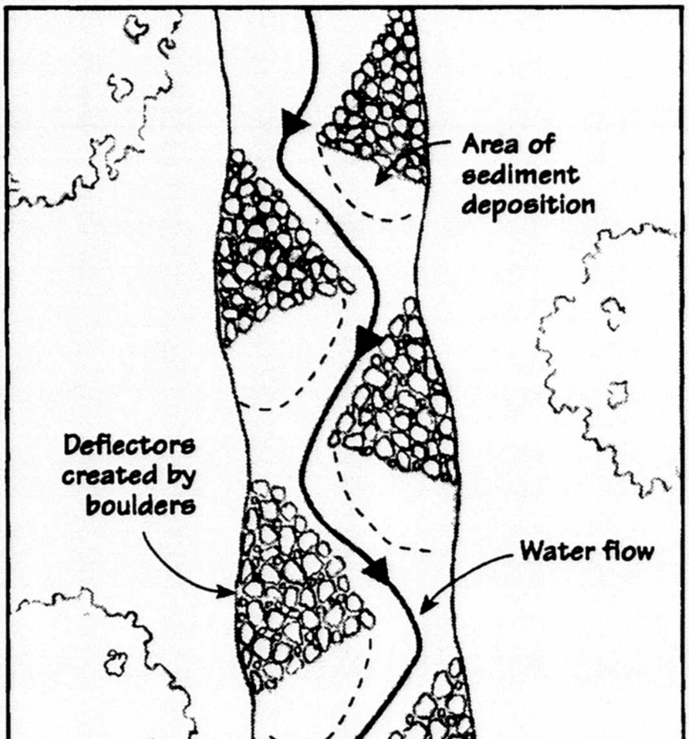
A small pond that has become filled with silt is located just upstream of the enhancement reach on Crystal Springs Creek Dredging of the pond is recommended prior to installation of habitat enhancement structures. Deepening of the pond will reactivate its sediment trapping capabilities and may provide suitable rearing habitat for juvenile coho salmon

UPPER WATERSHED

Although conditions for salmonids are poor in the upper watershed, modest measures will be taken to improve habitat for cut-throat trout and other resident fish species Efforts will focus on restoring and enhancing fish passage into underutilized habitat in tributaries and side channels. Kelley Creek and the North Fork of Johnson Creek offer opportunities for this type of habitat enhancement

FIG 43

Crystal Springs Creek Improvements



Action FW-4-4

Construct and maintain a trap for upstream migrating adult salmonids in lower Johnson Creek

Assessment of the relative contribution of wild and hatchery fish to the anadromous salmonid runs in Johnson Creek can be achieved by trapping upstream migrating adults on their spawning runs From examination of adult fish it is possible to determine whether they have reared in a hatchery or are wild fish that have reared in a natural stream environment If it is determined that the spawning runs are comprised primarily of wild fish or a mixture of wild and hatchery fish, the trap could be used to collect wild fish for hatchery augmentation (if deemed appropriate by Oregon Department of Fish and Wildlife) and for the selective release of wild fish to upstream spawning areas. If it is found that one or more runs are dominated by hatchery fish, selection of an ecologically suitable donor stock(s) from another nearby watershed would probably be necessary to initiate re-establishment of natural reproduction.

In addition to distinguishing between wild and hatchery fish, an adult trap will also provide information on the timing of upstream migration Differences in the timing of spawning runs can sometimes be used to separate hatchery stocks from native stocks. For example, there appear to be two distinct runs of adult steelhead in Johnson Creek The earlier spawning run could represent fish of hatchery origin whereas the late spawning fish could be a remnant of the native steelhead stock

A trap to capture most of the adult salmonids moving upstream in Johnson Creek, above approximately river mile 2, will be constructed in the existing fish ladder near 45th Street Except during flood events, all of the salmon and steelhead moving upstream beyond river mile 2 must pass over the fish ladder. Oregon Department of Fish and Wildlife will provide a trap design that has worked effectively in similar locations on other streams. The trap will have a lid that can be locked to prevent unauthorized removal of fish from the trap. Schedules for trap operation and maintenance will be determined by the WMO fisheries subcommittee

Data collected at the trap will include at least the following. 1) species, 2) presence of fin clips, 3) evidence of dorsal finray deformities indicative of hatchery reared fish, 4) approximate length, 5) sex, 6) stage of maturity, 7) any evidence of disease, 8) scale samples, 9) date and time of observations, and 10) name(s) of data collector Handling of the fish will be kept to a minimum All volunteer trap operators will be trained by a Oregon Department of Fish and Wildlife fisheries biologist. Data collected by the operators will be submitted to the WMO fisheries subcommittee for compilation and then forwarded to Oregon Department of Fish and Wildlife for review and analysis

It is expected that at least three years of trapping will be required to obtain sufficient information on species, numbers of fish, hatchery fish versus wild fish ratios, and run timing to provide meaningful input into the fisheries management plan. Depending on the results of the trapping operations, it may be determined that continuation of trapping will be required for additional years. If volunteer trap operators cannot be recruited, it may be necessary to provide some minimum level of funding to insure that reliable trap operators are available.

Action FW 4-5.

Construct and maintain a trap for downstream migrating salmonids in lower Johnson Creek

Information on the species, numbers, and timing of downstream migrants in Johnson Creek is needed to assess the status of natural production in the upper watershed By continuing the downstream trapping program over time an assessment can be made of the effectiveness of upstream habitat improvements and the overall fisheries management plan. A trap for downstream migrating juvenile salmonids will be installed and operated in lower Johnson Creek. The trap will be located at the fish ladder in close proximity to the adult upstream trap Oregon Department of Fish and Wildlife has a trap design which should work at the fish ladder. The trap will be operated on a set schedule that will allow estimation of total number of downstream migrants Refinement of the sampling schedule will occur after the first year of operation. A water velocity meter will be installed in the mouth of the downstream trap to allow calculation of volume of water sampled. The volume sampled by the net will be compared with the total stream volume passing the net during the sampling period to estimate the percentage of the stream volume sampled This value will be used to estimate the total number of downstream migrants passing the sampling location during the sampling interval

Fish captured in the trap net will be identified by species, enumerated and released to continue their downstream migration. Handling of the fish will be kept to a minimum. The trap operators will be trained by an Oregon Department of Fish and Wildlife fisheries biologist It is anticipated that the same operators that man the upstream migrant trap will also be responsible for the maintenance and operation of the downstream trap. Data collected by the operators will be submitted to the WMO fisheries subcommittee for compilation and then forwarded to Oregon Department of Fish and Wildlife.

Sampling will be conducted for several consecutive years (at least three) at the beginning of the downstream migration study After it is determined that an adequate baseline has been established to describe existing conditions, future sampling will occur less frequently, perhaps at 5-year intervals. These latter estimates will be used to document long-term changes in the capacity of the watershed to produce salmon and steelhead smolts

Action FW-4-6

Protect habitat for cutthroat trout

The measures included in the RMP to improve habitat for migratory fish will also benefit resident fish Some special measures may be needed, however, to ensure that cutthroat trout populations are maintained at current levels or increased. As a first step, the fisheries subcommittee will devise a method for initially inventorying and then monitoring cutthroat trout populations. Based on the results of monitoring it may be necessary to supplement the RMP by adding actions to specifically protect cutthroat trout

Objective FW-5.
Maintain a Minimum In-stream Flow.

One of the most severe limiting factors for all salmonid species in Johnson Creek is low stream flow in the mainstem upstream of Crystal Springs Creek in the late summer and early fall Low flow also degrades water quality Decreased flows can cause water temperatures to rise and dissolved oxygen levels to fall. Excessive aquatic plant growth may occur in stagnant pools and any spills or pollutant discharges have a disproportionately adverse effect when little dilution is available.
Low summertime flow in Johnson Creek, upstream of Crystal Springs Creek, probably occurred even before development as a result of the occasional extended dry period The condition has been exacerbated by hydrologic changes in the watershed resulting from development and by diversion of water for irrigation and other purposes Three possibilities were examined to reverse the decline in summertime flow alteration of the watershed's hydrologic characteristics, providing a supplementary water source during the summer, and curbing water diversions Reducing diversions appears to be the most promising

■ HYDROLOGIC CHANGES

Prior to development the watershed was largely forested. Much precipitation was intercepted by the forest canopy and the carpet of organic matter on the forest floor, and accumulated in small ponds and wetlands Some of this water was used by the native vegetation and some percolated into the ground where it served as a source for streamflow during the dry summer months In the post-development condition a larger proportion of precipitation runs off immediately to stream channels, increasing wet weather peak flows and reducing groundwater recharge It is doubtful that much can be done to alter this trend The creation of percolation basins as part of new development could increase groundwater recharge somewhat Increasing the numbers of trees in the urban area could increase interception by foliage and reduce runoff rates but it is doubtful that it would have much effect on percolation rates. Substantial increases in groundwater recharge, and consequently summertime flow, would not occur unless the watershed was returned to its former forested condition, obviously a practical impossibility

■ SUPPLEMENTARY WATER

Summertime creek flow could be increased by release of stored water or water from another source A portion of the wintertime storm flow could be stored in reservoirs in the upper watershed and released during the summer months As part of the flood management plan element, several detention reservoirs with a total storage capacity of 400 acre-feet are proposed As proposed the detention reservoirs would normally be dry. They would only retain water during large storms These reservoirs could be designed to have a dual purpose, flood control, and storage of water in the spring for later release during the summer low flow period. The proposed reservoirs, modified to store and release water, could provide a supplementary flow of 2 to 3 cfs for two months in the summer. The construction of additional reservoir storage, beyond the currently proposed 400 acre-feet, would probably involve the displacement of homes and businesses

The idea of dual purpose reservoirs was rejected for several reasons Dual purpose reservoirs would permanently inundate large upstream areas and destroy any wetlands present (creek channels are classified as wetlands) Wetlands are regulated by the U.S. Army Corps of Engineers and the Oregon Division of State Lands Because single purpose flood detention reservoirs would destroy a much smaller area of wetlands than dual purpose reservoirs it is likely that construction permits would be more simple to obtain

Dual purpose reservoirs would be more expensive to build and operate than single purpose reservoirs Once built, single purpose reservoirs would function passively They would work when needed without human intervention. Dual purpose reservoirs, on the other hand, would need to be actively managed. The outlet of the reservoir would be equipped with gates or valves At some time in the spring an operator would have to decide that the reservoir's winter time flood detention function had been fulfilled, and that the gates should be shut to store water for later release. As a reservoir begins to fill in the spring, it would become unavailable for flood

Water stored in the reservoirs would be subject to solar heating. Because elevated summertime water temperatures in Johnson Creek is a problem for salmonid fish, the release of warm water from the reservoirs might not be helpful It may be possible to reduce the problem of heated water releases by drawing from the bottom of the reservoirs but the effectiveness of this approach is limited by the shallowness of the reservoirs.

Another serious disadvantage of the dual purpose reservoirs is that they would have an unappealing appearance. After holding water for several months they would be drawn down over the summer to reveal muddy expanses of dead vegetation. Obtaining public, and particularly neighborhood, acceptance of dual purpose reservoirs would likely be more difficult than for the less visually-intrusive flood detention reservoirs.

Rather than construct dual-purpose reservoirs, it may be more practical, although expensive, to construct separate reservoirs for flood storage and for summer flow augmentation This would avoid the potential loss of flood storage in the spring However, the permitting and public acceptance problems noted above would remain

Other potential sources of supplemental water could be deep wells or releases from the Bull Run watershed Nurseries in the upper basin obtain some of their water supplies from deep wells Water from a similar source could be used to supplement Johnson Creek flows. The Bull Run aqueduct terminates at Powell Butte on the north side of Johnson Creek. Occasionally excess water is released from the terminal reservoirs to the creek Planned releases could be made to supplement Johnson Creek flow.

■ CURBING DIVERSIONS

Under Oregon law, all water is publicly owned With some minor exceptions, farmers, factory owners or other users must obtain a permit or water right from the Water Resources Department to divert and use water A water right is a type of property right and is attached to the land where it was established If the land is sold, the water right goes with the land to the new owner Landowners with water flowing past or through their property do not automatically have the right to divert the water without state permission

As in most western states, Oregon water law is based upon the "prior appropriation" doctrine Under this doctrine, rights for withdrawal of water are given priority based on the date they were acquired During shortages, earlier permittees receive water while more recent permittees may not In Oregon, the appropriation doctrine has been law since 1909 when passage of the first unified water code introduced state control over the right to use water Before then, water users had to depend on themselves or local courts to defend their rights to water

A water right is valid as long as it is used beneficially at least once every five years After five consecutive years of non-use, the right is considered forfeited. Some uses of water do not require water rights These are called "exempt uses." Exempt uses of surface water include the landowner's use of a spring which, under natural conditions, does not form a natural channel and flow off the property where it originates Stock watering is also exempt if it is directly from surface sources where there is no diversion or other modification to the source Water diversions for egg incubation projects under the Oregon Department of Fish and Wildlife's Salmon and Trout Enhancement Program (STEP) are also exempt

Quite commonly streams become over appropriated, that is, permits are issued for water diversions that exceed the flow available at certain times When this occurs the Oregon Water Resources Commission closes the stream to further appropriation. On May 25, 1966, Johnson Creek and its tributaries, except Crystal Springs Creek and tributaries with flows in excess of 10 cubic feet per second, as measured at their mouth, were withdrawn from further appropriation, except for protection of fish and minor power development. Appropriation and storage are allowed on Johnson Creek tributaries, but not on the main stem, from December 1 through June 1 of each year (ORS 538 170)

During the summer, water is diverted from Johnson Creek and its tributaries for irrigation and livestock watering Sixty nine permits to divert water from Johnson Creek and its tributaries have been issued by the Oregon Department of Water Resources Permitting procedures make it difficult to determine current levels of water diversion and use. Permits do not have expiration dates and permit holders do not always notify the Water Resources Department when they discontinue water use It is not known how many of the 69 permits actually represent current water users on the creek According to the Water Resources Department's watermaster, there may also be many additional water users on Johnson Creek who are withdrawing water without a water right

The first step in a program to increase summertime flow in Johnson Creek is to develop a complete and accurate picture of current water rights and actual diversions Some of the diversions occurring today may be illegal Elimination of illegal diversions could return some flow to the stream.

The second step is to establish rights to in-stream flow Historically water rights were only given for what were regarded as beneficial uses — maintaining in-stream flow for fish and wildlife was not regarded as a beneficial use Now rights to water for in-stream flow are issued by the Water Resources Department, but can only be held by the state. The Oregon Department of Fish and Wildlife often files for rights to in-stream flow They have done so for Johnson Creek and Crystal Springs Creek but in-stream rights have not yet been granted

Even if in-stream water rights are granted this will not guarantee that the desirable minimum flow in the creek will be maintained In-stream water rights, like all of Oregon's water rights are subject to the prior appropriation doctrine Water rights issued prior to the in-stream rights cannot be curtailed in time of shortage to meet the in-stream right. On an over-appropriated stream like Johnson Creek prior rights may still dewater the stream in dry years Because of this it may be necessary to buy, lease or receive as a gift prior water rights in order to be able to maintain the desired minimum in-stream flow

Action FW-5-1.

Update information on water rights and active diversions

With the assistance of the Water Resources Department, the current list of withdrawals in Johnson Creek will be updated, withdrawals will be quantified, and a concise, easily-readable list of current water rights prepared Water rights for existing impoundments will also be reviewed.

Action FW-5-2.

Eliminate all illegal diversions

Many people who live adjacent to streams may not be aware that they need a water right to withdraw water As a result illegal withdrawals occur even when there is no intent to break the law Preparation and distribution of a current water rights list for Johnson Creek and its tributaries, along with a map clearly locating each withdrawal, would enable citizens to identify illegal withdrawals Since water rights inspections by the water master are almost exclusively in response to complaints registered in the Water Resources Department office, this heightened citizen awareness would complement his efforts to control illegal withdrawals. In addition, citizens could assist agencies and the WMO in efforts to educate streamside landowners about water rights, and the need for and benefits of instream flow.

Action FW-5-3.

Establish and obtain rights to a minimum in-stream flow

Until 1955, Oregon water law did not recognize in-stream flow as a beneficial use of water. In that year the legislature allowed, by administrative rule, the establishment of minimum streamflow levels for fish and wildlife and for pollution abatement. Over the next 32 years minimum flows were set for most large streams and rivers. No minimum flow was established for Johnson Creek or its tributaries Minimum streamflows set by the state in this way did not enjoy the same legal status as water rights In times of shortage the Water Resources Commission could waive the minimum in-stream flow in favor of water rights that were granted after the establishment of the minimum flows. As a result the state's minimum streamflow administrative rule was not very effective in protecting in-stream water uses.

In 1987, legislation was passed to strengthen the protection of in-stream water uses The Instream Water Rights Act allows in-stream water uses to be regulated in the same way as other water uses Water rights are now granted for in-stream flows and the rights have the same legal status as any other water right In-stream rights can no longer be curtailed in favor of junior appropriative rights

Under the new legislation, instream water rights can be created in three ways Existing minimum streamflows under the 1955 administrative rule can be converted into water rights Three state agencies, the Oregon Departments of Fish and Wildlife, Environmental Quality and Parks and Recreation, may apply to the Oregon Water Resources Department for new instream water rights Private rights to water can be transferred permanently to in-stream use or leased temporarily for the same purpose

Only the last two methods are applicable to the RMP because no minimum flow was set for Johnson Creek under the 1955 administrative rule.

On April 30, 1991, the Director of the Oregon Fish and Wildlife Department applied for instream water rights for Johnson Creek and Crystal Springs Creek. The quantity of water requested on Johnson Creek varies from 4 to 25 cubic feet per second (cfs), and from 10 to 15 cfs in Crystal Springs Creek The applications underwent technical review by the Oregon Water Resources Department, and the results were released for public review until March 11, 1994.

According to ODFW, the Water Resource Department's technical review recommended that the instream water rights be reduced in Crystal Springs from 10 cfs to 0.1 cfs in September, and from 15 cfs to 3 65 cfs in February The Water Resources Department agreed with the application amounts on Johnson Creek ODFW submitted comments disagreeing with the accuracy of the technical review process for the Crystal Springs analysis No in-stream water rights have been granted yet for either stream.

If ODFW's original application for rights to 10 to 15 cfs in Crystal Springs Creek is granted, then in-stream flow, sufficient to meet the needs of aquatic life, will be protected from later appropriation This is because there is currently enough unappropriated flow in Crystal Springs Creek to fulfill the in-stream rights ODFW should continue to press for its application for 10 to 15 cfs Johnson Creek, on the other hand, is fully appropriated and so there is no water available to fulfill the new in-stream water rights. Unless water becomes available the state's ownership of in-stream rights will not provide a minimum flow for aquatic life.

Action FW-5-4.

Obtain water to meet in-stream minimum flows

Because Johnson Creek is fully appropriated, almost the only way to obtain more water for in-stream uses will be to buy, lease or receive as a gift existing water rights, as allowed under the provisions of the 1987 Instream Water Rights Act Water rights transfers of the kind contemplated in the Act are in their infancy in Oregon WMO will investigate the feasibility of executing transfers of water rights on Johnson Creek.

A second avenue for obtaining in-stream flow has been opened by recent state legislation A new law attempts to encourage investment in more efficient use of water while obtaining water for in-stream uses. If a water right holder implements an approved water conservation plan the holder is allowed to keep a portion of the water saved. Seventy percent of the water saved this way is allocated to the permit holder and the remaining 25 percent is allocated to the state. However, according to Water Resources Department staff, permit holders have shown little or no interest in the new law. Amendments to the law have recently been proposed which would make it easier for water rights holders to participate in this conservation program

It may also be possible to increase summer time base flow by requiring existing property owners to route all or part of their stormwater runoff to sumps or percolation ponds. This will increase groundwater storage and perhaps increase the amount of groundwater available to supply surface streams in the dry season

Action FW-5-5.

Investigate potential sources of supplemental water.

In the event that insufficient stream flow can be obtained via the water rights process, then supplementary water sources will be investigated Possibilities include modifying the proposed dry detention basins to provide storage for stream flow augmentation, construction of additional reservoirs dedicated to stream flow augmentation, deep wells in the upper basin or releases of water from the Portland water supply system The first two possibilities are considered superior to the latter two because they would provide water from the Johnson Creek watershed Water from a different source, groundwater or water from the Sandy River watershed, may make enhancement of the native fishery more difficult. Migratory fish use the unique characteristics of their native stream to locate their spawning grounds Also, there is a moratorium on well drilling in the upper watershed and Portland's water is chlorinated; it would have to be dechlorinated before it is released to a stream The dry detention basins would be constructed in a way that would not preclude the future possibility of conversion to multiple use. Also, the WMO will keep abreast of scientific developments concerning the use of shallow aquifers for stormwater disposal and deep aquifers for regional water supply.

Objective FW-6.

Protect and Restore Natural Stream Processes

As noted earlier, the lack of natural stream evolution processes reduces the fish habitat value of Johnson Creek The gradual erosion and deposition of eroded bank materials and the periodic accumulation of downed trees and shrubs in the stream channel are some of the processes that benefit fish. Although human intervention in these processes is necessary in some reaches of the creek in order to prevent flooding or destabilization of stream properties, it is not necessary or can be curtailed in less developed areas For example, in Leach Botanical Garden or the publicly-owned stream reaches downstream of Gresham, natural processes could be allowed to take their course An exception is that any large downed trees left in the stream channel will need to be secured to prevent fouling of downstream bridges during floods.

The general philosophy of this objective is embodied in several parts of the RMP which seek to maintain Johnson Creek in as natural a state as possible within an urban and urbanizing environment. Objective FM-1 seeks to prevent increases in downstream peak flow as a result of upstream development Objective FM-2 seeks to reduce flooding in vulnerable areas without replacing natural creek reaches with a lined channel, or destroying wildlife habitat during creek maintenance activities Objective FW-2 seeks to restore native vegetation along the creek banks

Action FW-6-1.

Promote low environmental impact road crossings.

There are many existing road crossings of Johnson Creek and its tributaries. As the watershed develops it can be expected that existing crossings will need to be rebuilt, as roads are widened, and new crossings will become necessary The new and rebuilt crossings will incorporate features that allow the creek channel to remain in as natural a state as possible. For example, crossings should not pose a barrier to the movement of fish or wildlife, a natural channel bottom should be retained, and the interruption in the canopy of riparian vegetation should be minimized.

WATERSHED STEWARDSHIP PLAN ELEMENT

INTRODUCTION

The watershed stewardship plan includes a variety of actions designed to protect and enhance environmental quality while encouraging wise human use of the watershed's natural resources It differs from the previous three plan elements in that it does not target a particular aspect of environmental quality The actions contained in the watershed stewardship plan are designed to improve the watershed as a whole, or integrate environmental improvement with other human interests The actions build on past, and complement current, watershed stewardship efforts by local governments and citizen groups

The stewardship plan element addresses four aspects of watershed management, management institutions, land use regulation, recreation, and protection of cultural resources It also addresses measuring progress toward RMP goals

Existing institutional arrangements for environmental management are not well-suited to implementing all aspects of the RMP. The RMP contains about 60 actions, some would be taken by public agencies and others by private parties or non-governmental organizations. The existing institutional arrangements need to be modified to improve coordination between public agencies in the watershed and to provide a vehicle for greater involvement of citizens and private organizations in decision-making and creek improvement projects

Cities and counties have the responsibility for regulating land use. Their goal is to reconcile the economic need for growth with the desire to protect natural resources and retain an attractive living environment. Some adjustments to current land use regulations are needed to achieve this goal in the Johnson Creek watershed

One of the JCCC's goals is to ensure that recreational opportunities exist in the creek corridor The fact that the Springwater Corridor Trail parallels much of Johnson Creek provides opportunities and challenges The trail offers hikers, cyclists and equestrians access to a enhanced creek corridor On the other hand, access can lead to conflicts between human use and wildlife habitat values The RMP seeks to balance public access and protection of natural resources

Another of the JCCC's goals is to protect the watershed's cultural heritage Properly protected and interpreted, cultural relics can aid understanding of man's influence on the watershed and its natural resources. They also add interest to the Springwater Corridor Trail

Finally, the watershed stewardship element addresses the need to continuously monitor progress with the RMP. It cannot be expected that implementation of the RMP will occur flawlessly. Life is unpredictable and circumstances change. While the RMP establishes an ultimate goal, the route to the goal may need to be modified Progress needs to be monitored so that successful approaches to creek improvement are recognized and capitalized upon. Less successful approaches can be modified or dropped

Watershed Management Institutions

Traditionally, environmental management has been the responsibility of local governments Citizens have relied on local government to make land use decisions, to dispose of solid and liquid wastes safely, to provide parks, and protection from flood waters. For much of this century, local governments alone decided whether, and how much, they should invest in environmental protection measures Their decisions were as varied as the views of their electorates However, in the last twenty years, local governments have increasingly performed their environmental management function within a regulatory framework established by state and federal governments. To a considerable degree, local governments now simply decide how best to comply with regulations imposed by state and federal governments Citizens' responsibilities have been largely limited to paying the taxes necessary to support government In most cases, this has worked satisfactorily and will continue in the future. However, as we move toward environmental management on a watershed basis, some reexamination of the division of responsibility between local government and citizens is necessary In addition, it is worth examining the related issue of watershed boundaries and their lack of coincidence with the boundaries of local governments

THE CHANGING ROLE OF CITIZENS AND GOVERNMENT IN WATERSHED MANAGEMENT

Watershed or basin plans were prepared all across the United States during the 1970s These watershed plans were a requirement of the amended federal Water Pollution Control Act passed by the Congress in 1972 The huge investment in water pollution control made by cities and industries in the 1970s and 1980s was based on these watershed plans As the nation begins to consider developing a second generation of watershed plans, it is worth examining the characteristic features of the earlier plans Watershed plans in the 1970s were

- Prepared by units of state government
- Focused on large, easily identified pollutant sources – point sources
- Dependent on regulatory action as the way of ensuring implementation
- Only peripherally involved citizens and stakeholders

The new generation of watershed plans, of which the Johnson Creek RMP is an example, are structured differently to succeed in an altered environment. The new plans focus on the control of diffuse sources of pollution – non-point sources. Their implementation will involve thousands of corrective actions taken by cities and counties, landowners, other stakeholders and private citizens, rather than a handful of major projects implemented by cities or industries Because of the diversity of the corrective actions, many more individuals are involved in plan development and implementation than were involved in the 1970s The RMP and other similar watershed plans are.

- Prepared by stakeholder groups organized as watershed councils or committees
- Focused on diffuse or non-point source pollutants but comprehensively address all aspects of watershed health
- Dependent on largely voluntary commitments by local governments and citizens to implement the plan
- Dependent on citizens and stakeholders in a partnership with local governments
- Encouraged, but not mandated, by federal or state law

Implementation of watershed plans prepared in the 1970s was largely the province of governments and large industries The watershed plans of the 1990s will be implemented by citizens, citizens groups, businesses large and small, and governments New institutions will be needed to deal with the complexities of a more participatory form of environmental management

WATERSHED AND INSTITUTIONAL BOUNDARIES

There is an overwhelming logic to environmental management on a watershed basis It is impossible to effectively manage stream water quality or fish habitat without exercising some control over land use in the stream's watershed. Flood control in the lower reaches of the stream is unlikely to be effective if it is not linked to controls on development in the upper watershed. However, this logic is rarely reflected by the boundaries of existing institutions of government because they have been shaped by social and economic, rather than environmental, factors The Johnson Creek watershed is typical in that its boundaries contain parts of two counties and four cities None of the city and county boundaries coincide with watershed boundaries

A further complicating factor is that the responsibility for certain aspects of watershed management lies with state and federal agencies rather than local government These agencies are organized on a regional or statewide basis. Again, their jurisdictional boundaries do not coincide with watershed boundaries

The lack of coincidence between watershed and institutional boundaries has several disadvantages Most important is the division of responsibility between several units of government. Divided responsibility tends to inhibit action and increases the need for coordination between agencies. Another disadvantage is the fact that no agency has Johnson Creek as its first priority. Many government agencies have some responsibility for the Johnson Creek watershed but their attention is spread over a larger area. The current division of responsibility for environmental management in the watershed is shown in Table 25

TABLE 25
Current Management and Regulatory Responsibilities in
Johnson Creek Watershed

Direct Management Responsibilities	
Land Use	Cities and counties
Sewerage	Cities, counties and special districts
Flood Control	Cities and counties
Fish and Wildlife	Oregon Department of Fish and Wildlife
Regulation	
Water Quality	Oregon Department of Environmental Quality and Oregon Department of Agriculture
Water Diversion	Oregon Water Resources Department
Wetlands	U S Army Corps of Engineers and Oregon Division of State Lands
Federal and state endangered and threatened species lists – also state species of concern list	U S Fish and Wildlife Service, National Marine Fisheries Service, and Oregon Department of Fish and Wildlife

Bearing in mind the current, less than ideal institutional structure, the question obviously arises how best to obtain the benefits of environmental management by watershed. Two basic approaches are apparent the first would radically change the existing institutions of government to conform to watershed boundaries, the second would attempt to implement watershed management largely through existing institutions The first of these approaches, while perhaps desirable theoretically, is a practical impossibility. Thus, the second approach is embodied in the RMP

LAND USE REGULATION

One aspect of stewardship is the wise management of land to protect the watershed's natural resources Regulation of land use is the responsibility of city and county government City and county government land use regulation occurs within a framework established by state government In 1973, the Oregon legislature passed a statewide land use planning law designed to control urban sprawl and the loss of open lands. The law established the Oregon Land Conservation and Development Commission which developed nineteen statewide planning goals. These goals provided a framework within which cities and counties prepare their comprehensive plans City and county comprehensive plans are reviewed by the Land Conservation and Development Commission for compliance with the statewide planning goals.

It was assumed, in developing the RMP, that the watershed's future would be as currently envisaged in the city and county comprehensive plans. Although current land use designations may not be ideal from an environmental perspective, they have been arrived at through the normal democratic procedures of local government The compromises that have been made to balance environment and economy represent the wishes of the majority Thus, in general, the RMP treats current land use designations as a given The only exception is in the area immediately adjacent to Johnson Creek and its tributaries where the RMP includes proposals that could lead to changes in land use designations.

Fourteen of the statewide planning goals apply to the Johnson Creek watershed However, Goal 5 is the most relevant to the RMP Goal 5 requires that cities and counties "conserve open space and protect natural and scenic resources." Each of the six local government units in the watershed has taken steps to comply with Goal 5, although their regulations vary widely from jurisdiction to jurisdiction (see Technical Memorandum No. 10) Portland has complied with Goal 5 by establishing environmental zones (E-zones) within which development is restricted The E-zones are applied as a zoning overlay in areas with high natural resource values E-zone boundaries were established based on the results of natural resource inventories The Cities of Gresham and Milwaukie, and Multnomah and Clackamas Counties have adopted similar, but not identical approaches Each jurisdiction's requirements are summarized in Table 26.

TABLE 26
Comparison of Land Use Restrictions in the Johnson Creek Watershed

	Sensitive Area Classifications		Riparian and Wetland Area Restrictions	
Jurisdiction	Open Spaces	Natural Areas	Buffer Widths	Transition Zones
Portland	Yes	Yes (Environmental Zone)	Determined by Natural Resource Area site-specific definition (Chapter 33 430)	25 feet
Gresham	Yes	Yes (Natural Resource District)	Natural Resource sites must be designated in environmental report (Vol 4, Article III, Section 2 0554)	25 feet
Milwaukie	Yes	Yes (Natural Resource Overlay Zone)	Defined in Zoning Ordinance Section 322 2 for riparian, wetland and habitat areas	"Adequate" development setback required (Section 322 7)
Happy Valley	No	No	No	No
Multnomah Co	Yes	Yes (Significant Environmental Concern District)	100 feet from the normal high water line, or FEMA 100-year floodplain	No
Clackamas Co	Yes	Yes (Significant Natural Area)	Maximum of 150 feet, defined in Development Standards, Section 1002 05, part B	25 feet

It is not clear how effective the zoning regulations are in actually protecting natural areas along the creek. There is probably considerable variation from jurisdiction-to-jurisdiction Portland's E-zone regulations provide a high level of protection to the creek, particularly from new development. When a developer proposes to build within an E-zone, a detailed permit application must be filed. The permit application is subject to scrutiny by city staff before a permit is granted. However, it is likely that many small creekside land owners do not understand the regulations. The fact that the cutting of large trees or modification of stream banks require E-zone permits may not be widely known or accepted. In general, minor violations of the E-zone regulations are not pursued by the city unless complaints are made.

Although the regulations applied to the rural areas appear weaker than those for the more urban parts of the watershed, they probably provide the creek a reasonable level of protection from the effects of major new development Proposals to convert land from agricultural uses to housing subdivisions undergo a rigorous environmental review On the other hand, agricultural land owners are relatively free to manage their land as they wish, even if it adversely affects the creek When agricultural land owners make changes on their property that could affect the creek, removal of riparian vegetation for example, no permits are required DEQ and the Oregon Department of Agriculture exercise some control over agricultural practices that adversely affect water quality, but restrictions do not extend to land use practices that may damage wildlife habitat if the practices do not substantially affect water quality.

RECREATION

Currently, there are 49 developed parks and recreational facilities within the Johnson Creek watershed The parks are managed by four public park providers, the Cities of Portland, Milwaukie, Gresham, and North Clackamas Parks and Recreation District. A few recreational facilities are privately-owned The total area of parks and recreational facilities is 1,023 acres. State guidelines indicate that, for the projected 1995 watershed population, there should be between 1,500 and 2,700 acres of open space accessible to the public. Without the acquisition of additional land for parks, the open space deficit will increase as the population of the watershed grows.

A key recreational facility in the Johnson Creek watershed is the Springwater Corridor Trail The Springwater Corridor, which occupies a former railroad right-of-way, parallels Johnson Creek for much of its length The Springwater Corridor Trail acts as an accessway to other parks and recreational facilities, 18 of which lie adjacent to, or within a short distance, of the trail The 18 parks and recreational facilities close to Johnson Creek and the Springwater Corridor are shown in Table 27

The Springwater Corridor extends more than 16 miles from S.E. McLoughlin Boulevard in Portland to the community of Boring and beyond. The corridor is part of a former railroad right-of-way that extends from Portland to Cazadero, on the Clackamas River. The railroad was built in 1903 to provide passenger service to suburban communities east of Portland,

and access to several dam sites on the Clackamas River Transmission lines along the corridor conveyed hydroelectric power, generated at the dams, back to Portland The railroad enjoyed its greatest success around 1910 After the First World War, patronage declined as automobiles became popular In 1932, service on the line between Boring and Cazadero was terminated, and the right-of-way purchased by the State of Oregon. In 1958 all passenger service ended. Freight service continued until 1989, when the remainder of the right-of-way was purchased by the Oregon Department of Transportation and its ownership transferred to the City of Portland. The City of Portland may use the property, but must keep the corridor intact and available for future rail use, should the need arise. The corridor continues to be used for the transmission of electrical power.

Planning for recreational use of the corridor began in 1991 The Springwater Corridor Master Plan was published in November 1992 The plan includes a trail running the full length of the corridor from McLoughlin Boulevard to Boring and beyond. A multi-purpose hard-surface trail will run approximately 13 miles from McLoughlin Boulevard to the eastern outskirts of Gresham A soft surface trail suitable for hikers will continue to Boring. A separate equestrian trail will run from near Tideman Johnson Park to Boring Eight trailheads are proposed along the corridor Three trailheads will be located in Portland near S E 45th Avenue, near Interstate 205 and at S E 136th Avenue Four trailheads will be in Gresham at Linneman Junction, 10th Street, Main City Park and Hogan Road The most easterly trailhead will be in Boring The S.E. 45th Avenue, 10th Street and Boring trailheads will accommodate equestrians

TABLE 27
Parks and Recreational Facilities Near Johnson Creek

Park	Park Type	Ownership	Acreage
Main City Park	Community	Gresham	17 5
Johnson Creek Park	Neighborhood	Portland	2 9
Leach Botanical Garden	Garden	Portland	5 0
Eastmoreland Golf Course	Golf course	Portland	149 6
Westmoreland Park	Community	Portland	46
Powell Butte	Open space	Portland	569
Beggar's Tick Marsh	Open space	Multnomah County	10 1
Butler Creek Greenway	Open space	Gresham	23 8
Johnson Creek Open Space	Open space	Gresham	28 9
Regner Road	Open space	Gresham	8 7
Tideman Johnson Park	Open space	Portland	6 0
Bundy Park	Undeveloped	Portland	3 7
Club Paesano	Picnic facilities	Non-profit corporation	11 2
Eastmoreland Tennis Club	Tennis club	Private	6 2

The Springwater Corridor Trail and Johnson Creek complement each other perfectly. An enhanced Johnson Creek will make use of the trail more pleasurable by providing a more scenic setting, and opportunities for wildlife observation and environmental education. The trail will provide managed public access to portions of the creek The actions contained in the RMP are designed to promote complementary improvements to the creek and trail.

CULTURAL HERITAGE

Limited surveys of cultural resources have been conducted in the Johnson Creek watershed A single prehistoric archeological site, near the headwaters of Crystal Springs Creek, is formally recorded, but local residents report finding arrowheads and other artifacts along the main stem of Johnson Creek for many years A predictive model developed for the Portland Bureau of Parks and Recreation indicates that about 40 prehistoric archeological sites can be expected to be found if a watershed-wide survey is conducted

Two historic archeological sites in the watershed have been documented They are old bridge footings at Tideman Johnson Park and near the existing covered Cedar Crossing bridge Forty-four historic structures have been identified, but only a few are located near the creek They include rockwork constructed by the Works Progress Administration, including the waterfall and fish ladder near S.E. Harney Street, the S E Tacoma Street bridge, the Bell Station store, Leach Botanical Garden, Linneman Railroad Station and the Gresham Pioneer Cemetery

PLAN OBJECTIVES AND ACTIONS

The watershed stewardship plan is organized as a series of objectives and actions The objectives are general statements of intent based on the goals established by the Johnson Creek Corridor Committee The actions are the specific programs and practices necessary to achieve the objectives Table 28 lists the objectives and actions, identifies the party responsible for each action, and includes an estimate of the cost of each action

OBJECTIVE WS-1
Establish Institutional Infrastructure for Long-term Watershed Management.

Establishment of the institutional infrastructure necessary to implement the RMP is critical to the plan's success. Without the right institutional infrastructure the RMP is likely to share the fate of many other well-meant plans – dust-gathering on a forgotten shelf. Because the actions proposed in the RMP are so diverse, they cut across the turf of many existing agencies. No single existing institution has a mandate for comprehensive planning of the Johnson Creek watershed, or the authority to implement the RMP on its own.

TABLE 28
Summary of Watershed Stewardship Plan Element

Objectives and Actions	Implementing Agency/ Responsible Party	Estimated Cost of Action	Portion of Estimated Annual Cost of Action Attributable to JCRMP	Priority
Objective WS-1. Establish Institutional Infrastructure for Long-Term Watershed Management				
Action WS-1-1 Establish permanent watershed management organization	JCCC	$20,000 one-time cost	$20,000 one-time cost	A
Action WS-1-2 Obtain stable funding source for watershed management organization	JCCC	$20,000 one-time cost	$20,000 one-time cost	A
Action WS-1-3 Operate watershed management organization[1]	WMO	$100,000 annual cost	$100,000 annual cost	A
Action WS-1-4 Establish special purpose subcommittees	WMO	Included in Action WS-1-3	Included in Action WS-1-3	B
Objective WS-2. Foster Development of a Watershed Stewardship Ethic (JCCC Goals 6, 8, 9, and 11)				
Action WS-2-1 Establish a Johnson Creek information clearinghouse and library	WMO	Included in Action WS-1-3	Included in Action WS-1-3	B
Action WS-2-2 Maintain a program of ongoing communication with watershed residents	WMO	Included in Action WS-1-3	Included in Action WS-1-3	A
Action WS-2-3 Support volunteer creek improvement projects	WMO	Included in Action WS-1-3	Included in Action WS-1-3	A
Action WS-2-4 Provide technical assistance to privately-funded creek improvement projects	WMO	Included in Action WS-1-3	Included in Action WS-1-3	B
Action WS-2-5 Develop a proactive program of public education about watershed issues and regulations	WMO, cities, counties, state and federal agencies	Included in Action WS-1-3	Included in Action WS-1-3	B
Objective WS-3. Increase Creek Protection Through Land Use Regulation and Incentives (JCCC Goals 8 and 11)				
Action WS-3-1 Coordinate community plans, zoning and development standards to provide protection to all reaches of creek[2]	Cities and counties with the advice of citizens and stakeholders	$30,000 (one-time cost)	$30,000 (one-time cost)	B

NOTE 1 See Tables 29 and 30 for a detailed budget for WMO
2 Restrictions on development could impose lost opportunity costs on landowners

TABLE 28
Summary of Watershed Stewardship Plan Element (Continued)

Objectives and Actions	Implementing Agency/ Responsible Party	Estimated Cost of Action	Portion of Estimated Annual Cost of Action Attributable to JCRMP	Priority
Objective WS-3. Increase Creek Protection Through Land Use Regulation and Incentives (JCCC Goals 8 and 11) (continued)				
Action WS-3-2 Provide incentives to private parties who manage lands in the public interest[3]	Cities and counties	Not estimated	Not estimated	B
Action WS-3-3 Review development proposals	WMO	Included in Action WS-1-3	Included in Action WS-1-3	A
Objective WS-4. Increase Recreation Opportunities in Creek Corridor (JCCC Goals 5)				
Action WS-4-1. Coordinate planning and management of Springwater Corridor Trail with Johnson Creek improvements	WMO, Portland and Gresham, counties and No Clackamas Parks and Recreation District	0	0	B
Action WS-4-2 Integrate Minor cost to public agencies recreation facilities into creek improvements[4]	WMO, cities and counties	Not estimated	Not estimated	B
Objective WS-5. Preserve Heritage Values Within Watershed (JCCC Goal 7)				
Action WS-5-1 Prepare a comprehensive history of the watershed[5]	Volunteers	0	0	B
Action WS-5-2 Develop interpretive program for cultural resources[6]	Cities and counties	$20,000 (One-time cost)	$20,000 (One-time cost)	B
Action WS-5-3 Preserve cultural resources	Cities and counties	0	0	B
Objective WS-6. Evaluate Progress Toward RMP Implementation				
Action WS-6-1 Establish and implement comprehensive monitoring and evaluation program	WMO Volunteers	Establishing program included in Action WS-1-3 Implementation will cost $50,000 annually	Establishing program included in Action WS-1-3	A
Action WS-6-2. Prepare annual "state-of-the watershed" report	WMO	Included in Action WS-1-3	Included in Action WS-1-3	

NOTE
3 Could result in some loss of property tax revenues
4 Minor cost to public agencies
5 Small printing cost might be donated by corporate sponsor
6 Cost assumes two exhibits in Portland

Several institutional models for watershed management were considered by the JCCC and its task groups. A common feature of the institutional models considered is that they all assumed that decision-making authority would remain where it is today The creation of a new body with statutory authority was deemed to be both unnecessary and impractical. The existing decision-making bodies, cities, counties and state and federal agencies, should continue to make and implement public policy. Any new committees or non-governmental organizations would attempt to influence public policy by making recommendations to the existing decision-making bodies

The model chosen by the JCCC is shown diagrammatically in Figure 44. It involves the creation of two new advisory bodies, a watershed management organization (WMO) with a very broad membership that includes all stakeholders in the watershed, and a watershed technical coordinating committee (WTCC) that includes staff members of the jurisdictions in the watershed

Action WS-1-1
Establish watershed management organization and watershed technical coordinating committee

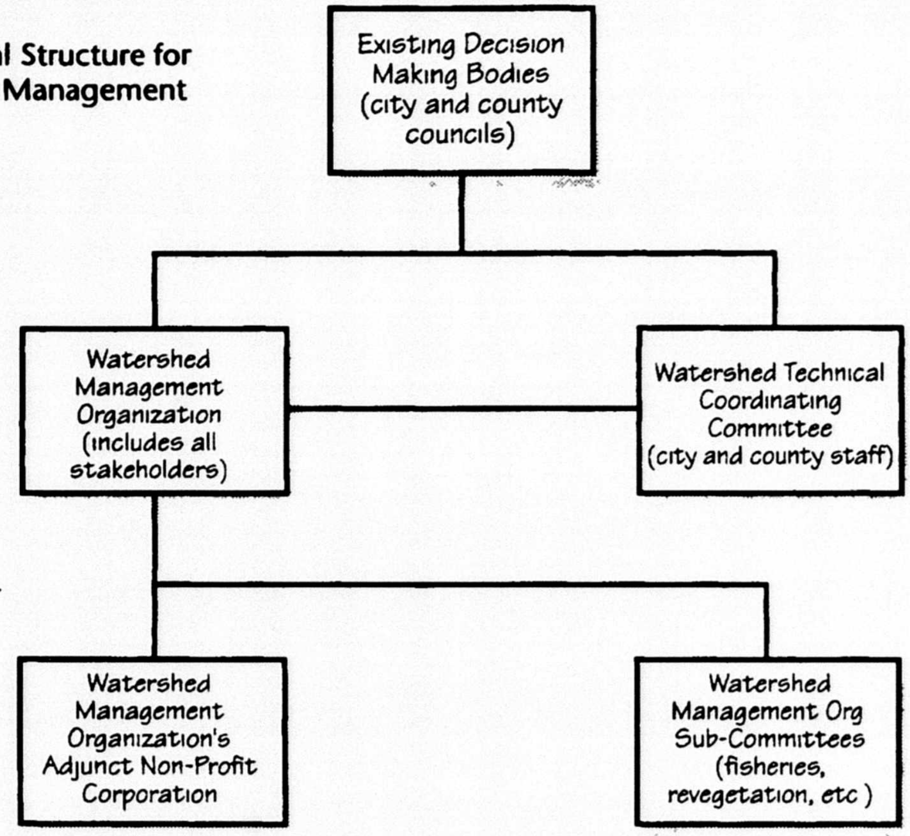
This RMP includes approximately 60 actions intended to protect and enhance the natural resources of the watershed while reducing the frequency of damaging floods. The actions fall into two categories, actions taken by private parties or non-governmental organizations, and actions taken by public agencies Actions taken by private parties or non-governmental organizations might include development of a stewardship ethic by information dissemination and education, revegetation of privately-owned creekside lands, the organization of volunteers, and the coordination of creek improvement efforts Actions taken by public agencies might include the construction and maintenance of flood reduction and water quality improvement facilities, revegetation of publicly-owned lands, and the adoption of various new regulations

The formation of a new WMO is proposed to address the first category of actions Functions of the WMO might include

- Acting as an advisory body to existing decision-making bodies
- Continuing the watershed planning process
- Helping to resolve citizen's problems by serving as a liaison between government and the public
- Resolving conflicts between parties and addressing contentious issues
- Acting as a repository for watershed information, and a source of information on enhancement techniques
- Raising funds to further watershed management and enhancement
- Increasing public awareness of environmental matters by involving citizens in enhancement projects and educational programs
- Evaluating progress toward watershed management goals
- Acting as an advocate in support of watershed management goals
- Coordinating volunteer activities

FIG 44

Institutional Structure for Watershed Management



The WMO would have a broad membership including all stakeholders in the watershed In this context, stakeholders means all individuals or groups that have an interest in the watershed. A stakeholder's interest might be that they own land, a home or a business in the watershed Cities, counties and other units of government are stakeholders So are government agencies with responsibilities for environmental management in the watershed, such as DEQ, ODFW, and WRD The present structure of the JCCC is an example of this institutional model.

This institutional model has been embraced by the State of Oregon In 1993, the state legislature passed HB 2215 which directed the Governor's Strategic Water Management Group (SWMG) to initiate a watershed management program The program, as developed to date, focuses on large rural watersheds So far, funds have been appropriated for work in two watersheds, the Grande Ronde and the South Coast/Rogue River. The first step in the state's watershed management process is to establish a watershed council The state's guidelines for watershed councils correspond to the model chosen by the JCCC Other successful watershed councils have also followed this institutional model, an example is the Nisqually River Council in Washington.

The key concept underlying this model is that watershed improvements can best be made by obtaining the prior agreement of all stakeholders The advantage of this approach is that it capitalizes on the widespread desire to manage natural resources wisely The WMO's political power would derive from its independence and its ability to present itself as a representative of all interests in the watershed. It would be most effective when the watershed improvements under consideration are not costly to private parties and are seen as advantageous to all – in common parlance, win-win situations Although many valuable incremental improvements can be made in this way, it is an unfortunate fact of life that most watershed management issues involve both winners and losers. The broad stakeholder representation may result in paralysis and an inability to reach consensus when contentious issues are under consideration Consequently, alternative decision-making processes may be needed to resolve stalemates

The WMO will differ from typical "friends" groups such as Friends of Johnson Creek. Friends groups do not include official representatives of cities or counties or other government agencies and usually consist of like-minded citizens with the single goal of environmental improvement Unlike the WMO, they do not need to balance environmental and economic considerations They function as watchdogs over the activities of government agencies and private parties and may take positions opposing the activities of either The WMO will be a public-private partnership that includes local government officials as well as all other stakeholders It will seek to further the goal of environmental improvement by cooperation among stakeholders However, because the WMO would not be a legal entity, it may choose to create an adjunct non-profit corporation or enter into an agreement with an existing non-profit corporation Leach Botanical Garden or Friends of Johnson Creek, if it incorporates, could fill this latter role Unlike the WMO, non-profit corporations can enter into contracts and receive tax-protected grants from private foundations They could also serve as a land trust to facilitate preservation of sensitive areas

The second category of actions in the RMP are already the responsibility of public agencies. The primary improvement needed is better coordination of public agency actions that affect the watershed For example, current regulation of stormwater flows from new development is inconsistent in the watershed All jurisdictions would benefit from coordinated regulations that better reflect the hydrology of the watershed (see Actions FM-1-1 and FM-1-2) The WTCC will provide the necessary coordination The functions of the WTCC might include

- Coordinating the construction and maintenance of physical improvements in the watershed
- Coordinating the drafting of hydrologic regulations for new development
- Coordinating the drafting of land use regulations to protect creekside natural resources

The WTCC would be made up of staff members of the six jurisdictions in the watershed. If possible, the individuals chosen by jurisdictions to be members of the

WTCC will also be chosen as the jurisdiction's representatives on the WMO. The WTCC would exchange information with the WMO.

Action WS-1-2

Obtain stable funding source for watershed management organization

Regardless of its institutional structure, a WMO is unlikely to be successful without a stable funding source Organizations that depend entirely on volunteers often falter because volunteers typically cannot make the organization their first priority It is difficult to move programs forward consistently when each volunteer can only contribute a few hours each week. On the other hand, an organization that has a core of permanent, salaried staff, assisted by volunteers can be very effective

Assuming that responsibility for building and maintaining flood control and water quality facilities remains with the cities and counties, a minimum funding level for the watershed organization would be $100,000 per year. Budget breakdowns are shown in Tables 29 and 30. An annual budget of this magnitude would support a small office in the watershed and the employment of a watershed steward The office would include an administrative space, and space for a library and resource center. The funding for the watershed organization's core activities may come from the following sources

- Grants and in-kind contributions from local, state and federal governments
- Grants from private foundations
- Contracts for service
- Gifts and donations

Local governments might provide assistance in two ways They could assist the WMO by using their own staff to undertake some WMO functions or by providing office space and administrative support (in-kind contributions). Alternatively, local government may choose to fund a full-time staff person to be the watershed steward The watershed steward would be employed by one of the public agencies but the cost of the position would be shared by some or all participating agencies

TABLE 29

Watershed Management Organization Initial Annual Budget

Item	Estimated Cost
Staff	$ 70,000
Rent	$ 6,000
Telephone/Utilities	$ 3,000
Mail Printing	$ 12,000
Miscellaneous	$ 9,000
Total	**$100,000**

TABLE 30
Watershed Management Organization Budget Breakdown by Task

	Action	Budget
WS-2-1	Establish information clearinghouse and library	$ 5,000
WS-2-2	Maintain communication program	$ 15,000
WS-2-3	Support volunteer projects	$ 5,000
WS-2-4	Provide technical assistance	$ 5,000
WS-2-5	Develop public education program	$ 10,000
WS-3-3	Review development applications	$ 5,000
WS-6-1	Establish monitoring program	$ 10,000
WS-6-2	Prepare "State of Watershed" Report	$ 10,000
PP-1-1	Periodically review information on point source discharges	$ 3,000
PP-2-6	Periodically review information on stormwater discharges	$ 5,000
PP-3-3	Periodically review information on container nursery/CAFO compliance	$ 2,000
PP-3-4	Periodically review compliance with forest practice rules	$ 3,000
PP-4-1	Periodically review information on compliance with spill control rules	$ 4,000
FW-2-1	Establish fishery subcommittee	$ 3,000
FW-3-4	Obtain water rights for in-stream flow	$ 10,000
Misc		$ 5,000
	TOTAL	**$ 100,000**

Action WS-1-3

Operate watershed management organization

Successful operation of a watershed management organization depends on several principles: involvement of all affected interests; identification of a dedicated core group of interested people, local ownership of the management and enhancement of the watershed, identification of problems and solutions through a collaborative process, implementation, monitoring, and continual evaluation, supporting an ongoing forum for communication, cooperation, and problem solving, and closely linking the watershed management organization to existing, more formal decision-making processes

Action WS-1-4

Establish special purpose subcommittees for fishery and wildlife habitat restoration

Certain activities of the WMO will require specialized technical knowledge. For example, wildlife habitat restoration involves specialized knowledge of botany, plant propagation and wildlife biology. The WMO will form a wildlife habitat subcommittee with specialized knowledge or interest in these and other related disciplines The subcommittee will review and comment on proposals for revegetation by public agencies and private parties The subcommittee will also establish priorities for protection of critical habitats.

Similarly, fisheries management and habitat restoration involves specialized knowledge of fish and their habitat preferences The WMO will establish a fisheries sub-committee. Oregon Department of Fish and Wildlife, which is the agency with direct responsibility for managing the state's fish resources, will be a key member of the subcommittee. All proposed fish habitat improvements, stocking, monitoring and surveying activities on Johnson Creek will be coordinated by the sub-committee It will be important that any action taken is consistent with Oregon Department of Fish and Wildlife's yet-to-be-developed fisheries' management plan for Johnson Creek, and is coordinated with the Salmon and Trout Enhancement Program (STEP) administered by the department.

OBJECTIVE WS-2
Foster Development of a Watershed Stewardship Ethic.

Significant improvements to the watershed environment are unlikely to occur without the active participation, or at least awareness, of most residents and property owners Thus, an important part of the plan is develop an awareness that all actions in the watershed are interconnected and that it is in everyone's interest to treat the watershed's natural resources with respect

Action WS-2-1
Establish Johnson Creek information clearinghouse and library

Although considerable information is available on Johnson Creek and its natural resources, it is located in many different places. Water quality and flow information are compiled by U.S Geological Survey, DEQ and by the City of Portland Fishery information is maintained by Oregon Department of Fish and Wildlife. Land use and natural area information is maintained by METRO Many other entities also maintain files on Johnson Creek The watershed could be managed more effectively if there were a single repository for data on the creek This would not mean that other agencies would not maintain files on Johnson Creek, just that copies of all information would be maintained at a single

A Johnson Creek library will be established and maintained by the WMO. The starting point will be the library of documents assembled by Woodward-Clyde during the RMP planning process In addition to conventional hard-copies of relevant documents, the library will include electronic copies of all maps contained in the geographic information system (GIS) used in the RMP

The WMO will also provide a watershed information and pollution prevention/reporting hotline for local residents. The hotline will provide information on: filling in the floodway, enhancement projects, erosion control, Springwater Corridor, nuisance control (rodents, insects, migratory birds, noxious weeds, etc), public education programs, wildlife and fish issues and sightings, location of parks, trails and recreation opportunities, regulations for streams, ponds and wetlands, drainage and runoff regulations, water quality problems, WMO meetings, subcommittees and events, flooding problems, StreamWalk programs, safe uses of pesticides and fertilizers, and hazardous waste collection

Action WS-2-2

Maintain communications with watershed residents

The WMO will keep watershed residents informed about progress with the RMP and opportunities to participate in enhancement projects and special purpose sub-committees The primary modes of communication will be a quarterly newsletter, and monthly WMO meetings

Action WS-2-3

Organize and support volunteer creek improvement activities

It is expected that volunteer activities will play an important role in implementing the RMP Many small creek clean-up, bank and riparian corridor enhancement and fish habitat improvement projects will need to be implemented by volunteers. The WMO will be responsible for planning and organizing volunteer projects. The WMO will also maintain a registry of potential volunteers and volunteer organizations An outreach program to schools, service clubs, scouts, etc., will be implemented to recruit volunteers. The WMO would coordinate activities with other groups with similar goals – the Springwater Corridor Steering Committee and the Friends of Johnson Creek, for example

Action WS-2-4

Provide technical assistance to privately-funded creek improvement projects

Most of Johnson Creek flows through privately-owned lands. Consequently, successful enhancement of the creek corridor will depend on the active participation of private land owners The WMO will be responsible for providing technical information and guidance to landowners wishing to enhance natural vegetation on their property. If, for example, a property owner wishes to replace lawn extending to the creek bank with a more natural complex of vegetation, the WMO will assist in the development of a landscape plan, provide guidance on sources of native plants, and may be able to provide volunteer assistance with the construction

The starting point for most property owners will be the streamside property owners guide developed as part of the RMP program. The WMO will update the guide periodically as new information becomes available. The U.S Department of Agriculture, Natural Resources Conservation Service and local Soil and Water Conservation Districts provide technical assistance and information to agricultural landowners, the Oregon Department of Forestry provides similar assistance to forest landowners The WMO will work with these agencies to provide coordinated landowner assistance. The WMO will also organize periodic workshops on creek bank revegetation and enhancement for streamside property owners

Action WS-2-5

Develop and implement a public education program.

The WMO will develop and implement an education program designed to increase public awareness and understanding of the effects of various activities on the natural resources of the Johnson Creek watershed This program will take advantage of existing sources of information and cooperate with other government and agency programs. Education activities might include.

- Lecture series at the WMO office describing the natural resources and history of the watershed
- Presentations to neighborhood groups and service clubs
- Material and informational support for cooperative teaching programs with schools, and school participation in other educational activities conducted by the WMO
- Workshops for streamside property owners
- Field trips to private properties that provide good examples environmentally-sensitive landscaping
- Information to new landowners in the watershed providing a full explanation of environmental regulations that apply to their property

OBJECTIVE WS-3
Increase Creek Protection Through Land Use Regulation and Incentives

In the past, largely unregulated growth and exploitation of natural resources in the Johnson Creek watershed have caused a wide range of environmental problems, including loss of habitat and natural areas, increased flooding, loss of recreational areas, and water quality impairment By providing financial incentives to property owners who manage their lands in a way that protects the stream, and developing an effective, consistent set of regulations for natural resource protection, this trend can be reversed.

Action WS-3-1

Coordinate community comprehensive plans, zoning and development standards to provide similar protection to all reaches of creek

The greatest need for change in land use regulation in the Johnson Creek watershed is the development of a consistent, watershed-wide set of standards for protection of natural resources Each of the six jurisdictions in the Johnson Creek watershed has adopted varying approaches to the protection of natural resources. Although their policies are generally compatible, there is no consistent watershed-wide approach. The City of Portland's practice of using environmental zoning based on mapped natural resources could serve as a model for the watershed as a whole

A task force comprised of land use planners from the six Johnson Creek jurisdictions, stakeholders, including JCCC members, and other interested citizens, will be convened to develop watershed-wide land use standards through coordination of all applicable community general plans Its goal would be to develop standards within one year which will include:

- A consistent definition of natural resource areas to be applied watershed-wide
- Consistently-prepared maps of natural resource areas for the entire watershed
- Restrictions on development and other activities within mapped natural resource areas
- Establishment of a transition zone of at least 25 feet between the mapped natural resource areas and development, within which some restrictions on use would apply

Because the new standards will take some time to develop and adopt, the JCCC considered providing some form of interim protection for streamside areas. Two possibilities were considered. The first possibility would involve immediately establishing a protected zone along the creek within which development would be restricted The protected zone might extend 50 or 100 feet back from the top of the creek bank but would be arbitrarily defined instead of based on biological mapping. The second possibility would establish a similar protected zone, but, rather than impose immediate restriction on development in the zone, all development applications for lands within the zone would be reviewed by the WMO for compliance with the goals of the RMP

The JCCC were unable to reach consensus on this action. The committee divided almost evenly into three groups· groups supporting the two approaches to interim protection discussed above and a third group favoring reliance on the standards developed by the multi-jurisdictional committee without interim protection measures

Although some leeway should be given to owners of subdivided land, the establishment of protected natural resource areas and delineation of these areas on a map would greatly clarify regulatory requirements for land owners, developers and regulators Land-use regulations which are easy to understand and apply would help re-establish an extensive vegetative cover along Johnson Creek, which is probably the most effective action that can be taken to enhance Johnson Creek and its tributaries.

Action WS-3-2

Provide financial and other incentives to property owners who manage natural resources in the public interest

Protection of natural resources and the control of non-point source pollution rely heavily on volunteer commitments by local citizens Although many citizens of the Johnson Creek watershed have shown great willingness to cooperate in actions to benefit the watershed, more incentives should be provided to encourage greater involvement

Tax advantages exist for land owners who grant open space easements on portions of their property Easements usually allow public access to natural resource areas, and therefore are not always desirable to all land owners Sale of property to environmental organizations, such as the Nature Conservancy or the Wetlands Conservancy, obviously reduces property tax assessments Special conditions can be included in the deed which allow continued use by the original land owner as long as they are alive. Land owners who provide public easements should be protected from liability claims resulting from accidents that occur on their property

The State of Oregon's Riparian Tax Incentives Program provides state income tax reductions to land owners who establish and maintain riparian protection measures, such as fencing However, the modest savings from this program do not provide an overwhelming incentive to reluctant land owners

Additional financial incentives include cost-share programs through local, state and federal resource management agencies Many programs are available through the Natural Resources Conservation Service, soil and water conservation districts and the Oregon Department of Agriculture for farmers to provide cost-share assistance for a wide range of agricultural Best Management Practices (BMPs), including fencing, providing watering supplies for livestock away from streams and revegetation Programs are also available to forest land owners for BMPs such as wildlife habitat enhancement, reforestation, and preserving vegetative buffer strips next to streams.

The WMO could publicize these cost-sharing programs to land owners, facilitate contact between the land owners and agencies, and help land owners prepare cost-share applications Serving a dual role as advocate for land owners and proponent for government programs would increase the chance of protecting and enhancing critical portions of the watershed.

Other ways to reward landowners for managing their lands for the public good include recognition in the media, and special awards. By publicly acknowledging conservation gains accomplished by private individuals, not only do the individuals gain recognition, their deeds and results are commended This may lead to a stronger conservation ethic in the community Each year, soil and water conservation districts give special recognition awards to farmers with outstanding conservation programs The WMO could make similar awards to exemplary landowners from anywhere in the watershed, not only agricultural landowners Outstanding landowners could be recognized at an annual banquet, could receive a plaque or other commendation, and a sign could be placed on their land recognizing their accomplishments.

Understandably, many land owners are unwilling to relinquish their private property rights or allow government interference in their enterprises, although their land management practices may be damaging a public resource If good existing programs can be utilized, equitable new programs designed, and cooperation increased between agencies and between agencies and landowners, incentives should be able to increase the amount of voluntary conservation, and thereby improve the condition of natural resources in the Johnson Creek watershed

Action WS-3-3

Review development proposals

One of the key functions of a long-term watershed management organization would be to support an on-going forum for communication, cooperation and problem solving.

A subcommittee of the watershed management organization would be established to review proposed development projects Developers and cities and counties would be encouraged to bring development proposals to the WMO subcommittee for review and comment The subcommittee would meet at least monthly and would report directly to the WMO, which may choose to submit comments to the municipalities The review procedure would allow proponents the opportunity to receive early public comment on their proposals

OBJECTIVE WS-4
Increase Recreational Opportunities in Creek Corridor

Action WS-4-1
Coordinate planning and management of Springwater Corridor Trail improvements with Johnson Creek improvements

Although construction of the Springwater Corridor Trail is well-advanced, some elements of the plan are not yet complete All planning of new facilities such as trailheads or interpretive signage should be coordinated with the elements of the RMP to take advantage of linkages between the Springwater Corridor Trail and points of interest on the Johnson Creek, and other trails Management of completed facilities should also be coordinated Coordinated planning and management would be advantageous in the vicinity of S E 45th Avenue and Johnson Creek Boulevard and in the Lents neighborhood as discussed below

Action WS-4-2
Integrate recreation facilities into creek improvements

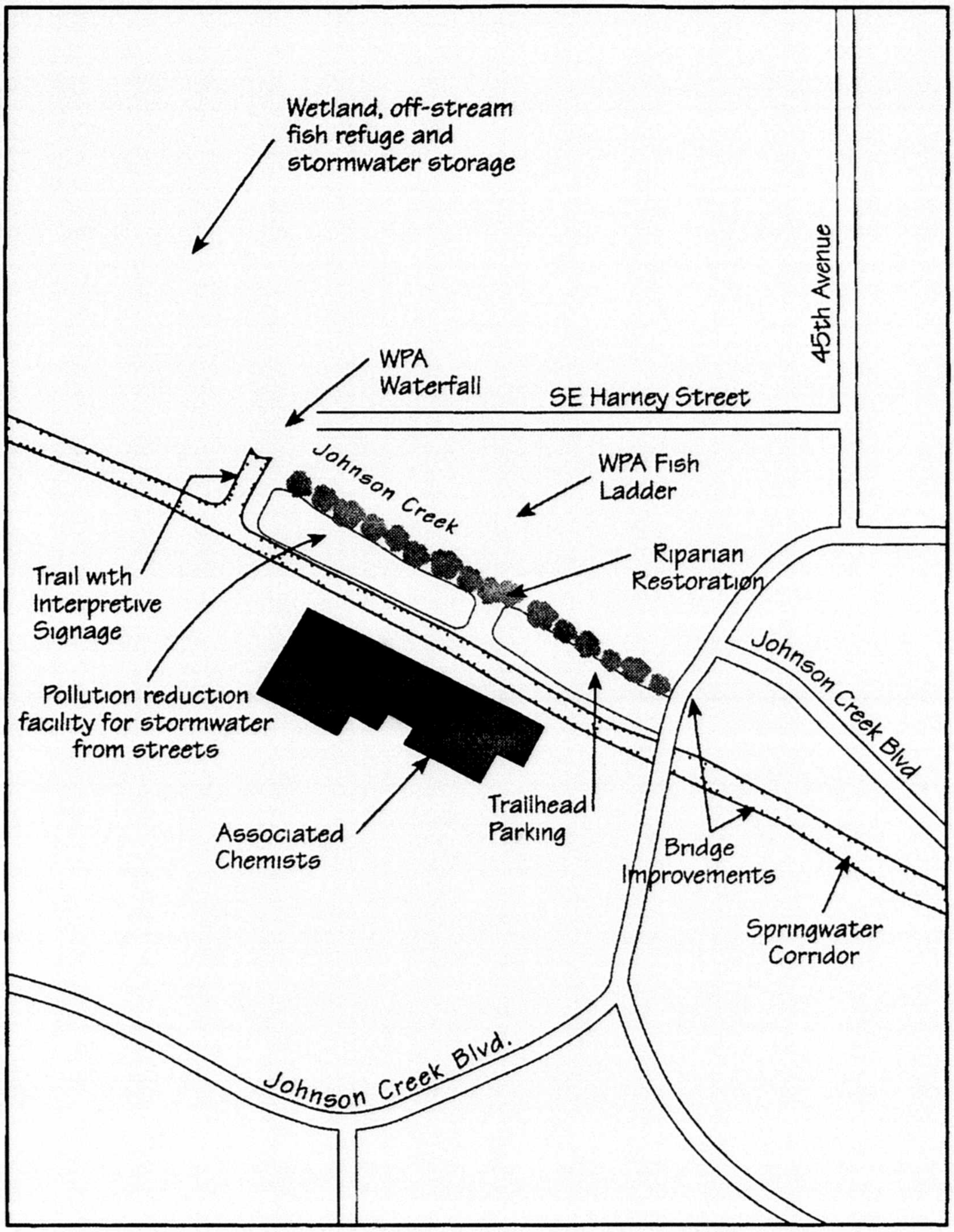
A number of recreation facilities will be integrated with other plan elements These include trailheads for the Springwater Corridor near S E 45th Avenue (at Johnson Creek Boulevard), and near Foster Road and 104th Street The Springwater Corridor roughly parallels Johnson Creek along its entire length, providing an excellent recreational component to the creek, and increasing exposure of the creek to the public, thereby increasing the number of citizens watching over the creek

Trailheads will include at least two path connections to the Corridor At the 45th Avenue and Johnson Creek Boulevard site, the trailhead will connect with short trails leading to the WPA waterfall (see Action WS-5-3) Interpretive signage will be added to this area to highlight the historical significance of the WPA sites, including the fish ladder near Harney Street and the waterfall Signage will also explain the importance of the proposed fish rearing pond across the creek from the waterfall The general layout of the multi-purpose facilities is shown in Figure 45

The City of Portland Parks and Recreation Department intends for one of the Johnson Creek trailheads to be considered a "signature" trailhead The signature trailhead will be advertised as the central entry point to the Corridor, and will be designed to welcome new users This trailhead will be centrally located, i e , as near to I-205 as possible The Foster Road – 104th Street site seems to ideal for this purpose, and is already used as an informal "jumping-off point" for many trail users, even without

FIG 45

Multi-purpose Improvements at 45th Avenue and Johnson Creek Boulevard



formal designation as a trailhead, or paved parking spaces A possible layout of future multi-purpose facilities at the site is shown in Figure 46

OBJECTIVE WS-5
Protect Cultural Heritage Values.

Protection of cultural heritage values includes physically preserving known cultural resources and ensuring that currently unknown relics are not destroyed as the watershed develops. Protection of cultural resources is enhanced by public understanding of and interest in local history. The actions listed below seek to both preserve and increase appreciation of the watershed's cultural heritage

Action WS-5-1
Prepare a popular history of watershed

Considerable information is available on the history of the Johnson Creek watershed, but it is not summarized in a single publication. Interest in the watershed and its early development could be stimulated by writing a history designed for the general reader. The history would include a listing of all known cultural resources in the watershed, a compilation of oral historical accounts, old photographs, and instructions on a self-guided tour for visitors to the Springwater Corridor Trail It could serve as the basis for a permanent exhibit and classes at the WMO's office (see Action WS-2-5) It would be prepared by volunteers, perhaps in association with Portland State University, or a similar educational institute.

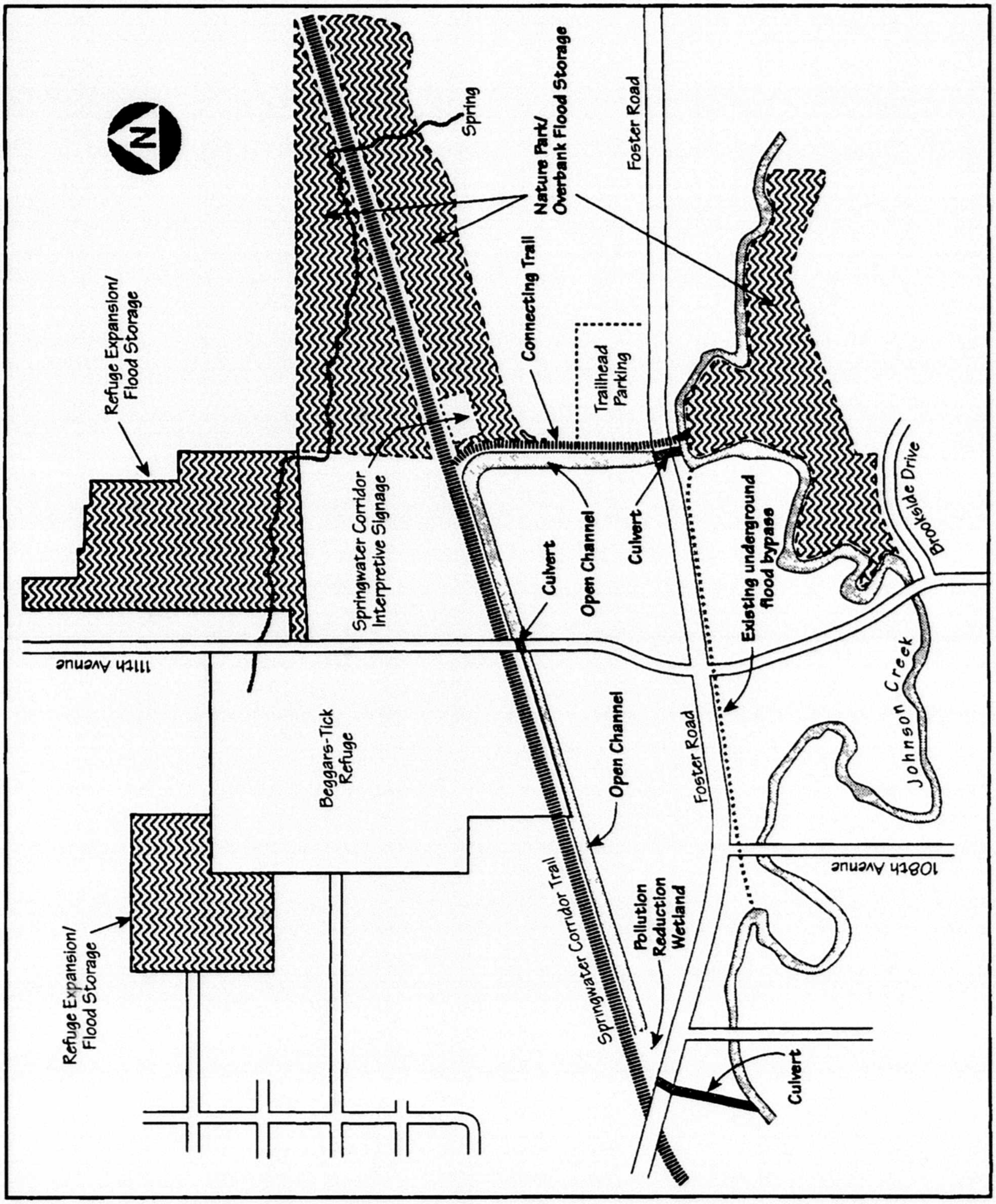
Action WS-5-2
Develop interpretive program for cultural resource

The purpose of this program would be to increase access to and awareness of cultural resources in the watershed The program would display historic information gathered in Action WS-5-1 on several interpretive signs. Signage would be coordinated with existing signage on the Springwater Corridor Trail Possible exhibits are described below, others could be developed by the WMO.

The Works Progress Administration rockwork is of aesthetic and historic interest. Good examples of rockwork structures, a fish ladder and a waterfall, are located at Johnson Creek Boulevard and S E 45th Avenue Currently the public has access to the waterfall, but the fish ladder is on private property No explanatory signage is in place Directional signage could guide users of the Springwater Corridor trailhead at Johnson Creek Boulevard to the waterfall. Interpretive signage could discuss the Great Depression of the 1930s and the role of the Works Progress Administration (WPA) in creating employment In addition, a fish rearing pond will be built on the opposite side of the creek, and a sign could be added to explain the significance of this habitat addition (see Figure 45) In the Lents area, interpretive signage could describe the history of the Portland Traction Company railroad and the use of the Springwater Corridor for electrical power transmission

FIG 46

Multi-purpose Improvements at SE Foster Road and 111th Avenue



Action WS-5-3

Preserve cultural resources

Inventories of historic structures have been conducted for most of the Johnson Creek watershed except for Happy Valley These inventories identified 44 historic structures or locations, two of which were listed in the National Register as of 1992 (Leach Botanical Garden, Bell Station Store). Other significant historic resources include Tideman Johnson Park, Cedar Crossing Bridge, Gresham Pioneer Cemetery, Escobar Cemetery, White Birch Cemetery, and the WPA rockwork

Most of the historical inventories in the watershed focus on architecture rather than history, and attempt to document visually interesting resources As a result, the historic resources identified in the surveys rarely reflect anything but architectural merit For example, archaeological surveys have examined about 0 6 percent of the watershed, and only one prehistoric archaeological site, a stone tool manufacturing site located near the headwaters of Crystal Springs Creek, has been formally recorded in the watershed Upstream of about S E 42nd, there are very few identified historic resources in the watershed, with the notable exception of Leach Botanical Garden and the urban cluster in Gresham.

Each municipality classifies and protects historic resources, and many historical sites which have been designated as significant may be eligible for the National Register In particular, the bridges, waterfall, fish ladder, and embankments constructed by the WPA constitute an important ensemble of resources and should be nominated to the National Register The WMO could help conduct thorough archaeological and historic surveys, and will work to ensure the preservation of identified sites Particular care should be exercised in any channel changes that could occur near Leach Botanical Garden and the various pioneer cemeteries along Johnson Creek

OBJECTIVE WS-6
Evaluate Progress Toward RMP Implementation.

It cannot be expected that the path toward enhancement of Johnson Creek will unfold exactly as envisaged in the RMP Many of the RMP's provisions involve fundamental changes in the way an urban stream is managed Some elements of the plan will probably be easier to implement than others. The RMP will need to be adjusted as information on the success and failure of various enhancement activities accumulates Progress will need to be systematically monitored to provide an informational basis for modifying the RMP and its implementation

Action WS-6-1

Establish and implement comprehensive evaluation program

Measuring progress of implementation of a plan as diverse as the RMP will be complex. Some aspects of progress are more easily measured than others. It is recommended that the WMO form a technical subcommittee to devise an evaluation program that is both effective and can be accommodated within the WMO's budget Some of the data gathering could be undertaken by other agencies such as ODFW and the cities, and existing data (including data gathered and analyzed during preparation of the RMP, and new data from state, federal and local agencies) would be utilized as much as possible. The evaluation program might include measurement of:

- In-stream water quality characteristics
- Numbers of spawning salmonids
- Vegetation surveys
- Other key indicator species
- Length of stream banks revegetated
- Numbers of bank enhancement projects
- Review of RMP implementation schedule and benchmarks

Some of these components can be measured and expressed numerically Others can only be evaluated subjectively The evaluation program should emphasize the former, whenever possible

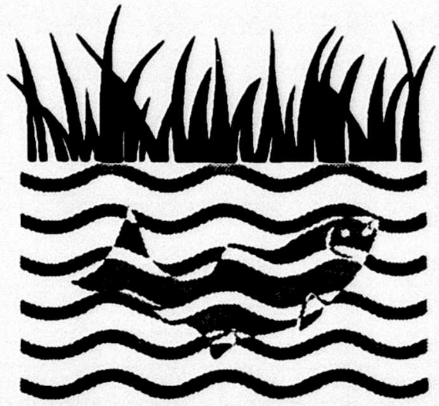
Developing an evaluation program is technically complicated Implementing it is labor-intensive and expensive The WMO will work with other jurisdictions to devise a program that obtains the greatest quantity of useful information at a minimum cost. It will also be designed to dovetail with the monitoring programs being conducted by Portland, Gresham, and Clackamas County as part of their stormwater management plans The U.S. Geological Survey is also collecting water and sediment quality information on Johnson Creek. Additional information on possible components for a water quality monitoring plan are described in Technical Memorandum No 18.

To the maximum extent possible, volunteers will be used to collect monitoring data. Since September 1992, a volunteer group, the "Johnson Creek Dippers," has been measuring water quality monthly at 12 locations in the creek. This volunteer program will continue with modifications that emphasize visual observations of creek conditions.

Action WS-6-2

Prepare an annual "State of the Watershed" report

The WMO will prepare an annual "state of the watershed report" This report will include the full results of the evaluation program described in Action WS-6-1. It will also summarize any data on Johnson Creek reported by other agencies. The report will include a record of all volunteer activities A summary of the report will be included in an issue of the quarterly newsletter (Action WS-2-2)



CHAPTER 5
PAYING FOR THE PLAN

Funds to pay for implementation of the RMP will come from a variety of public and private sources. The discussion of funding sources is prefaced by a description of the benefits produced and the costs incurred by RMP implementation.

ESTIMATED BENEFITS AND COSTS

■ BENEFITS

The RMP will produce a variety of benefits, only some of which can be readily expressed in monetary terms The primary near-term monetary benefits of the RMP stem from the diminution of flood risk for hundreds of existing homes and businesses Flood insurance and damage costs will be lowered and public safety will be improved The actions in the RMP designed to reduce damage to existing flood-vulnerable properties would prevent damages estimated at least $28 million over a fifty year period The actions in the RMP designed to prevent further development from making flooding worse will also save money

Monetary benefits will also accrue because implementation of the RMP will make the Johnson Creek watershed a better place to live By protecting water quality and wildlife habitat and reducing flooding, while allowing responsible development to continue, the watershed will attract new residents and visitors This will, in turn, increase the value of property and the patronage of local businesses New jobs may be created and, as property values increase, cities and counties will have more funds to spend on local services and capital improvements Thus, the RMP will act as a catalyst for economic growth, producing widespread, but difficult-to-estimate long-term monetary benefits, as well as the more obvious flood control benefits and the non-monetary benefits of a pleasant environment.