City of Ashland

Stormwater and Drainage Master Plan

Final Report

June 2000

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in Association with:

Greenworks, PC

CITY OF ASHLAND
STORMWATER AND DRAINAGE MASTER PLAN

JUNE 2000

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City of Ashland
Stormwater and Drainage Master Plan

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The City of Ashland *Stormwater and Drainage Master Plan* identifies existing drainage problems in the City of Ashland and proposes solutions to address them. It provides an inventory of creeks, including identification of areas requiring protection and restoration, and recommends future actions by the City and private developers to enhance the City's creek corridors, improve water quality, and handle future storm drain capacity problems.

The master plan completes the City's stormwater inventory, which was begun with preparation of reports on the watersheds of two city creeks: the *Roca Creek Watershed Assessment* (October 15, 1997) and the *Ashland Creek Flood Restoration Project* (November 26, 1997).

The January 9, 1998 revision of the Federal Register listed the City of Ashland is listed as a "potentially designated" incorporated area for inclusion in the National Pollutant Discharge Elimination System (NPDES). With this listing, the City is very likely to be subject to NPDES requirements in the near future. This report is a step toward meeting the requirements.

STUDY AREA DESCRIPTION

The City of Ashland is in southern Oregon along the Bear Creek and Interstate 5 corridor in Jackson County, approximately 14 miles north of the California-Oregon state border. The Ashland Urban Growth Boundary (UGB) contains approximately 9 square miles. Topographically, it consists of steep slopes in foothills to the south, a terrace in the center that is highly developed, and the relatively flat area of the Bear Creek floodplain along the northern edge. Soils in the area have moderate to very slow rates of infiltration. Annual precipitation is about 20 inches. Most land use in the City is residential, with two areas of commercial or industrial development.

EXISTING DRAINAGE SYSTEM DESCRIPTION

Within the City of Ashland, Tolman Creek, Hamilton Creek, Clay Creek, Cemetery Creek, Roca/Paradise Creek, Beach Creek, Mountain Creek, Ashland Creek, and Wright's Creek flow from north to south and discharge to Bear Creek, which flows through the north section of the City. Kitchen Creek, which discharges to Bear Creek from the north, enters the City at its downstream end. Several small, intermittent drainage courses in the eastern part of the City, in the vicinity of the golf course and the middle school, discharge to Bear Creek or Neil Creek.

Because they were previously evaluated in other reports, Ashland Creek and Roca/Paradise Creek were not assessed for this master plan, although the constructed storm drainage system in the Ashland Creek drainage area was evaluated. Piped systems also were evaluated in the Cemetery, Beach, and Mountain Creek basins, as well as the drainage basin surrounding the Ashland Hospital, which discharges to Billings Pond. Other constructed facilities evaluated include most of the culverts conveying open channels under roadways.

Existing flooding problems in the City drainage system have been identified by incidents reported during previous storms and the Flood Insurance Study prepared for the City in 1980.

DRAINAGE SYSTEM EVALUATION

The constructed drainage system was evaluated using computer modeling of hydrology (the expected rainfall runoff flowing to the system for a given storm) and hydraulics (the pipes' capacity to hold the runoff entering the system). Culverts were analyzed separately from the rest of the constructed drainage system. The analysis predicted flooding in all piped systems for the 25-year storm, which is the design storm for drainage system pipes (the design storm is the storm that drainage facilities should be designed to accommodate). The design storm for culverts is the 50-year storm, and the analysis showed flooding during the 50-year storm for 12 culverts.

Creeks were evaluated by inspection of aerial photography and by field visits to the streams. They were assessed for the condition of native vegetation in and along the stream, the condition of the stream channel itself, and the level of surrounding development. Findings for each creek were as follows:

- Wright's Creek is relatively undeveloped and the upper, steeply sloped reaches of its watershed are still heavily forested. Future development should be reviewed carefully because it would increase erosion and flooding problems and reduce the possibility of a wildlife connection.
- The small Beach, Mountain, and Clear Creek watersheds have been highly encroached by residential development. Ninety percent of the streams' lengths have been piped. Little native vegetation exists along the stream reaches. The streams pose little threat to property but they show some signs of erosion.
- Most of Cemetery Creek has been affected by development in its upper reaches and farm practices in the lower reaches. Approximately 30 percent of the native riparian vegetation remains along the stream corridor.
- Clay Creek has been highly encroached upon by residential development in the upper section and farmlands along its lower sections. Much of the creek's native riparian vegetation has been removed along the stream corridor. There is a large amount of erosion and many flooding problems along the creek.
- Hamilton Creek has been highly encroached by development, and about 50 percent of its native riparian vegetation is currently intact. Future development in the watershed would increase flooding and erosion.
- The Golf Course Creeks are small creeks that have been severely impacted by surrounding development. Little native riparian vegetation currently exists along the stream corridors. Water temperature is a major issue due to the lack of vegetation coverage.
- Tolman Creek has been highly encroached upon in its lower reaches that pass through the City. Riparian vegetation along the stream corridor is relatively intact. The slopes along the stream corridor are relatively low. Future development along the creek should be kept to a minimum.

EVALUATION OF IMPROVEMENTS

Improvements were evaluated to address identified problem areas as follows:

- A new storm system along Nutley Street was evaluated to alleviate excess flows in the existing system along Granite Street.

- A new outfall near the intersection of Central Avenue and Helman Street was evaluated to prevent storm flows in the area from overtopping Highway 99.
- Four alignments were evaluated for a new storm drain system to alleviated flooding in the Beach and Mountain Creek drainage basins, where most of the City's past flooding has been reported.
- New, larger culverts were evaluated to address inadequate existing capacity at the following culverts:
  - Clay Creek at Highway 99
  - Clay Creek at East Main Street
  - Cemetery Creek at East Main Street
  - Cemetery Creek at Railroad Tracks
  - Park Branch of Cemetery Creek at Clay Street
  - Kitchen Creek at Mountain Avenue
  - Clear Creek at Hersey Street
  - East Main Street at Dead Indian Memorial Road
  - East Main Culvert near Interstate 5
  - East Main Culvert near Tolman Creek
  - East Main Culvert near Greensprings Highway
- Three alternatives were evaluated to ensure adequate system capacity of the culvert under Interstate 5 near Crowson Road as future development occurs. The alternatives included enlarging the culvert, constructing a wetland to detain flows, and requiring on-site detention for new development.
- For each stream corridor in need of improvement, four improvement measures were evaluated: channel stabilization; riparian corridor restoration; community-based enhancement; and protection from future development.
- Three nonstructural approaches were evaluated for ongoing management of stormwater throughout the City: adoption of a stormwater manual; public education including preparation of "watershed owner's manuals"; and ongoing system operation and maintenance.

CAPITAL IMPROVEMENT PLAN

Based on the evaluation of improvements, a capital improvement plan (CIP) was developed ranking recommended improvements and including planning-level cost estimates. Table ES-1 summarizes the CIP.

TABLE ES-1.
CAPITAL IMPROVEMENT PROJECTS

Project	Estimated Cost	Priority
Nutley Street Storm System	$317,000	High
Central Avenue Outfall	$125,000	High

Beach Creek and Mountain Creek Basins Interceptor	$4,258,000	High
Clay Creek Culvert at Highway 99	$156,000	High
Clear Creek Wetland at Hersey Street	$95,000	High
Clay Creek Culvert at East Main Street	$125,000	Medium
Cemetery Creek Culvert at East Main Street	$125,000	Medium
Culvert at East Main Street and Dead Indian Memorial Road	$225,000	Medium
Culvert at East Main Street West of Green Springs Highway	$125,000	Medium
Stormwater Manual	$25,000	Low
Watershed Owner's Manual	$20,000	Low
Streamside Planting Brochure	$10,000	Low
Operations and Maintenance Plan	$15,000	Low

The following regulatory measures also are recommended:

- Develop a stormwater manual.
- Ensure enforcement of existing erosion and sediment control guidelines.
- Develop new water quality control guidelines.
- Include drainage design standards in the stormwater manual.
- Adopt landscape design standards.
- Adopt riparian corridor protection measures.

Chapter 1
INTRODUCTION

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INTRODUCTION

BACKGROUND

The City of Ashland recently prepared reports on the watersheds of two city creeks: the *Roca Creek Watershed Assessment* (October 15, 1997) and the *Ashland Creek Flood Restoration Project* (November 26, 1997). To complete the City's stormwater inventory, the City contracted with TetraTech/KCM, Inc. to evaluate drainage conditions and requirements in all areas of the City not covered by the Roca Creek and Ashland Creek studies and to prepare this stormwater and drainage master plan. The master plan identifies existing drainage problems and proposed solutions, provides an inventory of creeks, including identification of areas requiring protection and restoration, and recommends future actions by the City and private developers to enhance the City's creek corridors, improve water quality, and handle future storm drain capacity problems.

In the final Stormwater Phase II rule published in the Federal Register (December 9, 1999), the City of Ashland is listed as a "potentially designated" incorporated area for inclusion in the National Pollutant Discharge Elimination System (NPDES; 40 CFR Parts 122 and 123). This indicates that the City is very likely to be subject to NPDES requirements in the near future. This report is a step toward meeting the requirements.

AUTHORIZATION

In February 1998, the City of Ashland contracted with TetraTech/KCM, Inc. to develop this stormwater and drainage master plan. Greenworks, PC, participated with TetraTech/KCM by developing the inventory of the City's natural creek corridors and assisting in public involvement. The project was scheduled to allow the use of new citywide mapping that was completed in November 1998.

PURPOSE AND SCOPE

The approach to this study was to evaluate and inventory Ashland's man-made and natural drainage systems and to identify their condition and deficiencies. The study investigated ways to address deficiencies and protect the remaining system. The project scope includes the following:

- Review existing information, including previous designs, maps, drainage reports, and other data.
- Develop an inventory of existing drainage pipes using City as-built drawings and maps and City staff input. Evaluate the pipes using hydrologic and hydraulic modeling for existing and future land-use conditions.
- Develop an inventory of stream reaches and classify the reaches by geomorphology, vegetation, habitat, erosion, adjacent land-use and restoration potential.
- Identify measures for improving the piped and natural drainage systems. Investigate alternatives and recommend improvements to reduce existing and predicted future capacity problems.
- Present improvement alternatives to the City and public.

- Develop a capital improvement program for recommended projects with cost estimates and priorities for each recommendation.
- Document the analysis, recommendations and public meetings in a draft and final master plan report.
- Develop specific best management practices (BMPs) and maintenance recommendations.

REPORT ORGANIZATION

The *City of Ashland Stormwater and Drainage System Master Plan* consists of the following chapters:

- Introduction—Describing project background, authorization, purpose, scope, and report organization
- Study Area and Existing System Description—Describing the study area's location, topography, climate, existing storm sewer systems, creek corridors and land use
- Drainage System Evaluation—Describing the methods used to evaluate the drainage system and the findings of the evaluation
- Evaluation of Improvements—Describing alternatives to improve the existing system and methods for comparing alternatives
- Capital Improvement Program—Describing the overall plan for structural and nonstructural improvements, along with a phasing plan and alternative funding methods.

Appendices provide supporting information on project cost, hydrologic and hydraulic modeling, Examples of Stormwater Facilities and Best Management Practices (BMPs), and maintenance guidelines.

Chapter 2
STUDY AREA AND EXISTING DRAINAGE SYSTEM DESCRIPTION

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EXISTING DRAINAGE SYSTEM DESCRIPTION

STUDY AREA DESCRIPTION

Location and Boundaries

The City of Ashland is in southern Oregon along the Bear Creek and Interstate 5 corridor in Jackson County, approximately 14 miles north of the California-Oregon state border (see Figure 2-1). The Ashland Urban Growth Boundary (UGB) contains approximately 9 square miles. The study area is shown in Figure 2-2.

Topography

The study area can be divided into three topographic zones:

- The first zone is the southern section of the study area, which consists of steep slopes associated with foothills. This zone is fully developed in some basins and is seeing rapid development in other sections. Slopes in this zone range from 5 percent to greater than 20 percent.
- The second zone is the terrace between the foothills and the Bear Creek floodplain. This area is highly developed and contains most of the downtown area. Slopes in this zone range from 1 percent to greater than 10 percent.
- The third zone is the Bear Creek floodplain and associated banks. This area has slopes ranging from essentially flat to greater than 10 percent.

Sensitive Areas

Sensitive areas are identified by City maps and ordinance. They include floodplain corridor land, riparian preservation, hillside lands, wildfire lands, and severe constraint lands. A description of these areas and the regulations that apply to them is contained in Chapter 18.62 of the City ordinances.

Soils

Soils data for this study was obtained from the *Soil Survey of Jackson County* developed by the U.S. Department of Agriculture. The soil in Ashland is predominantly sediment derived from granite rock found in the surrounding mountains. The soil survey divides soils into four hydrologic soil groups defined by how easily rainfall can infiltrate the soil:

- Group A—Soils with a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

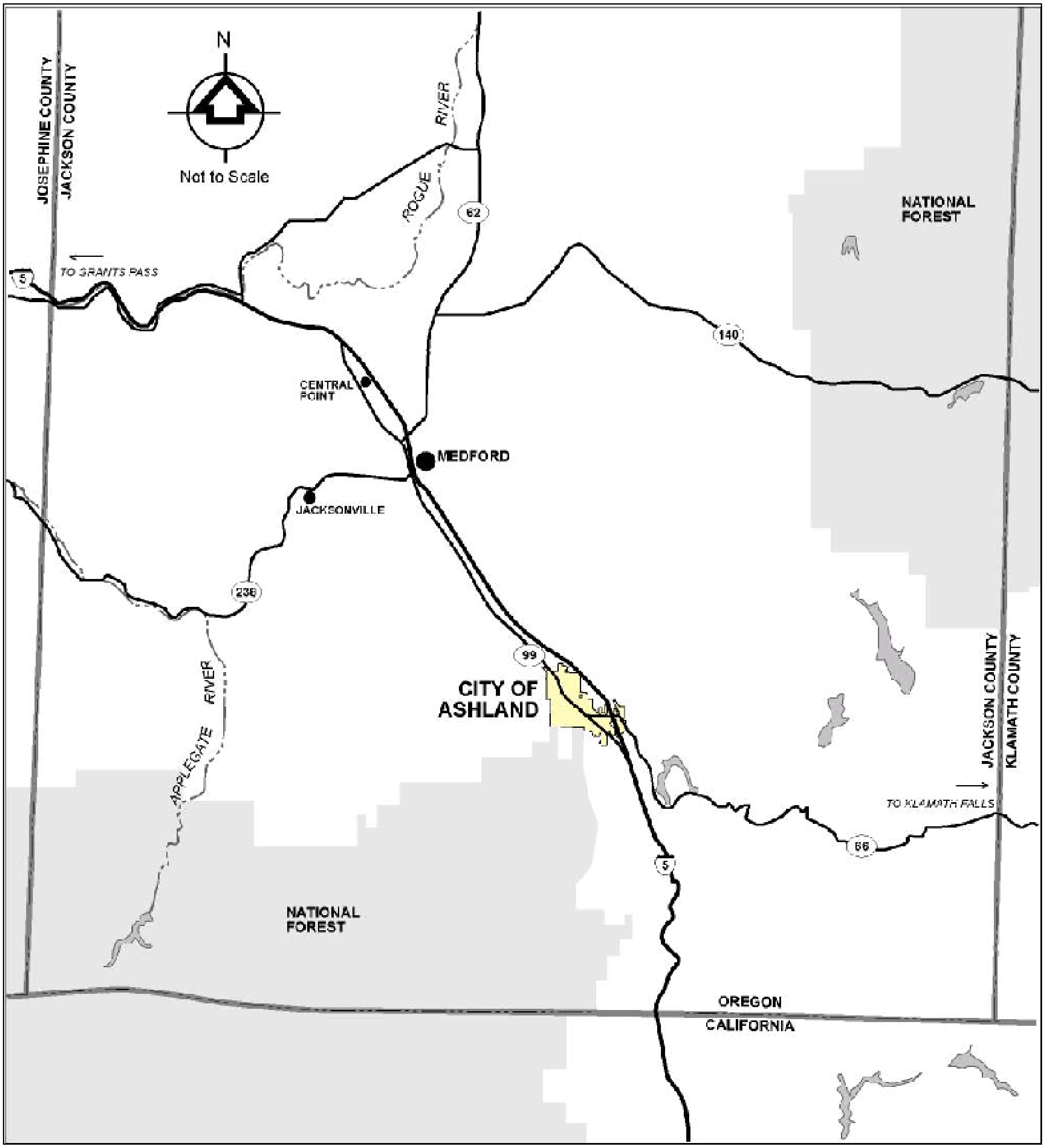
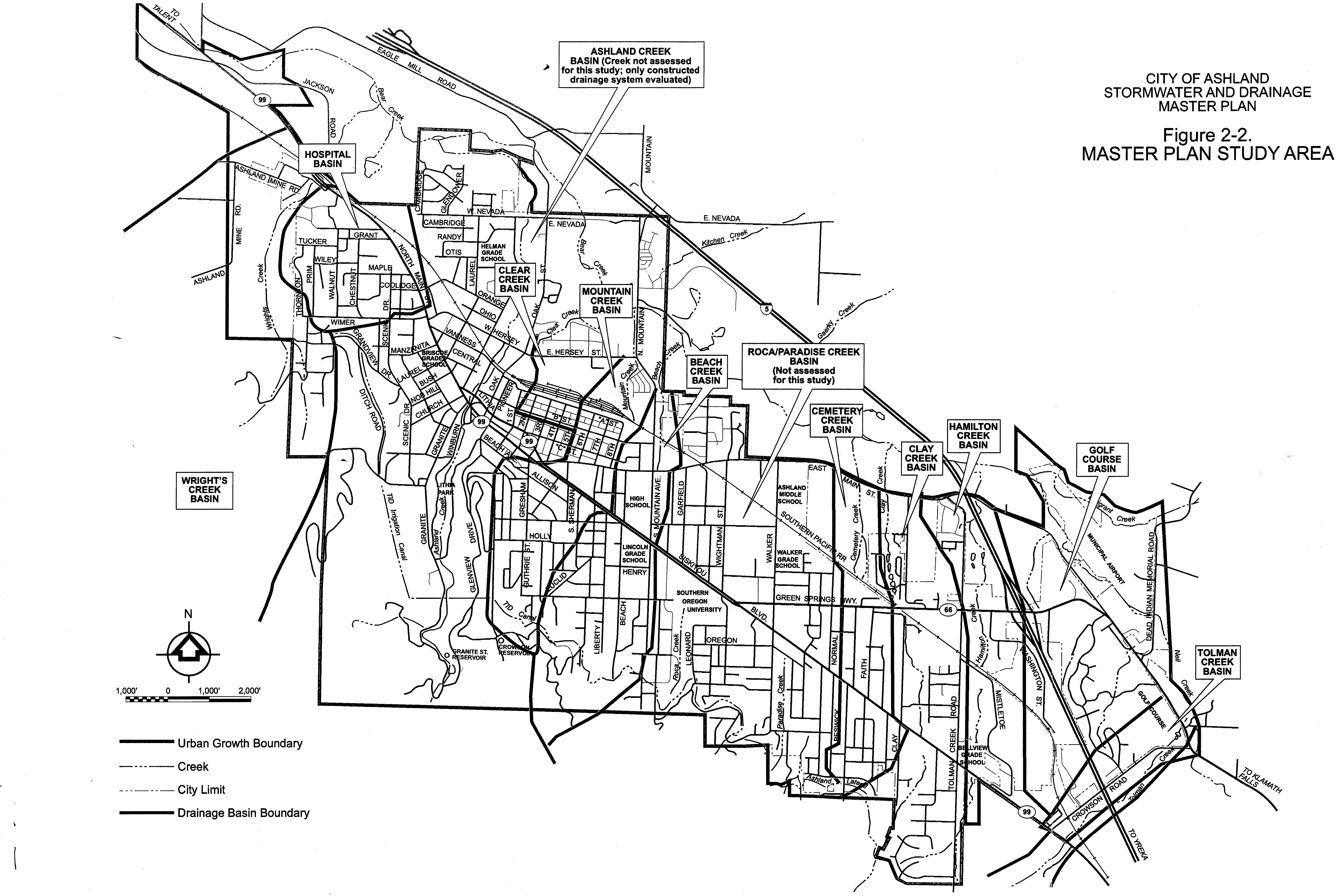


Figure 2-1. Project Vicinity



CITY OF ASHLAND
STORMWATER AND DRAINAGE
MASTER PLAN

Figure 2-2.
MASTER PLAN STUDY AREA

- Group B—Soils with a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
- Group C—Soils with a slow infiltration rate when thoroughly wet. These consist chiefly of soils with a layer that impedes the downward movement of water or soils of moderately fine or fine texture. These soils have a slow rate of water transmission.
- Group D—Soils with a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Only Group B, C and D soils are found in the study area. The area of Group B soils consists of Shefflein Loam over most of the developed areas of the City. The Group C soils are along the ridges and made up mainly of Tallowbox Gravelly Sandy Loam and Manita Loam. The Group D soils are around Bear Creek and the lower terraces and consist primarily of Kubli Loam, Coker Clay and Carney Cobbly Clay. A portion of the watersheds outside the UGB is not mapped in the soil survey.

Rainfall

Ashland receives approximately 20 inches of rainfall annually, most of it between October and March. These are the months when most flooding events have occurred. Summer months generally have hot days with little rainfall. Table 2-1 shows the rainfall amounts obtained from the *Precipitation—Frequency Atlas of the Western United States, Volume X—Oregon* developed by the National Oceanic and Atmospheric Administration (NOAA).

TABLE 2-1.
STUDY AREA RAINFALL DATA

Return Frequency	Rainfall Depth (in)	
	6-Hour	24-Hour
2-Year	1.0	2.5
5-Year	1.3	3.0
10-Year	1.6	3.5
25-Year	1.8	4.0
50-Year	2.2	4.3
100-Year	2.4	4.5

This study also used the rainfall intensity curves developed by the Oregon Department of Transportation (ODOT). ODOT divided the state into zones with similar rainfall patterns and developed intensity-duration-frequency curves for each zone. The City of Ashland is in Zone 5. The curves were used to analyze the piped storm sewer system in highly developed sections of the City.

Current and Future Land Use

Land use in the City of Ashland is mainly residential, with two areas of commercial or industrial development. The residential density generally ranges from high-density multi-family development to low-density 10,000-square-foot parcels. There are residential parcels much larger, but this study evaluates the effects of development on surface water runoff and therefore assumes that these parcels will develop to the highest density allowed by zoning.

The hydrologic analyses in this report look at existing and future flows. Existing flows were developed by estimating the impervious area in each basin as mapped in aerial photography in the spring of 1998. Future flows were estimated by assuming maximum buildout of the UGB, which is shown on Figure 2-2.

Tables in Appendix C provide details on the land use estimates used in developing the amount of impervious area in each basin. City zoning maps and land use maps were used to estimate future development in each basin. These maps were not reproduced in this report.

EXISTING DRAINAGE SYSTEM DESCRIPTION

Creek Systems

Natural and man-made open channel systems are assessed as creek systems in this report. Figure 2-2 shows the City's major creek systems and their drainage basins. Tolman Creek, Hamilton Creek, Clay Creek, Cemetery Creek, Roca/Paradise Creek, Beach Creek, Mountain Creek, Ashland Creek, and Wright's Creek flow from north to south and discharge to Bear Creek, which flows through the north section of the City. Kitchen Creek, which discharges to Bear Creek from the north, enters the City at its downstream end. Several small, intermittent drainage courses also are addressed in this report. These are generally in the eastern part of the City, with several in the vicinity of the golf course and the middle school, and discharge to Bear Creek or Neil Creek.

Ashland Creek was excluded from this study, although the storm drainage systems in its watershed are assessed. All drainage in the Roca/Paradise Creek watershed was excluded from this study.

The Talent Irrigation District (TID) has several canals in the study area that affect drainage patterns and flooding. The main TID canal through Ashland is shown on Figure 2-2. In winter, the canal carries both irrigation water and stormwater, leading to some interbasin transfer of stormwater. The effects of this transfer were not evaluated for this study.

Development in Ashland has altered the creeks to the extent that the natural stream's geomorphologic structure and processes cannot be fully restored; such impacts are typical of communities of similar size. However, some natural functions can be achieved by planning, capital projects, and community-based stream enhancement. Such measures would help achieve this master plan's goals of protecting property, improving water quality, and protecting and enhancing riparian habitat. Further stream degradation can be prevented to some extent with improved development regulations, and enforcement of citywide erosion control policies.

Water Quality

The Oregon Department of Environmental Quality (DEQ) has established Total Maximum Daily Load (TMDL) limitations on Bear Creek. These limitations were established under guidelines developed by the Environmental Protection Agency (EPA) under section 303(d) of 40 CFR Part 130 of the Clean Water Act. The parameters by which Bear Creek was originally listed are biochemical oxygen demand (BOD), ammonia, and phosphorus. Water temperature was added at a later date. Oregon's 303(d) list for water bodies was revised in 1998 and is due to be revised again in April 2000. The two creeks on the list directly affected by activities in the City of Ashland are Bear Creek and Ashland Creek.

Storm Sewers

Only piped storm sewers 12 inches in diameter or larger are evaluated in this study. It is assumed that smaller pipes serve only local drainage needs and need simply to be maintained or repaired. Storm systems with 12-inch diameter pipe and larger are main trunk lines whose proper sizing is essential to prevent flooding in the City.

Cemetery Basin

Cemetery Basin has three storm sewer systems that were modeled for this study.

- The first system starts on the west side of Clay Street at the intersection with Canyon Park Drive. It conveys flow north on Clay Street to Siskiyou Boulevard, where it discharges to the north side of Siskiyou Boulevard and flows in an open channel north to the park at the corner of Clay Street and Faith Avenue.
- The second system starts at the intersection of Terra Avenue and Verda Street. It conveys flow north on Faith Street, where it crosses Greensprings Highway and discharges to an open channel on the east side of the cemetery on Greensprings Highway.
- The third system starts at the intersection of Crestview Drive and Park Street. From this intersection it conveys flow north along Park Street under Siskiyou Boulevard and Greensprings Highway and discharges to the same channel as the second Cemetery Basin system.

Beach Creek Basin

The storm sewer system in the Beach Creek Basin is segmented, with reaches of open channel between pipe sections. Sewers in much of the upper reaches of the basin are smaller than 12 inches in diameter. The system starts at the Southern Oregon University (SOU) parking lot south of Henry Street along the alley between Mountain Avenue and Beach Street. The system then runs north on the west side of Mountain Avenue until it crosses Mountain Avenue north of Siskiyou Boulevard. It discharges east of Mountain Avenue and north of the Central Oregon Pacific Railroad tracks.

Mountain Creek Basin

The storm sewer system in the Mountain Creek Basin consists of pipe less than 12 inches in diameter south of Siskiyou Boulevard. At the corner of Siskiyou Boulevard and Morton Street, the 12-inch pipe starts, conveying flow north along the alley east of Dewey Street and then down 8th Street. It discharges to an open channel upstream of the Central Oregon Pacific Railroad tracks.

Ashland Creek Basin

Six storm sewer systems were modeled in the Ashland Creek Basin (upper reaches of the creek were modeled in the Otak study after the January 1997 flood):

- A system discharging at the north end of Glendower Street drains the section of the City north of the railroad tracks and west of Laurel Street.

- A system along Helman Street discharges to Ashland Creek at Nevada Street.
- A system along Oak Street on the east side of Ashland Creek starts south of the intersection of Oak Street and Hersey Street and discharges to Ashland Creek at Nevada Street.
- A system that runs along Hersey Street west of Ashland Creek starts on Wimer Street south of Highway 99 and discharges to Ashland Creek at Hersey Street.
- The Church Street system starts at Scenic Drive, goes north on Church Street, and discharges to Ashland Creek downstream of Highway 99.
- The Granite Street system starts at Nutley Street and discharges to Ashland Creek upstream of Highway 99.

Hospital Basin

The Hospital Basin system consists of all the pipes that discharge to the piped system along Highway 99. The Highway 99 system discharges north of the railroad tracks to Billings Pond. The pipe systems collect runoff from the area around the Ashland Hospital. Systems modeled in this area include the pipes along Maple Street and Sheridan Street.

Culverts

Most of the City’s road crossings of creeks and roadside channels were analyzed to determine whether existing culverts can accommodate design storms (storms with a 25-year recurrence interval) under buildout conditions (predicted development conditions in 2020). Table 2-2 summarizes the characteristics of the culverts evaluated. The data were compiled through field study of each culvert. Some of the identified culverts were not accessible for measurement. Although these culverts’ characteristics are not recorded, they have been identified for the hydrologic modeling described in Chapter 3.

TABLE 2-2.
CULVERTS EVALUATED FOR MASTER PLAN

Structure	Size and Type	Tributary Drainage Area (acres)	Assumed Slope (%)
Tolman Creek			
Highway 99	4' X 4' BC	1,683	
I-5	5' H X 6' V BC	1,710	
Crowson Rd.	60" CMP	1,735	1.11%
E. Main St.	6' X 6' BC	1,771	0.83%
Golf Course Basin			
GC-100	18" CMP	41	0.50%
GC-200	18" CONC.	6	0.50%
GC-350	*Not Accessible*	36	
GC-340	36" CONC.	56	0.50%
GC-330	18" CONC.	15	0.50%
GC-320	36" CMP	22	0.50%
GC-310	18" CONC.	109	0.50%
GC-300 (2)	18"HDPE	65	0.50%
	12"CONC.		0.50%
GC-400	18" CONC.	7	0.50%

GC-500	24" CONC.	73	0.50%
GC-600	30" CONC.	11	0.50%
GC-740	*Not Accessible*	56	
GC-730	*Not Accessible*	32	
GC-720	*Not Accessible*	52	
GC-710	*Not Accessible*	11	
GC-700	36" CMP	98	0.50%
GC-900	*Not Accessible*	21	
Hamilton Creek			
Tolman Cr. Rd.	36" CMP	142	1.25%
Tolman Cr. Rd.	24" CONC.	92	0.71%
Highway 99	4' X 6' BC	292	0.50%
School Field	24" HDPE	292	5.37%
RR Tracks	8' Arch 5' High	353	0.50%
Mistletoe Rd.	48" CMP	353	1.67%
Highway 66	6' X 6' BC	393	0.50%

BC = box culvert; CMP = corrugated metal pipe;
CONC = concrete pipe; HDPE = high-density polyethylene pipe

TABLE 2-2 (continued).
CULVERTS EVALUATED FOR MASTER PLAN

Structure	Size and Type	Tributary Drainage Area (acres)	Assumed Slope (%)
Clay Creek			
Highway 99	60" CMP	795	0.50%
Diane St.	96" CMP	807	0.62%
RR Tracks	8' X 4' BC	851	1.00%
E. Main St.	36" CMP	885	0.60%
Cemetery Creek			
Clay St.	12" CMP	48	1.67%
RR Tracks (2)	36" CMP	199	0.71%
	36" CMP		0.71%
E. Main St. (2)	30" CMP	261	0.83%
	24" CMP		0.83%
Middle School			
E. Main St. - East	24" CMP	34	0.55%
E. Main St. - West	24" CMP	28	0.44%
Beach Creek			
Village Green Dr.	60" CMP	199	1.11%
Kitchen Creek			
Mountain Ave.	72" CMP	2,838	1.82%
Clear Creek			
RR Tracks	1' X 2' BC	27	0.50%
Hersey St.	(2) 15" CONC.	41	0.50%
Crispin St.	36" CONC	45	0.50%
Wright's Creek			
Orchard	30" CONC.	79	4.44%
Wright's Creek Dr.	30" CONC.	96	4.44%
Benjamin Ct.	42" CONC.	197	4.71%
Highway 99	48" CONC.	2,084	3.75%

BC = box culvert; CMP = corrugated metal pipe;
CONC = concrete pipe; HDPE = high-density polyethylene pipe

A Flood Insurance Study (FIS) was prepared and adopted by the City in December 1980. The study investigated the flood levels of Bear Creek, Ashland Creek and Clay Creek. The structures along Bear Creek and Ashland Creek were not analyzed as part of this master plan. The flood profiles for Clay Creek show the 50-year storm overtopping all the structures along Clay Creek within the city limits. The structures shown on the profile are the mobile home park culvert, the Clay Street culvert, the Siskiyou Boulevard culvert and the culvert under the college housing block. The Ashland Street and Railroad overpass are shown on the profile, but the vertical location of the structure is not shown.

Reported Flooding Problems

The City has identified areas that have been subject to flooding during past storms. Figure 2-3 shows these areas.

Chapter 3
DRAINAGE SYSTEM EVALUATION

CHAPTER 3.
DRAINAGE SYSTEM EVALUATION

The following analyses were performed to evaluate the City's existing storm drainage system:

- Storm Sewers:
  - A hydrologic analysis of the storm sewer system was performed to estimate flows through each pipe reach for the 10- and 25-year storms under existing and future (full buildout) land use conditions. The 25-year storm is the design storm for storm sewers.
  - A hydraulic analysis of the storm sewer system was performed to determine the flow capacity of each pipe reach.
  - Computer modeling was performed for storm sewers with capacities less than the predicted design storm flows to determine the pipe size required to accommodate the flow.
- Culverts:
  - A hydrologic analysis of culverts was performed to estimate flows through each pipe reach for the 25-, 50-, and 100-year storms under existing and future (full buildout) land use conditions. The design storm for culverts is the 50-year storm.
  - A hydraulic analysis was performed to determine the flow capacity of each culvert.
  - Computer modeling was performed for culverts with capacities less than the predicted design storm flows to determine the pipe size required to accommodate the flow.
- Field reconnaissance of the City's creeks were conducted to classify the creeks and determine their condition

STORM SEWER SYSTEM EVALUATION

Evaluation Approach

Hydrologic Analysis

Storm system hydrologic analysis involved the determination of the following parameters:

- **A runoff coefficient for the area draining to each storm inlet**—Runoff coefficient is related to land use under buildout conditions. In this analysis, a percent of the total area that is covered with impervious surface (percent impervious) was defined for each type of land use, as shown in Table 3-1. After determining the amount of each type of land use in a drainage area (the actual amount for existing conditions and the maximum amount the zoning allows for future conditions), the percent impervious was used to calculate the total pervious and impervious surface in that drainage area. The runoff coefficient for each area was calculated by applying a coefficient of 0.20 to its percent of pervious area and a coefficient of 0.98 to its percent of impervious area.

TABLE 3-1.
PERCENT IMPERVIOUS BY LAND USE

Land Use	Percent Impervious
Open Area/Undeveloped	0
Residential	
R-20 (Low Density)	25
R-10	40
R-7	50
R-5	65
R-4	70
A-2 (High Density)	70
Commercial	80
Industrial Park	80

Source: *Unified Sewerage Agency Surface Water Management Subbasin Strategies, Volume II; Tualatin Basinwide Report and Technical Guidelines*. Brown and Caldwell. October 1992.

- **The equivalent impervious runoff area for the area draining to each storm inlet**—The equivalent impervious runoff area for each drainage area was calculated by multiplying its runoff coefficient by its total acreage.
- **The time of concentration to each storm inlet**—The time of concentration for a drainage area is defined as the time it takes for storm runoff to travel to the storm inlet from the most hydraulically distant point in the drainage area. Along the length of a storm sewer system, the time of concentration was calculated as the sum of the initial time of concentration and the travel time along the length of the system.
- **The corresponding rainfall intensity**—Rainfall intensity is a function of the duration of a storm. The shorter the duration of a given frequency storm, the higher the rainfall intensity. Time of concentration was used as an estimate of duration, and rainfall intensity was estimated from a chart developed by the Oregon Department of Transportation (ODOT). ODOT used historical Oregon rainfall information to develop a series of intensity-duration-frequency curves for zones with the same rainfall characteristics; the City of Ashland is in Zone 5 under this system. Table 3-2 summarizes the data for this zone.
- **Runoff discharge to each manhole along the length of each system**.— The runoff discharge for a drainage area was calculated by multiplying the equivalent impervious runoff area by the rainfall intensity.

TABLE 3-2.
RAINFALL DURATION AND INTENSITY

Storm Duration	Rainfall Intensity (inches/hour)	
(minutes)	10-Year Storm	25-Year Storm
5	2.50	2.90
10	1.95	2.25
15	1.65	1.92

20	1.42	1.68
25	1.28	1.59

Manholes were used as collection points because this was an evaluation of main lines; inlet spurs were not investigated. Runoff discharges were calculated along the length of each system.

Hydraulic Analysis

Storm tabulation spreadsheets were used to evaluate the storm sewers for existing and future development conditions. The full-flow gravity capacity and velocity of each pipe segment were calculated, based on the segment's material, slope, diameter, and length, the pipe invert elevation at the upstream and downstream ends, and the elevation of manhole tops. Head losses for free-surface and pressure conditions were calculated using flows estimated in the hydrologic analysis.

The hydraulic analysis assumed a tailwater elevation (the water elevation at the downstream end of the system) equal to the elevation of the crown of the downstream end of the outfall pipe. From this starting elevation, the system's hydraulic grade line (the effective elevation of the water throughout the system) was determined using the invert elevations provided by the storm system inventory and the head losses calculated for each pipe. The method used to determine tailwater and headwater elevations for each pipe is shown in Figure 3-1.

Evaluation Findings

Headwater elevations for each pipe determined in the hydraulic analysis were compared to the upstream top-of-manhole elevations. If the headwater elevation was greater than the top of manhole elevations (indicating surcharging in the manhole and flooding over the manhole rim), the system was defined as under-capacity somewhere downstream of the flooded manhole. Flooded manholes are likely to result only in nuisance flooding during the 25-year storm. The top of manhole elevations used in the evaluation were, in many cases, estimated from available mapping and may not reflect actual elevations.

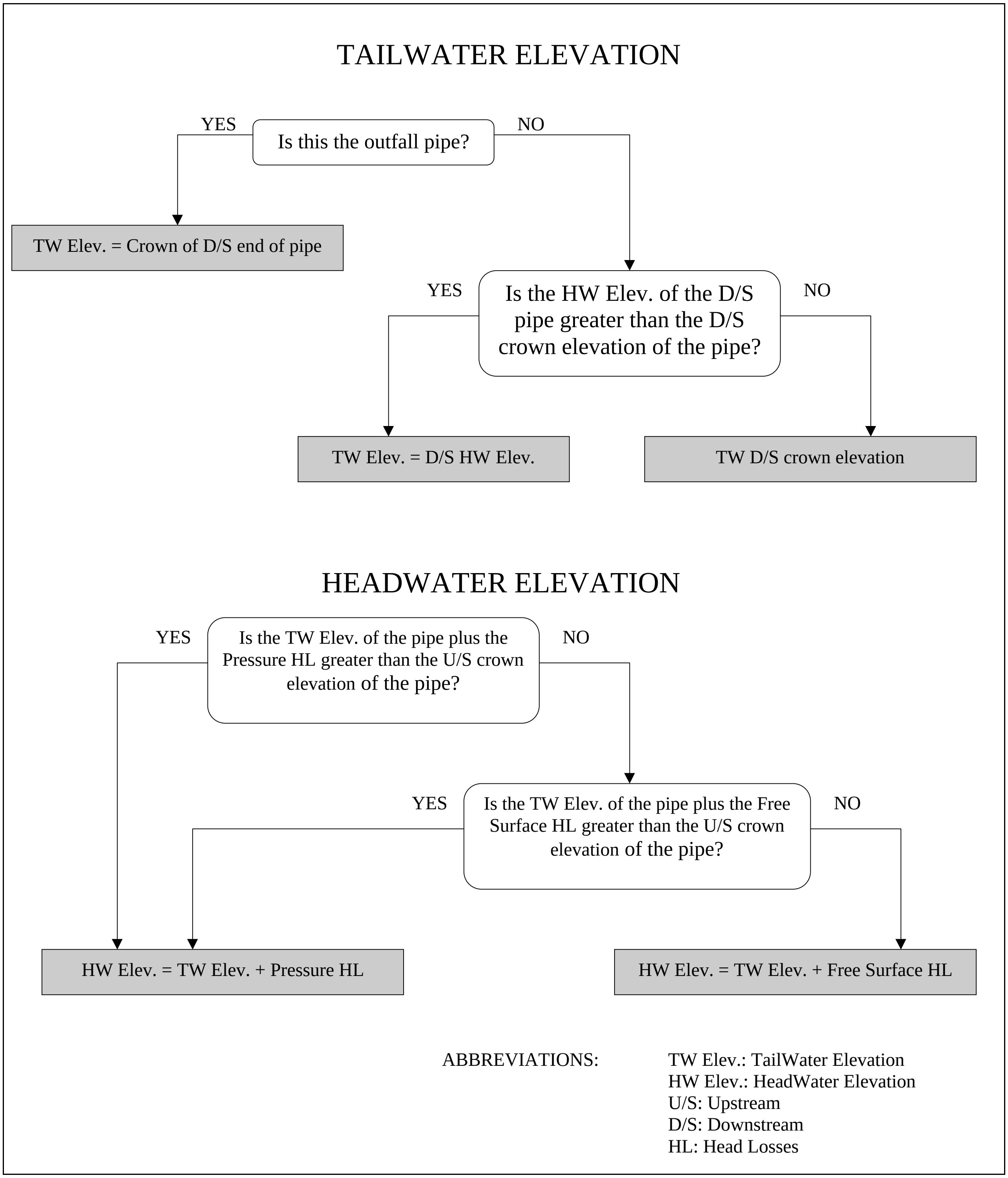


Figure 3-1. Procedure for Determining Headwater and Tailwater Elevations

All storm systems evaluated showed flooding. The modeling output shown in Appendix B shows the pipe size required for each pipe section to accommodate the future-conditions design flow.

CULVERT EVALUATION

Evaluation Approach

Hydrologic Analysis

The Hydrologic Engineering Center Flood Hydrograph Package (HEC-1) was used to generate hydrographs (estimates of expected flow for the duration of a storm) for each culvert. The information required for the HEC-1 hydrograph method includes basin area, soil permeability (as measured by "curve number," a value defined by the U.S. Soil Conservation Service), time of concentration (T_c), and rainfall information. The information for each culvert's drainage basin is summarized in Table 3-3 and listed in detail in Appendix C, which also contains the HEC-1 computer model input and output files.

TABLE 3-3.
DRAINAGE BASIN DATA USED FOR HYDROLOGIC EVALUATION OF CULVERTS

	Drainage	Impervious Surface						
	Area	% of Total Area		Area (acres)		Curve Number		T_c
Basin	(acres)	Existing	Future	Existing	Future	Existing	Future	(min.)
Tolman								
Highway 99	1,683.0	0%	0%	0.0	0.0	67	67	109
I-5	27.0	7%	7%	2.0	2.0	77	77	7
Crowson Rd.	25.0	8%	8%	2.0	2.0	77	77	8
E. Main St.	36.0	10%	38%	3.4	13.7	75	71	30
Golf Course								
GC-100	41.0	12%	12%	4.8	4.8	80	80	10
GC-200	6.1	0%	0%	0.0	0.0	80	80	14
GC-350	36.0	0%	0%	0.0	0.0	72	72	5
GC-340	20.4	30%	60%	6.1	12.2	84	84	5
GC-330	15.4	0%	0%	0.0	0.0	73	73	5
GC-320	6.8	57%	65%	3.9	4.4	84	84	3
GC-310	30.2	40%	80%	12.1	24.2	82	80	10
GC-300	65.4	24%	24%	15.9	15.9	80	80	22
GC-400	6.6	31%	31%	2.1	2.1	80	80	4
GC-500	73.2	42%	63%	31.0	46.3	81	80	15
GC-600	11.0	40%	80%	4.4	8.8	82	80	6
GC-740	55.8	73%	80%	40.6	44.6	80	80	11
GC-730	32.2	20%	80%	6.6	25.8	83	80	6
GC-720	19.3	47%	80%	9.0	15.4	82	80	7
GC-710	11.1	44%	80%	4.9	8.9	82	80	10
GC-700	35.0	11%	50%	4.0	17.5	83	80	9
GC-800	1.6	0%	45%	0.0	0.7	84	80	3
GC-900	21.3	0%	45%	0.0	9.6	84	80	6

TABLE 3-3 (continued).
DRAINAGE BASIN DATA USED FOR HYDROLOGIC EVALUATION OF CULVERTS

	Drainage	Impervious Surface		

Basin	Area (acres)	% of Total Area Existing	% of Total Area Future	Area (acres) Existing	Area (acres) Future	SCS Curve Number Existing	SCS Curve Number Future	Tc (min.)
Hamilton Creek								
H-100	142.0	0%	0%	0.0	0.0	68	68	20
H-200	58.3	27%	27%	15.8	15.8	72	72	43
H-250	91.8	20%	25%	18.0	22.5	72	72	25
H-300	60.7	22%	62%	13.4	37.9	82	80	26
H-400	30.3	40%	80%	12.0	24.2	84	84	14
H-500	36.2	40%	80%	14.5	29.0	84	80	22
H-510	31.4	33%	60%	10.5	18.7	81	80	23
H-520	14.2	24%	80%	3.4	11.4	84	80	15
H-530	40.2	48%	54%	19.3	21.9	81	80	24
H-540	7.8	80%	80%	6.2	6.2	80	80	17
H-600	9.5	17%	56%	1.6	5.4	84	80	45
Clay Basin								
U/S of Siskiyou Blvd	795.0	2%	5%	12.2	38.7	63	64	79
U/S of Diane St.	12.4	41%	55%	5.1	6.8	80	79	5
U/S of RR Tracks	44.0	35%	52%	15.3	22.8	80	79	16
U/S of E. Main St.	33.9	47%	47%	16.0	16.0	81	81	17
E. Main Basins								
E-100	23.4	0%	50%	0.0	11.7	84	80	10
E-200	1.6	30%	80%	0.5	1.3	83	80	4
E-300	2.9	0%	50%	0.0	1.5	84	80	8
E-310	1.8	36%	80%	0.6	1.4	82	80	6
E-320	23.7	0%	50%	0.0	11.9	84	80	27
E-330	21.5	0%	50%	0.0	10.8	84	80	33
Middle School								
E. Main - East	33.5	13%	50%	4.4	16.8	73	75	31
E. Main - West	27.5	44%	60%	12.0	16.5	72	66	19
Kitchen								
Mountain Ave.	2,838.0	0%	0%	0.0	0.0	83	83	72
Clear Creek								
RR Tracks	27.4	55%	55%	15.1	15.1	80	80	16
Hersey St.	13.8	0%	55%	0.0	7.6	84	80	10
Crispen St.	4.0	50%	50%	2.0	2.0	80	80	4
Wright's								
Orchard	79.0	0%	28%	0.0	21.8	59	74	30
Wright's Creek Dr.	96.0	8%	31%	7.7	29.4	61	74	24
Benjamin Ct.	197.0	0%	6%	0.0	12.3	58	60	22
Highway 99	2,084.0	1%	4%	22.5	86.3	66	66	56

Hydraulic Analysis

For the hydraulic analysis of culverts, circular pipes were modeled using Manning's equation. The value of "n," a measure of pipe surface roughness, was set at 0.013 for concrete pipe and 0.024 for corrugated metal pipe. Arches were modeled as circular pipes with an equivalent diameter. Slopes were based on survey measurements of upstream and downstream invert elevations and length of pipe. The hydraulic analysis assumed a tailwater elevation (the water elevation at the downstream end of the system) equal to the elevation of the crown of the downstream end of the outfall pipe.

Evaluation Findings

Table 3-4 summarizes the culvert capacities estimated by the hydraulic analysis, as well as the predicted flows estimated in the hydrologic analysis. Table 3-5 lists culverts whose capacity is less than the existing conditions 50-year storm flow, as identified by the hydrologic and hydraulic analysis.

TABLE 3-4.
SUMMARY OF RESULTS FROM CULVERT HYDROLOGIC AND HYDRAULIC ANALYSES

		Tributary Drainage	Flow (cfs)						
		Area	25-year		50-year		100-year		Capacity
Culvert	Size	(acres)	Existing	Future	Existing	Future	Existing	Future	(cfs)
Tolman Creek									
Highway 99	4'x4'	1,683	102	102	131	131	184	184	
I-5	5'x6'	1,710	104	104	134	134	187	187	
Crowson Rd.	60"	1,735	106	106	136	136	191	191	155
E. Main St.	6'x6'	1,771	110	111	141	142	197	198	492
Golf Course Basin									
GC-100	18"	41	8	8	9	9	11	11	4
GC-200	18"	6	1	1	1	1	2	2	7
GC-350	—	36	4	4	4	4	6	6	
GC-340	36"	56	8	9	10	11	13	13	47
GC-330	18"	15	2	2	2	2	3	3	7
GC-320	36"	22	4	4	4	4	5	5	27
GC-310	18"	109	19	22	22	25	28	30	7
GC-300	18"	65	32	35	37	40	46	48	7
(2 culverts)	12"								3
GC-400	18"	7	1	1	2	2	2	2	7
GC-500	24"	73	19	21	21	24	25	28	16
GC-600	30"	11	3	3	3	4	4	4	29
GC-740	—	56	16	17	18	19	21	22	
GC-730	—	32	23	27	26	29	30	34	
GC-720	—	52	28	31	32	36	37	41	
GC-710	—	11	3	3	3	4	4	4	
GC-700	36"	98	38	43	44	49	51	57	27
GC-900	—	21	4	5	5	6	6	7	

TABLE 3-4 (continued).
SUMMARY OF RESULTS FROM CULVERT
HYDROLOGIC AND HYDRAULIC ANALYSES

		Tributary Drainage	Flow (cfs)						
		Area	25-year		50-year		100-year		Capacity
Culvert	Size	(acres)	Existing	Future	Existing	Future	Existing	Future	(cfs)

Hamilton Creek									
Tolman Cr. Rd.	36”	142	10	10	12	12	17	17	42
Tolman Cr. Rd.	24”	92	9	9	10	10	13	13	19
Highway 99	4’x6’	292	29	29	35	35	46	47	219
School Field	24”	292	29	29	35	35	46	47	52
RR Tracks	8’x5’	353	41	45	49	53	64	68	210
Mistletoe Rd.	48”	353	41	45	49	53	64	68	105
Highway 66	6’x6’	393	48	54	57	64	73	80	381
Clay Creek									
Highway 99	60”	795	32	44	44	57	66	80	85
Diane St.	96”	807	34	46	45	59	68	82	405
RR Tracks	8’x4’	851	38	50	50	64	73	88	443
E. Main St.	36”	885	41	53	53	67	77	92	29
Cemetery Creek									
Clay St.	12”	48	10	11	11	12	13	15	8
RR Tracks	36”	199	46	50	52	56	63	67	32
(2 culverts)	36”								32
E. Main St.	30”	261	62	71	70	79	85	94	21
(2 culverts)	24”								12
Middle School									
E. Main - East	24”	34	4	8	5	9	7	10	9
E. Main - West	24”	28	6	7	6	7	8	9	9
Beach Creek									
Village Green Dr.	60”	199	59	61	66	68	79	81	132
Kitchen Creek									
Mountain Ave.	72”	2,838	491	491	574	574	716	716	275
Clear Creek									
RR Tracks	1’x2’	27	12	13	13	14	16	16	8
Hersey St. (2)	15”	41	15	17	16	18	19	22	9
Crispin St.	36”	45	15	17	16	18	19	22	47
Wright's Creek									
Orchard	30”	79	2	13	3	15	5	19	87
Wright's Creek Dr.	30”	96	5	17	6	20	9	24	87
Benjamin Ct.	42”	197	5	8	7	11	11	16	218
Highway 99	48”	2,084	117	130	152	166	215	230	278

TABLE 3-5.
CULVERTS WITH INADEQUATE CAPACITY AS IDENTIFIED BY HYDROLOGIC AND HYDRAULIC ANALYSES

Culvert	Current Size	Tributary Drainage Area (acres)	Design Flow[a] (cfs)	Existing Culvert Capacity (cfs)
GC-100 (E. Main St. west of Tolman Creek)	18”	41	9	4
GC-310 (Under Interstate 5)	18”	109	22	7

GC-300 (E. Main St. @ Dead Indian Memorial Rd; *2 culverts*)	18” 12”	65	37	7 3
GC-500 (E. Main St. at Greensprings Highway)	24”	73	21	16
GC-700 (E. Main St. east of I-5)	36”	98	44	27
Clay Creek at Highway 99	60”	795	44	85[b]
Clay Creek at E. Main St.	36”	885	53	29
Cemetery Creek at Clay St.	12”	48	11	8
Cemetery Creek at E. Main St. *(2 culverts)*	30” 24”	261	70	21 12
Kitchen Creek at Mountain Ave.	72”	2,838	574	275
Clear Creek at RR Tracks	1’x2’	27	13	8
Clear Creek at Hersey St. *(2 culverts)*	15”	41	16	9

a. The design flow is the predicted existing-conditions flow for the 50-year storm.
b. Although this culvert’s design capacity exceeds the design flow, the culvert is severely damaged and cannot convey its full design capacity.

CREEK SYSTEM EVALUATION

The process for inventorying existing stream corridor conditions focused on gathering data that would identify planning policies, capital projects, and community-based enhancement projects that would meet the project goals. The study team divided each stream into easily identifiable reaches and mapped each reach for conditions that indicate its overall health:

- **Existing vegetation**—Native vegetation helps hold banks during storm events, provides shade to lower water temperature, and provides habitat for many native species of wildlife.
- **Stream channel condition**—If a stream's banks appear stable and show few signs of erosion, then the stream is probably fairly healthy. Signs of erosion, downcutting, and flood damage indicate a stream in a degraded condition.
- **Encroachment of development**—If the land near a stream has been relatively undeveloped, then the overall health of the stream is probably good. Highly developed urban streams are usually the most degraded streams.

Using these three stream conditions as a tool for analysis gives a good indication of whether a stream is healthy. Most of the analysis of the streams was conducted by referencing the City's recent aerial photography, with some field-checking. Tables 3-6 through 3-12 summarize the findings of the creek system evaluation. Each table includes an overall description of the creek system, followed by photos and descriptions of individual stream reaches.

Table 3-6. Wright's Creek Evaluation

Wright's Creek lies in the northwest portion of Ashland. The creek is relatively undeveloped and the upper, steeply sloped reaches of its watershed are still heavily forested. With its preserved vegetation, the watershed provides an opportunity for a vegetated wildlife link between the National Forest and the Bear Creek Greenway. Future development should be reviewed carefully because it would increase erosion and flooding problems and reduce the possibility of a wildlife connection.

Reach Location	Reach Photo	Reach Condition
WR-1 From confluence of Bear Creek to 1000 feet upstream.		• Moderate vegetation coverage. Northern half of reach has major blackberry coverage. • No threat to buildings or other structures • Bank has been severely eroded along southern half of reach • Slopes average 2%
WR-2 From 1000 feet upstream to culvert at Highway 99.		• Good riparian vegetation coverage • Moderate encroachment from property owner along stream bank • Stable bank condition along 95% of reach • Slopes average 2%

Table 3-6 (continued). Wright's Creek Evaluation

Reach Location	Reach Photo	Reach Condition
WR-3 From culvert at Highway 99 to intersection near Birnam Wood Road		• Full riparian vegetation coverage along the entire stream reach • No major encroachment of buildings or structures • Reach bank is in stable condition
WR-4 From Birnam Road to Nyla Road		• Good vegetation coverage along stream reach • Moderate encroachment of private residences along east side of stream reach • Bank condition is stable and shows no major signs of erosion

Table 3-6 (continued). Wright's Creek Evaluation

Reach Location	Reach Photo	Reach Condition
WR-5 From Nyla Lane to intersection near Strawberry Lane	 *From Nyla Lane looking South*	• Northern section of reach has moderate vegetation due to encroachment along the stream bank. Banks show some signs of erosion in this area. • Southern section of stream reach has good vegetation coverage and little encroachment. Banks are intact and show little sign of erosion
WR-6 Tributary from confluence to intersection with Ashland Mine Road	No Photo Available – Private Property not accessed	• Moderate vegetation coverage along upper section of reach. • Reach is encroached at lower end by private property owner. Reach has been piped under property to confluence with main stem • Bank stability conditions unknown • Slopes average 7%
WR-7 Tributary that parallels Ashland Mine Road	No Photo Available – Private Property not accessed	• Moderate vegetation coverage along upper section of reach. • Reach is encroached at lower end by private property owner • Bank stability conditions unknown • Slopes average 4.5%
WR-8	No Photo Available – Private Property not accessed	• Good vegetation coverage along stream reach. • Reach is encroached by private property at confluence with main stem

Table 3-6 (continued). Wright's Creek Evaluation

Reach Location	Reach Photo	Reach Condition
WR-9 From Birnam Wood Road to 500 feet	No Photo Available – Private Property not accessed	• Good vegetation coverage along stream reach • No encroachment from any structures • Bank are in stable conditions
WR-10 From Grandview Drive to Orchard Street		• Moderate vegetation coverage. Major patches of blackberries along stream bank • Reach is highly encroached on either side of the stream bank • Bank conditions are moderate
WR-11 From Orchard Street south, parallel to Westwood Street along east side		• Good vegetation coverage along entire stream reach • Moderate encroachment due to road along west side of reach • Bank conditions are moderate. Reach shows some signs of erosion

Table 3-7. Beach, Mountain and Clear Creeks Evaluation

These small watersheds have been highly encroached by mostly residential development. Ninety percent of the streams' lengths have been piped. Little native vegetation exists along the stream reaches. Due to the streams' proximity to schools, there is an opportunity for public education in these areas. Overall, the streams and their watersheds pose little threat to property but they show some signs of erosion.

Reach Location	Reach Photo	Reach Condition
BE-1 From confluence with Bear Creek to Village Green Drive		• Little vegetation exists along the stream corridor • Severe erosion problems are apparent along stream bank • Reach has been highly encroached by structures in its northern section, and farming practices in its southern sections
BE-2 From Village Green Drive to East Main Street		• Most of the native riparian vegetation has been removed from the stream corridor • Reach has been highly encroached by farming at southern end • Banks are unstable and are showing signs of erosion

Table 3-7 (continued). Beach, Mountain and Clear Creeks Evaluation

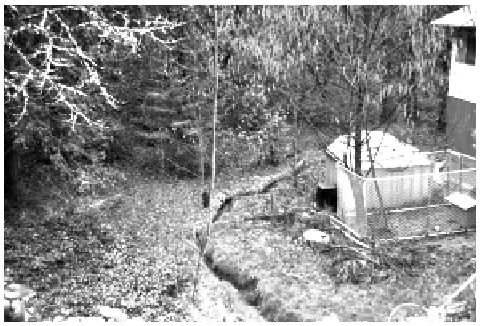
Reach Location	Reach Photo	Reach Condition
BE-3 From Beach Street to Waterline Road	 *Reach HA-2 at culvert under Ashland Street*	• Vegetation along this stream reach is in good condition • Banks appear to be downcutting severely in the lower portion of the reach. • This reach has been moderately encroached upon by development along its eastern bank.
BE-4 From confluence with CE-3 to railroad tracks	 *From Ashland Loop Road looking North*	• Riparian canopy is moderately intact along the stream reach • Banks are showing signs of downcutting in the upper portion of the stream reach • Reach has not been encroached by much development along its entire length
MT-1 From railroad tracks to Siskiyou Boulevard	 *From new development near Munson Drive*	• Little vegetation exists along the stream corridor. Most existing vegetation is blackberry patches • Severe erosion problems are apparent along stream bank • Reach has been highly encroached by new development along southern section of stream corridor

Table 3-7 (continued). Beach, Mountain and Clear Creeks Evaluation

Reach Location	Reach Photo	Reach Condition
CR-1 From railroad tracks to Siskiyou Boulevard	 *From Hersey Street looking North*	• No vegetation exists along this small stream reach • Banks are moderately unstable along the entire stream reach • Reach has been encroached by farming practices around the entire stream section. Also stream has been impacted by runoff from upstream development

Table 3-8. Cemetery Creek Evaluation

Cemetery Creek lies in the eastern portion of Ashland. The creek parallels Glendale Avenue, then passes Clay Street Park on the east side on its way to its confluence with Bear Creek. Most of the creek has been affected by development in its upper reaches and farm practices in the lower reaches. Approximately 30 percent of the native riparian vegetation currently remains along the stream corridor. The creek's proximity to Clay Street Park provides an opportunity for public education along this stretch.

Reach Location	Reach Photo	Reach Condition
CE-1 From confluence with Bear Creek to East Main Street		• Little vegetation exists along this stream reach. Blackberries cover 75% of stream reach • Bank is showing some signs of downcutting and erosion • Reach has only been encroached by farming practices
CE-2 From East Main Street to wetlands	 *From East Main Street looking South*	• Vegetation is in moderate condition along the stream reach • This reach has been moderately encroached along its northern portion • The banks are moderately stable and are mostly degraded along the middle portion of the reach

Table 3-8 (continued). Cemetery Creek Evaluation

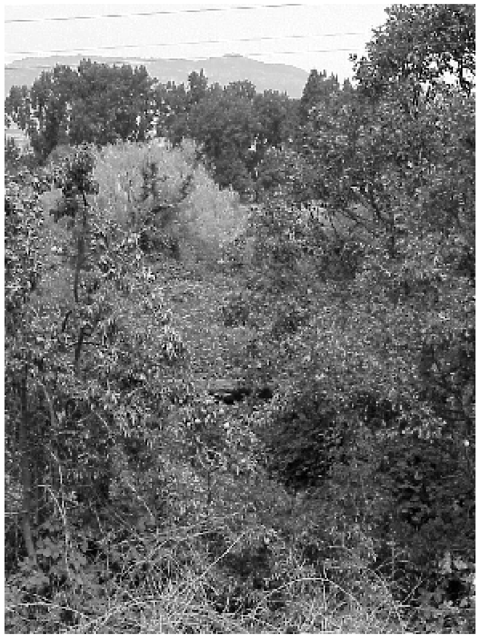
Reach Location	Reach Photo	Reach Condition
CE-3 From wetlands to railroad tracks		• Vegetation along this stream corridor is in good condition • There has been little encroachment of development along the stream banks • Banks are in stable condition
CE-4 From confluence with CE-3 to railroad tracks	 *Looking North from Railroad tracks*	• Vegetation is in good condition • Moderate encroachment along east side of stream bank • Banks are in moderately stable condition
CE-5 From Ashland St. to Siskiyou Drive	 *Looking South through Clay Street Park*	• Vegetation has been severely degraded along this stream reach • This reach has been highly encroached along both banks • Banks are in poor condition and are showing signs of erosion

Table 3-9. Clay Creek Evaluation

Clay Creek passes through the eastern portion of Ashland, parallel to Clay Street. This creek has been highly encroached upon by residential development in the upper section and farmlands along its lower sections. Much of the creek's native riparian vegetation has been removed along the stream corridor. There is a large amount of erosion and many flooding problems along the creek. Reestablishment of riparian species and stabilization of streambanks would reduce erosion problems and provide an opportunity for a link between the Nation Forest and the Bear Creek Greenway.

Reach Location	Reach Photo	Reach Condition
CL-1 From confluence with Bear Creek to East Main Street	 *At Main Street looking North*	• Little vegetation exists along the northern portion of the stream corridor. Vegetation consists mostly of blackberries • The stream reach has been encroached by farming practices along the southern portion • Bank conditions are unstable along the southern portion of the stream reach
CL-2 From East Main St. to southern end of new development	 *Looking South from Creek Drive*	• Vegetation coverage is in poor condition along this stream reach • This reach has been highly encroached at its northern and southern ends by development • Banks are unstable and in poor condition along the entire stream reach

Table 3-9 (continued). Clay Creek Evaluation

Reach Location	Reach Photo	Reach Condition
CL-3 From development to intersection with Ashland Street	 *Looking North from Railroad Tracks*	• Vegetation is in fair condition along the stream reach. • Stream reach has been moderately encroached by development. Storage ponds have been constructed along the entire reach. • Banks are stable along the entire stream reach
CL-4 From Ashland Street to 500 feet south of Takelma Way	 *Creek at Clay Street*	• Vegetation is in good condition along this stream reach • This reach has been highly encroached by residential development along both banks • Bank conditions are moderately stable along the reach
CL-5 From 500 feet south of Takelma Way to Diane Street	 *Behind Church on Clay Street*	• Vegetation is in moderate condition along this stream reach • The reach has been highly encroached by residential development along both banks • Banks along this stream reach are moderately unstable

Table 3-9 (continued). Clay Creek Evaluation

Reach Location	Reach Photo	Reach Condition
CL-6 From Diane St. to Siskiyou Blvd.	 *Looking North from Siskiyou Blvd.*	• Vegetation is in moderate condition in the southern end of the stream reach. • The reach has been highly encroached by development along both stream banks • Banks are highly unstable in the northern portion of the reach due to lack of vegetation
CL-7 From Siskiyou Boulevard to near end of Sam Evans Place	 *Looking South from Siskiyou Blvd.*	• Vegetation is in good condition along the stream reach • This reach has been highly impacted by development mainly in the northern portion of the stream reach • Bank conditions are moderately stable along the stream reach
CL-8 From near Sam Evans Place to 300 feet south of TID canal		• Vegetation is in good condition along this stream reach • No encroachment was found along the stream banks • Banks are in stable condition

Table 3-10. Hamilton Creek Evaluation

Hamilton Creek lies in the eastern portion of Ashland. The creek has been highly encroached by development, and about 50 percent of its native riparian vegetation is currently intact. Future development in the watershed would increase flooding and erosion. With the creek's proximity to Bellview Elementary School, there is an opportunity for public education of the natural riparian corridor that passes through the area.

Reach Location	Reach Photo	Reach Condition
HA-1 From confluence with Bear Creek, 500 feet upstream to culvert under I-5	 *Looking North from E. Main Street*	• Vegetation is in moderate condition along this stream reach. Upper section has been cleared of most riparian species • The reach has been moderately encroached upon mostly in the upper section of the stream reach • Bank conditions are moderate throughout the entire reach
HA-2 From culvert under I-5, 1,500 feet upstream to pipe outlet at Washington Street	 *North of Shopping Center looking North*	• Vegetation is poor along the majority of this stream reach. Development impacts have removed most of the vegetation in the upper section near the shopping mall • The reach has been highly encroached upon by both development and farm land on either side of the stream. • Banks are in poor condition and are showing signs of erosion along the entire stream section

Table 3-10 (continued). Hamilton Creek Evaluation

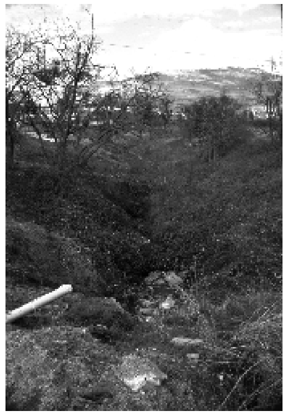
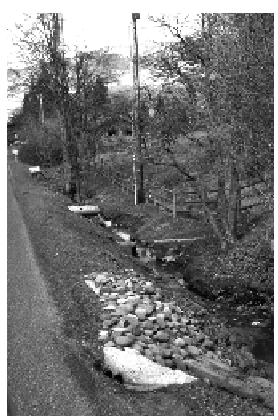
Reach Location	Reach Photo	Reach Condition
HA-3 From culvert south of railroad to pipe north of Bellview Elementary	 *Looking North from Bellview Elementary School*	• Vegetation is in good condition along the stream reach • Upper section of the stream reach was buried by construction of ball field at Bellview Elementary School. Rest of stream is moderately impacted by industrial development in the lower portions of the reach. • Banks are in moderate condition. Some downcutting was visible coming from pipe at school.
HA-4 From Siskiyou Blvd. to pipe outlet 1200 feet south of Greenmeadows Way.	 *Looking North near Washington Street*	• Vegetation along this stream reach is in good condition. Large amounts of riparian species were found • The reach has been highly encroached upon by residential development along the west bank and farm land to the east • Banks are in moderate condition
HA-5 From 300 feet south of Siskiyou Blvd. to end of Apple Way.	 *Looking North along Tolman Creek Road*	• Vegetation is in good condition. Riparian species cover three quarters of the stream reach. • Stream reach has been highly encroached upon by residential development along both stream banks • Banks are in moderate condition.

Table 3-10 (continued). Hamilton Creek Evaluation

Reach Location	Reach Photo	Reach Condition
HA-6 From 400 feet south of Greenmeadows Way to 700 feet south of reservoir drive		• Vegetation is in good condition • Encroachment in this reach has been minor • Bank conditions are in stable condition

Table 3-11. Golf Course Creeks Evaluation

The Golf Course Creeks lie in the southeast section of Ashland. Many of the creeks are small creeks that have been severely impacted by surrounding development. Little native riparian vegetation currently exists along the stream corridors. Water temperature is a major issue due to the lack of vegetation coverage. These creek corridors provide a great opportunity for public education with their proximity to the golf course.

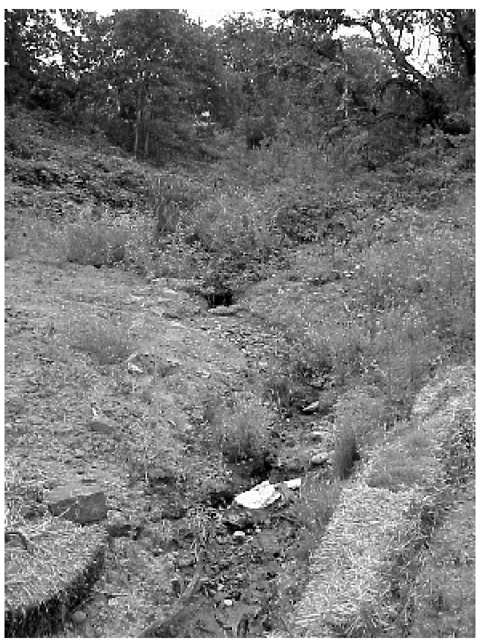
Reach Location	Reach Photo	Reach Condition
GC-1 From E. Main Street to Ashland Street		• Some vegetation exists along northern section of reach. Mostly blackberries occupy the southern section. • Reach has not been encroached by development • Bank condition appears mostly intact. Little erosion is apparent.
GC-2 From end of Spring Creek Drive to intersection with Interstate 5		• Moderate vegetation coverage is found along the reach corridor • Stream has been highly encroached along east bank • Bank condition is in moderate condition

Table 3-11 (continued). Golf Course Creeks Evaluation

Reach Location	Reach Photo	Reach Condition
GC-3 From E. Main Street to pond near Oak Knoll Drive		• Little vegetation exists along the stream reach • The stream has been highly encroached by private residences and the golf course • Banks along the stream corridor are in poor condition
GC-4 From mouth near railroad to Siskiyou Blvd.		• Little vegetation exists along this stream corridor • The reach has not been encroached by any structures • Banks are in poor condition and are showing signs of erosion

Table 3-12. Tolman Creek Evaluation

Tolman Creek lies in the southeasternmost portion of Ashland. The creek has been highly encroached upon in its lower reaches that pass through the City. Riparian vegetation along the stream corridor is relatively intact. The slopes along the stream corridor are relatively low. Future development along the creek should be kept to a minimum.

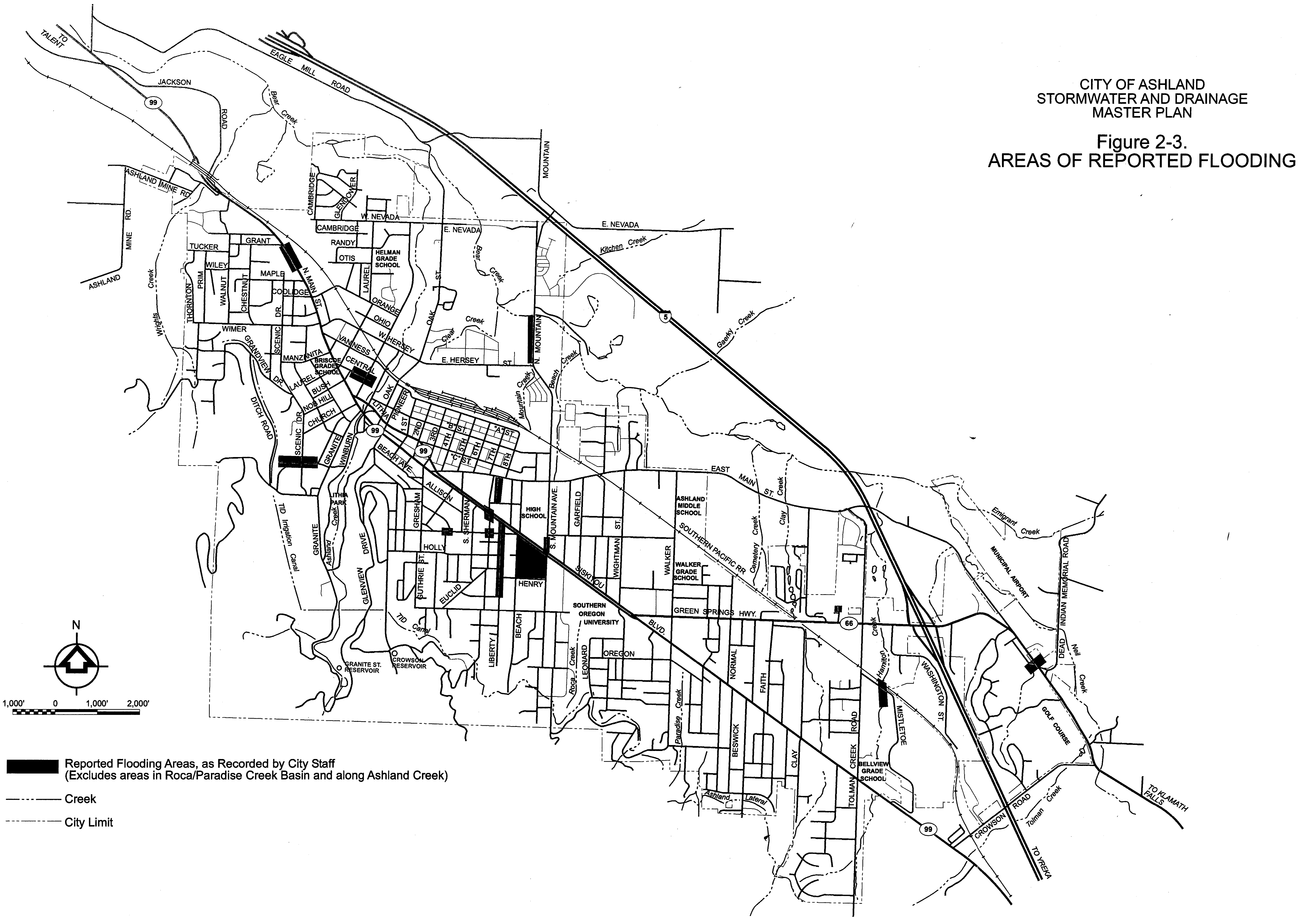
Reach Location	Reach Photo	Reach Condition
TO-1 From confluence with Neil Creek to Highway 66 (Greensprings Highway)	 *From Highway 66 looking North*	• Little vegetation exists along the stream reach • Stream corridor is highly encroached by development along both sides of creek • Bank conditions are moderate to low due to signs of erosion
TO-2 From Highway 66 to Crowson Road	 *From Highway 66 looking South*	• No vegetation along reach corridor • Creek has been encroached by golf course that it passes through • Bank is highly unstable along this reach

Table 3-12 (continued). Tolman Creek Evaluation

Reach Location	Reach Photo	Reach Condition
TO-3 From Crowson Road to Interstate 5		• Vegetation is providing good coverage along the corridor • Stream is highly encroached by private residences specifically along the west bank • Bank condition is moderate and shown some signs of erosion
TO-4 From Interstate 5 to Siskiyou Blvd.	 *From Siskiyou Blvd. looking North*	• Good vegetation coverage along stream reach • Reach is highly encroached with private residences along west bank • Bank condition is stable and showing little signs of erosion

CITY OF ASHLAND
STORMWATER AND DRAINAGE
MASTER PLAN

Figure 2-3.
AREAS OF REPORTED FLOODING



Reported Flooding Areas, as Recorded by City Staff (Excludes areas in Roca/Paradise Creek Basin and along Ashland Creek)

Creek

City Limit

Chapter 4
EVALUATION OF IMPROVEMENTS

CHAPTER 4.
EVALUATION OF IMPROVEMENTS

Four types of alternatives were identified to address problem areas and shortfalls in the City's stormwater system: storm sewer improvements, culvert improvements, creek corridor improvements and nonstructural improvements. Nonstructural alternatives include maintenance programs, regulations, education programs and other projects that do not involve specific project locations. Some projects fall under more than one section and are described in the section for which they are most important. Alternatives were developed and evaluated at a planning level of detail. Preliminary and final design will be required prior to construction. Design elements and costs described in this chapter are to be used only for comparison of alternatives as part of the planning process.

Cost estimates for the identified improvements are based on construction and land costs for similar projects. The estimates reflect project costs for June 1999 (Engineering News Record, Construction Cost Index, Seattle ENR CCI = 6932). The estimates are budget level estimates only; actual project cost should be within the range of plus 35 percent to minus 20 percent of the estimate. The budget estimates contain the following elements:

- Construction cost—the cost of materials and installation
- Construction contingencies—20 percent of construction cost
- Allied costs (engineering, administration, legal, financing and construction administration)—25 percent of construction.

STORM SEWER IMPROVEMENTS

Modification to two storm systems and the construction of a new storm system are proposed. The design storm for storm sewer projects is the 25-year storm.

Nutley Street Storm System

A new storm system along Nutley Street is required to relieve excess flows in the existing Granite Street storm system and to give future development in the Strawberry Lane area a place to discharge storm runoff. The new system should have a box structure that provides water quality treatment prior to discharging to Ashland Creek. Energy dissipation will also be needed prior to discharging to Ashland Creek. No other improvement alternative was found to be feasible for this area; upsizing the Granite Street system would be cost-prohibitive and discharging to Wright's Creek, would alter the basin hydrology and could degrade the creek system. The proposed Nutley Street storm system improvement is shown in Figure 4-1.

Recommendation—New System

The new system would extend from Alnutt Street to Ashland Creek. It will have inlets along Nutley Street and intercept the Granite Street system at the intersection of Nutley and Granite Streets. ***Estimated Cost:*** $317,000.

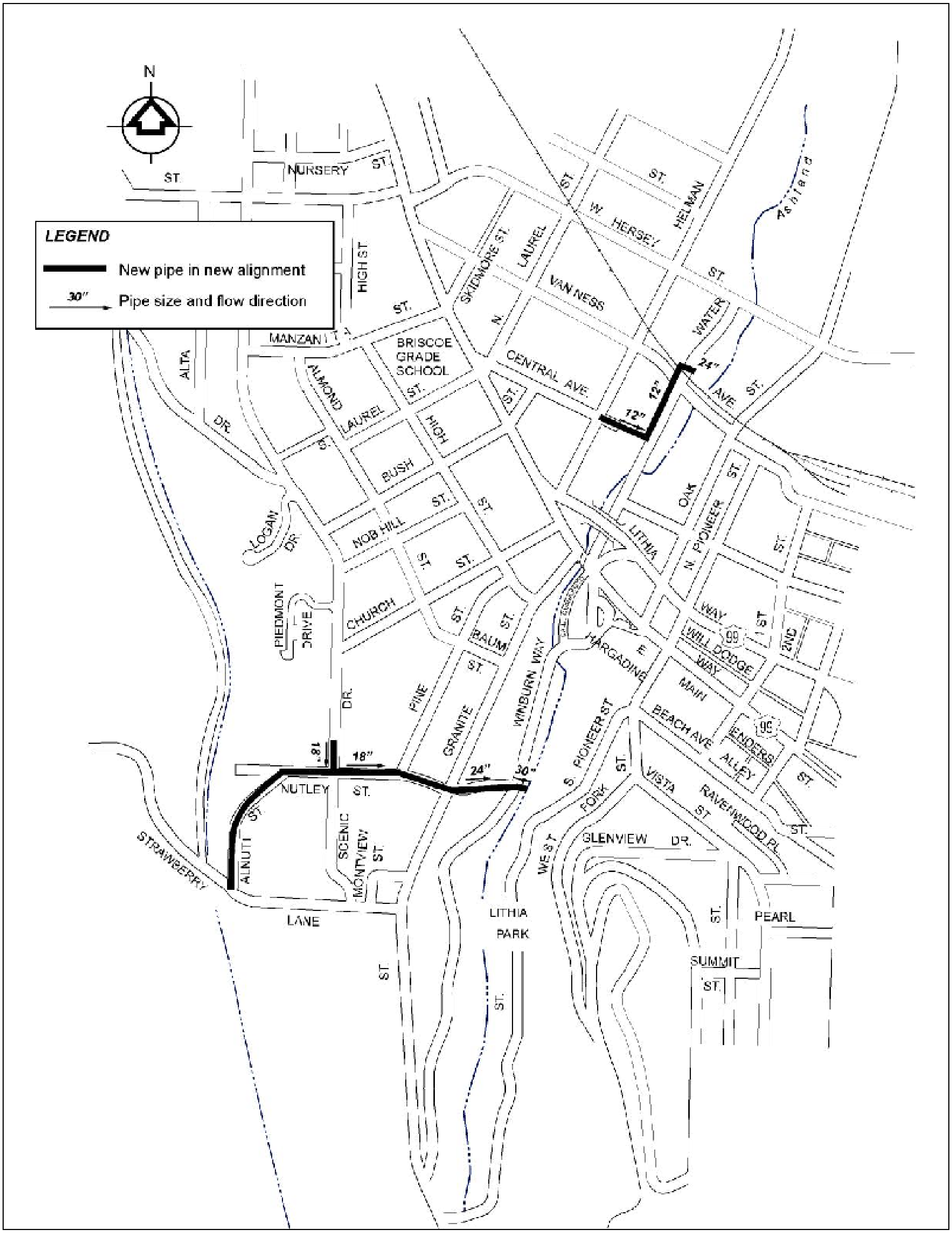


Figure 4-1. Recommended Improvements for Nutley Street and Central Avenue

Central Avenue Outfall

A new outfall is needed for the storm system at the corner of Central Avenue and Helman Street. The proposed improvement is to construct an inlet on the northwest corner of Central and Helman to intercept the 6- or 8-inch pipe going north from the southwest corner inlet. From this inlet, a 12-inch PVC pipe to Ashland Creek would be constructed. If there is room by Ashland Creek, the pipe should discharge to a sand filter vault to help improve water quality. The end of the pipe will need an energy dissipater.

The area should be inspected during a high-intensity rain to observe how the existing system performs. After this inspection, the system could be expanded northwest on Central Avenue to the alley connecting Central Avenue to Highway 99. A way is needed to direct curb flow into the inlets on the south side of Highway 99 at Bush Street. This will keep the flow from crossing Highway 99. Figure 4-1 shows the proposed Central Avenue outfall.

Recommendation—New system

Construct a new system to eliminate flooding in the area. The design should include a visual inspection during an intense storm. ***Estimated Cost:*** $125,000.

Beach Creek and Mountain Creek Basins

Most of the City’s reported flooding problems are in the Beach and Mountain Creek Basins, both of which were developed and piped through the flatter section of the City and have experienced new development in the last 20 years in the hills to the south. Most storm sewers in the basins are undersized. Several alternatives were investigated to alleviate the flooding in the basins. Figures 4-2 through 4-6 show the five alternatives. Detailed cost estimates are included in Appendix A. General approaches and estimated total project cost (based on a 10-year design storm) for the alternatives are as follows:

- Alternative 1—Enlarge all the major undersized pipes in the basins. This would include some realignment. The reduction of flooding would mean more flow at the downstream end of the pipes, so detention would be required. The detention could be designed with features to improve water quality. Estimated Cost: $4,007,000.
- Alternatives 2 and 5—Install a new bypass pipe system to intercept the existing Mountain Creek and Beach Creek systems and convey flood flows to a new downstream detention facility. The facility would also provide water quality treatment. Estimated Cost: $3,064,000 for Alternative 2; $3,956,000 for Alternative 5.
- Alternative 3—Provide detention upstream of the areas with flooding problems. The detention would reduce peak flows and therefore reduce flooding. The area available for such facilities is limited, so a large portion of the detention would be in underground pipes. Estimated Cost: $6,621,000.
- Alternative 4—Provide a combination of bypass pipe and upstream detention. Estimated Cost:$4,481,000.

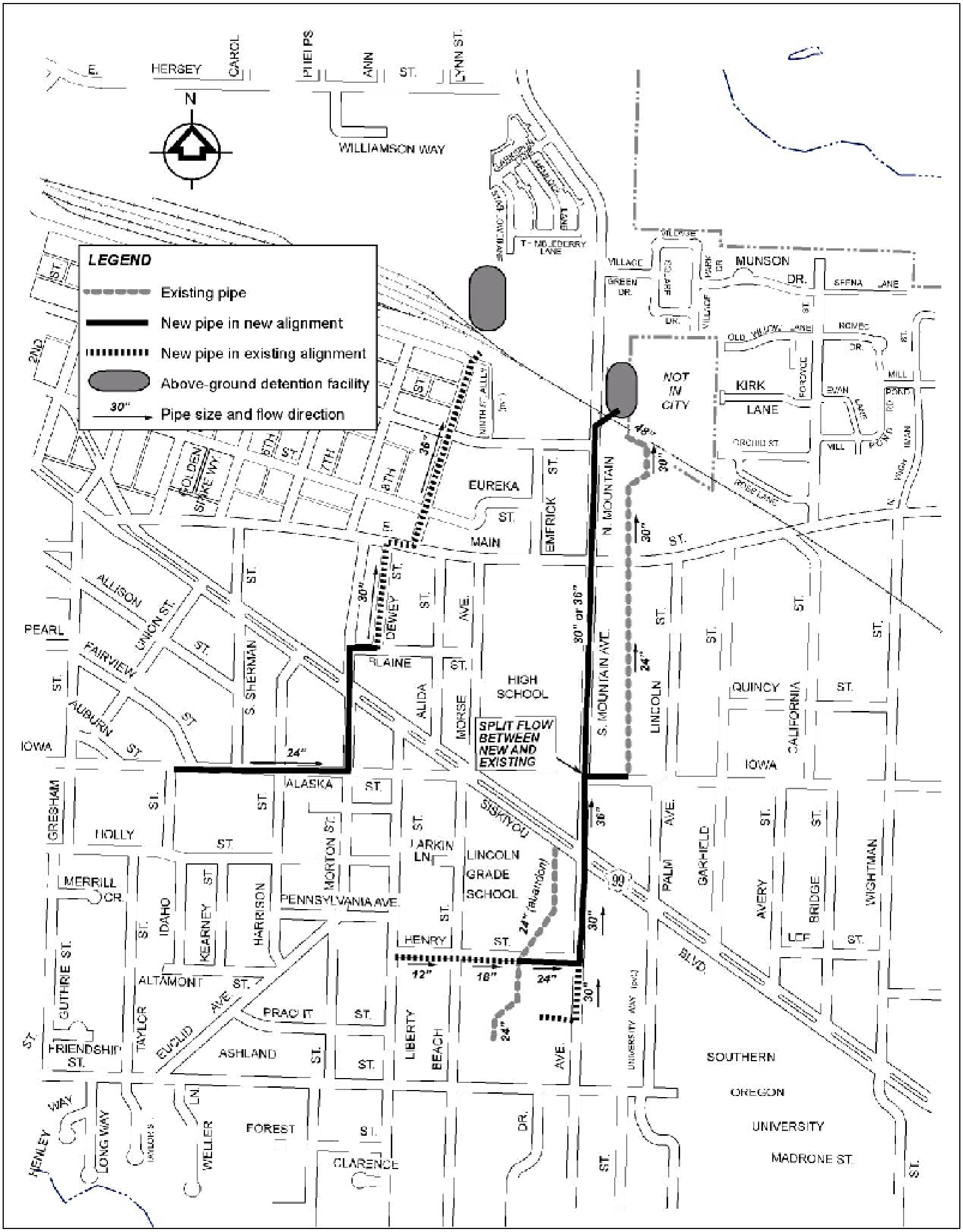


Figure 4-2. Improvement Alternative 1 for Beach/Mountain Basins

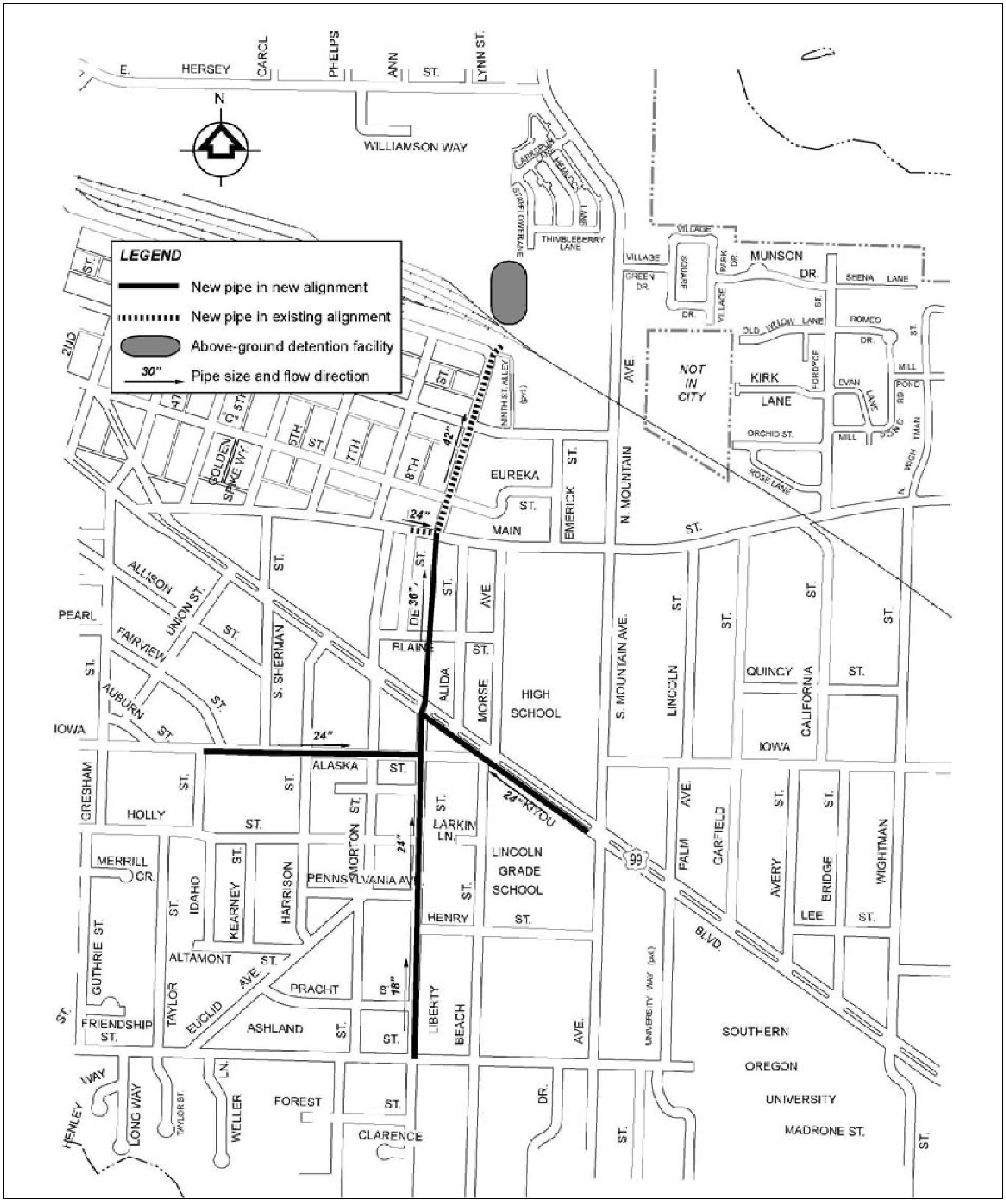


Figure 4-3. Improvement Alternative 2 for Beach/Mountain Basins

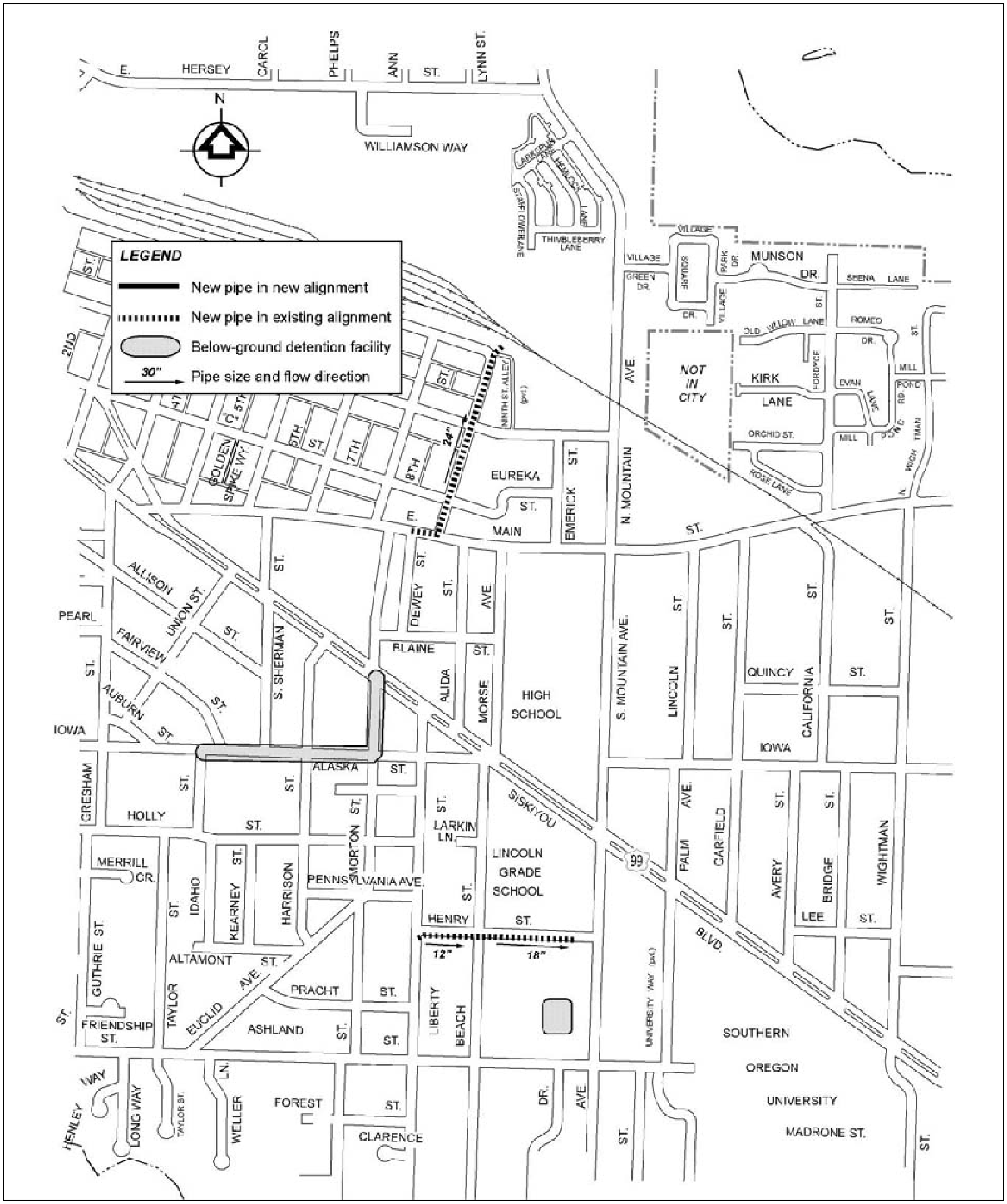


Figure 4-4. Improvement Alternative 3 for Beach/Mountain Basins

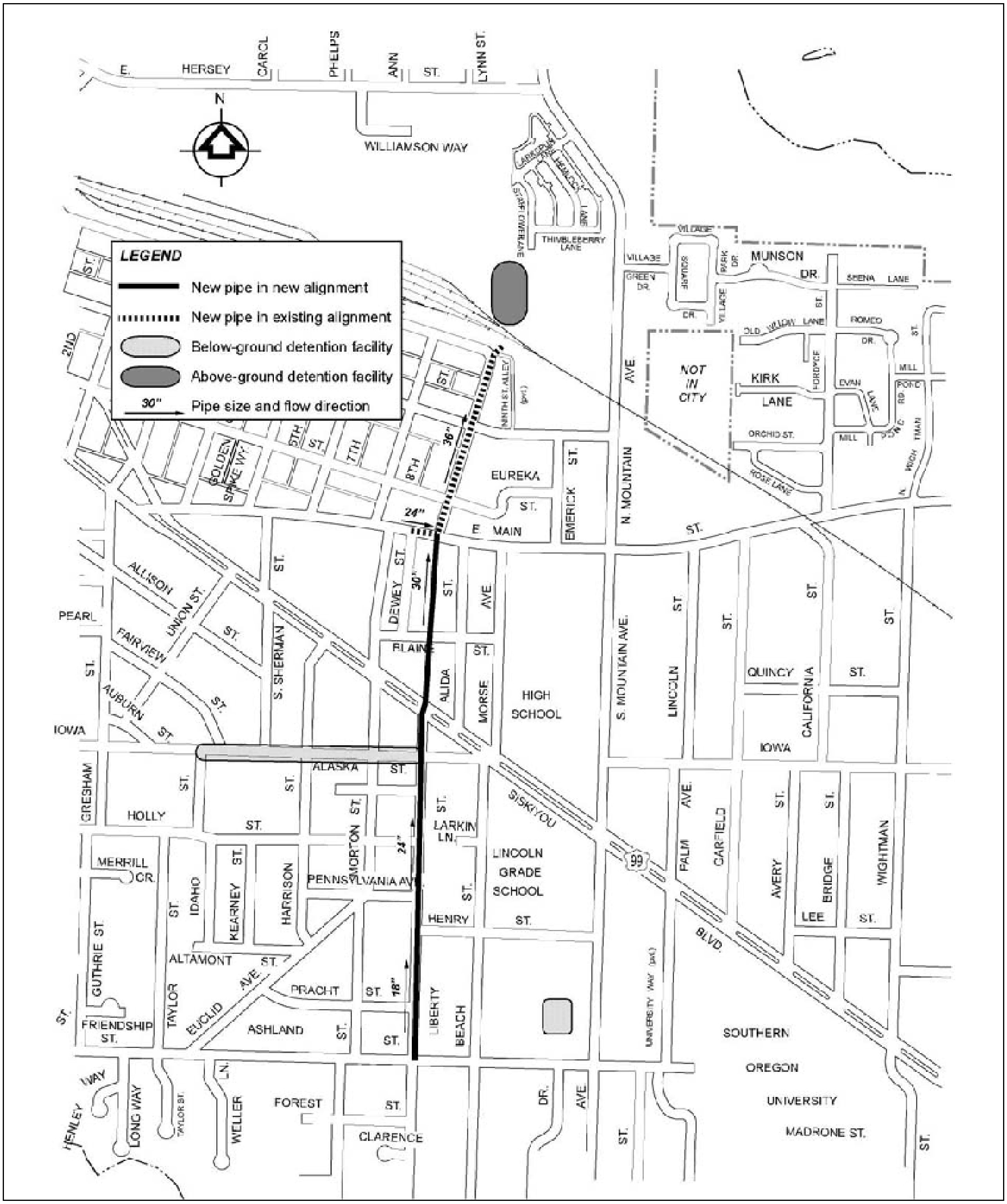


Figure 4-5. Improvement Alternative 4 for Beach/Mountain Basins

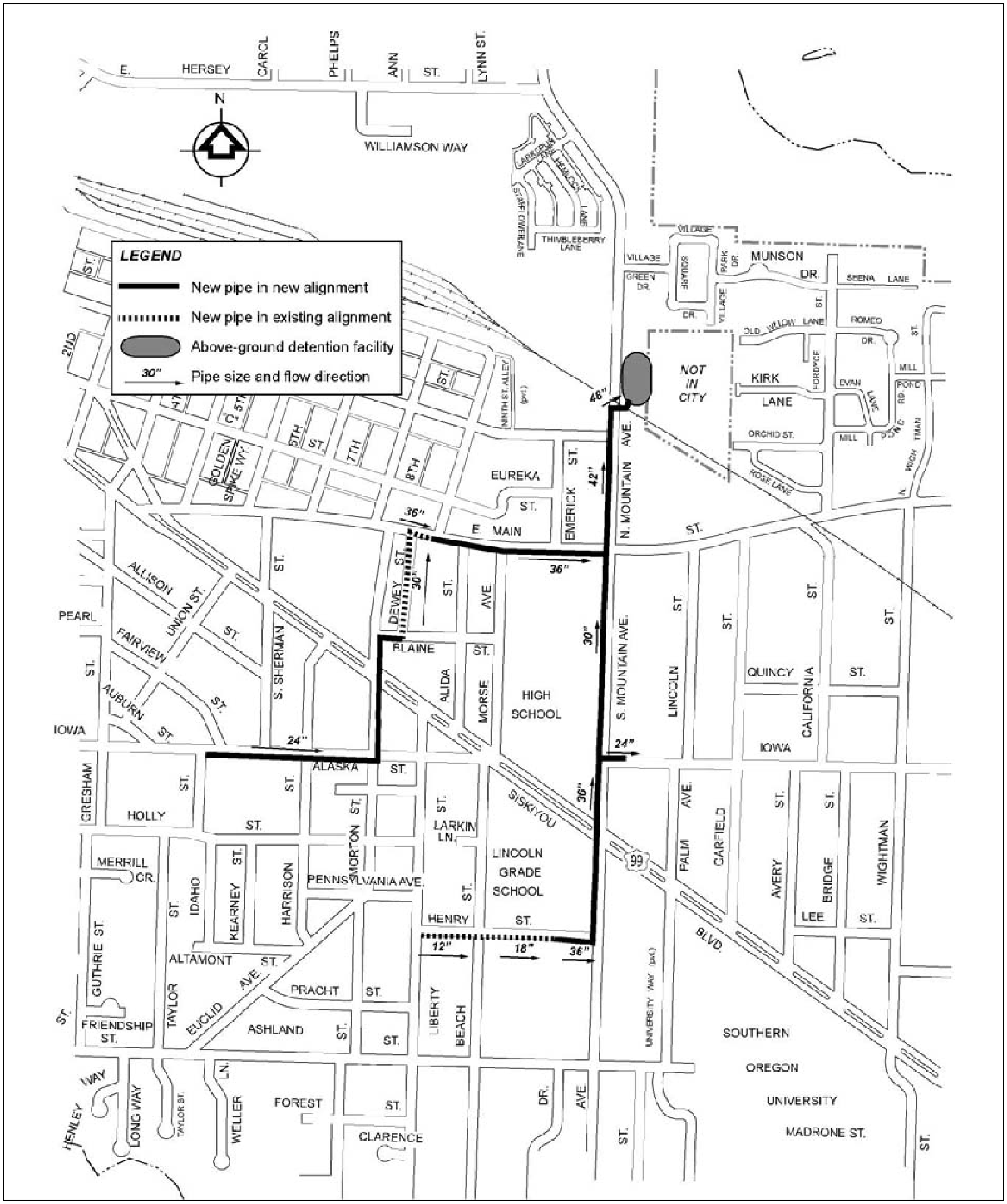


Figure 4-6. Improvement Alternative 5 *for Beach/Mountain Basins*

Recommendation—Combination of Bypass and Upstream Detention

Alternative 5 was selected as the recommended alternative for its cost-effectiveness, ability to be phased over several years, and water quality treatment. A cost estimate for designing this alternative to the 25-year storm was prepared once it was selected as the preferred alternative, and is included in Appendix A. ***Estimated Cost:*** $4,258,000 for the 25-year design storm.

CULVERT IMPROVEMENTS

The culverts assessed for potential improvement were selected based on existing flooding problems or the potential for flooding in the future. Improvement cost estimates were based on culverts sized to pass flows from the 50-year design storm. The culverts also were checked for their ability to convey 100-year flows.

Many culverts in the City could be improved for fish passage and habitat, but these are not included in the list of improvements. When new culverts or culvert replacements are proposed along the City's major creeks in the future, the design review should include fish passage in accordance with Oregon Department of Fish and Wildlife guidelines. This should include creeks with fish populations and creeks with historical populations. This would allow the introduction of fish populations in the future.

If a future driveway crosses a creek, its culvert should be sized the same as the structure downstream.

Clay Creek at Highway 99 (Siskiyou Boulevard)

The existing culvert is a 5-foot diameter corrugated metal pipe (CMP). This pipe is of sufficient size to pass the flows from the 100-year storm under future conditions. However, flooding has been reported upstream of the culvert and field inspection identified the following factors that adversely effect the capacity of the culvert:

- The approach of the creek to the culvert is an abrupt angle that is causing the flow to change direction and erode the banks.
- The culvert is in poor shape, with abrupt changes in slope and some collapsing at joints.

Recommendation—Replace Culvert

The new culvert should convey flows of 80 cfs and have a natural creek bottom. ***Estimated Cost:*** $156,000.

Clay Creek at East Main Street

The existing culvert is a 3-foot diameter CMP that is too small to convey existing or future flows.

Recommendation—Replace Culvert

The new culvert should convey flows of 92 cfs and have a natural creek bottom. ***Estimated Cost:*** $125,000.

Cemetery Creek at East Main Street

The existing culvert, consisting of a 30-inch CMP and a 24-inch CMP, is too small to convey existing or future flows.

Recommendation—Replace Culvert

The new culvert should convey flows of 92 cfs and have a natural creek bottom. ***Estimated Cost:*** $125,000.

Cemetery Creek at Railroad Tracks

The existing system is two 36-inch arch culverts approximately 400 feet apart. A drainage ditch that runs along the railroad tracks connects the upstream ends of culverts. The two culverts were analyzed as one culvert system and were found to be of adequate size.

Recommendation—Do Not Alter Conditions Directly Upstream of Pipes

If the upstream ditch were removed, the system would not act as one culvert and the system would not function properly. ***Estimated Cost:*** None.

Park Branch of Cemetery Creek at Clay Street

The existing culvert is a 12-inch diameter CMP below Clay Street near the intersection with Faith Avenue. It discharges to a 15-inch CMP that conveys runoff below Green Springs Highway. Both these pipes are too small to convey the existing or future flows. However, the park upstream of this crossing provides detention storage, and no flooding has been reported. Therefore, this project should not be upgraded unless flooding occurs in the future or there is an opportunity with other improvements in the area.

Recommendation—Do Not Replace Culvert

Monitor the crossing and, if an upgrade is required in the future, the replacement should be a 24-inch pipe with a design capacity of not less then 12 cfs. ***Estimated Cost:*** None.

Kitchen Creek at Mountain Avenue

The existing culvert is a 72-inch diameter CMP. Its slope was not measured, but it appears to be steep. This culvert is undersized for its tributary drainage area. The culvert for Kitchen Creek under Interstate 5 (upstream of Mountain Avenue) includes a 60-inch CMP and a 48-inch CMP. The open area for the pipes below Interstate 5 is 32.2 square feet and the open area for Mountain Avenue is 28.3 square feet. Since there has been no reported flooding at this location, it is assumed that the Interstate 5 culverts detain water upstream, so the culvert should not be replaced until flooding is reported at this location.

Recommendation—Do Not Replace Culvert

Monitor the crossing and, if an upgrade is required in the future, the replacement should be a bottomless arch culvert that can pass the 100-year flow of 716 cfs. ***Estimated Cost:*** None.

Clear Creek at Hersey Street

The existing culvert consists of twin 15-inch-diameter concrete pipes. A 24-inch pipe is required to convey 18 cfs at this location. Although culverts downstream of Hersey Street are of adequate size, additional flow in the channel downstream of Hersey Street might cause flooding at adjacent homes. An alternative to installing a larger pipe is to develop the upstream area into a wetland that would detain peak runoff events.

Recommendation—Create Wetland Upstream

Utility conflicts on Hersey Street could prohibit installation of a larger pipe. A wetland would improve water quality of runoff from the upstream commercial area. The wetland would need to reduce flows from 18 cfs to 9 cfs. ***Estimated Cost:*** $95,000, excluding the cost of land acquisition.

Culvert GC-310 under Interstate 5

Development west of Crowson Road and upstream of Interstate 5 will direct additional runoff to the 18-inch diameter concrete culvert under Interstate 5 approximately 1,200 feet west of Crowson Road. No flooding at this culvert has been reported, but the basin will continue to develop and there is a large low area upstream of the culvert. This area provides a place for the runoff to pond as it is discharged through the culvert. This area should be addressed before a problem arises. Three alternatives were identified:

- Replace the existing 18-inch concrete culvert with a 36-inch concrete pipe.
- Create a wetland that will continue to allow ponding upstream of the culvert.
- Require detention for all new development in the basin to reduce the 25-year, 24-hour post-development peak runoff rate to the 10-year, 24-hour pre-developed peak runoff rate.

Replacing the pipe would cause additional erosion along the channel downstream of Interstate 5, so detention upstream of the pipe is the best solution. Requiring upstream development to provide on-site detention would be a low-cost alternative. This alternative would require that no buildings or fill be placed in the low area adjacent to the upstream end of the culvert.

Recommendation—Require Detention for Upstream Development

Require upstream development to discharge the 25-year, 24-hour storm at the 10-year, 24-hour pre-developed peak runoff rate and keep the low area upstream of the culvert from being filled. ***Estimated Cost:*** None.

Culvert GC-300 under East Main Street at Dead Indian Memorial Road

Northwest of the intersection of East Main and Dead Indian Memorial Road are two culverts with a large tributary basin. The 12-inch concrete and 18-inch HDPE culverts are undersized.

Recommendation—Replace Pipes

The new pipe should be a 36-inch diameter pipe and able to convey 40 cfs. A new outfall location is required. The two existing outfall locations are not suitable for the increased flow. ***Estimated Cost:*** $225,000.

Culvert GC-700 under East Main East of Interstate 5

The existing 36-inch CMP culvert just east of Interstate 5 and 2,200 feet west of the Greensprings Highway (Ashland Street) will need to be replaced when the basin becomes more developed. The new culvert should be a 42-inch pipe capable of passing 49 cfs.

Recommendation—Replace Culvert

The culvert should be replaced with future roadwork or when future development in the basin starts increasing the flow downstream. ***Estimated Cost:*** $125,000.

Culvert GC-100 under East Main near Tolman Creek

The 18-inch culvert below East Main approximately 700 feet west of the Tolman Creek culvert was determined to be undersized; however, the ditch on the south side of the road (upstream) allows runoff to spill west to another culvert below East Main and east to Tolman Creek before impacting the road surface. Therefore this culvert is not recommended for replacement.

Recommendation—Do Not Replace Culvert

Monitor the crossing and replace the culvert if flooding becomes a problem in the future. ***Estimated Cost:*** None.

Culvert GC-500 under East Main near Greensprings Highway

The culvert serving basin GC-500 was replaced last year with a 24-inch pipe. The modeling shows that the culvert should have been replaced with a 30-inch pipe. Because the culvert was so recently replaced and the modeling shows that the required pipe diameter is only one pipe size larger, we recommend not replacing this pipe unless flooding becomes a problem at this location.

Recommendation—Do Not Replace Culvert

Monitor the crossing and replace the culvert if flooding becomes a problem in the future. ***Estimated Cost:*** None.

CREEK IMPROVEMENTS

Recommendations for creek system improvements are based on the inventory and analysis of each stream reach and the project goals of protecting property, protecting and enhancing water quality, and enhancing riparian habitat. Tables 4-1 through 4-7 list the improvements by stream reach, which are shown in Figures 4-7 through 4-13. Each recommendation is one of the following types of project:

- Channel Stabilization—The focus of these projects is to stabilize streambeds and streambanks to protect property and infrastructure and alleviate sedimentation problems. This type of project requires on-site professional expertise to determine appropriate measures to stabilize the streambed or streambank. The City should fully evaluate bioengineering concepts as the first choice for these projects, as opposed to traditional riprap solutions. Cost estimates for these projects are based on similar projects in Oregon, with input from local consultants. Cost-sharing suggestions included in the tables are assumed in the estimates.

- Riparian Corridor Restoration—The focus of these projects is to restore natural plant communities as much as practical to reduce stream temperature and sedimentation and to restore riparian wildlife habitat. Cost-sharing suggestions included in the tables are assumed in the cost estimates for these projects.
- Community-Based Enhancement—These projects provide water quality benefits and riparian habitat enhancements through local neighborhood improvements using volunteer involvement with some City resources. City contributions might include plant materials, site preparation, volunteer coordination, etc. The focus of these projects is to eliminate blackberry and other invasive exotic plants and to plant desirable native species that will reestablish the riparian forest canopy and wildlife habitat.
- Protection from future development—This strategy focuses on protecting existing riparian corridors and native vegetation by implementing stream buffer zones regulations in areas where future development might occur.

Table 4-1. Stream Corridor Recommendations—Wright's Creek

Main goals for the enhancement and protection of Wright's Creek are as follows:

1. Protection of undeveloped land along stream corridors and specifically in the upper reaches of the Wright's Creek basin and at the confluence with Bear Creek.

2. Reestablishment of riparian plant species and removal of blackberries by local community groups and landowners.

Location	Protection Method	Amount	Cost	Participants	Benefits
WR-1	Riparian enhancement Channel stabilization Protect banks from future development	37,500 ft^2 1300 feet -	$18,750 $123,500 -	County and City County and City County	Reduction of water temperature and sedimentation. Increase of riparian species diversity and wildlife habitat
WR-2	Protect existing farmland from future development Community enhancement	- 65,000 ft^2	- $16,250	Landowner with County and City involvement Community with City help	Reduction of water temperature and sedimentation. Increase of riparian plant species and wildlife habitat
WR-3	Protect from future development	-	-	City Project	Preservation of riparian corridor
WR-4	Protect from future development	-	-	City Project	Preservation of riparian corridor
WR-5	Community Enhancement (Northern section) Protection from development	50,000 ft^2 -	$12,500 -	City and future developers City Project	Reduction of water temperature and sedimentation, increase in plant diversity and wildlife habitat
WR-6	Community Enhancement Protection from development	20,000 ft^2	$5,000	Landowner with City involvement	Reduction of water temperature and sedimentation, increase in plant diversity and wildlife habitat
WR-7	Protection from development	-	-	City Project	Preservation of riparian corridor
WR-8	Protection from development	-	-	City Project	Preservation of riparian corridor
WR-9	Protection from development	-	-	City Project	Preservation of riparian corridor
WR-10	Community Enhancement (Removal of Blackberries)	50,000 ft^2	$12,500	Community with City help	Reduction of water temperatures and increase in diversity of plant species and wildlife habitat
WR-11	Protection from development	-	-	City Project	Preservation of riparian corridor

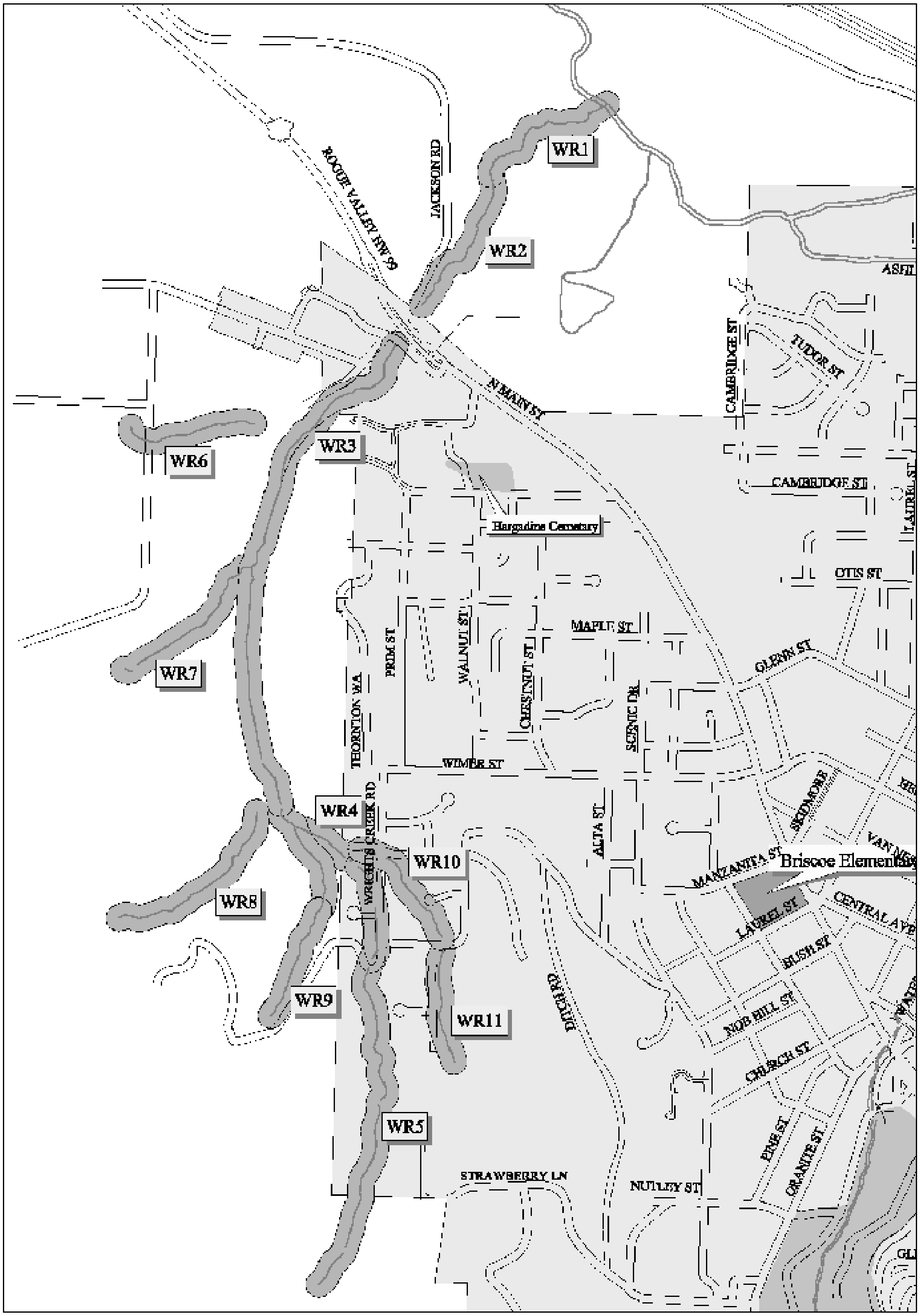


Figure 4-7. Wright's Creek Stream Reaches

Table 4-2. Stream Corridor Recommendations—Beach, Mountain and Clear Creeks

Location	Protection Method	Amount	Cost	Participants	Benefits
BE-1	Being addressed by other projects	-	-	City Project	Reduction of water temperature and sedimentation
BE-2	Riparian Enhancement	35,000 ft^2	$17,500	City with Local Landowner	Reestablishment of riparian species along stream corridor. Reduction of sedimentation and water temperature
BE-3	Protection from development	-	-	City Project	Preservation of riparian corridor
BE-4	Protection from development	-	-	City Project	Preservation of riparian corridor
Mountain Creek					
MT-1	Riparian Enhancement	60,000 ft^2	$30,000	City with Local Landowner	Revegetation of stream corridor for channel stability and reduction of water temperature
Clear Creek					
CR-1	Riparian Enhancement	30,000 ft^2	$15,000	City with Local Landowner	Reestablishment of Riparian species and reduction of water temperature
Water Quality Facilities					
WQF-CR1	Construction of Water Quality Facility			City Project	Reduction of Sedimentation
WQF-CR2	Construction of Water Quality Facility			City Project	Reduction of Sedimentation

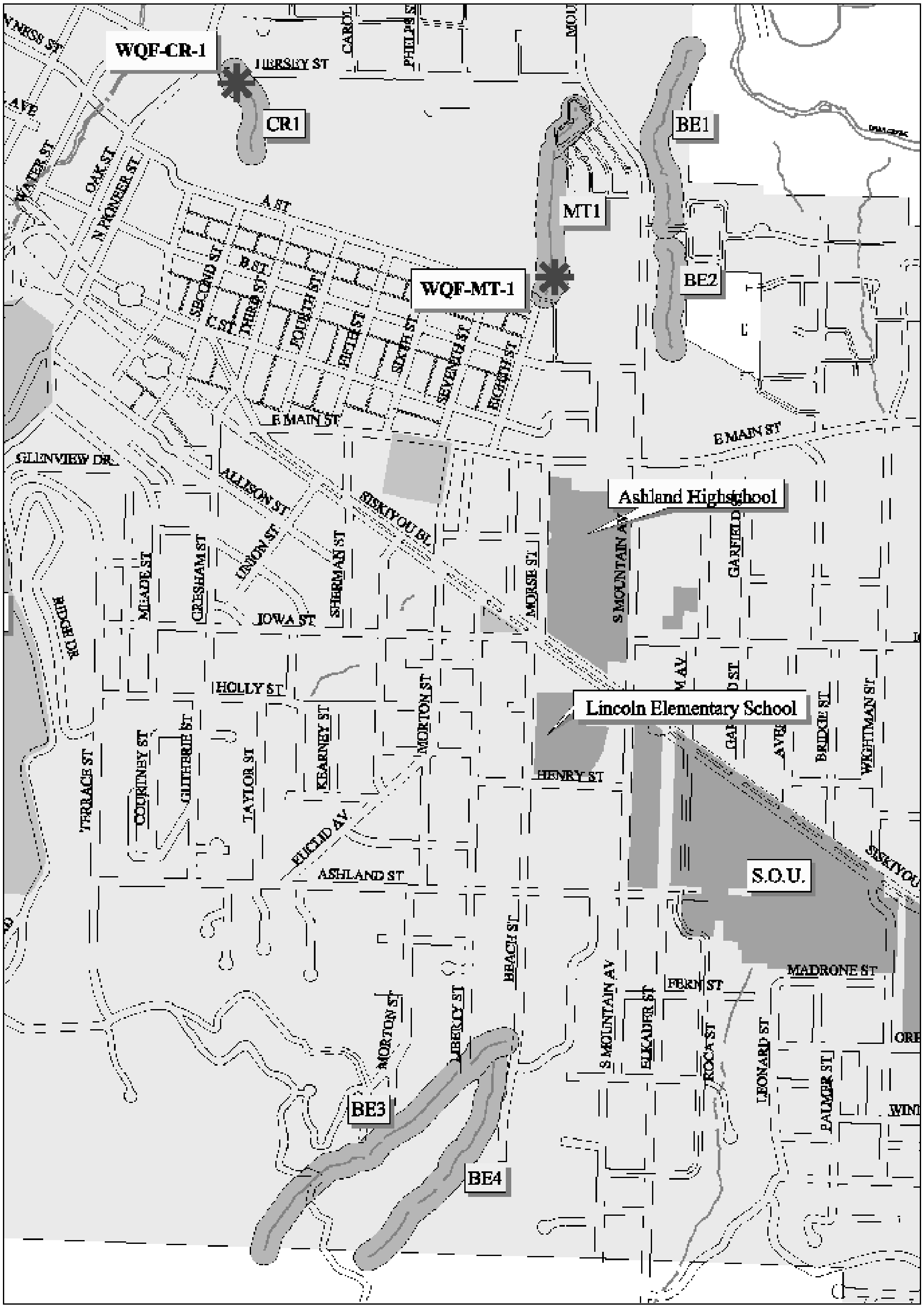


Figure 4-8. Beach, Mountain, and Clear Creeks Stream Reaches

Table 4-3. Stream Corridor Recommendations—Cemetery Creek

Goals for the protection and enhancement of Cemetery Creek are as follows:

1. Stabilize and enhance stream banks along entire stream corridor
2. Protection of undeveloped lower reaches of the stream corridor from future development
3. Revegetation and enhancement of native plant species along entire stream corridor

Location	Protection Method	Amount	Cost	Participants	Benefits
CE-1	Riparian Enhancement Protect banks from future development	35,500 ft^2 -	$17,750 -	City and County with Local Landowner	Reestablishment of riparian species and reduction of water temperature at confluence with Bear Creek
CE-2	Community Enhancement Channel Stabilization	30,000 ft^2 300 feet	$7,500 $28,500	Local Landowner with City	Reduction of water temperature and sedimentation, Increase in wildlife habitat and plant diversity
CE-3	Protection from future development	-	-	City Project	Preservation of riparian corridor
CE-4	Protection from future development Community Enhancement	- 25,000 ft^2	- $6,250	City Project Local Landowner with City	Preservation of riparian corridor, Increase in plant diversity and wildlife habitat
CE-5	Channel Stabilization Riparian Enhancement	600 feet 80,000 ft^2	$57,000 $40,000	City Project City Project with Landowners	Reduction of water temperature and sedimentation, Protection of structures from bank failure, Increase in plant diversity and wildlife habitat

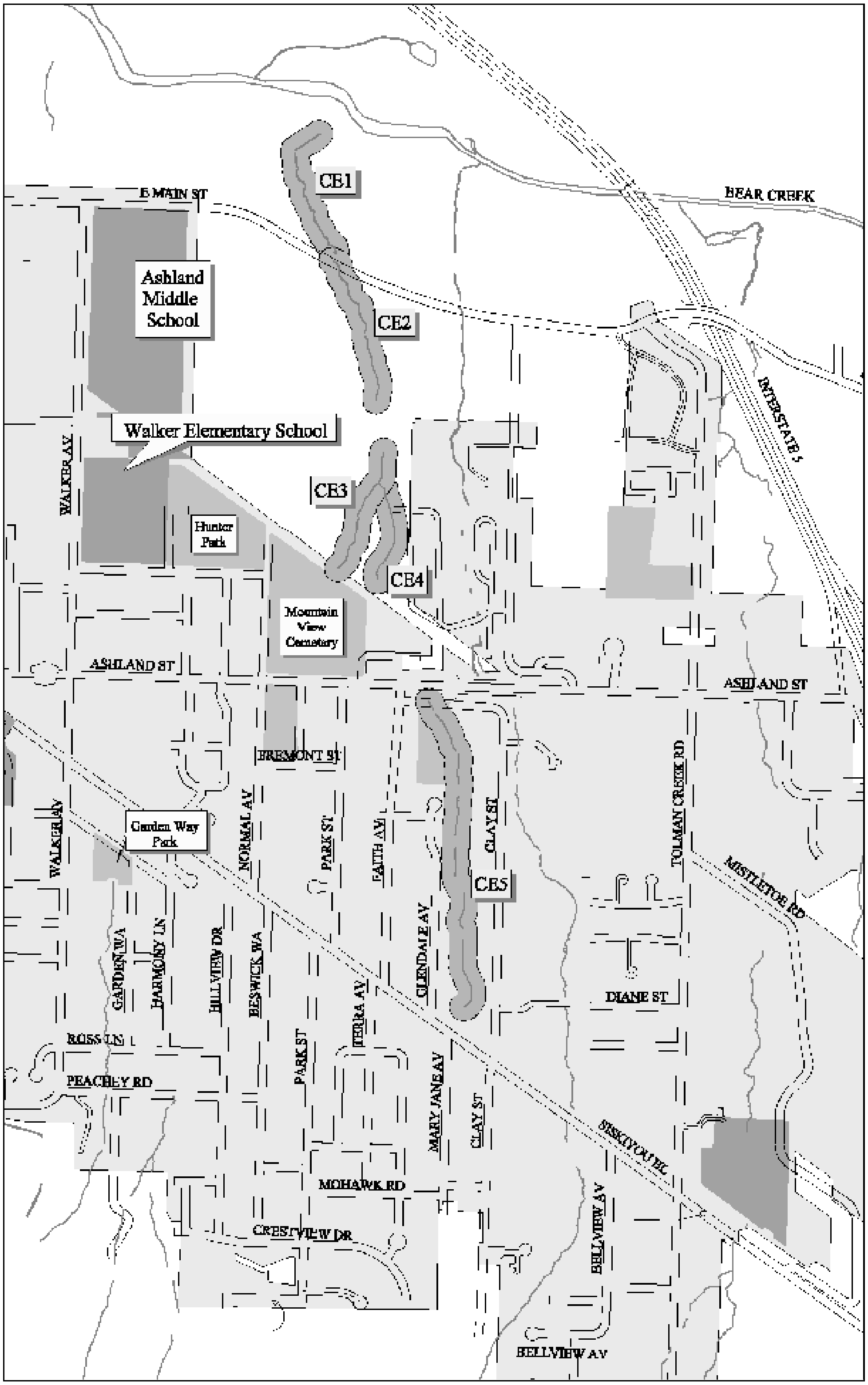


Figure 4-9. Cemetery Creek Stream Reaches

Table 4-4. Stream Corridor Recommendations—Clay Creek

The main goals for the protection and enhancement of Clay Creek are as follows:

1. Undeveloped land in the lower sections of the stream needs to be protected.
2. Stabilization and enhancement of stream banks in highly developed areas.
3. Reestablishment of native riparian plant species along the entire stream length.

Location	Protection Method	Amount	Cost	Participants	Benefits
CL-1	Channel Stabilization	500 feet	$47,500	City and County with Local Landowner	Reduction of water temperature and sedimentation, increase in native plant species, stabilization of bank
CL-2	Riparian Enhancement	50,000 ft^2	$25,000	City, Developers, and Church Group	Stabilization of stream bank and reduction of sedimentation
CL-3	Community Enhancement	10,000 ft^2	$2500	Community Project with City help	Reduction of water temperature
CL-4	Community Enhancement	7500 ft^2	$1,875	Community Project with City help	Reduction of water temperature, increase of native plant species
CL-5	Community Enhancement	60,000 ft^2	$15,000	Community Project with City help	Reduction of water temperature, increase of native plant species
CL-6	Community Enhancement Protection from future development	22,500 ft^2 -	$5,625 -	Local Landowners, Developers, and City	Protection of undeveloped stream reaches, increase of riparian plant species and wildlife habitat
CL-7	Community Enhancement	10,000 ft^2	$2,500	Neighborhood Organization and City	Increase in native plant species and wildlife habitat
CL-8	No recommendations	-	-	-	-

Water Quality Facilities

WQF-CL1	Construction of Water Quality Facility			City Project	Reduction of Sedimentation
WQF-CL2	Construction of Water Quality Facility			City Project	Reduction of Sedimentation

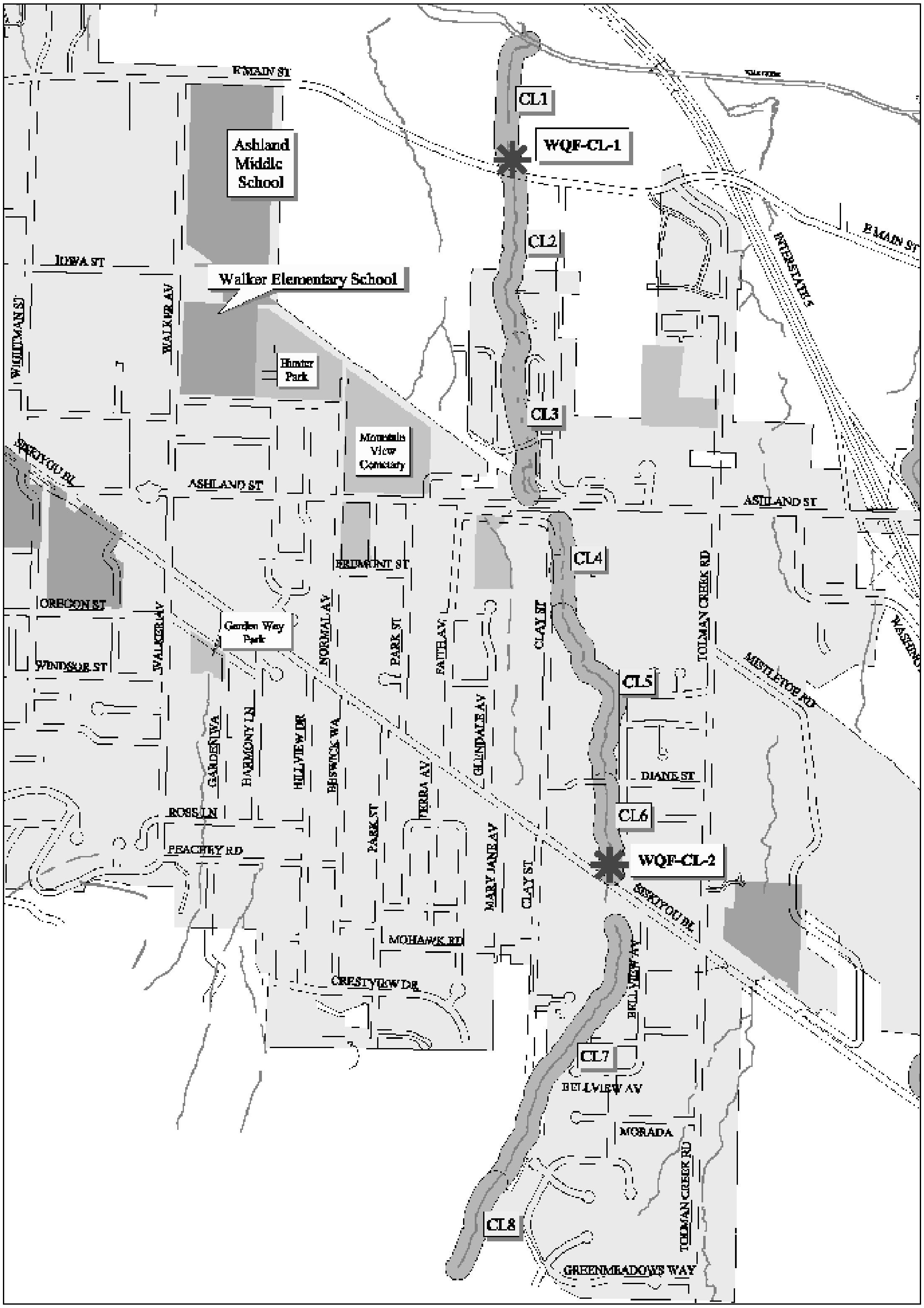


Figure 4-10. Clay Creek Stream Reaches

Table 4-5. Stream Corridor Recommendations—Hamilton Creek

Main goals for the protection and enhancement of Hamilton Creek are as follows:

1. Repair and enhancement of failing banks along the stream corridor.
2. Revegetation of stream corridor with native riparian species.
3. Protection and enhancement of undeveloped sections of stream corridor.

Location	Protection Method	Amount	Cost	Participants	Benefits
HA-1	Riparian Enhancement	40,000 ft^2	$20,000	City and Local Landowner	Reduction of water temperature and sedimentation at mouth of creek
HA-2	Channel Stabilization (Lower Section) Riparian Enhancement (Upper Section)	500 feet 50,000 ft^2	$47,500 $25,000	City Project (Lower Section) Property Owners with City (Upper Section)	Reduction of water temperature and sedimentation, Increase of native plant diversity and wildlife habitat
HA-3	Riparian Enhancement (Possible Daylighting Project) Protect from development	80,000 ft^2 -	$40,000 -	City Project City Project	Increase in native plant diversity, reduction of sedimentation and water temperature.
HA-4	Community Enhancement	75,000 ft^2	$18,750	Community Project with City help	Increase diversity of plant species and wildlife habitat, Reduction of water temperature and sedimentation
HA-5	Community Enhancement	50,000 ft^2	$12,500	Community Project with City help	Increase diversity of plant species and wildlife habitat, Reduction of water temperature and sedimentation

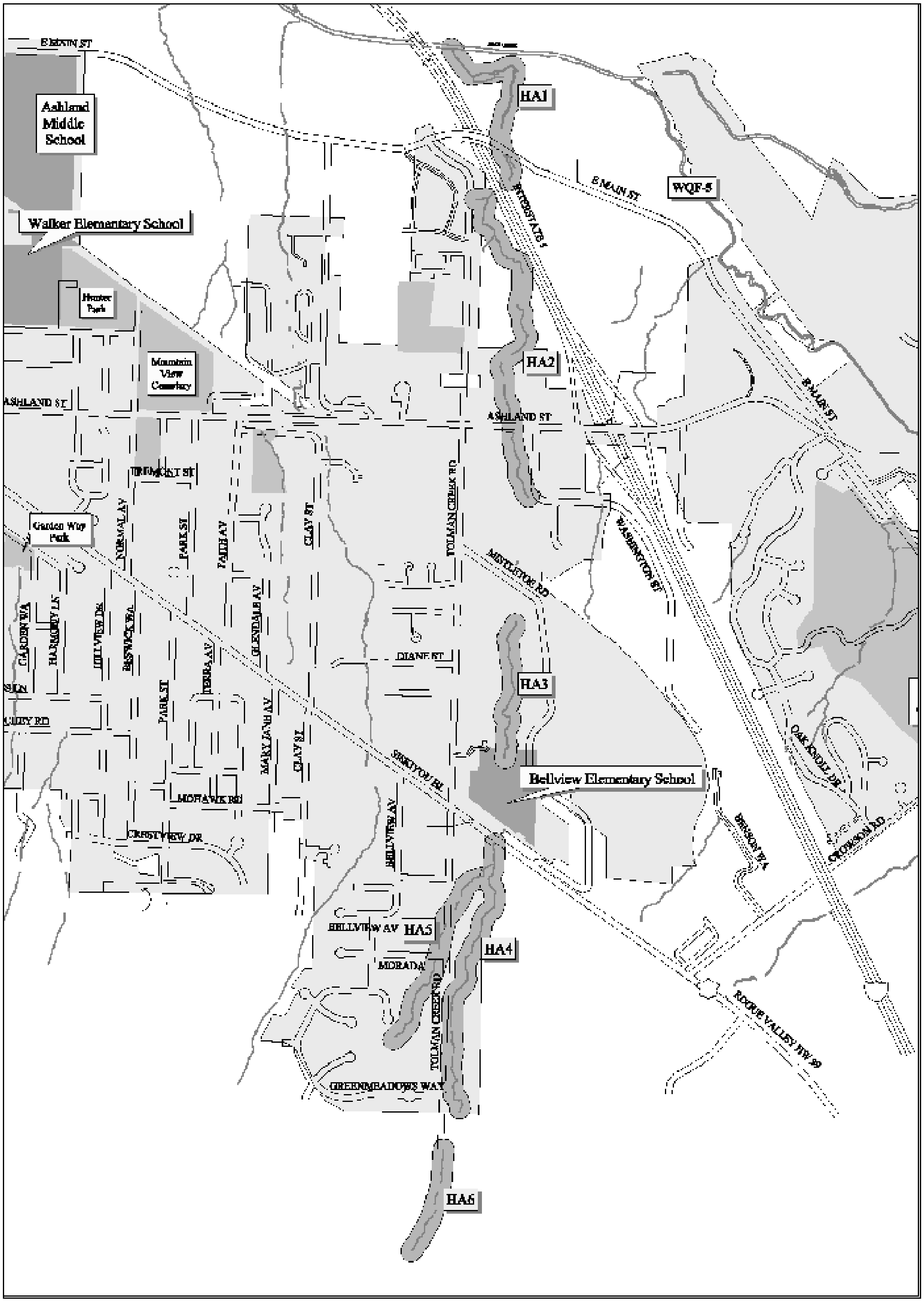


Figure 4-11. Hamilton Creek Stream Reaches

Table 4-6. Stream Corridor Recommendations—Golf Course Creeks

Goals for the protection and enhancement of the Golf Course Creeks are as follows:

1. Reestablishment of native riparian vegetation along all of the stream reaches
2. Protection and reconstruction of stream banks along degraded reach sections

Location	Protection Method	Amount	Cost	Participants	Benefits
GC-1	Community Enhancement (Removal of Blackberries), Protection from future development	60,000 ft^2 -	$15,000 -	Community Project with City help City with future developers	Reestablishment of native riparian vegetation and wildlife habitat, Preservation of riparian corridor
GC-2	Community Enhancement	30,000 ft^2	$7,500	Community Project with City help	Reestablishment of native riparian vegetation and wildlife habitat
GC-3	Community Enhancement Riparian Enhancement	40,000 ft^2 50,000 ft^2	$10,000 $25,000	City with Local Landowners City Project	Reestablishment of native riparian vegetation and wildlife habitat, Reduction of water temperature
GC-4	Community Enhancement	50,000 ft^2	$12,500	Community Project with City help	Reestablishment of native riparian vegetation and wildlife habitat

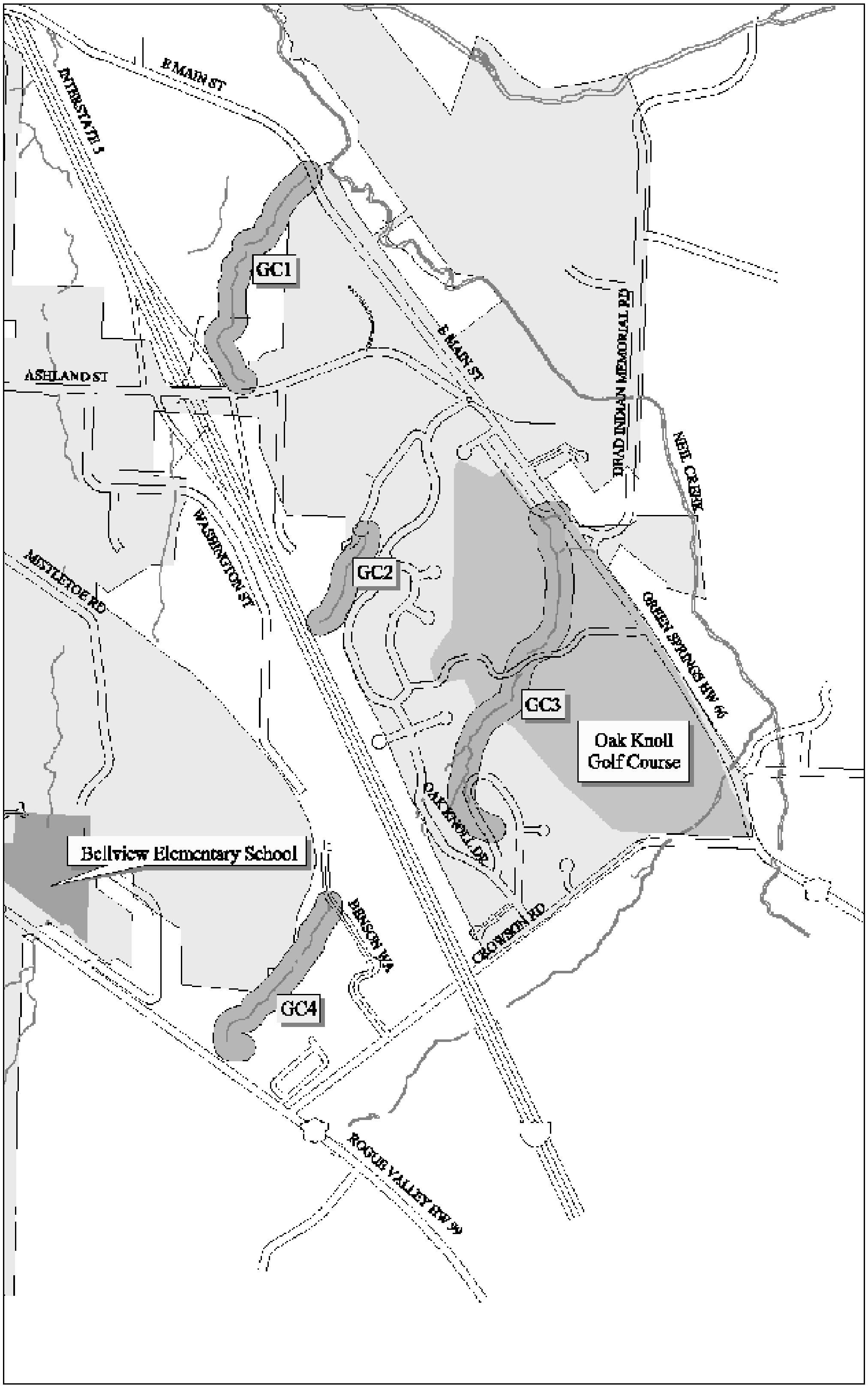


Figure 4-12. Golf Course Creeks Stream Reaches

Table 4-7. Stream Corridor Recommendations—Tolman Creek

Goals for the protection and enhancement of Tolman Creek are as follows:

1. Reestablishment of native riparian species along the stream corridor.
2. Reconstruction and preservation of stream banks in degraded areas

Location	Protection Method	Amount	Cost	Participants	Benefits
TO-1	Riparian Enhancement	20,000 ft^2	$10,000	City Project with County	Reduction of water temperature and sedimentation, Reestablishment of native vegetation and wildlife habitat
TO-2	Channel Restoration	300 feet	$28,500	City Project	Reduction of water temperature and sedimentation
TO-3	Community Enhancement	40,000 ft^2	$10,000	Community Project with City help	Reestablishment of native vegetation and wildlife habitat
TO-4	Community Enhancement	5000 ft^2	$1,250	Community Project with City help	Reestablishment of native vegetation and wildlife habitat

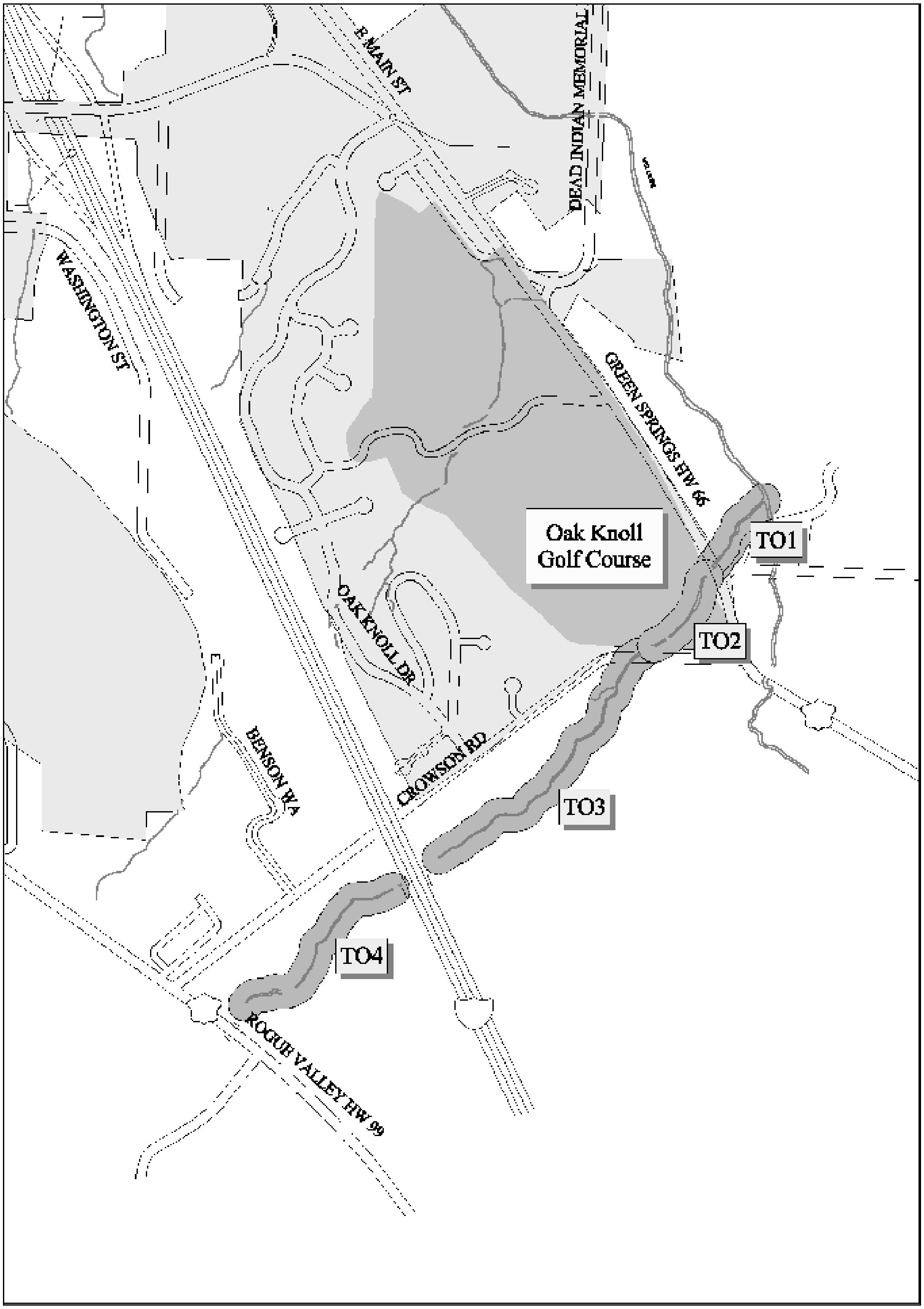


Figure 4-13. Tolman Creek Stream Reaches

NONSTRUCTURAL MEASURES

Nonstructural alternatives consist of regulations, operation and maintenance activities, and public education. Their costs vary with the level of complexity at which they are implemented and often can be passed on to developers, so cost estimates are not included with these recommendations.

Stormwater Manual

The City should develop stormwater standards in the form of a manual or a section of City code that addresses new development. The standards would be a guide for developers and reviewers to ensure that all projects meet long-term goals of the community. A low cost approach to this is to adopt another jurisdiction's existing manual with a list of special provisions for Ashland. Good manuals that have been adopted across the Northwest include the Washington State Department of Ecology's 1992 *Stormwater Management Manual for the Puget Sound Basin*, The City of Portland's *Stormwater Quality Facilities; A Design Guidance Manual*; Unified Sewerage Agency's February 2000 *Design and Construction Standards for Sanitary Sewer and Surface Water Management*; The City of Portland's 1999 *Stormwater Management Manual*, and King County, Washington's 1990 *Surface Water Design Manual.*

The manual would address issues such as on-site detention fees-in-lieu of detention for regional detention facilities, on-site water quality standards, design standards, and stream buffers and other sensitive area issues. The City has developed a Physical and Environmental Constraints Ordinance (Chapter 18.62) that would be a good cornerstone of a manual addressing development impacts on surface waters in Ashland. The City should budget in the range of $20,000 to $25,000 to complete this process.

Watershed Owner's Manuals

Public education is a large part of the NPDES requirements for municipalities. Manuals for the public along with classes on how to interpret and implement the manuals would help educate the public on current City trends and methods of cleaning up surface water. The City should budget from $15,000 to $20,000 to complete this activity.

Streamside Planting Brochure

Homeowners and the general public can help protect and enhance riparian corridors and other important natural resources. A guide for enhancement techniques could be developed in the form of a brochure to help the public control erosion, manage invasive plants and cultivate a native landscape. The City should budget from $5,000 to $10,000 to complete this activity.

Operation and Maintenance

This study did not attempt to match existing City maintenance staff with the duties and requirements of maintaining the City's storm system. This should be left up to staff who have knowledge of crew sizes and the time required to accomplish each task. In the process of developing an inventory for this study, the project team had the opportunity to inspect a considerable amount of the City's system, and it appears the system is well maintained. The maintenance program should be continued. When the City-wide GIS system is fully implemented, each segment of the system can be numbered and maintenance records can be kept using this system. This would allow the City to maintain long-term records of maintenance problems. The City should budget from $10,000 to $15,000 to complete this plan.

The City should prepare a program for maintaining all elements of its stormwater drainage system. This involves the following measures:

- Develop and implement an inspection and maintenance plan for all drainageways, catchbasins, drainage channels, detention facilities, flow control structures, and pump stations.
- Outline maintenance operations to clean catchbasins, remove channel debris, clear culvert obstructions, remove sediment from detention facilities, plant vegetation to control channel erosion, remove intrusive vegetation to increase channel conveyance capacity, and remove trash.
- Adopt stream dumping regulations and inform residents about the regulations and how to report violations.
- Develop an erosion protection program for areas susceptible to streambank erosion or head cutting.

Implementation begins by creating and maintaining a complete drainage inventory. All drainage channels, stormwater control facilities, pipe networks, and natural channels should be inventoried and mapped. Based on the inventoried facilities, a maintenance plan can be developed. The plan should outline scheduled maintenance for each facility, clearly define who is responsible, outline reports to be used for inspection documentation, and detail what can and cannot be removed. Implementing agencies can include cities, counties, flood control districts, or drainage districts.

Implementation should include the adoption of regulations to prohibit dumping debris in streams, lakes or other floodplain areas. Public outreach programs (e.g., mailings and stream clean-up days) should be conducted to inform affected residents and explain how to report violations. “No dumping” signs should be posted near problem areas.

Appendix E provides general maintenance guidelines for drainage system facilities. It outlines frequency of maintenance, specific problems to check for, and actions to be taken to correct any identified problem. Appropriate elements of these tables should be included in the City’s final maintenance plan. In addition, the plan should provide for the following ongoing maintenance efforts:

- **Street and Drainage System Cleaning**—A street cleaning program removes silt, sand, leaves, and miscellaneous debris from road surfaces before they enter the public drainage system, pollute the water, reduce the capacity of the conveyance system, and accelerate the deterioration of pumps. Street dirt should be removed by street sweepers once a month on all major, minor, and collector arterials and once every three months on residential roads. The drainage conveyance system should be cleaned by a vacuum or jet rodder truck. The entire drainage system, including catchbasins, manholes, pipes and vaults, should be cleaned on a three-year cycle.
- **Drainage Conveyance System Repair and Construction—**Repair and minor construction of catchbasins, manholes, and pipes ensure the proper operation of the drainage conveyance system. Repair or construction of drainage system structures should be initiated by management or City officials, citizen complaints, or work requests resulting from observations by City maintenance staff. Activities include the following: repair and replacement of pipe; installation, repair and replacement of manholes and catchbasins; construction of minor capital improvements; repairs to sidewalks, curbs and gutters; minor dredging with a backhoe; asphalt repairs; and brush cutting. Repairs to catchbasins, manholes, and pipes should be coordinated with street repairs to minimize construction disturbance.
- **Open Channel and Ditch Maintenance—**Cleaning and stabilizing public open-channel and ditch systems maintains their conveyance capacity, minimizes channel and

ditch erosion, and improves water quality. This work should be performed as needed and include silt removal. Activities after storm events include excavation of materials from ditches and major drainageways and checking for plugged catchbasin grates and trash racks.

- **Emergency and Miscellaneous Services Program**—A maintenance crew should provide emergency response during storm events and for other, non-storm-related emergencies. Typical emergency situations include flooding of roadways or buildings, landslides, trees fallen across roads or on structures, oil spills, chemical spills, etc.
- **Sensitive Areas**—Maintenance of stormwater facilities in or adjacent to sensitive areas consists of replacing pipe, manholes or catchbasins as needed. Erosion control while performing maintenance activities should be achieved by applying BMPs such as silt fences, straw bales, riprap, sandbags and hydroseeding. Dredging or excavation in sensitive areas and their buffers must occur during the dry season, with water pumped or piped around the work area.

Chapter 5
CAPITAL IMPROVEMENT PROGRAM

CHAPTER 5.
CAPITAL IMPROVEMENT PROGRAM

RECOMMENDED IMPROVEMENT PROJECTS

The recommended improvement projects developed in Chapter 4 are the capital projects included in the capital improvement program (CIP). In addition to the identification of the projects and their estimated cost, the CIP includes a priority for each project and a recommendation for project phasing based on priority. Five priority levels were identified:

- High priority—Projects that have an immediate, regional benefit, or resolve an existing observed problem.
- Medium priority—Projects that meet overall goals and objectives but require private land or private cooperation for implementation.
- Low priority—Projects that are needed in conjunction with future land development according to local Comprehensive Plan zoning. Projects that resolve future problems identified by system analysis.
- No action—Projects to address problems identified by the analysis process that don't present a threat to property. If the problem is identified by complaints in the future, then it should be addressed.
- Internal—Projects that can be conducted by City staff with no external cost.

The high priority rating indicates that a problem already exists and should be addressed as soon as possible. Medium and low priority ratings indicate that a problem is not immediate but is likely to require attention in the future. Medium ratings are for projects that address a more significant future problem than low priority projects. The no-action rating is for projects where analysis found the system to be undersized but no flooding has been reported. No action should be taken for these problem areas, but they should be monitored.

Capital improvement projects can be scheduled in phases based on their priority, the available annual funding for them, the availability of alternative funding sources, and the potential to perform the improvement in conjunction with other planned projects. Based on these considerations, the following phasing is recommended for projects in the CIP:

- High priority projects should be implemented within five years.
- Medium priority projects should be implemented between five and 10 years from completion of this master plan.
- Low priority projects should be implemented between 10 and 20 years from completion of this master plan.

No-action projects and internal projects are not included in the phasing plan.

Table 5-1 summarizes the capital projects in the CIP, along with their estimated costs and priorities. Project locations are shown on Figure 5-1.

TABLE 5-1. CAPITAL IMPROVEMENT PROJECTS		
Project	Estimated Cost	Priority
Nutley Street Storm System	$317,000	High
Central Avenue Outfall	$125,000	High
Beach Creek and Mountain Creek Basins Interceptor	$4,258,000	High
Clay Creek Culvert at Highway 99 (Siskiyou Blvd.)	$156,000	High
Clear Creek Wetland at Hersey Street	$95,000	High
Clay Creek Culvert at East Main Street	$125,000	Medium
Cemetery Creek Culvert at East Main Street	$125,000	Medium
Culvert GC-300 at East Main Street and Dead Indian Memorial Road	$225,000	Medium
Culvert GC-500 at East Main Street West of Greensprings Highway (Ashland Street)	$125,000	Medium
Stormwater Manual	$25,000	Low
Watershed Owner's Manual	$20,000	Low
Streamside Planting Brochure	$10,000	Low
Operation and Maintenance Plan	$15,000	Low

DEVELOPMENT STANDARD REVIEW

Stormwater regulations for the City of Ashland can be found in two documents. The Physical and Environmental Constraints Ordinance (Chapter 18.62, revised December 3, 1997) and the Streets Standard Handbook (adopted February 2, 1999). Based on the review of these documents and discussion with City staff, the following recommendations will help reduce the impacts of existing activities and future development on the City's wetlands and creek corridors. These recommendations are designed to augment and not replace existing regulations. The recommendations are designed to prepare the City for anticipated future nonpoint source stormwater regulations under the NPDES program.

Stormwater Manual

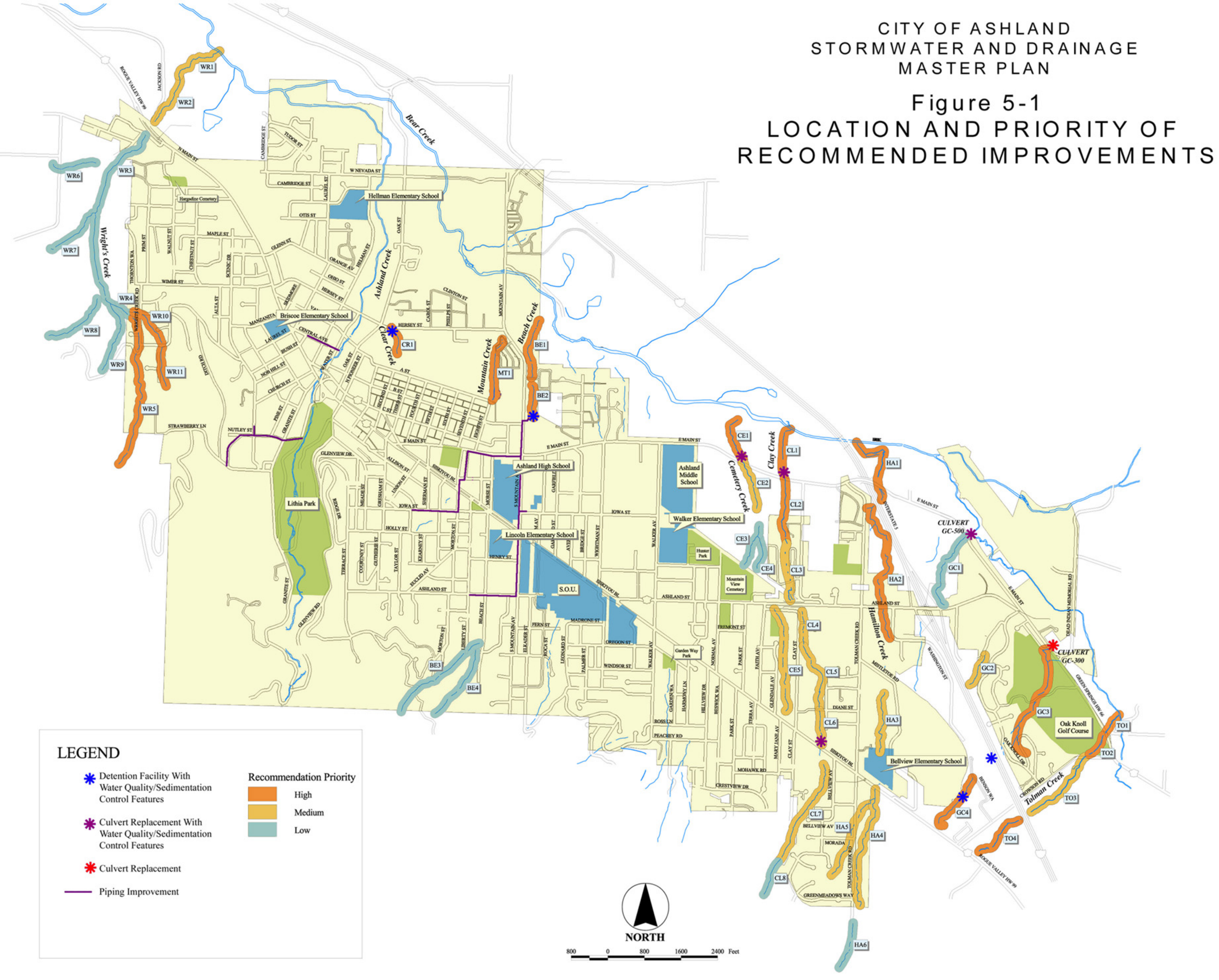
The City should develop a collection of development standards in a single stormwater manual. The manual will incorporate all existing regulations and give the minimum standards that all new construction must meet. It will address erosion control, water quality treatment, drainage design, riparian buffers, operation and maintenance, and fees. The manual can also address show how one facility might accomplish several functions (e.g., a detention pond that provides water quality treatment).

Erosion and Sediment Control Guidelines

The City should develop uniform Erosion and Sediment Control Guidelines based upon the type of development, land slope, amount of exposed ground area, and season of the year for construction. The City should build upon its existing ordinance to expand coverage and strengthen enforcement provisions. Sample highlights from other jurisdiction's requirements include the following:

CITY OF ASHLAND
STORMWATER AND DRAINAGE
MASTER PLAN

Figure 5-1
LOCATION AND PRIORITY OF RECOMMENDED IMPROVEMENTS



- An erosion control permit is required for all construction activities disturbing an area larger than 500 square feet.
- Construction on slopes steeper than 5 percent is subject to excavation limitations from November 1 through April 30.
- All erosion control facilities must be effectively maintained throughout construction. If a permittee is notified that the approved plans are not effective, a revised plan must be submitted within three working days.

Enforcement of erosion control measures is the responsibility of the City's Public Works staff.

Water Quality Control Guidelines

The City should develop new water quality treatment regulations—such as pollutant removal percentages for particular pollutants and storm events—that will apply to stormwater runoff from all new development. These regulations could outline design standards for best management practices (BMPs) and apply the BMPs to all new development. Examples of typical water quality facilities are included in Appendix D.

Drainage Design Standards

Drainage design standards should be part of the stormwater manual. They should define design storms, emergency overflow routes, detention and pipe sizing requirements, channel design, and standard drawings for inlets and manholes. The standards could also discuss requirements for submitting drainage calculations.

The City should use the above described guidelines for drainage improvements or develop design standards for drainage improvements within the UGB. The standards provided herein should be viewed as guidance for design, implementation, and construction of public drainage improvements.

Landscape Design Standards

In order to improve the function of open stormwater facilities, reduce maintenance requirements and enhance the aesthetics of surface water facilities, the following guidelines should be considered as part of stormwater design standards:

- Shrub and wetland plantings should be designed to minimize solar exposure of open water. Trees should be located along the east, south and west sides of a facility. Plantings should be designed to meet the following minimum quantities:

  Evergreen trees: 3 per 1000 square feet, minimum height 6 feet
  Deciduous trees: 2 per 1000 square feet, minimum caliper 1 to 1-1/2-inch at 2 feet above base
  Shrubs: 30 per 1000 square feet, minimum container 1 gallon or equivalent
  Wetland plants: 1 per 2 square feet of pond emergent plant zone

- Use of fences should be avoided whenever possible. Alternatively, side slopes should be constructed at safe slopes (side slopes greater than 3H:1V) and vegetated buffers or 10-foot wide safety bench provided to maximize safety. Where fencing is required by safety or security considerations, the fencing should be aesthetically designed and screened with vegetation and plantings that conform with the site design.

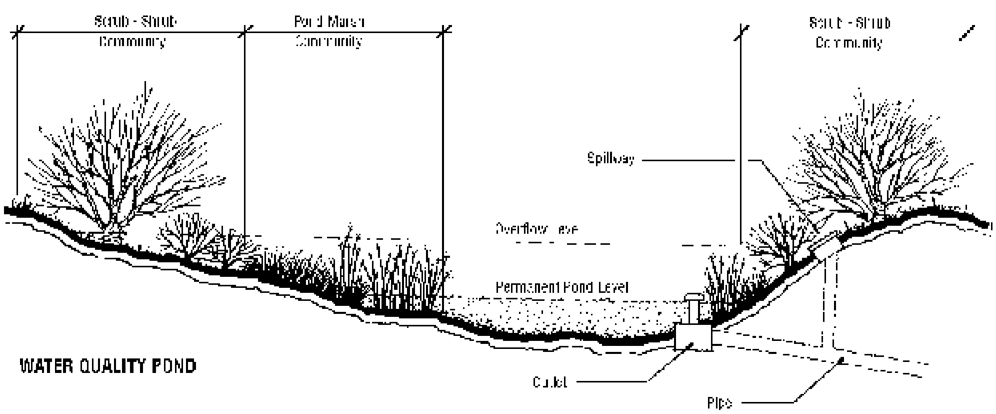
- Access should be provided for maintenance purposes. At a minimum, at least one access should be provided for maintenance and inspection. Access roads should have a minimum width of 15 feet and a maximum slope of 15%.

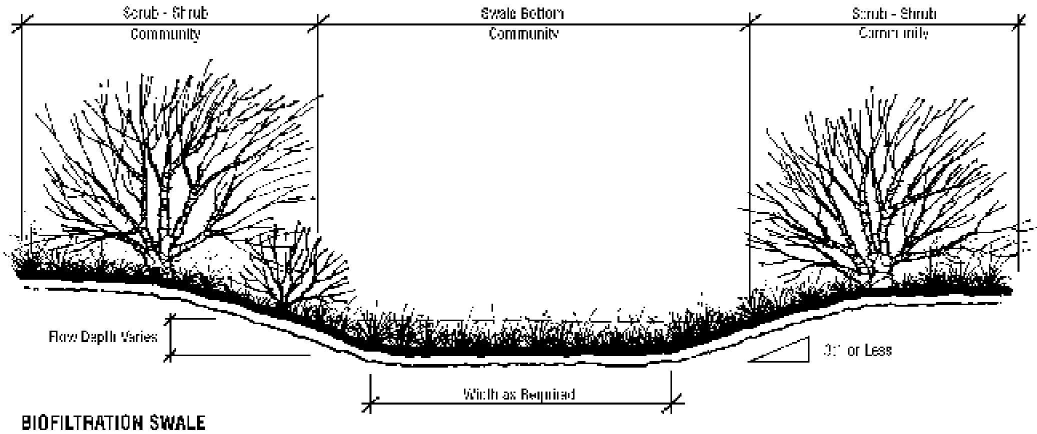
- Landscaping for new stormwater facilities should be maintained by the owner or responsible party. For stormwater facilities that become property of the City, landscaping should be maintained through a two year period prior to acceptance by the City.

Water quality facility design standards must be supplemented with landscaping standards to ensure community acceptance and long term maintainability. Other jurisdictions that have employed design standards that overlooked the landscape aspect of these facilities have witnessed a variety of failures. The recommendations below are included to address these problems.

Recommended Plant Communities

The two cross sections below illustrate the most common water quality facilities: the pond, and the biofiltration swale. Plant community types have been referenced in the cross-sections. These plant communities should be comprised of species native to the Ashland area and are suitable for the conditions typically encountered in these facility types. Specific plant communities should be identified in the stormwater manual.





BIOFILTRATION SWALE

Landscape Maintenance

Weed eradication should include eradicaton by herbicide and non-herbicide methods of all plants found on the prohibited species list below. The purpose of this is to discourage invasive exotic plant species from infesting Ashland’s natural drainage ways.

Irrigation Guidelines

It is recommended that all water quality facilities have a permanent or temporary automatic irrigation system to ensure initial establishment.

Riparian Corridor Protection

The City of Ashland should work with the Rogue Valley Council of Governments to adopt uniform stream buffer and setback requirements for urban streams. Setbacks could vary significantly depending upon the depth and side slopes of the existing stream and riparian corridor, whether the stream has perennial flow, and extent of existing vegetation. The new standards should supplement or replace the riparian preservation provisions in the City’s current ordinance revision (City Code Chapter 18.62 – Physical and Environmental Constraints). The City should preserve existing open surface water facilities and encourage the expansion of surface facilities where practical. The City Engineer should consider surface water facilities as a preferred approach, but may specify underground facilities where warranted because of efficiency, capacity, maintenance concerns, lack of perennial surface water flow or other considerations.

The City should require shading of surface facilities in order to reduce water temperatures in existing and new surface water facilities. In addition, the City should discourage the use of unshaded, shallow *(less than 3 feet average depth)* surface water facilities where water would be ponded more than two days.

ORS 498.351 and ORS 509.605, require any person, municipal corporation or government agency placing an artificial obstruction across a stream to provide a fishway for anadromous, food and game fish species where these are present, or could be present in the future. Pursuant to the ORS, the City should require the use of culvert designs that meet *Oregon Department of Fish and Wildlife Guidelines and Criteria for Stream-Road Crossings*.

NPDES REQUIREMENTS

The NPDES Storm Water Phase II Program identifies six minimum measures for implementation:

- **Public Education and Outreach—**Develop an education program to distribute materials to the community or conduct outreach about stormwater impacts.
- **Public Involvement and Participation—**Comply with state, tribal and local public notice requirements and encourage the public to become involved in program implementation.
- **Illicit Discharge Detection and Elimination—**Develop a storm system map with location of major pipes, outfalls and topography.
- **Construction Site Runoff Control—**Develop, implement and enforce a program to reduce pollutants moving from construction activities to storm sewer system.
- **Post-Construction Stormwater Management—**Develop, implement and enforce a program to address runoff from new development or redevelopment projects.
- **Pollution Prevention and Good Housekeeping—**Implement a pollution and maintenance program for municipal operations.

The capital improvement program addresses each of these items and therefore prepares the City for imminent NPDES requirements. This report also recommends projects that go beyond NPDES requirements by enhancing water quality and habitat value, reducing flooding and enhancing recreational use of creek corridors in the City.

FUNDING ALTERNATIVES

In Oregon, funding options available to cities for storm sewer operations, maintenance and improvements are identical to those established for other municipal utility functions. The flexibility established for stormwater financing and upheld in the Oregon Supreme Court (Oregon School District, et al. v. City of Roseburg) allows the City access to a service charge for funding stormwater operations and capital improvements. Following the adoption of this master plan, an evaluation of financing techniques and a re-calibration of rates will be required. This will provide the revenue to implement the CIP outlined in this document. The following is a general outline of funding options; no recommendation for funding options is made in this master plan.

General Obligation Bonds

Ashland can issue general obligation (GO) bonds for capital improvements and replacement. GO bonds are debt instruments backed by the full faith and credit of the City, which would be secured by an unconditional pledge of the City to levy assessments, charges or ad valorem taxes necessary to retire the bonds. GO bonds are the lowest-cost form of debt financing available to local governments and can be combined with other revenue sources such as specific fees, or special assessment charges to form a dual security through the City's revenue generating authority. These bonds are supported by the City as a whole, so the amount of debt issued for stormwater is limited to a fixed percentage of the real market value for taxable property within the City. This cap is a statutory mandate.

Revenue Bonds

Unlike GO bonds, revenue bonds are not backed by the City as a whole, but constitute a lien against the stormwater service charge revenues of the Storm Sewer Utility. Revenue bonds present a greater comparative risk to the investor than GO bonds, since repayment of debt depends on an adequate revenue stream, legally defensible rate structure and sound fiscal management by the issuing jurisdiction. Due to this increased risk, revenue bonds generally command a higher interest rate than GO bonds. This type of debt also has very specific coverage requirements in the form of a reserve fund specifying an amount, usually expressed in terms of average or maximum debt service due in any future year. This debt service is required to be held as a cash reserve for annual debt service payment to the benefit of bondholders.

State/Federal Grants and Loans

Historically, local and county governments have received significant infrastructure funding support from state and federal agencies in the form of block grants, direct grants, interagency loans, and general revenue sharing. With federal deficit reduction pressures and virtual elimination of federal revenue sharing, local government now can expect less funding assistance for infrastructure finance. Presently, the primary sources of assistance for stormwater are federally funded grants provided by the Housing and Urban Development's Community Development Block Grant (CDBG) Program. Recent experience indicates that even when jurisdictions secure grants for their programs, the revenue provides only a small portion of the capital improvement cost.

System Development Charges

ORS 223.297 establishes the use of system development charges (SDCs) and provides a framework for establishing fees that recover from new development the City’s costs in providing utility system capacity. It also establishes a basis for fee calculation, which the City must follow. However, the fundamental objective for the fee structure is the imposition on new development of a proportionate share of the costs associated with providing or expanding stormwater infrastructure to meet the capacity needs created by that specific development.

SDCs cannot be applied retroactively and are a one-time charge at the time of development approval. Only infrastructure funded through stormwater charges or other City fees is eligible for inclusion in the SDC. If the existing system has any capacity remaining and available to new development, this available capacity becomes the basis for reimbursement of the SDC. Table 5-2 provides some SDC rates for communities in Oregon.

TABLE 5-2.
RATES FOR SELECTED OREGON COMMUNITIES IN 1997

City	Population	Stormwater Utility Rate (per month)	ERU (square feet)	SDC (charge per ERU)
Banks	625	$4.00	2,640	$500.00
Beaverton	66,225	$5.00	2,640	$901.00
Cannon Beach	1,425	$3.50	5,000	$701.00
Cottage Grove	8,005	$2.50		$928.96
Gresham	81,865	$3.53	2,500	$725.00
Medford	57,610	$2.95	3,000	$400.00
Roseburg	19,810	$2.85	3,000	$400.00

Sherwood	8,125	$4.00	2,640	
Tigard	36,680	$4.00	2,640	$500.00
Tualatin	20,405	$4.00	2,640	$500.00
West Linn	20,415	$3.75		$376.00
Wilsonville	10,940	$1.40	2,000	$81.00
Woodburn	16,150	n/a	n/a	$275.00

Stormwater Management Service Charges

As conventional funding sources for stormwater management become more difficult to access and as federal and state stormwater quality requirements become mandatory, the utility approach toward funding is becoming generally accepted. There are numerous combinations and variations for stormwater service charges. One method for rate structures uses an equivalent residential unit (ERU) approach based on estimated impervious surface. An ERU can be defined as a set number of square feet of impervious surface. This is based on average single-family residential lot size in the City, along with land use limitations on the percent of impervious coverage. Because most single-family residents have similar impervious surface footprints, all single-family homes are considered to be 1 ERU. All other properties are charged based on their measured impervious surface divided by the base ERU square footage to determine the number of ERUs applied to that property. Table 5-2 provides some stormwater utility rates for communities in Oregon.

Appendix A
COST ESTIMATES

Appendix A

This appendix outlines the cost estimates for the various recommended projects. No detailed estimates were prepared for the culvert projects. These estimates were taken from cost of similar projects. The estimates reflect project costs for June 1999 (Engineering News Record, Construction Cost Index, Seattle ENR CCI = 6932).

CITY OF ASHLAND
STORM DRAINAGE MASTER PLAN

ASHLAND BASIN SYSTEM IMPROVEMENTS
Granite Street

Improvement	Quantity	Unit	Unit Cost *	Total Cost
Nutley Piping System				
30-inch through City Maintenance Yard	70	LF	$180	$13,000
24-inch to School Yard	350	LF	$144	$50,000
18-inch to upstream end of System	1160	LF	$108	$125,000
Nutley Piping System Subtotal				**$188,000**
Water Quality Facility	1	LS	$25,000	$25,000
Energy Dissipator	1	LS	$5,000	$5,000
Construction Total				$218,000
Construction Contingencies (percent of total)			20%	$44,000
Engineering / Legal / Administration Fees (percent of total)			25%	$55,000
TOTAL PROJECT COST				**$317,000**
* Unit Costs are based on the following:				
Upsize and Add RCP Piping			$6	per in.dia.-lf.

CITY OF ASHLAND
STORM DRAINAGE MASTER PLAN

BEACH-MOUNTAIN IMPROVEMENTS
Alternative #1 Cost Estimate - Piping System Upsizing; 10-yr

Improvement	Quantity	Unit	Unit Cost *	Total Cost
Upsize Beach Trunk, 1				
48-inch at downstream end of System	62	LF	$288	$18,000
42-inch through City Maintenance Yard	239	LF	$252	$60,000
36-inch to School Yard	2902	LF	$216	$627,000
Upsize Henry System (Beach), 1				
18-inch to Liberty	796	LF	$108	$86,000
12-inch across Liberty	24	LF	$72	$2,000
Beach Piping Subtotal				**$793,000**
Upsize Mountain Trunk, 1				
36-inch to East Main	1284	LF	$216	$277,000
30-inch along Dewey	649	LF	$180	$117,000
Add Iowa Trunk (Mountain), 1				
24-inch from Dewey and along Iowa	1920	LF	$144	$276,000
Mountain Piping Subtotal				**$670,000**
Detention Downstream of RR (Beach), 4				
Land Purchase	2.6	AC	$150,000	$390,000
Clearing/Grubbing and Planting	2.6	AC	$25,000	$65,000
Excavation / Backfill	6900	CY	$20	$138,000
Inlet/Outlet Structures	1	LS	$60,000	$60,000
Beach Detention Subtotal				**$653,000**
Detention Downstream of RR (Mountain), 4				
Land Purchase	2.2	AC	$150,000	$330,000
Clearing/Grubbing and Planting	2.2	AC	$25,000	$55,000
Excavation / Backfill	4500	CY	$20	$90,000
Inlet/Outlet Structures	1	LS	$60,000	$60,000
Mountain Detention Subtotal				**$535,000**
Construction Total				$2,651,000
Construction Contingencies (percent of total)			20%	$530,000
Engineering / Legal / Administration Fees (percent of total)			25%	$663,000
TOTAL PROJECT COST				**$3,844,000**

* Unit Costs are indexed and based on the following:

1) Upsize and Add RCP Piping	$6 per in.dia.-lf.
2) Underground Detention Facilities using CAP	$4 per in.dia.-lf.
3) Underground Detention Facilities using box culverts	$6 per in.dia.-lf.
4) Above Ground Detention Facilities	as shown

CITY OF ASHLAND
STORM DRAINAGE MASTER PLAN

BEACH-MOUNTAIN IMPROVEMENTS
Alternative #2 Cost Estimate - Beach-Mountain Bypass; 10-yr

Improvement	Quantity	Unit	Unit Cost *	Total Cost
Add Liberty Bypass				
36-inch from East Main to Iowa	1360	LF	$216	$294,000
24-inch to Henry	1040	LF	$144	$150,000
18-inch to Ashland	770	LF	$108	$83,000
Add Hwy 99 Trunk (Beach), 1				
24-inch to Liberty	1170	LF	$144	$168,000
Bypass Piping Subtotal				**$695,000**
Upsize Mountain Trunk, 1				
42-inch to East Main	1176	LF	$252	$296,000
24-inch along East Main	108	LF	$144	$16,000
Add Iowa Trunk (Mountain), 1				
24-inch to Liberty	1300	LF	$144	$187,000
Mountain Piping Subtotal				**$499,000**
Detention Downstream of RR (Mountain), 4				
Land Purchase	3.5	AC	$150,000	$525,000
Clearing/Grubbing and Planting	3.5	AC	$25,000	$88,000
Excavation / Backfill	12300	CY	$20	$246,000
Inlet/Outlet Structures	1	LS	$60,000	$60,000
Mountain Detention Subtotal				**$919,000**
Construction Total				$2,113,000
Construction Contingencies (percent of total)			20%	$423,000
Engineering / Legal / Administration Fees (percent of total)			25%	$528,000
TOTAL PROJECT COST				**$3,064,000**

* Unit Costs are indexed and based on the following:
1) Upsize and Add RCP Piping — $6 per in.dia.-lf.
2) Underground Detention Facilities using CAP — $4 per in.dia.-lf.
3) Underground Detention Facilities using box culverts — $6 per in.dia.-lf.
4) Above Ground Detention Facilities

CITY OF ASHLAND
STORM DRAINAGE MASTER PLAN

BEACH-MOUNTAIN IMPROVEMENTS
Alternative #3 Cost Estimate - Upstream Detention; 10-yr

Improvement	Quantity	Unit	Unit Cost *	Total Cost
Upsize Henry System (Beach), 1				
18-inch to Liberty	42	LF	$108	$5,000
12-inch across Liberty	796	LF	$72	$57,000
Beach Piping Subtotal				**$62,000**
Upsize Mountain Trunk, 1				
24-inch to East Main	1284	LF	$144	$185,000
Mountain Piping Subtotal				**$185,000**
Detention under SOU Parking Lot (Beach), 2				
9-foot Underground Detention	3800	LF	$432	$1,642,000
Beach Detention Subtotal				**$1,642,000**
Detention along Iowa (Mountain), 3				
10-foot by 16-foot Underground Detention	2600	LF	$1,030	$2,677,000
Mountain Detention Subtotal				**$2,677,000**
Construction Total				$4,566,000
Construction Contingencies (percent of total)			20%	$913,000
Engineering / Legal / Administration Fees (percent of total)			25%	$1,142,000
TOTAL PROJECT COST				**$6,621,000**

* Unit Costs are indexed and based on the following:
1) Upsize and Add RCP Piping — $6 per in.dia.-lf.
2) Underground Detention using CMP or CAP — $4 per in.dia.-lf.
3) Underground Detention using box culverts (for equiv. dia.) — $6 per in.dia.-lf.
4) Above Ground Detention Facilities

CITY OF ASHLAND
STORM DRAINAGE MASTER PLAN

BEACH-MOUNTAIN IMPROVEMENTS
Alternative #4 Cost Estimate - Combination Upstream Detention and Bypass; 10-yr

Improvement	Quantity	Unit	Unit Cost *	Total Cost
Add Liberty Bypass				
30-inch from East Main to Iowa	1360	LF	$180	$245,000
24-inch to Henry	1040	LF	$144	$150,000
18-inch to Ashland	770	LF	$108	$83,000
Bypass Piping Subtotal				**$478,000**
Upsize Mountain Trunk, 1				
36-inch to East Main	1176	LF	$216	$254,000
24-inch along East Main	108	LF	$144	$16,000
Mountain Piping Subtotal				**$270,000**
Detention under SOU Parking Lot (Beach), 2				
9-foot Underground Detention	2000	LF	$432	$864,000
Beach Detention Subtotal				**$864,000**
Detention along Iowa (Mountain), 3				
8-foot by 12-foot Underground Detention	1300	LF	$799	$1,039,000
Detention Downstream of RR (Mountain), 4				
Land Purchase	1.8	AC	$150,000	$270,000
Clearing/Grubbing and Planting	1.8	AC	$25,000	$45,000
Excavation / Backfill	3200	CY	$20	$64,000
Inlet/Outlet Structures	1	LS	$60,000	$60,000
Mountain Detention Subtotal				**$1,478,000**
Construction Total				$3,090,000
Construction Contingencies (percent of total)			20%	$618,000
Engineering / Legal / Administration Fees (percent of total)			25%	$773,000
TOTAL PROJECT COST				**$4,481,000**

* Unit Costs are indexed and based on the following:

1) Upsize and Add RCP Piping — $6 per in.dia.-lf.
2) Underground Detention Facilities using CAP — $4 per in.dia.-lf.
3) Underground Detention Facilities using box culverts — $6 per in.dia.-lf.
4) Above Ground Detention Facilities

CITY OF ASHLAND
STORM DRAINAGE MASTER PLAN

BEACH-MOUNTAIN IMPROVEMENTS

Alternative #5 Cost Estimate - Mountain Avenue Bypass; 10-yr

Improvement	Quantity	Unit	Unit Cost *	Total Cost
Upsize Beach Trunk, 1				
24-inch at downstream end of System	150	LF	$144	$22,000
36-inch to School Yard	1290	LF	$216	$279,000
Upsize Henry System (Beach), 1				
18-inch to Liberty	856	LF	$108	$92,000
12-inch across Liberty	24	LF	$72	$2,000
Beach Piping Subtotal				**$373,000**
Upsize Mountain Trunk, 1				
36-inch along East Main	108	LF	$216	$23,000
30-inch along Dewey	649	LF	$180	$117,000
Add Iowa Trunk (Mountain), 1				
24-inch from Dewey and along Iowa	1920	LF	$144	$276,000
Mountain Piping Subtotal				**$416,000**
Add Mountain Bypass				
48-inch from Detention to south of RR	120	LF	$288	$35,000
42-inch to East Main	880	LF	$252	$222,000
30-inch to Iowa	1240	LF	$180	$223,000
Add East Main Trunk (Beach), 1				
36-inch to Mountain	1060	LF	$216	$229,000
Bypass Piping Subtotal				**$709,000**
Detention Downstream of RR (Beach), 4				
Land Purchase	4.4	AC	$150,000	$660,000
Clearing/Grubbing and Planting	4.4	AC	$25,000	$110,000
Excavation / Backfill	20000	CY	$20	$400,000
Inlet/Outlet Structures	1	LS	$60,000	$60,000
Beach Detention Subtotal				**$1,230,000**
Construction Total				$2,728,000
Construction Contingencies (percent of total)			20%	$546,000
Engineering / Legal / Administration Fees (percent of total)			25%	$682,000
TOTAL PROJECT COST				**$3,956,000**

* Unit Costs are indexed and based on the following:

1) Upsize and Add RCP Piping — $6 per in.dia.-lf.
2) Underground Detention Facilities using CAP — $4 per in.dia.-lf.
3) Underground Detention Facilities using box culverts — $6 per in.dia.-lf.
4) Above Ground Detention Facilities — as shown

CITY OF ASHLAND
STORM DRAINAGE MASTER PLAN

BEACH-MOUNTAIN IMPROVEMENTS
Alternative #5 Cost Estimate - Mountain Avenue Bypass; 25-yr

Improvement	Quantity	Unit	Unit Cost *	Total Cost
Upsize Beach Trunk, 1				
24-inch at downstream end of System	150	LF	$144	$22,000
36-inch to School Yard	1290	LF	$216	$279,000
Upsize Henry System (Beach), 1				
18-inch to Liberty	856	LF	$108	$92,000
12-inch across Liberty	24	LF	$72	$2,000
Beach Piping Subtotal				**$373,000**
Upsize Mountain Trunk, 1				
36-inch along East Main	108	LF	$216	$23,000
30-inch along Dewey	649	LF	$180	$117,000
Add Iowa Trunk (Mountain), 1				
24-inch from Dewey and along Iowa	1920	LF	$144	$276,000
Mountain Piping Subtotal				**$416,000**
Add Mountain Bypass				
48-inch from Detention to south of RR	120	LF	$288	$35,000
42-inch to East Main	880	LF	$252	$222,000
30-inch to Iowa	1240	LF	$180	$223,000
Add East Main Trunk (Beach), 1				
36-inch to Mountain	1060	LF	$216	$229,000
Bypass Piping Subtotal				**$709,000**
Detention Downstream of RR (Beach), 4				
Land Purchase	5	AC	$150,000	$750,000
Clearing/Grubbing and Planting	5	AC	$25,000	$125,000
Excavation / Backfill	25200	CY	$20	$504,000
Inlet/Outlet Structures	1	LS	$60,000	$60,000
Beach Detention Subtotal				**$1,439,000**
Construction Total				$2,937,000
Construction Contingencies (percent of total)			20%	$587,000
Engineering / Legal / Administration Fees (percent of total)			25%	$734,000
TOTAL PROJECT COST				**$4,258,000**

* Unit Costs are indexed and based on the following:

1) Upsize and Add RCP Piping — $6 per in.dia.-lf.
2) Underground Detention Facilities using CAP — $4 per in.dia.-lf.
3) Underground Detention Facilities using box culverts — $6 per in.dia.-lf.
4) Above Ground Detention Facilities — as shown

Appendix B
STORMWATER TABULATION SHEETS

Appendix B

This appendix contains the modeling for the storm systems within the study area. Included in this appendix are models for Cemetery Creek Basin, Beach Creek Basin, Mountain Creek Basin, Ashland Creek Basin, and Hospital Basin. The 10-year and 25-year storms were modeled for existing and future conditions. The systems are included on electronic files to be used in the City's GIS system.

Also included are the proposed improvement projects modeled for the 10-year and 25-year storms. Improvements were designed for the 25-year storm.

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

CEMETARY CREEK - STORM TABULATION SHEET

10-YEAR STORM; EXISTING CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Ce148		3.6	0.41	1.5	0.0	1.5	10.0	0.3	1.94	2.9	19.64	12		15.8	20.2	385	2278.0	2202.4	2282.0	2203.40	2.79	2.48	2206.19	
Ce146		2.9	0.47	1.4	0.0	2.8	10.3	0.1	1.94	5.5	18.58	12		15.4	19.6	127	2202.4	2178.8	2206.4	2182.80	4.18	3.03	2186.98	
Ce144		31.4	0.30	9.3	0.0	12.1	10.4	0.0	1.94	23.5	18.82	12		15.5	19.7	17	2178.8	2175.6	2182.8	2179.60	28.36	7.41	2187.01	Flood
Ce142		0.0	0.00	0.0	0.0	12.1	10.4	0.4	1.94	23.5	11.63	12		12.2	15.5	399	2175.6	2129.2	2179.6	2133.20	194.97	174.02	2307.22	Flood
Ce140		0.0	0.00	0.0	0.0	12.1	10.9	0.3	1.94	23.5	7.35	12		9.7	12.3	226	2129.2	2112.6	2133.2	2116.60	119.52	98.57	2215.17	Flood
Ce138		0.0	0.00	0.0	0.0	12.1	11.2	0.4	1.88	22.8	5.82	12		8.6	11.0	261	2112.6	2097.4	2116.6	2101.40	126.57	106.90	2208.30	Flood
Ce136		0.0	0.00	0.0	0.0	12.1	11.6	0.4	1.88	22.8	5.06	12		8.0	10.2	257	2097.4	2084.4	2101.4	2088.40	124.93	105.26	2193.66	Flood
Ce134		7.8	0.47	3.7	0.0	15.8	12.0	0.6	1.88	29.7	4.33	12		7.4	9.5	328	2084.4	2070.2	2088.4	2074.20	261.14	227.79	2301.99	Flood
Ce132		0.0	0.00	0.0	0.0	15.8	12.6	0.2	1.80	28.4	4.13	15		13.2	10.7	104	2070.2	2065.9	2074.2	2071.00	32.66	20.14	2091.14	Flood
Ce130		4.3	0.42	1.8	0.0	17.6	12.7	0.1	1.80	31.7	4.11	15		13.1	10.7	56	2065.9	2063.6	2071.0	2070.00	29.02	13.47	2083.47	Flood
Ce128		8.3	0.48	4.0	0.0	21.6	12.8	0.2	1.80	38.8	4.03	15		13.0	10.6	124	2063.6	2058.6	2070.0	2063.80	68.03	44.71	2108.51	Flood
Ce126		0.0	0.00	0.0	0.0	21.6	13.0	0.3	1.75	37.7	4.10	15		13.1	10.7	212	2058.6	2049.9	2063.8	2052.40	94.29	72.25	2124.65	Flood
Ce124		0.0	0.00	0.0	0.0	21.6	13.3	0.3	1.75	37.7	4.12	15		13.1	10.7	165	2049.9	2043.1	2052.4	2044.80	78.28	56.23	2101.03	Flood
Ce122		4.3	0.63	2.7	0.0	24.3	13.6	0.2	1.75	42.5	4.09	15		13.1	10.7	132	2043.1	2037.7	2044.8	2039.80	84.93	57.00	2096.80	Flood
Ce120		0.0	0.00	0.0	0.0	24.3	13.8	0.3	1.75	42.5	4.11	15		13.1	10.7	190	2037.7	2029.9	2039.8	2032.40	109.98	82.05	2114.45	Flood
Ce118		0.0	0.00	0.0	0.0	24.3	14.1	0.2	1.70	41.3	4.09	15		13.1	10.7	137	2029.9	2024.3	2032.4	2027.20	82.19	55.83	2083.03	Flood
Ce116		5.3	0.62	3.3	0.0	27.6	14.3	0.4	1.70	46.8	4.11	15		13.1	10.7	236	2024.3	2014.6	2027.2	2018.60	157.96	123.98	2142.58	Flood
Ce114		0.0	0.00	0.0	0.0	27.6	14.7	0.1	1.70	46.8	4.20	15		13.3	10.8	44	2014.6	2012.8	2018.6	2017.00	57.09	23.12	2040.12	Flood
Ce112		0.0	0.00	0.0	0.0	27.6	14.7	0.2	1.70	46.8	3.76	15		12.6	10.2	121	2012.8	2008.2	2017.0	2012.40	97.54	63.57	2075.97	Flood
Ce110		8.9	0.69	6.1	0.0	33.6	14.9	0.3	1.70	57.2	3.86	15		12.7	10.4	215	2008.2	1999.9	2012.4	2003.60	219.14	168.47	2172.07	Flood
Ce108		0.0	0.00	0.0	0.0	33.6	15.3	0.6	1.65	55.5	3.81	15		12.6	10.3	354	1999.9	1986.4	2003.6	1989.20	309.04	261.30	2250.50	Flood
Ce106		14.9	0.53	7.9	0.0	41.6	15.9	0.2	1.65	68.6	3.87	15		12.7	10.4	124	1986.4	1981.6	1989.2	1987.00	212.76	139.83	2126.83	Flood
Ce104		7.0	0.56	3.9	0.0	45.5	16.1	0.3	1.60	72.8	3.78	15		12.6	10.3	172	1981.6	1975.1	1987.0	1978.60	300.50	218.38	2196.98	Flood
Ce102		0.0	0.00	0.0	0.0	45.5	16.3	0.2	1.60	72.8	3.91	15		12.8	10.4	110	1975.1	1970.8	1978.6	1973.40	221.78	139.66	2113.06	Flood
Ce100		0.0	0.00	0.0	0.0	45.5	16.5	0.0	1.60	72.8	3.64	15		12.4	10.1	22	1970.8	1970.0	1973.4	1971.25	110.05	27.93	1999.18	Flood
		98.7	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

CEMETARY CREEK - STORM TABULATION SHEET

10-YEAR STORM; EXISTING CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Ce240		6.0	0.41	2.5	0.0	2.5	10.0	0.8	1.94	4.8	0.60	15		5.0	4.1	193	2098.8	***2097.6***	2100.6	2098.85	1.41	1.05	2099.90	
Ce238		0.0	0.00	0.0	0.0	2.5	10.8	0.0	1.94	4.8	4.14	15		13.2	10.7	29	***2097.6***	***2096.4***	2101.6	2097.65	0.51	0.16	2098.16	
Ce236		7.3	0.50	3.7	0.0	6.1	10.8	0.6	1.94	11.9	3.98	15		12.9	10.5	366	***2096.4***	2081.8	2100.4	2084.00	14.49	12.31	2096.31	
Ce234		0.0	0.00	0.0	0.0	6.1	11.4	0.1	1.88	11.5	0.73	12		3.1	3.9	32	2081.8	2081.6	2084.0	2083.38	8.31	3.32	2086.70	**Flood**
Ce232		0.0	0.00	0.0	0.0	6.1	11.5	0.0	1.88	11.5	10.59	12		11.6	14.8	17	2081.6	2079.8	2084.6	2081.61	6.75	1.77	2083.38	**Surch.**
Ce230		8.8	0.48	4.2	0.0	10.3	11.6	0.1	1.88	19.4	2.97	18		18.2	10.3	74	2079.8	***2077.6***	2083.8	2079.10	5.31	2.51	2081.61	**Surch.**
Ce228		0.0	0.00	0.0	0.0	10.3	11.7	0.2	1.88	19.4	5.26	18		24.1	13.7	124	***2077.6***	2071.1	2082.6	2072.58	7.01	4.21	2076.79	
Ce226		0.0	0.00	0.0	0.0	10.3	11.8	0.3	1.88	19.4	3.42	18		19.5	11.0	195	2071.1	2064.4	2077.0	2065.92	9.42	6.62	2072.54	
Ce224		0.0	0.00	0.0	0.0	10.3	12.1	0.2	1.80	18.5	4.16	18		21.5	12.2	159	2064.4	2057.8	2068.0	2059.30	7.51	4.95	2064.25	
Ce222		0.0	0.00	0.0	0.0	10.3	12.3	0.3	1.80	18.5	4.37	18		22.0	12.5	200	2057.8	2049.1	2060.8	2052.40	8.79	6.22	2058.62	
Ce220		7.0	0.46	3.2	0.0	13.5	12.6	0.1	1.80	24.4	3.73	18		20.3	11.5	42	2049.1	***2047.5***	2052.4	2050.80	6.70	2.26	2053.06	**Flood**
Ce218		0.0	0.00	0.0	0.0	13.5	12.7	0.3	1.80	24.4	3.77	18		20.5	11.6	175	***2047.5***	***2040.9***	2050.8	2043.60	13.86	9.42	2053.02	**Flood**
Ce216		0.0	0.00	0.0	0.0	13.5	12.9	0.2	1.80	24.4	3.77	18		20.4	11.6	162	***2040.9***	***2034.8***	2043.6	2037.20	13.16	8.72	2045.92	**Flood**
Ce214		0.0	0.00	0.0	0.0	13.5	13.2	0.3	1.75	23.7	3.74	18		20.4	11.5	195	***2034.8***	***2027.5***	2037.2	2029.60	14.12	9.92	2039.52	**Flood**
Ce212		4.5	0.50	2.3	0.0	15.8	13.4	0.2	1.75	27.6	3.78	18		20.5	11.6	127	***2027.5***	***2022.7***	2029.6	2025.40	14.50	8.79	2034.19	**Flood**
Ce210		0.0	0.00	0.0	0.0	15.8	13.6	0.3	1.75	27.6	3.80	18		20.5	11.6	234	***2022.7***	***2013.8***	2025.4	2017.00	21.90	16.19	2033.19	**Flood**
Ce208		0.0	0.00	0.0	0.0	15.8	14.0	0.3	1.75	27.6	3.73	18		20.4	11.5	233	***2013.8***	***2005.1***	2017.0	2008.00	21.83	16.12	2024.12	**Flood**
Ce206		0.0	0.00	0.0	0.0	15.8	14.3	0.3	1.70	26.9	3.80	18		20.5	11.6	229	***2005.1***	***1996.4***	2008.0	1999.40	20.34	14.95	2014.35	**Flood**
Ce204		4.4	0.44	1.9	0.0	17.7	14.6	0.1	1.70	30.1	3.78	18		20.5	11.6	64	***1996.4***	1994.0	1999.4	1995.48	12.05	5.27	2000.75	**Flood**
Ce202		0.0	0.00	0.0	0.0	17.7	14.7	0.4	1.70	30.1	4.69	24	CMP	49.1	15.6	338	1994.0	1978.1	1997.4	1980.13	8.14	6.00	1988.28	
Ce200		2.0	0.55	1.1	0.0	18.8	15.1	0.1	1.65	31.1	3.56	24	CMP	42.8	13.6	60	1978.1	1976.0	1981.8	1978.00	3.41	1.13	1979.13	
		40.0	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

CEMETARY CREEK - STORM TABULATION SHEET
10-YEAR STORM; EXISTING CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Ce318		0.8	0.31	0.2	0.0	0.2	10.0	0.2	1.94	0.5	9.00	15	CONC	19.4	15.8	201	2195.8	2177.7	2201.2	2178.95	0.01	0.01	2178.96	
Ce316		0.0	0.00	0.0	0.0	0.2	10.2	0.2	1.94	0.5	7.34	15	CONC	17.5	14.3	152	2177.7	2166.6	2182.2	2167.80	0.01	0.01	2167.81	
Ce314		0.0	0.00	0.0	0.0	0.2	10.4	0.1	1.94	0.5	5.75	15	CONC	15.5	12.7	67	2166.6	2162.7	2170.8	2163.95	0.01	0.00	2163.96	
Ce312		6.2	0.32	2.0	0.0	2.2	10.5	0.1	1.94	4.3	4.71	15	CONC	14.1	11.4	51	2162.7	2160.3	2166.2	2161.55	0.52	0.23	2162.07	
Ce310		0.0	0.00	0.0	0.0	2.2	10.6	0.3	1.94	4.3	6.02	15	CONC	15.9	12.9	220	2160.3	2147.1	2163.8	2148.32	1.27	0.98	2149.59	
Ce308		0.0	0.00	0.0	0.0	2.2	10.8	0.4	1.94	4.3	5.28	15	CONC	14.9	12.1	322	2147.1	***2130.1***	2150.4	2131.32	1.73	1.44	2133.05	
Ce306		0.0	0.00	0.0	0.0	2.2	11.3	0.3	1.88	4.2	5.87	15	CONC	15.7	12.8	267	***2130.1***	2114.4	2133.4	2115.63	1.39	1.12	2117.03	
Ce304		0.0	0.00	0.0	0.0	2.2	11.6	0.1	1.88	4.2	3.33	15	CONC	11.8	9.6	35	2114.4	2113.2	2117.8	2114.47	0.42	0.15	2114.89	
Ce302	Ce330	1.5	0.47	0.7	2.0	5.0	11.7	0.5	1.88	9.4	3.06	18	CONC	18.4	10.4	295	2113.2	2104.2	2115.8	2105.70	2.99	2.34	2108.69	
Ce300		17.4	0.33	5.8	0.0	10.8	12.2	0.0	1.80	19.4	196.40	18	CONC	147.6	83.5	50	2104.2	2006.0	2107.2	2007.50	4.50	1.70	2012.00	
Ce340		0.2	0.65	0.1	0.0	0.1	10.0	0.8	1.94	0.3	1.96	12	CONC	5.0	6.4	321	2131.9	2125.6	2133.6	2126.63	0.02	0.02	2126.65	
Ce338		0.0	0.00	0.0	0.0	0.1	10.8	0.6	1.94	0.3	1.78	12	CONC	4.8	6.1	228	2125.6	2121.6	2127.8	2122.58	0.01	0.01	2122.60	
Ce336		0.3	0.65	0.2	0.0	0.3	11.5	0.3	1.88	0.6	2.70	12	CONC	5.9	7.5	134	2121.6	2118.0	2124.0	2118.97	0.05	0.04	2119.02	
Ce334		0.0	0.00	0.0	0.0	0.3	11.8	0.2	1.88	0.6	2.02	12	CONC	5.1	6.5	75	2118.0	2116.5	2120.8	2117.45	0.04	0.02	2117.49	
Ce332		0.0	0.00	0.0	0.0	0.3	12.0	0.1	1.88	0.6	2.28	12	CONC	5.4	6.9	54	2116.5	2115.2	2119.2	2116.22	0.03	0.02	2116.25	
Ce330		5.0	0.34	1.7	0.0	2.0	12.1	0.2	1.80	3.7	2.63	12	CONC	5.8	7.4	76	2115.2	2113.2	2117.8	2114.22	1.32	0.81	2115.54	
		31.4	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

CEMETARY CREEK - STORM TABULATION SHEET

10-YEAR STORM; FUTURE CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Ce148		3.6	0.50	1.8	0.0	1.8	10.0	0.3	1.94	3.5	19.64	12		15.8	20.2	385	2278.0	2202.4	2282.0	2203.40	4.16	3.70	2207.56	
Ce146		2.9	0.50	1.5	0.0	3.3	10.3	0.1	1.94	6.3	18.58	12		15.4	19.6	127	2202.4	2178.8	2206.4	2182.80	5.48	3.97	2188.28	
Ce144		31.4	0.32	10.0	0.0	13.3	10.4	0.0	1.94	25.8	18.82	12		15.5	19.7	17	2178.8	2175.6	2182.8	2179.60	34.07	8.91	2188.51	Flood
Ce142		0.0	0.00	0.0	0.0	13.3	10.4	0.4	1.94	25.8	11.63	12		12.2	15.5	399	2175.6	2129.2	2179.6	2133.20	234.19	209.03	2342.23	Flood
Ce140		0.0	0.00	0.0	0.0	13.3	10.9	0.3	1.94	25.8	7.35	12		9.7	12.3	226	2129.2	2112.6	2133.2	2116.60	143.56	118.40	2235.00	Flood
Ce138		0.0	0.00	0.0	0.0	13.3	11.2	0.4	1.88	25.0	5.82	12		8.6	11.0	261	2112.6	2097.4	2116.6	2101.40	152.04	128.41	2229.81	Flood
Ce136		0.0	0.00	0.0	0.0	13.3	11.6	0.4	1.88	25.0	5.06	12		8.0	10.2	257	2097.4	2084.4	2101.4	2088.40	150.07	126.44	2214.84	Flood
Ce134		7.8	0.50	3.9	0.0	17.2	12.0	0.6	1.88	32.3	4.33	12		7.4	9.5	328	2084.4	2070.2	2088.4	2074.20	309.42	269.90	2344.10	Flood
Ce132		0.0	0.00	0.0	0.0	17.2	12.6	0.2	1.80	31.0	4.13	15		13.2	10.7	104	2070.2	2065.9	2074.2	2071.00	38.70	23.86	2094.86	Flood
Ce130		4.3	0.52	2.2	0.0	19.4	12.7	0.1	1.80	34.9	4.11	15		13.1	10.7	56	2065.9	2063.6	2071.0	2070.00	35.28	16.37	2086.37	Flood
Ce128		8.3	0.55	4.5	0.0	23.9	12.8	0.2	1.80	43.1	4.03	15		13.0	10.6	124	2063.6	2058.6	2070.0	2063.80	83.86	55.12	2118.92	Flood
Ce126		0.0	0.00	0.0	0.0	23.9	13.0	0.3	1.75	41.9	4.10	15		13.1	10.7	212	2058.6	2049.9	2063.8	2052.40	116.24	89.07	2141.47	Flood
Ce124		0.0	0.00	0.0	0.0	23.9	13.3	0.3	1.75	41.9	4.12	15		13.1	10.7	165	2049.9	2043.1	2052.4	2044.80	96.49	69.32	2114.12	Flood
Ce122		4.3	0.63	2.7	0.0	26.6	13.6	0.2	1.75	46.6	4.09	15		13.1	10.7	132	2043.1	2037.7	2044.8	2039.80	102.39	68.72	2108.52	Flood
Ce120		0.0	0.00	0.0	0.0	26.6	13.8	0.3	1.75	46.6	4.11	15		13.1	10.7	190	2037.7	2029.9	2039.8	2032.40	132.59	98.92	2131.32	Flood
Ce118		0.0	0.00	0.0	0.0	26.6	14.1	0.2	1.70	45.3	4.09	15		13.1	10.7	137	2029.9	2024.3	2032.4	2027.20	99.08	67.31	2094.51	Flood
Ce116		5.3	0.62	3.3	0.0	29.9	14.3	0.4	1.70	50.9	4.11	15		13.1	10.7	236	2024.3	2014.6	2027.2	2018.60	186.40	146.31	2164.91	Flood
Ce114		0.0	0.00	0.0	0.0	29.9	14.7	0.1	1.70	50.9	4.20	15		13.3	10.8	44	2014.6	2012.8	2018.6	2017.00	67.37	27.28	2044.28	Flood
Ce112		0.0	0.00	0.0	0.0	29.9	14.7	0.2	1.70	50.9	3.76	15		12.6	10.2	121	2012.8	2008.2	2017.0	2012.40	115.11	75.01	2087.41	Flood
Ce110		8.9	0.69	6.1	0.0	36.0	14.9	0.3	1.70	61.2	3.86	15		12.7	10.4	215	2008.2	1999.9	2012.4	2003.60	251.20	193.11	2196.71	Flood
Ce108		0.0	0.00	0.0	0.0	36.0	15.3	0.6	1.65	59.4	3.81	15		12.6	10.3	354	1999.9	1986.4	2003.6	1989.20	354.26	299.53	2288.73	Flood
Ce106		14.9	0.57	8.5	0.0	44.5	15.9	0.2	1.65	73.5	3.87	15		12.7	10.4	124	1986.4	1981.6	1989.2	1987.00	243.78	160.22	2147.22	Flood
Ce104		7.0	0.65	4.6	0.0	49.1	16.1	0.3	1.60	78.5	3.78	15		12.6	10.3	172	1981.6	1975.1	1987.0	1978.60	349.33	253.87	2232.47	Flood
Ce102		0.0	0.00	0.0	0.0	49.1	16.3	0.2	1.60	78.5	3.91	15		12.8	10.4	110	1975.1	1970.8	1978.6	1973.40	257.82	162.36	2135.76	Flood
Ce100		0.0	0.00	0.0	0.0	49.1	16.5	0.0	1.60	78.5	3.64	15		12.4	10.1	22	1970.8	1970.0	1973.4	1971.25	127.93	32.47	2003.72	Flood
		98.7	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

CEMETARY CREEK - STORM TABULATION SHEET

10-YEAR STORM; FUTURE CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Ce240		6.0	0.50	3.0	0.0	3.0	10.0	0.8	1.94	5.8	0.60	15		5.0	4.1	193	2098.8	***2097.6***	2100.6	2098.85	2.09	1.57	2100.42	**Surch.**
Ce238		0.0	0.00	0.0	0.0	3.0	10.8	0.0	1.94	5.8	4.14	15		13.2	10.7	29	***2097.6***	***2096.4***	2101.6	2098.59	0.76	0.24	2098.82	
Ce236		7.3	0.50	3.7	0.0	6.7	10.8	0.6	1.94	12.9	3.98	15		12.9	10.5	366	***2096.4***	2081.8	2100.4	2084.00	17.16	14.59	2098.59	**Surch.**
Ce234		0.0	0.00	0.0	0.0	6.7	11.4	0.1	1.88	12.5	0.73	12		3.1	3.9	32	2081.8	2081.6	2084.0	2084.60	9.85	3.94	2088.54	**Flood**
Ce232		0.0	0.00	0.0	0.0	6.7	11.5	0.0	1.88	12.5	10.59	12		11.6	14.8	17	2081.6	2079.8	2084.6	2082.68	8.00	2.09	2084.77	**Flood**
Ce230		8.8	0.55	4.8	0.0	11.4	11.6	0.1	1.88	21.5	2.97	18		18.2	10.3	74	2079.8	***2077.6***	2083.8	2079.58	6.56	3.10	2082.68	**Surch.**
Ce228		0.0	0.00	0.0	0.0	11.4	11.7	0.2	1.88	21.5	5.26	18		24.1	13.7	124	***2077.6***	2071.1	2082.6	2074.38	8.66	5.20	2079.58	**Surch.**
Ce226		0.0	0.00	0.0	0.0	11.4	11.8	0.3	1.88	21.5	3.42	18		19.5	11.0	195	2071.1	2064.4	2077.0	2066.20	11.63	8.18	2074.38	**Surch.**
Ce224		0.0	0.00	0.0	0.0	11.4	12.1	0.2	1.80	20.6	4.16	18		21.5	12.2	159	2064.4	2057.8	2068.0	2060.09	9.28	6.11	2066.20	**Surch.**
Ce222		0.0	0.00	0.0	0.0	11.4	12.3	0.3	1.80	20.6	4.37	18		22.0	12.5	200	2057.8	2049.1	2060.8	2052.40	10.86	7.69	2060.09	**Surch.**
Ce220		7.0	0.53	3.7	0.0	15.2	12.6	0.1	1.80	27.3	3.73	18		20.3	11.5	42	2049.1	***2047.5***	2052.4	2050.80	8.39	2.83	2053.63	**Flood**
Ce218		0.0	0.00	0.0	0.0	15.2	12.7	0.3	1.80	27.3	3.77	18		20.5	11.6	175	***2047.5***	***2040.9***	2050.8	2043.60	17.35	11.79	2055.39	**Flood**
Ce216		0.0	0.00	0.0	0.0	15.2	12.9	0.2	1.80	27.3	3.77	18		20.4	11.6	162	***2040.9***	***2034.8***	2043.6	2037.20	16.48	10.92	2048.12	**Flood**
Ce214		0.0	0.00	0.0	0.0	15.2	13.2	0.3	1.75	26.5	3.74	18		20.4	11.5	195	***2034.8***	***2027.5***	2037.2	2029.60	17.68	12.42	2042.02	**Flood**
Ce212		4.5	0.50	2.3	0.0	17.4	13.4	0.2	1.75	30.5	3.78	18		20.5	11.6	127	***2027.5***	***2022.7***	2029.6	2025.40	17.60	10.67	2036.07	**Flood**
Ce210		0.0	0.00	0.0	0.0	17.4	13.6	0.3	1.75	30.5	3.80	18		20.5	11.6	234	***2022.7***	***2013.8***	2025.4	2017.00	26.59	19.66	2036.66	**Flood**
Ce208		0.0	0.00	0.0	0.0	17.4	14.0	0.3	1.75	30.5	3.73	18		20.4	11.5	233	***2013.8***	***2005.1***	2017.0	2008.00	26.51	19.58	2027.58	**Flood**
Ce206		0.0	0.00	0.0	0.0	17.4	14.3	0.3	1.70	29.6	3.80	18		20.5	11.6	229	***2005.1***	***1996.4***	2008.0	1999.40	24.70	18.16	2017.56	**Flood**
Ce204		4.4	0.50	2.2	0.0	19.6	14.6	0.1	1.70	33.3	3.78	18		20.5	11.6	64	***1996.4***	1994.0	1999.4	1995.48	14.73	6.44	2001.92	**Flood**
Ce202		0.0	0.00	0.0	0.0	19.6	14.7	0.4	1.70	33.3	4.69	24	CMP	49.1	15.6	338	1994.0	1978.1	1997.4	1980.13	9.96	7.33	1990.09	
Ce200		2.0	0.90	1.8	0.0	21.4	15.1	0.1	1.65	35.3	3.56	24	CMP	42.8	13.6	60	1978.1	1976.0	1981.8	1978.00	4.41	1.46	1979.46	
		40.0	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

CEMETARY CREEK - STORM TABULATION SHEET

10-YEAR STORM; FUTURE CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Ce318		0.8	0.35	0.3	0.0	0.3	10.0	0.2	1.94	0.5	9.00	15	CONC	19.4	15.8	201	2195.8	2177.7	2201.2	2178.95	0.02	0.01	2178.97	
Ce316		0.0	0.00	0.0	0.0	0.3	10.2	0.2	1.94	0.5	7.34	15	CONC	17.5	14.3	152	2177.7	2166.6	2182.2	2167.80	0.02	0.01	2167.82	
Ce314		0.0	0.00	0.0	0.0	0.3	10.4	0.1	1.94	0.5	5.75	15	CONC	15.5	12.7	67	2166.6	2162.7	2170.8	2163.95	0.01	0.00	2163.96	
Ce312		6.2	0.35	2.2	0.0	2.5	10.5	0.1	1.94	4.8	4.71	15	CONC	14.1	11.4	51	2162.7	2160.3	2166.2	2161.55	0.63	0.28	2162.18	
Ce310		0.0	0.00	0.0	0.0	2.5	10.6	0.3	1.94	4.8	6.02	15	CONC	15.9	12.9	220	2160.3	2147.1	2163.8	2148.32	1.54	1.19	2149.86	
Ce308		0.0	0.00	0.0	0.0	2.5	10.8	0.4	1.94	4.8	5.28	15	CONC	14.9	12.1	322	2147.1	***2130.1***	2150.4	2131.32	2.09	1.74	2133.41	
Ce306		0.0	0.00	0.0	0.0	2.5	11.3	0.3	1.88	4.6	5.87	15	CONC	15.7	12.8	267	***2130.1***	2114.4	2133.4	2115.63	1.68	1.36	2117.32	
Ce304		0.0	0.00	0.0	0.0	2.5	11.6	0.1	1.88	4.6	3.33	15	CONC	11.8	9.6	35	2114.4	2113.2	2117.8	2114.47	0.51	0.18	2114.97	
Ce302	Ce330	1.5	0.47	0.7	2.2	5.4	11.7	0.5	1.88	10.1	3.06	18	CONC	18.4	10.4	295	2113.2	2104.2	2115.8	2105.70	3.50	2.73	2109.20	
Ce300		17.4	0.37	6.4	0.0	11.7	12.2	0.0	1.80	21.1	196.40	18	CONC	147.6	83.5	50	2104.2	2006.0	2107.2	2007.50	5.35	2.02	2012.85	
Ce340		0.2	0.65	0.1	0.0	0.1	10.0	0.8	1.94	0.3	1.96	12	CONC	5.0	6.4	321	2131.9	2125.6	2133.6	2126.63	0.02	0.02	2126.65	
Ce338		0.0	0.00	0.0	0.0	0.1	10.8	0.6	1.94	0.3	1.78	12	CONC	4.8	6.1	228	2125.6	2121.6	2127.8	2122.58	0.01	0.01	2122.60	
Ce336		0.3	0.65	0.2	0.0	0.3	11.5	0.3	1.88	0.6	2.70	12	CONC	5.9	7.5	134	2121.6	2118.0	2124.0	2118.97	0.05	0.04	2119.02	
Ce334		0.0	0.00	0.0	0.0	0.3	11.8	0.2	1.88	0.6	2.02	12	CONC	5.1	6.5	75	2118.0	2116.5	2120.8	2117.45	0.04	0.02	2117.49	
Ce332		0.0	0.00	0.0	0.0	0.3	12.0	0.1	1.88	0.6	2.28	12	CONC	5.4	6.9	54	2116.5	2115.2	2119.2	2116.22	0.03	0.02	2116.25	
Ce330		5.0	0.38	1.9	0.0	2.2	12.1	0.2	1.80	4.0	2.63	12	CONC	5.8	7.4	76	2115.2	2113.2	2117.8	2114.22	1.57	0.96	2115.78	
		31.4	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

BEACH CREEK - STORM TABULATION SHEET

10-YEAR STORM; EXISTING CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time- Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
B64		186.0					19.0	0.0		68.0	27.64	24	PVC	119.3	38.0	24	2035.8	2029.2	2036.0	2034.20	13.09	2.17	2036.37	Flood
B62		0.0	0.00	0.0	0.0	0.0	19.0	0.2	1.46	68.0	4.22	24	PVC	46.6	14.8	154	2029.2	2022.7	2034.2	2028.20	24.83	13.90	2042.10	Flood
B60		0.0	0.00	0.0	0.0	0.0	19.2	0.1	1.46	68.0	6.67	24	SPP	58.6	18.6	141	2022.7	2013.3	2028.2	2018.80	23.66	12.73	2031.53	Flood
B59		0.0	0.00	0.0	0.0	0.0	19.3	0.2	1.46	68.0	4.72	24	SPP	49.3	15.7	172	2013.3	2005.2	2018.8	2010.60	26.45	15.53	2026.13	Flood
B58		0.0	0.00	0.0	0.0	0.0	19.5	0.1	1.46	68.0	2.23	24	SPP	33.9	10.8	50	2005.2	2004.1	2010.6	2010.40	15.44	4.51	2014.91	Flood
B56	B300	0.0	0.00	0.0	10.3	10.3	19.6	0.0	1.46	83.1	5.69	24	SPP	54.1	17.2	24	2004.1	2002.7	2010.4	2009.20	19.54	3.23	2012.43	Flood
B54		0.0	0.00	0.0	0.0	10.3	19.6	0.2	1.46	83.1	3.70	24	CMP	43.6	13.9	199	1993.2	1985.8	2009.2	1999.00	43.12	26.82	2025.82	Flood
B52		0.0	0.00	0.0	0.0	10.3	19.8	0.5	1.46	83.1	2.28	24	CP	34.2	10.9	298	1985.8	1979.1	1999.0	1981.80	56.46	40.16	2021.96	Flood
B51		0.0	0.00	0.0	0.0	10.3	20.3	0.2	1.42	82.7	3.91	24	CP	44.8	14.3	163	1976.6	1970.3	1981.8	1975.60	37.89	21.75	1997.35	Flood
B50	B200	2.9	0.90	2.6	4.8	17.7	20.5	0.2	1.42	93.1	4.64	24	CP	48.9	15.6	206	1970.3	1960.7	1975.6	1966.20	55.36	34.87	2001.07	Flood
B40		0.0	0.00	0.0	0.0	17.7	20.7	0.3	1.42	93.1	4.41	24	CP	47.6	15.2	311	1960.7	1947.0	1966.2	1955.00	73.14	52.65	2007.65	Flood
B30		1.7	0.65	1.1	0.0	18.8	21.0	1.7	1.40	94.3	3.89	24	SPP	44.7	14.2	1489	1947.0	1889.1	1955.0	1894.60	279.58	258.57	2153.17	Flood
B20		9.2	0.56	5.2	0.0	23.9	22.8	0.1	1.36	100.6	3.53	30	SPP	77.3	15.7	119	1889.1	1884.9	1894.6	1890.40	16.94	7.15	1897.55	Flood
B18		0.0	0.00	0.0	0.0	23.9	22.9	0.1	1.36	100.6	4.09	30	SPP	83.1	16.9	93	1884.9	1881.1	1890.4	1886.60	15.37	5.59	1892.19	Flood
B16		0.0	0.00	0.0	0.0	23.9	23.0	0.2	1.32	99.6	1.18	30	SPP	44.6	9.1	102	1881.1	1879.9	1886.6	1885.40	15.61	6.01	1891.41	Flood
B14	B100	2.8	0.75	2.1	1.3	27.3	23.2	0.2	1.32	104.0	1.39	30	SPP	48.4	9.9	101	1879.9	1878.5	1885.4	1884.00	16.97	6.49	1890.49	Flood
B12		0.0	0.00	0.0	0.0	27.3	23.4	0.1	1.32	104.0	0.83	30	SPP	37.5	7.6	36	1878.5	1878.2	1884.0	1883.20	12.79	2.31	1885.51	Flood
B10		0.0	0.00	0.0	0.0	27.3	23.4	0.2	1.32	104.0	0.32	30	SPP	23.4	4.8	62	1878.2	1878.0	1883.2	1880.50	14.46	3.99	1884.49	Flood
B100		1.4	0.90	1.3	0.0	1.3	10.0	0.3	1.94	2.4	1.50	24	CP	27.8	8.9	133	1889.1	1887.1	1892.0	1885.40	0.03	0.02	1885.43	
B200		11.1	0.43	4.8	0.0	4.8	10.0	0.0	1.94	9.2	1.67	24	CP	29.3	9.3	12	1970.5	1970.3	1975.8	1975.60	0.22	0.02	1975.62	Surch.
B360		9.3	0.47	4.4	0.0	4.4	10.0	0.0	1.94	8.5	8.21	8	CP	3.5	9.9	27	2024.6	2022.4	2025.6	2023.80	27.05	13.28	2037.08	Flood
B350		0.0	0.00	0.0	0.0	4.4	10.0	0.0	1.94	8.5	5.67	10	CP	5.2	9.6	15	2021.8	2021.0	2023.8	2023.20	7.88	2.25	2025.45	Flood
B340		0.0	0.00	0.0	0.0	4.4	10.1	2.3	1.94	8.5	0.34	10	CP	1.3	2.4	329	2020.9	2019.7	2023.2	2022.40	54.88	49.24	2071.64	Flood
B330		6.6	0.54	3.5	0.0	7.9	12.4	0.1	1.80	14.3	2.15	12	SPP	5.2	6.7	55	2019.6	2018.4	2022.4	2020.80	16.48	8.80	2029.60	Flood
B320		0.0	0.00	0.0	0.0	7.9	12.5	0.0	1.80	14.3	10.48	12	SPP	11.6	14.7	14	2018.2	2016.8	2020.8	2020.00	9.92	2.24	2022.24	Flood
B310		0.0	0.00	0.0	0.0	7.9	12.5	0.8	1.80	14.3	2.61	12	SPP	5.8	7.4	359	2016.6	2007.2	2020.0	2010.20	65.09	57.41	2067.61	Flood
B300		4.3	0.56	2.4	0.0	10.3	13.4	0.1	1.75	18.1	0.98	12	SPP	3.5	4.5	39	2007.2	2006.8	2010.2	2010.40	22.37	10.03	2020.43	Flood
		235.3	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

BEACH CREEK - STORM TABULATION SHEET

10-YEAR STORM; FUTURE CONDITIONS

System Labels: Station or MH No.	Spur	Runoff Area: Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Hydrologic Calculations: Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	System Inventory: Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	Hydraulic Calculations: TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
B64		186.0					18.0	0.0		72.0	27.64	24	PVC	119.3	38.0	24	2035.8	2029.2	2036.0	2034.20	14.68	2.43	2036.63	Flood
B62		0.0	0.00	0.0	0.0	0.0	18.0	0.2	1.50	72.0	4.22	24	PVC	46.6	14.8	154	2029.2	2022.7	2034.2	2028.20	27.84	15.59	2043.79	Flood
B60		0.0	0.00	0.0	0.0	0.0	18.2	0.1	1.50	72.0	6.67	24	SPP	58.6	18.6	141	2022.7	2013.3	2028.2	2018.80	26.52	14.27	2033.07	Flood
B59		0.0	0.00	0.0	0.0	0.0	18.3	0.2	1.50	72.0	4.72	24	SPP	49.3	15.7	172	2013.3	2005.2	2018.8	2010.60	29.66	17.41	2028.01	Flood
B58		0.0	0.00	0.0	0.0	0.0	18.5	0.1	1.50	72.0	2.23	24	SPP	33.9	10.8	50	2005.2	2004.1	2010.6	2010.40	17.31	5.06	2015.46	Flood
B56	B300	0.0	0.00	0.0	11.2	11.2	18.6	0.0	1.50	88.9	5.69	24	SPP	54.1	17.2	24	2004.1	2002.7	2010.4	2009.20	22.36	3.70	2012.90	Flood
B54		0.0	0.00	0.0	0.0	11.2	18.6	0.2	1.50	88.9	3.70	24	CMP	43.6	13.9	199	1993.2	1985.8	2009.2	1999.00	49.34	30.68	2029.68	Flood
B52		0.0	0.00	0.0	0.0	11.2	18.8	0.5	1.50	88.9	2.28	24	CP	34.2	10.9	298	1985.8	1979.1	1999.0	1981.80	64.60	45.94	2027.74	Flood
B51		0.0	0.00	0.0	0.0	11.2	19.3	0.2	1.46	88.4	3.91	24	CP	44.8	14.3	163	1976.6	1970.3	1981.8	1975.60	43.34	24.87	2000.47	Flood
B50	B200	2.9	0.90	2.6	8.5	22.4	19.5	0.2	1.46	104.7	4.64	24	CP	48.9	15.6	206	1970.3	1960.7	1975.6	1966.20	69.99	44.09	2010.29	Flood
B40		0.0	0.00	0.0	0.0	22.4	19.7	0.3	1.46	104.7	4.41	24	CP	47.6	15.2	311	1960.7	1947.0	1966.2	1955.00	92.46	66.56	2021.56	Flood
B30		1.7	0.65	1.1	0.0	23.5	20.0	1.7	1.42	105.4	3.89	24	SPP	44.7	14.2	1489	1947.0	1889.1	1955.0	1894.60	349.03	322.79	2217.39	Flood
B20		9.2	0.65	6.0	0.0	29.5	21.8	0.1	1.40	113.3	3.53	30	SPP	77.3	15.7	119	1889.1	1884.9	1894.6	1890.40	21.49	9.07	1899.47	Flood
B18		0.0	0.00	0.0	0.0	29.5	21.9	0.1	1.40	113.3	4.09	30	SPP	83.1	16.9	93	1884.9	1881.1	1890.4	1886.60	19.51	7.09	1893.69	Flood
B16		0.0	0.00	0.0	0.0	29.5	22.0	0.2	1.36	112.1	1.18	30	SPP	44.6	9.1	102	1881.1	1879.9	1886.6	1885.40	19.77	7.61	1893.01	Flood
B14	B100	2.8	0.75	2.1	1.3	32.8	22.2	0.2	1.36	116.7	1.39	30	SPP	48.4	9.9	101	1879.9	1878.5	1885.4	1884.00	21.34	8.16	1892.16	Flood
B12		0.0	0.00	0.0	0.0	32.8	22.4	0.1	1.36	116.7	0.83	30	SPP	37.5	7.6	36	1878.5	1878.2	1884.0	1883.20	16.08	2.91	1886.11	Flood
B10		0.0	0.00	0.0	0.0	32.8	22.4	0.2	1.36	116.7	0.32	30	SPP	23.4	4.8	62	1878.2	1878.0	1883.2	1880.50	18.18	5.01	1885.51	Flood
B100		1.4	0.90	1.3	0.0	1.3	10.0	0.3	1.94	2.4	1.50	24	CP	27.8	8.9	133	1889.1	1887.1	1892.0	1885.40	0.03	0.02	1885.43	
B200		11.1	0.77	8.5	0.0	8.5	10.0	0.0	1.94	16.6	1.67	24	CP	29.3	9.3	12	1970.5	1970.3	1975.8	1975.60	0.71	0.06	1975.66	Surch.
B360		9.3	0.50	4.7	0.0	4.7	10.0	0.0	1.94	9.0	8.21	8	CP	3.5	9.9	27	2024.6	2022.4	2025.6	2023.80	30.61	15.03	2038.83	Flood
B350		0.0	0.00	0.0	0.0	4.7	10.0	0.0	1.94	9.0	5.67	10	CP	5.2	9.6	15	2021.8	2021.0	2023.8	2023.20	8.92	2.54	2025.74	Flood
B340		0.0	0.00	0.0	0.0	4.7	10.1	2.3	1.94	9.0	0.34	10	CP	1.3	2.4	329	2020.9	2019.7	2023.2	2022.40	62.11	55.73	2078.13	Flood
B330		6.6	0.58	3.8	0.0	8.4	12.4	0.1	1.80	15.2	2.15	12	SPP	5.2	6.7	55	2019.6	2018.4	2022.4	2020.80	18.74	10.00	2030.80	Flood
B320		0.0	0.00	0.0	0.0	8.4	12.5	0.0	1.80	15.2	10.48	12	SPP	11.6	14.7	14	2018.2	2016.8	2020.8	2020.00	11.28	2.55	2022.55	Flood
B310		0.0	0.00	0.0	0.0	8.4	12.5	0.8	1.80	15.2	2.61	12	SPP	5.8	7.4	359	2016.6	2007.2	2020.0	2010.20	74.03	65.30	2075.50	Flood
B300		4.3	0.65	2.8	0.0	11.2	13.4	0.1	1.75	19.7	0.98	12	SPP	3.5	4.5	39	2007.2	2006.8	2010.2	2010.40	26.51	11.88	2022.28	Flood
		235.3	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

MOUNTAIN CREEK - STORM TABULATION SHEET

10-YEAR STORM; EXISTING CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time- Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
*M120		146.0					30.0			48.0														
M122		1.3	0.65	0.8	0.0	0.8	10.0	0.1	1.94	1.6	12.87	18		37.8	21.4	151	1932.1	1912.7	1934.6	1937.80	0.06	0.04	1937.84	**Flood**
*M120	M130	0.0	0.45	0.0	4.6	5.4	30.0	1.0	1.26	54.8	3.63	18		20.1	11.4	649	1935.5	1911.9	1937.8	1915.00	198.90	176.47	2091.47	**Flood**
M118	M140	5.1	0.65	3.3	15.8	24.5	31.0	0.2	1.26	78.9	2.19	18		15.6	8.8	108	1911.6	1909.2	1915.0	1912.80	107.28	60.83	1973.63	**Flood**
M116		0.0	0.00	0.0	0.0	24.5	31.2	0.1	1.26	78.9	0.35	18		6.2	3.5	24	1908.3	***1908.2***	1912.8	1911.80	59.97	13.52	1925.32	**Flood**
M114		0.0	0.00	0.0	0.0	24.5	31.3	0.1	1.26	78.9	0.79	18		9.4	5.3	21	***1908.2***	1908.1	1911.8	1910.80	58.28	11.83	1922.63	**Flood**
M112		0.0	0.00	0.0	0.0	24.5	31.3	0.2	1.26	78.9	3.35	18		19.3	10.9	158	1908.1	1902.8	1910.8	1906.00	135.44	88.99	1994.99	**Flood**
M110		4.9	0.65	3.2	0.0	27.7	31.6	0.4	1.26	82.9	3.17	18		18.7	10.6	232	1902.8	***1895.4***	1906.0	1898.40	195.61	144.31	2042.71	**Flood**
M106		0.0	0.00	0.0	0.0	27.7	31.9	0.4	1.26	82.9	2.62	18		17.0	9.6	252	***1895.4***	***1888.8***	1898.4	1891.80	208.05	156.75	2048.55	**Flood**
M104		0.0	0.00	0.0	0.0	27.7	32.4	0.3	1.26	82.9	4.33	18		21.9	12.4	213	***1888.8***	1879.6	1891.8	1882.40	183.79	132.49	2014.89	**Flood**
M102		0.0	0.00	0.0	0.0	27.7	32.7	0.3	1.26	82.9	4.22	18		21.6	12.2	223	1879.6	***1870.2***	1882.4	1873.00	190.01	138.71	2011.71	**Flood**
M100		7.4	0.60	4.4	0.0	32.1	33.0	0.1	1.26	88.5	4.09	18		21.3	12.1	53	***1870.2***	1868.0	1873.0	1869.50	96.02	37.57	1907.07	**Flood**
M130		7.0	0.65	4.6	0.0	4.6	10.0	0.4	1.94	8.8	2.58	12		5.7	7.3	173	1939.9	1935.5	1941.6	1937.80	13.56	10.61	1948.41	**Flood**
M146		19.0	0.67	12.8	0.0	12.8	10.0	0.3	1.94	24.8	3.11	15		11.4	9.3	183	***1921.8***	1916.1	1921.8	1919.20	36.44	26.92	1946.12	**Flood**
M144		8.6	0.35	3.0	0.0	15.8	10.3	0.1	1.94	30.6	3.99	15		12.9	10.5	33	1916.1	1914.8	1919.2	1917.80	21.94	7.41	1925.21	**Flood**
M142		0.0	0.00	0.0	0.0	15.8	10.4	0.2	1.94	30.6	3.10	15		11.4	9.3	94	1914.8	1911.9	1917.8	1915.80	35.64	21.11	1936.91	**Flood**
M140		0.0	0.00	0.0	0.0	15.8	10.5	0.1	1.94	30.6	1.00	15		6.5	5.3	30	1911.9	***1911.6***	1915.8	1915.00	21.26	6.74	1921.74	**Flood**
		199.3	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

MOUNTAIN CREEK - STORM TABULATION SHEET
10-YEAR STORM; FUTURE CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time- Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
*M120		146.0					30.0			53.0														
M122		1.3	0.65	0.8	0.0	0.8	10.0	0.1	1.94	1.6	12.87	18		37.8	21.4	151	1932.1	1912.7	1934.6	1937.80	0.06	0.04	1937.84	**Flood**
*M120	M130	0.0	0.52	0.0	4.6	5.4	30.0	1.0	1.26	59.8	3.63	18		20.1	11.4	649	1935.5	1911.9	1937.8	1915.00	236.85	210.15	2125.15	**Flood**
M118	M140	5.1	0.65	3.3	19.8	28.5	31.0	0.2	1.26	88.9	2.19	18		15.6	8.8	108	1911.6	1909.2	1915.0	1912.80	136.36	77.32	1990.12	**Flood**
M116		0.0	0.00	0.0	0.0	28.5	31.2	0.1	1.26	88.9	0.35	18		6.2	3.5	24	1908.3	***1908.2***	1912.8	1911.80	76.22	17.18	1928.98	**Flood**
M114		0.0	0.00	0.0	0.0	28.5	31.3	0.1	1.26	88.9	0.79	18		9.4	5.3	21	***1908.2***	1908.1	1911.8	1910.80	74.08	15.03	1925.83	**Flood**
M112		0.0	0.00	0.0	0.0	28.5	31.3	0.2	1.26	88.9	3.35	18		19.3	10.9	158	1908.1	1902.8	1910.8	1906.00	172.16	113.12	2019.12	**Flood**
M110		4.9	0.65	3.2	0.0	31.7	31.6	0.4	1.26	92.9	3.17	18		18.7	10.6	232	1902.8	***1895.4***	1906.0	1898.40	245.92	181.43	2079.83	**Flood**
M106		0.0	0.00	0.0	0.0	31.7	31.9	0.4	1.26	92.9	2.62	18		17.0	9.6	252	***1895.4***	***1888.8***	1898.4	1891.80	261.56	197.07	2088.87	**Flood**
M104		0.0	0.00	0.0	0.0	31.7	32.4	0.3	1.26	92.9	4.33	18		21.9	12.4	213	***1888.8***	1879.6	1891.8	1882.40	231.06	166.57	2048.97	**Flood**
M102		0.0	0.00	0.0	0.0	31.7	32.7	0.3	1.26	92.9	4.22	18		21.6	12.2	223	1879.6	***1870.2***	1882.4	1873.00	238.88	174.39	2047.39	**Flood**
M100		7.4	0.70	5.2	0.0	36.9	33.0	0.1	1.26	99.5	4.09	18		21.3	12.1	53	***1870.2***	1868.0	1873.0	1869.50	121.34	47.47	1916.97	**Flood**
M130		7.0	0.65	4.6	0.0	4.6	10.0	0.4	1.94	8.8	2.58	12		5.7	7.3	173	1939.9	1935.5	1941.6	1937.80	13.56	10.61	1948.41	**Flood**
M146		19.0	0.73	13.8	0.0	13.8	10.0	0.3	1.94	26.7	3.11	15		11.4	9.3	183	***1921.8***	1916.1	1921.8	1919.20	42.35	31.29	1950.49	**Flood**
M144		8.6	0.70	6.0	0.0	19.8	10.3	0.1	1.94	38.4	3.99	15		12.9	10.5	33	1916.1	1914.8	1919.2	1917.80	34.49	11.65	1929.45	**Flood**
M142		0.0	0.00	0.0	0.0	19.8	10.4	0.2	1.94	38.4	3.10	15		11.4	9.3	94	1914.8	1911.9	1917.8	1915.80	56.03	33.19	1948.99	**Flood**
M140		0.0	0.00	0.0	0.0	19.8	10.5	0.1	1.94	38.4	1.00	15		6.5	5.3	30	1911.9	***1911.6***	1915.8	1915.00	33.43	10.59	1925.59	**Flood**
		199.3	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

ASHLAND CREEK - STORM TABULATION SHEET

10-YEAR STORM; EXISTING CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A142		7.7	0.44	3.4	0.0	3.4	10.0	1.2	1.94	6.6	0.64	15		5.2	4.2	312	***1793.0***	***1791.0***	1796.0	1794.00	3.90	3.23	1797.23	**Flood**
A140		5.1	0.44	2.2	0.0	5.6	11.2	0.3	1.88	10.6	1.10	12		3.7	4.8	91	***1791.0***	1790.0	1794.0	1793.00	12.27	8.03	1801.03	**Flood**
A138		21.3	0.51	10.8	0.0	16.4	11.5	0.7	1.88	30.9	0.73	12		3.0	3.9	165	1790.0	***1788.8***	1793.0	1791.80	159.60	123.61	1915.41	**Flood**
A136		0.0	0.00	0.0	0.0	16.4	12.3	0.5	1.80	29.5	0.83	12		3.3	4.2	132	***1788.8***	***1787.7***	1791.8	1791.20	123.64	90.65	1881.85	**Flood**
A134		0.0	0.00	0.0	0.0	16.4	12.8	0.2	1.80	29.5	3.24	12		6.4	8.2	74	***1787.7***	1785.3	1791.2	1788.80	83.81	50.82	1839.62	**Flood**
A132		0.0	0.00	0.0	0.0	16.4	12.9	0.4	1.80	29.5	1.70	18		13.8	7.8	176	1785.3	1782.3	1788.8	1785.80	20.42	13.91	1799.71	**Flood**
A130		3.6	0.38	1.4	0.0	17.8	13.3	0.6	1.75	31.1	0.90	24		21.6	6.9	249	1782.3	1780.1	1785.8	1783.80	6.99	4.71	1788.51	**Flood**
A128	A170	0.0	0.00	0.0	10.0	27.8	13.9	0.2	1.75	48.6	1.30	24		25.9	8.2	96	1780.1	1778.8	1783.8	1782.80	10.02	4.43	1787.23	**Flood**
A126	A160	5.7	0.29	1.7	0.8	30.2	14.1	0.0	1.70	51.4	3.00	24		39.3	12.5	30	1778.8	1777.9	1782.8	1782.40	7.79	1.55	1783.95	**Flood**
A124		0.0	0.00	0.0	0.0	30.2	14.2	0.1	1.70	51.4	1.15	24		24.3	7.7	64	1777.9	1777.2	1782.4	1782.00	9.54	3.30	1785.30	**Flood**
A122		0.0	0.00	0.0	0.0	30.2	14.3	0.5	1.70	51.4	1.13	24		24.1	7.7	253	1777.2	***1774.3***	1782.0	1776.80	19.29	13.05	1789.85	**Flood**
A120		0.0	0.00	0.0	0.0	30.2	14.8	0.0	1.70	51.4	1.47	24		27.5	8.7	25	***1774.3***	1773.9	1776.8	1776.60	7.53	1.29	1777.89	**Flood**
A118		10.0	0.35	3.5	0.0	33.7	14.9	0.0	1.70	57.4	3.11	24		40.0	12.7	30	1773.9	1773.0	1776.6	1776.00	9.70	1.93	1777.93	**Flood**
A116		0.0	0.00	0.0	0.0	33.7	14.9	0.0	1.70	57.4	2.05	24		32.5	10.3	26	1773.0	1772.5	1776.0	1775.80	9.44	1.67	1777.47	**Flood**
A114		0.0	0.00	0.0	0.0	33.7	15.0	0.5	1.70	57.4	1.94	24		31.6	10.1	296	1772.5	1766.7	1775.8	1769.80	26.78	19.01	1788.81	**Flood**
A112		3.5	0.50	1.8	0.0	35.5	15.5	0.2	1.65	58.6	0.70	24		18.9	6.0	86	1766.7	1766.1	1769.8	1769.20	13.86	5.76	1774.96	**Flood**
A110	A150	0.0	0.00	0.0	2.2	37.6	15.7	0.1	1.65	62.1	1.61	24		28.8	9.2	31	1766.1	1765.6	1769.2	1768.20	11.45	2.33	1770.53	**Flood**
A108		0.0	0.00	0.0	0.0	37.6	15.8	0.5	1.65	62.1	0.91	24		21.6	6.9	200	1765.6	***1763.8***	1768.2	1767.80	24.17	15.06	1782.86	**Flood**
A106		0.0	0.00	0.0	0.0	37.6	16.2	1.1	1.60	60.2	1.16	24		24.4	7.8	527	***1763.8***	1757.7	1767.8	1763.20	45.88	37.31	1800.51	**Flood**
A104		0.0	0.00	0.0	0.0	37.6	17.4	0.1	1.55	58.3	1.63	24		29.0	9.2	49	1757.7	1756.9	1763.2	1762.40	11.30	3.26	1765.66	**Flood**
A102		2.8	0.50	1.4	0.0	39.0	17.5	0.4	1.55	60.5	6.86	24		59.4	18.9	463	1756.9	1725.1	1762.4	1730.80	41.75	33.09	1763.89	**Flood**
A100		4.0	0.50	2.0	0.0	41.0	17.9	0.3	1.55	63.6	6.44	24		57.6	18.3	328	1725.1	1704.0	1730.8	1706.00	35.47	25.91	1731.91	**Flood**
A154		0.6	0.50	0.3	0.0	0.3	10.0	1.2	1.94	0.6	0.92	12		3.4	4.4	303	***1771.8***	***1769.0***	1773.8	1770.00	0.09	0.08	1770.09	
A152		0.0	0.00	0.0	0.0	0.3	11.2	1.0	1.88	0.6	0.44	12		2.4	3.0	183	***1768.0***	1767.2	1770.0	1769.20	0.06	0.05	1769.25	**Surch.**
A150		3.7	0.50	1.9	0.0	2.2	12.2	0.3	1.80	3.9	1.12	12		3.8	4.8	97	1767.2	1766.1	1769.2	1769.20	1.71	1.14	1770.34	**Flood**
A164		2.1	0.38	0.8	0.0	0.8	10.0	0.1	1.94	1.5	3.21	12		6.4	8.2	56	***1784.3***	1782.5	1787.0	1783.53	0.20	0.11	1783.73	
A162		0.0	0.00	0.0	0.0	0.8	10.1	0.4	1.94	1.5	1.83	12		4.8	6.2	164	1782.5	1779.5	1785.2	1782.20	0.40	0.31	1782.60	
A160		0.0	0.00	0.0	0.0	0.8	10.6	0.2	1.94	1.5	1.15	12		3.8	4.9	64	1779.5	1778.8	1782.2	1782.80	0.21	0.12	1782.92	**Flood**
A180		8.6	0.65	5.6	0.0	5.6	10.0	0.3	1.94	10.8	5.18	15		14.7	12.0	207	***1825.3***	1814.6	1828.6	1815.80	7.65	5.83	1823.45	
A178		0.0	0.00	0.0	0.0	5.6	10.3	0.5	1.94	10.8	4.01	15		13.0	10.6	319	1814.6	1801.8	1817.8	1805.00	10.80	8.98	1813.98	
A176		0.0	0.00	0.0	0.0	5.6	10.8	0.7	1.94	10.8	2.75	12		5.9	7.5	309	1801.8	1793.3	1805.0	1795.60	33.05	28.61	1824.21	**Flood**
A174		0.0	0.00	0.0	0.0	5.6	11.5	0.1	1.88	10.5	5.00	12		8.0	10.2	34	1794.1	1792.4	1795.6	1794.40	7.13	2.96	1797.36	**Flood**
A172		9.4	0.47	4.4	0.0	10.0	11.5	0.1	1.88	18.8	3.19	15		11.6	9.4	35	1792.4	***1791.3***	1794.4	1794.20	8.45	2.97	1797.17	**Flood**
A170		0.0	0.00	0.0	0.0	10.0	11.6	0.6	1.88	18.8	3.20	15		11.6	9.4	351	***1791.3***	1780.1	1794.2	1783.80	35.23	29.75	1813.55	**Flood**
		88.1	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

ASHLAND CREEK - STORM TABULATION SHEET

10-YEAR STORM; EXISTING CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A216		2.8	0.41	1.1	0.0	1.1	10.0	0.6	1.94	2.2	2.99	18		18.2	10.3	381	***1796.5***	1785.1	1799.2	1786.63	0.21	0.17	1786.84	
A214		0.0	0.00	0.0	0.0	1.1	10.6	0.4	1.94	2.2	3.16	18		18.7	10.6	268	1785.1	1776.7	1787.8	1778.17	0.16	0.12	1778.32	
A212		5.0	0.23	1.2	0.0	2.3	11.0	0.5	1.88	4.3	1.61	18		13.4	7.6	213	1776.7	1773.2	1780.0	1774.73	0.50	0.36	1775.23	
A210		6.6	0.26	1.7	0.0	4.0	11.5	0.5	1.88	7.5	1.83	18		14.2	8.1	265	1773.2	1768.4	1776.4	1769.88	1.79	1.37	1771.68	
A208		0.0	0.00	0.0	0.0	4.0	12.1	0.4	1.80	7.2	1.49	18		12.9	7.3	164	1768.4	1765.9	1771.8	1768.19	1.17	0.78	1769.36	
A206		6.8	0.44	3.0	0.0	7.0	12.4	0.1	1.80	12.6	2.52	18		16.7	9.5	49	1765.9	1764.7	1769.6	1767.49	1.89	0.71	1768.19	**Surch.**
A204		0.0	0.00	0.0	0.0	7.0	12.5	0.7	1.80	12.6	0.92	18		10.1	5.7	249	1764.7	1762.4	1768.2	1763.90	4.77	3.59	1767.49	**Surch.**
A202		3.6	0.41	1.5	0.0	8.5	13.2	0.1	1.75	14.8	7.03	18		27.9	15.8	55	1762.4	1758.5	1765.4	1760.03	2.74	1.10	1762.78	
A200		0.0	0.00	0.0	0.0	8.5	13.3	0.5	1.75	14.8	2.00	18		14.9	8.4	276	1758.5	1753.0	1763.2	1754.50	7.15	5.51	1760.01	
		24.8	Total Area																					
A322		4.7	0.35	1.6	0.0	1.6	10.0	0.8	1.94	3.2	2.43	15		10.1	8.2	389	1834.3	***1824.9***	1837.0	1826.15	1.11	0.95	1827.26	
A320		0.0	0.00	0.0	0.0	1.6	10.8	1.2	1.94	3.2	1.84	15		8.8	7.2	527	***1824.9***	***1815.2***	1827.4	1816.45	1.44	1.29	1817.89	
A318		0.0	0.00	0.0	0.0	1.6	12.0	0.2	1.80	3.0	3.07	15		11.3	9.2	88	***1815.2***	1812.5	1818.2	1813.75	0.32	0.18	1814.07	
A316		3.0	0.57	1.7	0.0	3.3	12.2	0.1	1.80	6.0	3.16	15		11.5	9.4	59	1812.5	1810.6	1817.0	1811.88	1.08	0.51	1812.96	
A314		0.0	0.00	0.0	0.0	3.3	12.3	0.5	1.80	6.0	3.16	21		28.3	11.7	355	1810.6	1799.4	1815.8	1801.15	0.66	0.51	1801.81	
A312		0.0	0.00	0.0	0.0	3.3	12.8	1.0	1.80	6.0	1.91	21		22.0	9.1	546	1799.4	1789.0	1804.4	1790.72	0.94	0.79	1791.65	
A310		4.2	0.50	2.1	0.0	5.5	13.8	0.8	1.75	9.6	2.25	21		23.8	9.9	461	1789.0	1778.6	1794.8	1780.37	2.05	1.68	1782.41	
A308		0.0	0.00	0.0	0.0	5.5	14.6	0.2	1.70	9.3	3.88	21		31.3	13.0	186	1778.6	***1771.4***	1783.2	1773.15	0.99	0.64	1774.14	
A306		0.0	0.00	0.0	0.0	5.5	14.8	0.4	1.70	9.3	4.68	21		34.4	14.3	305	***1771.4***	1757.1	1777.4	1758.88	1.40	1.05	1760.28	
A304		0.0	0.00	0.0	0.0	5.5	15.1	0.1	1.65	9.0	1.58	24		28.5	9.1	40	1757.1	***1756.5***	1763.8	1758.50	0.26	0.06	1758.76	
A302		0.0	0.00	0.0	0.0	5.5	15.2	0.4	1.65	9.0	1.59	24		28.6	9.1	227	***1756.5***	***1752.9***	1764.0	1754.90	0.55	0.36	1755.45	
A301		0.0	0.00	0.0	0.0	5.5	15.6	0.0	1.65	9.0	1.67	24		29.3	9.3	6	***1752.9***	***1752.8***	1758.0	1754.80	0.20	0.01	1754.81	
A300		2.6	0.65	1.7	0.0	7.2	15.6	0.4	1.65	11.8	1.60	24		28.7	9.1	200	***1752.8***	1749.6	1758.0	1751.60	0.87	0.54	1752.47	
		14.5	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

ASHLAND CREEK - STORM TABULATION SHEET

10-YEAR STORM; EXISTING CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A454		6.7	0.26	1.7	0.0	1.7	10.0	0.3	1.94	3.4	0.80	12		3.2	4.1	79	2082.7	2082.1	2085.2	2083.10	1.13	0.70	2083.80	Surch.
A452		0.0	0.00	0.0	0.0	1.7	10.3	0.1	1.94	3.4	0.76	12		3.1	4.0	22	2082.1	2081.9	2085.4	2082.90	0.62	0.20	2083.10	Surch.
A450		0.0	0.00	0.0	0.0	1.7	10.4	0.1	1.94	3.4	3.08	12		6.3	8.0	26	2081.9	2081.1	2086.4	2082.10	0.66	0.23	2082.76	
A448		0.0	0.00	0.0	0.0	1.7	10.5	0.4	1.94	3.4	5.11	18		23.8	13.5	301	2080.6	2065.2	2083.6	2066.73	0.39	0.31	2067.13	
A446		0.0	0.00	0.0	0.0	1.7	10.8	0.2	1.94	3.4	7.55	18		28.9	16.4	187	2065.2	2051.1	2069.4	2052.62	0.28	0.19	2052.89	
A444		10.3	0.26	2.7	0.0	4.4	11.0	0.3	1.88	8.3	8.56	18		30.8	17.4	307	2051.1	2024.8	2055.2	2026.33	2.41	1.90	2028.74	
A442		0.0	0.00	0.0	0.0	4.4	11.3	0.3	1.88	8.3	7.68	18		29.2	16.5	317	2024.8	2000.5	2029.0	2001.98	2.47	1.96	2004.45	
A440		14.9	0.34	5.0	0.0	9.4	11.6	0.3	1.88	17.6	8.33	18		30.4	17.2	264	2000.5	1978.5	2004.4	1980.00	9.77	7.44	1989.77	
A438		0.0	0.00	0.0	0.0	9.4	11.9	0.3	1.88	17.6	6.82	18		27.5	15.6	255	1978.5	1961.1	1982.0	1963.14	9.52	7.19	1972.66	
A436		12.0	0.33	3.9	0.0	13.3	12.2	0.0	1.80	23.9	5.38	18		24.4	13.8	22	1960.4	1959.3	1963.6	1962.00	5.42	1.14	1963.14	Surch.
A434		0.0	0.00	0.0	0.0	13.3	12.2	0.2	1.80	23.9	10.46	15		20.9	17.1	223	1959.3	1935.9	1962.0	1938.60	39.47	30.59	1969.19	Flood
A432		0.0	0.00	0.0	0.0	13.3	12.4	0.2	1.80	23.9	8.47	15		18.9	15.4	196	1935.9	1919.3	1938.6	1922.00	35.76	26.89	1948.89	Flood
A430		0.0	0.00	0.0	0.0	13.3	12.6	0.3	1.80	23.9	6.88	15		17.0	13.8	221	1919.3	1904.1	1922.0	1906.80	39.19	30.32	1937.12	Flood
A428		12.3	0.47	5.8	0.0	19.1	12.9	0.3	1.80	34.3	6.97	15		17.1	13.9	223	1904.1	1888.6	1906.8	1891.60	81.24	62.98	1954.58	Flood
A426		8.4	0.61	5.1	0.0	24.2	13.2	0.1	1.75	42.3	6.41	15		16.4	13.4	64	1888.6	1884.5	1891.6	1888.00	55.08	27.40	1915.40	Flood
A424		0.0	0.00	0.0	0.0	24.2	13.2	0.3	1.75	42.3	5.89	18		25.6	14.5	235	1884.5	1870.7	1888.0	1875.40	51.39	38.04	1913.44	Flood
A422		3.1	0.76	2.4	0.0	26.5	13.5	0.3	1.75	46.4	7.46	12		9.8	12.4	250	1870.7	1852.0	1875.4	1859.00	505.18	423.77	2282.77	Flood
A420		0.0	0.00	0.0	0.0	26.5	13.9	0.1	1.75	46.4	2.22	12		5.3	6.8	60	1852.0	1850.7	1859.0	1856.00	183.12	101.70	1957.70	Flood
A418		0.0	0.00	0.0	0.0	26.5	14.0	0.4	1.75	46.4	2.50	12		5.7	7.2	171	1850.7	1846.4	1856.0	1852.80	371.27	289.86	2142.66	Flood
A416		0.0	0.00	0.0	0.0	26.5	14.4	1.9	1.70	45.1	0.27	12		1.9	2.4	264	1846.4	1845.7	1852.8	1850.00	499.12	422.29	2272.29	Flood
A414	A470	7.3	0.61	4.4	15.4	46.3	16.3	0.1	1.60	74.1	2.39	24		35.0	11.2	88	1845.7	1843.6	1850.0	1850.40	22.40	9.43	1859.83	Flood
A412		4.0	0.61	2.4	0.0	48.7	16.4	0.1	1.60	78.0	6.22	24		56.6	18.0	56	1843.6	1840.1	1850.4	1850.00	21.00	6.64	1856.64	Flood
A410		0.0	0.00	0.0	0.0	48.7	16.4	0.1	1.60	78.0	3.47	24		42.3	13.5	48	1840.1	1838.4	1850.0	1848.00	20.05	5.70	1853.70	Flood
A408		0.0	0.00	0.0	0.0	48.7	16.5	0.8	1.60	78.0	0.69	24		18.8	6.0	273	1838.4	1836.5	1848.0	1846.20	46.75	32.39	1878.59	Flood
A406		0.0	0.00	0.0	0.0	48.7	17.3	0.7	1.55	75.5	0.60	24		17.5	5.6	235	1836.5	1835.1	1846.2	1842.80	39.64	26.17	1868.97	Flood
A404		3.7	0.90	3.3	0.0	52.1	18.0	0.2	1.55	80.7	0.73	24		19.3	6.2	78	1835.1	1834.6	1842.8	1841.40	25.29	9.91	1851.31	Flood
A402		0.0	0.00	0.0	0.0	52.1	18.2	0.3	1.50	78.1	4.71	24		49.2	15.7	285	1834.6	1821.2	1841.4	1831.40	48.33	33.92	1865.32	Flood
A400		0.0	0.00	0.0	0.0	52.1	18.5	0.3	1.50	78.1	1.01	18		10.6	6.0	114	1821.2	1820.0	1831.4	1821.50	108.46	62.93	1884.43	Flood
A482		11.9	0.45	5.4	0.0	5.4	10.0	0.1	1.94	10.4	3.96	12		7.1	9.1	53	1889.1	1887.0	1891.6	1891.00	8.66	4.54	1895.54	Flood
A480		0.0	0.00	0.0	0.0	5.4	10.1	0.4	1.94	10.4	4.64	12		7.7	9.8	252	1887.0	1875.3	1891.0	1877.80	25.72	21.60	1899.40	Flood
A478		0.0	0.00	0.0	0.0	5.4	10.5	0.3	1.94	10.4	4.49	12		7.6	9.6	181	1875.3	1867.2	1877.8	1869.00	19.63	15.51	1884.51	Flood
A476		18.3	0.51	9.4	0.0	14.7	10.8	0.1	1.94	28.6	7.50	12		9.8	12.5	38	1867.2	1864.3	1869.0	1867.40	55.44	24.49	1891.89	Flood
A474		0.0	0.00	0.0	0.0	14.7	10.9	0.4	1.94	28.6	4.13	12		7.3	9.2	225	1864.3	1855.0	1867.4	1857.60	175.94	144.99	2002.59	Flood
A472		0.0	0.00	0.0	0.0	14.7	11.3	0.3	1.88	27.7	4.16	12		7.3	9.3	187	1855.0	1847.2	1857.6	1850.40	142.23	113.16	1963.56	Flood
A470		0.8	0.78	0.6	0.0	15.4	11.6	0.0	1.88	28.9	5.22	12		8.2	10.4	30	1847.2	1845.7	1850.4	1850.00	51.27	19.71	1869.71	Flood
		113.7	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

ASHLAND CREEK - STORM TABULATION SHEET
10-YEAR STORM; EXISTING CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A622		17.8	0.28	5.1	0.0	5.1	10.0	0.1	1.94	9.8	17.70	12		15.0	19.1	165	2048.1	2018.9	2050.6	2019.90	16.13	12.49	2036.03	
A620		0.0	0.00	0.0	0.0	5.1	10.1	0.2	1.94	9.8	16.67	12		14.6	18.6	168	2018.9	1990.9	2021.4	1991.90	16.36	12.72	2008.26	
A618		0.0	0.00	0.0	0.0	5.1	10.3	0.1	1.94	9.8	15.69	12		14.2	18.0	137	1990.9	1969.4	1993.4	1970.73	14.01	10.37	1984.74	
A616		0.0	0.00	0.0	0.0	5.1	10.4	0.0	1.94	9.8	11.36	12		12.0	15.3	44	1969.4	***1964.4***	1972.4	1967.40	6.97	3.33	1970.73	**Surch.**
A614		4.8	0.44	2.1	0.0	7.2	10.5	0.2	1.94	13.9	12.93	12		12.8	16.4	235	***1964.4***	1934.0	1967.4	1936.60	43.07	35.76	1972.36	**Flood**
A612		0.0	0.00	0.0	0.0	7.2	10.7	0.3	1.94	13.9	8.76	12		10.6	13.5	210	1934.0	1915.6	1936.6	1918.20	39.27	31.96	1950.16	**Flood**
A610		10.7	0.44	4.7	0.0	11.9	11.0	0.0	1.94	23.0	11.15	12		11.9	15.2	45	1915.6	1910.6	1918.2	1915.60	38.87	18.80	1934.40	**Flood**
A608		0.0	0.00	0.0	0.0	11.9	11.0	0.4	1.88	22.3	6.71	12		9.3	11.8	294	1910.6	1890.9	1915.6	1894.20	134.19	115.35	2009.55	**Flood**
A606		0.0	0.00	0.0	0.0	11.9	11.4	0.1	1.88	22.3	3.44	12		6.6	8.4	60	1890.9	1888.8	1894.2	1891.80	42.38	23.54	1915.34	**Flood**
A604		0.0	0.00	0.0	0.0	11.9	11.6	0.0	1.88	22.3	5.19	12		8.1	10.4	18	1888.8	1887.9	1891.8	1891.20	25.91	7.06	1898.26	**Flood**
A602		0.0	0.00	0.0	0.0	11.9	11.6	0.0	1.88	22.3	6.98	12		9.4	12.0	21	1887.9	***1886.4***	1891.2	1891.40	27.08	8.24	1899.64	**Flood**
A600		4.3	0.60	2.6	0.0	14.5	11.6	0.2	1.88	27.2	9.61	12		11.1	14.1	129	***1886.4***	1874.0	1891.4	1875.00	102.91	74.99	1949.99	**Flood**
		37.6	Total Area																					
A724		45.3	0.25	11.3	0.0	11.3	10.0	0.1	1.94	21.9	3.20	18		18.8	10.7	51	1958.1	1956.4	1963.4	1961.60	5.81	2.22	1963.82	**Flood**
A722		0.0	0.00	0.0	0.0	11.3	10.1	0.4	1.94	21.9	3.19	15	PVC	11.6	9.4	224	1956.4	1949.3	1961.6	1952.31	33.23	25.79	1978.10	**Flood**
A720		0.0	0.00	0.0	0.0	11.3	10.5	0.3	1.94	21.9	4.12	18	CONC	21.4	12.1	223	1949.3	1940.1	1953.2	1942.60	13.30	9.71	1952.31	**Surch.**
A718		3.5	0.50	1.8	0.0	13.1	10.8	0.2	1.94	25.3	4.88	18		23.3	13.2	170	1938.1	1929.8	1942.6	1934.80	14.66	9.87	1944.67	**Flood**
A716		0.0	0.00	0.0	0.0	13.1	11.0	0.2	1.94	25.3	4.42	18		22.1	12.5	149	1929.8	1923.2	1934.8	1926.23	13.44	8.65	1934.88	**Flood**
A714		29.3	0.33	9.6	0.0	22.6	11.2	0.2	1.88	42.6	0.17	24		9.3	2.9	30	1923.2	1923.2	1927.8	1925.17	5.35	1.06	1926.23	**Surch.**
A712		0.0	0.00	0.0	0.0	22.6	11.4	0.2	1.88	42.6	3.72	24		43.7	13.9	186	1921.6	1914.7	1926.0	1916.94	10.87	6.58	1923.52	
A710		0.0	0.00	0.0	0.0	22.6	11.6	0.2	1.88	42.6	5.87	24		55.0	17.5	168	1914.7	1904.8	1920.0	1910.99	10.23	5.95	1916.94	**Surch.**
A708		4.5	0.44	2.0	0.0	24.6	11.7	0.0	1.88	46.3	3.60	24		43.0	13.7	25	1904.8	***1903.9***	1912.8	1909.94	6.11	1.05	1910.99	**Surch.**
A706		0.0	0.00	0.0	0.0	24.6	11.8	0.1	1.88	46.3	3.51	24		42.5	13.5	56	***1903.9***	1901.9	1911.4	1907.60	7.41	2.34	1909.94	**Surch.**
A704		0.0	0.00	0.0	0.0	24.6	11.8	0.2	1.88	46.3	6.76	18		27.4	15.5	162	1901.9	1891.0	1907.6	1894.40	47.46	31.45	1925.85	**Flood**
A702		0.0	0.00	0.0	0.0	24.6	12.0	0.1	1.80	44.3	9.10	18		31.8	18.0	109	1891.0	1881.1	1894.4	1884.34	34.07	19.40	1903.74	**Flood**
A700		1.9	0.56	1.1	0.0	25.7	12.1	0.0	1.80	46.2	12.27	18		36.9	20.9	25	1881.1	1878.0	1885.4	1879.50	20.81	4.84	1884.34	**Surch.**
		84.5	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

ASHLAND CREEK - STORM TABULATION SHEET

10-YEAR STORM; FUTURE CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A142		7.7	0.50	3.9	0.0	3.9	10.0	1.2	1.94	7.5	0.64	15		5.2	4.2	312	*1793.0*	*1791.0*	1796.0	1794.00	5.03	4.17	1798.17	Flood
A140		5.1	0.50	2.6	0.0	6.4	11.2	0.3	1.88	12.0	1.10	12		3.7	4.8	91	*1791.0*	1790.0	1794.0	1793.00	15.84	10.37	1803.37	Flood
A138		21.3	0.54	11.5	0.0	17.9	11.5	0.7	1.88	33.7	0.73	12		3.0	3.9	165	1790.0	*1788.8*	1793.0	1791.80	189.94	147.12	1938.92	Flood
A136		0.0	0.00	0.0	0.0	17.9	12.3	0.5	1.80	32.2	0.83	12		3.3	4.2	132	*1788.8*	*1787.7*	1791.8	1791.20	147.15	107.89	1899.09	Flood
A134		0.0	0.00	0.0	0.0	17.9	12.8	0.2	1.80	32.2	3.24	12		6.4	8.2	74	*1787.7*	1785.3	1791.2	1788.80	99.74	60.48	1849.28	Flood
A132		0.0	0.00	0.0	0.0	17.9	12.9	0.4	1.80	32.2	1.70	18		13.8	7.8	176	1785.3	1782.3	1788.8	1785.80	24.30	16.55	1802.35	Flood
A130		3.6	0.50	1.8	0.0	19.7	13.3	0.6	1.75	34.5	0.90	24		21.6	6.9	249	1782.3	1780.1	1785.8	1783.80	8.59	5.78	1789.58	Flood
A128	A170	0.0	0.00	0.0	10.7	30.4	13.9	0.2	1.75	53.2	1.30	24		25.9	8.2	96	1780.1	1778.8	1783.8	1782.80	12.01	5.31	1788.11	Flood
A126	A160	5.7	0.50	2.9	1.1	34.3	14.1	0.0	1.70	58.3	3.00	24		39.3	12.5	30	1778.8	1777.9	1782.8	1782.40	10.04	1.99	1784.39	Flood
A124		0.0	0.00	0.0	0.0	34.3	14.2	0.1	1.70	58.3	1.15	24		24.3	7.7	64	1777.9	1777.2	1782.4	1782.00	12.30	4.25	1786.25	Flood
A122		0.0	0.00	0.0	0.0	34.3	14.3	0.5	1.70	58.3	1.13	24		24.1	7.7	253	1777.2	*1774.3*	1782.0	1776.80	24.86	16.82	1793.62	Flood
A120		0.0	0.00	0.0	0.0	34.3	14.8	0.0	1.70	58.3	1.47	24		27.5	8.7	25	*1774.3*	1773.9	1776.8	1776.60	9.71	1.66	1778.26	Flood
A118		10.0	0.50	5.0	0.0	39.3	14.9	0.0	1.70	66.8	3.11	24		40.0	12.7	30	1773.9	1773.0	1776.6	1776.00	13.18	2.62	1778.62	Flood
A116		0.0	0.00	0.0	0.0	39.3	14.9	0.0	1.70	66.8	2.05	24		32.5	10.3	26	1773.0	1772.5	1776.0	1775.80	12.83	2.27	1778.07	Flood
A114		0.0	0.00	0.0	0.0	39.3	15.0	0.5	1.70	66.8	1.94	24		31.6	10.1	296	1772.5	1766.7	1775.8	1769.80	36.38	25.82	1795.62	Flood
A112		3.5	0.50	1.8	0.0	41.1	15.5	0.2	1.65	67.8	0.70	24		18.9	6.0	86	1766.7	1766.1	1769.8	1769.20	18.56	7.71	1776.91	Flood
A110	A150	0.0	0.00	0.0	2.2	43.2	15.7	0.1	1.65	71.3	1.61	24		28.8	9.2	31	1766.1	1765.6	1769.2	1768.20	15.10	3.08	1771.28	Flood
A108		0.0	0.00	0.0	0.0	43.2	15.8	0.5	1.65	71.3	0.91	24		21.6	6.9	200	1765.6	*1763.8*	1768.2	1767.80	31.88	19.86	1787.66	Flood
A106		0.0	0.00	0.0	0.0	43.2	16.2	1.1	1.60	69.2	1.16	24		24.4	7.8	527	*1763.8*	1757.7	1767.8	1763.20	60.51	49.21	1812.41	Flood
A104		0.0	0.00	0.0	0.0	43.2	17.4	0.1	1.55	67.0	1.63	24		29.0	9.2	49	1757.7	1756.9	1763.2	1762.40	14.90	4.29	1766.69	Flood
A102		2.8	0.50	1.4	0.0	44.6	17.5	0.4	1.55	69.2	6.86	24		59.4	18.9	463	1756.9	1725.1	1762.4	1730.80	54.55	43.24	1774.04	Flood
A100		4.0	0.50	2.0	0.0	46.6	17.9	0.3	1.55	72.3	6.44	24		57.6	18.3	328	1725.1	1704.0	1730.8	1706.00	45.78	33.44	1739.44	Flood
A154		0.6	0.50	0.3	0.0	0.3	10.0	1.2	1.94	0.6	0.92	12		3.4	4.4	303	*1771.8*	*1769.0*	1773.8	1770.00	0.09	0.08	1770.09	
A152		0.0	0.00	0.0	0.0	0.3	11.2	1.0	1.88	0.6	0.44	12		2.4	3.0	183	*1768.0*	1767.2	1770.0	1769.20	0.06	0.05	1769.25	Surch.
A150		3.7	0.50	1.9	0.0	2.2	12.2	0.3	1.80	3.9	1.12	12		3.8	4.8	97	1767.2	1766.1	1769.2	1769.20	1.71	1.14	1770.34	Flood
A164		2.1	0.50	1.1	0.0	1.1	10.0	0.1	1.94	2.0	3.21	12		6.4	8.2	56	*1784.3*	1782.5	1787.0	1783.53	0.34	0.18	1783.87	
A162		0.0	0.00	0.0	0.0	1.1	10.1	0.4	1.94	2.0	1.83	12		4.8	6.2	164	1782.5	1779.5	1785.2	1782.20	0.69	0.54	1782.89	
A160		0.0	0.50	0.0	0.0	1.1	10.6	0.2	1.94	2.0	1.15	12		3.8	4.9	64	1779.5	1778.8	1782.2	1782.80	0.37	0.21	1783.01	Flood
A180		8.6	0.70	6.0	0.0	6.0	10.0	0.3	1.94	11.7	5.18	15		14.7	12.0	207	*1825.3*	1814.6	1828.6	1815.80	8.87	6.76	1824.67	
A178		0.0	0.00	0.0	0.0	6.0	10.3	0.5	1.94	11.7	4.01	15		13.0	10.6	319	1814.6	1801.8	1817.8	1805.00	12.53	10.42	1815.42	
A176		0.0	0.00	0.0	0.0	6.0	10.8	0.7	1.94	11.7	2.75	12		5.9	7.5	309	1801.8	1793.3	1805.0	1795.60	38.33	33.18	1828.78	Flood
A174		0.0	0.00	0.0	0.0	6.0	11.5	0.1	1.88	11.3	5.00	12		8.0	10.2	34	1794.1	1792.4	1795.6	1794.40	8.27	3.43	1797.83	Flood
A172		9.4	0.50	4.7	0.0	10.7	11.5	0.1	1.88	20.2	3.19	15		11.6	9.4	35	1792.4	*1791.3*	1794.4	1794.20	9.69	3.40	1797.60	Flood
A170		0.0	0.00	0.0	0.0	10.7	11.6	0.6	1.88	20.2	3.20	15		11.6	9.4	351	*1791.3*	1780.1	1794.2	1783.80	40.43	34.14	1817.94	Flood
		88.1	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN																								
ASHLAND CREEK - STORM TABULATION SHEET																								
10-YEAR STORM; FUTURE CONDITIONS																								
System Labels		**Runoff Area**					**Hydrologic Calculations**				**System Inventory**									**Hydraulic Calculations**				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A216		2.8	0.50	1.4	0.0	1.4	10.0	0.6	1.94	2.7	2.99	18		18.2	10.3	381	***1796.5***	1785.1	1799.2	1786.63	0.31	0.25	1786.94	
A214		0.0	0.00	0.0	0.0	1.4	10.6	0.4	1.94	2.7	3.16	18		18.7	10.6	268	1785.1	1776.7	1787.8	1778.17	0.23	0.18	1778.40	
A212		5.0	0.50	2.5	0.0	3.9	11.0	0.5	1.88	7.3	1.61	18		13.4	7.6	213	1776.7	1773.2	1780.0	1776.20	1.44	1.04	1777.64	
A210		6.6	0.50	3.3	0.0	7.2	11.5	0.5	1.88	13.5	1.83	18		14.2	8.1	265	1773.2	1768.4	1776.4	1771.80	5.77	4.40	1776.20	**Surch.**
A208		0.0	0.00	0.0	0.0	7.2	12.1	0.4	1.80	13.0	1.49	18		12.9	7.3	164	1768.4	1765.9	1771.8	1769.60	3.75	2.49	1772.09	**Flood**
A206		6.8	0.50	3.4	0.0	10.6	12.4	0.1	1.80	19.1	2.52	18		16.7	9.5	49	1765.9	1764.7	1769.6	1768.20	4.33	1.62	1769.82	**Flood**
A204		0.0	0.00	0.0	0.0	10.6	12.5	0.7	1.80	19.1	0.92	18		10.1	5.7	249	1764.7	1762.4	1768.2	1765.40	10.93	8.21	1773.61	**Flood**
A202		3.6	0.50	1.8	0.0	12.4	13.2	0.1	1.75	21.7	7.03	18		27.9	15.8	55	1762.4	1758.5	1765.4	1763.20	5.86	2.35	1765.55	**Flood**
A200		0.0	0.00	0.0	0.0	12.4	13.3	0.5	1.75	21.7	2.00	18		14.9	8.4	276	1758.5	1753.0	1763.2	1754.50	15.29	11.77	1766.27	**Flood**
		24.8	Total Area																					
A322		4.7	0.90	4.2	0.0	4.2	10.0	0.8	1.94	8.2	2.43	15		10.1	8.2	389	1834.3	***1824.9***	1837.0	1826.15	7.32	6.27	1833.47	
A320		0.0	0.00	0.0	0.0	4.2	10.8	1.2	1.94	8.2	1.84	15		8.8	7.2	527	***1824.9***	***1815.2***	1827.4	1816.45	9.54	8.50	1825.99	
A318		0.0	0.00	0.0	0.0	4.2	12.0	0.2	1.80	7.6	3.07	15		11.3	9.2	88	***1815.2***	1812.5	1818.2	1813.75	2.12	1.22	1815.87	
A316		3.0	0.66	2.0	0.0	6.2	12.2	0.1	1.80	11.2	3.16	15		11.5	9.4	59	1812.5	1810.6	1817.0	1811.88	3.70	1.77	1813.65	
A314		0.0	0.00	0.0	0.0	6.2	12.3	0.5	1.80	11.2	3.16	21		28.3	11.7	355	1810.6	1799.4	1815.8	1801.15	2.27	1.77	1803.42	
A312		0.0	0.00	0.0	0.0	6.2	12.8	1.0	1.80	11.2	1.91	21		22.0	9.1	546	1799.4	1789.0	1804.4	1790.72	3.22	2.72	1793.94	
A310		4.2	0.58	2.4	0.0	8.6	13.8	0.8	1.75	15.1	2.25	21		23.8	9.9	461	1789.0	1778.6	1794.8	1780.37	5.12	4.20	1785.49	
A308		0.0	0.00	0.0	0.0	8.6	14.6	0.2	1.70	14.7	3.88	21		31.3	13.0	186	1778.6	***1771.4***	1783.2	1773.15	2.47	1.60	1775.62	
A306		0.0	0.00	0.0	0.0	8.6	14.8	0.4	1.70	14.7	4.68	21		34.4	14.3	305	***1771.4***	1757.1	1777.4	1758.88	3.49	2.62	1762.38	
A304		0.0	0.00	0.0	0.0	8.6	15.1	0.1	1.65	14.3	1.58	24		28.5	9.1	40	1757.1	***1756.5***	1763.8	1758.50	0.64	0.16	1758.66	
A302		0.0	0.00	0.0	0.0	8.6	15.2	0.4	1.65	14.3	1.59	24		28.6	9.1	227	***1756.5***	***1752.9***	1764.0	1754.90	1.38	0.90	1756.28	
A301		0.0	0.00	0.0	0.0	8.6	15.6	0.0	1.65	14.3	1.67	24		29.3	9.3	6	***1752.9***	***1752.8***	1758.0	1754.80	0.50	0.02	1754.82	
A300		2.6	0.70	1.8	0.0	10.5	15.6	0.4	1.65	17.3	1.60	24		28.7	9.1	200	***1752.8***	1749.6	1758.0	1751.60	1.87	1.16	1753.47	
		14.5	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

ASHLAND CREEK - STORM TABULATION SHEET
10-YEAR STORM; FUTURE CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A454		6.7	0.40	2.6	0.0	2.6	10.0	0.3	1.94	5.1	0.80	12		3.2	4.1	79	***2082.7***	2082.1	2085.2	2083.36	2.64	1.64	2085.00	**Surch.**
A452		0.0	0.00	0.0	0.0	2.6	10.3	0.1	1.94	5.1	0.76	12		3.1	4.0	22	2082.1	***2081.9***	2085.4	2082.90	1.45	0.46	2083.36	**Surch.**
A450		0.0	0.00	0.0	0.0	2.6	10.4	0.1	1.94	5.1	3.08	12		6.3	8.0	26	***2081.9***	2081.1	2086.4	2082.10	1.54	0.54	2082.64	
A448		0.0	0.00	0.0	0.0	2.6	10.5	0.4	1.94	5.1	5.11	18		23.8	13.5	301	2080.6	2065.2	2083.6	2066.73	0.92	0.72	2067.65	
A446		0.0	0.00	0.0	0.0	2.6	10.8	0.2	1.94	5.1	7.55	18		28.9	16.4	187	2065.2	2051.1	2069.4	2052.62	0.64	0.45	2053.26	
A444		10.3	0.40	4.1	0.0	6.7	11.0	0.3	1.88	12.6	8.56	18		30.8	17.4	307	2051.1	2024.8	2055.2	2026.33	5.62	4.43	2031.95	
A442		0.0	0.00	0.0	0.0	6.7	11.3	0.3	1.88	12.6	7.68	18		29.2	16.5	317	2024.8	2000.5	2029.0	2001.98	5.76	4.57	2007.75	
A440		14.9	0.43	6.3	0.0	13.0	11.6	0.3	1.88	24.5	8.33	18		30.4	17.2	264	2000.5	1978.5	2004.4	1980.00	18.88	14.38	1998.88	
A438		0.0	0.00	0.0	0.0	13.0	11.9	0.3	1.88	24.5	6.82	18		27.5	15.6	255	1978.5	1961.1	1982.0	1963.60	18.39	13.89	1977.49	
A436		12.0	0.41	4.9	0.0	18.0	12.2	0.0	1.80	32.3	5.38	18		24.4	13.8	22	1960.4	1959.3	1963.6	1962.00	9.90	2.08	1964.08	**Flood**
A434		0.0	0.00	0.0	0.0	18.0	12.2	0.2	1.80	32.3	10.46	15		20.9	17.1	223	1959.3	***1935.9***	1962.0	1938.60	72.05	55.85	1994.45	**Flood**
A432		0.0	0.00	0.0	0.0	18.0	12.4	0.2	1.80	32.3	8.47	15		18.9	15.4	196	***1935.9***	***1919.3***	1938.6	1922.00	65.29	49.09	1971.09	**Flood**
A430		0.0	0.00	0.0	0.0	18.0	12.6	0.3	1.80	32.3	6.88	15		17.0	13.8	221	***1919.3***	1904.1	1922.0	1906.80	71.55	55.35	1962.15	**Flood**
A428		12.3	0.50	6.2	0.0	24.1	12.9	0.3	1.80	43.4	6.97	15		17.1	13.9	223	1904.1	***1888.6***	1906.8	1891.60	129.81	100.63	1992.23	**Flood**
A426		8.4	0.65	5.5	0.0	29.6	13.2	0.1	1.75	51.8	6.41	15		16.4	13.4	64	***1888.6***	***1884.5***	1891.6	1888.00	82.55	41.06	1929.06	**Flood**
A424		0.0	0.00	0.0	0.0	29.6	13.2	0.3	1.75	51.8	5.89	18		25.6	14.5	235	***1884.5***	1870.7	1888.0	1875.40	77.02	57.01	1932.41	**Flood**
A422		3.1	0.90	2.8	0.0	32.4	13.5	0.3	1.75	56.6	7.46	12		9.8	12.4	250	1870.7	1852.0	1875.4	1859.00	752.69	631.39	2490.39	**Flood**
A420		0.0	0.00	0.0	0.0	32.4	13.9	0.1	1.75	56.6	2.22	12		5.3	6.8	60	1852.0	1850.7	1859.0	1856.00	272.83	151.53	2007.53	**Flood**
A418		0.0	0.00	0.0	0.0	32.4	14.0	0.4	1.75	56.6	2.50	12		5.7	7.2	171	1850.7	1846.4	1856.0	1852.80	553.17	431.87	2284.67	**Flood**
A416		0.0	0.00	0.0	0.0	32.4	14.4	1.9	1.70	55.0	0.27	12		1.9	2.4	264	1846.4	1845.7	1852.8	1850.00	743.66	629.19	2479.19	**Flood**
A414	A470	7.3	0.65	4.7	18.1	55.2	16.3	0.1	1.60	88.3	2.39	24		35.0	11.2	88	1845.7	1843.6	1850.0	1850.40	31.83	13.40	1863.80	**Flood**
A412		4.0	0.65	2.6	0.0	57.8	16.4	0.1	1.60	92.5	6.22	24		56.6	18.0	56	1843.6	1840.1	1850.4	1850.00	29.55	9.35	1859.35	**Flood**
A410		0.0	0.00	0.0	0.0	57.8	16.4	0.1	1.60	92.5	3.47	24		42.3	13.5	48	1840.1	1838.4	1850.0	1848.00	28.22	8.01	1856.01	**Flood**
A408		0.0	0.00	0.0	0.0	57.8	16.5	0.8	1.60	92.5	0.69	24		18.8	6.0	273	1838.4	***1836.5***	1848.0	1846.20	65.78	45.58	1891.78	**Flood**
A406		0.0	0.00	0.0	0.0	57.8	17.3	0.7	1.55	89.6	0.60	24		17.5	5.6	235	***1836.5***	***1835.1***	1846.2	1842.80	55.78	36.82	1879.62	**Flood**
A404		3.7	0.90	3.3	0.0	61.1	18.0	0.2	1.55	94.7	0.73	24		19.3	6.2	78	***1835.1***	1834.6	1842.8	1841.40	34.88	13.67	1855.07	**Flood**
A402		0.0	0.00	0.0	0.0	61.1	18.2	0.3	1.50	91.7	4.71	24		49.2	15.7	285	1834.6	1821.2	1841.4	1831.40	66.64	46.77	1878.17	**Flood**
A400		0.0	0.00	0.0	0.0	61.1	18.5	0.3	1.50	91.7	1.01	18		10.6	6.0	114	1821.2	1820.0	1831.4	1821.50	149.56	86.78	1908.28	**Flood**
A482		11.9	0.56	6.7	0.0	6.7	10.0	0.1	1.94	12.9	3.96	12		7.1	9.1	53	1889.1	***1887.0***	1891.6	1891.00	13.29	6.97	1897.97	**Flood**
A480		0.0	0.00	0.0	0.0	6.7	10.1	0.4	1.94	12.9	4.64	12		7.7	9.8	252	***1887.0***	***1875.3***	1891.0	1877.80	39.47	33.15	1910.95	**Flood**
A478		0.0	0.00	0.0	0.0	6.7	10.5	0.3	1.94	12.9	4.49	12		7.6	9.6	181	***1875.3***	1867.2	1877.8	1869.00	30.13	23.81	1892.81	**Flood**
A476		18.3	0.59	10.8	0.0	17.5	10.8	0.1	1.94	33.9	7.50	12		9.8	12.5	38	1867.2	1864.3	1869.0	1867.40	77.70	34.32	1901.72	**Flood**
A474		0.0	0.00	0.0	0.0	17.5	10.9	0.4	1.94	33.9	4.13	12		7.3	9.2	225	1864.3	1855.0	1867.4	1857.60	246.61	203.23	2060.83	**Flood**
A472		0.0	0.00	0.0	0.0	17.5	11.3	0.3	1.88	32.8	4.16	12		7.3	9.3	187	1855.0	1847.2	1857.6	1850.40	199.36	158.62	2009.02	**Flood**
A470		0.8	0.78	0.6	0.0	18.1	11.6	0.0	1.88	34.0	5.22	12		8.2	10.4	30	1847.2	1845.7	1850.4	1850.00	70.97	27.29	1877.29	**Flood**
		113.7	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

ASHLAND CREEK - STORM TABULATION SHEET

10-YEAR STORM; FUTURE CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A622		17.8	0.41	7.3	0.0	7.3	10.0	0.1	1.94	14.2	17.70	12		15.0	19.1	165	2048.1	2018.9	2050.6	2019.91	33.61	26.03	2045.94	
A620		0.0	0.00	0.0	0.0	7.3	10.1	0.2	1.94	14.2	16.67	12		14.6	18.6	168	2018.9	1990.9	2021.4	1993.40	34.09	26.51	2019.91	**Surch.**
A618		0.0	0.00	0.0	0.0	7.3	10.3	0.1	1.94	14.2	15.69	12		14.2	18.0	137	1990.9	1969.4	1993.4	1972.40	29.20	21.62	1994.02	**Flood**
A616		0.0	0.00	0.0	0.0	7.3	10.4	0.0	1.94	14.2	11.36	12		12.0	15.3	44	1969.4	***1964.4***	1972.4	1967.40	14.52	6.94	1974.34	**Flood**
A614		4.8	0.50	2.4	0.0	9.7	10.5	0.2	1.94	18.8	12.93	12		12.8	16.4	235	***1964.4***	1934.0	1967.4	1936.60	78.86	65.48	2002.08	**Flood**
A612		0.0	0.00	0.0	0.0	9.7	10.7	0.3	1.94	18.8	8.76	12		10.6	13.5	210	1934.0	1915.6	1936.6	1918.20	71.89	58.51	1976.71	**Flood**
A610		10.7	0.50	5.4	0.0	15.0	11.0	0.0	1.94	29.2	11.15	12		11.9	15.2	45	1915.6	1910.6	1918.2	1915.60	62.41	30.19	1945.79	**Flood**
A608		0.0	0.00	0.0	0.0	15.0	11.0	0.4	1.88	28.3	6.71	12		9.3	11.8	294	1910.6	1890.9	1915.6	1894.20	215.48	185.22	2079.42	**Flood**
A606		0.0	0.00	0.0	0.0	15.0	11.4	0.1	1.88	28.3	3.44	12		6.6	8.4	60	1890.9	1888.8	1894.2	1891.80	68.06	37.80	1929.60	**Flood**
A604		0.0	0.00	0.0	0.0	15.0	11.6	0.0	1.88	28.3	5.19	12		8.1	10.4	18	1888.8	1887.9	1891.8	1891.20	41.60	11.34	1902.54	**Flood**
A602		0.0	0.00	0.0	0.0	15.0	11.6	0.0	1.88	28.3	6.98	12		9.4	12.0	21	1887.9	***1886.4***	1891.2	1891.40	43.49	13.23	1904.63	**Flood**
A600		4.3	0.70	3.0	0.0	18.1	11.6	0.2	1.88	33.9	9.61	12		11.1	14.1	129	***1886.4***	1874.0	1891.4	1875.00	160.61	117.03	1992.03	**Flood**
		37.6	Total Area																					
A724		45.3	0.37	16.5	0.0	16.5	10.0	0.1	1.94	32.1	3.20	18		18.8	10.7	51	1958.1	1956.4	1963.4	1961.60	12.44	4.75	1966.35	**Flood**
A722		0.0	0.00	0.0	0.0	16.5	10.1	0.4	1.94	32.1	3.19	15	PVC	11.6	9.4	224	1956.4	1949.3	1961.6	1953.20	71.12	55.19	2008.39	**Flood**
A720		0.0	0.00	0.0	0.0	16.5	10.5	0.3	1.94	32.1	4.12	18	CONC	21.4	12.1	223	1949.3	1940.1	1953.2	1942.60	28.46	20.78	1963.38	**Flood**
A718		3.5	0.50	1.8	0.0	18.3	10.8	0.2	1.94	35.5	4.88	18		23.3	13.2	170	1938.1	1929.8	1942.6	1934.80	28.77	19.37	1954.17	**Flood**
A716		0.0	0.00	0.0	0.0	18.3	11.0	0.2	1.94	35.5	4.42	18		22.1	12.5	149	1929.8	1923.2	1934.8	1927.80	26.37	16.98	1944.78	**Flood**
A714		29.3	0.46	13.3	0.0	31.6	11.2	0.2	1.88	59.4	0.17	24		9.3	2.9	30	1923.2	1923.2	1927.8	1926.00	10.42	2.07	1928.07	**Flood**
A712		0.0	0.00	0.0	0.0	31.6	11.4	0.2	1.88	59.4	3.72	24		43.7	13.9	186	1921.6	1914.7	1926.0	1920.00	21.18	12.83	1932.83	**Flood**
A710		0.0	0.00	0.0	0.0	31.6	11.6	0.2	1.88	59.4	5.87	24		55.0	17.5	168	1914.7	1904.8	1920.0	1912.80	19.94	11.59	1924.39	**Flood**
A708		4.5	0.50	2.3	0.0	33.9	11.7	0.0	1.88	63.7	3.60	24		43.0	13.7	25	1904.8	***1903.9***	1912.8	1911.40	11.56	1.98	1913.38	**Flood**
A706		0.0	0.00	0.0	0.0	33.9	11.8	0.1	1.88	63.7	3.51	24		42.5	13.5	56	***1903.9***	1901.9	1911.4	1907.60	14.01	4.43	1912.03	**Flood**
A704		0.0	0.00	0.0	0.0	33.9	11.8	0.2	1.88	63.7	6.76	18		27.4	15.5	162	1901.9	1891.0	1907.6	1894.40	89.74	59.47	1953.87	**Flood**
A702		0.0	0.00	0.0	0.0	33.9	12.0	0.1	1.80	61.0	9.10	18		31.8	18.0	109	1891.0	1881.1	1894.4	1885.40	64.43	36.68	1922.08	**Flood**
A700		1.9	0.65	1.2	0.0	35.1	12.1	0.0	1.80	63.2	12.27	18		36.9	20.9	25	1881.1	1878.0	1885.4	1879.50	38.85	9.04	1888.54	**Flood**
		84.5	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

HOSPITAL BASIN - STORM TABULATION SHEET

10-YEAR STORM; EXISTING CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
			0.00	0.0	0.0	0.0	10.0	#DIV/0!	1.94	0.0	######			#DIV/0!	#DIV/0!		-5.0	-5.3		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-5.2	-5.3		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-5.3	-5.5		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-5.5	-7.9		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-8.0	-7.9		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-8.0	-7.9		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-8.0	-7.9		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-8.0	-7.9		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-8.0	-7.9		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-8.0	-7.9		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-8.0	-7.9			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Ho110		12.8	0.44	5.6	0.0	5.6	10.0	0.1	1.94	10.9	4.19	15	CP	13.3	10.8	43	2005.4	2003.6	2009.4	2004.85	3.08	1.23	2006.08	
Ho108		0.0	0.00	0.0	0.0	5.6	10.1	0.2	1.94	10.9	3.59	15	CP	12.3	10.0	145	2003.6	1998.4	2007.6	1999.65	5.99	4.14	2003.79	
Ho106		0.0	0.00	0.0	0.0	5.6	10.3	0.2	1.94	10.9	15.20	15	CP	25.3	20.6	221	1998.4	1964.8	2002.4	1966.05	8.17	6.32	1974.22	
Ho104		8.2	0.38	3.1	0.0	8.7	10.5	0.3	1.94	17.0	9.82	15	CP	20.3	16.5	285	1964.8	1936.8	1971.8	1938.05	24.12	19.66	1962.17	
Ho102		0.0	0.00	0.0	0.0	8.7	10.8	0.2	1.94	17.0	18.85	18	CP	45.7	25.9	312	1936.8	1878.0	1942.8	1879.50	10.29	8.14	1889.79	
Ho100		2.8	0.50	1.4	0.0	10.1	11.0	0.1	1.94	19.7	385.63	18	CP	206.8	117.0	487	1878.0	0.0	1882.0	1.50	19.99	17.09	21.49	
Ho210		22.5	0.40	9.0	0.0	9.0	10.0	0.8	1.94	17.4	2.39	12	CP	5.5	7.0	326	1959.4	1951.6	1962.2	1954.40	88.86	77.45	2031.85	Flood
Ho208		11.1	0.48	5.3	0.0	14.2	10.8	0.5	1.94	27.6	6.51	12	CP	9.1	11.6	335	1951.6	1929.8	1954.4	1932.60	230.05	201.21	2133.81	Flood
Ho206		0.0	0.00	0.0	0.0	14.2	11.3	0.6	1.88	26.8	5.80	12	CP	8.6	11.0	421	1929.8	1905.4	1932.6	1908.20	264.55	237.46	2145.66	Flood
Ho204		9.8	0.70	6.9	0.0	21.1	11.9	0.0	1.88	39.7	12.16	12	CP	12.5	15.9	37	1905.4	1900.9	1908.2	1904.20	105.31	45.82	1950.02	Flood
Ho202		0.0	0.00	0.0	0.0	21.1	11.9	0.2	1.88	39.7	10.31	15	CP	20.8	17.0	249	1900.9	1875.2	1904.2	1876.43	118.17	93.81	1970.24	Flood
Ho200		2.1	0.65	1.4	0.0	22.5	12.2	0.0	1.80	40.4	1053.47	15	CP	210.2	171.3	178	1875.2	0.0	1878.6	1.25	95.00	69.68	96.25	
Ho320		12.8	0.32	4.1	0.0	4.1	10.0	0.1	1.94	7.9	4.42	18	CP	22.1	12.5	57	1958.9	1956.4	1962.0	1958.40	0.78	0.32	1959.18	
Ho318		0.0	0.00	0.0	0.0	4.1	10.1	0.3	1.94	7.9	5.05	12	CP	8.0	10.2	202	1956.4	1946.2	1958.4	1949.20	12.20	9.85	1959.05	Flood
Ho316		0.0	0.00	0.0	0.0	4.1	10.4	0.3	1.94	7.9	4.48	10	CP	4.6	8.5	128	1946.2	1940.5	1949.2	1943.80	21.37	16.51	1960.31	Flood
Ho314		0.0	0.00	0.0	0.0	4.1	10.7	0.2	1.94	7.9	12.27	10	CP	7.7	14.1	128	1940.5	1924.8	1943.8	1928.60	21.37	16.51	1945.11	Flood
Ho312		5.2	0.65	3.4	0.0	7.4	10.8	0.2	1.94	14.4	10.46	10	CP	7.1	13.0	172	1924.8	1906.8	1928.6	1910.20	90.86	74.53	1984.73	Flood
Ho310		0.0	0.00	0.0	0.0	7.4	11.0	0.4	1.88	14.0	3.60	10	CP	4.2	7.6	188	1906.8	1900.0	1910.2	1901.55	91.83	76.51	1978.06	Flood
Ho308		5.6	0.65	3.6	0.0	11.1	11.4	0.0	1.88	20.8	3.80	18	CP	20.5	11.6	25	1900.0	1899.1	1903.6	1900.57	4.22	0.98	1901.55	Surch.
Ho306		0.0	0.00	0.0	0.0	11.1	11.5	0.2	1.88	20.8	7.11	18	CP	28.1	15.9	220	1899.1	1883.4	1902.4	1885.60	11.88	8.64	1897.48	
Ho304		0.0	0.00	0.0	0.0	11.1	11.7	0.2	1.88	20.8	3.23	12	CP	6.4	8.2	115	1883.4	1879.7	1885.6	1881.80	55.66	39.26	1921.06	Flood
Ho302		0.0	0.00	0.0	0.0	11.1	11.9	0.1	1.88	20.8	3.21	12	CP	6.4	8.2	42	1879.7	1878.4	1881.8	1879.37	30.74	14.34	1893.71	Flood
Ho300		0.0	0.00	0.0	0.0	11.1	12.0	0.0	1.80	19.9	4816.32	12	CP	247.9	315.7	39	1878.4	0.0	1880.2	1.00	27.24	12.21	28.24	
		92.9	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

HOSPITAL BASIN - STORM TABULATION SHEET

10-YEAR STORM; FUTURE CONDITIONS

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time- Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
			0.00	0.0	0.0	0.0	10.0	#DIV/0!	1.94	0.0	######			#DIV/0!	#DIV/0!		-5.0	-5.3		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-5.2	-5.3		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-5.3	-5.5		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-5.5	-7.9		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-8.0	-7.9		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-8.0	-7.9		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-8.0	-7.9		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-8.0	-7.9		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-8.0	-7.9		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-8.0	-7.9		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
			0.00	0.0	0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	######			#DIV/0!	#DIV/0!		-8.0	-7.9			#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
Ho110		12.8	0.50	6.4	0.0	6.4	10.0	0.1	1.94	12.4	4.19	15	CP	13.3	10.8	43	***2005.4***	***2003.6***	2009.4	2005.00	3.97	1.59	2006.59	
Ho108		0.0	0.00	0.0	0.0	6.4	10.1	0.2	1.94	12.4	3.59	15	CP	12.3	10.0	145	***2003.6***	***1998.4***	2007.6	1999.65	7.74	5.35	2005.00	**Surch.**
Ho106		0.0	0.00	0.0	0.0	6.4	10.3	0.2	1.94	12.4	15.20	15	CP	25.3	20.6	221	***1998.4***	1964.8	2002.4	1966.37	10.54	8.16	1976.91	
Ho104		8.2	0.50	4.1	0.0	10.5	10.5	0.3	1.94	20.4	9.82	15	CP	20.3	16.5	285	1964.8	1936.8	1971.8	1938.05	34.74	28.32	1966.37	**Surch.**
Ho102		0.0	0.00	0.0	0.0	10.5	10.8	0.2	1.94	20.4	18.85	18	CP	45.7	25.9	312	1936.8	***1878.0***	1942.8	1879.50	14.82	11.72	1894.32	
Ho100		2.8	0.50	1.4	0.0	11.9	11.0	0.1	1.94	23.1	385.63	18	CP	206.8	117.0	487	***1878.0***	0.0	1882.0	1.50	27.48	23.50	28.98	
Ho210		22.5	0.53	11.9	0.0	11.9	10.0	0.8	1.94	23.1	2.39	12	CP	5.5	7.0	326	***1959.4***	***1951.6***	1962.2	1954.40	157.57	137.34	2091.74	**Flood**
Ho208		11.1	0.55	6.0	0.0	18.0	10.8	0.5	1.94	34.9	6.51	12	CP	9.1	11.6	335	***1951.6***	***1929.8***	1954.4	1932.60	366.61	320.64	2253.24	**Flood**
Ho206		0.0	0.00	0.0	0.0	18.0	11.3	0.6	1.88	33.8	5.80	12	CP	8.6	11.0	421	***1929.8***	1905.4	1932.6	1908.20	421.59	378.42	2286.62	**Flood**
Ho204		9.8	0.83	8.1	0.0	26.1	11.9	0.0	1.88	49.0	12.16	12	CP	12.5	15.9	37	1905.4	***1900.9***	1908.2	1904.20	160.65	69.91	1974.11	**Flood**
Ho202		0.0	0.00	0.0	0.0	26.1	11.9	0.2	1.88	49.0	10.31	15	CP	20.8	17.0	249	***1900.9***	1875.2	1904.2	1876.43	180.27	143.11	2019.54	**Flood**
Ho200		2.1	0.65	1.4	0.0	27.4	12.2	0.0	1.80	49.4	1053.47	15	CP	210.2	171.3	178	1875.2	0.0	1878.6	1.25	141.60	103.86	142.85	
Ho320		12.8	0.40	5.1	0.0	5.1	10.0	0.1	1.94	9.8	4.42	18	CP	22.1	12.5	57	1958.9	1956.4	1962.0	1958.40	1.22	0.50	1959.62	
Ho318		0.0	0.00	0.0	0.0	5.1	10.1	0.3	1.94	9.8	5.05	12	CP	8.0	10.2	202	1956.4	1946.2	1958.4	1949.20	18.94	15.30	1964.50	**Flood**
Ho316		0.0	0.00	0.0	0.0	5.1	10.4	0.3	1.94	9.8	4.48	10	CP	4.6	8.5	128	1946.2	1940.5	1949.2	1943.80	33.17	25.63	1969.43	**Flood**
Ho314		0.0	0.00	0.0	0.0	5.1	10.7	0.2	1.94	9.8	12.27	10	CP	7.7	14.1	128	1940.5	1924.8	1943.8	1928.60	33.17	25.63	1954.23	**Flood**
Ho312		5.2	0.65	3.4	0.0	8.4	10.8	0.2	1.94	16.4	10.46	10	CP	7.1	13.0	172	1924.8	1906.8	1928.6	1910.20	116.89	95.89	2006.09	**Flood**
Ho310		0.0	0.00	0.0	0.0	8.4	11.0	0.4	1.88	15.9	3.60	10	CP	4.2	7.6	188	1906.8	1900.0	1910.2	1901.73	118.14	98.43	2000.16	**Flood**
Ho308		5.6	0.65	3.6	0.0	12.1	11.4	0.0	1.88	22.7	3.80	18	CP	20.5	11.6	25	1900.0	***1899.1***	1903.6	1900.57	5.02	1.17	1901.73	**Surch.**
Ho306		0.0	0.00	0.0	0.0	12.1	11.5	0.2	1.88	22.7	7.11	18	CP	28.1	15.9	220	***1899.1***	1883.4	1902.4	1885.60	14.12	10.27	1899.72	
Ho304		0.0	0.00	0.0	0.0	12.1	11.7	0.2	1.88	22.7	3.23	12	CP	6.4	8.2	115	1883.4	1879.7	1885.6	1881.80	66.14	46.66	1928.46	**Flood**
Ho302		0.0	0.00	0.0	0.0	12.1	11.9	0.1	1.88	22.7	3.21	12	CP	6.4	8.2	42	1879.7	1878.4	1881.8	1879.37	36.53	17.04	1896.41	**Flood**
Ho300		0.0	0.00	0.0	0.0	12.1	12.0	0.0	1.80	21.7	4816.32	12	CP	247.9	315.7	39	1878.4	0.0	1880.2	1.00	32.37	14.50	33.37	
		92.9	Total Area																					

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

BEACH CREEK - STORM TABULATION SHEET

10-YEAR STORM; IMPROVEMENT CONDITIONS ALTERNATIVE #5

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
B64		186.0					18.0	0.0		72.0	27.64	30	PVC	216.2	44.0	24	2035.8	2029.2	2036.0	2031.70	5.76	0.74	2037.46	Flood
B62		0.0	0.00	0.0	0.0	0.0	18.0	0.1	1.50	72.0	4.22	30	PVC	84.5	17.2	154	2029.2	2022.7	2034.2	2025.20	9.76	4.74	2029.94	
B60		0.0	0.00	0.0	0.0	0.0	18.2	0.1	1.50	72.0	6.67	30	SPP	106.2	21.6	141	2022.7	2013.3	2028.2	2015.80	9.36	4.34	2025.16	
B59		0.0	0.00	0.0	0.0	0.0	18.3	0.2	1.50	72.0	4.72	30	SPP	89.3	18.2	172	2013.3	2005.2	2018.8	2007.68	10.31	5.30	2012.98	
B58N	B70N	0.0	0.00	0.0	11.2	11.2	18.4	0.4	1.50	88.9	1.33	36	SPP	77.0	10.9	240	2002.2	1999.0	2010.6	2002.00	7.94	4.26	2006.26	Surch.
B50N		2.9	0.90	2.6	0.0	13.9	18.8	0.4	1.50	92.8	5.28	36	CP	153.6	21.7	580	1999.0	1968.4	2008.0	1971.40	15.23	11.21	1986.63	
B40N	B200	0.0	0.00	0.0	8.5	22.4	19.2	0.4	1.46	104.7	3.57	36	CP	126.4	17.9	470	1968.4	1951.6	1977.4	1954.60	16.69	11.57	1971.29	
B35N	Bm520*									-62.0														
B35N		0.0	0.65	0.0	0.0	22.4	19.7	0.2	1.46	42.7	3.07	24	SPP	39.7	12.6	150	1951.6	1947.0	1957.6	1949.00	9.65	5.34	1954.34	Surch.
B30		1.7	0.65	1.1	0.0	23.5	19.9	1.7	1.46	44.3	3.89	24	SPP	44.7	14.2	1489	1947.0	1889.1	1955.0	1891.10	61.73	57.09	1948.19	
B20		9.2	0.65	6.0	0.0	29.5	21.6	0.1	1.40	51.3	3.53	30	SPP	77.3	15.7	119	1889.1	1884.9	1894.6	1887.40	4.40	1.86	1889.26	
B18		0.0	0.00	0.0	0.0	29.5	21.7	0.1	1.40	51.3	4.09	30	SPP	83.1	16.9	93	1884.9	1881.1	1890.4	1885.62	4.00	1.45	1887.08	
B16		0.0	0.00	0.0	0.0	29.5	21.8	0.2	1.40	51.3	1.18	30	SPP	44.6	9.1	102	1881.1	1879.9	1886.6	1884.03	4.14	1.59	1885.62	Surch.
B14	B100	2.8	0.75	2.1	1.3	32.8	22.0	0.2	1.36	54.7	1.39	30	SPP	48.4	9.9	101	1879.9	1878.5	1885.4	1882.24	4.68	1.79	1884.03	Surch.
B12		0.0	0.00	0.0	0.0	32.8	22.2	0.1	1.36	54.7	0.83	30	SPP	37.5	7.6	36	1878.5	1878.2	1884.0	1881.60	3.53	0.64	1882.24	Surch.
B10		0.0	0.00	0.0	0.0	32.8	22.3	0.2	1.36	54.7	0.32	30	SPP	23.4	4.8	62	1878.2	1878.0	1883.2	1880.50	3.99	1.10	1881.60	Surch.
B70N	B300	0.0	0.00	0.0	11.2	11.2	10.0	0.1	1.94	21.8	3.14	18	CP	18.7	10.6	60	2004.1	2002.2	2010.4	2006.26	6.13	2.58	2008.84	Surch.
B100		1.4	0.90	1.3	0.0	1.3	10.0	0.3	1.94	2.4	1.50	24	CP	27.8	8.9	133	1889.1	1887.1	1892.0	1889.10	0.03	0.02	1889.13	
B200		11.1	0.77	8.5	0.0	8.5	10.0	0.0	1.94	16.6	17.22	24	CP	94.1	30.0	12	1970.5	1968.4	1975.8	1971.29	0.71	0.06	1972.00	
B360		9.3	0.50	4.7	0.0	4.7	10.0	0.0	1.94	9.0	8.21	12	CP	10.2	13.0	27	2024.6	2022.4	2025.6	2023.80	4.81	1.73	2025.53	
B350		0.0	0.00	0.0	0.0	4.7	10.0	0.0	1.94	9.0	5.67	12	CP	8.5	10.8	15	2021.8	2021.0	2023.8	2023.20	4.04	0.96	2024.16	Flood
B340		0.0	0.00	0.0	0.0	4.7	10.1	1.6	1.94	9.0	0.34	18	CP	6.2	3.5	329	2020.9	2019.7	2023.2	2021.23	3.03	2.42	2023.66	Flood
B330		6.6	0.58	3.8	0.0	8.4	11.6	0.1	1.88	15.9	2.15	18	SPP	15.4	8.7	55	2019.6	2018.4	2022.4	2019.88	3.14	1.26	2021.14	Surch.
B320		0.0	0.00	0.0	0.0	8.4	11.7	0.0	1.88	15.9	10.48	18	SPP	34.1	19.3	14	2018.2	2016.8	2020.8	2018.39	2.20	0.32	2018.71	
B310		0.0	0.00	0.0	0.0	8.4	11.7	0.6	1.88	15.9	2.61	18	SPP	17.0	9.6	359	2016.6	2007.2	2020.0	2010.20	10.08	8.19	2018.39	Surch.
B300		4.3	0.65	2.8	0.0	11.2	12.4	0.0	1.80	20.2	8.03	18	SPP	29.9	16.9	39	2007.2	2004.1	2010.2	2008.84	4.50	1.45	2010.29	Flood
		235.3	Total Area																					

* Overflow to the Beach-Mountain Storm Improvement.

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

BEACH CREEK - STORM TABULATION SHEET

10-YEAR STORM; IMPROVEMENT CONDITIONS ALTERNATIVE #5; BYPASS LINE

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Bm520	B35N*	0.0	0.00	0.0	0.0	0.0	19.7	1.2		62.0	4.47	***30***	PVC	86.9	17.7	1240	1951.6	1896.2	1957.6	1898.70	32.03	28.31	1930.73	
Bm510	Bm515	0.0	0.00	0.0	0.0	0.0	32.6	0.8	1.26	136.0	2.84	***42***	PVC	170.0	17.7	880	1896.0	1871.0	1904.0	1875.07	20.73	16.07	1895.80	
Bm500		0.0	0.00	0.0	0.0	0.0	33.4	0.2	1.26	136.0	0.67	***48***	PVC	117.6	9.4	120	1870.8	1870.0	1876.8	1874.00	3.81	1.07	1875.07	**Surch.**
Bm515	M116^	0.0	0.00	0.0	0.0	0.0	30.8	1.7		74.0	1.14	***36***	PVC	71.5	10.1	1060	1908.3	1896.2	1912.8	1899.20	15.59	13.04	1912.24	**Surch.**
		0.0	Total Area																					

* Overflow from Beach Storm System at B35N.

^ Overflow from Mountain Storm System at M116.

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

BEACH CREEK - STORM TABULATION SHEET

25-YEAR STORM; IMPROVEMENT CONDITIONS ALTERNATIVE #5

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
B64		186.0					18.0	0.0		72.0	27.64	**30**	PVC	216.2	44.0	24	2035.8	2029.2	2036.0	2031.70	5.76	0.74	2037.46	**Flood**
B62		0.0	0.00	0.0	0.0	0.0	18.0	0.1	1.76	72.0	4.22	**30**	PVC	84.5	17.2	154	2029.2	2022.7	2034.2	2025.20	9.76	4.74	2029.94	
B60		0.0	0.00	0.0	0.0	0.0	18.2	0.1	1.76	72.0	6.67	**30**	SPP	106.2	21.6	141	2022.7	2013.3	2028.2	2015.80	9.36	4.34	2025.16	
B59		0.0	0.00	0.0	0.0	0.0	18.3	0.2	1.76	72.0	4.72	**30**	SPP	89.3	18.2	172	2013.3	2005.2	2018.8	2007.68	10.31	5.30	2012.98	
B58N	B70N	0.0	0.00	0.0	11.2	11.2	18.4	0.4	1.76	91.8	1.33	**36**	SPP	77.0	10.9	240	2002.2	1999.0	2010.6	2002.00	8.47	4.54	2006.54	**Surch.**
B50N		2.9	0.90	2.6	0.0	13.9	18.8	0.4	1.76	96.4	5.28	**36**	CP	153.6	21.7	580	1999.0	1968.4	2008.0	1971.40	16.44	12.10	1987.84	
B40N	B200	0.0	0.00	0.0	8.5	22.4	19.2	0.4	1.72	110.5	3.57	**36**	CP	126.4	17.9	470	1968.4	1951.6	1977.4	1954.60	18.60	12.89	1967.49	
B35N	Bm520*									-68.0														
B35N		0.0	0.65	0.0	0.0	22.4	19.7	0.2	1.72	42.5	3.07	**24**	SPP	39.7	12.6	150	1951.6	1947.0	1957.6	1949.00	9.57	5.30	1954.30	**Surch.**
B30		1.7	0.65	1.1	0.0	23.5	19.9	1.7	1.72	44.4	3.89	24	SPP	44.7	14.2	1489	1947.0	1889.1	1955.0	1891.10	62.03	57.37	1948.47	
B20		9.2	0.65	6.0	0.0	29.5	21.6	0.1	1.62	51.8	3.53	30	SPP	77.3	15.7	119	1889.1	1884.9	1894.6	1887.40	4.49	1.89	1889.29	
B18		0.0	0.00	0.0	0.0	29.5	21.7	0.1	1.62	51.8	4.09	30	SPP	83.1	16.9	93	1884.9	1881.1	1890.4	1885.81	4.07	1.48	1887.29	
B16		0.0	0.00	0.0	0.0	29.5	21.8	0.2	1.62	51.8	1.18	30	SPP	44.6	9.1	102	1881.1	1879.9	1886.6	1884.19	4.22	1.62	1885.81	**Surch.**
B14	B100	2.8	0.75	2.1	1.3	32.8	22.0	0.2	1.58	55.9	1.39	30	SPP	48.4	9.9	101	1879.9	1878.5	1885.4	1882.32	4.90	1.87	1884.19	**Surch.**
B12		0.0	0.00	0.0	0.0	32.8	22.2	0.1	1.58	55.9	0.83	30	SPP	37.5	7.6	36	1878.5	1878.2	1884.0	1881.65	3.69	0.67	1882.32	**Surch.**
B10		0.0	0.00	0.0	0.0	32.8	22.3	0.2	1.58	55.9	0.32	30	SPP	23.4	4.8	62	1878.2	1878.0	1883.2	1880.50	4.17	1.15	1881.65	**Surch.**
B70N	B300	0.0	0.00	0.0	11.2	11.2	10.0	0.1	2.26	25.4	3.14	**18**	CP	18.7	10.6	60	2004.1	2002.2	2010.4	2006.54	8.32	3.51	2010.05	**Surch.**
B100		1.4	0.90	1.3	0.0	1.3	10.0	0.3	2.26	2.8	1.50	24	CP	27.8	8.9	133	1889.1	1887.1	1892.0	1889.10	0.04	0.02	1889.14	
B200		11.1	0.77	8.5	0.0	8.5	10.0	0.0	2.26	19.3	17.22	24	CP	94.1	30.0	12	1970.5	1968.4	1975.8	1970.40	0.97	0.09	1971.37	
B360		9.3	0.50	4.7	0.0	4.7	10.0	0.0	2.26	10.5	8.21	**12**	CP	10.2	13.0	27	2024.6	2022.4	2025.6	2023.80	6.52	2.35	2026.15	**Flood**
B350		0.0	0.00	0.0	0.0	4.7	10.0	0.0	2.26	10.5	5.67	**12**	CP	8.5	10.8	15	2021.8	2021.0	2023.8	2023.20	5.48	1.30	2024.50	**Flood**
B340		0.0	0.00	0.0	0.0	4.7	10.1	1.6	2.26	10.5	0.34	**18**	CP	6.2	3.5	329	2020.9	2019.7	2023.2	2022.12	4.11	3.29	2025.41	**Flood**
B330		6.6	0.58	3.8	0.0	8.4	11.6	0.1	2.18	18.4	2.15	**18**	SPP	15.4	8.7	55	2019.6	2018.4	2022.4	2020.43	4.22	1.69	2022.12	**Surch.**
B320		0.0	0.00	0.0	0.0	8.4	11.7	0.0	2.18	18.4	10.48	**18**	SPP	34.1	19.3	14	2018.2	2016.8	2020.8	2020.00	2.96	0.43	2020.43	**Surch.**
B310		0.0	0.00	0.0	0.0	8.4	11.7	0.6	2.18	18.4	2.61	**18**	SPP	17.0	9.6	359	2016.6	2007.2	2020.0	2010.20	13.55	11.02	2021.22	**Flood**
B300		4.3	0.65	2.8	0.0	11.2	12.4	0.0	2.10	23.6	8.03	**18**	SPP	29.9	16.9	39	2007.2	2004.1	2010.2	2010.05	6.13	1.97	2012.01	**Flood**
		235.3	Total Area																					

* Overflow to the Beach-Mountain Storm Improvement.

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

BEACH CREEK - STORM TABULATION SHEET

25-YEAR STORM; IMPROVEMENT CONDITIONS ALTERNATIVE #5; BYPASS LINE

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Bm520	B35N*	0.0	0.00	0.0	0.0	0.0	19.7	1.1		68.0	4.71	***30***	PVC	89.3	18.2	1240	1951.6	1893.2	1957.6	1895.70	38.53	34.05	1934.23	
Bm510	Bm515	0.0	0.00	0.0	0.0	0.0	32.4	0.9	1.26	150.0	2.50	***42***	PVC	159.5	16.6	880	1893.0	1871.0	1904.0	1875.31	25.21	19.54	1894.85	
Bm500		0.0	0.00	0.0	0.0	0.0	33.3	0.2	1.26	150.0	0.67	***48***	PVC	117.6	9.4	120	1870.8	1870.0	1876.8	1874.00	4.63	1.31	1875.31	**Surch.**
Bm515	M116^	0.0	0.00	0.0	0.0	0.0	30.8	1.6		82.0	1.42	***36***	PVC	79.8	11.3	1060	1908.3	1893.2	1912.8	1896.20	19.15	16.01	1912.21	**Surch.**
		0.0	Total Area																					

* Overflow from Beach Storm System at B35N.

^ Overflow from Mountain Storm System at M116.

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

MOUNTAIN CREEK - STORM TABULATION SHEET

10-YEAR STORM; IMPROVEMENT CONDITIONS ALTERNATIVE #5

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
*M120		146.0					30.0			53.0														
M122		1.3	0.65	0.8	0.0	0.8	10.0	0.1	1.94	1.6	12.87	18		37.8	21.4	151	1932.1	1912.7	1934.6	1931.66	0.06	0.04	1931.72	
*M120	M130	0.0	0.52	0.0	4.6	5.4	30.0	0.7	1.26	59.8	3.63	**30**		78.3	16.0	649	1935.5	1911.9	1937.8	1914.42	17.24	13.78	1931.66	
M118	M140	5.1	0.65	3.3	19.8	28.5	30.7	0.1	1.26	88.9	2.19	**36**		99.0	14.0	108	1911.6	1909.2	1915.0	1912.22	5.61	1.92	1914.13	
	Bm515*									-74.0														
M116		0.0	0.00	0.0	0.0	28.5	30.8	0.1	1.26	14.9	0.35	18		6.2	3.5	24	1908.3	**1908.2**	1912.8	1909.97	2.15	0.48	1910.46	**Surch.**
M114		0.0	0.00	0.0	0.0	28.5	30.9	0.1	1.26	14.9	0.79	18		9.4	5.3	21	**1908.2**	1908.1	1911.8	1909.55	2.08	0.42	1909.97	**Surch.**
M112		0.0	0.00	0.0	0.0	28.5	31.0	0.2	1.26	14.9	3.35	18		19.3	10.9	158	1908.1	1902.8	1910.8	1905.93	4.84	3.18	1909.11	
M110		4.9	0.65	3.2	0.0	31.7	31.2	0.4	1.26	18.9	3.17	18		18.7	10.6	232	1902.8	**1895.4**	1906.0	1898.40	10.20	7.53	1905.93	**Surch.**
M106		0.0	0.00	0.0	0.0	31.7	31.6	0.4	1.26	18.9	2.62	18		17.0	9.6	252	**1895.4**	**1888.8**	1898.4	1890.30	10.85	8.18	1898.48	**Flood**
M104		0.0	0.00	0.0	0.0	31.7	32.0	0.3	1.26	18.9	4.33	18		21.9	12.4	213	**1888.8**	1879.6	1891.8	1881.07	9.59	6.91	1887.98	
M102		0.0	0.00	0.0	0.0	31.7	32.3	0.3	1.26	18.9	4.22	18		21.6	12.2	223	1879.6	**1870.2**	1882.4	1872.61	9.91	7.24	1879.85	
M100		7.4	0.70	5.2	0.0	36.9	32.6	0.1	1.26	25.5	4.09	18		21.3	12.1	53	**1870.2**	1868.0	1873.0	1869.50	7.95	3.11	1872.61	**Surch.**
M130		7.0	0.65	4.6	0.0	4.6	10.0	0.4	1.94	8.8	2.58	12		5.7	7.3	173	1939.9	1935.5	1941.6	1936.47	13.56	10.61	1947.08	**Flood**
M146		19.0	0.73	13.8	0.0	13.8	10.0	0.3	1.94	26.7	3.11	15		11.4	9.3	183	**1921.8**	1916.1	1921.8	1919.20	42.35	31.29	1950.49	**Flood**
M144		8.6	0.70	6.0	0.0	19.8	10.3	0.1	1.94	38.4	3.99	15		12.9	10.5	33	1916.1	1914.8	1919.2	1917.80	34.49	11.65	1929.45	**Flood**
M142		0.0	0.00	0.0	0.0	19.8	10.4	0.2	1.94	38.4	3.10	15		11.4	9.3	94	1914.8	1911.9	1917.8	1915.80	56.03	33.19	1948.99	**Flood**
M140		0.0	0.00	0.0	0.0	19.8	10.5	0.1	1.94	38.4	1.00	15		6.5	5.3	30	1911.9	**1911.6**	1915.8	1914.13	33.43	10.59	1924.73	**Flood**
		199.3	Total Area																					

* Overflow to Mountain Avenue system.

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

MOUNTAIN CREEK - STORM TABULATION SHEET

25-YEAR STORM; IMPROVEMENT CONDITIONS ALTERNATIVE #5

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
*M120		146.0					30.0			53.0														
M122		1.3	0.65	0.8	0.0	0.8	10.0	0.1	2.26	1.9	12.87	18		37.8	21.4	151	1932.1	1912.7	1934.6	1932.35	0.08	0.05	1932.43	
*M120	M130	0.0	0.52	0.0	4.6	5.4	30.0	0.7	1.48	61.0	3.63	***30***		78.3	16.0	649	1935.5	1911.9	1937.8	1914.42	17.93	14.34	1932.35	
M118	M140	5.1	0.65	3.3	19.8	28.5	30.7	0.1	1.48	95.2	2.19	***36***		99.0	14.0	108	1911.6	1909.2	1915.0	1912.22	6.43	2.20	1914.41	
	Bm515*									-82.0														
M116		0.0	0.00	0.0	0.0	28.5	30.8	0.1	1.48	13.2	0.35	18		6.2	3.5	24	1908.3	***1908.2***	1912.8	1909.88	1.68	0.38	1910.26	**Surch.**
M114		0.0	0.00	0.0	0.0	28.5	30.9	0.1	1.48	13.2	0.79	18		9.4	5.3	21	***1908.2***	1908.1	1911.8	1909.55	1.63	0.33	1909.88	**Surch.**
M112		0.0	0.00	0.0	0.0	28.5	31.0	0.2	1.48	13.2	3.35	18		19.3	10.9	158	1908.1	1902.8	1910.8	1904.34	3.79	2.49	1908.13	
M110		4.9	0.65	3.2	0.0	31.7	31.2	0.4	1.48	17.9	3.17	18		18.7	10.6	232	1902.8	***1895.4***	1906.0	1897.61	9.13	6.73	1904.34	**Surch.**
M106		0.0	0.00	0.0	0.0	31.7	31.6	0.4	1.48	17.9	2.62	18		17.0	9.6	252	***1895.4***	***1888.8***	1898.4	1890.30	9.71	7.31	1897.61	**Surch.**
M104		0.0	0.00	0.0	0.0	31.7	32.0	0.3	1.48	17.9	4.33	18		21.9	12.4	213	***1888.8***	1879.6	1891.8	1881.07	8.57	6.18	1889.64	
M102		0.0	0.00	0.0	0.0	31.7	32.3	0.3	1.48	17.9	4.22	18		21.6	12.2	223	1879.6	***1870.2***	1882.4	1872.64	8.86	6.47	1879.11	
M100		7.4	0.70	5.2	0.0	36.9	32.6	0.1	1.48	25.6	4.09	18		21.3	12.1	53	***1870.2***	1868.0	1873.0	1869.50	8.02	3.14	1872.64	**Surch.**
M130		7.0	0.65	4.6	0.0	4.6	10.0	0.4	2.26	10.3	2.58	12		5.7	7.3	173	1939.9	1935.5	1941.6	1936.47	18.40	14.40	1950.87	**Flood**
M146		19.0	0.73	13.8	0.0	13.8	10.0	0.3	2.26	31.1	3.11	15		11.4	9.3	183	***1921.8***	1916.1	1921.8	1919.20	57.48	42.47	1961.67	**Flood**
M144		8.6	0.70	6.0	0.0	19.8	10.3	0.1	2.26	44.7	3.99	15		12.9	10.5	33	1916.1	1914.8	1919.2	1917.80	46.81	15.81	1933.61	**Flood**
M142		0.0	0.00	0.0	0.0	19.8	10.4	0.2	2.26	44.7	3.10	15		11.4	9.3	94	1914.8	1911.9	1917.8	1915.80	76.04	45.05	1960.85	**Flood**
M140		0.0	0.00	0.0	0.0	19.8	10.5	0.1	2.26	44.7	1.00	15		6.5	5.3	30	1911.9	***1911.6***	1915.8	1914.41	45.37	14.38	1928.79	**Flood**
		199.3	Total Area																					

* Overflow to Mountain Avenue system.

CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN

ASHLAND CREEK - STORM TABULATION SHEET

10-YEAR STORM; IMPROVEMENT CONDITIONS FOR GRANITE STREET

System Labels		Runoff Area					Hydrologic Calculations				System Inventory									Hydraulic Calculations				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A724		0.0	0.00	0.0	0.0	0.0	10.0	0.1	1.94	0.0	3.20	18		18.8	10.7	51	1958.1	1956.4	1963.4	1957.93	0.00	0.00	1957.93	
A722		0.0	0.00	0.0	0.0	0.0	10.1	0.4	1.94	0.0	3.19	15	PVC	11.6	9.4	224	1956.4	1949.3	1961.6	1950.53	0.00	0.00	1950.53	
A720		0.0	0.00	0.0	0.0	0.0	10.5	0.3	1.94	0.0	4.12	18	CONC	21.4	12.1	223	1949.3	1940.1	1953.2	1941.60	0.00	0.00	1941.60	
A718		3.5	0.50	1.8	0.0	1.8	10.8	0.2	1.94	3.4	4.88	18		23.3	13.2	170	1938.1	1929.8	1942.6	1931.30	0.26	0.18	1931.56	
A716		0.0	0.00	0.0	0.0	1.8	11.0	0.2	1.94	3.4	4.42	18		22.1	12.5	149	1929.8	1923.2	1934.8	1925.29	0.24	0.16	1925.53	
A714		14.3	0.41	5.9	0.0	7.6	11.2	0.2	1.88	14.3	0.17	24		9.3	2.9	30	1923.2	1923.2	1927.8	1925.17	0.60	0.12	1925.29	**Surch.**
A712		0.0	0.00	0.0	0.0	7.6	11.4	0.2	1.88	14.3	3.72	24		43.7	13.9	186	1921.6	1914.7	1926.0	1916.67	1.23	0.74	1917.89	
A710		0.0	0.00	0.0	0.0	7.6	11.6	0.2	1.88	14.3	5.87	24		55.0	17.5	168	1914.7	1904.8	1920.0	1906.80	1.16	0.67	1907.96	
A708		4.5	0.50	2.3	0.0	9.9	11.7	0.0	1.88	18.5	3.60	24		43.0	13.7	25	1904.8	***1903.9***	1912.8	1905.90	0.98	0.17	1906.07	
A706		0.0	0.00	0.0	0.0	9.9	11.8	0.1	1.88	18.5	3.51	24		42.5	13.5	56	***1903.9***	1901.9	1911.4	1903.93	1.19	0.38	1905.12	
A704		0.0	0.00	0.0	0.0	9.9	11.8	0.2	1.88	18.5	6.76	18		27.4	15.5	162	1901.9	1891.0	1907.6	1892.48	7.61	5.04	1900.09	
A702		0.0	0.00	0.0	0.0	9.9	12.0	0.1	1.80	17.8	9.10	18		31.8	18.0	109	1891.0	1881.1	1894.4	1882.57	5.46	3.11	1888.03	
A700		1.9	0.65	1.2	0.0	11.1	12.1	0.0	1.80	20.0	12.27	18		36.9	20.9	25	1881.1	1878.0	1885.4	1879.50	3.88	0.90	1880.40	
A758		23.3	0.28	6.4	0.0	6.4	10.0	0.2	1.94	12.4	17.88	***18***		44.5	25.2	260	2092.0	2045.5	2097.0	2047.00	4.79	3.64	2051.79	
A756	A760	0.0	0.00	0.0	7.5	13.9	10.2	0.3	1.94	27.0	14.63	***18***		40.3	22.8	400	2045.5	1987.0	2050.5	1988.50	31.80	26.37	2020.30	
A754		0.0	0.00	0.0	0.0	13.9	10.5	0.3	1.94	27.0	9.38	***18***		32.2	18.2	320	1987.0	1957.0	1992.0	1958.50	26.53	21.09	1985.03	
A752		22.0	0.49	10.7	0.0	24.6	10.8	0.2	1.94	47.7	12.71	***24***		80.9	25.7	350	1957.0	1912.5	1962.0	1915.45	20.91	15.54	1936.35	
A750		0.0	0.00	0.0	0.0	24.6	11.0	0.2	1.94	47.7	0.71	***30***		34.8	7.1	70	1912.5	1912.0	1917.5	1914.50	3.15	0.95	1915.45	**Surch.**
A760		15.0	0.50	7.5	0.0	7.5	10.0	0.3	1.94	14.6	2.22	***18***		15.7	8.9	180	2049.5	2045.5	2054.5	2047.00	5.03	3.45	2050.45	
		84.5	Total Area																					

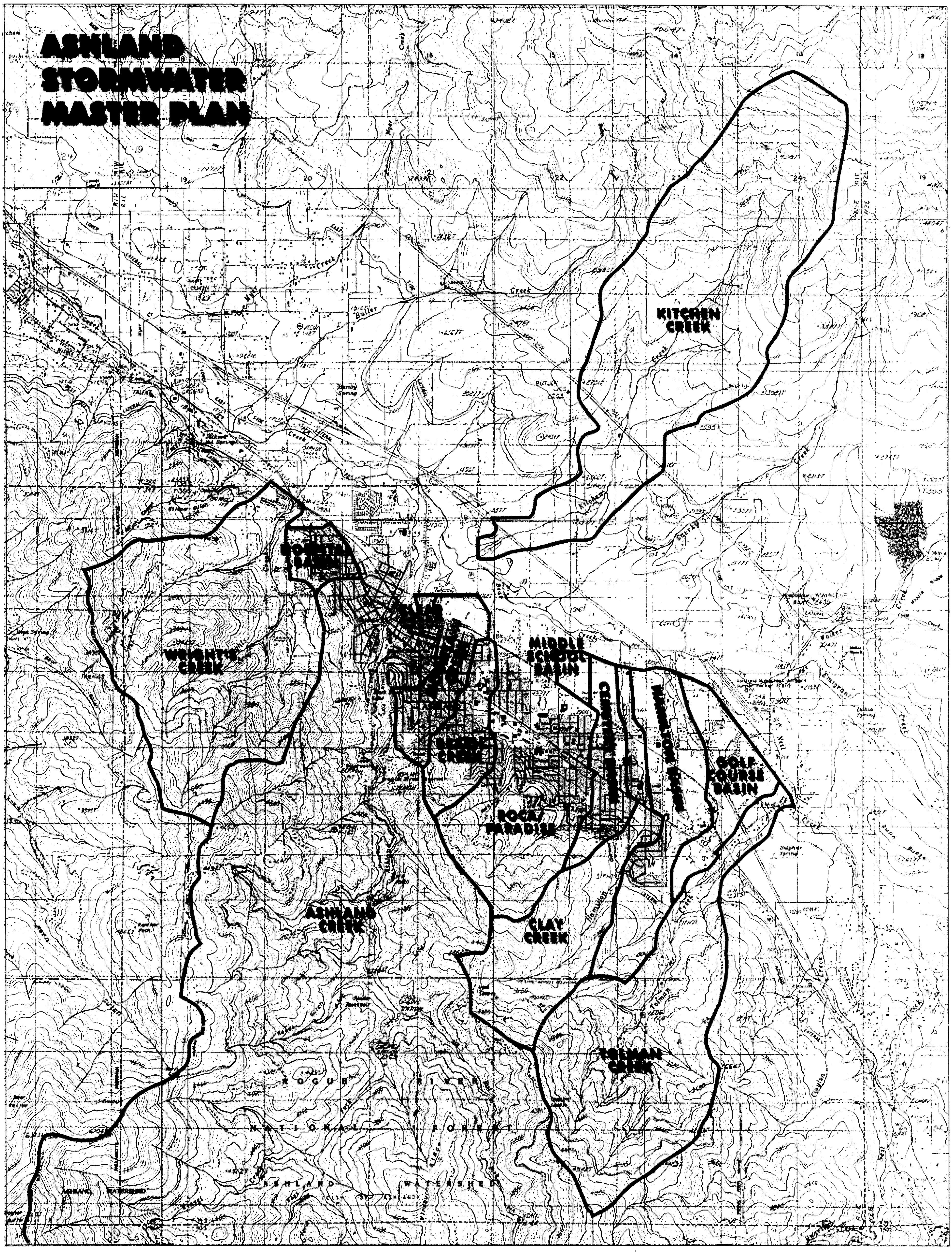
CITY OF ASHLAND - STORM DRAINAGE MASTER PLAN																								
ASHLAND CREEK - STORM TABULATION SHEET																								
25-YEAR STORM; IMPROVEMENT CONDITIONS FOR GRANITE STREET																								
System Labels		**Runoff Area**					**Hydrologic Calculations**				**System Inventory**									**Hydraulic Calculations**				
Station or MH No.	Spur	Area A (acres)	Runoff Coeff. C	Equiv. Area CA (3)x(4)	Spur Sum CA	Total Sum CA (acres)	Time of Conc. Tc (min)	Travel Time-Pipe (min)	Rainfall Intensity I (in/hr)	Design Discharge Q (cfs)	Invert Slope S (%)	Pipe Size D (in.)	Pipe Mat'l	Full Flow Capacity Qf (cfs)	Full Flow Velocity Vf (fps)	Length L (ft.)	Pipe Invert Elevations U/S (ft)	Pipe Invert Elevations D/S (ft)	Top of U/S MH Elev. (ft)	TW Elev. (ft)	Head Loss (grav.) (ft)	Head Loss (pres.) (ft)	HW Elev. (ft)	Surch. or Flood (ft)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A724		0.0	0.00	0.0	0.0	0.0	10.0	0.1	2.26	0.0	3.20	18		18.8	10.7	51	1958.1	1956.4	1963.4	1957.93	0.00	0.00	1957.93	
A722		0.0	0.00	0.0	0.0	0.0	10.1	0.4	2.26	0.0	3.19	15	PVC	11.6	9.4	224	1956.4	1949.3	1961.6	1950.53	0.00	0.00	1950.53	
A720		0.0	0.00	0.0	0.0	0.0	10.5	0.3	2.26	0.0	4.12	18	CONC	21.4	12.1	223	1949.3	1940.1	1953.2	1941.60	0.00	0.00	1941.60	
A718		3.5	0.50	1.8	0.0	1.8	10.8	0.2	2.26	4.0	4.88	18		23.3	13.2	170	1938.1	1929.8	1942.6	1931.30	0.36	0.24	1931.66	
A716		0.0	0.00	0.0	0.0	1.8	11.0	0.2	2.26	4.0	4.42	18		22.1	12.5	149	1929.8	1923.2	1934.8	1925.33	0.33	0.21	1925.66	
A714		14.3	0.41	5.9	0.0	7.6	11.2	0.2	2.18	16.6	0.17	24		9.3	2.9	30	1923.2	1923.2	1927.8	1925.17	0.81	0.16	1925.33	**Surch.**
A712		0.0	0.00	0.0	0.0	7.6	11.4	0.2	2.18	16.6	3.72	24		43.7	13.9	186	1921.6	1914.7	1926.0	1916.67	1.65	1.00	1918.32	
A710		0.0	0.00	0.0	0.0	7.6	11.6	0.2	2.18	16.6	5.87	24		55.0	17.5	168	1914.7	1904.8	1920.0	1906.80	1.55	0.90	1908.35	
A708		4.5	0.50	2.3	0.0	9.9	11.7	0.0	2.18	21.5	3.60	24		43.0	13.7	25	1904.8	***1903.9***	1912.8	1905.90	1.32	0.23	1906.13	
A706		0.0	0.00	0.0	0.0	9.9	11.8	0.1	2.18	21.5	3.51	24		42.5	13.5	56	***1903.9***	1901.9	1911.4	1903.93	1.60	0.51	1905.53	
A704		0.0	0.00	0.0	0.0	9.9	11.8	0.2	2.18	21.5	6.76	18		27.4	15.5	162	1901.9	1891.0	1907.6	1892.48	10.23	6.78	1902.72	
A702		0.0	0.00	0.0	0.0	9.9	12.0	0.1	2.10	20.7	9.10	18		31.8	18.0	109	1891.0	1881.1	1894.4	1882.57	7.44	4.23	1890.00	
A700		1.9	0.65	1.2	0.0	11.1	12.1	0.0	2.10	23.3	12.27	18		36.9	20.9	25	1881.1	1878.0	1885.4	1879.50	5.29	1.23	1880.73	
A758		23.3	0.28	6.4	0.0	6.4	10.0	0.2	2.26	14.5	17.88	***18***		44.5	25.2	260	2092.0	2045.5	2097.0	2047.00	6.50	4.94	2053.50	
A756	A760	0.0	0.00	0.0	7.5	13.9	10.2	0.3	2.26	31.4	14.63	***18***		40.3	22.8	400	2045.5	1987.0	2050.5	1988.50	43.16	35.78	2031.66	
A754		0.0	0.00	0.0	0.0	13.9	10.5	0.3	2.26	31.4	9.38	***18***		32.2	18.2	320	1987.0	1957.0	1992.0	1958.50	36.00	28.63	1987.13	
A752		22.0	0.49	10.7	0.0	24.6	10.8	0.2	2.26	55.5	12.71	***24***		80.9	25.7	350	1957.0	1912.5	1962.0	1915.78	28.37	21.08	1944.16	
A750		0.0	0.00	0.0	0.0	24.6	11.0	0.2	2.26	55.5	0.71	***30***		34.8	7.1	70	1912.5	1912.0	1917.5	1914.50	4.27	1.28	1915.78	**Surch.**
A760		15.0	0.50	7.5	0.0	7.5	10.0	0.3	2.26	17.0	2.22	***18***		15.7	8.9	180	2049.5	2045.5	2054.5	2047.00	6.83	4.68	2051.68	**Surch.**
		84.5	Total Area																					

Appendix C
HEC-1 MODEL INPUT AND OUTPUT

Appendix B

This appendix contains the modeling for the storm systems within the study area. Included in this appendix are models for Cemetery Creek Basin, Beach Creek Basin, Mountain Creek Basin, Ashland Creek Basin, and Hospital Basin. The 10-year and 25-year storms were modeled for existing and future conditions. The systems are included on electronic files to be used in the City's GIS system.

Also included are the proposed improvement projects modeled for the 10-year and 25-year storms. Improvements were designed for the 25-year storm.


ASHLAND
STORMWATER
MASTER PLAN
KITCHEN CREEK
WRIGHT'S CREEK
MIDDLE SCHOOL BASIN
GOLF COURSE BASIN
ROCK/ PARADISE
CLAY CREEK
ASHLAND CREEK
TOLMAN CREEK
ROGUE RIVER
NATIONAL FOREST
ASHLAND WATERSHED

Appendix C

This appendix outlines the hydrologic modeling developed for this report. The following tables present how the parameters were estimated for inputting into the HEC-1 Model.

Table C-1 is a comparison of flows developed by various hydrologic models to justify the selection of the HEC-1 model for this project. The HEC-1 model was compared with the rational method, Santa Barbara Urban Hydrograph Model (SBUH), and the regression equations developed for Western Oregon.

Table C-2 is a summary of the culvert structure evaluation including assumed slopes and measured pipe lengths.

Table C-3 is the summary of how the time of concentration was calculated for each basin. The velocity equation from section 3.5.2 of the King County, Washington, Surface Water Design Manual was used to calculate the channel and overland (Figure 4.3.3B in the Manual) velocities.

Table C-4 is the estimates of undeveloped land use. Undeveloped land use was Forest, Pastures and Open Space, and Lawns. Technical Release 55 (TR-55) developed by the SCS was used to estimate the Hydrologic Curve Numbers for these land uses.

Table C-5 is how the amount of impervious surface was estimated for each land use.

APPENDIX C.

TABLE C-1. COMPARISON OF FLOWS FROM VARIOUS HYDROLOGY METHODS

	Rational Method (cfs)	HEC-1		SBUH		Regression	
		(cfs)	cfs/acre	(cfs)	cfs/acre	(cfs)	cfs/acre
Clay Creek @ E. Main Area = 885 10% Impervious							
2yr		15	0.017	17	0.019	16	0.018
5yr		25	0.028	24	0.027	45	0.051
10yr		45	0.051	38	0.043	78	0.088
25yr		53	0.060	45	0.051	139	0.157
50yr		67	0.076	56	0.063	200	0.226
100yr		92	0.104	76	0.086	283	0.320
Beach Creek @ RR Tracks (136 ac) Area = 136 43% Impervious							
2yr	92	32	0.235	52	0.382	5	0.037
5yr		44	0.324	73	0.537	14	0.103
10yr	104	56	0.412	95	0.699	25	0.184
25yr	110	61	0.449	103	0.757	43	0.316
50yr		68	0.500	117	0.860	61	0.449
100yr		81	0.596	140	1.029	87	0.640
Mountain Creek @ RR Tracks (198 ac.) Area = 198 57% Impervious							
2yr	85	31	0.157	45	0.227	4	0.020
5yr		41	0.207	61	0.308	12	0.061
10yr	89	51	0.258	77	0.389	21	0.106
25yr	96	55	0.278	84	0.424	37	0.187
50yr		61	0.308	94	0.475	52	0.263
100yr		72	0.364	111	0.561	74	0.374

	W. Fork Ashland Creek Area= 6720		E. Fork of Ashland Creek Area= 5210	
	(cfs)	(cfs/acre)	(cfs)	(cfs/acre)
2yr	92	0.014	94	0.018
5yr	267	0.040	278	0.053
10yr	467	0.069	491	0.094
25yr	847	0.126	900	0.173
50yr	1240	0.185	1330	0.255
100yr	1760	0.262	1890	0.363

APPENDIX C.
TABLE C-2. SUMMARY OF STRUCTURE EVALUATION

STRUCTURE	DRAINAGE AREA (ACRES)	SIZE AND TYPE	LENGTH FT	ROAD ELEV.	ASSUMED U/S INVERT	ASSUMED D/S INVERT	ASSUMED SLOPE %	FLOW (CFS)						STRUCTURE CAPACITY (CFS)
								25 YR		50 YR		100 YR		
								EXISTING	FUTURE	EXISTING	FUTURE	EXISTING	FUTURE	
Tolman Creek														
Hwy 99	1683.0	4' X 4' BC						102	102	131	131	184	184	
I-5	1710.0	5' H X 6' V BC						104	104	134	134	187	187	
Crowson Rd.	1735.0	60" CMP	90	1969.0	1961.0	1960.0	1.11%	106	106	136	136	191	191	155
E. Main	1771.0	6' X 6' BC	60	1951.0	1940.0	1939.5	0.83%	110	111	141	142	197	198	492
Golf Course Basin														
GC-100	41.0	18" CMP	80	1942.0	1936.0		0.50%	8	8	9	9	11	11	4
GC-200	6.1	18" CONC.	50	1930.0	1924.0		0.50%	1	1	1	1	2	2	7
GC-350	36.0	*Could Not Locate*						4	4	4	4	6	6	
GC-340	56.4	36" CONC.	55	2094.0	2086.0		0.50%	8	9	10	11	13	13	47
GC-330	15.4	18" CONC.	65	2142.0	2130.0		0.50%	2	2	2	2	3	3	7
GC-320	22.2	36" CMP	70	2106.0	2098.0		0.50%	4	4	4	4	5	5	27
GC-310	108.8	18" CONC.	290	2065.0	2034.0	2032.0	0.50%	19	22	22	25	28	30	7
GC-300	65.4	18"HDPE	100	1921.0	2016.0		0.50%	32	35	37	40	46	48	7
		12"CONC.	100	1921.0	2016.0		0.50%							3
GC-400	6.6	18" CONC.	65	1906.0	2016.0		0.50%	1	1	2	2	2	2	7
GC-500	73.2	24" CONC.	80	1984.0	1978.0		0.50%	19	21	21	24	25	28	16
GC-600	11.0	30" CONC.	70	1885.0	1879.0		0.50%	3	3	3	4	4	4	29
GC-740	55.8	*Could Not Locate*						16	17	18	19	21	22	
GC-730	32.2	*Could Not Locate*						23	27	26	29	30	34	
GC-720	51.5	*Could Not Locate*						28	31	32	36	37	41	
GC-710	11.1	*Could Not Locate*						3	3	3	4	4	4	
GC-700	97.6	36"CMP	60	1878.0	1870.0		0.50%	38	43	44	49	51	57	27
GC-900	21.3	*Could Not Locate*						4	5	5	6	6	7	
Hamilton Creek														
Tolman Cr. Rd.	142.0	36" CMP	40	2300.0	2292.0	2291.5	1.25%	10	10	12	12	17	17	42
Tolman Cr. Rd.	91.8	24" CONC.	70	2184.0	2076.0	2075.5	0.71%	9	9	10	10	13	13	19
Hwy 99	292.1	4' X 6' BC	115	2151.5	2025.0		0.50%	29	29	35	35	46	47	219
School Field	292.1	24" HDPE	670	2131.0	2122.0	2086.0	5.37%	29	29	35	35	46	47	52
RR Tracks	352.8	8' ARCH 5' HIGH	60	2040.0	2020.0		0.50%	41	45	49	53	64	68	210
Mistletoe Rd.	352.8	48" CMP	480	2040.0	2038.0	2030.0	1.67%	41	45	49	53	64	68	105
Hwy 66	393.1	6' X 6' BC	80	1990.0	1972.0		0.50%	48	54	57	64	73	80	381
Hwy 66 @ YMCA	40.2	NO STRUCTURE						10	10	11	11	13	14	
Clay Creek														
Hwy 99	795.0	60" CMP	100	2130.0	2116.0	2115.5	0.50%	32	44	44	57	66	80	85
Diane St.	807.4	96" CMP	65	2084.7	2074.0	2073.6	0.62%	34	46	45	59	68	82	405
RR Tracks	851.4	8' X 4' BC	400	1998.0	1990.0	1986.0	1.00%	38	50	50	64	73	88	443
E. Main St.	885.3	36" CMP	50	1908.0	1902.0	1901.7	0.60%	41	53	53	67	77	92	29
Cemetery Creek														
Clay St.	47.6	18" CMP	600	---	1990.0	1980.0	1.67%	10	11	11	12	13	15	8
RR Tracks	199.0	36" CMP	70	1956.0	1948.5	1948.0	0.71%	46	50	52	56	63	67	32
		36" CMP	70	1974.0	1964.5	1964.0	0.71%							32
E. Main St.	261.2	30" CMP	60	1894.0	1886.5	1886.0	0.83%	62	71	70	79	85	94	21
E. Main St. #2		24" CMP	60	1880.6	1872.5	1872.0	0.83%							12
Middle School														
E. Main - East	33.5	24" CMP	55	1876.0	1871.0	1870.7	0.55%	4	8	5	9	7	10	9
E. Main - West	27.5	24" CMP	45	1876.0	1871.0	1870.8	0.44%	6	7	6	7	8	9	9
Beach Creek														
Village Green Dr.	199.0	60" CMP	180	1838.0	1829.0	1827.0	1.11%	59	61	66	68	79	81	132
Kitchen Creek														
Mountain Ave.	2838.0	72" CMP	110	1784.0	1773.0	1771.0	1.82%	491	491	574	574	716	716	275
Clear Creek														
RR Tracks	27.4	1' X 2' BC	100	1867.0		1850.0	0.50%	12	13	13	14	16	16	8
Hersey St.	41.2	(2) 15" CONC.	80	1845.8	1839.0		0.50%	15	17	16	18	19	22	9
Crispin St.	45.2	36" CONC	50	1817.0	1812.0		0.50%	15	17	16	18	19	22	47
Wright's Creek														
Orchard	79.0	30" CONC.	90	2238.0	2224.0	2220.0	4.44%	2	13	3	15	5	19	87
Wright's Creek Dr.	96.0	30" CONC.	90	2171.0	2162.0	2158.0	4.44%	5	17	6	20	9	24	87
Benjamin Ct.	197.0	42" CONC.	85	2197.0	2180.0	2176.0	4.71%	5	8	7	11	11	16	218
Hwy 99	2084.0	48" CONC.	160	1794.0	1782.0	1776.0	3.75%	117	130	152	166	215	230	278

STRUCTURES THAT WERE FOUND TO BE UNDERSIZED

APPENDIX C.
TABLE C-3. DEVELOPING TIME OF CONCENTRATION FOR EACH BASIN

BASIN	AREA	AREA	OVERLAND FLOW				CHANNEL FLOW					Tc	Lag	Tc	MAIN CHANNEL					
	(ACRES)	(SQ.MI)	LENGTH FT	DELTA H FT	SLOPE %	VEL. FT/SEC	LENGTH FT	ELEV UP	ELEV DOWN	SLOPE %	VEL. FT/SEC	HRS	HRS	MIN	LENGTH FT	U/S ELEV.	D/S ELEV.	SLOPE %	VEL. FT/SEC	Cum. Tc
Tolman																				
	1683	2.630	500	200	40.0%	1.6	10000	4600	2800	18.0%	4.2	0.74	0.44							
Hwy 99							10000	2800	2130	6.7%	2.6	1.81	1.09	109						
I-5	27	0.042	300	6	2.0%	1.0	500	2076	2055	4.2%	4.1	0.12	0.07	7	1800	2130	2055	4.2%	4.1	116
Crowson Rd.	25	0.039	400	20	5.0%	1.6	1200	2036	1965	5.9%	4.9	0.14	0.08	8	2100	2055	1965	4.3%	4.1	125
E. Main	36	0.056	100	6	6.0%	1.7	3000	1965	1942	0.8%	1.8	0.49	0.30	30	600	1965	1942	3.8%	3.9	127
Golf Course Basin																				
GC-100	41	0.064	200	8	4.0%	1.5	2000	2030	1940	4.5%	4.2	0.17	0.10	10						
GC-200	6.1	0.010	600	14	2.3%	1.1	800	1948	1930	2.3%	3.0	0.23	0.14	14						
GC-350	36	0.056	200	8	4.0%	1.5	2000	2800	2140	33.0%	11.5	0.09	0.05	5						
GC-340	20.4	0.032	200	6	3.0%	1.3	600	1948	1910	6.3%	5.0	0.08	0.05	5						
GC-330	15.4	0.024	200	8	4.0%	1.5	2000	2700	2140	28.0%	10.6	0.09	0.05	5						
GC-320	6.8	0.011	100	6	6.0%	1.7	600	2136	2106	5.0%	4.5	0.05	0.03	3						
GC-310	30.2	0.047	300	16	5.3%	1.6	1600	2100	2042	3.6%	3.8	0.17	0.10	10						
GC-300	65.4	0.102	400	6	1.5%	0.8	2800	2000	1922	2.8%	3.3	0.37	0.22	22						
GC-400	6.6	0.010	100	6	6.0%	1.7	800	1960	1910	6.3%	5.0	0.06	0.04	4						
GC-500	73.2	0.114	400	20	5.0%	1.6	3000	2060	1905	5.2%	4.5	0.25	0.15	15						
GC-600	11	0.017	100	4	4.0%	1.5	1200	1961	1900	5.1%	4.5	0.09	0.06	6						
GC-740	55.8	0.087	200	6	3.0%	1.3	2200	2130	2030	4.5%	4.3	0.19	0.11	11						
GC-730	32.2	0.050	300	8	2.7%	1.2	800	2060	1990	8.8%	5.9	0.11	0.06	6						
GC-720	19.3	0.030	100	4	4.0%	1.5	1700	2030	1930	5.9%	4.9	0.12	0.07	7						
GC-710	11.1	0.017	100	4	4.0%	1.5	1600	2018	1980	2.4%	3.1	0.16	0.10	10						
GC-700	35	0.055	200	10	5.0%	1.6	1600	1950	1890	3.8%	3.9	0.15	0.09	9						
GC-800	1.6	0.003	300	30	10.0%	2.3	400	1990	1930	15.0%	7.7	0.05	0.03	3						
GC-900	21.3	0.033	200	6	3.0%	1.3	1200	1950	1840	9.2%	6.1	0.10	0.06	6						
Hamilton Creek																				
H-100	142	0.222	600	200	33.3%	3.0	4000	3000	2330	16.8%	4.1	0.33	0.20	20						
H-200	58.3	0.091	700	30	4.3%	1.6	2800	2172	2125	1.7%	1.3	0.72	0.43	43	2800	2172	2125	1.7%	2.6	38
H-250	91.8	0.143	2000	400	20.0%	3.0	2200	2340	2180	7.3%	2.7	0.41	0.25	25						
H-300	60.7	0.095	400	16	4.0%	1.5	2800	2142	2016	4.5%	2.1	0.44	0.26	26	2600	2125	2016	4.2%	4.1	35
H-400	30.3	0.047	500	14	2.8%	1.2	900	2016	1978	4.2%	2.1	0.24	0.14	14	1500	2016	1978	2.5%	3.2	34
H-500	36.2	0.057	400	12	3.0%	1.3	2200	1976	1872	4.7%	2.2	0.37	0.22	22	2500	1978	1872	4.2%	4.1	24
H-510	31.4	0.049	400	14	3.5%	1.4	2000	1982	1914	3.4%	1.8	0.38	0.23	23						
H-520	14.2	0.022	400	8	2.0%	1.0	800	2000	1980	2.5%	1.6	0.25	0.15	15						
H-530	40.2	0.063	400	12	3.0%	1.3	2400	2125	2018	4.5%	2.1	0.40	0.24	24						
H-540	7.8	0.012	100	4	4.0%	1.5	2200	1992	1872	5.5%	2.3	0.28	0.17	17						
H-600	27.5	0.043	100	2	2.0%	1.0	4500	2018	1886	2.9%	1.7	0.76	0.45	45						
Clay																				
Siskiyou Blvd.	795	1.242	2000	800	40.0%	1.6	11000	3200	2100	10.0%	3.2	1.31	0.79	79						
Diane St.	12.4	0.019	600	36	6.0%	2.0	100	0	0	0.0%	0.0	0.08	0.05	5	700	2114	2074	5.7%	4.8	81
RR Tracks	44	0.069	600	50	8.3%	1.9	2000	2040	1990	2.5%	3.2	0.26	0.16	16	2400	2074	1990	3.5%	3.7	92
E. Main St.	33.9	0.053	700	14	2.0%	2.2	2600	1986	1902	3.2%	3.6	0.29	0.17	17	3000	1990	1902	2.9%	3.4	107
E. Main Basins																				
E-100	23.4	0.037	200	8	4.0%	1.5	1400	1964	1850	8.1%	2.9	0.17	0.10	10						
E-200	1.6	0.003	200	20	10.0%	2.3	250	1906	1900	2.4%	1.5	0.07	0.04	4						
E-300	2.9	0.005	200	4	2.0%	1.0	500	1920	1900	4.0%	2.0	0.13	0.08	8						
E-310	1.8	0.003	250	20	8.0%	2.0	400	1916	1902	3.5%	1.9	0.09	0.06	6						
E-320	23.7	0.037	300	8	2.7%	1.3	2400	1984	1910	3.1%	1.8	0.44	0.27	27						
E-330	21.5	0.034	400	12	3.0%	1.3	2700	1980	1910	2.6%	1.6	0.55	0.33	33						
Middle School																				
E. Main - East	33.5	0.052	600	10	1.7%	0.9	2000	1930	1871	3.0%	1.7	0.51	0.31	31						
E. Main - West	27.5	0.043	600	12	2.0%	1.1	1200	1918	1871	3.9%	2.0	0.32	0.19	19						
Kitchen																				
Mountain Ave.	2838	4.434	600	40	6.7%	1.9	28000	5200	1778	12.2%	7.0	1.20	0.72	72						
Clear Creek																				
RR Tracks	27.4	0.043	400	18	4.5%	1.1	1000	1897	1868	2.9%	1.7	0.26	0.16	16						
Hersey St.	13.8	0.022	200	8	4.0%	2.1	800	1860	1839	2.6%	1.6	0.16	0.10	10	800	1856	1839	2.1%	2.9	20
Crispen St.	4	0.006	50	2	4.0%	1.5	300	1832	1826	2.0%	1.4	0.07	0.04	4	450	1830	1826	0.9%	1.9	14
Wright's																				
Orchard	79	0.123	400	60	15.0%	0.4	3600	3000	2230	21.4%	4.6	0.49	0.30	30						
Wright's Creek Dr.	96	0.150	400	60	15.0%	0.4	4100	3000	2160	20.5%	9.1	0.40	0.24	24						
Benjamin Ct.	197	0.308	600	200	33.3%	1.4	8000	3800	2236	19.6%	8.8	0.37	0.22	22						
Hwy 99	2084	3.256	2000	1000	50.0%	1.7	15000	3600	1800	12.0%	6.9	0.93	0.56	56						

APPENDIX C.
TABLE C-4. DEVELOPING PERVIOUS LAND USE SCS HYDROLOGIC CURVE NUMBERS (CN)

	Forest						Pasture & Open Space						Lawns								
Pervious CN	B 55		C 70		D 77		B 69		C 79		D 84		B 61		C 74		D 80		Total (acreas)	Existing Pervious SCS CN	Future Pervious SCS CN
	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)			
Tolman																					
Hwy 99	340.0	340.0	1343.0	1343.0															1683.0	67	67
I-5							13.5	13.5			13.5	13.5							27.0	77	77
Crowson Rd.							12.5	12.5			12.5	12.5							25.0	77	77
E. Main							13.5				13.5		4.5	18.0			4.5	18.0	36.0	75	71
Golf Course Basin																					
GC-100																	41.0	41.0	41.0	80	80
GC-200																	6.1	6.1	6.1	80	80
GC-350							30.0	30.0			6.0	6.0							36.0	72	72
GC-340											20.4	20.4							20.4	84	84
GC-330							11.4	11.4			4.0	4.0							15.4	73	73
GC-320											6.8	6.8							6.8	84	84
GC-310											15.1						15.1	30.2	30.2	82	80
GC-300																	65.4	65.4	65.4	80	80
GC-400																	6.6	6.6	6.6	80	80
GC-500											20.0						53.2	73.2	73.2	81	80
GC-600											5.5						5.5	11.0	11.0	82	80
GC-740											5.0						50.8	55.8	55.8	80	80
GC-730											24.0						8.2	32.2	32.2	83	80
GC-720											8.0						11.3	19.3	19.3	82	80
GC-710											5.0						6.1	11.1	11.1	82	80
GC-700											30.0						5.0	35.0	35.0	83	80
GC-800											1.6							1.6	1.6	84	80
GC-900											21.3							21.3	21.3	84	80
Hamilton Creek																					
H-100	36.0	36.0	36.0	36.0			35.0	35.0	35.0	35.0									142.0	68	68
H-200							13.3	13.3			10.0	10.0	17.5	17.5			17.5	17.5	58.3	72	72
H-250							21.8	21.8	15.0	15.0			20.0	20.0	15.0	15.0	20.0	20.0	91.8	72	72
H-300											30.7						30.0	60.7	60.7	82	80
H-400											30.3	30.3							30.3	84	84
H-500											36.2							36.2	36.2	84	80
H-510											11.4						20.0	31.4	31.4	81	80
H-520											14.2							14.2	14.2	84	80
H-530											8.2						32.0	40.2	40.2	81	80
H-540																	7.8	7.8	7.8	80	80
H-600											27.5							27.5	27.5	84	80
Clay Basin																					
U/S of Siskiyou Blvd	384.0	354.5	384.0	354.5													27.0	86.0	795.0	63	64
U/S of Diane St.		0.6					0.6				2.8						9.0	11.8	12.4	80	79
U/S of RR Tracks		2.0					4.0				10.0						30.0	42.0	44.0	80	79
U/S of E. Main St.											10.0	10.0					18.7	18.7	28.7	81	81
E. Main Basins																					
E-100											23.4							23.4	23.4	84	80
E-200											1.0						0.6	1.6	1.6	83	80
E-300											2.9							2.9	2.9	84	80
E-310											1.0						0.8	1.8	1.8	82	80
E-320											23.7							23.7	23.7	84	80
E-330											21.5							21.5	21.5	84	80
Middle School																					
East							8.0				8.0		9.0	10.5			8.0	23.0	33.3	73	75
West							3.5				4.0		10.0	20.0			10.0	7.5	27.5	72	66
Kitchen																					
Mountain Ave.									568.0	568.0	2270.0	2270.0							2838.0	83	83
Clear Creek																					
RR Tracks																	27.4	27.4	27.4	80	80
Hersey St.											13.8							13.8	13.8	84	80
Crispen St.																	4.0	4.0	4.0	80	80
Wright's																					
Orchard	59.0						20.0									79.0			79.0	59	74
Wright's Creek Dr.	59.0						20.0								17.0	96.0			96.0	61	74
Benjamin Ct.	148.0	148.0					49.0									49.0			197.0	58	60
Hwy 99	521.0	521.0	1042.0	1042.0			471.0	441.0							50.0	80.0			2084.0	66	66

APPENDIX C.
TABLE C-5. DEVELOPING IMPERVIOUS LAND AMOUNTS FOR EXISTING AND FUTURE CONDITIONS

Impervious %	0 Impervious 0%		Multi Family 65%		3,500 SqFt 60%		5,000 SqFt 50%		7,500 SqFt 45%		10,000 SqFt 38%		0.5 Acre 25%		1 Acre 20%		Com. & ROW 80%		Industrial 60%		Area	Existing Impervious	Future Impervious	Existing Impervious Area	Future Impervious Area
	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	Exist (ac)	Future (ac)	(acreas)	%	%	(ac)	(ac)
Tolman																									
Hwy 99	1683	1683																			1683	0%	0%	0.0	0.0
I-5	17.0	17.0													10.0	10.0					27.0	7%	7%	2.0	2.0
Crowson Rd.	15.0	15.0													10.0	10.0					25.0	8%	8%	2.0	2.0
E. Main	27.0										9.0	36.0									36.0	10%	38%	3.4	13.7
Golf Course Basin																									
GC-100	30.3	30.3							10.7	10.7											41.0	12%	12%	4.8	4.8
GC-200	6.1	6.1																			6.1	0%	0%	0.0	0.0
GC-350	36.0	36.0																			36.0	0%	0%	0.0	0.0
GC-340	10.2																		10.2	20.4	20.4	30%	60%	6.1	12.2
GC-330	15.4	15.4																			15.4	0%	0%	0.0	0.0
GC-320	0.8		6.0	6.8																	6.8	57%	65%	3.9	4.4
GC-310	15.1																15.1	30.2			30.2	40%	80%	12.1	24.2
GC-300	30.0	30.0							35.4	35.4											65.4	24%	24%	15.9	15.9
GC-400	2.0	2.0							4.6	4.6											6.6	31%	31%	2.1	2.1
GC-500	19.1								35.0	35.0							19.1	38.2			73.2	42%	63%	31.0	46.3
GC-600	5.5																5.5	11.0			11.0	40%	80%	4.4	8.8
GC-740	5.0																50.8	55.8			55.8	73%	80%	40.6	44.6
GC-730	24.0																8.2	32.2			32.2	20%	80%	6.6	25.8
GC-720	8.0																11.3	19.3			19.3	47%	80%	9.0	15.4
GC-710	5.0																6.1	11.1			11.1	44%	80%	4.9	8.9
GC-700	30.0									30.0							5.0	5.0			35.0	11%	50%	4.0	17.5
GC-800	1.6									1.6											1.6	0%	45%	0.0	0.7
GC-900	21.3									21.3											21.3	0%	45%	0.0	9.6
Hamilton Creek																									
H-100	142.0	142.0																			142.0	0%	0%	0.0	0.0
H-200	23.3	23.3							35.0	35.0											58.3	27%	27%	15.8	15.8
H-250	51.8	41.8							40.0	50.0											91.8	20%	25%	18.0	22.5
H-300	38.7							35.7			10.0						12.0	25.0			60.7	22%	62%	13.4	37.9
H-400	15.3																15.0	30.3			30.3	40%	80%	12.0	24.2
H-500	18.1																18.1	36.2			36.2	40%	80%	14.5	29.0
H-510	16.4						5.0	21.4									10.0	10.0			31.4	33%	60%	10.5	18.7
H-520	10.0																4.2	14.2			14.2	24%	80%	3.4	11.4
H-530	5.2							5.2	25.0	25.0							10.0	10.0			40.2	48%	54%	19.3	21.9
H-540																	7.8	7.8			7.8	80%	80%	6.2	6.2
H-600	7.5							7.5									2.0	2.0			9.5	17%	56%	1.6	5.4
Clay Basin																									
U/S of Siskiyou Blvd	768.0	709.0							27.0	86.0											795.0	2%	5%	12.2	38.7
U/S of Diane St.	3.4	0.0	4.0	4.0			5.0	8.4													12.4	41%	55%	5.1	6.8
U/S of RR Tracks	14.0	0.0					29.0	41.5									1.0	2.5			44.0	35%	52%	15.3	22.8
U/S of E. Main St.	10.0	10.0	12.4	12.4	6.3	6.3											5.2	5.2			33.9	47%	47%	16.0	16.0
E. Main Basins																									
E-100	23.4							23.4													23.4	0%	50%	0.0	11.7
E-200	1.0																0.6	1.6			1.6	30%	80%	0.5	1.3
E-300	2.9							2.9													2.9	0%	50%	0.0	1.5
E-310	1.0																0.8	1.8			1.8	36%	80%	0.6	1.4
E-320	23.7							23.7													23.7	0%	50%	0.0	11.9
E-330	21.5							21.5													21.5	0%	50%	0.0	10.8
Middle School																									
E. Main - East	16.0							33.5					17.5								33.5	13%	50%	4.4	16.8
E. Main - West	7.5																		20.0	27.5	27.5	44%	60%	12.0	16.5
Kitchen																									
Mountain Ave.	2838	2838																			2838	0%	0%	0.0	0.0
Clear Creek																									
RR Tracks									12.4	12.4							2.5	2.5	12.5	12.5	27.4	55%	55%	15.1	15.1
Hersey St.	13.8							6.9													13.8	0%	55%	0.0	7.6
Crispen St.							4.0	4.0													4.0	50%	50%	2.0	2.0
Wright's																									
Orchard	79.0									10.0				69.0							79.0	0%	28%	0.0	21.8
Wright's Creek Dr.	79.0								17.0	27.0				69.0							96.0	8%	31%	7.7	29.4
Benjamin Ct.	197.0	148.0												49.0							197.0	0%	6%	0.0	12.3
Hwy 99	2034	1795							50.0	70.0				219.0							2084	1%	4%	22.5	86.3

APPENDIX C.
HEC-1 MODELING FOR TOLMAN CREEK
AND GOLF COURSE BASINS

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HEC1 S/N: 1343001167       HMVersion: 6.33    Data File: tolman.hc1

*****************************************                          ***************************************
*                                       *                          *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                          *    U.S. ARMY CORPS OF ENGINEERS     *
*              MAY   1991               *                          *    HYDROLOGIC ENGINEERING CENTER    *
*           VERSION 4.0.1E              *                          *          609 SECOND STREET          *
*                                       *                          *       DAVIS, CALIFORNIA 95616       *
*  RUN DATE  04/19/1999  TIME  17:54:25 *                          *           (916) 756-1104            *
*                                       *                          *                                     *
*****************************************                          ***************************************


                    X     X  XXXXXXX   XXXXX          X
                    X     X  X        X     X        XX
                    X     X  X        X               X
                    XXXXXXX  XXXX     X       XXXXX   X
                    X     X  X        X               X
                    X     X  X        X     X         X
                    X     X  XXXXXXX   XXXXX         XXX


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                :::                                     :::
                :::  Full Microcomputer Implementation  :::
                :::                by                   :::
                :::        Haestad Methods, Inc.        :::
                :::                                     :::
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                :::::::::::::::::::::::::::::::::::::::::::

       37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID           CITY OF ASHLAND STORM WATER AND DRAINAGE MASTER PLAN
  2           ID           EXISTING AND BUILT-OUT CONDITIONS
  3           ID           RAINFALL DISTRIBUTION - SCS 1A
  4           ID           PREPARED BY KCM INC., MARCH, 1999
  5           ID           TOLMAN CREEK AND GOLF COURSE BASINS
  6           IT       2                1080
  7           IO       5       0
  8           JP       2
              *          2-YR    5-YR    10-YR   25-YR   50-YR   100-YR
  9           JR    PREC     2.0     2.5     3.0     3.2     3.5     4.0
              *

 10           KK    T100  TOLMAN CREEK UPSTREAM OF HWY 99
 11           KM           RUNOFF FROM BASIN T100
 12           BA   2.630
 13           BF    -1.0    -.07    1.07
 14           IN      30
 15           PC    .010    .013    .025    .038    .050    .067    .083    .102    .120    .141
 16           PC    .162    .194    .225    .257    .288    .335    .383    .436    .488    .529
 17           PC    .569    .592    .614    .637    .660    .679    .698    .717    .735    .752
 18           PC    .768    .783    .797    .812    .826    .841    .855    .870    .884    .897
 19           PC    .910    .923    .935    .947    .959    .969    .979    .990    1.00
 20           LS       0      67       0
 21           UD     .44
              *          FUTURE HYDROLOGY
 22           KP       2
 23           LS       0      67       0
 24           UD     .44
              *

 25           KK  RTT100
 26           KM           ROUTE BASIN T100
 27           RT       0               4
              *

 28           KK    T200  TOLMAN CREEK BETWEEN HWY 99 & I-5
 29           KM           RUNOFF FROM BASIN T200
 30           BA   0.042
 31           LS       0      77       7
 32           UD     .07
              *          FUTURE HYDROLOGY
 33           KP       2
 34           LS       0      77       7
 35           UD     .07
              *

 36           KK    CMB1  COMBINE T100 & T200
 37           KM           TOLMAN CREEK FLOW AT I-5
 38           HC       2
              *
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 39           KK  RTT200  ROUTE FLOW BETWEEN I-5 & CROWSON ROAD
 40           KM            ROUTE CMB1
 41           RT       5
              *

 42           KK    T300  TOLMAN CREEK BETWEEN I-5 & CROWSON ROAD
 43           KM            RUNOFF FROM BASIN T300
 44           BA   0.039
 45           LS       0      77       8
 46           UD     .08
              *
 47           KP       2
 48           LS       0      77       8
 49           UD     .08
              *

 50           KK    CMB2  COMBINE T300 & CMB1
 51           KM            TOLMAN CREEK FLOW AT CROWSON ROAD
 52           HC       2
              *

 53           KK  RTT300  ROUTE FLOW BETWEEN CROWSON ROAD AND EAST MAIN
 54           KM            ROUTE CMB2
 55           RT       1
              *

 56           KK    T400  RUNOFF FROM BAISN BETWEEN CROWSON ROAD & E. MAIN
 57           KM            RUNOFF FROM BASIN T400
 58           BA    .056
 59           LS       0      75      10
 60           UD      .3
              *           FUTURE HYDROLOGY
 61           KP       2
 62           LS       0      71      38
 63           UD      .3
              *

 64           KK    CMB3  COMBINE CMB2 & T400
 65           KM            TOLMAN CREEK FLOWS AT E. MAIN
 66           HC       2
              *
              * GOLF COURSE AREA
              *

 67           KK    G100
 68           KM            RUNOFF FROM BASIN G100
 69           BA   0.064
 70           LS       0      80      12
 71           UD    0.10
              *           FUTURE HYDROLOGY
 72           KP       2
 73           LS       0      80      12
 74           UD    0.10
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


  75          KK    G200
  76          KM            RUNOFF FROM BASIN G200
  77          BA   0.010
  78          LS       0      80       0
  79          UD    0.14
              *
  80          KP       2
  81          LS       0      80       0
  82          UD    0.14
              *

  83          KK    G350
  84          KM            RUNOFF FROM BASIN G-350
  85          BA   0.056
  86          LS       0      72       0
  87          UD    0.05
              *           FUTURE HYDROLOGY
  88          KP       2
  89          LS       0      72       0
  90          UD    0.05
              *

  91          KK    G340
  92          KM            RUNOFF FROM G-340
  93          BA   0.032
  94          LS       0      84      30
  95          UD    0.08
              *
  96          KP       2
  97          LS       0      84      60
  98          UD    0.08
              *

  99          KK    CMB4
 100          KM            COMBINE G340 & G350
 101          HC       2
              *

 102          KK    G330
 103          KM            RUNOFF FROM G-330
 104          BA   0.024
 105          LS       0      73       0
 106          UD    0.09
              *           FUTURE HYDROLOGY
 107          KP       2
 108          LS       0      73       0
 109          UD    0.09
              *
```

```
LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 110           KK    G320
 111           KM            RUNOFF FROM BASIN G-320
 112           BA   0.011
 113           LS       0      84      57
 114           UD     .03
               *           FUTURE HYDROLOGY
 115           KP       2
 116           LS       0      84      65
 117           UD     .03
               *

 118           KK    CMB5
 119           KM            COMBINE G330 & G320
 120           HC       2
               *

 121           KK    G310
 122           KM            RUNOFF FROM BASIN G-310
 123           BA   0.047
 124           LS       0      82      40
 125           UD    0.10
               *           FUTURE HYDROLOGY
 126           KP       2
 127           LS       0      80      80
 128           UD    0.10
               *

 129           KK    CMB6
 130           KM            COMBINE G310 & G320 & G340
 131           HC       3
               *

 132           KK     RT4
 133           KM            ROUTE COMBINE 6
 134           RT       0               6
               *

 135           KK    G300
 136           KM            RUNOFF FROM BASIN G300
 137           BA   0.102
 138           LS       0      80      24
 139           UD    0.22
               *
 140           KP       2
 141           LS       0      80      24
 142           UD    0.22
               *

 143           KK    CMB7
 144           KM            COMBINE G300 & G310
 145           HC       2
               *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 146          KK    G400
 147          KM           BASIN G400
 148          BA   0.010
 149          LS       0      80      31
 150          UD    0.04
              *
 151          KP       2
 152          LS       0      80      31
 153          UD    0.04
              *

 154          KK    G500
 155          KM           BASIN G500
 156          BA   0.114
 157          LS       0      81      42
 158          UD    0.15
              *
 159          KP       2
 160          LS       0      80      63
 161          UD    0.15
              *

 162          KK    CMB8
 163          KM           COMBINE G500 & G400
 164          HC       2
              *

 165          KK    G600
 166          KM           BASIN G600
 167          BA   0.017
 168          LS       0      82      40
 169          UD    0.06
              *
 170          KP       2
 171          LS       0      80      80
 172          UD    0.06
              *

 173          KK    G740
 174          KM           BASIN G740
 175          BA   0.087
 176          LS       0      80      73
 177          UD    0.11
              *
 178          KP       2
 179          LS       0      80      80
 180          UD    0.11
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 181          KK     RT5
 182          KM             ROUTE G740
 183          RT       0               3
              *

 184          KK    G730
 185          KM             BASIN G730
 186          BA    0.05
 187          LS       0      83      20
 188          UD    0.06
              *
 189          KP       2
 190          LS       0      80      80
 191          UD    0.06
              *

 192          KK    CMB9
 193          KM             COMBINE G730 & G740
 194          HC       2
              *

 195          KK    G720
 196          KM             BASIN G720
 197          BA    0.03
 198          LS       0      82      47
 199          UD    0.07
              *
 200          KP       2
 201          LS       0      80      80
 202          UD    0.07
              *

 203          KK   CMB10
 204          KM             COMBINE G720 & G730
 205          HC       2
              *

 206          KK    G710
 207          KM             BASIN G710
 208          BA   0.017
 209          LS       0      82      44
 210          UD    0.10
              *
 211          KP       2
 212          LS       0      80      80
 213          UD    0.10
              *

 214          KK   CMB11
 215          KM             COMBINE G710 & CMB10
 216          HC       2
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 217          KK     RT6
 218          KM            ROUTE CMB11
 219          RT       3
              *

 220          KK    G700
 221          KM            BASIN G700
 222          BA   0.055
 223          LS       0      83      11
 224          UD    0.09
              *
 225          KP       2
 226          LS       0      80      50
 227          UD    0.09
              *

 228          KK   CMB12
 229          KM            COMBINE G700 & CMB11
 230          HC       2
              *

 231          KK    G800
 232          KM            BASIN G800
 233          BA   0.003
 234          LS       0      84       0
 235          UD    0.03
              *
 236          KP       2
 237          LS       0      80      45
 238          UD    0.03
              *

 239          KK    G900
 240          KM            BASIN G900
 241          BA   0.033
 242          LS       0      84       0
 243          UD    0.06
              *
 244          KP       2
 245          LS       0      80      45
 246          UD    0.06
              *
 247          ZZ
```

```
HEC1 S/N: 1343001167       HMVersion: 6.33    Data File: tolman.hc1

*****************************************                               ****************************************
*                                       *                               *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                               *   U.S. ARMY CORPS OF ENGINEERS      *
*              MAY   1991               *                               *   HYDROLOGIC ENGINEERING CENTER     *
*           VERSION 4.0.1E              *                               *        609 SECOND STREET            *
*                                       *                               *     DAVIS, CALIFORNIA 95616         *
*  RUN DATE  04/19/1999  TIME  17:54:25 *                               *         (916) 756-1104              *
*                                       *                               *                                      *
*****************************************                               ****************************************



                                    CITY OF ASHLAND STORM WATER AND DRAINAGE MASTER PLAN
                                    EXISTING AND BUILT-OUT CONDITIONS
                                    RAINFALL DISTRIBUTION - SCS 1A
                                    PREPARED BY KCM INC., MARCH, 1999
                                    TOLMAN CREEK AND GOLF COURSE BASINS

   7 IO          OUTPUT CONTROL VARIABLES
                       IPRNT           5  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN           2  MINUTES IN COMPUTATION INTERVAL
                       IDATE      1    0  STARTING DATE
                       ITIME        0000  STARTING TIME
                          NQ        1080  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      2    0  ENDING DATE
                      NDTIME        1158  ENDING TIME
                      ICENT           19  CENTURY MARK

                 COMPUTATION INTERVAL    0.03 HOURS
                      TOTAL TIME BASE   35.97 HOURS

        ENGLISH UNITS
             DRAINAGE AREA         SQUARE MILES
             PRECIPITATION DEPTH   INCHES
             LENGTH, ELEVATION     FEET
             FLOW                  CUBIC FEET PER SECOND
             STORAGE VOLUME        ACRE-FEET
             SURFACE AREA          ACRES
             TEMPERATURE           DEGREES FAHRENHEIT

     JP          MULTI-PLAN OPTION
                       NPLAN           2  NUMBER OF PLANS

     JR          MULTI-RATIO OPTION
                     RATIOS OF PRECIPITATION
                    2.00      2.50      3.00      3.20      3.50      4.00
```

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIO 1 2.00	RATIO 2 2.50	RATIO 3 3.00	RATIO 4 3.20	RATIO 5 3.50	RATIO 6 4.00
					RATIOS APPLIED TO PRECIPITATION					
HYDROGRAPH AT										
	T100	2.63	1	FLOW	25.	43.	84.	102.	131.	184.
				TIME	18.83	18.80	10.17	10.17	10.13	10.13
			2	FLOW	25.	43.	84.	102.	131.	184.
				TIME	18.83	18.80	10.17	10.17	10.13	10.13
ROUTED TO										
	RTT100	2.63	1	FLOW	25.	43.	84.	102.	131.	184.
				TIME	18.97	18.93	10.30	10.30	10.27	10.27
			2	FLOW	25.	43.	84.	102.	131.	184.
				TIME	18.97	18.93	10.30	10.30	10.27	10.27
HYDROGRAPH AT										
	T200	0.04	1	FLOW	1.	2.	4.	4.	5.	6.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	1.	2.	4.	4.	5.	6.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
2 COMBINED AT										
	CMB1	2.67	1	FLOW	25.	44.	86.	104.	134.	187.
				TIME	18.97	18.93	10.30	10.30	10.27	10.23
			2	FLOW	25.	44.	86.	104.	134.	187.
				TIME	18.97	18.93	10.30	10.30	10.27	10.23
ROUTED TO										
	RTT200	2.67	1	FLOW	25.	44.	86.	104.	134.	187.
				TIME	18.97	18.93	10.30	10.30	10.27	10.23
			2	FLOW	25.	44.	86.	104.	134.	187.
				TIME	18.97	18.93	10.30	10.30	10.27	10.23
HYDROGRAPH AT										
	T300	0.04	1	FLOW	1.	2.	3.	4.	5.	6.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	1.	2.	3.	4.	5.	6.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
2 COMBINED AT										
	CMB2	2.71	1	FLOW	26.	46.	88.	106.	136.	191.
				TIME	18.97	18.93	10.30	10.30	10.27	10.03
			2	FLOW	26.	46.	88.	106.	136.	191.
				TIME	18.97	18.93	10.30	10.30	10.27	10.03
ROUTED TO										
	RTT300	2.71	1	FLOW	26.	46.	88.	106.	136.	191.
				TIME	18.97	18.93	10.30	10.30	10.27	10.03
			2	FLOW	26.	46.	88.	106.	136.	191.
				TIME	18.97	18.93	10.30	10.30	10.27	10.03
HYDROGRAPH AT										
	T400	0.06	1	FLOW	2.	3.	4.	5.	6.	7.
				TIME	10.07	9.17	9.13	9.13	9.13	9.10
			2	FLOW	3.	4.	6.	6.	7.	9.
				TIME	9.10	9.10	9.10	9.10	9.07	9.07
2 COMBINED AT										
	CMB3	2.77	1	FLOW	27.	47.	91.	110.	141.	197.
				TIME	18.93	10.37	10.30	10.27	10.27	10.03
			2	FLOW	27.	48.	92.	111.	142.	198.
				TIME	18.93	10.33	10.30	10.27	10.23	10.03
HYDROGRAPH AT										
	G100	0.06	1	FLOW	3.	5.	7.	8.	9.	11.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	3.	5.	7.	8.	9.	11.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	G200	0.01	1	FLOW	0.	1.	1.	1.	1.	2.
				TIME	9.03	9.03	9.03	9.03	9.03	9.03
			2	FLOW	0.	1.	1.	1.	1.	2.
				TIME	9.03	9.03	9.03	9.03	9.03	9.03
HYDROGRAPH AT										
	G350	0.06	1	FLOW	1.	2.	3.	4.	4.	6.
				TIME	10.00	10.00	9.00	9.00	9.00	9.00
			2	FLOW	1.	2.	3.	4.	4.	6.
				TIME	10.00	10.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	G340	0.03	1	FLOW	3.	4.	5.	5.	6.	7.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	3.	4.	5.	6.	6.	8.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00

2 COMBINED AT										
	CMB4	0.09	1	FLOW	3.	5.	8.	8.	10.	13.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	4.	6.	8.	9.	11.	13.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	G330	0.02	1	FLOW	0.	1.	1.	2.	2.	3.
				TIME	10.00	10.00	9.03	9.00	9.00	9.00
			2	FLOW	0.	1.	1.	2.	2.	3.
				TIME	10.00	10.00	9.03	9.00	9.00	9.00
HYDROGRAPH AT										
	G320	0.01	1	FLOW	1.	1.	2.	2.	2.	3.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	1.	2.	2.	2.	2.	3.
				TIME	9.00	9.00	9.00	8.50	8.50	8.50
2 COMBINED AT										
	CMB5	0.04	1	FLOW	1.	2.	3.	4.	4.	5.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	1.	2.	3.	4.	4.	5.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	G310	0.05	1	FLOW	4.	5.	7.	7.	8.	10.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	5.	7.	9.	9.	10.	12.
				TIME	8.53	8.53	8.53	8.53	8.53	8.53
3 COMBINED AT										
	CMB6	0.17	1	FLOW	8.	13.	17.	19.	22.	28.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	11.	15.	20.	22.	25.	30.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
ROUTED TO										
	RT4	0.17	1	FLOW	8.	13.	17.	19.	22.	28.
				TIME	9.20	9.20	9.20	9.20	9.20	9.20
			2	FLOW	11.	15.	20.	22.	25.	30.
				TIME	9.20	9.20	9.20	9.20	9.20	9.20
HYDROGRAPH AT										
	G300	0.10	1	FLOW	6.	9.	12.	13.	15.	18.
				TIME	9.07	9.07	9.07	9.03	9.03	9.03
			2	FLOW	6.	9.	12.	13.	15.	18.
				TIME	9.07	9.07	9.07	9.03	9.03	9.03
2 COMBINED AT										
	CMB7	0.27	1	FLOW	14.	21.	29.	32.	37.	46.
				TIME	9.13	9.10	9.10	9.10	9.10	9.10
			2	FLOW	17.	24.	32.	35.	40.	48.
				TIME	9.10	9.10	9.10	9.10	9.10	9.10
HYDROGRAPH AT										
	G400	0.01	1	FLOW	1.	1.	1.	1.	2.	2.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	1.	1.	1.	1.	2.	2.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	G500	0.11	1	FLOW	9.	12.	16.	18.	20.	24.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	11.	15.	18.	20.	22.	26.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
2 COMBINED AT										
	CMB8	0.12	1	FLOW	10.	13.	17.	19.	21.	25.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	12.	16.	20.	21.	24.	28.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	G600	0.02	1	FLOW	1.	2.	2.	3.	3.	4.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	2.	3.	3.	3.	4.	4.
				TIME	8.50	8.50	8.50	8.50	8.50	8.50
HYDROGRAPH AT										
	G740	0.09	1	FLOW	9.	12.	15.	16.	18.	21.
				TIME	8.53	8.53	8.53	8.53	8.53	8.53
			2	FLOW	10.	13.	16.	17.	19.	22.
				TIME	8.53	8.53	8.53	8.53	8.53	8.53
ROUTED TO										
	RT5	0.09	1	FLOW	9.	12.	15.	16.	18.	21.
				TIME	8.63	8.63	8.63	8.63	8.63	8.63
			2	FLOW	10.	13.	16.	17.	19.	22.
				TIME	8.63	8.63	8.63	8.63	8.63	8.63
HYDROGRAPH AT										
	G730	0.05	1	FLOW	3.	5.	6.	7.	8.	10.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	6.	7.	9.	10.	11.	12.
				TIME	8.50	8.50	8.50	8.50	8.50	8.50

2 COMBINED AT										
	CMB9	0.14	1	FLOW	13.	17.	21.	23.	26.	30.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	16.	20.	25.	27.	29.	34.
				TIME	8.53	8.53	8.53	8.53	8.53	8.53
HYDROGRAPH AT										
	G720	0.03	1	FLOW	3.	4.	5.	5.	6.	7.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	3.	4.	5.	6.	6.	7.
				TIME	8.50	8.50	8.50	8.50	8.50	8.50
2 COMBINED AT										
	CMB10	0.17	1	FLOW	15.	21.	26.	28.	31.	37.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	19.	25.	30.	32.	36.	41.
				TIME	8.53	8.53	8.53	8.53	8.53	8.53
HYDROGRAPH AT										
	G710	0.02	1	FLOW	1.	2.	3.	3.	3.	4.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	2.	3.	3.	3.	4.	4.
				TIME	8.50	8.50	8.50	8.50	8.50	8.50
2 COMBINED AT										
	CMB11	0.18	1	FLOW	17.	22.	28.	31.	34.	41.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	21.	27.	33.	36.	39.	46.
				TIME	8.53	8.53	8.53	8.53	8.53	8.53
ROUTED TO										
	RT6	0.18	1	FLOW	17.	22.	28.	31.	34.	41.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	21.	27.	33.	36.	39.	46.
				TIME	8.53	8.53	8.53	8.53	8.53	8.53
HYDROGRAPH AT										
	G700	0.05	1	FLOW	3.	5.	7.	7.	8.	10.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	5.	6.	8.	9.	10.	12.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
2 COMBINED AT										
	CMB12	0.24	1	FLOW	20.	27.	35.	38.	43.	51.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	26.	33.	41.	44.	49.	57.
				TIME	8.53	8.53	8.53	8.53	8.53	8.53
HYDROGRAPH AT										
	G800	0.00	1	FLOW	0.	0.	0.	0.	0.	1.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	0.	0.	0.	0.	1.	1.
				TIME	8.97	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	G900	0.03	1	FLOW	2.	3.	4.	4.	5.	6.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	3.	4.	5.	5.	6.	7.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00

*** NORMAL END OF HEC-1 ***

APPENDIX C.
HEC-1 MODELING FO HAMILTON CREEK AND BASINS ALONG E. MAIN AVENUE

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HEC1 S/N: 1343001167        HMVersion: 6.33    Data File: ASHLAND.hc1

*****************************************                    ***************************************
*                                       *                    *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                    *    U.S. ARMY CORPS OF ENGINEERS     *
*              MAY   1991               *                    *    HYDROLOGIC ENGINEERING CENTER    *
*           VERSION 4.0.1E              *                    *         609 SECOND STREET           *
*                                       *                    *       DAVIS, CALIFORNIA 95616       *
*  RUN DATE  03/18/1999  TIME  21:58:23 *                    *           (916) 756-1104            *
*                                       *                    *                                     *
*****************************************                    ***************************************


                X     X  XXXXXXX   XXXXX           X
                X     X  X        X     X         XX
                X     X  X        X                X
                XXXXXXX  XXXX     X        XXXXX   X
                X     X  X        X                X
                X     X  X        X     X          X
                X     X  XXXXXXX   XXXXX          XXX


            ::::::::::::::::::::::::::::::::::::::::::
            ::::::::::::::::::::::::::::::::::::::::::
            :::                                    :::
            :::  Full Microcomputer Implementation :::
            :::                 by                 :::
            :::        Haestad Methods, Inc.       :::
            :::                                    :::
            ::::::::::::::::::::::::::::::::::::::::::
            ::::::::::::::::::::::::::::::::::::::::::

     37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID           CITY OF ASHLAND STORM WATER AND DRAINAGE MASTER PLAN
  2           ID           CITY OF ASHLAND STORM WATER AND DRAINAGE MASTER PLAN
  3           ID           EXISTING AND BUILT-OUT CONDITIONS
  4           ID           RAINFALL DISTRIBUTION - SCS 1A
  5           ID           PREPARED BY KCM INC., MARCH, 1999
  6           ID           HAMILTON CREEK AND BASINS AROUND E. MAIN & I-5
  7           IT       2                   1080
  8           IO       5       0
  9           JP       2
              *          2-YR    5-YR    10-YR   25-YR   50-YR   100-YR
 10           JR    PREC     2.0     2.5     3.0     3.2     3.5     4.0
              *

 11           KK    H100
 12           KM           RUNOFF FROM BASIN H100
 13           BA   0.222
 14           BF    -1.0    -.07    1.07
 15           IN      30
 16           PC    .010    .013    .025    .038    .050    .067    .083    .102    .120    .141
 17           PC    .162    .194    .225    .257    .288    .335    .383    .436    .488    .529
 18           PC    .569    .592    .614    .637    .660    .679    .698    .717    .735    .752
 19           PC    .768    .783    .797    .812    .826    .841    .855    .870    .884    .897
 20           PC    .910    .923    .935    .947    .959    .969    .979    .990    1.00
 21           LS       0      68       0
 22           UD     .20
              *          FUTURE HYDROLOGY
 23           KP       2
 24           LS       0      68       0
 25           UD    0.20
              *

 26           KK  RTH100
 27           KM           ROUTE BASIN H100
 28           RT       0              19
              *

 29           KK    H200
 30           KM           RUNOFF FROM BASIN H200
 31           BA   0.091
 32           LS       0      72      27
 33           UD     .43
              *          FUTURE HYDROLOGY
 34           KP       2
 35           LS       0      72      27
 36           UD     .43
              *

 37           KK    H250
 38           KM           RUNOFF FROM BASIN H250
 39           BA   0.143
 40           LS       0      72      20
 41           UD    0.25
              *          FUTURE HYDROLOGY
 42           KP       2
 43           LS       0      72      25
```

```
LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  44           UD
               *

  45           KK    CMB1
  46           KM            HAMILTON CREEK AT HWY 99
  47           HC       3
               *

  48           KK  RTH200
  49           KM            ROUTE CMB1
  50           RT      17
               *

  51           KK    H300
  52           KM            RUNOFF FROM BASIN H300
  53           BA   0.095
  54           LS       0      82      22
  55           UD     .26
               *
  56           KP       2
  57           LS       0      80      62
  58           UD     .26
               *

  59           KK    CMB2
  60           KM            COMBINE H300 & RT2
  61           HC       2
               *

  62           KK  RTH400
  63           KM            ROUTE CMB2
  64           RT      17
               *

  65           KK    H400
  66           KM            RUNOFF FROM BASIN H400
  67           BA    .047
  68           LS       0      84      40
  69           UD    0.14
               *           FUTURE HYDROLOGY
  70           KP       2
  71           LS       0      84      80
  72           UD    0.14
               *

  73           KK    CMB3
  74           KM            COMBINE H400 & RT3
  75           HC       2
               *
```

```
LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


  76           KK  RTCMB3
  77           KM              ROUTE COMBINE 3
  78           RT      12
               *

  79           KK    H500
  80           KM              RUNOFF BASIN H500
  81           BA   0.057
  82           LS       0      84      40
  83           UD    0.22
               *
  84           KP       2
  85           LS       0      80      80
  86           UD    0.22
               *

  87           KK    CMB4
  88           KM              COMBINE H500 & RT4
  89           HC       2
               *
               *
               *

  90           KK    H570
  91           KM              RUNOFF FROM BASIN H570
  92           BA   0.085
  93           LS       0      84      27
  94           UD    0.24
               *             FUTURE HYDROLOGY
  95           KP       2
  96           LS       0      84      60
  97           UD    0.24
               *

  98           KK    H560
  99           KM              RUNOFF FROM BASIN H560
 100           BA   0.052
 101           LS       0      84      19
 102           UD    0.30
               *
 103           KP       2
 104           LS       0      84      63
 105           UD    0.30
               *

 106           KK    CMB5
 107           KM              COMBINE H570 & H560
 108           HC       2
               *
```

```
LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 109           KK    H550
 110           KM           RUNOFF FROM BASIN H550
 111           BA   0.016
 112           LS       0      83      17
 113           UD    0.24
               *          FUTURE HYDROLOGY
 114           KP       2
 115           LS       0      80      81
 116           UD    0.24
               *

 117           KK    CMB6
 118           KM           COMBINE H550 AND CMB5 AND 500
 119           HC       3
               *

 120           KK    H540
 121           KM           RUNOFF FROM H540
 122           BA   0.044
 123           LS       0      80      85
 124           UD    0.29
               *
 125           KP       2
 126           LS       0      80      85
 127           UD    0.29
               *

 128           KK    CMB7
 129           KM           COMBINE H540 & H500
 130           HC       2
               *

 131           KK    H530
 132           KM           RUNOFF FROM H530
 133           BA   0.063
 134           LS       0      81      48
 135           UD    0.24
               *         FUTURE HYDROLOGY
 136           KP       2
 137           LS       0      80      54
 138           UD    0.24
               *

 139           KK    H520
 140           KM           RUNOFF FROM BASIN H520
 141           BA   0.022
 142           LS       0      84      24
 143           UD     .15
               *          FUTURE HYDROLOGY
 144           KP       2
 145           LS       0      80      80
 146           UD    0.15
               *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 147          KK    CMB8
 148          KM            COMBINE H520 & 530
 149          HC       2
              *

 150          KK    H510
 151          KM            RUNOFF BASIN H510
 152          BA   0.049
 153          LS       0      81      33
 154          UD    0.23
              *
 155          KP       2
 156          LS       0      80      60
 157          UD    0.23
              *

 158          KK    CMB9
 159          KM            COMBINE H510 & CMB8 & H500
 160          HC       3
              *

 161          KK    H600
 162          KM            BASIN H600
 163          BA   0.043
 164          LS       0      84      18
 165          UD    0.76
              *
 166          KP       2
 167          LS       0      84      57
 168          UD    0.76
              *

 169          KK   CMB10
 170          KM            COMBINE H500 & H600
 171          HC       2
              *
 172          ZZ
```

```
HEC1 S/N: 1343001167        HMVersion: 6.33    Data File: ASHLAND.hc1

*****************************************                                                   ***************************************
*                                       *                                                   *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *   U.S. ARMY CORPS OF ENGINEERS      *
*              MAY  1991                *                                                   *   HYDROLOGIC ENGINEERING CENTER     *
*           VERSION 4.0.1E              *                                                   *         609 SECOND STREET           *
*                                       *                                                   *      DAVIS, CALIFORNIA 95616        *
*  RUN DATE  03/18/1999  TIME  21:58:23 *                                                   *          (916) 756-1104             *
*                                       *                                                   *                                     *
*****************************************                                                   ***************************************



                                    CITY OF ASHLAND STORM WATER AND DRAINAGE MASTER PLAN
                                    CITY OF ASHLAND STORM WATER AND DRAINAGE MASTER PLAN
                                    EXISTING AND BUILT-OUT CONDITIONS
                                    RAINFALL DISTRIBUTION - SCS 1A
                                    PREPARED BY KCM INC., MARCH, 1999
                                    HAMILTON CREEK AND BASINS AROUND E. MAIN & I-5

   8 IO          OUTPUT CONTROL VARIABLES
                       IPRNT          5  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN          2  MINUTES IN COMPUTATION INTERVAL
                       IDATE      1   0  STARTING DATE
                       ITIME       0000  STARTING TIME
                          NQ       1080  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      2   0  ENDING DATE
                      NDTIME       1158  ENDING TIME
                      ICENT          19  CENTURY MARK

                   COMPUTATION INTERVAL    0.03 HOURS
                        TOTAL TIME BASE   35.97 HOURS

          ENGLISH UNITS
               DRAINAGE AREA         SQUARE MILES
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT

     JP          MULTI-PLAN OPTION
                       NPLAN          2  NUMBER OF PLANS

     JR          MULTI-RATIO OPTION
                     RATIOS OF PRECIPITATION
                    2.00      2.50      3.00      3.20      3.50      4.00
```

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIO 1 2.00	RATIO 2 2.50	RATIO 3 3.00	RATIO 4 3.20	RATIO 5 3.50	RATIO 6 4.00
					RATIOS APPLIED TO PRECIPITATION					
HYDROGRAPH AT										
	H100	0.22	1	FLOW	2.	5.	8.	10.	12.	17.
				TIME	18.57	10.07	10.03	10.03	10.03	9.10
			2	FLOW	2.	5.	8.	10.	12.	17.
				TIME	18.57	10.07	10.03	10.03	10.03	9.10
ROUTED TO										
	RTH100	0.22	1	FLOW	2.	5.	8.	10.	12.	17.
				TIME	19.20	10.70	10.67	10.67	10.67	9.73
			2	FLOW	2.	5.	8.	10.	12.	17.
				TIME	19.20	10.70	10.67	10.67	10.67	9.73
HYDROGRAPH AT										
	H200	0.09	1	FLOW	4.	6.	8.	9.	10.	13.
				TIME	9.23	9.20	9.20	9.20	9.20	9.17
			2	FLOW	4.	6.	8.	9.	10.	13.
				TIME	9.23	9.20	9.20	9.20	9.20	9.17
HYDROGRAPH AT										
	H250	0.14	1	FLOW	5.	8.	11.	13.	15.	19.
				TIME	9.10	9.10	9.10	9.10	9.10	9.07
			2	FLOW	6.	9.	13.	15.	17.	21.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
3 COMBINED AT										
	CMB1	0.46	1	FLOW	9.	16.	25.	29.	35.	46.
				TIME	9.13	10.07	9.73	9.73	9.73	9.17
			2	FLOW	10.	17.	26.	29.	36.	47.
				TIME	9.00	10.00	9.77	9.77	9.73	9.00
ROUTED TO										
	RTH200	0.46	1	FLOW	9.	16.	25.	29.	35.	46.
				TIME	9.13	10.07	9.73	9.73	9.73	9.17
			2	FLOW	10.	17.	26.	29.	36.	47.
				TIME	9.00	10.00	9.77	9.77	9.73	9.00
HYDROGRAPH AT										
	H300	0.09	1	FLOW	6.	9.	12.	13.	15.	18.
				TIME	9.10	9.07	9.07	9.07	9.07	9.07
			2	FLOW	9.	12.	15.	16.	18.	21.
				TIME	9.03	9.03	9.03	9.03	9.03	9.03
2 COMBINED AT										
	CMB2	0.55	1	FLOW	15.	23.	36.	41.	49.	64.
				TIME	9.10	10.07	9.13	9.13	9.13	9.13
			2	FLOW	19.	28.	40.	45.	53.	68.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
ROUTED TO										
	RTH400	0.55	1	FLOW	15.	23.	36.	41.	49.	64.
				TIME	9.10	10.07	9.13	9.13	9.13	9.13
			2	FLOW	19.	28.	40.	45.	53.	68.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	H400	0.05	1	FLOW	4.	6.	7.	8.	9.	10.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	6.	7.	9.	9.	10.	12.
				TIME	8.53	8.53	8.53	8.53	8.53	8.53
2 COMBINED AT										
	CMB3	0.60	1	FLOW	19.	29.	42.	48.	57.	73.
				TIME	9.07	9.10	9.10	9.10	9.10	9.10
			2	FLOW	25.	35.	48.	54.	64.	80.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
ROUTED TO										
	RTCMB3	0.60	1	FLOW	19.	29.	42.	48.	57.	73.
				TIME	9.07	9.10	9.10	9.10	9.10	9.10
			2	FLOW	25.	35.	48.	54.	64.	80.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	H500	0.06	1	FLOW	5.	7.	8.	9.	10.	12.
				TIME	9.03	9.03	9.03	9.03	9.03	9.03
			2	FLOW	7.	8.	10.	11.	12.	14.
				TIME	8.63	8.63	8.63	8.63	8.63	8.63
2 COMBINED AT										
	CMB4	0.65	1	FLOW	23.	35.	51.	57.	68.	86.
				TIME	9.07	9.10	9.10	9.10	9.07	9.07
			2	FLOW	31.	43.	59.	65.	76.	94.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00

HYDROGRAPH AT										
	H570	0.09	1	FLOW	6.	9.	12.	13.	14.	17.
				TIME	9.07	9.07	9.03	9.03	9.03	9.03
			2	FLOW	9.	11.	14.	15.	17.	20.
				TIME	9.03	9.03	9.03	9.03	9.00	9.00
HYDROGRAPH AT										
	H560	0.05	1	FLOW	3.	5.	7.	7.	8.	10.
				TIME	9.10	9.10	9.07	9.07	9.07	9.07
			2	FLOW	5.	7.	9.	9.	11.	12.
				TIME	9.03	9.03	9.03	9.03	9.03	9.03
2 COMBINED AT										
	CMB5	0.14	1	FLOW	10.	14.	18.	20.	23.	28.
				TIME	9.07	9.07	9.07	9.07	9.07	9.03
			2	FLOW	14.	18.	23.	25.	28.	32.
				TIME	9.03	9.03	9.03	9.03	9.03	9.00
HYDROGRAPH AT										
	H550	0.02	1	FLOW	1.	1.	2.	2.	2.	3.
				TIME	9.07	9.07	9.07	9.07	9.03	9.03
			2	FLOW	2.	2.	3.	3.	3.	4.
				TIME	8.63	8.67	8.67	8.67	8.67	8.67
3 COMBINED AT										
	CMB6	0.81	1	FLOW	34.	51.	71.	80.	93.	116.
				TIME	9.07	9.07	9.07	9.07	9.07	9.07
			2	FLOW	47.	64.	85.	93.	107.	130.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	H540	0.04	1	FLOW	5.	7.	8.	9.	10.	11.
				TIME	8.73	8.73	8.73	8.73	8.73	8.73
			2	FLOW	5.	7.	8.	9.	10.	11.
				TIME	8.73	8.73	8.73	8.73	8.73	8.73
2 COMBINED AT										
	CMB7	0.85	1	FLOW	40.	57.	79.	88.	103.	127.
				TIME	9.07	9.07	9.07	9.07	9.07	9.07
			2	FLOW	52.	71.	93.	102.	116.	141.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	H530	0.06	1	FLOW	5.	7.	9.	10.	11.	13.
				TIME	9.03	9.03	9.03	9.03	9.03	9.03
			2	FLOW	6.	7.	9.	10.	11.	14.
				TIME	9.03	9.03	9.03	9.03	9.03	9.03
HYDROGRAPH AT										
	H520	0.02	1	FLOW	2.	2.	3.	3.	4.	4.
				TIME	9.03	9.03	9.00	9.00	9.00	9.00
			2	FLOW	3.	3.	4.	4.	5.	5.
				TIME	8.57	8.57	8.57	8.57	8.57	8.57
2 COMBINED AT										
	CMB8	0.09	1	FLOW	7.	10.	12.	13.	15.	18.
				TIME	9.03	9.03	9.03	9.03	9.03	9.03
			2	FLOW	8.	11.	13.	15.	16.	19.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	H510	0.05	1	FLOW	3.	5.	6.	7.	8.	10.
				TIME	9.07	9.03	9.03	9.03	9.03	9.03
			2	FLOW	5.	6.	8.	8.	9.	11.
				TIME	9.03	9.03	9.03	9.03	9.03	9.00
3 COMBINED AT										
	CMB9	0.99	1	FLOW	50.	72.	98.	109.	126.	155.
				TIME	9.07	9.07	9.07	9.07	9.07	9.07
			2	FLOW	65.	87.	114.	125.	142.	171.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	H600	0.04	1	FLOW	3.	4.	5.	6.	7.	8.
				TIME	9.53	9.50	9.47	9.43	9.43	9.43
			2	FLOW	4.	5.	7.	7.	8.	9.
				TIME	9.37	9.37	9.33	9.33	9.33	9.33
2 COMBINED AT										
	CMB10	1.03	1	FLOW	52.	75.	103.	114.	132.	162.
				TIME	9.07	9.07	9.07	9.07	9.07	9.07
			2	FLOW	69.	93.	120.	132.	150.	180.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00

*** NORMAL END OF HEC-1 ***

APPENDIX C.
HEC-1 MODELING FOR CLAY CREEK, CEMETERY BASIN, AND THE MIDDLE SCHOOL BASINS

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HEC1 S/N: 1343001167        HMVersion: 6.33    Data File: CLAYCEM.hc1

*****************************************                                                   ***************************************
*                                       *                                                   *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
*              MAY   1991               *                                                   *   HYDROLOGIC ENGINEERING CENTER     *
*           VERSION 4.0.1E              *                                                   *         609 SECOND STREET           *
*                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
*  RUN DATE  03/22/1999  TIME  11:09:04 *                                                   *           (916) 756-1104            *
*                                       *                                                   *                                     *
*****************************************                                                   ***************************************


                                                X     X  XXXXXXX   XXXXX           X
                                                X     X  X        X     X         XX
                                                X     X  X        X                X
                                                XXXXXXX  XXXX     X        XXXXX   X
                                                X     X  X        X                X
                                                X     X  X        X     X          X
                                                X     X  XXXXXXX   XXXXX          XXX


                                            ::::::::::::::::::::::::::::::::::::::::::
                                            ::::::::::::::::::::::::::::::::::::::::::
                                            :::                                    :::
                                            :::  Full Microcomputer Implementation :::
                                            :::                by                  :::
                                            :::        Haestad Methods, Inc.       :::
                                            :::                                    :::
                                            ::::::::::::::::::::::::::::::::::::::::::
                                            ::::::::::::::::::::::::::::::::::::::::::

                                 37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


           THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

           THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
           THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
           NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
           DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
           KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID           CITY OF ASHLAND STORM WATER AND DRAINAGE MASTER PLAN
  2           ID           EXISTING AND BUILT-OUT CONDITIONS
  3           ID           RAINFALL DISTRIBUTION - SCS 1A
  4           ID           PREPARED BY KCM INC., MARCH, 1999
  5           ID           CLAY,CEMETERY & MIDDLE SCHOOL BASINS
  6           IT       2                  1080
  7           IO       5       0
  8           JP       2
              *          2-YR    5-YR    10-YR   25-YR   50-YR   100-YR
  9           JR    PREC     2.0     2.5     3.0     3.2     3.5     4.0
              *

 10           KK    C100
 11           KM           RUNOFF FROM BASIN C100
 12           BA   1.242
 13           BF    -1.0    -.07    1.07
 14           IN      30
 15           PC    .010    .013    .025    .038    .050    .067    .083    .102    .120    .141
 16           PC    .162    .194    .225    .257    .288    .335    .383    .436    .488    .529
 17           PC    .569    .592    .614    .637    .660    .679    .698    .717    .735    .752
 18           PC    .768    .783    .797    .812    .826    .841    .855    .870    .884    .897
 19           PC    .910    .923    .935    .947    .959    .969    .979    .990    1.00
 20           LS       0      63       2
 21           UD     .79
              *          FUTURE HYDROLOGY
 22           KP       2
 23           LS       0      64       5
 24           UD     .44
              *

 25           KK  RTC100
 26           KM           ROUTE BASIN C100
 27           RT       0              40
              *

 28           KK    C200
 29           KM           RUNOFF FROM BASIN C200
 30           BA   0.019
 31           LS       0      80      41
 32           UD     .05
              *          FUTURE HYDROLOGY
 33           KP       2
 34           LS       0      79      55
 35           UD     .05
              *

 36           KK    CMB1
 37           KM           COMBINE C100 & C2005
 38           HC       2
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


  39          KK  RTC200
  40          KM           ROUTE CMB1
  41          RT       0             45
              *

  42          KK    C300
  43          KM           RUNOFF FROM BASIN C300
  44          BA   0.069
  45          LS       0      80      35
  46          UD     .16
              *
  47          KP       2
  48          LS       0      79      52
  49          UD     .16
              *

  50          KK    CMB2
  51          KM           COMBINE C200 & CC300
  52          HC       2
              *

  53          KK  RTC300
  54          KM           ROUTE CMB2
  55          RT       0             53
              *

  56          KK    C400
  57          KM           RUNOFF FROM BASIN C400
  58          BA    .053
  59          LS       0      81      48
  60          UD     .17
              *         FUTURE HYDROLOGY
  61          KP       2
  62          LS       0      81      60
  63          UD     .17
              *

  64          KK    CMB3
  65          KM           COMBINE C300 & C400
  66          HC       2
              *
              *
              * *************  CEMETERY BASIN  **********************
              *
              *

  67          KK   CE100
  68          KM          CEMETERY BASIN U/S OF RR TRACKS
  69          BA   0.320
  70          LS       0      80      37
  71          UD    0.18
              *         FUTURE HYDROLOGY
  72          KP       2
  73          LS       0      80      47
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  74          UD    0.18
              *

  75          KK   CE200
  76          KM             CEMETERY BASIN D/S OF RR TRACKS
  77          BA    .115
  78          LS       0      84      10
  79          UD     .15
              *            FUTURE HYDROLOGY
  80          KP       2
  81          LS       0      84      60
  82          UD     .15
              *

  83          KK    CMB4
  84          KM             COMBINE CEMETERY CREEK AT E. MAIN ST.
  85          HC       2
              *
              *
              * **************  MIDDLE SCHOOL BASIN  *****************
              *
              *

  86          KK   MS100
  87          KM             MIDDLE SCHOOL BASIN EAST
  88          BA    .052
  89          LS       0      73      13
  90          UD     .31
              *            FUTURE HYDROLOGY
  91          KP       2
  92          LS       0      75      50
  93          UD     .15
              *

  94          KK   MS200
  95          KM             MIDDLE SCHOOL BASIN WEST
  96          BA    .043
  97          LS       0      72      44
  98          UD     .19
              *
  99          KP       2
 100          LS       0      72      60
 101          UD     .15
              *

 102          KK    CMB5
 103          KM             COMBINE MIDDLE SCHOOL BASIN AT E. MAIN ST.
 104          HC       2
              *
 105          ZZ
```

```
HEC1 S/N: 1343001167        HMVersion: 6.33    Data File: CLAYCEM.hc1

*****************************************                                                      ***************************************
*                                       *                                                      *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                      *   U.S. ARMY CORPS OF ENGINEERS      *
*             MAY  1991                 *                                                      *   HYDROLOGIC ENGINEERING CENTER     *
*          VERSION 4.0.1E               *                                                      *        609 SECOND STREET            *
*                                       *                                                      *     DAVIS, CALIFORNIA 95616         *
* RUN DATE  03/22/1999  TIME  11:09:04 *                                                       *         (916) 756-1104              *
*                                       *                                                      *                                     *
*****************************************                                                      ***************************************


                                    CITY OF ASHLAND STORM WATER AND DRAINAGE MASTER PLAN
                                    EXISTING AND BUILT-OUT CONDITIONS
                                    RAINFALL DISTRIBUTION - SCS 1A
                                    PREPARED BY KCM INC., MARCH, 1999
                                    CLAY,CEMETERY & MIDDLE SCHOOL BASINS

   7 IO          OUTPUT CONTROL VARIABLES
                       IPRNT           5  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN           2  MINUTES IN COMPUTATION INTERVAL
                       IDATE      1    0  STARTING DATE
                       ITIME        0000  STARTING TIME
                          NQ        1080  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      2    0  ENDING DATE
                      NDTIME        1158  ENDING TIME
                      ICENT           19  CENTURY MARK

                   COMPUTATION INTERVAL    0.03 HOURS
                        TOTAL TIME BASE   35.97 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

     JP          MULTI-PLAN OPTION
                       NPLAN           2  NUMBER OF PLANS

     JR          MULTI-RATIO OPTION
                     RATIOS OF PRECIPITATION
                    2.00      2.50      3.00      3.20      3.50      4.00
```

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIO 1 2.00	RATIO 2 2.50	RATIO 3 3.00	RATIO 4 3.20	RATIO 5 3.50	RATIO 6 4.00
					RATIOS APPLIED TO PRECIPITATION					
HYDROGRAPH AT										
	C100	1.24	1	FLOW	9.	16.	25.	32.	44.	66.
				TIME	20.97	19.27	19.20	10.50	10.43	10.37
			2	FLOW	11.	19.	36.	44.	57.	80.
				TIME	18.83	18.80	10.17	10.17	10.13	10.13
ROUTED TO										
	RTC100	1.24	1	FLOW	9.	16.	25.	32.	44.	66.
				TIME	22.30	20.60	20.53	11.83	11.77	11.70
			2	FLOW	11.	19.	36.	44.	57.	80.
				TIME	20.17	20.13	11.50	11.50	11.47	11.47
HYDROGRAPH AT										
	C200	0.02	1	FLOW	1.	2.	3.	3.	3.	4.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	2.	2.	3.	3.	3.	4.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
2 COMBINED AT										
	CMB1	1.26	1	FLOW	9.	17.	26.	34.	45.	68.
				TIME	23.50	20.50	11.87	11.83	11.77	11.70
			2	FLOW	11.	20.	38.	46.	59.	82.
				TIME	20.17	20.13	11.50	11.50	11.47	11.47
ROUTED TO										
	RTC200	1.26	1	FLOW	9.	17.	26.	34.	45.	68.
				TIME	25.00	22.00	13.37	13.33	13.27	13.20
			2	FLOW	11.	20.	38.	46.	59.	82.
				TIME	21.67	21.63	13.00	13.00	12.97	12.97
HYDROGRAPH AT										
	C300	0.07	1	FLOW	5.	7.	9.	10.	11.	13.
				TIME	9.03	9.03	9.03	9.03	9.03	9.00
			2	FLOW	6.	8.	10.	11.	12.	15.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
2 COMBINED AT										
	CMB2	1.33	1	FLOW	10.	19.	30.	38.	50.	73.
				TIME	22.03	22.00	13.37	13.33	13.27	13.20
			2	FLOW	13.	23.	42.	50.	64.	88.
				TIME	11.50	13.07	13.00	13.00	12.97	12.97
ROUTED TO										
	RTC300	1.33	1	FLOW	10.	19.	30.	38.	50.	73.
				TIME	23.80	23.77	15.13	15.10	15.03	14.97
			2	FLOW	13.	23.	42.	50.	64.	88.
				TIME	13.27	14.83	14.77	14.77	14.73	14.73
HYDROGRAPH AT										
	C400	0.05	1	FLOW	5.	6.	8.	8.	10.	11.
				TIME	9.03	9.00	9.00	9.00	9.00	9.00
			2	FLOW	5.	7.	8.	9.	10.	12.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
2 COMBINED AT										
	CMB3	1.38	1	FLOW	12.	20.	33.	41.	53.	77.
				TIME	23.77	23.67	15.13	15.07	15.03	14.97
			2	FLOW	15.	25.	45.	53.	67.	92.
				TIME	10.10	14.83	14.77	14.77	14.73	14.70
HYDROGRAPH AT										
	CE100	0.32	1	FLOW	23.	32.	42.	46.	52.	63.
				TIME	9.03	9.03	9.03	9.03	9.03	9.03
			2	FLOW	26.	36.	46.	50.	56.	67.
				TIME	9.03	9.03	9.03	9.03	9.00	9.00
HYDROGRAPH AT										
	CE200	0.12	1	FLOW	7.	11.	14.	16.	18.	22.
				TIME	9.03	9.03	9.03	9.03	9.03	9.00
			2	FLOW	12.	15.	19.	21.	23.	27.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
2 COMBINED AT										
	CMB4	0.44	1	FLOW	30.	43.	56.	62.	70.	85.
				TIME	9.03	9.03	9.03	9.03	9.03	9.03
			2	FLOW	38.	51.	65.	71.	79.	94.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	MS100	0.05	1	FLOW	1.	2.	4.	4.	5.	7.
				TIME	10.07	9.17	9.13	9.13	9.13	9.13
			2	FLOW	4.	5.	7.	8.	9.	10.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00

HYDROGRAPH AT										
	MS200	0.04	1	FLOW	3.	4.	5.	6.	6.	8.
				TIME	9.03	9.03	9.03	9.03	9.03	9.03
			2	FLOW	4.	5.	6.	7.	7.	9.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
2 COMBINED AT										
	CMB5	0.09	1	FLOW	4.	6.	9.	10.	11.	14.
				TIME	9.07	9.07	9.07	9.07	9.07	9.07
			2	FLOW	8.	10.	13.	14.	16.	19.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00

*** NORMAL END OF HEC-1 ***

APPENDIX C.
HEC-1 MODELING FOR BEACH CREEK, KITCHEN CREEK, AND CLEAR CREEK

```
HEC1 S/N: 1343001167        HMVersion: 6.33    Data File: beachm.hc1

*****************************************                                                    ***************************************
*                                       *                                                    *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                    *    U.S. ARMY CORPS OF ENGINEERS     *
*              MAY   1991               *                                                    *    HYDROLOGIC ENGINEERING CENTER    *
*           VERSION 4.0.1E              *                                                    *          609 SECOND STREET          *
*                                       *                                                    *       DAVIS, CALIFORNIA 95616       *
*  RUN DATE  04/26/1999  TIME  07:58:18 *                                                    *           (916) 756-1104            *
*                                       *                                                    *                                     *
*****************************************                                                    ***************************************


                                                  X     X  XXXXXXX   XXXXX          X
                                                  X     X  X        X     X        XX
                                                  X     X  X        X               X
                                                  XXXXXXX  XXXX     X       XXXXX   X
                                                  X     X  X        X               X
                                                  X     X  X        X     X         X
                                                  X     X  XXXXXXX   XXXXX         XXX


                                              ::::::::::::::::::::::::::::::::::::::::::
                                              ::::::::::::::::::::::::::::::::::::::::::
                                              :::                                    :::
                                              :::  Full Microcomputer Implementation :::
                                              :::                 by                 :::
                                              :::        Haestad Methods, Inc.       :::
                                              :::                                    :::
                                              ::::::::::::::::::::::::::::::::::::::::::
                                              ::::::::::::::::::::::::::::::::::::::::::

                                   37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


           THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

           THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
           THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
           NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
           DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
           KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```

```
LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1            ID           CITY OF ASHLAND STORM WATER AND DRAINAGE MASTER PLAN
  2            ID           EXISTING AND BUILT-OUT CONDITIONS
  3            ID           RAINFALL DISTRIBUTION - SCS 1A
  4            ID           PREPARED BY KCM INC., MARCH, 1999
  5            ID           BEACH CREEK, MOUNTAIN CREEK,KITCHEN AND CLEAR
  6            IT       2                   1080
  7            IO       5       0
  8            JP       2
               *          2-YR    5-YR    10-YR   25-YR   50-YR   100-YR
  9            JR    PREC     2.0     2.5     3.0     3.2     3.5     4.0
               *

 10            KK    B100
 11            KM           BEACH CREEK AT RR TRACKS
 12            BA   0.368
 13            BF    -1.0    -.07    1.07
 14            IN      30
 15            PC    .010    .013    .025    .038    .050    .067    .083    .102    .120    .141
 16            PC    .162    .194    .225    .257    .288    .335    .383    .436    .488    .529
 17            PC    .569    .592    .614    .637    .660    .679    .698    .717    .735    .752
 18            PC    .768    .783    .797    .812    .826    .841    .855    .870    .884    .897
 19            PC    .910    .923    .935    .947    .959    .969    .979    .990    1.00
 20            LS       0      84      37
 21            UD    0.20
               *          FUTURE HYDROLOGY
 22            KP       2
 23            LS       0      84      43
 24            UD     .20
               *
               *
               * ****************  MOUNTAIN CREEK *******************
               *
               *

 25            KK    M100
 26            KM           MOUNTIAN CREEK AT RR TRACKS
 27            BA   0.311
 28            LS       0      84      49
 29            UD      .2
               *          FUTURE HYDROLOGY
 30            KP       2
 31            LS       0      84      57
 32            UD      .2
               *

 33            KK    M200
 34            KM           MOUNTAIN CREEK DOWNSTREAM OF RR TRACKS
 35            BA    0.11
 36            LS       0      84      20
 37            UD     0.2
               *
 38            KP       2
 39            LS       0      84      85
 40            UD     0.2
               *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


  41          KK    CMB2
  42          KM            COMBINE FLOWS AT HERSEY STREET
  43          HC       2
              *
              *
              * **************  CLEAR CREEK  **************************
              *
              *

  44          KK   CL100
  45          KM            CLEAR CREEK U/S OF RR TREACKS
  46          BA    .069
  47          LS       0      84      50
  48          UD     .15
              *           FUTURE HYDROLOGY
  49          KP       2
  50          LS       0      84      65
  51          UD     .15
              *

  52          KK   CL200
  53          KM            RUNOFF OF BASIN D/S OF RR TRACKS
  54          BA   0.021
  55          LS       0      84       0
  56          UD    0.15
              *           FUTURE HYDROLOGY
  57          KP       2
  58          LS       0      84      65
  59          UD    0.15
              *

  60          KK    CMB3
  61          KM            COMBINE FLOW AT HERSEY STREET
  62          HC       2
              *
              *
              * *****************   KITCHEN CREEK   **************************
              *
              *

  63          KK    K100
  64          KM            KITCHEN CREEK
  65          BA   4.434
  66          LS       0      83       0
  67          UD    0.72
              *
  68          KP       2
  69          LS       0      83       0
  70          UD    0.72
              *
  71          ZZ
```

```
HEC1 S/N: 1343001167        HMVersion: 6.33    Data File: beachm.hc1

*****************************************                                                  ****************************************
*                                       *                                                  *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                  *    U.S. ARMY CORPS OF ENGINEERS      *
*             MAY   1991                *                                                  *    HYDROLOGIC ENGINEERING CENTER     *
*          VERSION 4.0.1E               *                                                  *          609 SECOND STREET           *
*                                       *                                                  *       DAVIS, CALIFORNIA 95616        *
*  RUN DATE  04/26/1999  TIME  07:58:18 *                                                  *           (916) 756-1104             *
*                                       *                                                  *                                      *
*****************************************                                                  ****************************************



                                    CITY OF ASHLAND STORM WATER AND DRAINAGE MASTER PLAN
                                    EXISTING AND BUILT-OUT CONDITIONS
                                    RAINFALL DISTRIBUTION - SCS 1A
                                    PREPARED BY KCM INC., MARCH, 1999
                                    BEACH CREEK, MOUNTAIN CREEK,KITCHEN AND CLEAR

   7 IO          OUTPUT CONTROL VARIABLES
                       IPRNT           5  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN           2  MINUTES IN COMPUTATION INTERVAL
                       IDATE      1    0  STARTING DATE
                       ITIME        0000  STARTING TIME
                          NQ        1080  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      2    0  ENDING DATE
                      NDTIME        1158  ENDING TIME
                      ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL    0.03 HOURS
                         TOTAL TIME BASE   35.97 HOURS

          ENGLISH UNITS
               DRAINAGE AREA         SQUARE MILES
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT

     JP          MULTI-PLAN OPTION
                       NPLAN           2  NUMBER OF PLANS

     JR          MULTI-RATIO OPTION
                     RATIOS OF PRECIPITATION
                    2.00      2.50      3.00      3.20      3.50      4.00
```

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

					RATIOS APPLIED TO PRECIPITATION					
OPERATION	STATION	AREA	PLAN		RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6
					2.00	2.50	3.00	3.20	3.50	4.00
HYDROGRAPH AT										
	B100	0.37	1	FLOW	30.	42.	54.	59.	66.	79.
				TIME	9.03	9.03	9.03	9.03	9.03	9.03
			2	FLOW	32.	44.	56.	61.	68.	81.
				TIME	9.03	9.03	9.03	9.03	9.03	9.00
HYDROGRAPH AT										
	M100	0.31	1	FLOW	29.	39.	49.	53.	59.	70.
				TIME	9.03	9.03	9.03	9.03	9.00	9.00
			2	FLOW	31.	41.	51.	55.	61.	72.
				TIME	9.03	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	M200	0.11	1	FLOW	8.	11.	14.	16.	18.	22.
				TIME	9.07	9.03	9.03	9.03	9.03	9.03
			2	FLOW	14.	17.	21.	22.	25.	28.
				TIME	8.60	8.60	8.60	8.60	8.60	8.60
2 COMBINED AT										
	CMB2	0.42	1	FLOW	36.	50.	63.	69.	77.	92.
				TIME	9.03	9.03	9.03	9.03	9.03	9.03
			2	FLOW	44.	58.	72.	77.	86.	100.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
HYDROGRAPH AT										
	CL100	0.07	1	FLOW	6.	9.	11.	12.	13.	16.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	7.	10.	12.	13.	14.	16.
				TIME	9.00	9.00	9.00	9.00	8.57	8.57
HYDROGRAPH AT										
	CL200	0.02	1	FLOW	1.	2.	2.	3.	3.	4.
				TIME	9.03	9.03	9.03	9.03	9.03	9.03
			2	FLOW	2.	3.	4.	4.	4.	5.
				TIME	9.00	9.00	9.00	9.00	8.57	8.57
2 COMBINED AT										
	CMB3	0.09	1	FLOW	8.	10.	13.	15.	16.	19.
				TIME	9.00	9.00	9.00	9.00	9.00	9.00
			2	FLOW	10.	12.	15.	17.	18.	22.
				TIME	9.00	9.00	9.00	9.00	8.57	8.57
HYDROGRAPH AT										
	K100	4.43	1	FLOW	193.	309.	437.	491.	574.	716.
				TIME	10.10	9.60	9.53	9.50	9.47	9.43
			2	FLOW	193.	309.	437.	491.	574.	716.
				TIME	10.10	9.60	9.53	9.50	9.47	9.43

*** NORMAL END OF HEC-1 ***

APPENDIX C.
HEC-1 MODELING FOR WRIGHT'S CREEK

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HEC1 S/N: 1343001167       HMVersion: 6.33    Data File: WRIGHT.hc1

*****************************************                                                   ***************************************
*                                       *                                                   *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
*              MAY   1991               *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
*           VERSION 4.0.1E              *                                                   *          609 SECOND STREET          *
*                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
*  RUN DATE  03/22/1999  TIME  15:09:25 *                                                   *           (916) 756-1104            *
*                                       *                                                   *                                     *
*****************************************                                                   ***************************************


                                                X     X  XXXXXXX   XXXXX           X
                                                X     X  X        X     X         XX
                                                X     X  X        X                X
                                                XXXXXXX  XXXX     X       XXXXX    X
                                                X     X  X        X                X
                                                X     X  X        X     X          X
                                                X     X  XXXXXXX   XXXXX          XXX


                                            :::::::::::::::::::::::::::::::::::::::::::
                                            :::::::::::::::::::::::::::::::::::::::::::
                                            :::                                     :::
                                            :::  Full Microcomputer Implementation  :::
                                            :::                 by                  :::
                                            :::        Haestad Methods, Inc.        :::
                                            :::                                     :::
                                            :::::::::::::::::::::::::::::::::::::::::::
                                            :::::::::::::::::::::::::::::::::::::::::::

                                  37 Brookside Road * Waterbury, Connecticut  06708 * (203) 755-1666


           THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

           THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
           THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
           NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
           DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
           KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID           CITY OF ASHLAND STORM WATER AND DRAINAGE MASTER PLAN
  2           ID           EXISTING AND BUILT-OUT CONDITIONS
  3           ID           RAINFALL DISTRIBUTION - SCS 1A
  4           ID           PREPARED BY KCM INC., MARCH, 1999
  5           ID           WRIGHT'S CREEK
  6           IT       2                   1080
  7           IO       5       0
  8           JP       2
              *          2-YR    5-YR    10-YR   25-YR   50-YR   100-YR
  9           JR    PREC     2.0     2.5     3.0     3.2     3.5     4.0
              *

 10           KK    W100
 11           KM           RUNOFF FROM BASIN W100 U/S OF ORCHARD
 12           BA   0.123
 13           BF    -1.0    -.07    1.07
 14           IN      30
 15           PC    .010    .013    .025    .038    .050    .067    .083    .102    .120    .141
 16           PC    .162    .194    .225    .257    .288    .335    .383    .436    .488    .529
 17           PC    .569    .592    .614    .637    .660    .679    .698    .717    .735    .752
 18           PC    .768    .783    .797    .812    .826    .841    .855    .870    .884    .897
 19           PC    .910    .923    .935    .947    .959    .969    .979    .990    1.00
 20           LS       0      59       0
 21           UD     0.3
              *          FUTURE HYDROLOGY
 22           KP       2
 23           LS       0      74      28
 24           UD     0.3
              *

 25           KK    W200
 26           KM           WRIGHT'S CREEK ABOVE WRIGHT'S CREEK BLVD
 27           BA    0.15
 28           LS       0      61       8
 29           UD    0.24
              *          FUTURE HYDROLOGY
 30           KP       2
 31           LS       0      74      31
 32           UD    0.24
              *

 33           KK    W300
 34           KM           RUNOFF AT BENJAMIN COURT
 35           BA   0.308
 36           LS       0      58       0
 37           UD     .22
              *
 38           KP       2
 39           LS       0      60       6
 40           UD     .22
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


  41          KK    W400
  42          KM            RUNOFF FROM WRIGHT'S CREEK U/S OF HWY 99
  43          BA   3.256
  44          LS       0      66       1
  45          UD    0.56
              *           FUTURE HYDROLOGY
  46          KP       2
  47          LS       0      66       4
  48          UD     .56
              *
  49          ZZ
```

```
HEC1 S/N: 1343001167        HMVersion: 6.33    Data File: WRIGHT.hc1

*****************************************                                                     ***************************************
*                                       *                                                     *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                     *   U.S. ARMY CORPS OF ENGINEERS      *
*             MAY   1991                *                                                     *   HYDROLOGIC ENGINEERING CENTER     *
*          VERSION 4.0.1E               *                                                     *        609 SECOND STREET            *
*                                       *                                                     *     DAVIS, CALIFORNIA 95616         *
*  RUN DATE  03/22/1999  TIME  15:09:25 *                                                     *         (916) 756-1104              *
*                                       *                                                     *                                     *
*****************************************                                                     ***************************************


                                    CITY OF ASHLAND STORM WATER AND DRAINAGE MASTER PLAN
                                    EXISTING AND BUILT-OUT CONDITIONS
                                    RAINFALL DISTRIBUTION - SCS 1A
                                    PREPARED BY KCM INC., MARCH, 1999
                                    WRIGHT'S CREEK

   7 IO          OUTPUT CONTROL VARIABLES
                       IPRNT          5  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN          2  MINUTES IN COMPUTATION INTERVAL
                       IDATE      1   0  STARTING DATE
                       ITIME       0000  STARTING TIME
                          NQ       1080  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      2   0  ENDING DATE
                      NDTIME       1158  ENDING TIME
                       ICENT         19  CENTURY MARK

                   COMPUTATION INTERVAL    0.03 HOURS
                        TOTAL TIME BASE   35.97 HOURS

          ENGLISH UNITS
               DRAINAGE AREA         SQUARE MILES
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT

     JP          MULTI-PLAN OPTION
                       NPLAN          2  NUMBER OF PLANS

     JR          MULTI-RATIO OPTION
                     RATIOS OF PRECIPITATION
                    2.00      2.50      3.00      3.20      3.50      4.00
```

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIO 1 2.00	RATIO 2 2.50	RATIO 3 3.00	RATIO 4 3.20	RATIO 5 3.50	RATIO 6 4.00
					RATIOS APPLIED TO PRECIPITATION					
HYDROGRAPH AT										
	W100	0.12	1	FLOW	1.	1.	2.	2.	3.	5.
				TIME	23.60	18.67	18.63	18.63	10.13	10.10
			2	FLOW	6.	9.	12.	13.	15.	19.
				TIME	9.13	9.10	9.10	9.10	9.10	9.10
HYDROGRAPH AT										
	W200	0.15	1	FLOW	2.	2.	4.	5.	6.	9.
				TIME	8.60	8.60	10.07	10.07	10.07	10.03
			2	FLOW	8.	11.	15.	17.	20.	24.
				TIME	9.07	9.07	9.07	9.07	9.07	9.07
HYDROGRAPH AT										
	W300	0.31	1	FLOW	1.	3.	5.	5.	7.	11.
				TIME	23.57	22.03	18.60	18.60	18.57	10.07
			2	FLOW	3.	4.	7.	8.	11.	16.
				TIME	8.57	18.57	10.07	10.07	10.07	10.03
HYDROGRAPH AT										
	W400	3.26	1	FLOW	29.	51.	95.	117.	152.	215.
				TIME	19.03	18.93	10.27	10.23	10.23	10.17
			2	FLOW	31.	57.	107.	130.	166.	230.
				TIME	19.00	10.30	10.23	10.23	10.20	10.17

*** NORMAL END OF HEC-1 ***

Appendix D

EXAMPLES OF STORMWATER FACILITIES

IV

BMP Info Sheets

Best Management Practices Info Sheets

This chapter provides information on how to implement several best management practices discussed in Chapter 3. It also provides information on available water quality treatment facilities.

Table 4.1 below lists the BMPs that are discussed in this chapter. The BMP Info Sheets are divided into two sections: Source Control and Water Quality Treatment. The Source Control section includes BMP Info Sheets 1-7. The Water Quality Treatment Section includes BMP Info Sheets 8-15.

TABLE 4.1
BMP INFO SHEETS

No.	TITLE
1	Illicit Connections
2	Disposal Options
3	Covering Options
4	Pave Area and Slope to Holding Tank
5	Containment and Elevation
6	Integrated Pest Management
7	Catch Basin Cleaning
8	Oil/Water Separator
9	Catch Basin Insert
10	Catch Basin Sump and Vault Filter
11	Leaf Compost Filter
12	Wet Pond, Wet Vault, or Constructed Wetland
13	Vegetated Biofilters
14	Sand Filter
15	Infiltration

See Chapter Five--Other Agency Requirements and Chapter Six--Technical and Financial Assistance for other useful information to assist you in implementing the best management practices on your site.

Source Control BMPs

The following BMP Info Sheets discuss a variety of source control BMPs and other methods used to prevent, control, and dispose of pollutants. Source control BMPs prevent pollutants from contaminating stormwater runoff or entering water bodies. Some source control BMPs are operational, such as reducing the frequency of a polluting activity, checking regularly for leaks and drips, and educating employees about site clean up procedures. Other source control BMPs use a structure to prevent rainwater from contacting materials that will contaminate stormwater runoff. Examples of these BMPs include a berm or containment structure to prevent clean stormwater from entering work areas, or a roof over a storage area. A source control BMP can also include altering or revising your industrial process to use less of a contaminating substance in the first place.

The goal of King County's program is to reduce the contamination of water resources through emphasis on source control BMPs. The following BMP Info Sheets provide more detail information on how to implement some of these source control BMPs.

BMP INFO SHEET #1

Illicit Connections

An illicit connection is a connection that could convey anything not composed entirely of surface and storm water directly to the storm drainage system or a water body. Many buildings throughout King County may have illicit connections to the storm drainage system. These typically include, but are not limited to, sanitary sewer pipes, process waste water discharges, sump overflows, and internal building drains connected to the storm drainage system. As a result of illicit connections, waste water containing a variety of pollutants is discharged directly to storm sewers and drainage ditches, and ultimately to receiving waters rather than to the sanitary sewer system or septic system. In many instances these connections are unknown to the business, and may not even show up on building drawings. Elimination of illicit storm drainage connections is an important facet of a stormwater pollution reduction program and must be addressed as a top priority. King County is currently making a committed effort to determine where illicit connections are present and to require their removal.

FINDING AN ILLICIT CONNECTION

All businesses and public agencies in unincorporated King County must investigate their plumbing systems to determine if there are any illicit connections to the storm drainage system, such as internal floor drains plumbed to the storm drainage system. If building and property drawings are available with plumbing details, they should be reviewed to understand pipe connections.

If you are unsure weather a particular drain (such as a floor drain) discharges to the storm drainage system, you have two choices. The first is to assume it does and permanently plug the drain or connection. This would be the easiest and most cost effective solution. The second is to correctly identify where the connection drains by consulting plans, side sewer cards and possibly conducting a dye test. This option can be time consuming and costly.

Any pipes or other conveyances connected to storm drainage facilities that drain anything but stormwater must be permanently plugged or rerouted to a sanitary sewer, holding tank, on-site process treatment system, or septic system (with approval).

If building plans and side sewer cards do not show your plumbing, the most basic method for determining a connection is dye tracing. A non-toxic dye of obvious color, such as red, can be put in water and flushed or drained into suspect piping. Observations should then be made in manholes, drainage ditches, or whatever other storm drainage conveyances are present on site (or adjacent to the property) to search for the dye. Enough water must be poured or flushed through the indoor drain to force the flow to reach the point(s) of observation. If possible, all other drains in the building should be out of use while the dye test is conducted to ensure the results can pinpoint the problem drain. This test should be conducted for each suspect drain on the property. Any observations of dye in the storm drainage system must be noted and the corresponding indoor drains tagged for follow-up pipe plugging or rerouting.

If there is uncertainty as to the locations of manholes which can be used for observation, or how storm drainage is achieved for a property, King County staff should be contacted for assistance in defining the storm drainage system characteristics for the site. King County Surface Water Management must be notified of a dye test at least one day in advance of testing.

ELIMINATING AN ILLICIT CONNECTION

Drains and pipes which are found to connect to the storm drainage system must either be permanently plugged or disconnected and rerouted as soon as possible. Drains that are no longer needed can be plugged with concrete or similarly effective materials. Whenever the diversion of any process water, stormwater, or other waste water to the sanitary sewer is the required or chosen BMP, the local sewer authority and the King County Department of Metropolitan Services (Metro) must be contacted to obtain approval prior to commencement of discharges to the sanitary sewer. The local sewer authority and Metro must also be contacted prior to the installation of any permanent connection to the sanitary sewer. The name of your local sewer authority is identified on your water and sewer billing. The local sewer authority and Metro will regulate the connection both for discharge quantity and quality, but the responsible party will have to arrange for the necessary plumbing supplies and pipe disconnection/rerouting work.

If the property is not serviced by a sanitary sewer, and one is not available nearby for a hookup, alternative measures are necessary. If the discharge is domestic waste water from a toilet, sink, appliance, or shower/bathtub, a septic system can be used to receive the rerouted discharge. The connection of plumbing fixtures to an on-site sewage disposal system usually requires an on-site sewage disposal system repair permit. Therefore, before pipes are rerouted, the Seattle-King Department of Public Health must be contacted for further information. If a septic system is not present on the property, then one should be installed. If this is the case, the Seattle-King County Department of Public Health should be contacted for advice and information on septic system requirements. If the discharge is industrial process water or other non-domestic waste water, a holding tank or on-site treatment system will be needed. If an illicit connection needs to be rerouted to a holding tank, King County staff should be contacted for assistance and information on tank content disposal requirements. As with septic system and sanitary sewer hookups, the property owner or responsible business operator is responsible for rerouting the illicit pipe connections.

End of Info Sheet 1

Disposal Options

Every business and public agency in King County must dispose of solid and liquid wastes and contaminated stormwater properly. There are generally five options for disposal depending on the types and quantity of materials. These options are: (1) sanitary sewer system, (2) septic system, (3) recycling, (4) municipal solid waste disposal facilities, and (5) waste transportation and disposal services. Ordinary stormwater runoff is not considered to be contaminated to the point of requiring special disposal. Stormwater that is mixed with concentrated wastes requires special disposal, as discussed below.

DISCHARGE TO SANITARY SEWER SYSTEM

Process waste water (depending on the pollutants and associated concentrations present) can be put into the sanitary sewer, subject to approval by the local sewer authority and the King County Department of Metropolitan Services (Metro). Animal waste can be disposed of in a sanitary sewer, subject to loading capacity constraints. The King County Department of Metropolitan Services may require that all stormwater discharged to a sanitary sewer be metered. Sewer fees may be collected on such discharges.

The first priority is to discharge process water to a sanitary sewer via an existing plumbing connection or a new pipe connection. Whenever the diversion of any process water or other waste water to the sanitary sewer is the required or chosen BMP, the local sewer authority and Metro must be contacted to obtain approval prior to commencement of discharges to the sanitary sewer. Pretreatment of discharges to remove some of the process water pollutants may be required as a condition of discharging to the sanitary sewer. The local sewer authority and Metro must also be contacted prior to the installation of any permanent connection to the sanitary sewer. The name of your local sewer authority is identified on your water and sewer billing. See Chapter 5 for more information on sanitary sewer authority requirements.

If you can not discharge to a sanitary sewer system, sumps or other temporary storage devices may be useful for storing liquid wastes on a temporary basis. Consideration should be given to using a holding tank for used process water if the volume of process water generated by the activity is not excessive. See BMP Info Sheet 4 for more information on holding tanks. The contents of the holding tank must be pumped out or drained before the tank is full. Several commercial services are available for pumping out sumps and holding tanks. These can be found in your telephone directory's yellow pages under the headings "Sewer Contractors" and "Tanks Cleaning." Septic system pump-out and hauling contractors must not be used for disposing wastes other than domestic sewage. They are not allowed to haul industrial wastes.

Currently stormwater is prohibited from being discharged to the sanitary sewer, however, Metro is developing rules that may authorize the discharge of contaminated stormwater from certain types of industrial activities under certain circumstances.

DISCHARGE TO SEPTIC SYSTEM

If your site is not serviced by a sanitary sewer system, you probably have a septic system. Only liquid waste that is comparable to residential sewage in strength and constituency may be disposed of in septic systems. Hazardous chemicals cannot be disposed of in septic systems. Further, the septic system must be designed to accommodate the volume of suitable waste water generated. Any changes in waste volume and constituency from those present when the system was permitted must be approved by the Seattle-King County Department of Public Health. Stormwater, whether contaminated or not, may not be disposed of in septic systems. Animal waste may not be disposed in a septic system.

RECYCLING

Recycling facilities are a recommended option for many commercial items, including used oils, used batteries, old equipment, a variety of used auto parts, metal scrap materials, solvents, paints, and various other solid wastes. There are a number of private businesses that accept materials for recycling. In addition there is an Industrial Material Exchange clearinghouse which facilitates the transfer of unwanted materials from the generator to another business that can use them.

Process waste water such as wash water can be recycled on-site as an alternative to discharge to sanitary sewer. There are numerous products on the market to recycle wash water.

See Chapter 6 for more information.

MUNICIPAL SOLID WASTE DISPOSAL FACILITIES

Municipal solid waste disposal facilities are designed to handle solid wastes. Hazardous and dangerous wastes and many liquid wastes must be properly disposed of at an appropriate facility. Contact your local landfill for information on materials accepted at the facilities. The Business Waste Line at (206) 296-3976 can provide information on disposal of oil, antifreeze and other hazardous wastes.

WASTE TRANSPORTATION AND DISPOSAL SERVICES

There are numerous services that can help you identify, quantify, transport, and dispose of waste that you may generate. Many people have their wastes picked up by a disposal contractor.

Costs of disposal vary considerably depending on the types of materials, quantities, methods of collection and transport, and whether the wastes are mixed. The rate the contractor charges will generally reflect the costs of testing and/or treating waste materials (if necessary) and subsequent disposal. It is important to keep different types of wastes separated, so that the disposal contractor(s) can take them to the appropriate place(s) without causing inadvertent contamination problems elsewhere, and so that you are not paying too much for disposal of materials that are not contaminated (e.g. regular garbage). If you are doing a good job with BMPs and collect contaminated waste materials for proper disposal, your efforts are compromised if a disposal contractor subsequently disposes the contaminated materials as regular garbage. Therefore, it is essential to be familiar with disposal alternatives and the different types of contractors for each disposal option.

The Seattle-King County Department of Public Health's Waste Characterization Program serves hazardous waste generators in Seattle and King County that have questionable wastes. Information supplied by the generator on questionable wastes such as sludges, sandblast waste, treated wood, and contaminated soils is reviewed by the Health Department. Permits are issued for those wastes that will be allowed in the garbage. The dangerous waste regulations as well as other criteria are used in the decision process.

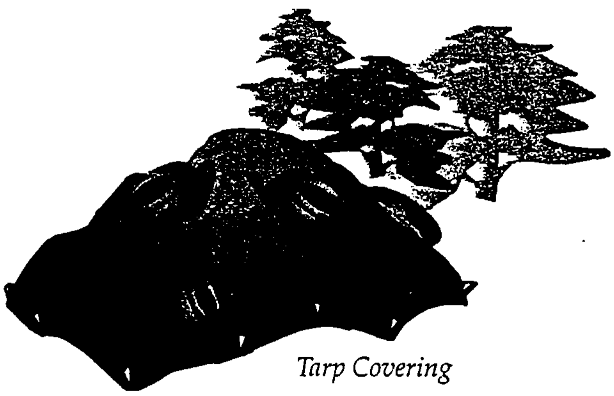
The disposal of wastes is the responsibility of the generator. Before agreeing to let a company handle your waste, it is recommended that you ask for (and check) the company's references. All waste collected by the company should be delivered to an authorized site. Make sure you keep copies of all your transactions.

End of Info Sheet 2

Covering Options: Tarp, Roof, or Awning

One of the most effective actions a person can take to prevent stormwater contamination is keeping potential pollutants out of the rain. There are numerous options for covering an activity. This BMP, combined with prevention of stormwater run-on into the covered area, can be as effective as indoor enclosure.

The simplest cover is the use of tarps or other non-structural devices. Any building of structures requires a building permit and must comply with applicable building and fire codes. These building requirements may, in some cases, make some of these structures too expensive to be practical. Contact the King County Department of Development and Environmental Services for information on building permits and requirements for a roof structure.



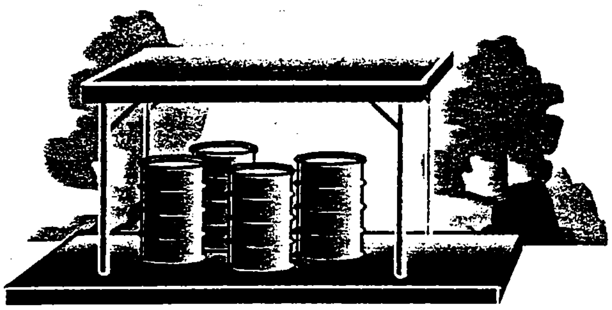
Tarp Covering

Many activities, such as stockpiling of raw materials or storage of drums, can be effectively covered with a heavy plastic tarp made of impermeable material. Weights such as bricks, tires, or sandbags should be used to anchor the cover in place. Care should be taken to ensure that the tarp covers the activity completely and that stormwater run-on does not penetrate significantly under the cover. If several tarps are used to form a cover, they should be tethered together or laid in an overlapping manner. If necessary, pins or stakes should be used to anchor the tarps to the ground. The tarp covering will be easier to keep in place and will last longer if some form of wind protection is possible. Attempts should be made to locate stockpiles in areas where winds are minimal.

The tarps must be in place when the material is not being used. The tarps must be inspected weekly to ensure that no holes or gaps are present. Tarps are inexpensive, and therefore are a cost-effective BMP for many activities. This BMP can be combined with containment for better effectiveness. See BMP Info Sheet 5 for more information.

The other option for covering is the use of a roof structure. The particular roof cover option used at a given site is subject to the site layout, available space, affordability, and limitations imposed by other regulations. The area of the roof cover should be sufficient to prevent any precipitation from reaching the protected contents underneath. This BMP should usually be implemented in conjunction with prevention of stormwater run-on into the covered area. BMP Info Sheet 5 presents information on containment/run-on prevention. Examples of various structures are shown below.

Lean-To Structure



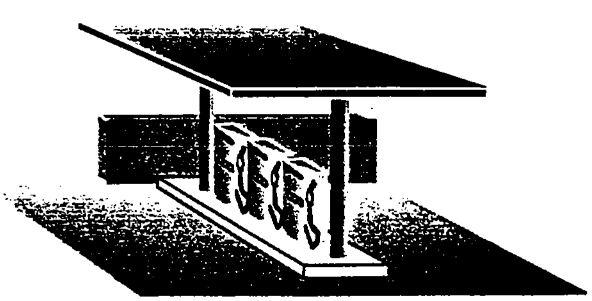
Stand-Alone Canopy

There are also numerous prefabricated storage sheds that can be purchased to enclose and cover materials. This may be a preferred alternative on some sites. Again, before purchasing these structures ensure they meet applicable building and fire codes.

Another option for covering an activity is to use an overhanging awning of sufficient size to prevent precipitation from reaching the contents underneath. This cannot be an awning already in place over a public right-of-way such as a sidewalk in front of a store. Many of the building permit, fire code, and zoning code requirements mentioned above apply to these structures also.

Overhanging Awning

Activities such as fueling operations may be conveniently covered by an island-type overhanging roof. This roof arrangement is supported by columns along the center of the structure rather than at the corners, enabling vehicular traffic underneath while still providing sufficient protection from precipitation.



Island-Type Overhanging Roof

End of Info Sheet 3

Pave Area and Slope to Holding Tank

This BMP applies to several activities that cannot be covered effectively, and therefore require a method of controlling off-site runoff that may be contaminated. It is particularly suited to activities with the potential for spills and leaks, but otherwise do not generate excessive amounts of polluted runoff. In addition, this BMP is well suited to activities that intermittently produce waste water such as washing operations. A sump or holding tank serves to provide spill containment until the liquids can be pumped out and properly disposed. If the activity produces large amounts of runoff, this BMP will not be very effective because the stray contaminants will overflow the sump or pass through the sump before collection and disposal are possible. The following implementation information is intended for situations where this BMP can be effective.

A designated activity area should be paved and sloped to drain to a central collection point. A sump, vault, or holding tank should be installed underneath this collection drain. Some materials, such as gasoline, can react with asphalt pavement and cause the release of toxic oils from the pavement. It is preferable for the area to be paved with portland cement concrete. If the area is already paved with asphalt, an asphalt sealant should be applied to the pavement surface. Whichever paving material is used, the paved surface must be free of gaps and cracks.

The sump or holding tank should have a large enough capacity to contain the entire volume of waste water generated by the activity, or the entire volume of a potential spill (whichever is applicable, or the greater of the two). Depending on the circumstances, the sump or tank can be equipped with an outflow pipe to allow discharge of normal, uncontaminated runoff to the storm drainage system. The local sewer authority may, in some instances, allow a connection of sump outflow to the sanitary sewer system. This is unlikely, but may be a consideration.

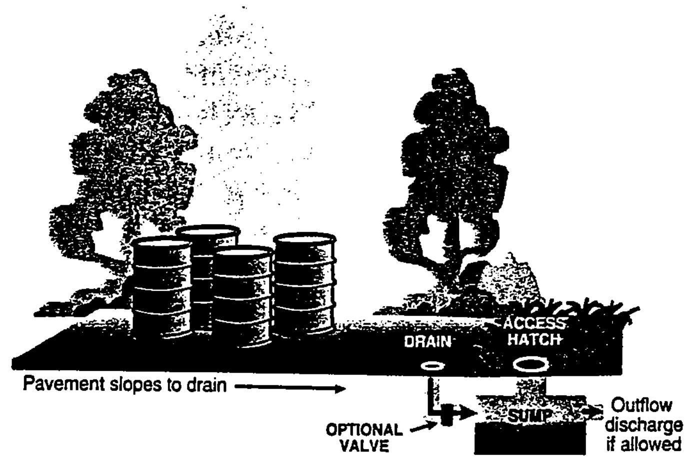
The paved activity area must also be contained to prevent stormwater run-on and run-off. This can be a curb, dike, or berm or similarly effective impediment to run-on, or intercepting storm drains (see BMP Info Sheet 5 in this chapter for more information). This way only the precipitation that falls within the activity area is discharged and/or treated along with the activity process water.

The drain pipe can have a two-way valve in it so that uncontaminated runoff from the activity area can discharge to the storm drainage system at times when the activity is not occurring. The two-way valve can therefore switch between discharges to the sanitary sewer, holding tank, or treatment facility, and discharges to the storm drainage system. Each time the activity is occurring, the two-way valve must be switched so that the site runoff discharges to the sanitary sewer, holding tank, or treatment facility. After the activity operations are finished and no more process water is generated, the area must be sprayed, hosed, or otherwise washed down with the runoff going to the sanitary sewer, holding tank, or treatment facility. The two-way valve must be switched after site drainage is complete so that subsequent runoff is discharged to the storm drainage system until the next time the activity occurs. It is critical that careful attention be given to this valve so that it is always switched to the correct position. Approval for discharges with a two-way valve should be obtained from the King County Department of Metropolitan Services (Metro).

If discharges to the storm drainage system or sanitary sewer are not allowed, the sump or holding tank contents will need to be pumped out periodically and disposed of properly. This requirement can make this BMP costly, especially during the wet season. See BMP Info Sheet 2 for disposal options.

An example of a paved activity area with a sump drain is shown to the right.

Drainage into the sump or holding tank should only occur at times when the activity is occurring. To keep disposal costs down, a drain cover, plug, or shutoff valve in the pipe leading to the sump should be used at times when the activity is not occurring. Before starting the activity (if the activity is intermittent), the cover, plug, or valve must be opened.



Paved Area with Sump Drain

The cost of constructing a sump and disposing of accumulated contents can be high, so businesses should consider whether other allowable BMP alternatives can be used. Additional fees are charged by individual cities and Metro if a sanitary sewer hookup is made. The fees depend on location, quantity of discharge, and whether the hookup is for a business or residence. A Metro industrial waste permit may also be required in some situations.

Several commercial services are available for pumping out sumps and holding tanks. These can be found in your telephone directory's yellow pages under the headings "Sewer Contractors" and "Tanks Cleaning." Septic system pump-out and hauling contractors must not be used for disposing wastes other than domestic sewage. They are not allowed to haul industrial wastes.

End of Info Sheet 4

Containment and Elevation: Surround with Dike or Berm, or Elevate

This set of BMP options can be an effective means for prevention of stormwater run-on to a contaminated activity area and for containment of spills in the activity area. This BMP may be less expensive to implement than paving the activity area and providing proper drainage collection, but can also be more difficult to maintain if stormwater ponding occurs inside a containment dike.

If a curb, berm, or dike is used to prevent stormwater run-on to a covered activity area, and the activity area is paved or otherwise impermeable, it should be placed underneath the covering so that precipitation will not pond inside it. In some instances, run-on prevention can be accomplished by placing containment materials on up-slope sides of the activity area. Stormwater run-on can also be prevented by elevating the activity with a platform or other type of pedestal.

Containment may be achieved with concrete curbing, an earthen berm, a tub such as a plastic wading pool, or some other dike material, depending on the activity, its size, and resources available. If a curb, berm, or dike is used to contain possible spills, and other containment sizing regulations (such as fire codes or Washington State Department of Ecology requirements) do not apply, it should be sized to hold a volume of 110% of the volume contained in the tank/containers.

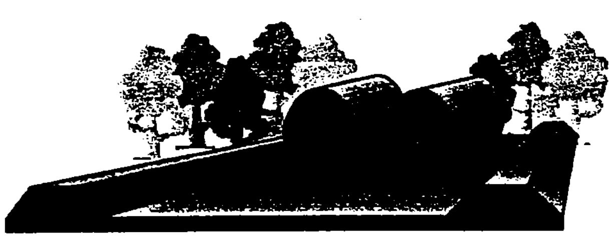
Containment without a cover means water will accumulate in the area during and after rain. Any contaminated water cannot simply be drained from the area; it must be collected and disposed of either in a sanitary sewer, a stormwater treatment system, or at a licensed disposal facility. During the wet season, this course of action can lead to frequent draining requirements that may prove costly. In addition, some type of monitoring may be needed to determine if the water is contaminated. If the stormwater is typically clean, or if a stormwater treatment system is present on-site, a valve should be installed in the containment dike so that excess stormwater can be drained out of the activity area and directed either to storm drainage facilities (if clean) or into the stormwater treatment system (if contaminated), whichever applies. This valve should always be kept closed unless excess stormwater is being discharged, so that any spills that occur within the activity area can be effectively contained. Local sewer authorities and the King County Department of Metropolitan Services will probably not allow discharges from a large containment area into the sewer system. Therefore, containment in conjunction with a sanitary sewer hookup is usually not applicable to large sites.

If containment is used rather than covering for stockpiles of material, a dike, berm, or filter must be placed on at least three sides of every stockpile to act as a barrier or filter to runoff. If the containment device is three-sided, the open side should be neither on the upslope or downslope side of the stockpile, if feasible. The dike or filter can be made of hay bales, silt fencing (filter fabric), concrete curbing, ecology blocks, compacted earth with grass planted on it, or similarly effective materials. Timbers treated with creosote or other preservatives should not be used because they can leach contaminants into runoff. If undesired ponding will occur due to a sturdy dike, filter materials should be used instead. All filter materials used around stockpiles must be maintained to work effectively and must be replaced when necessary.

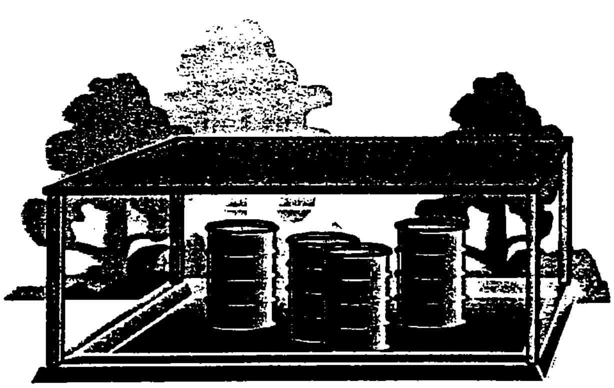
Simple Containment Devices

For storage of small items, the simplest containment device is a tub or wading pool. A rubber or plastic children's wading pool may be sufficient for some activities that do not require a lot of space, such as storing remodeling and painting materials, and temporary storage of wastes in drums. These small storage devices should also be covered with a tarp or other cover. An example of this is shown to the left.

It should also be noted, with caution, that neglect and poor maintenance can render the containment useless. Maintenance of containment devices has to be stressed as essential for them to work as intended. Commercial products are available that are a combination containment box/elevated pedestal. These devices prevent stormwater run-on by elevating containers of liquids (such as drums) off the ground and collecting spills and drips inside the pedestal box.



Containment Dike



Containment Curb

End of Info Sheet 5

Integrated Pest Management

Use of herbicides, insecticides, fungicides, and rodenticides can be extremely harmful to the environment due to the highly toxic nature of many chemicals in pesticide products. In light of this, special attention should be given to pesticide usage in all applications. The discussion below applies more to large-scale pesticide users, but should be considered for backyard applications as well.

Commercial, agricultural, and other large-scale pesticide users such as golf courses and parks should adhere to the principles of integrated pest management (IPM), a decision-making process for pest management that strives for intelligent, environmentally sound control of pests. It is a systems approach to pest management that combines agronomic, biological, chemical, and genetic information for educated decisions on the type of control(s) to use, the timing and extent of chemical application, and whether non-chemical means can attain an acceptable level of pest control.

IPM is a preventive measure aimed at knowing the exact pest(s) being targeted for control, the locations and times when pests will pose problems, the level of pest-induced damage that can be tolerated without taking action, the most vulnerable life stage, and control actions that are least damaging to the environment. The major components of IPM are as follows: monitoring and inventory of pest populations, determination of pest-induced injury and action levels, identification of priority pest problems, selection and timing of least toxic management tools, site-specific treatment with minimized chemical use, and evaluation and adjustment of pesticide applications. Monitoring of pest populations is a key to successful IPM implementation. Pest problems are universally easier to control if the problem can be discovered early. With IPM pesticides are used only as a last resort; maximization of natural controls, including biological controls and removal of pests by hand, is a guiding rule.

End of Info Sheet 6

Clean Catch Basins

Many commercial, industrial, and public agency properties have underground storm sewer drainage systems with catch basins as key components. Catch basins are typically located along curbs, under low spots in parking lots, and where sewer pipes combine flows. Storm drains visible on the surface collect runoff for catch basins that are typically located directly underneath them. Most catch basins have a few feet of storage in the bottom that never drains to an outflow pipe. This permanent storage area is intended to trap sediments, debris, and other particles that can settle out of stormwater, to prevent clogging of down-stream pipes and washing of these solids into receiving waters.

Anyone who has ever looked into a catch basin can attest to its ability to capture dirt, leaves, twigs, litter, and a variety of other materials that make for a mucky buildup in the bottom. However, if the sump in the bottom is full of solid material, everything in the incoming runoff passes straight through to an outflow pipe. The bottom (or sump) in catch basins must be cleaned out periodically so they can continue to trap solids in runoff. Routine maintenance practices at all sites with storm drains and catch basins must include cleaning of these important drainage system features. If catch basins are not cleaned, they can actually contribute to receiving water pollution problems as trapped solids and stagnant, polluted water in sumps can be flushed out in large quantities with turbulent storm flow conditions.

Check your catch basins regularly for needed maintenance (at minimum once per season). As a rule of thumb, catch basins must be cleaned out when the solids, trash and debris in the sump at the bottom reaches one-third of the depth between the bottom of the sump and the bottom (invert) of the lowest inflow or outflow pipe connected to the catch basin. This is the level at which flushing of pollutants can be a problem. The rate at which a sump fills with solid material is quite variable, and depends on the characteristics of the drainage basin feeding into it. If activities that generate a lot of sediments are taking place in the drainage area feeding a catch basin, such as stripping soils bare, stockpiling erodible raw materials, and washing of vehicles and other equipment, the sump will obviously fill up relatively quickly. Therefore, sites with activities generating a lot of sediments and other debris will have to clean out their catch basins more often.

If you clean the catch basin yourself, you may dispose of up to one cubic yard of catch basin material as solid waste in your regular garbage. If you exceed this threshold you are encouraged to contact a company offering catch basin cleaning services. You can locate a cleaning service by calling King County SWM at 296-1900 for a list of firms performing drainage system maintenance services or in your telephone directory's yellow pages under headings like "Sewer Cleaning Equipment and Supplies," "Sewer Contractors," and "Tanks Cleaning." All of the solids and stagnant water collected from catch basin sumps must be disposed of properly. None of the sump contents can be flushed into the catch basin outflow pipe. Depending on the nature of the pollutants in the sump, and the associated types of activities taking place on the site, the sump contents may need to be disposed of as hazardous waste. Contractors who perform catch basin clean-out services are required to follow appropriate disposal requirements.

Frequent sweeping of activity areas, covering activity areas, reducing activity occurrence, and containing runoff from activity areas will help reduce catch basin cleaning frequency, and probably save time and money spent on catch basin cleaning. All businesses and public agencies should set up maintenance schedules for all of their BMPs so that coordinated BMP maintenance efforts result in reduced catch basin cleaning necessity.

End of Info Sheet 7

Water Quality Treatment BMPs

The following BMP Info Sheets discuss a variety of water quality treatment facilities used to treat stormwater runoff. Treatment BMPs are usually complex structures that treat the stormwater to remove contaminants. Most treatment facilities require careful planning, design, and construction and no facility is capable of removing 100 percent of the contaminants in stormwater. Because of this, source control BMPs, as presented in Chapter Three, should always be considered first.

The BMP Info Sheets describe the water quality treatment facilities including the applicability, maintenance, and design considerations of each. Design and construction details are deferred to either the *King County Surface Water Design Manual* (which contains relevant information for the treatment BMPs discussed), or to a private vendor specializing in the treatment system.

Businesses and agencies are allowed to select a treatment BMP other than those presented in this manual if they follow the variance process as outlined in the King County Surface Water Design Manual.

Table 4.2 (next page) presents a brief description of each water quality treatment BMP discussed in the info sheets. Table 4.3 presents the appropriate water quality treatment BMPs for removing specified pollutants. One treatment BMP usually cannot treat all pollutant problems. Each BMP is designed for a specific purpose and is capable of removing only specified pollutants. If you decide to install a water quality treatment BMP, always ensure that it is removing the pollutant of concern from your site runoff.

TABLE 4.2
WATER QUALITY TREATMENT BMPs

TREATMENT BMP	BRIEF DESCRIPTION
Oil/Water Separator	An underground vault specifically designed to remove oil and grease. Also will remove floatables and some settleable solids.
Catch Basin Insert	A filtering device that is installed within a catch basin and uses various sorbent materials and settling space to collect pollutants.
Catch Basin Sump and Vault Filter	A device similar to catch basin inserts, only larger and placed underground.
Leaf Compost Filters	A filtering device that is installed above or below ground and uses leaf compost to remove pollutants from stormwater.
Wet Pond, Constructed Wetland, Wet Vault	A wet pond is a stormwater pond that retains a permanent pool of water. A constructed wetland is similar to a wet pond, but shallower and supporting wetland vegetation in large areas. A wet vault is an underground, covered, engineered structure that retains a permanent pool of water.
Vegetated Biofilter - Biofiltration Swale and Filter Strip	A biofiltration swale is a long, gently sloped ditch or depression designed to treat water as it passes through the vegetation. Grass is the most common vegetation. A filter strip is a grass area, wider than biofilters, also with gentle slopes. Water usually enters as a thin sheet flow from the adjoining pavement.
Sand Filter	A structure placed in the landscape, with grass grown on top, or in vaults. Stormwater passes through the sand allowing particulate pollutants to be filtered out.
Infiltration	A normally dry basin which temporarily stores stormwater until it soaks through the bottom and sides of the basin, and infiltrates into surrounding soil.

TABLE 4.3
APPROPRIATE USES FOR WATER QUALITY TREATMENT BMPs

POLLUTANTS TO REMOVE	APPROPRIATE TREATMENT BMPs
Oil/grease Sources: vehicle and equipment areas, industrial areas, food preparation	Oil/water separators; catch basin inserts; catch basin sump/vault filters, leaf compost filters.
Sediments/Solids Sources: sand/gravel storage, construction sites, unpaved areas, agriculture/livestock uses	For coarse sediments - Wet pond/vault; constructed wetland (with forebay); vegetated biofilter; sand filter; catch basin insert; catch basin sump/vault filters; leaf compost filters. For fine sediments - Wet pond/vault; constructed wetland (with forebay); vegetated biofilter; sand filter. Also see catch basin sump/vault filters.
Phosphorus Compounds Sources: detergents/cleaners, fertilizers, organic matter, animal wastes	For particulate phosphorus - Wet pond/vault; constructed wetland (with forebay); vegetated biofilter; sand filter. If dissolved phosphorus must also be removed - a large "oversized" wet pond or sand filter.
Nitrogen Compounds Sources: fertilizers, animal wastes, organic matter	For particulate nitrate - Wet pond/vault; constructed wetland (with forebay); vegetated biofilter; sand filter. For dissolved nitrate - constructed wetland.
Metals Sources: industrial areas, vehicle and equipment areas, paints, pesticides	For particulate metals - Wet pond/vault; constructed wetland (with forebay); vegetated biofilter; sand filter. For dissolved metals - leaf compost filter or constructed wetland.
Fecal Coliform Bacteria Sources: animal wastes; fertilizers	There is no treatment BMP that can reliably reduce fecal coliform bacteria to acceptable levels. Some studies have shown constructed wetlands provide some benefit.
pH Sources: metal plating, printing/ graphic industries, cement/ concrete production, cleaners	A constructed wetland can neutralize some ranges of pH
BOD and Trace Organics Sources: organic debris, food wastes, some chemical wastes	For particulate BOD - see "particulate nitrate" above. For dissolved BOD - A constructed wetland will remove some dissolved BOD and trace organics; more reliable performance requires activated carbon.

BMP INFO SHEET #8

Oil/Water Separator

APPLICATION AND DESCRIPTION

An oil/water separator is a device designed to remove oil, grease, and similar floatable pollutants from stormwater runoff. The name commonly refers to an underground vault structure, however, more simple designs exist.

Oil/water separators are appropriate at locations where petroleum products and/or byproducts cannot be effectively controlled with source-control BMPs. An oil/water separator can be a simple tee section in a catch basin that traps floating materials, or a complex unit that is more expensive and maintenance-intensive.

For many sites, such as small parking lots, a simple tee section in a catch basin will temporarily retard pollutants, making it possible to clean up a spill before pollutants leave the site. On sites with greater potential for oil spills and high concentrations of oil and grease in runoff, such as a fleet vehicle lot, auto repair shop, or fueling station, a more complex oil/water separator is needed.

Simple tee sections can be placed in catch basins in the primary conveyance system. Because of their simplicity, there are few restrictions on their application and locations of use.

There are two types of complex oil/water separators commonly used in situations where oily runoff is a significant concern: the American Petroleum Institute (API) and the coalescing plate interceptor (CPI). The API separator has the appearance of a long septic tank. An API separator must be large relative to the area it is treating to be effective. By placing coalescing plates in the separator, its size can be significantly reduced while retaining the efficiency needed. Consequently, the CPI separator is more commonly used. The relatively high cost of the plates is offset by the savings from reducing the cost of vault construction.

These oil/water separators should be used for targeted pollutant removal in heavily oiled areas rather than as an all purpose stormwater treatment facility. The separator will function more efficiently and require less maintenance if the amount of stormwater passing through is limited. Only runoff that has been exposed to high oil activity areas should be directed through the oil/water separator. Avoid directing stormwater (from other areas on your site) through the separator.

For information on oil/water separators for discharges to the sanitary sewer, contact Metro's Industrial Waste Section to obtain copies of the Oil/Water Separator Fact Sheet.

DESIGN AND MAINTENANCE

Oil/water separators should be designed and sized in accordance with the *King County Surface Water Design Manual.*

Oil/water separators must be checked at least weekly during the wet season. How often material should be removed depends on the amount of petroleum in the influent, but the separator should be cleaned at least quarterly, and particularly in the fall before the first storm of the wet season. All residuals removed from the surface and vault bottom must be disposed of properly. In addition, the following maintenance requirements apply:

- Oil absorbent pads should be replaced as needed, but should always be replaced in the fall prior to the wet season, and in the spring.

- The effluent shutoff valve is to be closed during cleaning operations.

- Waste oil and residuals shall be disposed in accordance with current Seattle-King County Department of Public Health requirements. Several vendors handle waste oil hauling and disposal.

- Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at a discharge location approved by the local government.

End of Info Sheet 8

BMP INFO SHEET #9

Catch Basin Insert

APPLICATION AND DESCRIPTION

A catch basin insert is a device installed under a storm drain grate to provide water quality treatment through filtration, settling, or absorption.

Catch basin inserts are commercially available products which fit into existing catch basins and are generally configured to remove one or more of the following contaminants: coarse sediment, oil and grease, and litter and debris. While it has been suggested that some units may be able to remove dissolved pollutants and pollutants associated with fine sediments, King County is not aware of independent tests which have confirmed this. Catch basin insert technology, however, is rapidly changing and future products may be able to remove dissolved pollutants. When selecting a system, ensure that your specific pollutant-removal needs are met. As with any treatment BMP, catch basin inserts should never be used in place of sound source control practices.

Oil and Grease Removal: Inserts designed for the removal of oil and grease contain, and depend on, oil-absorbing media. These inserts are appropriate for use in any area in which vehicles are used or stored. Because of the small storage capacity of the these inserts (about 1 quart of oil under ideal conditions) they are not acceptable as the sole line of defense against actual oil spills in areas where larger amounts of oil could be released. Large amounts of sediment entering the catch basin significantly reduces the effectiveness and longevity of the oil absorbing media. Under these conditions, an oil/water separator with a pre-settling chamber, may be more appropriate.

Sediment Removal: Inserts designed for sediment removal may be used at construction sites, and in situations where stockpiles or unpaved areas are likely to contribute high sediment loads. They may also be appropriate for small (low traffic) businesses in which the per-inlet cost of cleaning would be excessive. Tests indicate that these units do little to remove fine materials and dissolved pollutants and should not be considered a substitute for other pollutant-removal BMPs.

Debris Removal: Inserts can also be used for the removal of litter and debris. Some evidence suggests that the removal of large debris such as cigarette butts, candy wrappers, and beauty bark reduces the amount of harmful bacteria in receiving waters.

DESIGN AND MAINTENANCE

Unlike most other treatment BMPs, which must be designed and constructed specifically for your site, catch basin inserts may be purchased directly from a vendor and installed by the user. While standardized units are available, most vendors are able to customize their systems for your site. This service may dramatically improve the performance of your system while adding relatively little to the cost of the product. Before purchasing a catch basin insert, the following factors must be considered.

Conveyance Capacity: The conveyance capacity refers to the amount of water which the system can pass without causing flooding. This capacity is equal to the amount of water which is able to pass through the insert's treatment area, plus the amount which can pass through the built-in overflow structure. As the unit treats the stormwater, the treatment area begins to clog and the total conveyance capacity is reduced. If maintenance is neglected, or an unusually high amount of sediment or debris enter the system, the treatment capacity may drop to zero, and all of the water will have to exit through the overflow. In order to minimize the chance of flooding, the insert should be able to pass the maximum expected flow from the area draining to the catch basin. In most cases the vendor should be able to tell you what the overflow capacity is.

Treatment Capacity and Bypass: The treatment capacity refers to the amount of water which the unit will pass through its treatment area. The unit should be sized to ensure that most of the water entering the drain-inlet is treated even as the treatment area starts to clog. The ability of the unit to remove pollutants will be reduced if water is able to seep between the storm-drain grate and the edge of the pavement. Ensure that this gap is sealed. The vendor should provide you with information on how to prevent this situation and information on the treatment capacity of the system.

Maximum Weight: The maximum weight of the filter will be equal to the weight of the unit when new, plus the weight of the sediment and water trapped in the unit. Under the most extreme cases, the treatment area of the unit may become completely clogged, and the unit may be full of water when it comes time to service it. It is essential the maximum weight of the unit be less than what can be lifted by the people or equipment to be used during maintenance. Before ordering a system, or having a system customized to your site, be sure the vendor knows how you will be removing the unit for maintenance.

Simplicity and Durability: Since the installation of one or more catch basin inserts represents a long-term commitment to maintenance, it is important that the unit selected be easy to use and maintain, and that it is built to last. Be sure to have the vendor provide a complete demonstration of the product at your site, and if possible, ask to try a unit for a month or so before committing to its purchase and use.

Catch basin inserts will generally require more frequent, but less costly maintenance than other treatment BMPs. Frequent inspection of the units is necessary to ensure that they are not clogged by large debris. Actual maintenance will generally consist of removing the unit from the catch basin, cleaning or replacing the filter media (if applicable), and re-installing the unit. In addition to the weight considerations mentioned above, you must insure that the drain-inlet will not be obstructed when it is time to clean the filter, that you have the time and personnel to do the job (or can arrange for this service through a private contractor), and that you have a legal means of disposing of the trapped material and spent media. In most cases these materials may be disposed of as regular solid waste, however, media used for oil and grease removal may require special treatment. See BMP Info Sheet 2 in this chapter and resources in Chapter 6 for more information on disposal.

Maintenance frequency will vary depending on the amount and type of pollutant targeted. Tests conducted by King County suggest that initially, all units should be inspected every one to two weeks (except during periods of dry weather), and that complete maintenance will be required approximately monthly. Units configured simply to catch litter and debris may work for several months without maintenance. The simplest way to determine whether the units need maintenance is to inspect them during a rainstorm and see whether water is exiting out the overflow. If this is the case, the unit is probably in need of service. Alternatively, the depth of sediment accumulation or appearance of the filter media, may provide insight as to whether the unit is in need of maintenance. Again, be sure the vendor provides you with this information.

End of Info Sheet 9

BMP INFO SHEET #10

Catch Basin Sump and Vault Filters

APPLICATION AND DESCRIPTION

Catch basin sump and vault filters are devices installed underground to provide water quality treatment through filtration, settling, or absorption. These are similar to, but larger than catch basin inserts.

At this writing, several new but unproved technologies are being developed which are based on the installation of a filter media wall or cartridge in a catch basin sump, pipe system, or existing vault. The fundamental difference between these systems and the catch basin insert, is that sump and vault filters take advantage of the natural settling characteristics of the existing drainage system. By allowing coarse sediment to settle out before reaching the filter surface, the life of the filter will be increased (in catch basin inserts, however, the filtering media is subject to the entire sediment load and tend to clog after only a few inches of rainfall. In addition, the volume available to catch basin inserts is generally limited to about two cubic feet, further limiting their ability to remove sediments and sediment-related pollutants).

Sump and vault filters used so far have been designed to remove oil and fine sediments. Currently, efforts are under way to develop filter media to remove dissolved metals and nutrients. However, these options are not likely to be available for several years. While very little performance information exists on sump or vault filters, the likelihood that new products will be developed, and the strong interest on the part of both government agencies and pollution-control firms, makes them worth considering. Those considering these space saving, and potentially low-cost options, should contact the Surface Water Management Division for information on the latest technology.

DESIGN AND MAINTENANCE

All of the design considerations regarding filtration capacity, overflow capacity, and media selection which were discussed in BMP Info Sheet 9 - Catch Basin Inserts apply to sump and vault filters. In addition, the variety of conditions in the drainage systems in which these systems could be installed requires that care be taken to ensure the more generic versions of this technology will function properly. The ability of the absorptive media to survive extended periods of immersion must also be considered.

Maintenance of sump and vault filters will generally be more difficult, but less frequent, than for catch basin inserts. While systems installed in the sump of a Type 1 catch basin may be maintainable from the surface, those installed in larger catch basins and vaults will need to be maintained by persons trained in and equipped for confined-space entry. *Under no circumstances should an individual enter a tank, vault, or manhole without appropriate training and equipment.*

End of Info Sheet 10

Leaf Compost Filters

APPLICATION AND DESCRIPTION

Leaf Compost Filters are a filtering structure that is installed above or below ground and uses leaf compost to remove pollutants from stormwater.

Leaf compost filters are commercially available products which provide three modes of removal: filtration, ion exchange, and adsorption. They are best used to remove moderate concentrations of particulate pollutants and oil and grease. They are particularly effective in removing metals and some organic pollutants. Leaf compost filters should NOT, however be used in areas where nutrient loadings are a concern. These filters release dissolved phosphorous and are not a good choice if the business is located in the watershed of a phosphorous sensitive lake.

Above ground leaf compost systems can be used to treat runoff from small or large sites. As such, they are recommended for use in redevelopment projects. Below ground leaf compost filters are also well suited in urban areas where land surface constraints are important, since they require relatively little surface area of compost filter media.

DESIGN AND MAINTENANCE

Leaf compost filters should be designed, sized, and maintained in accordance with the *King County Surface Water Design Manual.* They should be located in areas that are easily accessible for routine maintenance and inspection. The filters should also have adequate maneuvering area for replacement of the compost media. Replacement usually requires the use of a backhoe for above ground filters and a vactor truck for below ground filters.

Leaf compost filters are subject to clogging by fine sediment and other debris. At a minimum the facility should be inspected every three months during the first year of operation. Based on these findings, the intervals of inspection may be reduced to every six months. In all cases, the facility shall be inspected and maintained after each significant storm event.

End of Info Sheet 11

Wet Pond, Wet Vault, or Constructed Wetland

APPLICATION AND DESCRIPTION

A wet pond, wet vault, and constructed wetland are facilities that maintain a permanent pool of water for removing settleable solids, particulate pollutants, and some dissolved pollutants from incoming stormwater runoff.

A wet pond is a basin with a permanent pool of water to enhance pollutant removal. In a wet pond, wetland vegetation may grow along the pond edge. A constructed wetland is heavily vegetated along the edges and through the center of the pool. The pool depth in a wet pond typically ranges from three to six feet, but is much less in a constructed wetland. A wet vault is essentially an underground pond with walls, and without vegetation. Because of the lack of vegetation, a wet vault is incapable of removing dissolved pollutants.

A wet pond and constructed wetland are large facilities requiring a considerable amount of space. A wet vault, however, is an underground system, less dependent on above ground area.

At existing businesses and public agencies, wet ponds and constructed wetlands will likely only be used when the site has an older stormwater detention pond which has the appropriate characteristics for conversion. Underground detention pipes can also be converted to wet pipes (becoming a wet vault). A new wet vault is probably the most suitable system for businesses that do not have a detention facility or where the detention facility cannot be converted to treat stormwater.

Numerous field studies indicate these systems are able to remove the majority of the settleable solids and particulate pollutants in stormwater. The amount of pollutants removed is directly related to the size of the pond. Some dissolved pollutants are probably removed although the data are too limited to draw definitive conclusions. Although these three BMPs have the potential to provide different levels of treatment, particularly in regard to dissolved pollutants, they are placed together because there is insufficient data to distinguish their performance at removing pollutants.

DESIGN AND MAINTENANCE

These facilities are to be designed in accordance with the *King County Surface Water Design Manual,* if possible. If the site already has a detention facility, it may be possible to convert it to a treatment BMP.

Regarding maintenance, follow standards specified in the *King County Surface Water Design Manual.* Studies have indicated that bottom sediments will typically not reach hazardous levels necessitating special disposal arrangements.

End of Info Sheet 12

Vegetated Biofilters

APPLICATION AND DESCRIPTION

A vegetated biofilter is an earthen channel, strip, or swale in which pollutants are removed from stormwater by filtration through grass, settling, and infiltration through soil.

There are two general configurations of vegetated biofilters: *swale* and *strip*. A swale is a long, gently sloped ditch or depression designed to treat water as it passes through the vegetation. Grass is the most common vegetation although wetland vegetation is used if higher water tables or base flows are encountered. A filter strip treats sheet flow and is placed parallel to the contributing surface. Grass is the most common vegetation, although emergent wetland vegetation is sometimes used.

Field studies in western Washington have shown that well maintained swales will remove the majority of the suspended solids and particulate pollutants. They may remove some dissolved pollutants, but field data are too limited to draw definitive conclusions. Heavy oil producing sources should be first treated with other oil control BMPs before runoff is directed to vegetated biofilters.

Vegetated biofilters will likely see limited application for retrofitting existing businesses. In some cases it will be possible to convert landscaped areas to biofilters. Roof drains that are currently piped directly to the storm drain could be modified to discharge to the grassed areas next to the building and then to a catch basin located in the grassed area. Some parking lots might be reconfigured so that a grass median can be placed over the existing catch basins. Given the appropriate site conditions, vegetated biofilters can complement (but seldom substitute for) source control BMPs.

DESIGN AND MAINTENANCE

These facilities are to be designed, sized and maintained in accordance with the *King County Surface Water Design Manual.*

A flow spreader at the inlet of the swale may enhance the use of the entire swale width. Bypassing flows above the peak rate of the design storm reduces the risk of damage. Filter strips must only be used where sheet flow of runoff occurs. If runoff becomes concentrated, a biofiltration swale should be used.

End of Info Sheet 13

BMP INFO SHEET #14

Sand Filter

APPLICATION AND DESCRIPTION

Sand filters consist of a layer of sand underlain by gravel in which runoff is filtered through to remove pollutants, collected in underground pipes, and returned back to the stream or channel.

Sand filters can be used to remove particulate pollutants, including suspended solids and some metals. They are also able to reduce nutrient levels. They are very adaptable, able to be used in areas with thin soils, high evaporation rates, low soil infiltration rates, and limited space. Sand filters and peat sand filters can be used to treat stormwater runoff from small infill developments and from small parking lots (i.e. gas stations, convenience stores). Sand filters can either be placed in the landscape, with grass grown on top, or in vaults.

DESIGN AND MAINTENANCE

The sand filter should be sized according to the *King County Surface Water Design Manual.*

Regular maintenance is critical to ensure effective functioning and pollutant removal. Experience with commercial and residential stormwater indicates that the surfaces of sand filters require semiannual cleaning. Failure to periodically clean the filter surface will eventually require replacement of the entire sand bed. Follow standards specified in the *King County Surface Water Design Manual.*

End of Info Sheet 14

Infiltration

APPLICATION AND DESCRIPTION

Infiltration uses the natural filtering ability of the soil to remove pollutants in stormwater runoff. Infiltration facilities store runoff until it gradually exfiltrates through the soil and eventually into the water table.

Infiltration systems have traditionally been used only in highly drained soils for handling excess runoff quantity. They have more recently been applied to runoff treatment situations. Infiltration of stormwater through soil can be effective at removing most pollutants, however, for the soil to be able to treat runoff and capture pollutants, one of three situations must exist: 1) the soil must be fine-grained, 2) it must have a high organic content, or 3) it must have a high cation exchange capacity.

Infiltration facilities can be either ponds or vaults which may be used on small to large developments. It is also possible to use modular pavement or concrete grid for infiltration on smaller sites. Modular pavement and concrete grid are lattice grid structures with grassed, pervious material placed in the openings where water can thus drain through the open areas of the grid into the soil below. Porous and grid pavements can only be used in areas with no traffic or low-volume parking.

There are two different retrofit situations to consider. The first situation is a development that is currently disposing stormwater to an infiltration system without pretreatment, which due to circumstances is degrading groundwater quality. Pretreatment of the stormwater is essential for coarse soils to protect groundwater quality, and for finer soils to avoid premature clogging of the infiltrative surface. The other treatment BMPs presented in this chapter can be used for pretreatment to resolve this problem.

The second situation is a development which currently disposes its stormwater to a piped system, but its soils are suitable for at least partial infiltration. Again, soil type plays an extremely important role in the performance of infiltration systems. To have the characteristics listed above, soils must contain loam and/or fine sand and silt.

An infiltration system is not appropriate at industrial sites where spills of hazardous chemicals may occur unless strict controls are in place that prevent spills from reaching the infiltration system.

DESIGN AND MAINTENANCE

Infiltration systems for water quality are to be designed and maintained in accordance with the *King County Surface Water Design Manual*. Porous pavement is not discussed in the *Surface Water Design Manual*, but maintenance should be to vacuum-sweep and pressure wash frequently (quarterly is suggested).

End of Info Sheet 15

Appendix E
DRAINAGE FACILITY MAINTENANCE GUIDELINES

MAINTENANCE CHECKLIST FOR CLOSED DETENTION SYSTEMS (PIPES/TANKS)			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
Air vent in storage area			
Q	Plugged air vents (small pipe that connects catchbasin to storage pipe)	One-half of the end area of a vent is blocked at any point with debris or sediment. Plugged vent can cause storage area to collapse.	Clean out vents so they are free of debris or sediment.
Storage area (pipe or tank)			
Q	Debris and sediment	Accumulated sediment depth exceeds 15 percent of diameter. Example: 72-inch storage tank would require cleaning when sediment reaches depth of 10 inches.	Remove all sediment and debris from storage area.
A	Joints between tank/pipe sections	Any cracks in tank or pipe wall allowing material to leak into facility.	Seal all joints between tank/pipe sections.
A	Tank/pipe bent out of shape	Any part of tank/pipe is noticeably bent out of shape.	Repair or replace tank/pipe to design. Use professional engineer for evaluation as needed.
Manhole cover			
Q, S	Cover not in place	Cover is missing or only partially in place. Any open manholes require maintenance.	If cover is only partially in place, slide it to a secured position. If cover is missing, replace.
A	Locking mechanism not working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2-inch of thread (may not apply to self-locking lids).	Repair or replace so that mechanism opens with proper tools.
A	Cover difficult to remove	One maintenance person cannot remove lid after applying 80 pounds of lift. Intent is to keep cover from sealing off access to maintenance.	Repair or replace so that cover can be removed and reinstalled by one maintenance person.
Manhole ladder			
A	Ladder rungs unsafe	Ladder is unsafe due to missing rungs, misalignment, rust, or cracks.	Repair or replace so that ladder meets design standards and allows safe access for maintenance.

A = Annual (March or April preferred), Q = Quarterly, M = Monthly, W = Weekly, S = After major storms

MAINTENANCE CHECKLIST FOR CATCHBASINS AND INLETS			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
Catchbasin opening			
M, S	Trash or debris in or on basin	Trash or debris in front of the catchbasin opening is blocking capacity by more than 10 percent.	Remove trash or debris located immediately in front of catchbasin opening. Clean grate so that it allows water to enter.
Catchbasin grate			
Q	Broken grate	Grate has multiple cracks or any cracks longer than 2 inches.	Replace grate.
Catchbasin			
Q	Sediment or debris in or on basin	Sediment or debris (in the basin) that exceeds 1/3 of the depth from the bottom of the basin to invert of the lowest pipe into or out of the basin.	Remove sediment or debris from the catchbasin. Dig out and clean catchbasin.
A	Settlement/misalignment	Basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Replace or repair basin to design standards. Contact a professional engineer for evaluation.
Q, S	Fire hazard or other pollution	Presence of chemicals such as natural gas, oil, and gasoline. Obnoxious color, odor, or sludge noted.	Clean out catchbasin so that there is no color, odor, or sludge.
Oil-water separator (elbow or T in basin)			
Q	Pollutants	Water surface in catchbasin has significant sludge, oil, grease, or scum layer covering all or most of the water surface.	Remove catchbasin lid and skim off oil layer. Place oil into a disposable container, seal, wrap securely in newspaper, and place in trash. Water surface should be clear of oily layer
Inlet and outlet pipes			
Q	Blocked pipes	Trash or debris in any inlet or pipe blocking more than 1/3 of its height.	Clear trash or debris from inlet and outlet pipes.
Q, S	Outlet pipe is clogged with vegetation	Vegetation or roots growing in the inlet/outlet pipe joints that is more than 6 inches tall and less than 6 inches apart.	No vegetation or root growth present.
Inlet and outlet pipe joints			
A	Cracks	Cracks wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catchbasin through cracks.	Repair or replace so that no cracks are more than 1/4 inch wide at the joint of inlet/outlet pipe.

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MAINTENANCE CHECKLIST FOR CATCHBASINS AND INLETS (continued)			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
Pipe elbow			
Q	Pipe elbow broken	Top or bottom of pipe appears to have broken off. Check for any apparent damage and check to see if it is plumb.	Remove catchbasin lid and examine pipe for damage. The pipe elbow should be intact. If broken, replace.
Frame			
Q	Structural damage to frame and/or top slab	Corner of frame extends more than 3/4 inch past curb into the street (if applicable)	Repair or replace so that frame is even with curb.
M		Top slab has holes larger than 2 square inches or cracks wider than 1.4 inch (intent is to ensure all material is running into basin).	Repair or replace so that top slab is free of holes and cracks.
Q		Frame is not sitting flush on top of slab, i.e., there is a separation of more than 3/4 inch between the frame and the top of the slab.	Repair or replace so that frame is sitting flush on top of the slab.
A	Cracks in basin walls/bottom	Cracks wider than 1/2 inch and longer than 3 feet, any evidence of soil particles entering catchbasin through cracks, or maintenance person judges that structure is unsound.	Replace or repair basin to design standards. Contact a professional engineer for evaluation.

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MAINTENANCE CHECKLIST FOR CONVEYANCE SYSTEMS (PIPES, DITCHES AND SWALES)			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
Pipes			
Q	Sediment and debris	Accumulated sediment that exceeds 20 percent of the diameter of the pipe.	Clean pipe of all sediment and debris.
Q	Vegetation	Vegetation that reduces free movement of water through pipes.	Remove all vegetation so water flows freely through pipes.
A	Damaged (rusted, bent, or crushed)	Protective coating is damaged; rust is causing more than 50 percent deterioration to any part of pipe.	Repair or replace pipe.
Q		Any dent that significantly impedes flow (i.e., decreases the cross section area of pipe by more than 20 percent).	Repair or replace pipe.
A		Pipe has major cracks or tears allowing groundwater leakage.	Repair or replace pipe.
Open ditches and swales			
Q	Trash and debris	Dumping of yard wastes such as grass clippings and branches into basin. Unsightly accumulation of nondegradable materials such as glass, plastic, metal, foam, and coated paper.	Remove trash and debris and dispose of. Educate property owners.
A	Sediment buildup	Accumulated sediment that exceeds 20 percent of the design depth.	Clean ditch of all sediment and debris so that it matches design. Vegetation may need to be replanted in swales after cleaning.
A	Vegetation	Vegetation (e.g., weedy shrubs or saplings) that reduces free movements of water through ditches.	Clear blocking vegetation so water flows freely through ditches. Grassy vegetation should be left alone.
Q, S	Erosion damage	See Ponds Checklist.	See Ponds Checklist.
A	Rock lining out of place or missing (if applicable)	Native soil can be seen beneath the rock lining.	Replace rocks to design standard.

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MAINTENANCE CHECKLIST FOR CONVEYANCE SYSTEMS (PIPES, DITCHES AND SWALES) (continued)			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
Swales			
Q	Vegetation not growing or overgrown in swales	Grass cover is sparse and seedy or areas are overgrown with woody vegetation.	Aerate soils and reseed and mulch bare areas. Maintain grass height at a minimum of 6 inches for best stormwater treatment. Remove woody growth, recontour, and reseed as necessary.
Q	Conversion by homeowner to incompatible use	Swale has been filled in or blocked by shed, woodpile, shrubbery, etc.	Speak with homeowner and request that swale area be restored.
A	Swale does not drain	Water stands in swale or flow velocity is very slow. Stagnation occurs.	A survey may be needed to check grades. Grades need to be in 1-5 percent range if possible. If grade is less than 1 percent underdrains may need to be installed.

MAINTENANCE CHECKLIST FOR DOWNSPOUTS			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
Downspout			
A	Water overflows	Water overflows from the gutter or downspout during rain.	Clean gutters and downspouts first. Install a bigger dry well if necessary.
Roof			
A	Moss and algae	Moss and algae are taking over the shadier parts of the shingles.	Disconnect the flexible part of the downspout that leads to the dry well. Perform moss removal as desired. Pressure wash or use fatty acid solutions instead of highly toxic pesticides or chlorine bleach. Install a zinc strip as a preventative.

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MAINTENANCE CHECKLIST FOR ACCESS ROADS AND EASEMENTS			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
General			
Once	No access road exists	If ponds or other drainage system features needing maintenance by motorized equipment are present, either an access road or access from public streets is required.	Determine whether an easement to drainage feature exists. If so, obtain the necessary permits and construct gravel (or equal) access road.
Q	Blocked roadway	Debris that could damage vehicle tires (glass or metal).	Clear roadway of debris that could damage tires.
A		Any obstructions that reduce clearance above road surface to less than 14 feet.	Clear roadway overhead clearance to 14 feet high.
A		Any obstructions restricting the access to less than 15 feet width.	Remove obstruction to allow at least a 15-foot-wide access.
Road Surface			
A, S	Settlement, potholes, mushy spots, ruts	Any surface defect exceeding 6 inches in depth and 6 square feet in area; any surface defect that hinders or prevents maintenance access.	Keep road surface uniformly smooth with no evidence of settlement, potholes, mush spots, or ruts. Occasionally apply additional gravel or pit-run rock as needed.
M	Vegetation in road surface	Woody growth that could block vehicular access. Excessive weed cover.	Remove woody growth at early stage to prevent vehicular blockage. Cut back weeds if they begin to encroach on road surface.
Shoulders and ditches			
A, S	Erosion damage	Erosion within 1 foot of the roadway more than 8 inches wide and 6 inches deep.	Replace eroded material and match shoulder to the surrounding road.

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MAINTENANCE CHECKLIST FOR SAND FILTERS			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
Sand bed			
Q	Dirt and debris	Dirt and debris layer is more than 1 inch deep on top of the sand and covers more than half the surface of the sand bed.	Carefully shovel or rake dirt into a pile, then remove and dispose of in the trash. If sand bed appears to be compacted or in need of replenishing, first loosen up the remaining sand with a rake or shovel. If sand still looks low, or is chunky or gummy, replenish or replace with fine to medium sand.
Q, S	Water not flowing right	All water flows to one area or spills over the top of the sand bed, rather than percolating through it, even in small rain storms.	When it rains, examine the system used to distribute water to the sand bed. Clear any diversions or blockages found. If water flows to one end, try to level the distribution system by pulling or pushing on it. If water flows over the top of the bed, even out the sand with a shovel or rake. Replenish areas that have settled.
Q	Standing water	Standing water on the sand bed, or sand bed bypass for almost all storms.	If there is no layer of dirt or debris preventing infiltration, then the problem is internal to the sand bed. The most likely problem is blockage in the underdrain or outlet from the system. Use a contractor to investigate problem and determine solution.

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MAINTENANCE CHECKLIST FOR OUTFLOW CONTROL STRUCTURE/FLOW RESTRICTOR			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
Orifice Plate			
Q	Trash and debris (includes sediment)	Distance between debris buildup and bottom of orifice plate is less than 1-1/2 feet.	Remove all trash and debris.
Outlet pipe			
A	Structural Damage	Structure is not securely attached to manhole wall and outlet pipe; structure should support at least 1,000 pounds of up or down pressure.	Securely attach structure to wall and outlet pipe.
A		Structure is not in upright position (allow up to 10 percent from plumb).	Realign structure in correct position.
A		Connections to outlet pipe are not watertight and show signs of rust.	Repair or replace structure so that connections to outlet pipe are watertight and structure works as designed.
M		Any holes - other than designed holes - in the structure.	Repair or replace so that pipe has no holes and works as designed.
Cleanout gate			
Q, S	Damaged or missing	Cleanout gate is not watertight or is missing.	Repair or replace so that gate is watertight and works as designed.
Q		Gate cannot be moved up and down by one maintenance person.	Repair or replace so that gate moves up and down easily and is watertight.
Q		Pull chain leading to gate is missing or damaged.	Repair or replace so that chain is in place and works as designed.
A		Gate is rusted over 50 percent of its surface area.	Repair or replace gate to meet design standards.
Orifice plate			
Q, S	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate	Remove trash or debris so that plate is free of all obstructions and works as designed.
Overflow pipe			
Q, S	Obstructions	Any trash, debris, vegetation, or sediment blocking (or having the potential of blocking) the overflow pipe.	Use rake or pitchfork to remove all obstructions.

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MAINTENANCE CHECKLIST FOR PONDS (WET, DRY OR INFILTRATION)			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
Entire pond			
Q	Trash and debris buildup in pond.	Dumping of yard wastes such as grass clippings and branches into basin. Unsightly accumulation of nondegradable materials such as glass, plastic, metal, foam, and coated paper.	Remove and dispose of trash and debris.
Q	Poisonous/noxious vegetation	Any poisonous or noxious vegetation that may constitute a hazard to the public, such as tansy ragwort, poison oak, stinging nettles, devilsclub.	Remove poisonous vegetation. Do not spray chemicals on vegetation without obtaining guidance from a cooperative extension service.
M, S	Fire hazard or pollution	Presence of chemicals such as natural gas, oil, and gasoline, obnoxious color, odor, or sludge noted.	Find sources of pollution and eliminate them. Water should be free from noticeable color, odor, or contamination.
M	Vegetation not growing or is overgrown	For grassy ponds, grass cover is sparse and weedy or is overgrown. For wetland ponds, plants are sparse or invasive species are present.	For grassy ponds, selectively thatch, aerate, and reseed ponds. Grass cutting unnecessary unless dictated by aesthetics. For wetland ponds, hand-plant nursery-grown wetland plants in bare areas. Contact a cooperative extension service for direction on invasive species such as purple loosestrife and reed canary grass. Pond bottoms should have uniform dense coverage of desired plant species.
Dam or berm			
Q	Rodent holes	Any evidence of rodent holes in facility dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Destroy rodents and repair dam or berm. Contact the County Health Department for guidance.
General			
M	Insects	Insects such as wasps and hornets interfere with maintenance activities, or mosquitoes become a nuisance.	Destroy or remove insects from site. Contact a cooperative extension service for guidance.
A	Tree growth	Tree growth does not allow maintenance access or interferes with maintenance activity (e.g., slope mowing, silt removal, or equipment movements). If trees are not interfering with access, leave trees alone.	Prune trees to allow maintenance activities. Selectively cultivate trees such as alders for firewood.
Inlet			
A	Missing riprap or sediment buildup	Check whether the riprap under the inlet pipe is intact and whether native soil is exposed. Check for accumulation of sediment more than half the height of the rock.	Clean out sediment and/or replace rocks to avoid blocking the inlet.

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MAINTENANCE CHECKLIST FOR PONDS (WET, DRY OR INFILTRATION) (continued)			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
Outlet			
Q	Bar screen damaged or blocked	The bar screen over the outlet should be intact and clear of debris. Water should flow freely through the outlet pipe.	Replace screen if it is not attached. Remove any trash or debris and dispose of properly. Clean out the end of pipe if necessary.
Side slopes of pond			
Q, S	Erosion on berms or at entrance or exit	Check around inlets and outlets for signs of erosion. Check berms for signs of sliding or settling. Action is needed where eroded damage is over 2 inches deep and where there is potential for continued erosion.	Find causes of erosion and eliminate them. Stabilize slopes using appropriate erosion control measures; e.g., rock reinforcement, planting of grass, compaction.
Storage area			
A	Sediment buildup in pond	Accumulated sediment exceeds 10 percent of the designed pond depth. Buried or partially buried outlet structure or very slow infiltration rate probably indicates significant sediment deposits.	Clean out sediment to designed pond shape and depth; reseed pond if necessary to control erosion.
Pond dikes			
A	Settlements	Any part of dike has settled 4 inches lower than the design elevation.	Dike should be built back to the design elevation.
Emergency overflow/spillway			
A	Rock missing	Only one layer of rock exists above native soil in area 5 square feet or larger, or any exposure of native soil.	Replace rocks to design standards.
Once	Overflow missing	Side of pond has no area to handle emergency overflows.	Install emergency spillway to handle overflows.

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MAINTENANCE CHECKLIST FOR INFILTRATION SYSTEMS

Frequency	Problem	Problems to Check For	What to Do
Storage area			
A	Sediment buildup in system	A soil texture test indicates facility is not working at its designed capabilities or was incorrectly designed.	Remove sediment and/or clean facility so that infiltration system works according to design. Install a sediment trapping area to reduce sediment transport into infiltration area. Determine source of sediment and take steps to reduce erosion.
A	Storage area drains slowly (more than 48 hours) or overflows	A soil texture test indicates facility is not working at its designed capabilities or was incorrectly designed.	Add additional volume through excavation to provide needed storage. Aerate and rototill to improve drainage.
M	Sediment trapping area	Any sediment and debris filling area to 10 percent of depth from sump bottom to bottom of outlet pipe or obstructing flow into the connector pipe.	Clean out sump to design depth.
Once	Sediment trapping area not present	Stormwater enters infiltration area directly without treatment.	Add a trapping area by constructing a sump for settling of solids. Segregate settling area from rest of facility.
Rock filters			
M	Sediment and debris	By visual inspection little or no water flows through filter during heavy rain storms.	Replace gravel in rock filter.

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MAINTENANCE CHECKLIST FOR ENERGY DISSIPATERS			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
Rock pad			
A	Missing or moved rock	Only one layer of rock exists above native soil in area 5 square feet or larger, or any exposure of native soil.	Replace rocks to design standard.
Rock-filled trench for discharge from pond			
A	Missing or moved rock	Trench is not full of rock	Add large rock (± 30 lb. each) so that rock is visible above edge of trench.
Dispersion trench			
Q	Pipe plugged with sediment	Accumulated sediment exceeds 20 percent of the design depth.	Clean/flush pipe. In severe cases, the rocks will have to be removed, cleaned, and then replaced.
Q	Perforations plugged	Over half of perforations in pipe are plugged with debris and sediment.	Clean or replace perforated pipe.
Q, S	Not discharging water properly	Visual evidence of water discharging at concentrated points along trench creating erosion. Normal condition is a "sheet flow" of water along trench. Intent is to prevent erosion damage.	Trench must be redesigned or rebuilt to standard. Elevation of lip of trench should be the same (flat) at all points.
Q, S	Water flows out top of "distributor" catchbasin	Water flows out during any storm less than the design storm or it is causing or appears likely to cause damage.	Facility must be rebuilt or redesigned to standards. Pipe is probably plugged or damaged and needs replacement.
Q, S	Receiving area over-saturated	Water in receiving area is causing or has potential of causing landslide.	Stabilize slope with grass or other vegetation, or rock if condition is severe.

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MAINTENANCE CHECKLIST FOR GROUNDS (LANDSCAPING)			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
Landscaped areas			
Q	Weeds (nonpoisonous)	Weeds growing in more than 20 percent of the landscaped area (trees and shrubs only).	If possible, pull weeds by hand to avoid using chemical weed controls. Weeds should be present in less than 5 percent of the landscaped area.
Q	Safety hazard	Any presence of poison ivy or other poisonous vegetation or insect nests.	Remove poisonous vegetation or insect nests present in landscaped area.
Q	Trash or litter	Yard waste or litter in landscaped areas.	Remove and dispose of properly.
Q, S	Erosion of Ground Surface	Noticeable rills are seen in landscaped areas.	Identify causes of erosion and take steps to slow down/spread out the water. Fill, contour, and seed eroded areas.
Trees and shrubs			
A	Damage	Limbs or parts of trees or shrubs that are split or broken which affect more than 25 percent of the total foliage of the tree or shrub.	Trim trees/shrubs to restore shape. Replace trees/shrubs with severe damage.
A		Trees or shrubs that have been blown down or knocked over.	Replant tree, inspecting for injury to stem or roots. Replace if severely damaged.
A		Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Place stakes and rubber-coated ties around young trees/shrubs for support.

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MAINTENANCE CHECKLIST FOR FENDING, SHRUBBERY SCREEN, OTHER LANDSCAPING			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
Fence or shrubbery screen			
M Q	Missing or broken parts/dead shrubbery	Any defect in the fence or screen that permits easy entry to a facility.	Mend fence or replace shrubs to form a solid barrier to entry.
M, S	Erosion	Erosion has resulted in an opening under a fence that allows entry by people or pets.	Replace soil under fence so that no opening exceeds 4 inches in height.
Shrubbery			
M Q	Unruly vegetation	Shrubbery is growing out of control or is infested with weeds.	Trim and weed shrubbery and to provide appealing aesthetics. Do not use chemicals to control weeds.
Wire Fences			
A	Damaged parts	Posts out of plumb more than 6 inches.	Align posts to within 1-1/2 inches of plumb.
A		Top rails bent more than 6 inches.	Repair top rail so that it is free of bends greater than 1 inch.
A		Any part of fence (including posts, top rails, and fabric) more than 1 foot out of design alignment.	Repair fence so that it is aligned and meets design standards.
A		Missing or loose tension wire.	Repair or replace tension wire so that it is in place and holding fabric.
A		Missing or loose barbed wire that is sagging more than 2-1/2 inches between posts.	Repair or replace barbed wire so that it is in place with less than 3/4-inch sag between posts.
A		Extension arm missing, broken, or bent out of shape more than 1-1/2 inches.	Repair or replace extension arm so that it is in place with no bends larger than 3/4 inch.
A	Deteriorated paint or protective coating	Part or parts have a rusting or scaling condition that has affected structural adequacy.	Paint or coat rusting or scaling posts or parts with a protective coating.
M Q	Openings in fabric	Openings in fabric are such that an 8-inch diameter ball could fit through.	Repair or replace so there are no openings in fabric.

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MAINTENANCE CHECKLIST FOR GATES			
Frequency	**Problem**	**Problems to Check For**	**What to Do**
General			
M	Damaged or missing components	Gate is broken, jammed, missing, or won't open easily.	Repair or replace so pond has a functioning gate to allow entry of people and maintenance equipment such as mowers and backhoe. If a lock is used, make sure City field staff have a key.
M		Broken or missing hinges such that gate cannot be easily opened and closed by a maintenance person.	Lubricate or replace hinges and/or gate.
A		Gate is out of plumb more than 6 inches and more than 1 foot out of design alignment.	Align gate to vertical.
A		Missing stretcher bands, and ties.	Make sure stretcher bar, bands, and ties are in place.

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