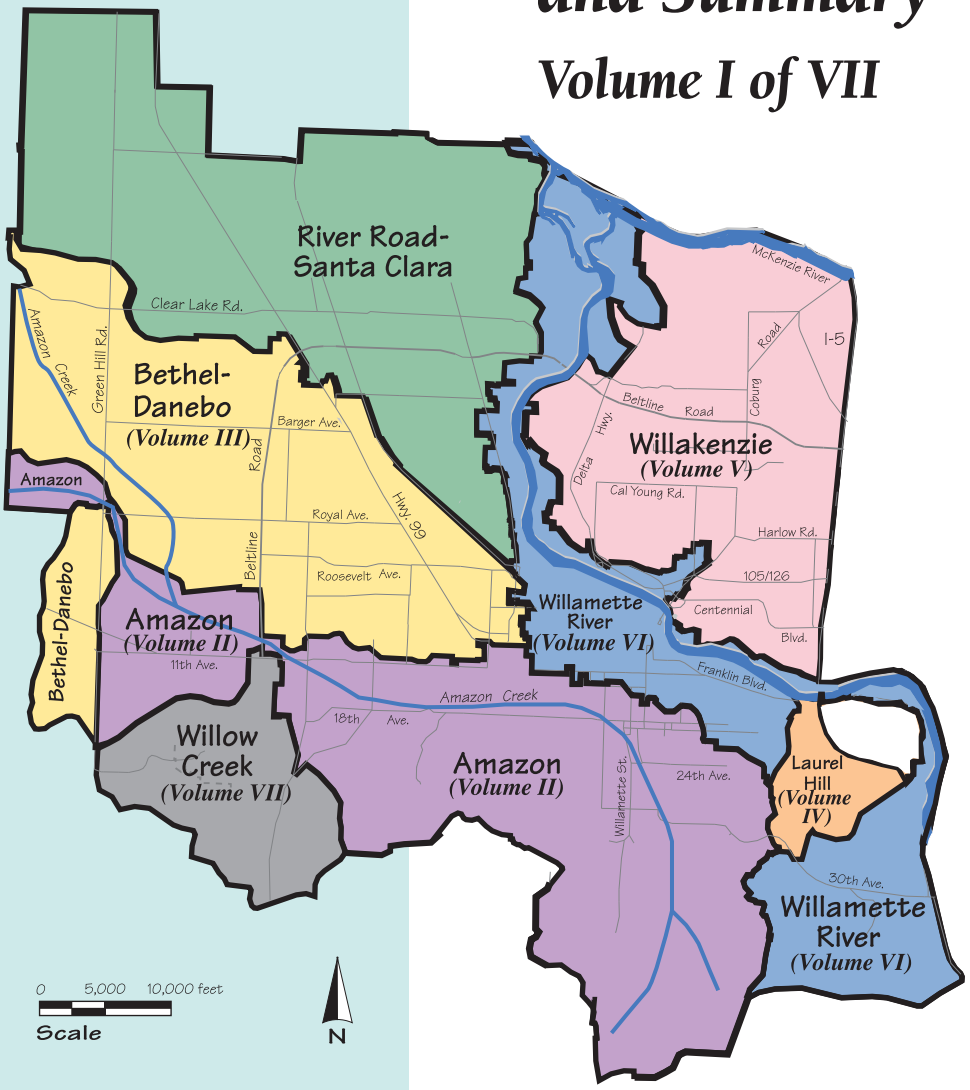
City of Eugene

Stormwater Basin Master Plan

Study Methodology and Summary

Volume I of VII



CITY OF EUGENE
STORMWATER
MANAGEMENT PROGRAM

August 2002
Prepared by:
City of Eugene
URS Corporation
Lane Council of Governments

Local Stormwater Planning Can Make a World of Difference

ADMINISTRATIVE ORDER NO. 58-03-06
of the
Executive Manager
Public Works Department
City of Eugene, Oregon

APPROVING THE EUGENE STORMWATER BASIN MASTER PLANS.

The Executive Manager of the Public Works Department of the City of Eugene finds that:

A. Under the provisions of Chapter IV, Section 16 of the Eugene Charter of 2002, the City Manager is designated as the administrative head of the City, and is specifically authorized to appoint and remove all employees (except as otherwise provided in the Charter), and to enforce all ordinances of the City.

B. Pursuant to that authority, the former City Manager, James R. Johnson, and the current City Manager pro tem, James R. Carlson have designated and/or affirmed my appointment as Executive Manager of the City's Public Works Department. In such capacity I have the responsibility for supervision of that department and its employees.

C. The Eugene Stormwater Basin Master Plans (Basin Plans) have been developed to replace the 1990 Otak Areawide Drainage Master Plans. The Basin Plans document the comprehensive basin planning process and results, and provide guidance for the management of stormwater throughout the study area. These plans describe a "multiple-objective" approach (*i.e.*, incorporating water quality, stormwater-related natural resources and flood control) to stormwater management, and are to be used by City staff for background/contextual information, for development of the City's biennial CIP, for contextual support for proposed development standards, and for evaluating technical information about the stormwater system. However, the Basin Plans will not be used in a manner that regulates conduct or activities of the public.

D. The new Basin Plans:

- Identify the major drainage basins and major subbasin delineations;
- Describe the study area characteristics (existing/build-out land use, impervious surface cover, slopes, topography, soil types, drainage features, etc.);
- Describe the flood control, water quality and stormwater-related natural resource problems and opportunities in each major basin;

- Describe the long-term (35 year multiple objective capital improvement program (including water quality, flood control and sw-related natural resources projects as well as stream corridor acquisitions) and proposed new development standards that would, together and along with the other multitude of activities in the stormwater program, address the identified problems and opportunities; and

- Describe the City's drainage criteria for design of stormwater system improvements.

E. The drainage criteria for design of stormwater system improvements contained in the Basin Plans, and other specific information about design storm events and analysis and design methods serve as guidance to the City and the public and are neither requirements nor prohibited conduct.

NOW, THEREFORE,

The Executive Manager of the Public Works Department of the City of Eugene orders and directs that:

1. The Eugene Stormwater Basin Master Plans (Basin Plans) are hereby approved, and shall be utilized by staff of the Public Works Department in lieu of the 1990 Otak Areawide Drainage Master Plans in evaluating development proposals. The Basin Plans shall not be used as approval criteria.

2. Copies of this Order shall be forwarded to all Public Works Department Division Managers.

Dated this 14 **day of** April **, 2003.**

Kurt A. Corey
Executive Manager
Public Works Department

Stormwater Basin Master Plan

Volume I of VII

City-Wide Study Methodology and Summary



December 2002

Prepared by:

City of Eugene
URS Corporation
Lane Council of Governments

ACKNOWLEDGEMENTS

The Stormwater Basin Master Plan represents the culmination of a long term planning effort by a multi-agency team consisting of representatives from the City of Eugene, Lane Council of Governments (LCOG), and URS Corporation.

The project team would like to gratefully acknowledge the efforts of the many present and former city and consultant staff who provided input for and review of this document. The following acknowledgements include a representative from each of the divisions, departments and agencies involved over the years. The project team would like to especially acknowledge the leadership, guidance, commitment and contribution to this effort by Christine Andersen, former Public Works Director and the late Les Lyle, City Engineer (1983-2001) for Eugene.

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The information published in this report is subject to revision. Please contact the City of Eugene's Engineering Division for potential changes before proceeding with any engineering design that uses the information published herein.

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This document represents the introductory volume of a seven-volume report that describes the process and results of the City of Eugene's development of Stormwater Basin Master Plans. Volume I provides an overview of the Project and also summarizes information that is presented in detail in the six companion volumes, each of which covers one of the City's major drainage basins. Specifically, Volume I includes:

1) Background, goals and objectives, and project scope.
2) City-wide study area characteristics.
3) Study methods for evaluating flood control, water quality, and open waterways.
4) Development of an integrated stormwater management strategy for each basin.
5) Implementation of the strategies.

Volumes II through VII provide more detailed information regarding development of the stormwater management strategies for each of the basins as follows: *Volume II - Amazon Creek, Volume III - Bethel-Danebo, Volume IV – Laurel Hill, Volume V - Willakenzie, Volume VI - Willamette River; Volume VII - Willow Creek*. Each of these basin specific volumes include: characteristics unique to the basin; results of the basin evaluation for flood control, water quality and natural resources; and resulting integrated stormwater management strategies.

Volume I includes information about the characteristics of the River Road Santa Clara basin and specific elements of a stormwater management strategy, but Volume I does not include the full integrated management strategy for this basin as it has not been fully developed. Likewise, a final basin specific plan was not produced for River Road Santa Clara, pending resolution of inter-jurisdictional issues as well as additional information gathering and analysis. An initial study towards the development of a River Road Santa Clara stormwater basin master plan was developed and is available upon request from Public Works Engineering.

NOTE: It should be noted that the term basin is typically used to refer to a defined surface area that drains to a common discharge point. However, for the purposes of this study, the term basin is used to refer to a specific planning or study area. While the planning or study areas were developed based on topography and drainage patterns, they may include several discharge points, or they may exclude specific tributary areas based on convenience for planning purposes. In some cases, portions of the basin were not included in the planning area as they are managed by other jurisdictions. The basin areas as defined in this plan are also further divided into major subbasins and subbasins as described in individual basin master plan reports. See Section 1.4.

As is typical for most cities, large portions of the City of Eugene's existing stormwater collection and conveyance system were designed and built with the sole objective of addressing flooding issues. More recently, concerns related to urban stormwater quality have come into the foreground. As a result, the City has taken a new direction in planning for stormwater management. Eugene Public Works has developed a program to comply with regulatory mandates in ways that reflect the City's unique characteristics, values, needs, intentions, and priorities. The driving forces behind this initiative included the following:

- The need to apply for and comply with a municipal stormwater National Pollutant Discharge Elimination System (NPDES) permit under the Clean Water Act.

- The need to address emerging water quality standards to ensure beneficial uses are met in receiving water bodies (i.e., total maximum daily load (TMDL) requirements under the Clean Water Act).
- Impending Issues - Although not an issue at the outset of the project, listing of the Spring Chinook salmon as a Threatened Species (*Federal Register, Vol. 65, No. 32, February 16, 2000*) was considered in the final development of these plans. Another impending issue includes recently promulgated state rules under the Safe Drinking Water Act requirements related to the underground injection of stormwater.

The first step Eugene took in revising its stormwater management program was to develop a Comprehensive Stormwater Management Plan (CSWMP). CSWMP provides the policy direction for stormwater management in Eugene, and was adopted by the Eugene City Council in 1993. The Stormwater Basin Master Plans described in this document comprise two of the specific CSWMP implementation actions: P&A1, "Develop Comprehensive Basin Plans", and P&A7, Stormwater Development Standards (see CSWMP, pages A-1 to A-3). One additional implementation action was ultimately addressed as part of the project: CAP1, Stream Corridor Acquisition.

The overall goal of the Stormwater Basin Master Plans was to develop a stormwater management strategy for each basin that proactively addresses the multiple objectives of CSWMP. In addition to flood control, these multiple objectives include:

- Protect and improve water quality.
- Protect waterways that provide beneficial stormwater functions.
- Use best management practices (BMPs) that promote a green infrastructure (see glossary for a definition of green infrastructure).
- Address the unique qualities of each drainage basin.
- Meet federal, state, and local laws and policies (including CSWMP).
- Complement other existing BMPs that are part of the City's stormwater program.
- Balance responsibilities community-wide.
- Provide a dynamic and flexible program that can be refined based on a changing regulatory climate.

The work that was conducted to develop these integrated stormwater management strategies included the following major tasks:

Step 1) Compile information regarding the unique characteristics of each basin with respect to the stormwater drainage system.
Step 2) Identify problems and opportunities associated with the stormwater drainage system with respect to flood control, water quality, and open waterways.
Step 3) Develop potential solutions in the form of capital projects and development standards for addressing identified problems.
Step 4) Evaluate and compare potential solutions in terms of feasibility, costs, and effectiveness.
Step 5) Evaluate capital projects to address problems expected under existing conditions.

Step 6) Evaluate capital projects and development standards to address problems expected as a result of future build-out.
Step 7) Select an integrated stormwater management strategy based on the evaluations conducted in steps 5 and 6.
Step 8) Develop a maintenance strategy for the proposed solutions.
Step 9) Obtain feedback regarding integrated stormwater management strategies and the maintenance strategy from the public and refine the strategies as appropriate.
Step 10) Prioritize selected capital projects for implementation and conduct a financial analysis.
Step 11) Develop stormwater basin master plans to summarize the integrated stormwater management strategies including proposed capital projects and development standards.
Step 12) Develop ordinance language to codify the proposed development standards.
Step 13) Develop a best management practices manual to help guide developers in meeting the requirements of the development standards.

As a result of the process described above, a capital improvement program and development standards were proposed. The capital improvement program includes capital projects and stream corridor acquisitions.

Capital Projects:

A total of 44 location specific capital projects were selected for the integrated stormwater management strategies city-wide (not including all of the potential River Road Santa Clara basin capital projects). For flood control, 23 capital projects are proposed which include: increased pipe/culvert sizes, increased open waterway capacities, a piped bypass system, and construction of a new drainage channel. For water quality, 14 capital projects are proposed which include: retrofits of existing ponds, and construction of new water quality facilities. For open waterways, 7 capital projects are proposed which include: bank restoration, wetland protection, and enhancement of physical and biological resources. Although the capital projects are accounted for here according to their main objective, many of the projects will address multiple objectives. For example, if increased capacity is needed in an open waterway system, vegetative resource enhancements will be included as part of the project. In addition to the projects listed above, there are 4 new line items in the capital project budget that will be used in various locations each year to implement the following types of projects: structural water quality facilities in high pollutant source areas, retrofits of tip-ups to address flooding and water quality issues, stream stabilization projects to addressed impacts from increased runoff volumes, and stormwater outfall stabilization projects. See Section 4.2 including Table 4-1 for additional details regarding capital projects.

Stream Corridor Acquisitions:

This is an enhancement of an existing program area where stream corridor protection becomes the primary objective and acquisition for maintenance access purposes continues but on an as needed basis. Approximately eleven miles of corridor length and 172 acres of corridor area are targeted for acquisition over a five-to-seven year period.

Stormwater Development Standards:

Water Quality Related Design Requirements: The recommended water quality development standard is to capture and treat 80% of the average annual rainfall volume. This standard was reviewed and recommended within the context of each of the individual integrated stormwater management strategies. The standard is recommended for application city-wide to all new development and significant redevelopment within Eugene City limits except for those properties which will be listed as exempt under City Code. This standard is scheduled for adoption in Fall 2003.

The water quality standard will require treatment BMPs that are designed according to a City BMP Manual and the City's water quality design storms. The standard will also require additional BMPs for specific land use activities of concern (i.e., oil control for high traffic areas, and structural source controls for commercial/industrial activities that are exposed to stormwater).

Public and private maintenance responsibilities associated with implementation of the BMPs will be outlined in City Code.

An additional water quality requirement is recommended for the headwaters areas located in the south hills of Eugene. Most of the streams in this area are currently in fairly good condition and will require additional protection from imminent and future development to maintain their condition. The purpose of this additional requirement will be to ensure that either a piped bypass system, implementation of stream stabilization projects, or detention ponds to control peak flows from small frequent events are constructed in a manner to protect these streams from impacts associated with the expected increases in runoff peak flows and volumes.

Open Waterways Requirements: Recommended open waterways development standards are as follows. In addition to the selected standards, the strategy includes coordination with other ongoing programs; also described below.

- Support Existing Waterway Protection Standards: (i.e., Waterside Protection Overlay Zone, "Needed Housing", Natural Resource Zone, Planned Unit Development, Site Review as applicable).

- Key Waterways Protection Standard– No Fill/No Pipe: This standard was selected and processed through the Planning Commission and City Council. Ultimately, this standard was replaced by an approach that would apply no-fill/no-pipe prohibitions to all waterways until the Metropolitan Natural Resource Study (NR Study) was completed.

  Note: When processed for adoption, this standard was referred to as the Open Waterways Ordinance which was remanded back to the City for further processing. This ordinance is no longer in effect.

- Interim Setbacks Standard: This standard was selected to be applied as an interim measure until the NR Study was completed. Processing of the ordinance began but was halted when:

1) Oregon voters approved Ballot Measure 7 requiring compensation for land use regulations that would lower land values, and 2) when the open waterways ordinance appeal was upheld by the Oregon Land Use Board of Appeals.

Note: Due to the situation described above with respect to the Open Waterways ordinance, an Interim Setbacks standards will not be pursued at this time.

- Coordination with the Metropolitan Natural Resources Study (described in Section 3.3) to ensure consistency with stormwater program objectives for long term stream corridor protection and to identify and fill gaps in long-term protection measures for waterways.

- Coordination with the Endangered Species Act/Salmon program (described in Section 3.3).

- Coordination with the Metro Waterway Restoration Study (described in Section 3.3).

The Stormwater Basin Master Plans represent three of thirty-four stormwater management practices being implemented as part of the City's National Pollutant Discharge Elimination System (NPDES) municipal stormwater permit requirements and hence CSWMP. This project addresses water quality through the implementation of capital projects, stream corridor acquisitions and development standards. Other essential water quality management practices that the City has already undertaken and are a regular part of the stormwater program include: inspections, enforcement and monitoring with respect to potential illicit connections and illegal dumping; public education programs; revised operations and maintenance practices; and erosion prevention and construction site management requirements.

SECTION 1 Introduction

This document represents the introductory volume of a seven-volume report that describes the process and results of the City of Eugene's development of Stormwater Basin Master Plans. Volume I provides an overview of the Project and also summarizes information that is presented in detail in the six companion volumes, each of which covers one of the City's major drainage basins. Specifically, Volume I includes: 1) background, goals and objectives, and project scope 2) City-wide study area characteristics, 3) study methods for evaluating flood control, water quality, and stormwater related natural resources, 4) development of an integrated stormwater management strategy for each basin, and 5) implementation of the strategies.

Volumes II through VII provide more detailed information regarding development of the stormwater management strategies for each of the basins as follows: *Volume II - Amazon Creek, Volume III - Bethel-Danebo, Volume IV – Laurel Hill, Volume V - Willakenzie, Volume VI - Willamette River; Volume VII - Willow Creek* (see Figure 1-1 for basin locations). Each of these basin specific volumes include: characteristics unique to the basin; results of the basin evaluation for flood control, water quality and natural resources; and resulting integrated stormwater management strategies. A basin specific plan was not produced for River Road Santa Clara, pending resolution of inter-jurisdictional issues as well as additional information gathering and analysis. Volumes II through VII also contain technical appendices which include summary tables from the hydrologic/hydraulic modeling, natural resource assessment field data sheets, and capital project fact sheets.

Volume I includes information about the characteristics of the River Road Santa Clara basin and specific elements of a stormwater management strategy, but Volume I does not include the full integrated management strategy for this basin as it has not been fully developed. Likewise, a final basin specific plan was not produced for River Road Santa Clara, pending resolution of inter-jurisdictional issues as well as additional information gathering and analysis. An initial study towards the development of a River Road Santa Clara stormwater basin master plan was developed and is available upon request from Public Works Engineering.

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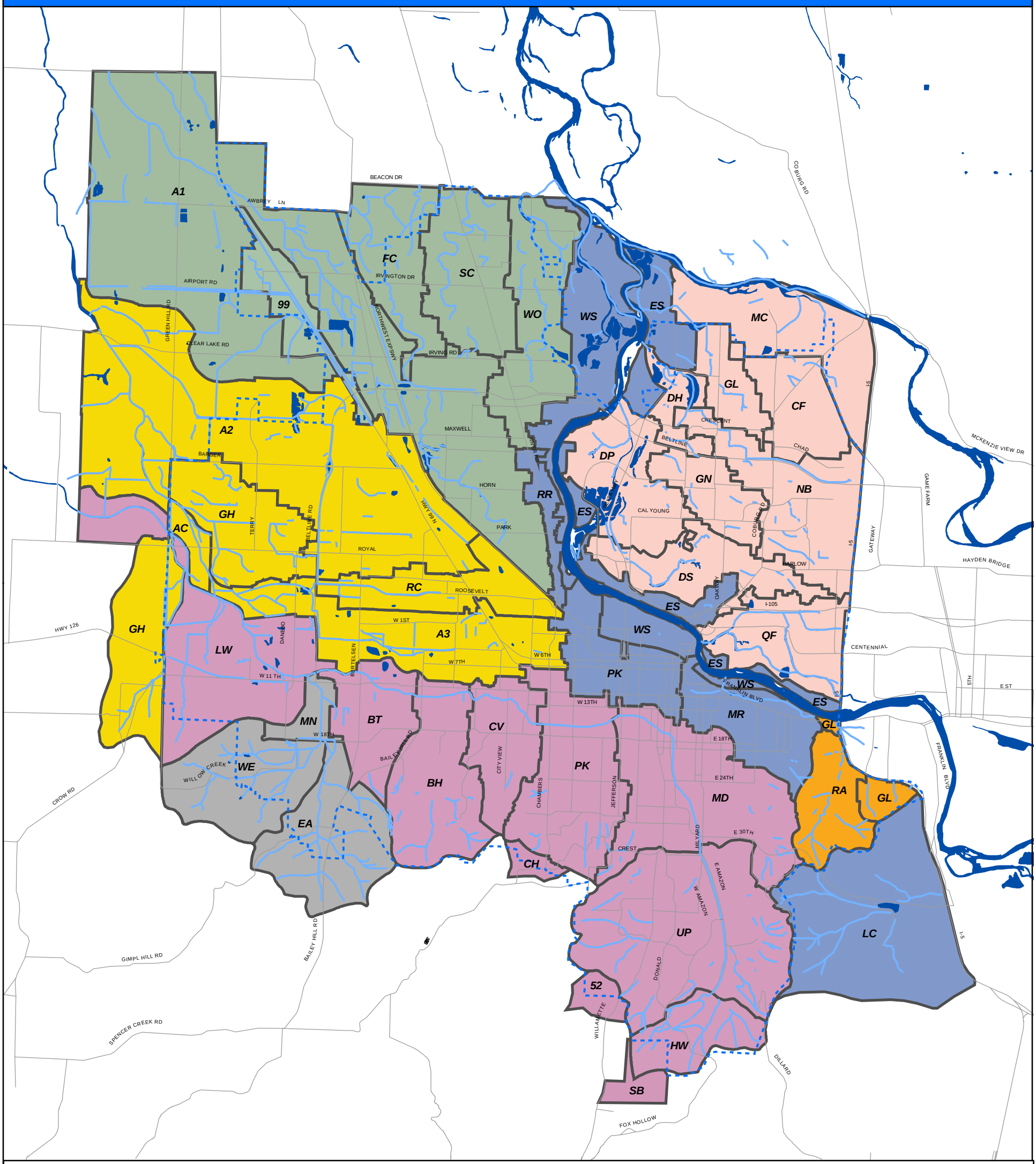
The remaining text in this section describes the background of the project, goals and objectives, and the scope of the project.

1.1 Background

As is typical for most cities, large portions of the City of Eugene's existing stormwater collection and conveyance system were designed and built with the sole objective of addressing flooding issues. More recently, concerns related to urban stormwater quality have come into the

City of Eugene Stormwater Plans

Drainage System Study Area



Amazon
Major Subbasins:
- BH = Bailey Hill
- BT = Bertelsen
- CV = City View
- HW = Headwaters
- LW = Lower Amazon
- MD = Middle Amazon
- PK = Polk Street
- UP = Upper Amazon
- 52 = 52nd Avenue*
- CH = Chambers*
- SB = Spencer Butte*

*Ridgeline major subbasins not modeled as they drain away from Amazon Basin and into Spencer Creek drainage system to the South.

Bethel Danebo
Major Subbasins:
- A2 = A2 Channel
- A3 = A3 Channel
- AC = A Channel
- GH = Green Hill
- RC = Roosevelt Channel

Laurel Hill
Major Subbasins:
- GL = Glenwood
- RA = Riverview-Augusta

River Road/ Santa Clara
Major Subbasins:
- 99 = Highway 99
- A1 = A1 Channel
- FC = Flat Creek
- SC = Spring Creek
- WO = Willamette Overflow

Willow Creek
Major Subbasins:
- EA = East Branch
- MN = Main Stem
- WE = West Branch

Willakenzie
Major Subbasins:
- CF = County Farm
- DH = Delta Highway
- DP = Delta Pond
- DS = Debrick Slough
- GL = Gilham Norkenzie
- GN = Gilham North
- MC = McKenzie River
- NB = North Beltline
- QF = Q Street Floodway

Willamette River
Major Subbasins:
- ES = East Side
- LC = Lane College
- MR = Mill Race
- PK = Polk
- RR = River Road
- WS = West Side

0 0.5 1 1.5 2 Miles

- Eugene Master Plan Boundary
- Urban Growth Boundary
- Open Waterway

Produced by LCOG
August 2002
g:\projects\basins\drainage_maps\major_subbasins.mxd

Figure 1-1

foreground. In the late 1970s and early 1980s, the City of Eugene and Lane Council of Governments (LCOG) participated in a national-scale study of stormwater quality problems, causes, and potential control strategies known as the U.S. Environmental Protection Agency's (EPA's) Nationwide Urban Runoff Program (NURP). The results of the NURP study indicated that urban stormwater runoff is a significant source of pollutant loads to receiving water bodies. By the late 1980s, it was apparent that emerging federal and state environmental and planning policies and regulations would alter the way stormwater would need to be managed in Eugene.

As a result, the City decided to proactively rethink the way stormwater should be managed. Eugene Public Works took what had been learned since the early 1980's and developed a program that would comply with regulatory mandates, but would do so in ways that reflect the City's unique characteristics, values, needs, intentions, and priorities. The driving forces behind this initiative included the following:

- The need to apply for and comply with a municipal stormwater National Pollutant Discharge Elimination System (NPDES) permit under the Clean Water Act. This permit is issued by the Oregon Department of Environmental Quality (DEQ).
- The need to address emerging water quality standards to ensure beneficial uses are met in receiving water bodies (i.e., total maximum daily load (TMDL) requirements under the Clean Water Act). This program is also administered by DEQ.
- Impending Issues - Although not an issue at the outset of the project, listing of the Spring Chinook Salmon (Federal Register, Volume 65, No. 32, Wednesday, February 16, 2000) was considered in the final development of these plans. Another impending issue includes recently promulgated state rules under the Safe Drinking Water Act requirements related to the underground injection of stormwater.

The first step Eugene took in revising its stormwater management program was to develop a Comprehensive Stormwater Management Plan (CSWMP). CSWMP provides the policy direction for stormwater management in Eugene, and was adopted by the Eugene City council in 1993 following an extensive public involvement process. CSWMP contains goals, policies and implementation actions. Many components of the City's stormwater management program, such as erosion control standards, a public education program, revised maintenance practices, and detection/elimination of illicit connections, have already been implemented to address some of the CSWMP goals and policies.

In parallel to the development of CSWMP, the City was preparing the required application materials for a municipal NPDES stormwater permit. The permit application was required in two parts. The first part, submitted in 1992, required a compilation of information regarding the City's existing stormwater system such as maps of outfalls, maintenance practices, monitoring data, and legal authority. The second part, submitted in 1993, consisted primarily of a proposed management plan for reducing the discharge of pollutants in stormwater runoff to the "maximum extent practicable." The stormwater management plan proposed by Eugene and accepted by DEQ included a total of 34 best management practices (BMPs) in the following five categories: 1) capital projects (capital projects), 2) inspections, enforcement and monitoring, 3) operations and maintenance, 4) planning and administration, and 5) public education. As these two plans

were being developed in parallel, the NPDES BMPs were incorporated into CSWMP as specific implementation actions for accomplishing goals.

The Stormwater Basin Master Plans described in this document comprise two of the specific NPDES BMPs, and hence CSWMP implementation actions. The two implementation actions include: P&A1, "Develop Comprehensive Basin Plans", and P&A7, Stormwater Development Standards (see CSWMP, pages A-1 to A-3). One additional implementation action was ultimately addressed as part of the project: Stream Corridor Acquisitions. The Stormwater Basin Master Plans include the assessment of the major stormwater drainage basins in the City with respect to applying management measures according to the multiple objectives of CSWMP and with respect to the opportunities and constraints of each basin. The overall goals and objectives of the Stormwater Basin Master Plans are described in the following section.

1.2 Goals and Objectives

The overall goal of the Stormwater Basin Master Plans was to develop a stormwater management strategy for each basin that proactively addresses the multiple objectives of CSWMP. In addition to flood control, these multiple objectives include:

- Protect and improve water quality.
- Protect natural resources that provide beneficial stormwater functions.
- Use best management practices that promote a green infrastructure (see glossary for a definition of green infrastructure).
- Address the unique qualities of each drainage basin.
- Meet federal, state, and local laws and policies (including CSWMP).
- Complement other existing BMPs that are part of the City's stormwater program.
- Balance responsibilities community-wide.
- Provide a dynamic and flexible program that can be refined based on a changing regulatory climate.

With respect to CSWMP, the following specific goals and policies were addressed by the Stormwater Basin Master Plans. These goals and policies were considered as each of the basin management strategies was developed and evaluated.

GOAL 1
Through an interconnected system of constructed and natural facilities, provide multiple storm water benefits to the community including: flood control and drainage services, protection and enhancement of water quality and other natural resources that perform stormwater functions, recreational facilities, and educational opportunities.

> *POLICY 1.1*
> *Incorporate the beneficial functions (flood control, storm water conveyance, water quality treatment) of natural resources into the City's storm drainage system.*

POLICY 1.2
Maintain flood control, drainage, and water quality treatment capacities along the City's storm water conveyance corridors while protecting and enhancing the health, diversity and continuity for wildlife habitat, native vegetation, and endangered species.

POLICY 1.4
Amend existing regulations and administrative policies and practices to be consistent with the goals and policies of CSWMP.

POLICY 1.5
Develop new design standards and maintenance practices that meet the multiple objectives of CSWMP.

POLICY 1.7
Develop a storm water facility plan that incorporates the goals and policies of CSWMP.

GOAL 2
Protect life and property from flood and drainage hazards through a combination of constructed flood control and drainage facilities and natural resource systems.

POLICY 2.1
Meet or exceed federal flood hazard requirements.

POLICY 2.3
Maximize the capacity of existing storm water facilities especially where deficiencies exist by encouraging the use of techniques that have the effect of lowering and slowing the rate of storm water runoff.

GOAL 3
Maintain and improve water quality in the City's rivers, creeks, channels, ponds, and wetlands to provide a safe and healthy environment for humans, plants, aquatic and other wildlife.

POLICY 3.1
Meet or exceed federal and state storm water quality requirements especially where they conform to existing local policy.

POLICY 3.3
Reduce storm water pollution associated with new construction and development, soil erosion, improper use of storm water facilities, and City operations and maintenance practices.

GOAL 5
Educate, inform, and organize the citizens of Eugene about stormwater issues so they can become active participants in improving stormwater quality, protecting natural resources, and minimizing drainage and flood related hazards.

> *POLICY 5.2*
> *Develop programs to encourage and coordinate volunteer efforts to protect water quality, preserve and enhance natural resource areas, and reduce public costs.*

The recommendations presented in these Stormwater Basin Master Planning documents have been developed as appropriate responses to the goals and objectives of the regulatory and policy climate that prevailed during the course of the project. In coming years, it will be important to assess how this plan should be refined to respond to changing conditions, new information, new requirements and other City programs (e.g., Endangered Species Act, TMDLs, and the Environmental Management System the City is currently developing).

1.3 Project Scope

The purpose of the Stormwater Basin Master Plans was to prepare multiple objective strategies for managing stormwater in Eugene's major drainage basins. The scope of work for completing these integrated stormwater management strategies included the following major tasks:

Step 1) Compile information regarding the unique characteristics of each basin with respect to the stormwater drainage system.
Step 2) Identify problems and opportunities associated with the stormwater drainage system with respect to flood control, water quality, and natural resources.
Step 3) Develop potential solutions in the form of capital projects and development standards for addressing identified problems.
Step 4) Evaluate and compare potential solutions in terms of feasibility, costs, and effectiveness.
Step 5) Evaluate capital projects to address problems expected under existing conditions.
Step 6) Evaluate capital projects and development standards to address problems expected as a result of future build-out.
Step 7) Select an integrated stormwater management strategy based on the evaluations conducted in steps 5 and 6.
Step 8) Develop a maintenance strategy for the proposed solutions.
Step 9) Obtain feedback regarding integrated stormwater management strategies and the maintenance strategy from the public and refine the strategies as appropriate.
Step 10) Prioritize selected capital projects for implementation and conduct a financial analysis.
Step 11) Develop stormwater basin master plans to summarize the integrated stormwater management strategies including proposed capital projects and development standards.
Step 12) Develop ordinance language to codify the proposed development standards.
Step 13) Develop a best management practices manual to help guide developers in meeting the requirements of the development standards.

This process is illustrated in a flow chart (Figure 4-1) and described in more detail in Section 4.1 (Process for Developing the Integrated Strategies) of this document.

The scope of the Stormwater Basin Master Plans was focused solely on the City's stormwater drainage system. Therefore, the basin master plans represent stormwater master plans and are not intended as watershed plans. For example they do not include an evaluation of land use designations which would be essential in a watershed plan. In addition, all natural resource areas were not evaluated; only those which were associated with the storm drainage system. With respect to the storm drainage system, the larger public system was the focus of the evaluation. This included pipes and culverts, 36" in diameter or greater and all open waterways that connect these pipes. Some smaller piped systems were included in the evaluation based on a desire for additional information regarding specifically identified problems. Specific criteria were not established for the selection of open waterways that were modeled. Meetings were held to select open waterways for modeling based on use of the waterway for public drainage and based on expected development patterns.

As mentioned above, this project represents three of thirty-four stormwater management practices that the City is implementing as part of their NPDES municipal stormwater permit requirements. This project addresses water quality through development standards and through implementation of a capital improvement program that includes capital projects and stream corridor acquisitions. Other essential water quality management practices are covered under the remaining NPDES BMPs.

1.4 Study Area

As noted earlier (page 1-1), the term *basin* is typically used to refer to a defined surface area that drains to a common discharge point. However, for the purposes of this study, the term basin is used to refer to a specific planning or study area. While the planning or study areas were developed based on topography and drainage patterns, they may include several discharge points, or they may exclude specific tributary areas based on convenience for planning purposes. In some cases, portions of the basin were not included in the planning area as they are managed by other jurisdictions. The basin areas as defined in this plan are also further divided into major subbasins and subbasins as described below and in the individual basin master plan reports. The study area was divided into 7 basins and 38 major subbasins as follows (see Figure 1-1):

Amazon Creek Basin*
BH = Bailey Hill Major Subbasin
BT = Bertelsen Major Subbasin
CV = City View Major Subbasin
HW = Headwaters Major Subbasin
LW = Lower Amazon Major Subbasin
MD = Middle Amazon Major Subbasin
PK = Polk Street Major Subbasin
UP = Upper Amazon Major Subbasin

Bethel-Danebo Basin
A2 = A-2 Channel Major Subbasin
A3 = A-3 Channel Major Subbasin
GH = Greenhill Tributary Major Subbasin
RC = Roosevelt Channel Major Subbasin
AC = Amazon Channel

Laurel Hill Basin
GL = Glenwood Major Subbasin
RA = Riverview-Augusta Major Subbasin

Willakenzie Basin
GL = Gilham Road Major Subbasin
CF = County Farm Road Major Subbasin
DH = Delta Highway Major Subbasin
NB = North Beltline Major Subbasin
GN = Gilham-Norkenzie Major Subbasin
DP = Delta Ponds Major Subbasin
DS = Debrick Slough Major Subbasin
QF = Q-Street Floodway Major Subbasin
MC = McKenzie River Major Subbasin

Willamette River Basin
RR = River Road Major Subbasin
ES = East Riverside Major Subbasin
WS = West Riverside Major Subbasin
PK = Polk Street Major Subbasin
MR = Millrace Major Subbasin
LC = Lane Community College Major Subbasin

Willow Creek Basin
WE = West Branch Major Subbasin
EA = East Branch Major Subbasin
MN = Main Stem Major Subbasin

River Road Santa Clara Basin
A1 = A-1 Channel Major Subbasin
FC = Flat Creek Major Subbasin
SC = Spring Creek Major Subbasin
WO = Willamette Overflow Major Subbasin
99 = Highway 99

*The three ridgeline basins shown as CH, 52 and SB on Figure 1-1 drain to the south, not to Amazon creek. They are included on Figure 1-1 to show where this area adjacent to the Amazon Creek basin, inside the UGB, drains.

The 38 major subbasins were further divided into 463 subbasins. Subbasins were typically less than 100 acres. Not all subbasins were included in the model. The subbasins that were not included and the reasons why they were not included are presented in each of the individual basin reports, particularly for the Willamette River, Willakenzie and River Road Santa Clara basins. As described above, the subbasin boundaries were delineated based on both topography and the storm drainage system layout. The subbasin boundaries were digitized into the City's GIS so that hydrologic data could be compiled for each subbasin.

Seven-character names were assigned to each subbasin. The first two characters represent a two-letter abbreviation for the major basin (e.g., WK for Willakenzie). The third and fourth characters represent a two-letter abbreviation for the major subbasin (e.g., GL for the Gilham Rd. major subbasin). The last three characters of the subbasin name consist of numbers, starting with 010 and increasing in increments of 10 generally moving upstream in a major subbasin.

1.5 Information Updates

The information contained in the seven volumes of this report represents a "snapshot-in-time." The Study Area Characteristics data are current through 1998, and the evaluation data are current through June, 2001. As conditions in the basin change, the information will need to be updated to reflect those conditions.

Some of the current conditions have changed or are about to change but are not reflected in these documents. The known changes are listed in Section 1.0 of each basin document.

This section provides a summary of the citywide study area characteristics that are important with respect to stormwater management planning. These characteristics include: location and area; climate; land use and surface cover; landform, topography and slopes; surface water features and drainage system; water quality; rare, threatened, and endangered plants, animals, and communities; soils; groundwater; and recreational and educational facilities.

2.1 Location and Area

2.1.1 Regional Drainage Context

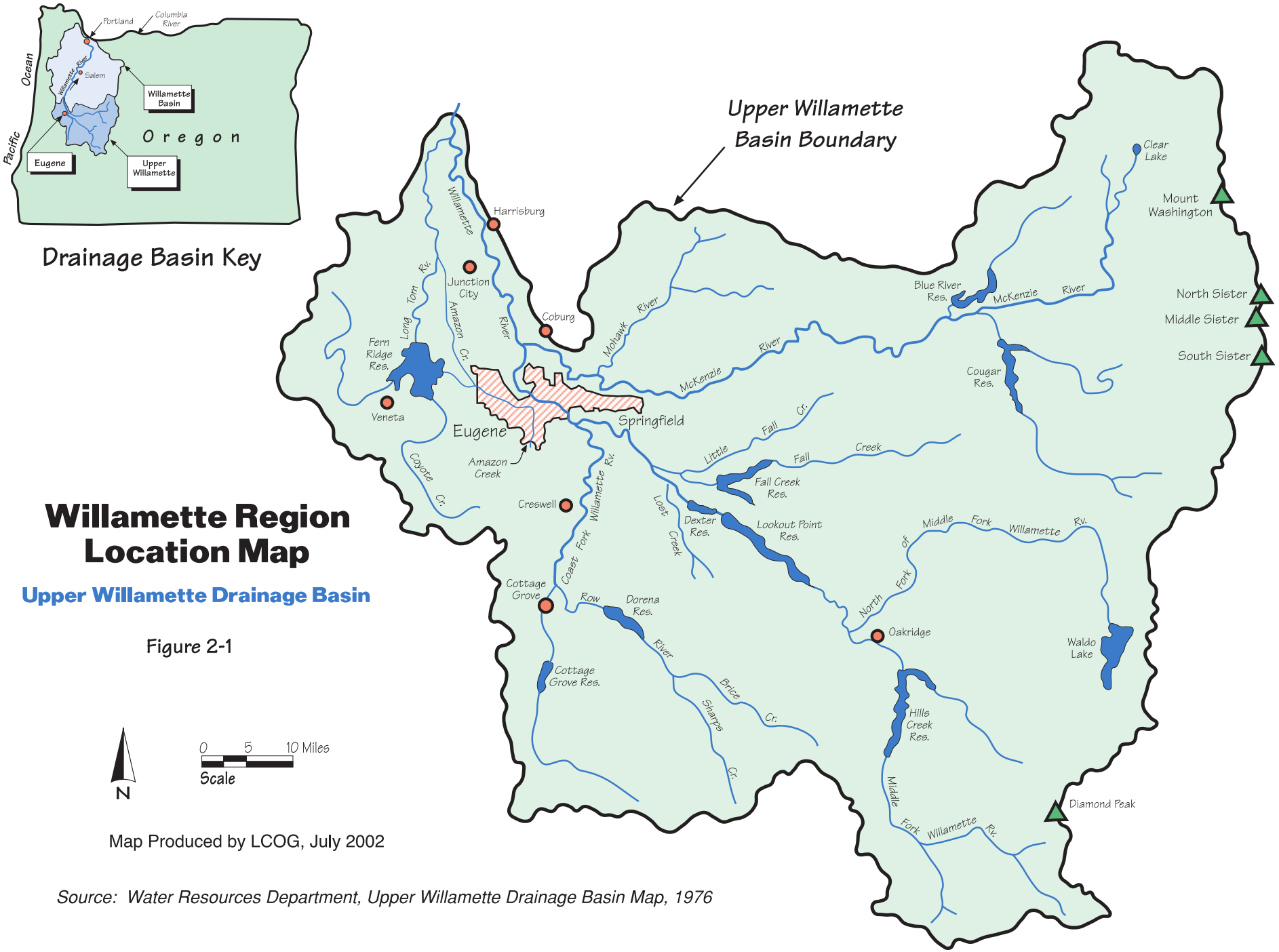
Eugene is located in the western third of the Upper Willamette Drainage Basin as shown on Figure 2-1. Drainage in the southern Willamette Valley is a combination of natural and built systems that have evolved over time. The natural system is composed of rivers, waterways, and a series of interconnected and isolated ponds and wetlands. Historically, the natural system had an extensive floodplain that frequently experienced over-bank flooding. The built drainage system includes a series of dams, pipes, and waterways that were constructed to contain over-bank flooding, and to retain water for recreational and irrigation purposes. The primary drainage features of the Upper Willamette Drainage Basin are: Main Stem of the Willamette River, Middle Fork of the Willamette River, Coast Fork of the Willamette River, McKenzie River, Amazon Creek, Amazon Diversion Channel, Coyote Creek, and the Long Tom River. From 1940 to 1960, the U.S. Army Corps of Engineers built nine dams on this system.

The cities of Cottage Grove, Creswell, and Springfield are all upstream from the City of Eugene and contribute urban runoff to the regional drainage system. Runoff from Cottage Grove, Creswell, and South Springfield flows through Eugene via the Willamette River. A significant portion of west Springfield's drainage area, approximately 4,800 acres, discharges urban runoff into the Q Street Floodway which is within Eugene's public drainage system. This discharge presents potential capacity and water quality issues to the City of Eugene. Refer to Figure 2-2.

2.1.2 Study Area

For the purposes of this report, "study area" includes the Eugene city limits and the unincorporated area west of Interstate Highway 5 (I-5) and within the metropolitan plan boundary. The unincorporated portion includes land both within and outside the UGB. The study area is about 49,000 acres in size, with about 34,500 acres located within the city limits and UGB, and about 14,500 acres outside the UGB. The study area was delineated into seven major drainage basins: *1) Amazon, 2) Bethel-Danebo, 3) Laurel Hill, 4) Willakenzie, 5) Willamette River, 6) Willow Creek, and 7) River Road Santa Clara.*

While the basin plans contain a general description of the broader study area's physical characteristics, analysis and management strategies of each plan apply only to the city limits and the unincorporated UGB.



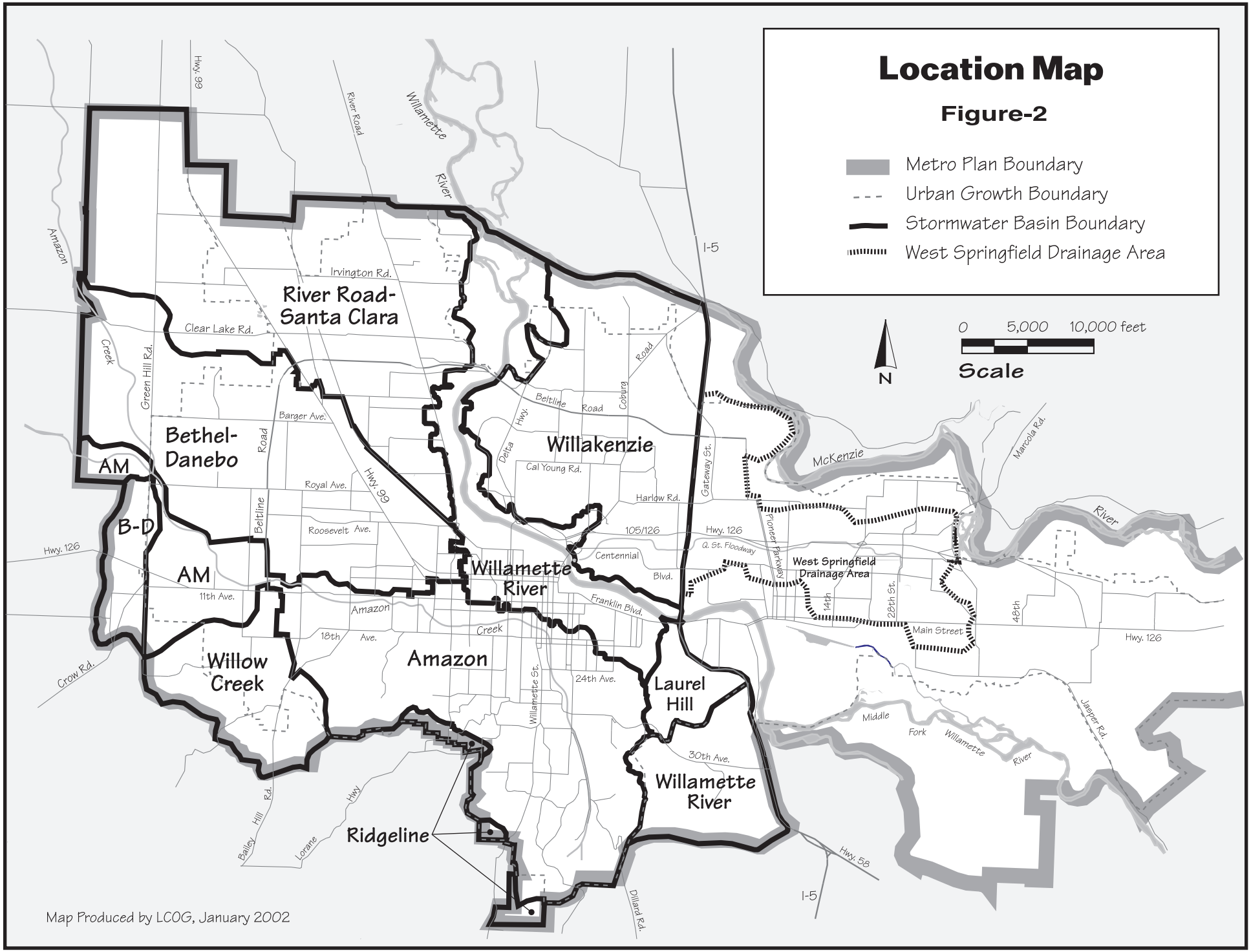
Willamette Region Location Map

Upper Willamette Drainage Basin

Figure 2-1

Map Produced by LCOG, July 2002

Source: Water Resources Department, Upper Willamette Drainage Basin Map, 1976



Map Produced by LCOG, January 2002

Table 2-1 summarizes information about each of the seven delineated basins. For the purposes of this report, "vacant" acres refers to undeveloped land (1998) located only within the city limits and the unincorporated UGB. It does not include land outside the UGB and within the metropolitan plan boundary.

Vacant acres within UGBs are designated for and expected to convert to urban uses over the course of the planning period. The conversion of these vacant acres will increase total impervious surface area which, in turn, will increase stormwater runoff volumes, rates, and pollutant loads. Vacant acres and their respective zoning designations were analyzed to project incremental increases in impervious surface area and pollutant loads and for identifying future conveyance capacity problems within the drainage system. Table 2-1 shows existing (1998) and buildout impervious surface area (existing and projected due to conversion of vacant acres).

Table 2-1
Basin Size, Vacant Land, Impervious Surface Area

Basin		Basin Size *(acres)*	Remaining Vacant Acres *(1998)*	Existing Impervious Surface Acres *(1998)*	Buildout Impervious Surface Acres
Amazon Creek					
Inside UGB		10,656 (93% of basin)	2,415 (23% of UGB)	3,566 (33% of UGB)	4,655 (44% of UGB)
Outside UGB	Urban Reserve*	173 (2% of basin)	0	11 (6% of UR)	11 (6% of UR)
	Not Urban Reserve*	613 (5% of basin)	0	68 (11% not-UR)	68 (11% of not-UR)
Total Basin		**11,442 (100% of basin)**	**2,415 (21% of basin)**	**3,645 (32% of basin)**	**4,734 (41% of basin)**
Bethel-Danebo					
Inside UGB		6,175 (66% of basin)	1,593 (26% of UGB)	2,186 (35% of UGB)	3,060 (50% of UGB)
Outside UGB	Urban Reserve*	880 (10% of basin)	0	141 (16% of UR)	141 (16% of UR)*
	Not Urban Reserve*	2,263 (24% of basin)	0	193 (9% of not-UR)	193 (9% of not-UR)
Total Basin		**9,318 (100% of basin)**	**1,593 (17% of basin)**	**2,520 (27% of basin)**	**3,394 (36% of basin)**
Laurel Hill					
Inside UGB		804 (97% of basin)	458 (57% of UGB)	163 (20% of UGB)	348 (43% of UGB)
Outside UGB	Urban Reserve*	0	0	0	0
	Not Urban Reserve*	25 (3% of basin)	0	0	0
Total Basin		**829 (100% of basin)**	**458 (55% of basin)**	**163 (20% of basin)**	**348 (42% of basin)**

Table 2-1 (continued)

Basin		Basin Size *(acres)*	Remaining Vacant Acres *(1998)*	Existing Impervious Surface Acres *(1998)*	Buildout Impervious Surface Acres
River Road Santa Clara					
Inside UGB		6,063 (58% of basin)	1,744 (29% of UGB)	2,056 (34% of UGB)	3,063 (51%)
Outside UGB	Urban Reserve*	503 (5% of basin)	0	24 (5% of UR)	24 (5% of UR)
	Not Urban Reserve*	3,867 (37% of basin)	0	724 (19% not-UR)	724 (19% not-UR)
Total Basin		**10,432 (100% of basin)**	**1,744 (17% basin)**	**2,804 (27% of basin)**	**3,811 (37% of basin)**
Willakenzie					
Inside UGB		6,096 (83% of basin)	1,124 (18%)	2,258 (37%)	2,842 (47%)
Outside UGB	Urban Reserve*	0	0	0	0
	Not Urban Reserve*	1,218 (17% of basin)	0	125 (10% of not-UR)	125 (10% of not-UR)
Total Basin		**7,314 (100% of basin)**	**1,124 (15% of basin)**	**2,383 (33% of basin)**	**2,967 (41% of basin)**
Willamette River					
Inside UGB		3,492 (50% of basin)	295 (8% of UGB)	1,412 (40% of UGB)	1,552 (44% of UGB)
Outside UGB	Urban Reserve*	0	0	0	0
	Not Urban Reserve*	3,531 (50% of basin)	0	445 (13% of not-UR)	445 (13% of not-UR)
Total Basin		**7,023 (100% of basin)**	**295 (4% of basin)**	**1,857 (26% of basin)**	**1,997 (28% of basin)**
Willow Creek					
Inside UGB		1,169 (46% of basin)	553 (47% of UGB)	159 (14% of UGB)	486 (42% of UGB)
Outside UGB	Urban Reserve*	1,398 (54% of basin)	0	110 (8% of UR)	110 (8% of UR)**
	Not Urban Reserve*	0	0	0	0
Total Basin		**2,567 (100% of basin)**	**553 (22% of basin)**	**269 (10% of basin)**	**596 (23% of basin)**

Table 2-1 (continued)

Basin		Basin Size *(acres)*	Remaining Vacant Acres *(1998)*	Existing Impervious Surface Acres *(1998)*	Buildout Impervious Surface Acres
All Basins					
Inside UGBs		34,455 (70% all basins)	8,182 (24% all UGBs)	11,799 (34% of all UGBs)	16,010 (46% of all UGBs)
Outside UGB	Urban Reserve*	2,954 (6% of all basins)	0	286 (10% of all URs)	286 (10% of all URs)
	Not Urban Reserve*	11,518 (24% of all basins)	0	1,554 (13% not-URs)	1,554 (13% not-URs)
Total Study Area		**48,927 (100% all basins)**	**8,182 (17% of all basins)**	**13,639 (28% of all basins)**	**17,850 (36% of all basins)**

* Areas outside UGBs (urban reserve, not urban reserve) were evaluated under existing land use conditions. "Buildout impervious surface area" calculations for these areas did not change from existing impervious surface area conditions.

**Two buildout scenarios were developed for the Willow Creek Basin for hydrologic modeling purposes: UGB and UR. The data in this column reflects only UGB buildout. Buildout of the UR would add 490 acres of impervious surface area (assumes all UR acres develop as Low Density Residential: 1,398 x 35% = 490 acres) for a basin total of 976 acres or 38% impervious.

2.2 Climate

The climate in the study area is primarily affected by humid air masses from the west and south, and infrequent influxes of cold, continental air masses from the east. As a result, the year-round climate in Eugene is moderate with relatively cool, wet winters, and warm, dry summers.

Average minimum winter temperatures are in the mid-30s with extremes seldom dropping below 10 degrees Fahrenheit (-12.2 Celsius). Average maximum summer temperatures are in the low 80s (26.7 to 28.9 Celsius) with extremes seldom exceeding 100 degrees Fahrenheit (37.8 Celsius). Snowfall constitutes only 2 percent of the annual precipitation in Eugene. Winter snow does not accumulate; however, quick snow melt can contribute to flooding problems throughout the Eugene area.

The National Weather Service records rainfall information at the Mahlon Sweet Airport in Eugene. Average annual precipitation is approximately 46 inches with 86 percent occurring from October to May. Figure 2-3 provides an average monthly rainfall distribution based on the airport's 48-year rainfall record from 1949-1987.

Figure 2-3
Average Monthly Rainfall

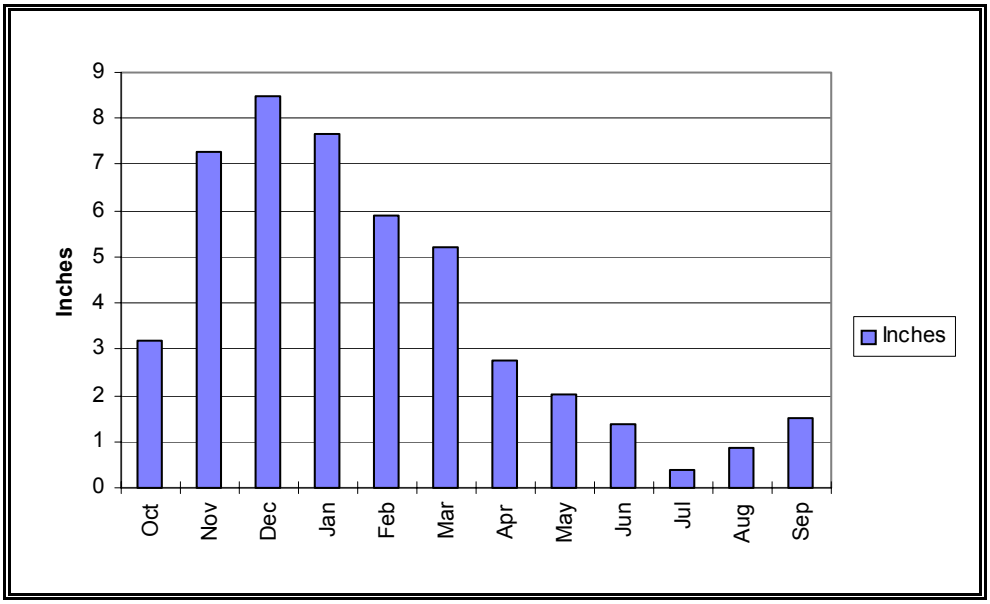


Table 2-2 characterizes a typical storm event for the Eugene area based on the historic 48-year precipitation record measured at the Mahlon Sweet Airport:

Table 2-2
Average Storm Event

Storm Event Parameter	Average
Volume	0.67 inches
Duration	16.9 hours
Intensity	0.042 inches per hour

Since 1992, rainfall information has been recorded at six rain-gage stations within the Eugene City limits. Comparison of that data with the National Weather Service's Eugene Airport data indicates a significant difference between the two, with the airport data approximately 30 percent higher. For additional information regarding this issue, see Section 3.1.2 and Appendix A.

2.3 Land Use and Surface Cover

The conversion from undisturbed to developed land uses can significantly affect the quantity and quality of stormwater runoff. Stormwater runoff volumes and velocities increase as impervious surface areas increase. Likewise, stormwater quality decreases due to nonpoint source pollution from highways and urban uses such as commercial, industrial, and residential. The purpose of this section is to describe existing land use and impervious surface conditions within the study area and to forecast changes in these conditions due to *buildout* of remaining vacant lands

according to *Metro Plan* designations. Existing land use data are current as of November 1998. Buildout data are based on *Metro Plan* designations of vacant lands within the study area.

2.3.1 Existing Land Use

See Table 2-3, Existing Land Use, for complete listing of all land use types.

2.3.1.1 Urban Growth Boundary (34,455 acres)

The following describes the predominant land use categories in the UGB. The UGB includes the city limits and unincorporated UGB. For a complete listing of all land use categories, see Table 2-3. In 1998, 76% of the UGB area was considered developed to urban uses with low density residential (31% of UGB) and street rights-of-way (17% of UGB) being the predominant land uses. About 10% of the UGB is either commercial, government, or industrial. Parks and recreation make up 8% of the UGB. Approximately 24% of the UGB is in agricultural, timber, or undeveloped conditions which are considered *vacant* and potentially available for urban development.

2.3.1.2 Urban Reserve Area (2,954 acres)

The following describes the predominant land use categories in Urban Reserves. For a complete listing of all land use categories, see Table 2-3. The 1998 land use distribution in Urban Reserves was: 36% agricultural, 22% undeveloped, 19% timber, and 7% parks and recreation. It is noted that the current urban reserve areas were recently determined (summer 2001) to be not consistent with existing Oregon Administrative Rules and not viable for future urban growth boundary expansion. Elected officials of Lane County, Springfield, and Eugene directed staff to remove the urban reserve designations. Staff is developing a schedule and process for implementing this direction, expected in mid-year 2002.

2.3.1.3 Outside UGB and Urban Reserves (11,518 acres)

The following describes the predominant land use categories in the area that is outside the UGB and not within an Urban Reserve area. For a complete listing of all land use types, refer to Table 2-3. The 1998 land use distribution outside the UGB and urban reserve areas were: 44% agricultural, 24% undeveloped, 9% industrial, and 4% medium-high density residential.

Table 2-3
Existing Land Use

Land Use Categories	Acres	Percent of Area
Inside UGB		
Agriculture*	2,285	7.0%
Commercial	1,819	5.0%
Communication and Utilities	286	1.0%
Industrial	1,195	3.0%
Low- to Medium-Density Residential	10,605	31.0%
Medium- to High-Density Residential	978	3.0%
Other Government	293	1.0%
Parks and Recreation	2,790	8.0%
Railroads	276	1.0%
Streets (ROW)	5,945	17.0%
Willamette River and Ponds	320	1.0%
Schools-Churches-Cemetery	1,365	4.0%
Golf Course	402	1.0%
Timber*	90	0.0%
Undeveloped*	5,807	17.0%
Subtotal	34,455	100.0%
Outside UGB (In Urban Reserves)		
Agriculture	1,050	35.5%
Commercial	25	0.8%
Communication and Utilities	7	0.2%
Industrial	7	0.2%
Low- to Medium-Density Residential	13	0.4%
Medium- to High-Density Residential	293	9.9%
Other Government	12	0.4%
Parks and Recreation	214	7.2%
Streets (ROW)	113	3.8%
Timber	561	19.0%
Undeveloped	659	22.3%
Subtotal	2,954	100.0%
Outside UGB and Outside Urban Reserve		
Agriculture	5,053	43.9%
Commercial	41	0.4%
Communication and Utilities	6	0.1%
Industrial	1,045	9.1%
Low- to Medium-Density Residential	4	0.0%
Medium-to High-Density Residential	504	4.4%
Other Government	293	2.5%
Parks and Recreation	363	3.2%
Railroads	16	0.1%
Streets (ROW)	851	7.4%
Willamette River and Ponds	107	0.9%
Schools-Churches-Cemetery	167	1.4%
Golf Course	47	0.4%
Timber	20	0.2%
Undeveloped	2,759	24.0%
Sand and Gravel	241	2.1%
Subtotal	11,518	100.0%
Grand Total	48,927	

*These land use categories constitute "vacant" acres that are expected to develop to urban uses.

2.3.2 Buildout Land Use

The *Eugene-Springfield Metro Plan* (1987) is the primary land use policy document governing the study area. Other policy documents include the *Bethel-Danebo Refinement Plan* (1982), the *Laurel Hill Neighborhood Plan* (1974), the *Laurel Hill Plan* (1982), the West Eugene Wetlands Plan (November 2000, amended), the *Willakenzie Area Plan* (1992), the *Willow Creek Special Area Study* (1982), and the *River Road Santa Clara Public Facilities Plan (1987), Eugene Downtown Plan (1984), and the South Hills Study (1974)*.

Several areas that are designated Urban Reserve (UR) in the *Metro Plan* are included in the study area. Urban reserves indicate areas where future UGB expansions are likely to occur. UR are designated within the Amazon, Bethel-Danebo, River Road Santa Clara, and Willow Creek basins. See subsection 2.3.2.2 for status of URs.

For each buildout land use category, Table 2-4 indicates the total amount of acres allocated and the amount vacant for development. Vacant acres are used to estimate future impervious surface area, stormwater runoff volumes and pollutant loads. Because urban levels of land use are restricted to urban growth boundaries by state law, vacant acres apply only to areas within UGBs. The acres listed under Currently Developed do not necessarily reflect actual land use. For example, the low-density residential category indicates 11,758 acres are currently developed within the UGB. Not all of those acres may, in fact, be in a residential use as there may have been preexisting, non-conforming uses that existed prior to the *Metro Plan* designation. For a more accurate description of existing land uses, refer to Table 2-3, Buildout Land Use.

2.3.2.1 Buildout Land Use Within the UGB

This area includes both the current City limits and the unincorporated UGB. Approximately 70 percent of the study area is currently within the UGB. Of this, 8,182 acres are considered vacant and expected to develop to urban land uses and intensities. As shown in Table 2-4, Buildout Land Use, the land use categories with the most remaining vacant acres are: low-density residential (3,749 acres), industrial (1,630 acres), and medium-density residential (643 acres).

Since adoption of the *Metro Plan* in 1982 and the update in 1987, significant concentrations of wetland resources have been identified on land in the western portion of the Amazon basin and in Willow Creek and Bethel-Danebo basins. This area is accounted for in either the natural resources, parks, and opens space category or under Wetlands Protection column of the Buildout Land Use table (Table 2-4).

2.3.2.2 Buildout Land Use Outside the UGB

Approximately 30 percent of the study area lies outside the UGB. The majority of this land will remain in agriculture and forest use based on current *Metro Plan* designation.

Approximately 20 percent of the study area outside the UGB is designated in the *Metro Plan* as Urban Reserve (UR) which indicates areas where future UGB expansions are likely to occur. According to policies governing UR, it can be assumed that this area will eventually be

developed for low-density residential use at approximately 3.5 dwelling units per acre but, before the UR can be developed, a *Metro Plan* amendment process is needed to amend the UGB.

For the Willow Creek Basin, two buildout scenarios were evaluated as part of the projected land use process: 1) buildout of only UGB, and 2) buildout of both the UGB and UR. For the remaining six basins, only the UGB buildout scenario was evaluated. The differing approach was due to a variety of factors:

- The Willow Creek Basin is relatively undeveloped with few existing stormwater infrastructure facilities.
- The upstream location of UR in the Willow Creek Basin and its potential buildout could have a significant negative effect on the capacity of downstream drainage facilities and existing, significant wetlands and other natural resources in the basin.

During preparation of the basin plans, a separate study evaluated the existing UR areas for consistency with Statewide Planning Goals. The study was prepared as part of the Eugene-Springfield Metropolitan Plan periodic review process and concluded the URs did not comply with current state administrative rules. Direction was given by the elected officials to remove the UR designations as part of the final periodic review adoption process scheduled for 2003.

Table 2-4 displays the amount of land by metropolitan plan designation and the amount of vacant land in the study area.

Table 2-4
Buildout Land Use

Generalized Plan Designation	Designated Acres	
	Total	Vacant (1998) for future Urban Development
Inside UGB		
Agriculture	9	6
Forest	0	0
Sand and Gravel	5	1
Commercial/Residential Commercial	1,458	189
High-Density Residential	596	186
Industrial and Com/Industrial	4,191	1,630
Low- Density Residential	15,538	3,749
Parks and Recreation	3,315	217
Roads/Walkways/Water	6,599	1,524
Gov, Ed	711	37
Medium-Density	1,713	643
Willamette River and Ponds	320	0
Subtotal	34,455	8,182
Inside Urban Reserve		
Agriculture	808	0
Forest	1,380	0
Sand and Gravel	0	0
Commercial/Residential Commercial	2	0
High-Density Residential	0	0
Industrial and Com/Industrial	16	0
Low-Density Residential	1	0

Table 2-4 (continued)

Generalized Plan Designation	Designated Acres	
	Total	Vacant (1998) for future Urban Development
Parks and Recreation	223	0
Roads/Walkways/Water	221	0
Gov, Ed	0	0
Medium-Density	0	0
Rural Residential	303	0
Subtotal	2,954	0
Outside UGB/UR		
Agriculture	4,894	0
Forest	1,287	0
Sand and Gravel	1,072	0
Commercial/Residential Commercial	29	0
High- Density Residential	0	0
Industrial and Com/Industrial	15	0
Low- Density Residential	10	0
Parks and Recreation	703	0
Roads/Walkways/Water	1,693	0
Gov, Ed	1,417	0
Med. Density	0	0
Rural Residential	291	0
Willamette River and Ponds	107	0
Subtotal	11,518	0
Grand Total	48,927	8,182

Source: LCOG and City of Eugene Geographic Information System, 1998

Notes:

1. *Streets (Right-of-Way). The Metro Plan does not have a "Streets" Plan designation. This amount was estimated based on the difference between total designated area and total basin size. In undeveloped areas, 15% of the land area was put into the Streets (Right-of-Way) category to account for streets that will serve future designated development.*
2. *Wetlands Protection. This category accounts for the lands that have been designated for protection or enhancement under the West Eugene Wetlands Plan, but that are not currently in the Natural Resource, Parks, and Open Spaces Category because they are in private ownership.*

2.3.3 Surface Cover

Other than precipitation, surface cover is perhaps the single most influential factor that affects the volume and velocity of stormwater runoff and the ability to treat runoff through filtration and other natural processes. Pervious surfaces are undeveloped lands that are typically covered with lawn, forest, prairie, agricultural fields, or pasture where water is free to infiltrate into the ground. Undisturbed pervious surfaces provide certain stormwater functions. They help reduce the amount and velocity of runoff by facilitating absorption of precipitation into the groundwater, which results in less runoff and a lower but longer duration of peak flows. The vegetative cover associated with pervious surfaces is also important for stabilizing steep slopes and streambanks.

Impervious surfaces are lands covered by hard surfaces such as rooftops, roads, and parking lots and allow little or no infiltration of water. In contrast, impervious surfaces are unable to absorb and infiltrate precipitation, which results in greater runoff volumes, higher but shorter duration peak flows, and higher concentrations of pollutants. The transition from undisturbed to developed land uses and densities involves a significant change from pervious to impervious surfaces. As a consequence, adequate facilities must be planned, constructed, and maintained to minimize drainage and flood problems and impacts to water quality and open waterways.

The purpose of this section is to describe surface cover conditions as they currently exist and as they are projected to exist at buildout of the entire study area.

2.3.3.1 Impervious Surfaces

Total impervious surface area for the study area was calculated using a set of impervious surface area factors (ISAF) that were applied to the existing and projected land use data. To calculate total impervious surface area, the ISAF percentages were multiplied by the total land area in each of the land use categories.

The ISAF factors used are shown in Appendix B. These factors were derived through a process that used existing developed properties in Eugene to generate typical impervious percentages. Impervious surface area for residential, commercial, and industrial land uses had previously been developed and digitized as the basis for calculating stormwater user fees. By using this data source, the resulting ISAFs have been calibrated specific to the City of Eugene and in some cases specific to the basin. The ISAF percentages for land use categories that were not previously digitized were derived through review of national standards and by calculating impervious surface area on sample sites.

The amount of existing impervious surface area in 1998 is estimated to be 11,799 acres in UGBs (34% of all UGBs), 286 acres in UR (10% of all UR), and 1,554 acres outside UGBs and not in UR (13% of all areas outside UGBs, not in UR) for a grand total of 13,639 acres in the study area (28%).

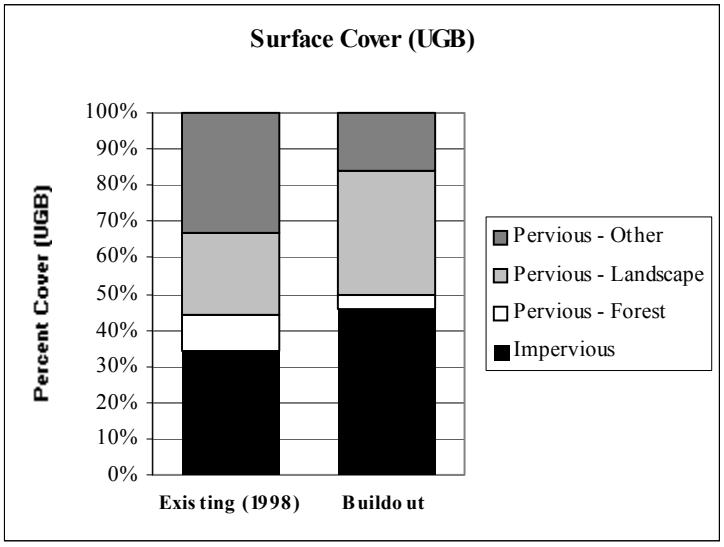
2.3.3.2 Pervious Surfaces

The majority of pervious surface contained within the study area is mainly in the form of lawn and landscaped areas associated with developed land uses and small vacant lots. Overall, pervious cover is expected to decrease from 66 percent within the UGB (1998) to 54 percent at UGB buildout. Pervious surfaces have been organized into Forest Cover, Landscaping, and Other Vegetated Areas for the following reasons:

- Forest Cover is highly effective in preventing erosion (e.g., reduces soil impact by slowing down the velocity of precipitation and by intercepting up to 35 percent of it before hitting the ground) and stabilizing steep slopes (established root zones). Areas were included in this category if the forested area exceeded one acre in size. Existing Forest Cover within the UGB is estimated at 3,310 acres (10%) and is projected to decrease to 1,062 acres (4%) at UGB Buildout.
- Landscaping areas, including lawns, streetscape and parking lot landscaping are associated with site improvements due to urban development. This category was distinguished to highlight both its positive and potential negative impacts on stormwater resources. Positive impacts include protection of surface soils, filtration of sediments, and infiltration. The use of chemical fertilizers, pesticides, and herbicides can cause negative impacts to water quality. Existing Landscaping area within the UGB is estimated at 8,086 acres (23%) and is projected to increase to 11,668 acres (34%) at UGB buildout.
- Other Vegetated Areas are those not in *forest cover* or *landscaping* use, such as agriculture

fields, pasture, vacant lots, prairie wetlands, and small clusters of trees (less than one acre). Similar to the landscaping category, these areas have both positive and negative impacts on stormwater resources. Agriculture and pasture uses are perhaps the largest contributors of pollutants in this category due to the use of chemical fertilizers, pesticides, herbicides, and fecal coliform due to grazing. Existing Other Vegetated Areas within the UGB is estimated at 11,523 acres (33%) and is projected to decrease to 5,496 acres (16%) at UGB buildout.

Figure 2-4
Surface Cover



2.4 Landform, Topography, Slopes

The landform of the study area is diverse yet well defined with the southerly portion characterized by the steep slopes of the South Hills and the northerly area being the flat valley bottoms of the Willamette River, McKenzie River, and Amazon Creek floodplains.

Table 2-5 displays the slope distribution of the study area. Of significance is that approximately 74 percent of the study area is affected by slopes ranging from 0 percent to 5 percent, and about 5 percent is affected by slopes greater than 25 percent. 14% of the UGB area has slopes greater than 10%.

Table 2-5
Slope Distribution

Location	Slope Distribution by Acres and Percent of Area					
	Slopes 0-5%	Slopes 6-10%	Slopes 11-15%	Slopes 16-25%	Slopes >25%	Total
UGB	26,250 acres (76% UGB)	2,453 (7% UGB)	1,959 (6% UGB)	2,493 (7% UGB)	1,300 (4% UGB)	34,455 (100% UGB)
Urban Reserves	948 acres (32% UR)	260 (9% UR)	424 (14% UR)	870 (30% UR)	452 (15% UR)	2,954 (100% UR)
Not UGB/UR	8,911 acres (77% not UGB/UR)	649 acres (6% not UGB/UR)	564 (5% not UGB/UR)	849 (7% not UGB/UR)	545 (5% not UGB/UR)	11,518 (100% not UGB/UR)
Total Study Area	36,109 acres (74%)	3,362 acres (7%)	2,947 (6%)	4,212 (8%)	2,297 (5%)	48,927 (100%)

Slope gradient and length are important factors of stormwater management. Generally, in disturbed areas, steeper and longer slopes result in greater runoff volumes and velocities. These conditions require special engineering designs to accommodate the hydraulic conditions that occur at the interface of waterways with the piped system. Depending on soil and surface cover type, slope gradient can also increase risks to water quality impacts—due to erosion and sedimentation—and to public safety due to earth slides and slumping.

2.5 Surface Water Features and Drainage System

This chapter describes the existing drainage features of the study area including the City's stormwater facilities, open waterways, and wetlands. The major drainage features in the study area include: Willamette River, McKenzie River, Amazon Creek, Canoe Canal-Patterson Slough, Debrick Slough, North Beltline Floodway, Willow Creek, East Santa Clara Waterway, Flat Creek, Spring Creek, Laurel Hill Creek, Mill Race, Roosevelt Channel, Bertelsen Slough, and the so-called "A" Channels. In addition, an extensive network of headwater streams exist in the South Hills.

2.5.1 Waterways

Pre-settlement (prior to 1855) morphological conditions in the Willamette Valley reflected a network of shallow, broad swales that would often experience over-bank flooding during storm events creating ponded conditions. Today, most of the drainages have been altered into narrow, deep, and well-defined channels where the management objective of preventing over-bank flooding conditions has been accomplished for most storm events. Comparing historic drainage patterns in the South Hills area to current conditions, it is clear that pipes and other built drainage facilities have replaced many of the historic open drainage system where urban development has occurred. See Table 2-6, Open Waterways, for description of remaining waterways (miles) by basin.

2.5.2 Open Waterways

For purposes of this planning process, the term "open waterways" refers to creeks, streams, and channels that, along with the City's stormwater pipe system, constitutes the "local" drainage

network. In this context, the Willamette and McKenzie rivers are outside the local drainage system and, therefore, are not reflected in the data below. Table 2-6 shows the extent of remaining open waterways within the study area.

Table 2-6
Open Waterways

Basin	Open Waterways (miles)			Total
	Inside UGB	Urban Reserve	Outside UGB/UR	
Amazon	36	0	2	38
Bethel-Danebo	31	3	14	48
Laurel Hill	3	0	0	3
River Road Santa Clara	29	5	14	48
Willakenzie*	22	0	3	25
Willamette River*	3	0	8	11
Willow Creek	9	8	0	17
Total	**133**	**16**	**41**	**190**

*Open waterways does not include the Willamette River and McKenzie River.

Most of these waterways are on the "Draft Inventory for the Metropolitan Natural Resources Study."

2.5.3 Wetlands

The extent and accuracy of wetlands information within the study area varies significantly. In west Eugene, the information is of high quality due to the *West Eugene Wetlands Plan* (WEWP). WEWP includes areas within the Amazon, Bethel-Danebo, and Willow Creek basins.

Wetlands information for the remaining study area is based primarily on the *National Wetlands Inventory* (NWI). The NWI provides basic data about general characteristics and the extent of wetlands. The NWI identifies general wetland boundaries; however, in many instances actual wetland boundaries and features are more extensive than what is identified through this mapping.

The WEWP provides a more detailed and extensive inventory of existing wetlands than the NWI. As part of the WEWP, assessments have been made as to wetland values and a determination regarding the need for either protection, restoration, or future fill. Table 2-7 shows the amount and management status of these wetlands:

Table 2-7
Wetlands by Management Categories

Protect	Management Category (acres)		Total
	Restore	Future Fill	
720	445	326* *Includes Transportation Corridor (8 acres) and Utility Corridor (13 acres)	1,491

Source: West Eugene Wetlands Plan (2000, as amended).

To improve the quality of wetlands information for the study area, the City is pursuing grant funds to conduct a local wetlands inventory. The inventory would be conducted in the spring of 2003.

2.5.4 Public Piped System

There are about 324 miles of stormwater pipes located within the study area (mostly within City limits). The public piped system includes the stormwater facilities that the City of Eugene owns and maintains. The public system does not include private drainage facilities. The extent of privately owned and maintained storm pipe systems within the city limits is unknown.

The piped system primarily serves the function of carrying stormwater away from development and conveying it to receiving waters such as Amazon Creek and the Willamette River. Table 2-8 shows the extent of the piped system by basin.

Table 2-8
Public Piped Stormwater System

Basin	Miles of public piped system
Amazon	123
Bethel-Danebo	54
Laurel Hill	3
River Road Santa Clara	30
Willakenzie	59
Willamette River	54
Willow Creek	1
Total	**324**

2.5.5 Maintaining the Drainage System

The City of Eugene is responsible for maintaining all drainage facilities within the City that carry storm runoff originating on public right-of-ways or other publicly owned land. Most of the piped system lies within street rights-of-way or within easements on private property. Nearly 30 miles of open drainage channels are maintained by the City as either public right-of-way or through easements.

Historically, the focus of the City's maintenance practices has been drainage and flood control services. More recently the City has begun managing riparian vegetation by allowing it to

remain within streams and channels for its beneficial effects of slowing runoff for filtration and sedimentation. Other than pipes and open channels, the City is minimally involved in maintaining detention facilities and, to date, has not been actively involved in maintaining water quality treatment Best Management Practices (BMPs).

Outside the City limits, Lane County maintains roadside ditches but does not actively maintain runoff from adjacent private lands. As land is annexed to the City, Eugene will assume maintenance responsibilities provided that they meet City standards.

2.5.6 Floodplain

While most streams and open waterways in Eugene have natural, hydrologic floodplains, the only waterways that have *official* floodplains are those where the Federal Emergency Management Agency (FEMA) has performed specific flood studies. FEMA designates 100-year and 500-year floodplain areas and offers flood insurance at reduced rates for cities and property owners that participate in the federal insurance rate program. The overall floodplain consists of two areas: 1) the *floodway*, which is the area needed to pass the 100-year peak flow condition, is the most restrictive where development activities are prohibited; 2) the *floodway fringe* area extends landward from the floodway and is often inundated during 100-year overbanking conditions. Development activities are allowed in the floodway fringe provided flood standards are met, such as building above the 100-year flood elevation. To date, the Willamette River, McKenzie River, and Amazon Creek are the only waterways to have *officially* designated floodways.

FEMA designated floodplains in the study area include: Willamette River; Q Street-Patterson Slough-Canoe Canal system; Debrick Slough; Ayers Pond-Dodson Slough system; McKenzie River, East Santa Clara Waterway; Spring Creek; Flat Creek; A1, A2, A3, A Channel system; and Amazon Creek-Diversion Channel system. The study area includes about 8,104 acres of 100-year floodplain.

Table 2-9 shows the distribution of floodplain acres by basin. The relatively small amount of floodplain acres in Willow Creek and Laurel Hill are partly due to basin size but also due to lack of a FEMA flood studies in these basins. The lack of designated floodway area in the Amazon and Bethel-Danebo basins outside the UGB is due to lack of a detailed FEMA study in these areas. A detailed study is being conducted by the City of Eugene in these areas, for approval by FEMA, and is expected to be completed by late 2001.

Table 2-9
Floodplain Area

Basin	Floodplain Area (acres)								
	Floodway			Floodway Fringe			Total Floodplain		
	UGB	Outside UGB	Total	UGB	Outside UGB	Total	UGB	Outside UGB	Total
Amazon	128	0	128	503	222	725	631	222	853
Bethel-Danebo	4	0	4	705	1,306	2,011	709	1,306	2,015
Laurel Hill	1	0	1	3	0	3	4	0	4
River Road Santa Clara	0	0	0	635	636	1,271	635	636	1,271
Willakenzie	77	12	89	947	896	1,843	1,024	908	1,932
Willamette River	462	575	1,037	310	660	970	772	1,235	2,007
Willow Creek	1	0	1	21	0	21	22	0	22
Total	**673**	**587**	**1,260**	**3,124**	**3,720**	**6,844**	**3,797**	**4,307**	**8,104**

2.6 Water Quality

This section provides a description of water quality conditions in the study area. Water quality conditions vary depending on time of day, weather conditions, land use activities conducted in the watershed, and location in the water body. Without significant amounts of data, it is often difficult to adequately evaluate water quality conditions. It is even more difficult to evaluate the water quality impacts of stormwater runoff on receiving waters. Therefore, a variety of available sources of water quality-related information was reviewed in an attempt to provide a general picture of water quality conditions in the study area. The following sources of information were reviewed and are described below:

- Observed water quality problems based on existing chemical and biological data.
- Oregon Department of Environmental Quality's (DEQ's) designations of water quality limited water bodies.
- Reported field observations of water quality problems.
- Natural and built environmental conditions that influence water quality.

2.6.1 Observed Water Quality Problems

2.6.1.1 Stormwater Data

The State of Oregon has established water quality standards for the Willamette River Basin (Oregon Administrative Rules, Chapter 340, Division 41, Section 445). The standards that are referred to here are those instream standards that have been established for the protection of aquatic life. Four of the City's six stormwater monitoring stations (1992-1997) were located instream where these standards would apply. Figure 2-5 provides a map of the monitoring station locations. Table 2-10 includes a description of the problem pollutants, typical sources of the pollutants, specific results from Eugene, and potential problems associated with the pollutants. Pollutant concentrations exceeding instream water quality standards have been observed within the Amazon, Bethel-Danebo, and Willow Creek basins during storm events. Stormwater monitoring did not occur for the other basins.

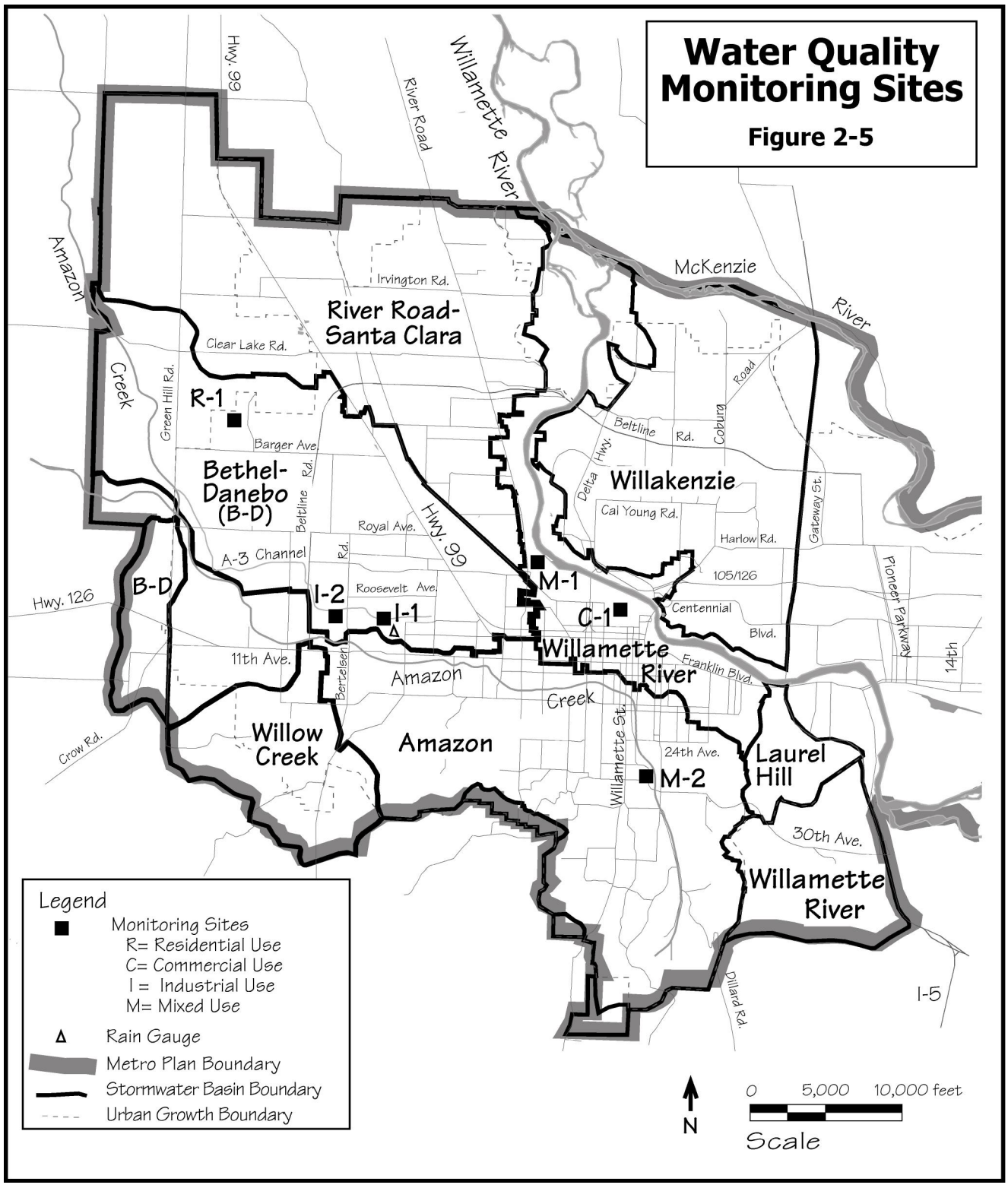

Water Quality Monitoring Sites
Figure 2-5
Hwy. 99
River Road
Willamette River
McKenzie River
Amazon Creek
Irvington Rd.
River Road-Santa Clara
Clear Lake Rd.
Green Hill Rd.
R-1
Barger Ave.
Bethel-Danebo (B-D)
Beltline Rd.
Royal Ave.
Hwy. 99
A-3 Channel
B-D
Hwy. 126
I-2
Roosevelt Ave.
I-1
11th Ave.
Bertelsen Rd.
Crow Rd.
Willow Creek
Amazon
Amazon Creek
Willamette St.
24th Ave.
M-2
Laurel Hill
30th Ave.
Willamette River
Dillard Rd.
I-5
Delta Hwy.
Beltline Rd.
Coburg Road
Willakenzie
Cal Young Rd.
Harlow Rd.
Gateway St.
105/126
Centennial Blvd.
M-1
C-1
Willamette River
Franklin Blvd.
Pioneer Parkway
14th
Legend
Monitoring Sites
R= Residential Use
C= Commercial Use
I = Industrial Use
M= Mixed Use
Rain Gauge
Metro Plan Boundary
Stormwater Basin Boundary
Urban Growth Boundary
N
0 5,000 10,000 feet
Scale

Table 2-10
Summary of Stormwater Quality Monitoring in Eugene

Pollutant	Description	Sources	Eugene's Results	Potential Problems
Bacteria	- Enterococcus, - Fecal coliform, and - Fecal streptococcus	- Animal Wastes (droppings from wild/domestic animals), - Human Wastes (leaking sanitary sewer pipes, and seepage from septic tanks).	**Results from almost all of the samples significantly exceeded the DEQ standard for water quality**.	These are commonly used indicators of human pathogens. Water contact may cause eye and skin irritations and gastro-intestinal diseases if swallowed.
Heavy Metals	Antimony Arsenic Beryllium Cadmium Chromium Copper Lead Mercury Nickel Selenium Silver Thallium Zinc	- Vehicles (combustion of fossil fuels, improper disposal of car batteries, wear/tear of tires and brake pads), - Metal Corrosion, - Pigments for Paints, - Solder, - Fungicides, - Pesticides, - Wood Preservatives	Cadmium, chromium, copper, lead, nickel, and zinc were typically present in samples. **Copper, lead, and zinc in stormwater samples frequently exceeded DEQ standards for the protection of aquatic life.**	Heavy metals are toxic to freshwater aquatic ecosystems. These metals are considered to be the most significant toxic substances which are commonly found in urban stormwater runoff.
Oil & Grease	A broad group of pollutants including: - Animal fats, and - Petroleum products.	- Food Wastes (animal and vegetable fats from garbage), - Petroleum Products (gas, engine oil, lubricants, etc.).	**Two of fifty-three samples had concentrations which exceeded discharge limitations specified for industrial stormwater discharges (i.e., > 10 mg/L).**	These compounds can coat the surface of the water limiting oxygen exchange, clog fish gills, and cling to waterfowl feathers. When ingested these compounds can be toxic to birds, animals and other aquatic life.
Sediments	Sediments in the water are considered pollutants when they exceed natural concentrations and negatively affect water quality and/or beneficial uses of the water.	- Erosion from increased stream flows, - Construction site runoff, - Landscaping activities, - Agricultural activities, - Logging, - All other activities where the ground surface is disturbed.	**Excess levels were measured at all stations. Results from the urban sampling stations in Eugene were all 40% to 70% higher than results from an open space (i.e., undeveloped) sampling.**	Sediments cause increased turbidity, reduced prey capture for sight feeding predators, clogging of gills/filters of fish and aquatic insects, and blocked light which limits food production available for fish. Sediments also accumulate in stream bottoms which reduces the capacity of the stream (and hence increases the potential for flooding) and covers stream bottom habitats. Sediment also acts as a carrier of toxic pollutants such as metals and organics.
Nutrients	- Nitrate - Ammonia - Kjeldahl Nitrogen - Phosphorus - Orthophosphate	- Landscaping activities, - Yard debris, - Human wastes (leaks from septic tanks and sanitary sewers), - Animal wastes, - Vehicle exhausts, - Agricultural activities, - Detergents (car washing), - Food Processing	**The DEQ guidance value of 0.1 mg/L for total phosphorus was exceeded in 100% of the samples collected.**	Excess levels of nutrients can lead to eutrophication in downstream receiving waters. Problems include surface algal scums, odors, reduced oxygen levels, and dense mats of algae. In addition to water quality problems, these effects have a negative impact to the aesthetic quality of water bodies.
Organics	There are many organic compounds, however, the synthetic organics are of most concern and include: - Fuels - Solvents - Pesticides - Herbicides.	- Illegal dumping, - Illicit connections, - Spills, - Leaks from drums and storage tanks, - Landscaping activities - Agricultural activities.	Although sampling for these compounds was limited, **nine volatile organic compounds were detected (including one pesticide).**	Most synthetic organics are highly toxic to aquatic life at very low concentrations, and many are carcinogenic (cancer causing) or suspected carcinogens. Diazinon has been identified in many recent studies as one of the causes of toxicity in stormwater.

Table 2-10 (continued)

Pollutant	Description	Sources	Eugene's Results	Potential Problems
Litter and other Floatable Debris	- Plastics, - Paper products, - Yard debris, - Tires, - Metal, - Glass.	- Littering, - Dumping, - Spills.	Sampling for litter and floatables was not conducted, however, **specific problem dumping areas have been identified in Eugene** (see notes below).	These pollutants degrade the aesthetic quality of water bodies. In addition, they contribute pollutants as they decompose, and they can reduce the capacity of the water body. Excess yard debris contributes to high levels of nutrients and it reduces oxygen levels as it decomposes.

Table 2-11 displays the number of occurrences state standards were exceeded by parameter.

Table 2-11
Storm Event Samples Exceeding State Instream Standards

Parameter	Number of Exceedances/ Number of Samples	Percentage of Samples Exceeding the Standard
Amazon		
Dissolved Copper	2/13	15 %
Dissolved Zinc	1/13	8 %
Phosphorus[1]	12/13	92%
E. Coli	9/9	100%
Bethel Danebo		
Dissolved Copper	Station I – 2/15 Station II – 5/18	Station I – 13% Station II – 28%
Dissolved Zinc	Station I – 8/15 Station II – 6/18	Station I – 53% Station II – 33%
Phosphorus[1]	Station 1 – 15/15 Station II – 17/17	Station I – 100% Station II – 100%
E. Coli	Station I – 6/9 Station II –5/9	Station I – 67% Station II – 56%
Willow Creek		
Phosphorous[1]	2/17	12%
Total Dissolved Solids[2]	13/17	76%
Dissolved Oxygen	1/17	6%
Temperature[3]	5/17	29%

[1]This exceedance is based on comparisons to a State guidance value for phosphorus concentrations because instream standards for phosphorus do not exist.

[2]DEQ has stated that the primary beneficial use protected by the total dissolved solids standard is "municipal and industrial water supply". Since Willow Creek is not used as a drinking water source, exceedance of this standard is not of primary concern.

[3]The temperature standard is measured as a rolling seven-day average of daily maximum temperature. Although the samples do not represent a seven-day average, the temperature measured in five samples exceeded the new standard.

Temperature and algae problems have also been observed in Amazon Creek and Delta Ponds. Warmer temperatures and higher concentrations of nutrients such as phosphorus contribute to the growth of algae. Large algae mats are observed in Amazon Creek during the summer from the concrete channel downstream to the UGB, but are most apparent downstream to Beltline Road. Algae produce oxygen during daylight, but utilize oxygen during the hours of darkness. Thus, extensive algae growth can contribute to exceedances of dissolved oxygen criteria. In addition, these mats eventually decay, utilizing additional oxygen and creating odors.

2.6.1.2 Findings from Macroinvertebrate Sampling

Aquatic macroinvertebrate sampling is useful in evaluating water quality and ecological integrity. Pronounced changes in biological communities indicate a disruption of healthy environmental conditions and can be useful in identifying cumulative effects of pollutants, habitat alterations, effects from bioaccumulative chemicals, and other impacts that chemical monitoring may not reveal. A comprehensive macroinvertebrate study has not been conducted for the study area. Willow Creek is the only basin where a comprehensive sampling approach was conducted. Other inventories occurred at site specific locations in Amazon Creek and Willamette River. Results of these studies are provided in the individual basin plans. However, in general, for Willow Creek the results suggest that pollution and habitat impacts are highest in the downstream segments of the basin and are possibly due to cattle grazing, creek channelization, maintenance activities, and water quality degradation.

2.6.1.3 Field Observations of Water Quality Problems

In addition to the information obtained from the stormwater monitoring data described above, specific water quality related problems/issues have been observed throughout Eugene. Examples of these problems include stagnant water bodies covered with algae, debris and trash in open waterways, discharges of unknown substances from outfalls, significant erosion of streambanks. Details regarding problems observed in each basin are provided in each of the individual basin plans (Volumes II through VII).

2.6.2 Oregon Department of Environmental Quality Water Quality Limited Designations [303(d) List]

The federal Clean Water Act requires states to maintain a list of water bodies that do not meet water quality standards. These standards are established to protect beneficial uses such as drinking water, fisheries, industrial water supply, recreational, and agricultural uses. This list is called the 303(d) List based on the section of the Clean Water Act that mandates this requirement. The list is meant only as a means of identifying water quality problems and not the causes.

States must monitor water quality and review available data and information to determine if the standards are being met. In Oregon, this responsibility is carried out by the DEQ. If available data indicate a water body is not meeting water quality standards, and the data meet listing guidelines, DEQ must assume that the water body is water quality limited. Water bodies with no information, or information incompatible with the EPA guidelines, are not included on the 303(d) list. The 303(d) list is updated and revised every two years. Once a water body is included on the 303(d) list, DEQ is required to develop a total maximum daily load (TMDL) requirement for both point and non-point sources of the pollutants of concern. It is anticipated that DEQ will develop TMDL requirements for all designated water quality limited water bodies sometime within the next ten years.

The Amazon Diversion Channel (Fern Ridge Reservoir to the Amazon diversion structure) is included on the 1998 303(d) list for bacteria and dissolved oxygen within the Amazon basin.

The Amazon Diversion Channel discharges into the Fern Ridge Reservoir, which is also on the 303(d) list for turbidity and bacteria.

Within the Bethel-Danebo basin, the A-3 Channel (Seneca Avenue to the confluence with the "A" Channel) is included on the 1998 303(d) list for toxics. Within the Willamette River basin, the Upper Willamette River (from the McKenzie River to the Coast/Mid Forks of the Willamette) is listed on the 1998 303(d) list for temperature and mercury. Finally, in the Willakenzie basin, the McKenzie River is listed for temperature.

As of the published date of this report, there are no waterbodies listed in the Willow Creek, Laurel Hill or River Road Santa Clara basins.

The Draft 2002 303(d) list - expected to be approved in late 2002 - would add Amazon Creek (headwaters to Long Tom River) and Willow Creek (headwaters to Amazon Creek) as water quality limited steams within the study area.

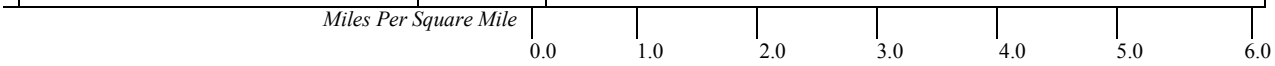
2.6.3 Natural and Built Conditions

Evaluating the natural and built conditions that influence water quality can be useful in indirectly assessing water quality conditions in the study area. As urbanization occurs, negative impacts to the health of receiving waters result from changes in the quality of stormwater runoff. Natural features such as riparian areas, wetlands, and open drainage systems have the ability to treat stormwater pollutants, prevent channel scour by slowing down runoff rates, settle out sediments, and protect stream banks from erosion. However, with research showing that water quality degradation occurs at relatively low levels of imperviousness (10-20 percent), the implications of development on water quality is significant.[1]

Figures 2-6, 2-7, and 2-8 examine natural and built conditions relative to the other Eugene drainage basins.

Figure 2-6
Extent of Open Drainage System (UGB)

Basin	Miles/ Sq. Mile	Extent of Open Drainage in relation to other basins
Amazon	2.1	
Bethel-Danebo	3.2	
Laurel Hill	2.8	
River Road Santa Clara	3.0	
Willakenzie	2.3*	
Willamette River	0.50**	
Willow Creek	5.0	

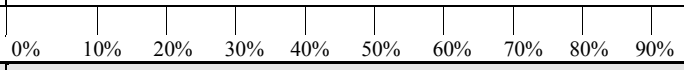


*Does not include McKenzie River
**Does not include Willamette River

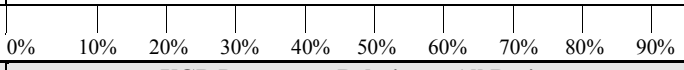
[1] Tom Schueler, et al. *Site Planning for Urban Stream Protection: The Importance of Imperviousness*, 1995.

Figure 2-7
Comparison of Water Quality-Related Basin Characteristics

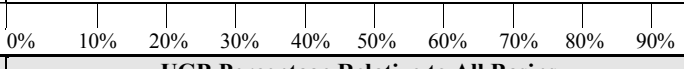
Remaining Vacant Lands	Acres	% UGB
Amazon	2,415	23%
Bethel-Danebo	1,593	25%
Laurel Hill	458	57%
River Road Santa Clara	1,744	29%
Willakenzie	1,124	18%
Willamette River	295	8%
Willow Creek	553	47%



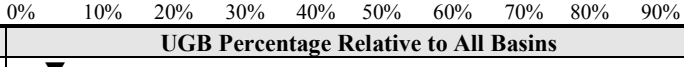
Existing Impervious Surface	Acres	% UGB
Amazon	3,566	33%
Bethel-Danebo	2,186	34%
Laurel Hill	163	20%
River Road Santa Clara	2,056	34%
Willakenzie	2,258	37%
Willamette River	1,412	40%
Willow Creek	159	14%



Projected Impervious Surface Area	Acres	% UGB
Amazon	4,655	44%
Bethel-Danebo	3,060	50%
Laurel Hill	348	43%
River Road Santa Clara	3,063	51%
Willakenzie	2,842	47%
Willamette River	1,552	44%
Willow Creek	486	42%



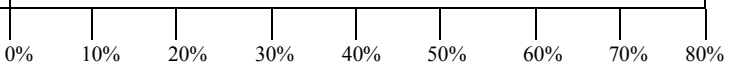
Wetlands	Acres	% UGB
Amazon	1,574	14%
Bethel-Danebo	717	8%
Laurel Hill	0	0%
River Road Santa Clara	313	3%
Willakenzie	439	6%
Willamette River	773	11%
Willow Creek	334	13%



100-Year Floodplain	Acres	% UGB
Amazon	624	6%
Bethel-Danebo	708	11%
Laurel Hill	4	.4%
River Road Santa Clara	635	10%
Willakenzie	1,021	17%
Willamette River	768	22%
Willow Creek	22	.01%

Figure 2-8
Extent of 100-Year Floodway Fringe That is Vacant within the UGB by Basin

Basin	100-Year Floodway Fringe (acres)	100-Year Floodway Fringe Vacant Acres (% of UGB)	Percent Vacant Individual Basins Relative to the Range in Other Eugene Basins
Amazon	503	98 (19%)	
Bethel-Danebo	705	425 (60%)	
Laurel Hill	3	0 (0%)	
River Road Santa Clara	635	277 (44%)	
Willakenzie	947	149 (16%)	
Willamette River	310	50 (16%)	
Willow Creek	21	7 (4%)	



2.6.4 Conclusions

Natural and built indicators show a variety of water quality conditions within the study area. Findings show that:

- Temperature, dissolved oxygen, and other pollutant concentrations (i.e., total dissolved solids and phosphorus) that exceed state instream water quality standards have been observed in the Amazon Creek, Bethel-Danebo, and Willow Creek basins, although similar data have not been collected for the other basins.
- Macroinvertebrate sampling suggests pollution and habitat impacts are highest in the downstream segments of the Willow Creek basin, possibly due to cattle grazing, creek channelization, maintenance activities, and water quality degradation.
- The extent of the open drainage system on a miles per square mile basis ranges from 2 in Bethel-Danebo to 4.3 in Willow Creek.
- The Amazon Diversion Channel, the A3 Channel, the Upper Willamette River and the McKenzie River have been identified by the State as "water quality limited" with respect to meeting their beneficial uses. These water bodies are therefore listed on the States' 1998 303(d) list and scheduled for the development of a TMDL.

2.7 Rare, Threatened, and Endangered Plants, Animals, and Communities

Stormwater management decisions and practices can affect rare, threatened, and endangered plant and animal species. Local populations can be reduced or even eliminated as a result of decisions to pipe a waterway, install upstream detention, or to allow significant increases in runoff due to new development. The purpose of this subsection is to describe the known rare species and communities located in the study area so that the details of these resources can be consulted prior to any final decisions.

Table 2-12 indicates rare plant and animal species that have been observed in the study area and that appear on the Oregon Natural Heritage Program's database. Specific locations of these species are available through the Oregon Natural Heritage Database Program.

Due to the WEWP and The Nature Conservancy's interest in the Willamette Valley Wet Prairies, the most extensive surveys for rare plant and animal species have occurred in Willow Creek, Amazon Creek, and Bethel-Danebo basins. As a consequence, more species information is known about these areas than in the other basins; however, given the relatively high level of urban development in the remaining basins, the occurrence of rare species is likely to be low when compared with basins within the WEWP Boundary.

In March 1999, the National Marine Fisheries Service (NMFS) listed spring-run Chinook salmon as a threatened species under the Endangered Species Act (ESA). It includes all naturally spawned populations of Spring Chinook in the Clackamas River, and in the Willamette River and its tributaries above Willamette Falls, Oregon. Because runoff from Eugene discharges either directly or indirectly to the Willamette River, the listing will affect the City's stormwater management program and practices.

A species that is listed as *threatened* means it is *likely to become endangered within the foreseeable future throughout all or a significant portion of its range.* Protective regulations, known as 4(d) rules have been developed that are *deemed necessary and advisable to provide for the conservation of the species*. These rules spell-out the *take* prohibitions that pertain to Spring Chinook and focus on the type of activities that are likely to lead to a *take*. The City is in the process of reviewing its own processes, procedures, and development standards for identifying and adjusting those that may not be compatible with the 4(d) rules.

Table 2-12 displays the inventoried rare plants and animal species within the study area.

Table 2-12
Rare Plants and Animals

Species	Federal		State		TNC Rank		Associated Habitat	ONHP List
	Listed	Candidate	Listed		Global	State		
Bradshaw's lomatium (*Lomatium bradshawii*)	E		E	SC	G2	S2	Wet Prairie	1
Howell's montia *(Montia howelli)*				C	G3	S2	Wet Prairie	1
Fenders Blue Buttefly *(Icaricia icarioides fenderi)*	E				T1	S1	Upland Prairie	1
Kincaid's lupine (*Lupinus sulphureus ssp. Kincaidii)*			T				Upland Prairie	1
Oregon Chub *(Oregonichthys crameri)*	E			SC	G2	S2	Aquatic	1
Pacific Western Big-Eared Bat *(Plecotus townsendii)*		SOC		SC	G4T4	S3	Uplands – Rocks, Caves, Bridges	2
Pallid Bat *(Antrozous Pallidus)*				SV	G5	S3	Uplands - Rocks, Caves, Bridges	3

Table 2-12 (continued)

Species	Federal		State		TNC Rank		Associated Habitat	ONHP List
	Listed	Candidate	Listed	Candidate	Global	State		
Spring Chinook (*Oncorhynchus tshawytscha)*	E			SC	G5T2Q	S2	Upper Willamette River Basin	1
Shaggy horkelia *(Horkelia congesta* ssp. *congesta)*		SOC		C	G4t1	S2	Prairie	1
Sharptail Snake *(Contia tenuis)*				SV	G5	S3	Varied Forest-Grassland mix	4
Tall bugbane (*Cimicifuga elata)*		SOC		C	G2	S2	Coniferous Forest	1
Thompson's romanzoffia (*Romanzoffia thompsonii*)					G3	S3	Moist rock places in Coniferous Forest	1
Timwort (*Cicendia quadrangularis*)					G4	S2	Wet Prairie	2
Wayside aster (*Aster vialis*)			T		G2	S2	Coniferous Forest	1
Western pond turtle (*Clemmys marmorata marmorata*)*		SOC		SC	G3	S2	Riparian/Wetlands	1
White-topped aster (*Aster curtus*)		SOC	T		G3	S2	Prairie	1
Willamette valley daisy (*Erigeron decumbens var.decumbens*)	E		E		T1	S1	Prairie	1
Willow Creek stonefly (*Capnia sp. Nov.)*					G1	S1	Headwater Streams	1

KEY: *Federal and State (E=Endangered, T=Threatened, C=Candidate throughout its range, SOC=Species of Concern, SC=Sensitive/Critical, SV=Sensitive/Vulnerable, *=Under Consideration for Protective Status).* ***TNC Rank*** *(State Rank: 1=critically imperiled, 2=imperilled, 3=rare, uncommon or threatened but not immediately imperiled, 4=not rare and apparently secure, and 5=demonstrably secure, widespread. Global Rank: The number is prefixed by a "G" and for the state an "S". A "T" ranks subspecific species on a global scale (but not on state scale)).* ***ONHP List*** *(List 1= threatened or endangered throughout their range, List 2= threatened or endangered in Oregon but more stable elsewhere, List 3 = need more information, List 4=species of concern but are not currently threatened or endangered).*

2.8 Soils

Soil characteristics are important factors in predicting the amount, rate, and quality of stormwater runoff and for selecting management measures for addressing the effects of runoff. This chapter describes the key soil parameters relative to stormwater issues and the distribution of those parameters in the entire study area. All soil data were obtained from the *Soil Survey of Lane County, Oregon (1987)*.

2.8.1 Permeability

Soil permeability measures the rate of water movement through the soil horizon. This factor is important in managing stormwater quantity and quality. Permeability rates are assigned based on the dominant soil horizon (15-40 inches). Nearly 80 percent of the study area contains soils in the very slow to moderately slow categories, and most of these soils are located in the Amazon Creek, Laurel Hill, Willow Creek, and Bethel-Danebo basins. The following table displays the distribution of soil permeability rates for the study area:

Table 2-13
Permeability

Location	Permeability (percent)							
	Very Rapid	Moderately Rapid	Moderate	Moderately Slow	Slow	Very Slow	No Data*	Total
In UGB (% UGB)	6%	5%	5%	43%	19%	20%	2%	100%
Outside UGB within Urban Reserves (% URs)	3%	0%	1%	34%	39%	23%	0%	100%
Outside UGB Outside URs (% outside UR/UGB)	7%	8%	2%	36%	16%	22%	9%	100%
All Basins (% of all basins)	6%	6%	4%	41%	19%	20%	4%	100%

Source: USDA Soil Survey of Lane County Area, Oregon, 1987.
**Includes gravel pits and ponds.*

2.8.2 Runoff Potential

Soil groups have been rated according to their runoff potential under nonvegetated and saturated conditions without consideration to topographic conditions. Hydrologic stormwater models often use this parameter in conjunction with slope and surface cover factors for estimating surface flows under undeveloped conditions. Runoff potential measures a soil's capacity to permit infiltration and can be used to describe the degree of runoff expected during storm events. For example, soils rated "low runoff potential" are more likely to have high infiltration rates and, conversely, soils rated "high runoff potential" are more likely to have slow infiltration rate. Over 80 percent of the study area contains soils that are in the moderately high to high categories, which are primarily located in the Amazon Creek, Laurel Hill, Willow Creek, and Bethel-Danebo basins. The following table displays the distribution of soil runoff potential for the study area:

Table 2-14
Runoff Potential

Location	Runoff Potential (percent)					
	High	Moderately High	Moderately Low	Low	No Data*	Total
In UGB (% of UGB)	39%	44%	15%	2%	%	100%
Outside UGB within Urban Reserves (% of in UR)	44%	53%	3%	0%	0%	100%
Outside UGB Outside URs (% of UR/UGB)	47%	27%	15%	6%	5%	100%
All Basins (% of all basins)	41%	40%	15%	3%	1%	100%

Source: USDA Soil Survey of Lane County Area, Oregon, 1987.
**Includes gravel pits and ponds.*

2.8.3 Erodible Soils

For erodibility purposes, the U.S. Department of Agriculture classifies soils as high, moderate, or other. The other category indicates soils that do not meet the criteria for high and moderate and, therefore, are either less erodible or require more research.

Highly erodible soils have significant stormwater management implications. If not properly protected during construction and logging activities, erosion and sedimentation from these soils can have the following negative effects:

- Reduction in the conveyance capacity of downstream stormwater facilities resulting in potential drainage and flooding problems.
- Reduction or elimination of aquatic habitat by covering or destroying spawning beds.
- Water quality impacts due to pollutants that are attached to sediments.

25% of the study area is affected by highly erodible soils; most are located in the South Hills and adjacent, low-lying patches of Amazon basin. Refer to Table 2-15.

Table 2-15
Erodible Soils

Location	Erodible Soils		
	High	Moderate	Low
In UGB (% UGB)	23%	4%	73%
Outside UGB within Urban Reserves (% URs)	62%	6%	32%
Outside UGB Outside URs (% outside UR/UGB)	19%	4%	77%
All Basins (% of all basins)	25%	4%	71%

Source: USDA Soil Survey of Lane County Area, Oregon, 1987.

2.8.4 Unstable Slopes

Unstable slopes can present structural problems especially where extensive grading is needed for siting roads and building foundations. Roads requiring significant cuts should not be located on these soils. Unstable slopes combined with saturated soil conditions create high potential for mass movement. Properly designed drainage systems can help mitigate slump potential. Table 2-16 provides the percentage of areas that are subject to slumping.

Table 2-16
Unstable Slopes

Location	Percent of Area Subject to Slumping
In UGB (% in UGB)	18%
Outside UGB within Urban Reserves (in URs)	15%
Outside UGB Outside URs (outside UR/UGB)	21%
All Basins (of all basins)	17%

Source: USDA Soil Survey of Lane County Area, Oregon, 1987

2.8.5 Hydric Soils

Hydric soils are one of three criteria for determining the presence of wetlands; the other two being inundated or saturated soil conditions and the presence of hydrophytic vegetation. Federal and state regulations limit activities that can occur in wetlands, including the direct discharge of untreated stormwater runoff. 26% of the study area is affected by hydric soils, with most located in the low-lying, historic drainageways of the Amazon Creek, Laurel Hill, Willow Creek, and Bethel-Danebo basins. The following table shows the percentage of hydric soils within the UGB, urban reserves, and outside of the urban reserves and UGB.

Table 2-17
Hydric Soils

Location	Percent in Area
In UGB (% of UGB)	24%
Outside UGB within Urban Reserves (% of URs)	19%
Outside UR/UGB (% of area outside UR/UGB)	34%
All Basins % of all basins)	26%

Source: USDA Soil Survey of Lane County Area, Oregon, 1987

2.9 Groundwater

Two aspects related to groundwater need to be considered when planning for stormwater management. The first relates to the regional aquifer that underlies much of the lower Willamette Valley basin. This aquifer is the source of drinking water for rural residents and several nearby communities (e.g., Springfield, Coburg, Junction City) and has also been investigated as a potential future source of water for Eugene. For this reason, consideration needs to be given to the effects that stormwater management can have on groundwater quality and quantity.

Groundwater table also plays a role in determining feasibility for using infiltration as a BMP. Generally, areas with deeper groundwater tables are more suitable than shallower areas provided other factors of soil permeability and depth to bedrock are met.

Generally, where depth to groundwater is less than six feet from the surface, infiltration feasibility becomes more problematic. Two-thirds of the study area has groundwater within six feet of the surface and these areas are generally located in the South Hills, Amazon Creek floodplain, and in the Bethel-Danebo area.

Table 2-18
Depth to High Water Table

Location	Depth to high water table as percentage of the area	
	2-3 feet or less	6 feet or more
In UGB (% UGB)	47%	53%
Outside UGB within Urban Reserves (% URs)	28%	72%
Outside UGB Outside URs (% outside UR/UGB)	60%	40%
All Basins (% of all basins)	48%	52%

Source: USDA Soil Survey of Lane County Area, Oregon, 1987
*Mapped soil units within the study area do not contain high water table depths between 3 and 6 feet.

2.10 Recreational and Educational Facilities

The Comprehensive Stormwater Management Plan's (CSWMP) multiple-objectives approach to stormwater management includes incorporating recreational and educational facilities. Recreational facilities, such as trails and parks, are compatible with and are often located within areas that are prone to flooding. Drainages can provide corridors for hiking and biking trails as well as for conveying stormwater runoff. Parks can be used as storm event overflow areas with minimal property repair costs. Drainages and wetlands provide opportunities for classroom study and open space recreation and, therefore, their proximity to schools have educational benefits.

The community has already taken advantage of this opportunity in many locations, such as:

- Willamette River bike and pedestrian path: University of Oregon, Alton Baker Park, Morrey Jacobs Park.
- Amazon Creek bike and pedestrian path with Amazon Park, Jefferson Middle School, South Eugene High School, Patterson Elementary School, Westmoreland Park.
- West Eugene Wetlands public access and trails.
- Ridgeline Trail system.

Other future opportunities include:

- Willow Creek.
- Spring Creek.
- Willakenzie Floodway.
- McKenzie River.
- East Santa Clara Waterway.
- Flat Creek.
- Braeburn Creek.
- Laurel Hill Creek.
- Timberline Creek.
- Gilham Creek.
- Videra Creek

SECTION 3 Study Methods for Identifying Problems and Opportunities

This section describes the study methods that were used to identify problems and opportunities related to storm system management. Specifically, problems and opportunities were identified with respect to flood control, water quality and natural resources.

3.1 Flood Control Evaluation

To develop a flood control strategy for each of the basins, computer models were used to evaluate hydrologic/hydraulic conditions of the public storm drainage system. The storm system was evaluated under both existing and anticipated future land use conditions. The City of Eugene selected the XP-SWMM model software to conduct these analyses. The following text describes:

- Model Selection (Section 3.1.1).
- Model Input Parameters (Section 3.1.2).
  - Meteorological Data.
  - Hydrologic Data.
  - Hydraulic Data.
- Model Calibration (Section 3.1.3).
- Design Storm Selection (Section 3.1.4).
- Model Output (Section 3.1.5).

3.1.1 Model Selection

The SWMM model (stormwater management model) was developed by the Environmental Protection Agency for the hydrologic, hydraulic and water quality analyses of combined sewer or separate sewer systems in urban environments. Single storm events or continuous simulation may be used in the model for runoff computations. The drainage system may include regular or irregular open channels (natural streams), closed conduits of various shapes or sizes, weirs, orifices, pumps, flood gates, single or interconnected ponds/reservoirs, dry wells, infiltration trenches and other facilities. The portion of the software that is used to conduct hydrologic analyses is called the RUNOFF block. The portion of the software used to conduct the hydraulic analyses is called the EXTRAN block. The program is available as a stand alone public domain software. As mentioned above, Eugene elected to use the software with an easy-to-use graphic interface called XP-SWMM.

3.1.2 Model Input Parameters

In order to develop the hydrologic and hydraulic computer models for each major basin, a number of input parameters were developed for the RUNOFF and EXTRAN blocks of XP-SWMM. Many of these input parameters were developed through the use of the City's GIS (geographic information system). The input parameters and their sources are described in detail in Appendix C (Hydrologic/Hydraulic Model Input Parameters) according to the following three categories:

- Meteorological Data (rainfall, evaporation).

- Subbasin Hydrologic Data (subbasin channel or pipe inlet number, subbasin width, area, impervious percentage, slope, Manning's roughness coefficient, depression storage, and infiltration parameters).
- Storm Drainage System Hydraulic Data (e.g., channel, pipe or culvert length and material, invert elevations).

Long-term, hourly, rainfall data since 1948 are available from the National Weather Service rain gage at the Eugene airport. Since 1992, rainfall information has been recorded at six rain-gage stations within the Eugene City limits. Comparison of these data indicates a significant difference between the two, with the airport data approximately 30 percent higher than the National Weather Service Data. The City decided to use the closest rain gage data (City data) for model calibration, and the NWS data once design storms were selected in order to be conservative. For additional information regarding this issue, also see Appendix A (City of Eugene Analysis of Precipitation Data for Use in Hydrologic/Hydraulic Modeling, April 12, 1996).

The impervious surface area factors used for each metro plan designation under existing (1998) and buildout land use conditions are provided in Appendix B (Impervious Surface Area Factors).

The delineation and numbering convention for basins, major subbasins and subbasins is described in Section 1.4.

Nodes were typically assigned whenever there was a change in conduit size, slope, or material. Nodes were also assigned as inlet points for subbasin hydrographs and at locations where there was a confluence of multiple conduits. Five-digit numbers were assigned to each modeled node; these numbers were provided by City GIS staff and match the stormwater system index maps. The node numbers are not geographically related.

Pipes, culverts, and open channel segments between nodes were assigned eight-character names. The first seven characters are the subbasin name such that all modeled segments located within a subbasin have the same first seven characters. The eighth character is a letter (a, b, c…) moving upstream within the subbasin. For parallel pipes (e.g. two culverts under a roadway), the segment names include a ninth character (e.g. "WKCF010a1" and "WKCF10a2"). Segment names were given for roads which parallel pipes as such: "WKCF010aRd."

3.1.3 Model Calibration

As with all mathematical models, the accuracy of the predictions is significantly improved if field measurements can be used to calibrate the model. Approximately five years of continuous flow and rainfall measurements were available for two of the basins: the Amazon Basin at Amazon Park (29th Street) and the Bethel-Danebo Basin at the Bertelsen Slough. One year of continuously measured flow and rainfall data were also available from The Nature Conservancy for the Willow Creek basin at Willow Creek near 18th St.

From these records, storm events were selected to compare actual measured flows with model predictions. The model parameters were adjusted to reduce the differences between them.

Finally, several other storms were used to verify the calibrations. The calibration adjustments turned out to be the same for the Amazon and Bethel Danebo basins. These calibration adjustments were therefore applied to the remaining basins. The Willow Creek calibration adjustments were somewhat different. These results were not surprising due to the fact that the Willow Creek basin characteristics are quite different from the rest of the City. The Willow Creek basin is the most undeveloped basin, and it contains a significant area in wetlands. A summary of the calibration adjustments to the models is as follows. More detail regarding the calibrations is provided in Appendix D (City of Eugene SWMM Calibration Information, September 25, 1997).

Amazon Creek, Bethel Danebo, Willakenzie, Laurel Hill, Willamette River and River Road Santa Clara Basin

- Effective impervious areas were set to be equal to 85% of the mapped impervious area.
- Soil infiltration parameters were reduced by 10%.
- Initial subbasin widths were increased by 50%.
- For subbasins that contain wetlands, the saturated hydraulic conductivity (SHC) was reduced to 0.02 inches/hour for the wetland areas and an area weighted SHC was computed for the subbasin.

Willow Creek

- Effective impervious area was set to be equal to the mapped impervious area for existing conditions.
- Effective impervious area was set to be 85% of the mapped impervious area for future conditions.
- Soil infiltration parameters were reduced by 40%.
- The saturated hydraulic conductivity was reduced to 0.02 inches/hour for the wetland areas and an area weighted SHC was computed for the subbasin.

Once the calibrations were completed, a process was initiated to select historical design storms from the long-term rainfall record in order to evaluate the system. This process is described in the following text.

3.1.4 Design Storm Selection

Design storms are typically used to evaluate the capacity of storm drainage systems and design capital improvements for the desired level of flood protection. The definition of a design storm is the largest storm (based on rainfall volume) which is expected to occur within a given period of time (i.e., 5-year, 10-year, etc.). Traditionally, design storms have been based on the recurrence interval of rainfall volumes. For example, a 10-year design storm is a storm event of a given rainfall volume which has a 10% chance of occurring in any given year. A synthetic storm is then developed based on rainfall volume and an assumed shape for the hyetograph.
For this master plan, an alternative method was chosen for selecting design storms. The City elected to use a long-term continuous rainfall record to select historical design storm events based on the recurrence interval of peak flows predicted by the computer models. The advantage of this method is that real storm events, which account for antecedent conditions (e.g., prior rainfall, soil conditions) are utilized. Other methods do not realistically account for back to back

rainfall events which are typical in the pacific northwest. Another advantage of this method is that the design storm is based on the recurrence interval of the peak flow rather than the recurrence interval of rainfall volumes. With respect to flooding, peak flow is the parameter of interest.

Prior to this study, design standards for flood protection levels in Eugene were based on the most recent storm drainage master plan (OTAK 1990). The 1990 plan includes varying degrees of protection depending on the size of the drainage area, type of system (open channel or pipe), and type of roadway (local collector vs. major arterial). Depending upon these factors, the current design standards range from 5-year to 50-year recurrence interval storms (see page A-19 of *Public Improvement Design Standards Manual* prepared by the City of Eugene). For this plan, the City elected to retain the flood protection levels listed in the 1990 plan with the exception that the minimum level of protection would be the 10-year as opposed to the 5-year storm (see Table 3-1 for exceptions). Flooding problems were identified for the open waterways and the pipe system based on the results for the relevant design storm listed in Table 3-1. A flooding problem was identified for an open waterway if the water depth exceeded the top of bank elevation. For the pipe system, surcharging was allowed, however, if the water entered the street a flooding problem was identified.

Table 3-1
Storm Recurrence Intervals for Planning and Design of Drainage Improvements

Drainage Area (acres)			Type of Drainage Improvement				Design Storm Recurrence Interval in Years
					Culverts and Bridges - Type of Roadway		
			Open Channel	Closed Pipe	Major Collectors and Neighborhood Collectors	Major Arterials and Minor Arterials	
<40	40 TO 640	>640	(a)	(b)	(c)	(d)	(e)
X				X			5/10 (h)
X			X		X	X	10 (f)
	X			X			10 (f)
	X		X		X		10 (f)
	X					X	25
		X	X	X(g)	X		25
		X				X	50
All improvements on waterways with FEMA 100-year floodplains							100

(a) Includes roadside ditches and drainage swales
(b) Storm sewer systems or a closed conduit whose length exceeds that of a normal culverted crossing of a single roadway
(c) Includes local or residential streets, local collectors, and any other roadways up to a major arterial
(d) Major arterial or better within the City's right-of-way maintenance
(e) Assuming ultimately planned development conditions (i.e., impervious cover) within the City's Urban Growth Boundary (UGB) and existing development conditions outside of the City's UGB
(f) The 5-year recurrence interval can be used in unusual situations involving sufficient topographical conditions that result in an exceptionally high cost differential between the 10-year and 5-year improvement design (e.g., 40%)
(g) Closed pipe systems should not be used on waterways draining more than 640 acres (i.e., 1 square mile)
(h) The 5-year storm may be used when the Rational Method is applied to calculate the design flow rate. The 10-year storm should be used for closed pipes with <40 acre drainage areas when using the City's SWMM modeling results or when extending the City's SWMM model using consistent methods and assumptions as used for the City's SWMM modeling work.

For this plan, historical design storm events were selected to achieve the desired level of flood protection. The selection of events was conducted using a long-term continuous National Weather Service (NWS) rainfall record from the Eugene Airport (1948 – 1997, or 49 years). The process that was used is as follows:

Step 1: Run Long-Term Continuous Simulation
The long-term 49-year NWS rainfall record was used as input for a 3000-acre test subbasin (Amazon Creek at Amazon Park) of the Amazon Creek Basin. This generated more than 1500 distinct flow events. Amazon Creek was selected as the first test subbasin because the Amazon model was completed and calibrated at an early date.

Step 2: Select 49 Top Storms
From the long term rainfall record, the 49 independent historical storm events were selected which produced the 49 highest modeled peak flows in the Amazon subbasin.

Step 3: Run the 49 Selected Storm Events Through One or More Representative Subbasins for Each Major Basin
The 49 storm events selected in Step 3 were run through seven additional subbasins representing typical characteristics (e.g., slopes, soil types, future impervious percentages, etc.) of each of the major basins. Within each of these subbasins, the effect of subbasin size was also evaluated. Frequency distributions were conducted of the model run results and the recurrence intervals of the peak flows from each of the 49 storms were established for each of the seven subbasins. Rankings of storms based on peak flow were not consistent between basins. For example, high intensity, short duration August storms resulted in some of the highest peak flows for small, highly impervious areas and large volume, long duration storms produced the highest peak flows in larger, less impervious drainage areas.

Step 4: Compare the Results From Each Subbasin
The results from all subbasins were compared to determine if a consistent group of storm events produced the peak flows of interest for subbasins with similar characteristics. An effort was made to minimize the number of design events selected and to choose those that were consistent among subbasins to the extent possible.

Step 5: Select Historical Design Events
Based on the results from step 4, a set of historical rainfall events associated with the 10, and 25-year recurrence interval peak flows were selected for use as design storms in each major basin. Results for the medium sized catchment areas within the modeled subbasins showed that the high intensity August storms were also significant and therefore both a dry-season and wet-season 25-year design storm event was identified for these basins. The short, high-intensity (dry-season) events were not as critical as the long duration, high-volume (wet-season) events in the Willow Creek basin..

The above process was used to select design storms for the 10-year, and 25-year storms. As the Eugene historic rainfall record was only 49 years old, a decision was made to continue to use the SCS Synthetic Design Storms for the 50-year and 100-year level of protection.

As a result of the six steps discussed above, the selected design events are provided as follows in Table 3-2. Characteristics of each of the events are also provided in Table 3-3.

Table 3-2
Selected Design Events for Each Basin

Design Event	Amazon Creek	Willow Creek	Bethel Danebo	Laurel Hill	Willakenzie	Willamette River	River Road Santa Clara
10-Year	11/25/77	11/23/60	11/23/60	11/25/77	11/25/77	8/16/68 2/5/96	11/23/60
25-Year Summer	8/16/68	**	8/16/68	8/16/72	8/21/79	*	8/21/79
25-Year Winter	2/5/96	2/5/96	10/31/94	10/31/94	10/31/94	*	10/31/94
50-Year	5.76" SCS Type 1A	5.76" SCS Type 1A	5.76" SCS Type 1A	5.76" SCS Type 1A	5.76" SCS Type 1A	*	5.76" SCS Type 1A
100-Year	6.48" SCS Type 1A	6.48" SCS Type 1A	6.48" SCS Type 1A	6.48" SCS Type 1A	6.48" SCS Type 1A	*	6.48" SCS Type 1A

*For the Willamette basin, only the 10-year storm was needed for the evaluation because only selected portions of the basin were modeled.
**For the Willow Creek basin, an August storm was not evaluated as the short, high-intensity events were not as critical in this basin as the long duration, high-volume events.

Table 3-3
Design Events Characteristics

Design Event	Rainfall Volume (inches)	Maximum Intensity (in/hour)	Approximate Duration (hours)
11/23/60	7.36	0.67	114
8/16/68	1.36	1.14	10
8/16/72	1.38	0.92	5
11/25/77	2.09	0.66	7
8/21/79	1.82	1.11	3
10/31/94	4.05	0.70	32
2/5/96	7.24	0.66	51
50-Year SCS Type 1A	5.76	0.95	24
100-Year SCS Type 1A	6.48	1.06	24

The above information is based on NWS rain gage data.

3.1.5 Model Output

Output from the models was compiled into summary tables for each basin. These summary tables are provided in Appendix E (Hydrologic /Hydraulic Model Output Tables for Each Basin) and in each of the specific basin volumes of this report. For each modeled conduit, for the relevant design storm, the summary tables show the following information:

- Upstream and downstream node numbers.
- Structure size/type.
- Structure length.
- Drainage area.
- Design storm.

- Peak flow for the design storm under both existing and future conditions.
- Water surface elevations for the design storm for both upstream and downstream nodes for both existing and future conditions.
- Identification regarding identified capacity deficiencies.

Surcharging was considered to be acceptable and problems were only identified if the models showed water getting out of the system and into the streets.

In addition to hydrologic/hydraulic modeling results to identify flooding problems, surveys were conducted of City of Eugene maintenance staff. The purpose of the surveys was to identify areas which currently have recurring flooding problems and areas where complaints are frequently received related to flooding. Special attention was then paid to the model results for these locations to ensure that flooding problems were also identified by the models. However, in many cases, the observed flooding problems were not due to insufficient capacity in the system but to clogging of storm drain inlets due to the accumulation of debris.

3.2 Water Quality Evaluation

Since the fall of 1992, the City has collected and analyzed samples of stormwater runoff from 6 sampling stations in Eugene. Table 2-10 provides the results from that sampling including a description of the problem pollutants which were found, typical sources of the pollutants, specific results from Eugene, and potential problems associated with the pollutants. These data provide general information regarding stormwater quality in Eugene and were used in identifying stormwater management strategies for each of the basins.

To supplement this information, pollutant loads were estimated for each of the basins under both existing and future land use conditions. These pollutant load estimates provide an indication of the expected increase in pollutant loads as a result of future development. The relative values and not the absolute values of the pollutant loads were used to assign priorities and to target those drainage basins or land uses that appear to contribute the largest pollutant loads to receiving waters. The methods used to estimate pollutant loads are described in the following steps.

Step 1: 1998 acreages were obtained for existing land use categories from LCOG's (Lane Council of Government's) GIS. The information was obtained for each basin. Acreages were taken from within the UGB (urban growth boundary). For the Willow Creek basin, the whole basin area was also evaluated including the Urban Reserves. This was based on the assumption that the urban reserves could potentially be developed in this basin. Only the results from within the UGB are reported here. For the existing land uses, the land use categories were grouped for the loads model as shown in Table 3-4.

Table 3-4
Grouping of Existing Land Use Categories for the Pollutant Loads Model

Major Land Use Category:	Land Use Categories Included in the Major Land Use Category:
Residential (light density)	Residential (light density)
Residential (medium/high density)	Residential (medium/high density)
Commercial	Commercial, Communication and utilities, Other government, Schools, churches, and cemeteries, Sand and gravel.
Industrial	Industrial
Parks and Open Space	Parks and open space, Agriculture, Golf courses, Parks and recreation, Timber, Undeveloped
Not included in basin area calculated under this step. See step 2.	Railroads, Roads/Walkways/Water, No land use data.

Step 2: Based on the groupings in the table above, the sum of the acres from the following land uses was taken to be the whole UGB basin area with the exception of the area representing the roads.

- Residential (light density).
- Residential (medium/high density).
- Commercial.
- Industrial.
- Parks and Open Space.

The total UGB basin areas were also obtained from LCOG's GIS. The difference between this total UGB basin area, and the UGB basin area computed under step 1 above, was assumed to be the area of the roads (based on conversations with LCOG). This area was distributed among the other land uses based on the percentage of that land use in the basin. For example, if 50% of the basin was light residential, then 50% of the roads area was added to the light residential land use category. The resulting land use breakdowns are provided in Table 3-5.

Table 3-5
Land Use Breakdowns for Existing (1998) Conditions

Land Use Category:	Amazon Creek Basin (acres)	Willow Creek Basin (acres)	Laurel Hill Basin (acres)	Bethel Danebo Basin (acres)	Willakenzie Basin (acres)	River Rd./ Santa Clara Basin (acres)	Willamette River Basin (acres)
Residential (Light)	4,328	85	207	2,084	2,725	2,789	800
Residential (Medium)	495	0	5	55	348	49	287
Commercial	1,208	21	27	969	842	595	78
Industrial	152	107	0	636	48	448	1,092
Parks and Open Space	4,304	956	565	2,432	2,139	2,182	1,235
Total:	10,488	1,169	804	6,175	6,102	6,063	3,492

Step 3: Acreages were obtained for future land uses from LCOG's GIS. The future land uses were based on Metropolitan Plan Designations. Acreages were based on the UGB. For future land uses, the land use categories were grouped for the loads model as shown in Table 3-6.

Table 3-6
Grouping of Metropolitan Plan Designation Land Use Categories for Pollutant Loads Model

Major Land Use Category:	Land Use Categories Included in the Major Land Use Category:
Residential (light density)	Residential (light density) Rural residential
Residential (medium/high density)	Medium density residential Medium density residential mixed
Commercial	Commercial, Commercial/residential mixed, Government and education, Sand and gravel.
Industrial	Industrial
Parks and Open Space	Parks and Open Space, Agriculture, Agriculture/airport reserve, Forest, Natural resources.
Not included in basin area calculated under this step. See step 4.	Railroads, Roads/Walkways/Water, No land use data.

Step 4: Based on the groupings in the table above, the sum of the acres from the following land uses was taken to be the whole UGB basin area with the exception of the area representing the roads.

- Residential (light density).
- Residential (medium/high density).
- Commercial.
- Industrial.
- Parks and Open Space.

As described under step 2, the total UGB basin areas were also obtained from LCOG's GIS. The difference between this total UGB basin area, and the UGB basin area computed under step 3 above was assumed to be the area of the roads (based on conversations with LCOG). As described in step 2, this area was distributed among the other future land uses based on the percentage of that land use in the basin. The resulting land use breakdowns are provided in Table 3-7.

Table 3-7
Land Use Breakdowns for Expected Future Buildout Conditions

Land Use Category:	Amazon Creek Basin (acres)	Willow Creek Basin (acres)	Laurel Hill Basin (acres)	Bethel Danebo Basin (acres)	Willakenzie Basin (acres)	River Rd Santa Clara Basin (acres)	Willamette River Basin (acres)
Residential (Light)	6,714	392	687	3,216	3,580	3,705	858
Residential (Medium)	812	104	8	222	922	246	686
Commercial	491	55	23	360	566	220	1,040
Industrial	880	245	0	1,943	243	1,878	133
Parks and Open Space	1,591	373	86	434	791	14	775
Total:	10,488	1,169	804	6,175	6,102	6,063	3,492

Step 5: The above acreages for land use were entered into a pollutant loads spreadsheet model. The focus of the model was on loads for Total Suspended Solids (TSS). Although TSS may not be associated with all of the other pollutants of concern, it was used as a general indicator of other pollutants for this study for the sole purpose of making relative comparisons. Loading estimates for other pollutants should be made specific to that pollutant. As shown in the following equations: the spreadsheet model takes the acreage for each land use and multiplies that acreage by the average annual rainfall volume to get the total rainfall volume. Then it multiplies that number by the runoff coefficient for the relevant land use to get the expected runoff volume. Then the expected runoff volume is multiplied by the TSS concentration for the relevant land use to get a total TSS load for the relevant land use. In the equations below, the subscript x represents the individual land use.

1. (Basin $\text{Acreage}_{x)}$ x (Average Annual Rainfall Volume) = (Total Rainfall Volume_x)

2. (Total Rainfall Volume$_x$) x (Runoff Coefficient$_x$) = (Runoff Volume$_x$)

3. (Runoff Volume$_x$) x (TSS Concentration$_x$) = (TSS Load$_x$)

4. Total Basin TSS Load = Sum of the Results from equation 3. For all land uses represented by the subscript x.

In addition to land use acreages, values were needed for annual rainfall, runoff coefficients, and TSS concentrations for each land use. The values that were used in the model are provided in Table 3-8.

Table 3-8
Pollutant Loads Model Input Parameters

Land Use	Runoff Coefficient	TSS Concentration*	Average Annual Rainfall
Residential (light)	0.37	76 mg/L	44.9 inches
Residential (medium/high)	0.55	76 mg/L	″ ″
Commercial	0.59	87 mg/L	″ ″
Industrial	0.68	114 mg/L	″ ″
Parks and Open Space	0.19	36 mg/L	″ ″

* TSS concentrations were taken from Eugene's third annual NPDES compliance report except for the parks and open space number which was taken from the ACWA (Oregon Association of Clean Water Agencies) data base and is based on values collected from the City of Portland's parks and open space site. The values from the parks and open space land use do not represent a completely pristine and undeveloped area, but were collected from a 1,500 acre subbasin in a large forested park that is heavily used for recreation and includes some underground septic systems.

Figures 3-1, 3-2, and 3-3 provide the estimated TSS loads for the basins within the study area. Figure 3-1 shows loads in terms of pounds/year and Figure 3-2 shows loads in terms of pounds per acre per year. The projected increase in TSS at buildout is expected to be 3,259 pounds per year, or a 36 percent increase from 1998 of 9,074 pounds per year.

Figure 3-1
Estimated Total Suspended Sediments Loads Per Year (within UGB)

	Estimated Pounds Per Year (1,000 pounds)	TSS Pounds Per Year in Eugene Basins
From Existing Development		
Amazon	2,578	
Bethel-Danebo	1,806	
Laurel Hill	117	
River Road Santa Clara	1,634	
Willakenzie	1,615	
Willamette River	1,147	
Willow Creek	177	
Total	9,074	
From Development of Vacant Lands		
Amazon	695	
Bethel-Danebo	784	
Laurel Hill	103	
River Road Santa Clara	948	
Willakenzie	362	
Willamette River	161	
Willow Creek	206	
Total	3,259	
Total at Buildout		
Amazon	3,273	
Bethel-Danebo	2,590	
Laurel Hill	220	
River Road Santa Clara	2,582	
Willakenzie	1,977	
Willamette River	1,308	
Willow Creek	383	
Total	12,333	
	1,000 Pounds:	0 1,000 2,000 3,000 4,000 5,000

Figure 3-2
Estimated Total Suspended Sediments Loads Per Acre Per Year (within UGB)

	Estimated Pounds Per Acre Per Year	TSS Pounds Per Year in Eugene Basins
From Existing Land Uses		
Amazon	246	
Bethel-Danebo	292	
Laurel Hill	146	
River Road Santa Clara	270	
Willakenzie	265	
Willamette River	328	
Willow Creek	151	
Total at Buildout		
Amazon	312	
Bethel-Danebo	419	
Laurel Hill	274	
River Road Santa Clara	426	
Willakenzie	324	
Willamette River	375	
Willow Creek	328	
Pounds:		0 100 200 300 400 500

Figure 3-3
Estimated Increases in Total Suspended Sediments Loads Associated with Future Buildout (within the UGB)

Estimated Increase in TSS Loads with Future Buildout	Percent	Increase in TSS Loading in Eugene Basins
Amazon	27	
Bethel-Danebo	43	
Laurel Hill	88	
River Road Santa Clara	58	
Willakenzie	22	
Willamette River	14	
Willow Creek	216	
Percentage		0 30 60 90 120 150

*Total suspended sediments (TSS) estimates are for the entire basin. Other characterization reports estimate TSS within the UGB only.

3.3 Natural Resources Evaluation

For purposes of the basin master planning process, the term "stormwater related natural resources" pertains specifically to the City's open waterways drainage system and the characteristics of it that provide or assist in providing beneficial stormwater functions such as: storm conveyance, flood storage, water quality treatment, and water temperature controls. These natural resources include the primary waterway corridors of Eugene and adjoining riparian and

wetland areas, and headwater streams and wetlands. These characteristics are described in Section 2.0 of this report.

This section describes the evaluation process used to identify problems and/or opportunities under existing and expected future conditions. The following provides the objectives, methods of conducting a stormwater-related natural resources evaluation City-wide, a description of other related ongoing efforts, and data gaps.

Objectives of the evaluation

- Determine the extent of the open waterway drainage system that should be protected for beneficial stormwater functions.
- Determine where existing protection policies apply and where gaps exist.
- Determine where restoration efforts should be targeted to improve stormwater functions.
- Determine where intervention efforts are needed to correct streambank stability problems.
- Determine what other efforts are underway which may ultimately provide protection consistent with stormwater program objectives.

Methods used to conduct the evaluation

Several methods were used to conduct the natural resources evaluation including the following:

- The following information was compiled and reviewed to assess the location, condition, and function of the City's waterway system. Most of the data were contained in the City's geographic information system (GIS):
  - Open waterway drainage system.
  - Draft inventory of the Eugene-Springfield Metropolitan Plan Natural Resources Study.
  - FEMA floodway and floodplain areas.
  - National wetland inventory.
  - Soil Survey of Lane County Area, Oregon (1987), Natural Resources Conservation Service.
  - Historic photos, hydric soils – to help reconstruct the historic drainage system (i.e., pre-settlement).
  - Areas with stormwater pipe system.
  - 1999 aerial photography.
- Site visits to collect and verify GIS information about select portions of the waterway system including location, size, condition, and function. For the site visits that were conducted, functions were evaluated using a modified version of the Oregon Freshwater Assessment Methodology (OFWAM). This method was modified to focus on the stormwater related benefits of natural resources. See Appendix F (City of Eugene Field Reconnaissance for Potential CIP Sites Data Collection Forms) for a copy of the Data Collection form that was used.
- Eugene Public Works Department engineering and maintenance staff were interviewed as to their knowledge of the system.

- Property owners provided site specific information at public workshops and through other contacts.
- Policy plans were reviewed to determine where and how waterways were protected.
- Other City of Eugene and Metro area staff were consulted to identify other on-going efforts which may ultimately provide protection for waterways consistent with stormwater program objectives.

Other Related On-going Efforts

- Endangered Species/Salmon program is expected to develop strategies for responding to the January 2001 listing of spring Chinook salmon. Strategies are likely to include incentives and regulatory measures for protection and restoration of salmon habitat in Eugene. Timeline for developing strategy options for Council consideration is summer 2002.
- The Metro Natural Resources Study (NR Study) is expected to provide long term protection for some waterways with riparian habitat functions. Timeline for implementation of protection measures is summer 2005.
- The Eugene/Springfield Metropolitan Waterway Restoration Study – This Corps of Engineers study would identify and potentially construct waterway restoration and enhancement projects within the Eugene-Springfield metropolitan area. The Corps is currently conducting a Reconnaissance Study. Following the reconnaissance phase comes feasibility, engineering, design and construction. This is a long-term effort, however, and the timeline for implementing projects is approximately 2007 or later.

Data Gaps

There are little or no available data regarding the existing aquatic habitat and species conditions in the City's waterways. These data would not only help further inform the condition of the waterways, but would also allow for better evaluation of the effects of proposed capital improvements to these waterways.

SECTION 4 Development of the Integrated Citywide Stormwater Management Strategies

This section provides information on the process and assumptions used to prepare stormwater management strategies for Eugene's major drainage basins: Bethel-Danebo, Willakenzie, Amazon Creek, Willow Creek, Laurel Hill, and Willamette River. The process is described in Section 4.1. Section 4.2 provides a list of the capital projects that were selected to implement the integrated stormwater management strategies. Section 4.3 describes the development standards that were selected to implement the integrated stormwater management strategies. Section 4.3 also includes a summary of existing conveyance system design methods.

4.1 Process for Developing the Integrated Strategies

This section describes the process for developing the integrated stormwater management strategy in each basin. Figure 4-1 presents a flow chart illustrating the general scope and process that were followed for developing the Stormwater Basin Master Plans. A more detailed description of each of the steps is provided as follows:

Step 1 – Basin Characterizations: In the first step, the Lane Council of Governments (LCOG) compiled and reviewed basin characterization information for each basin that was relevant to stormwater management planning. Specifically, this information included the following: location/area, surface water features, drainage system, climate, existing land uses, planned land uses, topography, soils, groundwater, floodplain locations, water quality, natural resources, surface cover, and recreational/educational facilities. LCOG summarized the information in a city-wide basin characterization report and seven individual basin specific characterization reports. Color maps were included in the reports to illustrate the elements listed above. The City-wide characterization report is included as Section 2.0 of this document. The specific basin characterization reports are included in the *Study Area Characteristics* section of each of the separate basin volumes of this document (Volumes II – VII).

Step 2 – Problems/Opportunities Identification: The second step in the project was to identify problems and opportunities associated with the storm drainage system in each of the major drainage basins. Problems and opportunities were identified under both existing and future land use conditions for flood control, water quality, and natural resources. Study methods used to identify problems and opportunities are described in detail in Section 3.0 of this document. This information was compiled in the form of informational packets for each basin for use in Step 3. Specific information regarding the results of the problems/opportunities identification is provided in each of the separate basin volumes of this document (Volumes II – VII). In general, however, the results were as follows:

Flood Control: Historically, performance of the City's drainage system has been very good. For example, as mentioned in Section 2.0, the City's system handled the February 1996 storm event with very few problems even though most of the City's system is designed to meet the five- and ten-year events. The February storm event was considered to be an event of the magnitude that occurs approximately once every 25 years. The hydrologic/hydraulic models replicated these results. In the Bethel Danebo and Willakenzie basins, only a few flooding problems are anticipated to occur based on model results under both existing and future conditions. These basins have soils that are more permeable than those of the other basins, and the existing storm

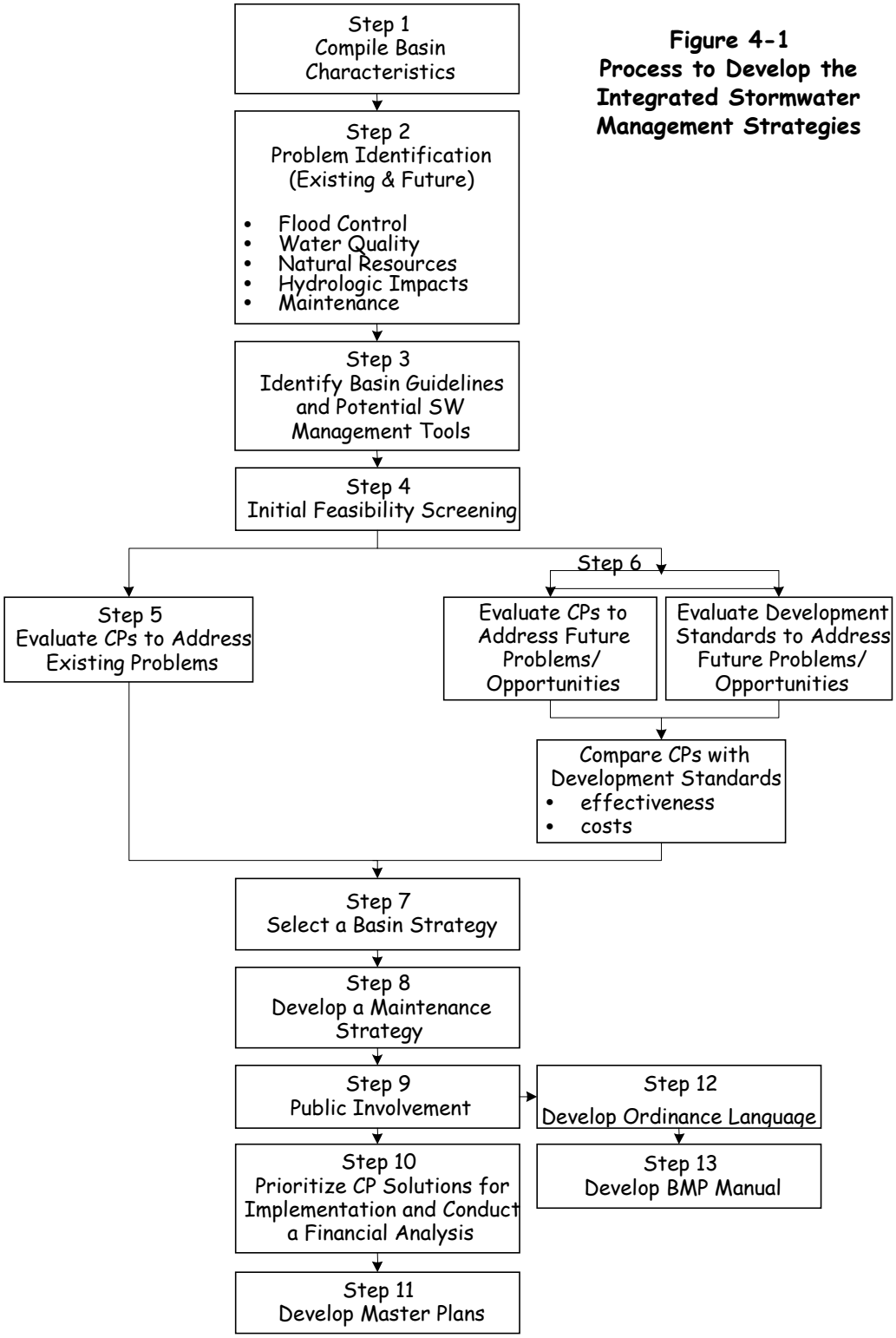


Figure 4-1
Process to Develop the Integrated Stormwater Management Strategies

system appears to include capacity that is available in excess of the relevant design storm. The Willamette River basin also experiences very few flooding problems under existing conditions and new problems are not expected to occur as a result of future development as this basin is already mostly built-out. Most of the flooding problems that were identified by the models are anticipated to occur in those basins of the City which include the South Hills; specifically the Amazon Creek, Willow Creek and Laurel Hill basins. The South Hills are steeply sloped, have relatively thin, impermeable soils, and include the areas where a large portion of the future development in Eugene is expected to occur.

Water Quality: Stormwater monitoring in Eugene showed that urban runoff includes several pollutants of concern that are being discharged to Eugene's open waterways city-wide. A summary of these problem pollutants, their sources, and the negative impacts they cause is provided in Table 2-10. An evaluation of stormwater monitoring that has been conducted regionally also showed that pollutant levels are sometimes highly associated with land use. For example, many pollutants are found in elevated concentrations from densely developed areas; especially those that include commercial and industrial land uses and major arterial roadways.

Stormwater Related Natural Resources: Comparing historic drainage patterns in the City to current conditions, it was clear that pipes and other built drainage facilities have replaced many of the historic open waterways where urban development has occurred. For those waterways that remain open, field surveys conducted for this project showed that many are in a degraded condition and are experiencing problems such as downcutting, bank erosion, and an influx of invasive plant species in the riparian corridors. Negative impacts to these channels were associated with two aspects of urbanization. The first is encroachment of development on the waterway itself and the second is impacts associated with significant increases in peak flows and runoff volumes from new development.

Step 3 – Identify Potential Solutions: Once the problems/opportunities were identified, all-day basin assessment meetings were held for each basin. The meetings were attended by a large multi-disciplinary group of people including staff with experience in water quality, engineering, maintenance, natural resources and planning. When appropriate, representatives from outside the City were also included such as staff from Lane County and the Springfield Utility Board. The first part of the meeting included an overview of the information compiled from Steps 1 and 2. During the second part of the meeting, the group divided into three subgroups to address water quality, flood control, and natural resources. One maintenance staff was included in each of these subgroups. Each subgroup developed preliminary ideas for stormwater management tools that could be applied in the basin to address problems/opportunities. Preliminary ideas were developed based on the goals and objectives of the project as described in Section 1.2 of this document. Tools that were considered for use included a range of capital projects and development standards options as follows:

Capital Project Options:

- Replace undersized pipes, culverts, and bridges.
- Widen, enlarge, realign open channels.
- Enhance open channels, stabilize stream banks, plant native vegetation.

- Enhance existing stormwater-related natural resources such as riparian areas and wetlands.
- Construct multiple-objective neighborhood stormwater facilities: detention ponds, constructed wetlands, infiltration facilities.
- Construct structural, in-pipe treatment facilities: sand filters, sediment filters, compost filters.
- Construct piped bypass systems.
- Retrofit existing drainage facilities to include multiple objectives.
- Acquire areas that provide stormwater benefits: open channels, headwater tributaries, floodplains, riparian zones, wetlands.

Development Standard Options:
- Require control of stormwater peak flows for flood control.
- Control of stormwater discharge peaks and volumes for the protection of open waterways.
- Require setbacks to buffer open channels, tributaries and riparian zones.
- Require on-site water quality treatment.
- Require control of runoff volumes to avoid channel stability problems.
- Further restrict development in the floodway fringe.
- Allow payment of in-lieu of fees.

The subgroups then reconvened to present their preliminary ideas and to coordinate/combine management tools with other groups in order to ensure multiple objectives were addressed where possible. Feasibility of the preliminary ideas was not considered during these meetings.

Step 4 – Evaluate the Feasibility of Potential Solutions: The purpose of this step was to evaluate the feasibility of the preliminary capital projects and development standards proposed under Step 3. The capital project list that came out of Step 3 included 144 preliminary single and multiple-objective capital projects. First, a subjective screening of the capital projects was conducted. Capital projects were removed from the list based on the fact that they weren't really considered to be capital projects. In other words, they fell into the category of maintenance rehabilitation projects, or planning projects. Second, an evaluation method was developed and applied to screen the capital projects. The following evaluation criteria were selected:

- Addresses an identified capacity problem.
- Provides water quality benefits.
- Provides natural resource benefits.
- Provides maintenance benefits.
- Requires acquisition.
- Capital costs.

A scoring method was applied based on the above evaluation criteria. Single-objective capital projects were isolated from multiple-objective capital projects in the scoring process to assure that high priority single-objective capital projects were not screened from the list based on the fact that they were single-objective. Capital projects were eliminated from the list based on a selected cutoff score. In addition, the list was reviewed from a subjective standpoint to assure high priority capital projects had not been screened off the list. After the screening process, 82

capital projects remained on the list. Each of these 82 capital projects was then further evaluated as described in Steps 5 and 6 below. It should be noted that some of the capital projects, such as a detention pond for flood control and a detention pond for water quality, could be combined with each other to achieve an efficiency in project costs. However, they were evaluated individually so that relative comparisons could be made with other capital project and development standard options to address the same problem. Once projects were selected for the strategy, they were combined where appropriate to address multiple objectives.

With respect to development standards, each of the options listed above was proposed for application in Eugene to address problems expected as a result of future development. Therefore, an initial review of each development standard option was conducted. The review resulted in a list of advantages and disadvantages of each option. As a result, only one development standard option was screened from the list for further evaluation: further restrict development in the floodway fringe. There were several reasons for screening this from further evaluation including the fact that the remaining fringe areas are small and additional restrictions on development in these areas would not be effective at reducing/eliminating identified flooding problems. The exception would be in the Willow Creek and Laurel Hill basins. However, the preference was to go in the direction of protecting these open waterways through the use of buffers or setbacks because a significant investment would be required to define the regulatory floodplain boundaries for these waterways.

Step 5 – Evaluate Solutions to Address Existing Problems: Development standards which place limits on stormwater discharges from future development would not address problems expected under existing land use conditions. Therefore, only capital project options were considered to address all identified problems/opportunities under existing land use conditions. Under Steps 3 and 4, preliminary capital projects were specifically identified and screened to provide the required level of flood protection, reduce existing pollutant loads, and protect stormwater-related natural resources in existing developed areas. Under this step, preliminary designs were developed for each of the proposed capital projects. The preliminary designs were used to evaluate the projects in more detail for feasibility, effectiveness, and estimated costs. The preliminary capital projects tended to fall into one of the following four categories:

Flood Control Projects: These projects were developed to address capacity related problems identified as a result of the hydrologic/hydraulic model simulations. They include retrofits of the existing pipe system to increase capacity (i.e., increased pipe sizes, high flow bypass systems, underground storage and bridges to replace culverts).

Multi-purpose Flood Control Projects: These projects were developed to address capacity related problems identified as a result of the hydrologic/hydraulic modeling and they have opportunities to address water quality and/or natural resource objectives in addition to flood control. They include the construction of ponds to detain runoff volumes, and modification/enhancement of open channels to provide increased capacity.

Water Quality Projects: These projects were developed to take advantage of opportunities in the existing system to reduce pollutant loads in stormwater runoff. They

include settling ponds, treatment wetlands, and underground structural facilities that provide filtration of stormwater. These projects may provide some additional flood control capacity but they are typically located in portions of the drainage system that do not have capacity problems.

Natural Resource Protection/Enhancement Projects: These projects were developed to take advantage of opportunities in the existing system. They include the protection of open waterways systems from future development pressures, and enhancement of open waterways to provide additional natural resource and water quality benefits. The protection of these open waterways will also preclude future capacity problems associated with the potential elimination or degradation of these systems.

Where appropriate, the XP-SWMM models were used to develop preliminary designs of the capital projects. For each capital project, the following design criteria were applied:

- All capital projects were designed based on the future land-use scenario.
- For flood control projects, the projects were designed in upstream locations first and then working in a downstream direction. Flood control capital projects designed at the downstream end of a system may therefore depend on the implementation of capital projects at the upstream end of a system.
- The following capacity related design criteria were used:
  - If the surrounding drainage system was not surcharged, the pipe improvements were designed based on flow depths equal to 0.8 x diameter.
  - For surcharged systems, the pipe improvements were designed in an attempt to keep the hydraulic grade line more than 1 foot below the manhole rim.
  - The minimum design velocity for all pipe improvements was 2.5 ft/sec.
  - For all channel improvements, one foot of freeboard was provided if space was available. An attempt was also made to keep velocities under 5 ft/sec.
- Each water quality facility was designed to capture and treat 80% of the average annual rainfall volume from the upstream drainage area.
- For the Willow Creek Basin, a roughness coefficient of 0.10 to 0.15 was used for open waterways with the assumption that the riparian corridor will be well vegetated and there will be very limited long-term channel maintenance. For the other major basins, a roughness coefficient of 0.06 to 0.08 was used assuming the open waterways have brush, small saplings, and emergent grasses.
- For open waterway enhancements (flood control or natural resource enhancement), buffer widths were provided by the Water Resources Team. These buffer widths varied from 20 feet to 60 feet.

If a project was readily found to be infeasible (based on size, topography, costs, public acceptance, etc.), the project was removed from the list and other ideas were considered and developed to address the identified problem. For all of the preliminary capital projects that remained on the list, a capital project fact sheet was developed. The fact sheets include the following information:

- Location of the capital project, including major basin and subbasin names, capital project number (e.g., WK07), project title, GIS node location, total drainage area, impervious percentages (existing and future), and future design flows.
- A description of the capital project, including the project elements (e.g., size and length of pipe, volume of neighborhood water quality facility).
- A summary of the problems or opportunities identified during the basin assessment meetings that are addressed by the capital project.
- A description of the annual maintenance requirements.
- A summary of the flood control, water quality, and natural resources benefits provided by the capital project.
- Implementation costs that include construction costs, and a 20% contingency to account for engineering and administration.
- Annual maintenance costs.

In order to estimate implementation and maintenance costs for each project, a set of unit cost tables was developed. The unit costs were based on information collected from recent bid tabulation sheets from the Eugene, Lebanon and Portland areas. These costs were representative of average conditions and were based on the assumption that the capital projects would be competitively bid. Unit costs included materials and installation. The unit cost tables are provided in Appendix G (Eugene Basin Master Planning Unit Cost Tables for Estimating Capital Project Costs).

The information presented on the Preliminary Capital Project Fact Sheets was meant to provide the necessary information to support the selection and prioritization process. The project fact sheets represented preliminary planning level evaluations and did not address the following feasibility related issues:

- Permitting.
- Liability.
- Feasibility (e.g., site visits have not been made to each project location).
- Conflicts with existing public utilities.
- Conflicts with existing uses of public open spaces.
- Public or City staff acceptance.

It should be noted that for some of the capital projects, alternatives were identified. For example, two alternatives such as a detention basin or increased pipe sizes may have been proposed to address the same problem. Both alternatives were evaluated to provide information necessary to support the selection process.

Step 6 – Evaluate Solutions to Address Future Problems: For those problems/opportunities associated with future development, either capital projects or development standards could be applied as a solution. Therefore, capital project options and development standard options were evaluated. The capital project options were evaluated as described under Step 5. The development standard options were evaluated as described in Appendix H (Eugene Development

Standards Draft Development Standards Fact Sheets for Water Quality Standards #1 and #3, and Flood Control Standards #1 and #2). The capital project and development standard options were evaluated in terms of effectiveness and costs in order that they could be compared with each other. For example, a flood control development standard requiring developers to reduce their post-development peak flows to pre-development levels would likely result in on-site storage facilities. The hydrologic/hydraulic models were used to estimate the difference in post-and pre-development flows from future developments in order to estimate on-site storage facility costs per acre. These costs estimates were then compared with the capital project cost estimates for projects addressing these future flooding problems. Details regarding the comparisons of the capital project alternatives with the development standard alternatives is provided in each of the separate basin volumes.

Step 7 – Select an Integrated Stormwater Management Strategy: Based on the preliminary capital project list from Steps 5 and 6, and the capital project/development standard comparisons conducted under Step 6, an integrated stormwater management strategy was developed for each basin. The integrated stormwater management strategy was developed to provide the required level of flood protection, reduce pollutant loads, and protect natural resources with beneficial stormwater functions. Stormwater management options were selected for the strategy based on effectiveness and costs and, in some cases, perceived feasibility.

Step 8 – Develop a Maintenance Strategy: Prior to this project, City maintenance staff were responsible for maintaining the public storm drainage system and any public stormwater facilities within the City. The City did not provide maintenance for private stormwater facilities. Potential water quality standards for new development would result in the construction of additional stormwater facilities. Maintenance of these facilities is essential to their success. Therefore, the purpose of this step in the process was to estimate the maintenance implications associated with implementation of a stormwater quality development standard and to provide a recommendation regarding a maintenance strategy. Maintenance implications were estimated based on several scenarios of assumptions regarding how the remaining vacant land would be developed, and what types of BMPs would be implemented. Each scenario was then evaluated based on various assumptions with respect to who would be responsible for maintenance (i.e., the City or the landowner). A summary of this step in the process is described in detail in Appendix I *(Development Standards Memorandum #8 Potential Maintenance Implications)*.

Step 9 – Conduct Public Involvement: The proposed stormwater management strategies were presented at monthly meetings (for approximately 15 months) to a Department Advisory Committee (DAC). The DAC was a 14- member citizen group appointed by the City of Eugene to represent a broad spectrum of community interests, including Citizens for Public Accountability, neighborhoods, voters, businesses, home builders, environmental groups, the League of Women Voters, Friends of Eugene, architects, and engineers. The DAC's charge was to provide input related to: 1) opportunities and constraints for water quality and stormwater-related natural resource protection for each basin; and 2) roles and responsibilities in designing, constructing and maintaining the public and private stormwater systems. Documentation from DAC meetings was compiled in 3-ring binders titled "Eugene Stormwater Management DAC". Copies of this documentation may be obtained from the City. The documentation includes,

meeting agendas, meeting minutes, technical memos, and copies of presentations made at the meetings. The DAC was one element of the public involvement program approved by the Eugene Citizen Involvement Committee for this project. Other elements involved an interested parties mailing list, neighborhood outreach, open houses, media, newsletter/internet articles, check-ins with local officials and staff presentations to groups.

Step 10 – Prioritize Solutions for Implementation and Conduct a Financial Analysis: Based on DAC feedback, the strategies were modified and refined. Capital project elements of each strategy were then prioritized for implementation. Prioritization was based on: 1) the score for the capital project that was developed under Step 4 above, 2) whether implementation of another capital project was dependent on the implementation of the capital project in question, 3) whether the capital project could be designed/implemented in an integrated fashion with another capital project, and 4) whether the capital project addressed an area where development is expected to be significant and imminent. A memo that describes the process and results of capital project selection/prioritization is provided in Appendix J *(Capital Project Prioritization)*. The city-wide selected capital project list is included in Section 4.2 (Table 4-1). The priorities for implementation will be reviewed by the City every few years as priorities and circumstances will likely change over time.

A financial analysis for the overall strategy was conducted and included the following:

- Estimated cost of each element of the strategy (capital projects, stormwater development standards, stormwater-related natural resources development standards).
- Total estimated annual capital and operations costs, including on-going stormwater program activities.
- Estimated annual revenue (stormwater user fees, stormwater systems development charges, assessments, state and federal funding for partnership projects).
- Projection of stormwater fund balance.

From this analysis a determination was made that no stormwater rate increase would be needed at this time, however a rate increase would likely be needed by fiscal year 2004.

The City will continue to monitor revenues, costs and the stormwater fund balance and will initiate rate changes as appropriate in the future.

In an effort to achieve consistency with the integrated stormwater management strategies, a review of the user fee and SDC methodologies was conducted by the Stormwater Department Advisory Committee and revisions were recommended. Modifications to the user fee and SDC methodologies will be implemented as appropriate coincident with implementation of the overall strategy.

Step 11 – Develop Stormwater Basin Master Plans: This seven volume report was produced to summarize the master planning process and to summarize the resulting basin stormwater management strategies. The capital projects included in this report have been incorporated into the most recent 2002-2007 CIP and will be incorporated into future CIPs as well.

Step 12 – Develop Ordinance Language: The development standards selected for the integrated stormwater management strategies are summarized in Section 4.3. Ordinance language is under development in order to implement the selected stormwater quality requirements for new development. These requirements represent a portion of the management strategy for each basin.

Step 13 – Develop a BMP Manual: A BMP manual is being developed to provide guidance to developers for meeting the selected stormwater quality requirements for new development.

4.2 Selected Capital Projects

As a result of the process described above, a final capital project list was developed for each basin. Table 4-1 provides a list of the 44 capital projects selected city-wide (not including all of the River Road Santa Clara Basin potential projects). The objective fulfilled by each capital project is also noted. For flood control, 23 capital projects are proposed which include: increased pipe/culvert sizes, increased open waterway capacities, a piped bypass system, and construction of a new channel. For water quality, 14 capital projects are proposed which include: retrofits of existing ponds, and construction of new water quality facilities. For natural resources 7 capital projects are proposed which include: bank restoration, wetland protection, and enhancement of existing natural resources. It should be noted that although the capital projects are accounted for here according to their main objective, many of the projects will address multiple objectives. For example, if increased capacity is needed in an open waterway system, natural resources enhancement will be included as part of the project.

In addition to the projects listed above, there are 4 new line items in the capital project budget that will be used in various locations each year to implement the following types of projects: underground structural water quality facilities in high source areas, retrofits of tip-ups to address flooding and water quality issues, stream stabilization projects to addressed impacts from increased runoff volumes, and stormwater outfall stabilization projects. The City will also continue to include the following existing line items in the budget: wetland mitigation bank, services for new development, general stormwater rehabilitation projects, and stream corridor acquisition (previously called “channel easement acquisition”).

With respect to the existing line item for stream corridor acquisition, this program area will be enhanced as a result of this basin master planning process. Stream corridor protection will become the primary objective and acquisition for maintenance access purposes will continue but on an as-needed basis. Approximately eleven miles of corridor length and 172 acres of corridor area are targeted for acquisition for stream corridor protection over a five-to-seven year period.

Table 4-1
Selected Capital Projects

Project ID #	Project	Main Objective Addressed
AM06A	Kinney Park Water Quality Facility	WQ
AM08B	Mt. Calvary Pipe Improvements, Option B	FC
AM08D	Mt. Calvary Water Quality Facility	WQ
AM09	Frederick Court Pipe Daylight	FC
AM11	Hilyard Street Pipe Improvements	FC
AM12	Pine View Water Quality Facility	WQ
AM13	43rd Avenue Pipe Improvements	FC
AM14	Morse Park Ranch Park Pipe Improvements	FC
AM15B	Laurelwood Flood Control Facility/Pipe Imps	FC
AM15D	North Laurelwood Water Quality Facility	WQ
AM15E	South Laurelwood Water Quality Facility	WQ
AM17	Jackson Street Pipe Improvements	FC
AM27B	Windsor Circle Pipe Improvements	FC
AM27C	Hawkins Lane Water Quality Facility	WQ
AM29	Sam R. Street Water Quality Facility	WQ
AM30	Interior Street Water Quality Facility	WQ
AM100	Upper Amazon Creek Restoration	NR
AM101	Central Amazon Creek Restoration	NR
BD06	Increase Pipe Sizes Along Bell Avenue	FC
BD08	Retrofit Empire Park Pond	WQ
BD11A	Greenhill Tributary Improvements	FC
BD11C	Greenhill Tributary Water Quality Facility	WQ
BD15	Roosevelt Channel – Culvert Improvement	FC
BD100	Royal Node Stormwater Infrastructure	FC
LH06C	Riverview/Augusta Piped Bypass	FC
LH07	Minor System Between Riverview/Augusta	FC
LH08	Riverview/Augusta Minor System Plan	FC
LH09	Augusta/I-5 Water Quality Facility	WQ
WC3C3	West Branch Culvert/Channel Improvements	FC
WC3C4	East Branch Culvert/Channel Retrofits	FC
WC08	Realign/restore Willow Creek Mainstem	NR
WK07	River Point Pond Outlet Channel	FC
WK08A	Gilham Road System Culvert Replacement	FC
WK08B	Gilham Road System Water Quality Facility	WQ
WK11A	Wetland Protection – Coburg/Co. Farm Roads	NR
WK13	Ayers Pond Outfall Retrofit	WQ
WK16A	Modify Ascot Park Open Waterway	FC
WK100	Delta Ponds Habitat Enhancement	NR
WR06	Polk Street Water Quality Facilities	WQ
WR100	Willamette River Bank Restoration	NR
WR101	Eugene Millrace Restoration	NR
RS12*	East Santa Clara Channel Improvements	FC
RS24	Irvington Drive Stormwater Improvements	FC
RS25	River Road Stormwater Improvements	FC

Table 4-1 (continued)

Project ID #	Project	Main Objective Addressed
New Line Item #1	Water Quality Facilities in High Source Areas	WQ
New Line Item #2	Stormwater Outfall Stabilization	NR
New Line Item #3	Streambank Stabilization	NR
New Line Item #4	Retrofit tip-ups	FC
Existing Line Item	Wetland Mitigation Bank	NR
Existing Line Item	Services for New Development	FC
Existing Line Item	General Stormwater Rehabilitation	Multiple Objectives
Existing Line Item**	Stream Corridor Acquisition	Multiple Objectives

* RS12 is represented by capital projects RS12, RS13, and RS14 in the Initial Study towards the Development of a Stormwater Basin Master Plan.

** Although this is an existing line item, the program will be enhanced as a result of this basin master planning process. Stream corridor protection will be the focus of the program and acquisition for maintenance access will continue but on an as-needed basis.

4.3 Selected Development Standards

4.3.1 Existing and New Water Quality and Stormwater Related Natural Resources Design Requirements

As a result of the process to develop integrated stormwater management strategies described in Section 4.1, the following existing and new development standards were recommended:

Water Quality Related Design Requirements

The recommended water quality development standard is to capture and treat 80% of the average annual rainfall volume. This standard was reviewed and recommended within the context of each of the individual integrated stormwater management strategies. The standard is recommended for application city-wide to all new development and significant redevelopment within Eugene City limits except for those properties which will be listed as exempt under City Code. This standard is scheduled for adoption in Fall 2003.

The water quality standard will require treatment BMPs that are designed according to a City BMP Manual and the City's water quality design storms. See Appendix K (Water Quality Design Storm Development) for methods used to develop water quality design storms. The standard will also require additional BMPs for specific land use activities of concern (i.e., oil control for high traffic areas, and structural source controls for commercial/industrial activities that are exposed to stormwater).

Public and private maintenance responsibilities associated with implementation of the BMPs will be outlined in City Code.

An additional water quality requirement is recommended for the headwaters areas located in the south hills of Eugene. Most of the streams in this area are currently in fairly good condition and will require additional protection from imminent and future development to maintain their

condition. The purpose of this additional requirement will be to ensure that either a piped bypass system, detention ponds, or stream stabilization projects are designed and constructed in a manner to protect these streams from impacts associated with the expected increases in runoff peak flows and volumes.

Open Waterways Requirements

Recommended open waterways development standards are as follows. In addition to selected standards, the strategy includes coordination with other ongoing programs; also described below:

- Support Existing Waterway Protection Standards (i.e., Waterside Protection Overlay Zone, "Needed Housing", Natural Resource Zone, Planned Unit Development, Site Review as applicable).

- Key Waterways Protection Standard– No Fill/No Pipe: This standard was selected and processed through the Planning Commission and City Council. Ultimately, this standard was replaced by an approach that would apply no-fill/no-pipe prohibitions to all waterways until the Metropolitan Natural Resources Study (NR Study) was completed.

  Note: When processed for adoption, this standard was referred to as the Open Waterways Ordinance which was remanded back to the City for further processing. This ordinance is no longer in effect.

- Interim Setbacks Standard: This standard was selected to be applied as an interim measure until the NR Study was completed. Processing of the ordinance began but was halted when: 1) Oregon voters approved Ballot Measure 7 requiring compensation for land use regulations that would lower land values, and 2) when the open waterways ordinance appeal was upheld by the Oregon Land Use Board of Appeals.

  Note: Due to the situation described above with respect to the Open Waterways ordinance, an Interim Setbacks standards will not be pursued at this time.

- Coordination with Natural Resources Study (described in Section 3.3) to ensure consistency with stormwater program objectives for long term stream corridor protection and to identify and fill gaps in protection measures for waterways.

- Coordination with the Endangered Species Act/Salmon program (described in Section 3.3).

- Coordination with the Metro Waterway Restoration Study (described in Section 3.3).

4.3.2 Conveyance System Design Methods

As described in Section 3, the City's XP-SWMM model uses continuous simulations with actual rainfall data for historical storm events. This type of modeling is more sophisticated than is typically required by jurisdictions for the construction of privately initiated development

projects. The City is going to continue to allow privately engineered projects to size proposed systems using relatively simple design methods as outlined below.

Where the City has modeled the drainage system, private developers will be provided with the City's modeling results. Where the system has not been modeled, the developer may chose to extend the SWMM model using consistent methods and assumptions with the City's modeling work, or they may size the system using other methods acceptable to the City. Acceptable methods, which are typically used, are discussed below. Calculation methods, other than those discussed below, will be reviewed and accepted by the City if appropriate. Use of more sophisticated analysis methods would generally be dictated by an outside jurisdiction rather than being initiated by the developer, for example FEMA dictates analysis methods used within the floodway.

The currently accepted methods for calculating runoff rates include the Rational and SCS methods. The Rational Runoff Method predicts peak runoff rates using published runoff coefficients, basin area, and rainfall intensity. Runoff coefficients are selected based on factors such as soil type, topography, surface roughness, vegetation and land use. The rainfall intensity is selected from intensity, duration, and frequency (IDF) curves generated from weather data collected at Eugene's Mahlon Sweet Airport weather station (Figure 4-2). The duration of the design storm is based on the time of concentration for the development site. The appropriate design storm recurrence interval is determined using Table 3-1 of this plan based on drainage area, type of construction and type of drainage improvement being considered. The storm recurrence intervals for design of drainage systems within Table 3-1 will continue to be accepted as the appropriate balance between system construction costs and risk of flood damage.

The SCS method is accepted for prediction of total runoff volumes and of peak runoff rates through the use of a unit hydrograph. A Type 1A rainfall distribution is appropriate for use in these calculations in the Pacific Northwest. The design storm duration has been set at 24-hours. Table 3-1 establishes the appropriate storm recurrence interval. Twenty-four hour rainfall totals for each recurrence interval design storm have been generated from weather data collected at Eugene's Mahlon Sweet Airport weather station and are available in Table 4-2. Runoff curve numbers for various combinations of soils, cover and land use practices and methods for calculating the time of concentration are provided in Appendix M of the draft Public Improvements Design Standards Manual.

Two methods of hydraulic analysis are typically used for sizing conveyance systems. The uniform flow analysis method is used when friction losses along the system alone control capacity (i.e. other head losses, backwater effects or inlet control conditions are not present). Use of a backwater analysis is necessary when other head losses, backwater effects or inlet control conditions are present. Both methods are conducted following standard engineering practices.

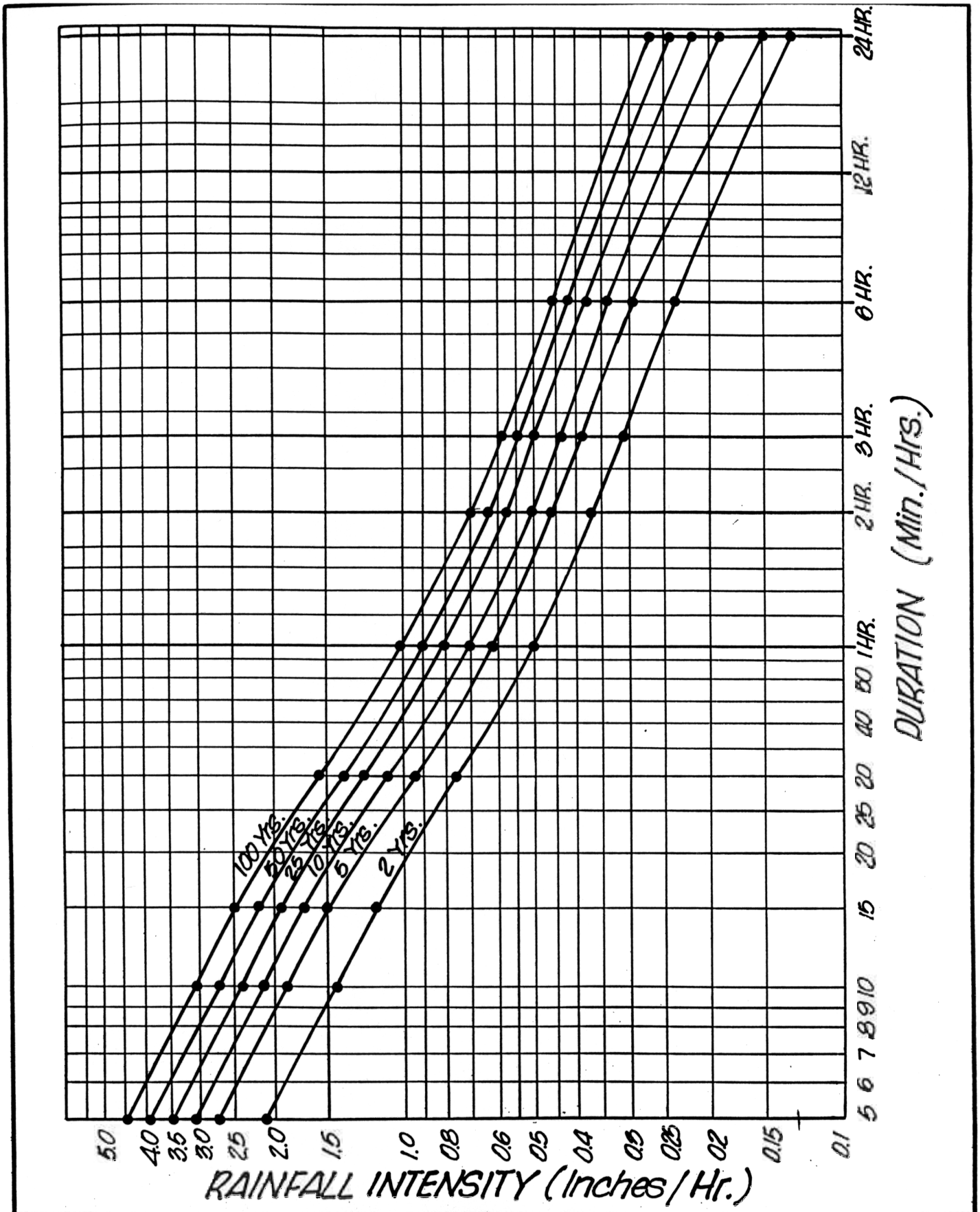


FIGURE 4-2.
Rainfall Intensity, Duration and Frequency Curves for Eugene, Oregon

otak incorporated
INC., ARCHITECTS, P.C.
17355 S.W. Boones Ferry Rd. Lake Oswego, OR 97035. (503) 635-3618
101 E. 8th Street. Vancouver, WA 98660. (206) 695-0357
11058 Main Street #215. Bellevue, WA 98004. (206) 455-5340

Table 4-2
Estimated 24-Hour Rainfall Depths

Storm Recurrence Interval	24-Hour Rainfall Depth (inches)
2-Year	2.67
5-Year	3.60
10-Year	4.46
25-Year	5.18
100-Year	6.48

This chapter describes the implementation approach for the Integrated Stormwater Management Strategy. Section 5.1 describes the actions, resource needs, estimated costs and financing for implementing the selected development standards. Section 5.2 describes the implementation and funding for the selected capital projects.

5.1 Development Standards

Water Quality Related Design Requirements

Implementing new water quality design requirements and headwaters flow control design requirements (Section 4.3) requires certain actions and has financial impacts.

Implementation Actions:
- Adopt stormwater development standards ordinance for codifying water quality treatment and headwater flow control requirements in the Eugene Code.
- Adopt administrative rules to implement the ordinance.
- Develop a Best Management Practices Manual for Water Quality and Flow Control.

Resource Needs and Estimated Costs:
- Development review process: It is estimated that additional staff will be needed upon adoption of the stormwater development standards ordinance to provide development review and implementation services.
- Maintenance of water quality treatment facilities: Estimates of resource needs assumes that the City will maintain water quality treatment facilities for new residential developments that involve multiple ownerships, i.e., single-family residential subdivisions and planned unit developments, that share a common water quality facility (BMP). The City would not maintain water quality facilities for multiple-family residential, commercial, and industrial uses. Additional resources will be needed to fund this higher level of maintenance responsibility, plus administrative, inspection and enforcement needs.
- Decreased revenues: It is anticipated that revenues will decrease slightly due to lower impervious surface areas, reduced impacts, and incentives.
- Estimated annual cost to implement the new water quality related design requirements: $1,300,000 by fiscal year 2011 (dollars in year 2000).

Financing:
- Stormwater user fees will be used to cover the cost of implementing the new water quality related design requirements. Current user fee revenues are projected to be adequate through fiscal year 2003. A user fee rate increase will likely be needed beginning in fiscal year 2004.

Open Waterway Requirements

Implementation Actions:
- Adopt ordinance to prohibit piping and filling of significant waterways.
- Adopt riparian corridor protection requirements in coordination with the Metropolitan Natural Resources Study and Endangered Species Act/Salmon Program.

Resource Needs and Estimated Costs:

- Maintenance of open waterways: The City currently maintains 29 miles of waterways. With an increase in public responsibility for managing waterways, this could potentially increase to 95 miles. Additional resources will be needed to fund this higher level of maintenance responsibility, plus administration.
- Estimated annual cost: $1,400,000 by year 2011 (dollars in year 2000).

Financing:

- Stormwater user fees will be used to cover the cost of implementing new open waterway requirements. Current user fee revenues are projected to be adequate through fiscal year 2003. A user fee rate increase will likely be needed beginning in fiscal year 2004.

5.2 Capital Improvement Program

Eugene's Stormwater Capital Improvement Program (CIP) includes new projects and priority stream corridor acquisitions identified through the development of these Stormwater Basin Master Plans as well as existing yearly capital budget expenditures for system rehabilitation, services for new development and wetland mitigation bank restoration projects.

Specifically included in the CIP are: forty-four new projects, selected and prioritized for implementation over a 35-year time period (2001-2035); eight annual capital project categories identified for implementation on an on-going basis over the same 35-year period; and 10.5 miles of priority stream corridors representing 170 acres are targeted for acquisition over a five-to-seven year period. Refer to Figure 5-1 for a generalized location of these projects. The following describes the prioritization and financing related to the new capital projects. Tables 5-1, 5-2, and 5-3 show the schedule, costs, and funding allocations for the 44 specific capital projects and the annual line item projects, with the exception of wetland mitigation projects which are financed through the sale of wetland mitigation credits. Table 5-4 shows the schedule and costs associated with the priority stream corridors identified for acquisition.

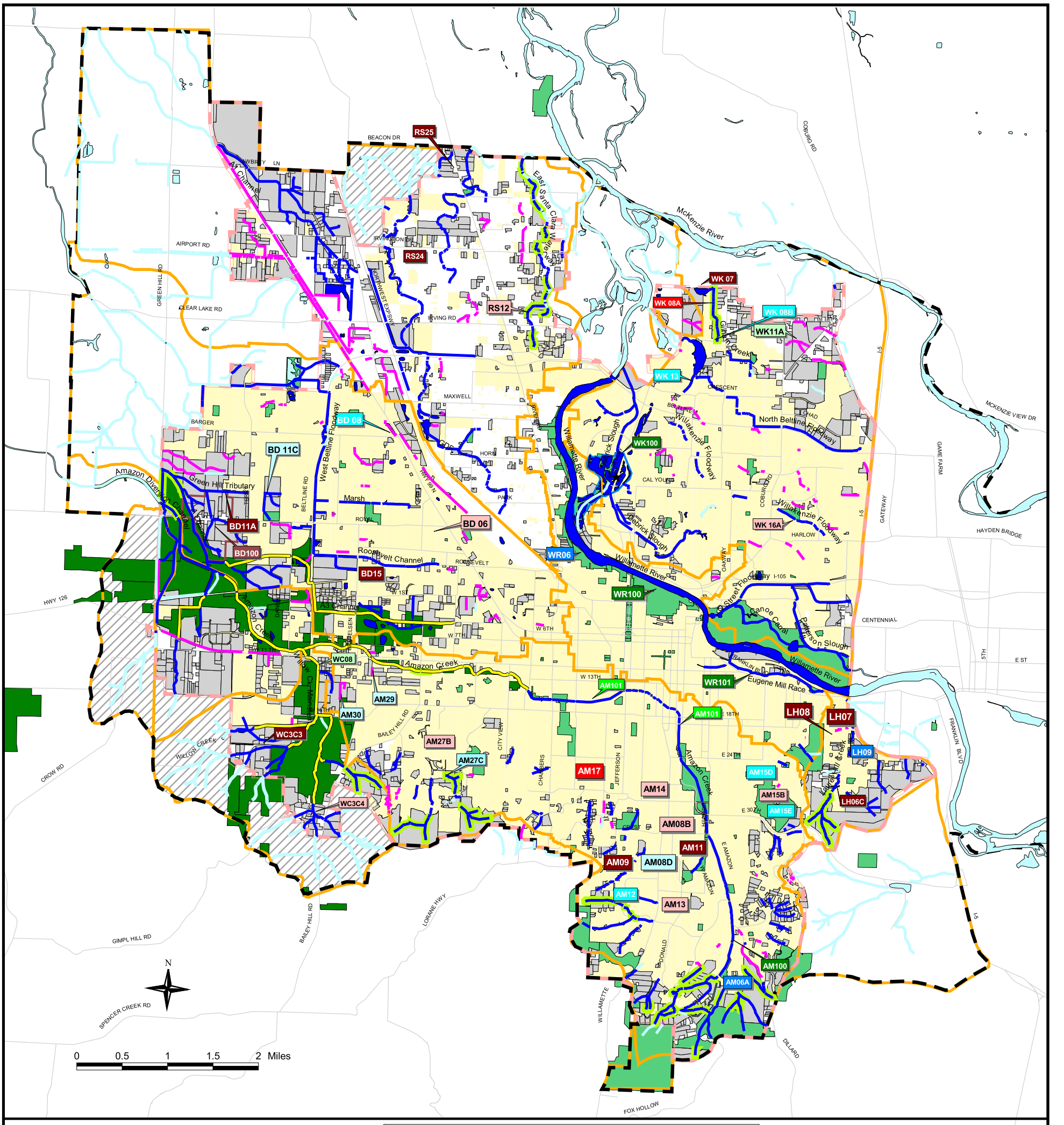
5.2.1 Capital Projects and Stream Corridor Acquisition

Prioritization

The following guiding principles were used to prioritize and place the capital projects into one of three time periods:

First period 2001-2005:

- Water quality facilities in public ownership, federal or local restoration projects, and system retrofits.
- Water quality projects with discharges to the Willamette River.
- Projects that incorporate multiple objective outcomes.
- Flood control projects that address confirmed capacity problems.
- Projects where benefits are relatively high when compared to costs.
- Acquisition of high priority stream corridors identified in the *City of Eugene Stream Corridor Acquisition Study (May 2001).*



Legend

Proposed Water Quality Standards Apply

Vacant Land over 0.5 acres not already committed to development

Open Waterways

- Waterways (UGB) with Beneficial Stormwater Functions
- Other Waterways inside UGB
- Other Waterways outside UGB
- Protected Waterways with Buffers (West Eugene Wetlands Plan area)
- Waterways Recommended for Acquisition

- Eugene City Limits
- Metro Plan Boundary
- Urban Growth Boundary
- Basin Boundaries
- City of Eugene Parks
- Urban Reserve Area
- Publicly owned restoration and open space sites

Multiple Objectives Capital Program Priorities*

Through Fiscal Year 2006

WATER QUALITY

AM06A	Kinney Park Water Quality Facility
LH09	I-5 and Augusta Water Quality Retrofit
WR06	Polk Street Water Quality Facilities

NATURAL RESOURCES

AM100	Federal Priority Project for Upper Amazon Creek Restoration
WK100	Federal Priority Project for Delta Ponds Enhancement
WR100	Federal Priority Project for Willamette River Bank Restoration
WR101	Federal Priority Project for the Eugene Mill Race Enhancement

FLOOD CONTROL

AM09	Frederick Ct. Pipe Daylight
AM11	Hilyard Street Pipe Improvements
BD11A	Greenhill Tributary Culvert Replacement
BD15	Roosevelt Channel Culvert Replacement
BD100	Royal Node Infrastructure
LH06C	Riverview/Augusta Bypass and System Improvements
LH07	Riverview and Augusta Pipe Improvements
LH08	Riverview/Augusta Minor Storm Drainage System Plan
RS12	East Santa Clara Channel Improvements*
WC3C3	Willow Creek West Branch Culvert/Channel Improvements
WK07	River Point Pond Outlet Channel

*RS12 is represented by capital projects RS12, RS13 and RS14 in the Initial Study towards the Development of a Stormwater Basin Master Plan

Notes$_1$:
For a summary of River Road/Santa Clara basin preliminary capital projects, see the Initial Study Towards the Development of a Stormwater Basin Master Plan for the River Road/Santa Clara Basin. This can be obtained from the City of Eugene Public Works Department, Engineering Division

Fiscal Year 2007 - 2011

WATER QUALITY

AM12	Pine View Water Quality Facility
AM15D	North Laurelwood Water Quality Facility
AM15E	South Laurelwood Water Quality Facility
BD08	Empire Park Pond Enhancements
WK08B	Gilham Road System Water Quality Facility
WK13	Ayers Pond Outfall Retrofit

NATURAL RESOURCES

AM101 Federal Priority Project for Central Amazon Creek Restoration

FLOOD CONTROL

AM17	Jackson Street Pipe Improvements
WK08A	Gilham Road System Culvert Replacement

Yearly Capital Program "Line Items" (City-wide)

- Channel Easement Acquisition
- General Stormwater Rehabilitation
- Outfall Stabilization
- Streambank Stabilization
- Retrofit Tip-ups
- Structural Water Quality Facilities in High Source Areas
- Services for New Development
- Wetland Mitigation Bank Projects

Notes$_2$:
Projects are categorized by primary objective but will be designed for multiple objectives.

Fiscal Year 2012 - 2035

WATER QUALITY

AM08D	Mt. Cavalry Water Quality Facility
AM27C	West of Hawkins Lane Water Quality Facility
AM29	Sam R. St. Water Quality Facility
AM30	Interior St. Water Quality Facility
BD11C	Greenhill Tributary Water Quality Facility

NATURAL RESOURCES

WC08	Realign/Restore Willow Creek Main Stem
WK11A	Wetland Acquisition County Farm Rd System

FLOOD CONTROL

AM08B	Mt. Cavalry Flood Control Facility
AM13	43rd Ave. Pipe Improvements
AM14	Morse Ranch Park Pipe Improvements
AM15B	Laurelwood Flood Control Facility
AM27B	Windsor Circle Pipe Improvements
BD06	Bell Ave Pipe Improvements
WC3C4	Willow Creek East Branch Culvert Improvements
WK16A	Modify Ascot Park Open Waterway

Map produced by the Lane Council of Governments
August, 2002
g:\projects\basins\greenvision.apr

Figure: 5-1

A Vision for Green Infrastructure

Stormwater - Going beyond Flood Control

Second period 2006-2010:

- Projects that focus on water quality and related natural resources protection/restoration.
- Projects that incorporate multiple objective outcomes.
- Flood control projects where need is based on model results that have not been verified through field observations.
- Projects where benefits are relatively high when compared to costs.
- Continued acquisition of high priority stream corridors identified in the *City of Eugene Stream Corridor Acquisition Study (May 2001).*

Third period 2011-2035:

- Remaining projects to be prioritized based on highest need and results of years 2001 through 2010.

Financing

Stormwater user fees, system development charges (SDCs), assessments, and federal priority funds are the primary funding sources for capital projects. The allocation of these funds to the projects are based on the following criteria:

- User fees. User fees are paid by all existing and new residents and businesses. They are based on impervious surface area, and the fee is reduced if a property does not discharge to the stormwater system or is retained on site. These fees fund operations, maintenance and some capital. They are used to address needs associated with existing conditions where no future development is expected to increase demand. User fee revenues are expected to be adequate for capital programming and operational needs through fiscal year 2003, and a user fee rate increase may be needed beginning in fiscal year 2004. In October 2001, Eugene City Council authorized a user fee increase specifically for enhancing the stream corridor acquisition program. The increase of $0.50 (per medium density residential customer, and an equivalent commensurate increase for other user categories) will become effective July 1, 2003 and will continue for a three-year period, after which time the funding level will return to a lower level unless re-authorized.
- Systems development charges (SDCs): SDCs are paid by new and expanding development. They are based on impervious surface area, number of dwelling units, or footprint. These fees typically fund construction of capacity oriented improvements to the stormwater system including waterways, catch basins, culverts and pipes. The SDC rate methodology and funding level are expected to be adjusted to accommodate the new programming needs beginning in fiscal year 2003.
- Assessments. Assessments are charged to property owners who derive a special benefit from a local improvement. They are commonly used to finance capital improvements (including stormwater improvements) that serve a specific local area or property. They can generally be used only for capital projects, not operating expenses.
- Federal priority funds. Federal funds may be available for projects that are consistent with specific federal environmental restoration objectives or programs. The City has an established relationship with certain federal agencies and program areas that is expected to continue. These "external" funds are susceptible to the federal political process.

Table 5-1*
Capital Project Implementation Schedule Years 2001 – 2005

Capital Project Identification	Total Cost	Funding Source and Allocation		
		SDCs	User Fees	Federal Priority Funds
AM 06A – Kinney Park Water Quality Facility	$486,800	$360,232 [74%]	$126,568 [26%]	$0
AM 09 – Frederick Court Pipe Daylight	$118,300	$54,418 [46%]	$63,882 [54%]	$0
AM 11 – Hilyard Street Pipe Improvements	$290,200	$66,746 [23%]	$223,454 [77%]	$0
AM 100 – Upper Amazon Creek Restoration	$3,300,000	$0	$1,155,00 [35%]	$2,145,000 [65%]
BD 11A – Green Hill Tributary Improvements	$940,600	$319,804 [34%]	$620,796 [66%]	$0
BD 15 – Roosevelt Channel Culvert	$135,900	$43,488 [32%]	$92,412 [68%]	$0
BD 100 – Royal Node Infrastructure	$1,400,000	$1,400,000 [100%]	$0	$0
LH 06C – Riverview/Aug. Piped Bypass System	$541,600	$444,112 [82%]	$97,488 [18%]	$0
LH 07 – Riverview/ Augusta Minor Pipe System	$59,400	$0	$59,400 [100%]	$0
LH 08 – Riverview/ Augusta Drainage Plan	$48,000	$0	$48,000 [100%]	$0
LH 09 – Augusta/I-5 Water Quality Facility	$1,245,600	$0	$1,245,600 [100%]	$0
WK 07 – River Point Pond Outlet Channel	$373,300	$153,053 [41%]	$220,247 [59%]	$0
WK 100 – Delta Ponds Habitat Enhancement	$2,330,600	$0	$815,710 [35%]	$1,514,890 [65%]
WR 06 – Polk Street Water Quality Facilities	$500,000	$0	$500,000 [100%]	$0
WR 100 – Willamette River Bank Restoration	$1,050,000	$0	$367,500 [35%]	$682,500 [65%]
WR 101 – Eugene Millrace Restoration	$3,550,000	$0	$1,242,500 [35%]	$2,307,500 [65%]
WC 3C3 – Willow Creek W. Branch Culvert	$82,200	$0	$82,200 [100%]	$0
Subtotal	**$16,452,500**	**$2,841,853 [17%]**	**$6,960,757 [42%]**	**$6,649,890 [41%]**
Yearly Capital Program Line Items Citywide (amounts shown are totals for 2001-2005):				
- WQ High Source Areas	$750,000	$0	$750,000 [100%]	$0
- Outfall Stabilization	$625,000	$0	$625,000 [100%]	$0
- Streambank Stabilization	$750,000	$187,500 [25%]	$562,500 [75%]	$0
- Retrofit Tip-ups	$625,000	$0	$625,000[100%]	$0
- General Rehabilitation	$2,000,000	$0	$2,000,000 [100%]	$0
- Stream Acquisition	$2,481,000	$0	$2,481,000 [100%]	$0
- Services for New Dev.	$500,000	$500,000 [100%]	$0	$0
Subtotal	**$7,731,000**	**$687,500 [9%]**	**$7,043,500 [91%]**	**$0**
Total	**$24,183,500**	**$3,529,253 [15%]**	**$14,004,257 [58%]**	**$6,649,890 [27%]**

* This table does not include the three projects identified for early implementation in the River Road Santa Clara basin.

Table 5-2
Implementation Schedule Years 2006 - 2010

Capital Project Identification	Total Cost	Funding Source and Allocation		
		SDCs	User Fees	Federal Priority Funds
AM 12 – Pine View Water Quality Facility	$309,100	$0	$309,100 [100%]	$0
AM 15D – N. Laurelwood Water Quality Facility	$445,600	$0	$445,600 [100%]	$0
AM 15E – S. Laurelwood Water Quality Facility	$371,400	$0	$371,400 [100%]	$0
AM 17 – Jackson Street Pipe Improvements	$77,400	$19,350 [25%]	$58,050 [75%]	$0
AM 101 – Central Amazon Creek Restoration	$3,504,000	$0	$1,226,400 [35%]	$2,277,600 [65%]
BD 08 – Retrofit Empire Park Pond	$385,000	$77,000 [20%]	$308,000 [80%]	$0
WK 08A – Gilham Rd System Culvert Replacement	$27,000	$27,000 [100%]	$0	$0
WK 08B – Gilham Rd Water Quality Facility	$653,800	$65,380 [10%]	$588,420 [90%]	$0
WK 13 – Ayers Pond Outfall Retrofit	$774,000	$0	$774,000 [100%]	$0
Subtotal	**$6,547,300**	**$188,730 [3%]**	**$4,080,970 [62%]**	**$2,277,600 [35%]**
Yearly Capital Program Line Items Citywide (amounts shown are totals 2006-2010):				
- WQ High Source Areas	$750,000	$0	$750,000 [100%]	$0
- Outfall Stabilization	$625,000	$0	$625,000 [100%]	$0
- Streambank Stabilization	$750,000	$187,500 [25%]	$562,500 [75%]	$0
- Retrofit Tip-ups	$625,000	$0	$625,000 [100%]	$0
- General Rehabilitation	$2,000,000	$0	$2,000,000 [100%]	$0
- Stream Acquisition	$750,000	$0	$750,000 [100%]	$0
- Services for New Dev.	$500,000	$500,000 [100%]	$0	$0
Subtotal	**$6,000,000**	**$687,500 [11%]**	**$5,312,500 [89%]**	**$0**
Total	**$12,547,300**	**$876,230 [7%]**	**$9,393,470 [75%]**	**$2,277,600 [18%]**

Table 5-3
Implementation Schedule Years 2011 - 2035

Capital Project Identification	Total Cost	Funding Source and Allocation		
		SDCs	User Fees	Federal Priority Funds
AM 08B – Mt. Cavalry Pipe Improvements	$763,200	$183,168 [24%]	$580,032 [76%]	$0
AM 08D – Mt. Cavalry Water Quality Facility	$469,600	$0	$469,600 [100%]	$0
AM 13 – 43rd Avenue Pipe Improvements	$2,155,500	$689,760 [32%]	$1,465,740 [68%]	$0
AM 14 – Morse Ranch Park Pipe Improvements	$1,054,500	$115,995 [11%]	$938,505 [89%]	$0
AM 15B – Laurelwood Flood Control/Pipe Imp	$2,008,400	$301,260 [15%]	$1,707,140 [85%]	$0
AM 27B – Windsor Circle Pipe Improvements	$919,000	$588,160 [64%]	$330,840 [36%]	$0
AM 27C –West Hawkins Water Quality Facility	$625,300	$506,493 [81%]	$118,807 [19%]	$0
AM 29 –Sam R. Street Water Quality Facility	$486,400	$0	$486,400 [100%]	$0
AM 30 –Interior Street Water Quality Facility	$328,200	$0	$328,200 [100%]	$0
BD 06 – Increase Pipe Sizes Along Bell Avenue	$794,600	$365,516 [46%]	$429,084 [54%]	$0
BD 11C – Greenhill Trib. Water Quality Facility	$748,800	$224,640 [30%]	$524,160 [70%]	$0
WC 3C4 – East Branch Culvert/Channel/Retrofit	$69,400	$0	$69,400 [100%]	$0
WC 08 – Realign/Restore Willow Creek Mainstem	$920,200	$0	$322,070 [35%]	$598,130 [65%]
WK 11A – Wetland Protection Coburg/Co Farm Rds	$225,600	$63,168 [28%]	$162,432 [72%]	$0
WK 16A – Modify Ascot Park Open Waterway	$72,200	$47,652 [66%]	$24,548 [34%]	$0
Subtotal	**$11,640,900**	**$3,085,812 [27%]**	**$7,956,958 [68%]**	**$598,130 [5%]**
Yearly Capital Program Line Items Citywide (amounts shown are totals 2011-2035):				
- WQ High Source Areas	$3,750,000	$0	$3,750,000 [100%]	$0
- Outfall Stabilization	$3,125,000	$0	$3,125,000 [100%]	$0
- Streambank Stabilization	$3,750,000	$937,500 [25%]	$2,812,500 [75%]	$0
- Retrofit Tip-ups	$1,875,000	$0	$1,875,000 [100%]	$0
- General Rehabilitation	$10,000,000	$0	$10,000,000 [100%]	$0
- Stream Acquisition	$2,359,000	$0	$2,359,000 [100%]	$0
- Services for New Dev.	$2,500,000	$2,500,000 [100%]	$0	$0
Subtotal	**$27,359,000**	**$3,437,500 [13%]**	**$23,921,500 [87%]**	**$0**
Total	**$38,999,900**	**$6,523,312 [16%]**	**$31,878,458 [82%]**	**$598,130 [2%]**
Grand Total Years 2001 - 2035	**$75,730,700**	**$10,928,895 [14%]**	**$55,276,185 [73%]**	**$9,525,620 [13%]**

Prioritization - Stream Corridor Acquisition Sites

Sites were prioritized into one of four tiers. Tiers I and II are highest priority and were identified based on the following:

- Site is at-risk from development (i.e., land use application has been submitted).
- Opportunity exists to purchase the site (i.e., on the market) or to partner with other program areas for additional funds.

Tier III sites were the next highest in priority and were identified based on:

- High probability that a land use application would be submitted in the near future.
- Opportunity is likely to exist to partner with other program areas for additional funds.

Tier IV sites represent all the remaining sites and are yet to be prioritized.

For detailed background information regarding the prioritizing and location of individual sites within priority stream corridors, see *City of Eugene Stream Corridor Acquisition Study (May 2001).*

Funding – Stream Corridor Acquisition Sites

The estimated cost to acquire the stream corridor sites is $5,590,000. The source for funding the acquisitions is stormwater user fees. Wherever possible, other methods and sources will be used to supplement the funds, such as financial incentives, donations, and state and federal grants.

In October 2001, the Eugene City Council authorized a one-time transfer of $850,000 from the stormwater fund balance and a limited duration user fee increase specifically for enhancing the stream corridor acquisition program. The $0.50 increase (per medium density residential customer, with an equivalent commensurate increase for other user categories) will become effective July 1, 2003 and will continue for a three-year period, after which time the funding level will return to a lower level unless re-authorized. If the user fee increase is re-authorized, the acquisitions may be complete by approximately 2007. If the user fee increase is not re-authorized after the initial three-year period, the yearly funding will be reduced to $150,000 and it will take until approximately 2026 to complete the acquisitions.

Table 5-4
Stream Corridor Acquisition Schedule Years 2001 – 2007*

Priority Stream Corridor / Site	Area		Estimated Cost
	Miles	Acres	
Amazon Creek Headwaters – East Fork	1.3	24.0	$480,000
Amazon Creek Headwaters – Middle Fork	1.8	30.0	$600,000
Amazon Creek Headwaters – West Fork	0.6	5.0	$100,000
Braeburn Creek	0.4	7.0	$210,000
Timberline Creek	0.7	13.0	$390,000
Videra Creek	1.0	18.0	$540,000
Portions of Lee-Marvin parcels along the Amazon Diversion Channel, Amazon Creek, and Greenhill Roadside channel	1.1	7.6	$260,000
Laurel Hill Creek – West Fork	1.0	19.0	$380,000
Gilham Creek Corridor	0.8	13.0	$1,020,000
Bailey Hill Oak Woodland	0.6	11.0	$330,000
East Santa Clara Waterway	1.4	24	$1,280,000
Total	**10.8**	**171.6**	**$5,590,000**

* Actual acquisition timeline will depend upon funding availability. See "Financing – Stream Corridor Acquisition Sites," this section.

ACRONYMS

ACOE	Army Corps of Engineers
ACE	Amazon Creek Enhancement (project)
ACWA	Association of Clean Water Agencies
AM	Amazon Creek Basin
B-D	Bethel-Danebo Basin
BLM	Bureau of Land Management
BMPs	Best Management Practices
CP	Capital Project
CIP	Capital Improvement Program
CFS	Cubic Feet Per Second
Corps	U.S. Army Corps of Engineers
CSWMP	Comprehensive Stormwater Management Plan (Eugene)
CWA	Clean Water Act
DAC	Department Advisory Committee
DEQ	Department of Environmental Quality (Oregon)
DLCD	Department of Land Conservation and Development
DSL	Division of State Lands (Oregon)
EMS	Environmental Management System
EPA	Environmental Protection Act
EPOS	Eugene Parks, Open Spaces and Natural Areas Study
ESA	Endangered Species Act
EWEB	Eugene Water and Electric Board
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GIS	Geographic Information System
ISAF	Impervious Surface Area Factors
LCDC	Land Conservation and Development Commission
LCOG	Lane Council of Governments
LH	Laurel Hill Basin
LID	Local Improvement District
LTD	Lane Transit District
LUCU	Land Use Code Update (Eugene)
MEP	Maximum Extent Practicable
Metro Plan	Eugene-Springfield Metropolitan Area General Plan
MOA	Memorandum of Agreement
MWMC	Metropolitan Wastewater Management Commission
NFIP	National Flood Insurance Program
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source Pollution
NRCS	Natural Resources Conservation Service (formerly SCS- Soil Conservation Service)
NRDC	Natural Resources Defense Council
NR Study	Metropolitan Natural Resources Study
NURP	National Urban Runoff Program

NWI	National Wetlands Inventory
O&M	Operations and Maintenance
ODF&W	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OFWAM	Oregon Freshwater Assessment Methodology
ONHP	Oregon Natural Heritage Program
ORS	Oregon Revised Statutes
PFP	Public Facilities Plan
PUD	Planned Unit Development
RR-SC	River Road Santa Clara Basin
SDCs	System Development Charges
T&E	Threatened and Endangered (species)
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TSS	Total Suspended Solids
UGB	Urban Growth Boundary
UIC	Underground Injection Control Program
UR	Urban Reserves
USDA	United States Department of Agriculture
USF&WS	U.S. Fish and Wildlife Service
WC	Willow Creek Basin
WEWP	West Eugene Wetlands Plan
WEWSAS	West Eugene Wetlands Special Area Study
WK	Willakenzie Basin
WR	Willamette River Basin
XP-SWMM	Stormwater Management Model Software developed by XP

GLOSSARY

ACUTE: Involves a stimulus severe enough to rapidly induce a response; in aquatic toxicity tests, a response measuring lethality observed in percent hours or less is typically considered acute.

AQUIFER: A stratum of gravel, sand, or porous, fractured, or cavernous and vesicular rock capable of holding and/or conducting water. When fully charged, an aquifer is saturated with water.

BASIN MASTER PLAN: A plan that addresses stormwater management within the context of the physical and cultural conditions of individual drainage basins.

BEST MANAGEMENT PRACTICES (BMPs): Management practices or techniques used to guide design and construction of new development or infrastructure improvements to minimize adverse environmental impacts. Often organized into a list of practices, from which those practices most suited to a specific site can be chosen to halt or offset anticipated problems.

BIOFILTER, BIOLOGICAL FILTER, BIOFILTRATION: Using vegetation and water features as a means of filtering pollution from stormwater or streams. Water is passed over

grassy areas, through sediment traps, and through specially created ponds, which trap pollutants or allow them to settle out of the water.

BUFFER: A designated area along the perimeter of a stream or wetland which is regulated to control (resist, absorb, or otherwise preclude) the negative effects of adjacent development from intruding into the natural area beyond the buffer.

BUILDABLE LANDS: Lands in urban and urbanized areas that are suitable, available, and necessary for urban development.

BUILDOUT: In this report, buildout refers to the development of all land according to the Metro Plan diagram. It is important to note that there are legal non-conforming uses within the designated zones (e.g. zoned commercial but used as a residence). These broad projections are useful to generally characterize rather than to provide precise detail.

CAPITAL IMPROVEMENT PLAN: A comprehensive list of the capital infrastructure projects (including storm water projects) that will be needed over the next six years.

CAPITAL PROJECTS: The planned physical improvements to the stormwater system for implementing the goals and policies of the stormwater management plan.

CATCH BASIN: In a traditional urban storm water conveyance system, surface runoff collects in gutters, flows into curbside inlets and/or underground catch basins, then travels through underground pipes, open drainage channels, and/or natural creeks to the major receiving water, such as a river or bay. A catch basin is usually a rectangular concrete box designed to capture large debris and prevent it from entering the storm drainage system.

CHRONIC: Involves a stimulus that lingers or continues over a relatively long period of time, often one-tenth of a life span or more. Chronic be considered a relative term depending on the life span of an organism. The measurement of a chronic effect can be reduced growth, reduced reproduction, in addition to lethality.

CLEAN WATER ACT (CWA): Federal law regulating the quality of the waters of the United States. Initially enacted in the late 1940's as the Federal Water Pollution Control Act, it was subsequently reauthorized in 1972 as the Clean Water Act. Amendments to the CWA in 1987 require local jurisdictions to develop stormwater management plans for the control of municipal nonpoint source pollution.

COMPREHENSIVE STORMWATER MASTER PLAN (CSWMP): The City of Eugene's Comprehensive Stormwater Master Plan (adopted November 1993) establishes public policy for addressing stormwater conveyance and urban stormwater quality issues. The plan includes a goals, policies, implementation measures, and maps to guide the community toward achieving local objectives and meeting federal laws and regulations. These basin characterization reports include additional information about the protection and enhancement of stormwater quality and related natural resources and serve to update the plan.

CONSTRUCTED WETLANDS: A facility that exhibits wetland characteristics but was constructed for the express purpose to perform a utility need, such as a sedimentation pond, and is not eligible for mitigation credit or subject to the jurisdictional requirements or federal and state wetland law.

CREATED WETLANDS: For the purpose of receiving mitigation credits, the alteration of soils, hydrology, and plants to produce a wetland where no wetland previously existed.

CSWMP (Comprehensive Stormwater Management Plan): A comprehensive approach for managing stormwater runoff so that multiple benefits to the community are achieved, including flood protection, clean water, and wildlife habitat.

CULVERT: A covered channel or pipe that takes a water course under a road, through the downstream dike or a detention facility or simply below ground. When a culvert is located in the downstream dike of a detention facility, it is positioned and sized to control the level of water at some desirable elevation based on the designed stormwater runoff rates. A culvert is usually some type of pipe, either metal or concrete.

DETENTION FACILITY/BASIN: Designed for the storage of stormwater runoff for controlled release during or immediately following a storm. A typical facility consists of a detention pond with an embankment (small dam) on the downstream side, and a pipe or concrete box outlet (see Culvert). The size of the pond is based on a specific design storm event and the amount of water that can be discharged through the outlet.

DIGITIZE: In general, digitize means to enter graphic information into a computer system. In this report, digitize means to trace impervious surface from an aerial photo into a computer mapping system or a geographic information system.

DISSOLVED OXYGEN: Dissolved oxygen is the amount of oxygen that is dissolved in the water column. The amount of dissolved oxygen in water is measured as an index of pollution. Low dissolved oxygen levels may indicate high levels of pollutants (specifically nutrients). The presence of dissolved oxygen is fundamental to maintaining aquatic life and the aesthetic quality of waters. Because of its importance, oxygen is one of the most widely measured water-quality parameters.

DRAINAGEWAY: A route or course along which water moves or may move to drain an area; a "natural" drainageway refers to the route or course in an area prior to the construction of any urban improvements. Also known as a watercourse or channel.

ENHANCEMENT: Actions taken to raise the value, desirability, attractiveness or function of a resource.

ENHANCEMENT OF WETLANDS: To improve one or more values in an existing wetland. The improvements may be to soils, water, or plants. Enhancement may improve a particular wetland value at the expense of other values. For example, diking an area to create a marsh environment for waterfowl nesting may flood a grassy wetland and reduce habitat for small rodents such as mice and voles.

EROSION CONTROL: Any temporary or permanent measure taken to reduce the loss of soils as a result of water, wind, ice, or gravity.

EUGENE PARKS, OPEN SPACES AND NATURAL AREAS STUDY (EPOS): The Eugene Parks, Open Spaces and natural Areas Study (EPOS) is not adopted as local policy, but provides a conceptual plan for park, open space, and natural area site acquisitions.

EUGENE-SPRINGFIELD METROPOLITAN GENERAL AREA PLAN (METRO PLAN): Eugene-Springfield Metropolitan Area General Plan (1987 Update, amendments incorporated as of July 1997, 1997 Reprint) is the official document adopted by local governments in which are set forth the general, long-range policies on how the community's future development should occur.

FECAL COLIFORM BACTERIA: Bacteria associated with the digestive tracts of mammals. Although fecal coliform bacteria is almost always present in natural waters, high levels provide evidence of water pollution associated with fecal matter.

FEMA (Federal Emergency Management Agency): Federal agency whose function is to provide assistance and emergency aid to communities impacted by the effects of natural hazards such as floods, hurricanes, etc. FEMA also administers the National Flood Insurance Program (NFIP).

FILL/REMOVAL LAW: Oregon statute, administered and enforced by the Division of State Lands (DSL), that regulates activities in state waters associated with dredging and filling activities. Requires permit for any fill or removal activities involving more than 50 cubic yards of material.

FLOOD CONTROL PROGRAM: Program activities that provide storm drainage and flood controls through the construction and maintenance of facilities such as storm drains, channels, and catch basins.

FLOOD FRINGE: That portion of the floodplain which lies beyond the floodway hazard that should be recognized although it may not be great enough to make floodway regulations desirable.

FLOODPLAIN: The relatively flat or lowland area adjoining a river, stream or watercourse which has been or may be converted temporarily by flood water.

FLOODWAY: That portion or the floodplain required for the reasonable passage or conveyance on the design flood; this is the area of significant depths and velocities and due consideration should be given to effects of fill, loss of cross-sectional flow area, and resulting increased water elevations.

FUNCTIONAL PLAN: Adopted public policy document providing goals and policies dealing with specific public utility functions and services (e.g. transportation, sanitary sewers, parks master plans) for the Metropolitan area or geographic subregion.

GOALS: Broad statements of philosophy adopted by the City Council. Goals may never be completely attainable, but they describe the hopes of the people and help establish direction.

GRASSY SWALE: An earthen conveyance system designed specifically to remove pollutants from urban stormwater through the filtering action of the grass and soil infiltration.

GREEN INFRASTRUCTURE: Green infrastructure is a combination of constructed and natural stormwater systems linked together into one system. This system is further integrated with streets, schools, parks, and utilities to create a truly "green infrastructure." An example is the Amazon Creek, which begins in the steep South Hills and flows, via pipe and open channels, through the city before entering the wider, slow-moving channels in west Eugene. The creek flows through Amazon Park, runs adjacent to several schools, and parallels the Fern Ridge bike/pedestrian path.

GROUNDWATER: Any water, except capillary moisture, beneath the land surface or beneath the bed of any stream, lake, reservoir or other body of surface water within the boundaries of this state, whatever may be the geological formation or structure in which such water stands, flows, percolates or otherwise moves.

HEAVY METALS: Metals of relatively high atomic weight, including but not limited to, chromium, cadmium, copper, lead, mercury, nickel, and zinc. Heavy metals come from some "natural" sources (e.g., minerals contained in soils, rocks and some vegetation) and from many "human-made" sources (e.g., vehicle exhausts, weathered paint and metal plating, wood preservatives and corrosion-control compounds, motor oils, or tire compounds). Heavy metals increase the toxicity of runoff.

HYDRIC SOIL: Soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation (plants that are adapted to live in wetland conditions).

HYDRAULIC CAPACITY: Under ideal conditions, the hydraulic capacity of a pipe or channel is the maximum flow possible through that pipe or channel.

ILLICIT CONNECTIONS: Illegal connections which discharge prohibited substances into the stormwater system, such as a connection of a sanitary sewer to a storm drain.

IMPERVIOUS SURFACE: Surfaces which prohibit water from soaking into the ground. Concrete, asphalt, and rooftops are the most common urban impervious surfaces.

IMPLEMENTATION MEASURES: Actions to be taken for implementing adopted public policy, such as regulatory, administrative and financial provisions.

INCENTIVES: Methods the government can use to influence decisions made in the private sector. Even when the term is only applied to the desires of the government, incentives can take many forms. Tax breaks and zoning changes are just two examples.

LCDC STATE GOALS: Adopted goals established through the Oregon State Land Use Planning Act of 1973 which require all state, county, and city units of local government to adopt local comprehensive land use plans. The plans and associated implementation measures must comply with the goals and associated administrative rules. The goals have the full force of the law and are administered by LCDC (Land Conservation and Development Commission).

LOCAL IMPROVEMENT DISTRICT: Cities can form Local Improvement Districts (LID) within which special assessments can be levied against the LID's properties.

MANAGEMENT MEASURES: Specific activities to be undertaken as part of an overall implementation measure, such as recommended Best Management Practices.

METROPOLITAN AREA GENERAL PLAN: The comprehensive land use planning document for the Eugene-Springfield Metropolitan Area. This document outlines broad goals objectives, and policies for long range planning inside the urban growth boundary (UGB).

METROPOLITAN NATURAL RESOURCES STUDY (NR STUDY): An inventory within the Eugene-Springfield metropolitan area of three types of natural resources listed under Statewide Planning Goal 5: wetlands, water bodies and associated riparian habitat, and upland wildlife habitat.

MITIGATION: One of two meanings, both relevant to this plan:

1. The actual enhancement, restoration, or creation of wetlands to compensate for permitted wetland losses in terms of area and wetlands functions, values and,

2. To protect wetlands by avoiding damage to them (i.e., long-term wetland protection status), by altering the design or timing of development to minimize negative impacts on wetlands, or by reducing external negative impacts (e.g., treating water pollution before it enters a wetland or creating a buffer area between the wetland and adjacent development).

MONITOR: A systematic and repeated activity designed to track and assess characteristics of certain physical conditions, such as water quality or fish habitat, and measure effectiveness of management activities designed to improve such conditions.

MULTIPLE OBJECTIVES: A program designed to provide multiple benefits to the community through an integrated management structure. Multiple objectives for CSWMP include flood control, water quality treatment, and related natural resource protection.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES): A permitting system devised by the U.S. Environmental Protection Agency (EPA) to administer provisions of the federal Clean Water Act. In Oregon the permitting system has been delegated by the EPA to the Oregon Department of Environmental Quality (DEQ). First applied to water quality in municipal sanitary waste discharges, the permitting system is now being expanded to apply to municipal storm water quality.

NATURAL RESOURCES FUNCTIONAL PLAN: A draft policy document, not yet adopted, that guides the management of riparian areas, waterways, wetlands and uplands throughout the metropolitan area.

NATURAL WATERWAY: A route or course along which water moves or may move to drain an area; a natural waterway refers to the route or course in an area prior to the construction of any urban improvements.

NATIONAL FLOOD INSURANCE PROGRAM (NFIP): A voluntary program administered by FEMA, which provides reduced flood insurance rates to property owners in participating communities.

NEIGHBORHOOD REFINEMENT PLAN: Refinement plans include a detailed examination of the service needs and land use problems peculiar to a particular area. Refinements to the General Plan include specific neighborhood plans, community plans, or special purpose plans (such as water, sewer, or transportation plans). In addition, refinement plans can be in the form of major planned unit developments, annexation and zoning applications, or other special area studies.

NITRATE: Nitrogen occurring as NO_3.

NITRITE: Nitrogen occurring as NO_2.

NITROGEN/PHOSPHOROUS: Nitrogen and phosphorous are nutrients typically derived from natural sources, such as soils, mineral deposits, and decaying vegetation. However, fertilizers, synthetic detergents and other manufactured chemicals often contribute significant quantities of nutrients via storm water systems. Phosphorous and nitrogen runoff can lead to accelerated growth of algae and other aquatic plants in receiving waters. This in turn can lead to dissolved oxygen problems.

NONPOINT SOURCE: Causes of water pollution that are not associated with point sources. Examples include: agricultural fertilizer/pesticide runoff; sediment runoff from construction; or materials from deicing activities (sand or salt). Nonpoint sources may enter a discrete conveyance and become a point source.

NONSTRUCTURAL CONTROLS: Nonstructural controls include public education and maintenance of existing facilities (street sweeping, catch basin cleaning).

NUMERIC END-OF-PIPE STANDARDS: (Numeric Effluent Discharge Standards). Numerical end of pipe standards are numerical limits placed on the quality of water discharged (usually expressed as a "not to exceed" concentration) from the end of a pipe.

OFF-STREAM OR OFF-LINE DETENTION: Temporary storage of runoff accomplished off-line (not within a principal drainage system).

ON-SITE DETENTION FACILITY: Temporary storage of runoff on the same land development where the runoff is generated.

ON-STREAM DETENTION: Temporary storage of runoff within the principal drainage system (in receiving streams or conduits).

OPEN CHANNEL: A water course which carries the storm runoff collected by the drainage basin to the outfall of the basin. It has definite bed and banks which serve to confine the water, though it has no cover.

OPERATIONS AND MAINTENANCE (O & M): A CSWMP program element charged with the ongoing operations and maintenance of the physical stormwater system. O & M activities are performed regularly to ensure the stormwater system functions as designed and to protect the public investment in the constructed system. Sample activities include channel clearing, vegetation management, storm system rehabilitation, and equipment purchases.

OREGON NATURAL HERITAGE PROGRAM (ONHP): The Oregon Natural Heritage Program manages Oregon's most comprehensive database of rare, threatened and endangered species. It acquires, maintains, and distributes data including site-specific information on the occurrences, biology and status of over 1,000 species.

ORGANIC COMPOUNDS: Any chemical compound containing carbon atoms. Examples include many solvents, gasoline, etc.

OUTFALL: An outfall is a point where a discrete conveyance enters a receiving water. Examples include municipal storm water discharges, treatment plant discharge points, and industrial process water discharge points.

PILOT PROJECT: Project undertaken specifically to test effectiveness of BMPs and recommended actions and their feasibility for future application on a city-wide basis.

PLANNING AND ADMINISTRATION: A CSWMP program element charged with research, data collection and analysis and the preparation of plans and implementation measures.

POINT SOURCE: Any discernable, confined, and discrete conveyance, including but not limited to pipes, ditches, channels, tunnels, or conduits, from which pollutants are or may be discharged to a receiving water.

POLICIES: Provide the basis for consistent action to move the community toward its goals. Policies are adopted by the City Council. Policies are used to evaluate actions relative to the Plan.

POLLUTANT LOADING: The total amount (usually expressed in lbs., or lbs./yr.) of the pollutant discharged to a receiving water. The pollutant loading is estimated by multiplying flow volume (per some unit of time, e.g., per year) by the concentration of the specific pollutant.

PROGRAM ELEMENTS: The management structure of CSWMP charged with the overall implementation of the program. There are five program elements: Planning and Administration, Capital Projects, Operations and Maintenance, Enforcement/Inspection/Monitoring, and Public Communications.

PROGRAM FUNCTIONS: Primary stormwater services outlined by CSWMP, to be provided by the City of Eugene--flood control, water quality treatment and related natural resources protection.

PROTECTION MEASURES: Type of management measure designed to protect certain values deemed important.

PUBLIC COMMUNICATION: A CSWMP program element charged with the development of a broad-based public education and involvement program. Citizen involvement may include volunteer programs, environmental education activity or seasonal events. Public information efforts can involve information campaigns, advisory committees and the use of newsletters, brochures and other media to inform interested citizens.

RECOMMENDED ACTIONS: Ideas on how to implement the policies, not adopted by City Council. Recommended actions suggest ways the policies may be carried out and are reviewed, studied, and revised over time. They may or may not be implemented in the form they appear. Recommended actions are evaluated in light of their ability to address the Plan's goal and policy direction, while considering aspirations, financial options, and legal requirements.

RECEIVING WATERS: Any surface water body that receives discharges from natural drainages, point sources, and/or nonpoint sources. Receiving waters can include: wetlands, creeks, rivers, lakes, streams, estuaries, or oceans.

REFINEMENT PLAN: Refinement plans are a detailed examination of the service needs and land use problems peculiar to a particular area. Refinements to the Metropolitan Area General Plan include specific neighborhood plans, community plans, or special purpose plans (such as water, sewer, or transportation plans). In addition, refinement plans can be in the form of major planned unit developments, annexation and zoning applications, or other special area studies.

REGIONAL DETENTION FACILITIES: Regional detention facilities are storm water pollution controls that target an entire region or watershed rather than a specific site (e.g., industry, construction site) within a watershed.

REHABILITATION: Rehabilitation involves replacing an existing facility due to structural failure of that facility. In conjunction with major projects, rehabilitation may include minor safety improvements.

RELATED NATURAL RESOURCES: Natural resources that are directly or indirectly related to the flood control and water quality treatment functions of CSWMP, including wetlands and riparian areas within and adjacent to the public conveyance system.

RESTORATION: To improve a disturbed wetland by returning wetland parameters which may be missing - by adding wetland soils, water, or plants. The restoration may return a missing or damaged wetland function to achieve a desired outcome. For example, removing an agricultural crop and planting native seeds to produce a wet prairie grassland.

RETENTION FACILITY: A facility similar to a pond or lake which permanently retains water. (A detention facility temporarily detains/stores water).

RIPARIAN: The land bordering a stream or river, also pertaining to the vegetation typical of those borders (grasses, shrubs, and trees such as reed canary grass, spiraea, willows, ash and cottonwoods).

SEDIMENT: Fragmented material that originates from weathering and erosion of rocks or unconsolidated deposits, and is transported by, suspended in, or deposited by water.

SETBACK: Regulatory measure prohibiting construction of a structure in a defined area.

SOURCE CONTROLS: Refers to the technique of stopping and/or controlling pollutants at their point of generation so that they do not come into contact with storm water. Source controls are preventative measures. Examples include community programs for facilitating proper disposal of waste oil and waste solvents; and use of aggressive inspection programs to identify and eliminate illicit connections. Source controls are generally nonstructural. Nonstructural and source controls are generally cheaper and easier to implement than structural controls.

SPECIAL ASSESSMENT REVENUES: A revenue source for financing infrastructure projects that directly benefit specific properties. Unlike property taxes, special assessments are specifically designed to recover part or all of the cost of an improvement that specifically benefits an individual property.

STANDARDS: Established limits which reflect minimum performance conditions for an activity, use, or structure.

STORM ASSESSMENT REVENUES: Revenues generated from storm sewer user fees.

STORM RUNOFF: The water from precipitation running off from the surface of a drainage area during and immediately following a period of rain.

STORMWATER FACILITY: A component of a stormwater drainage system, performing a single or multiple functions, including, but not limited to, pipes, swales, ditches, culverts, gutters, detention basins, and constructed wetlands.

STORMWATER MONITORING PROGRAM: A storm water monitoring program is a program which includes the collection and analysis of storm water runoff samples to determine the types and amounts of pollutants present.

SUSPENDED SOLIDS: Suspended solids are fine particulates that remain suspended in the water column. These solids can include clays, mud, algae, silica, etc. Suspended solids can interfere with and endanger aquatic ecosystems by reducing light penetration, interfering with sight feeding and photosynthesis, and clogging the gills and filter systems of aquatic organisms. Sediments that carry contaminants can cause additional problems. Contamination of sediments occurs because pesticides, heavy metals, and other toxic chemicals bind to fine silts, clay and organic particles, and can endanger aquatic ecosystems by entering the food chain. Suspended

solids content in storm water is a common parameter determined by using a gravimetric measurement.

SWALE: A natural depression or wide shallow ditch used to temporarily store, route, or filter pollutants from runoff.

SYSTEM DEVELOPMENT CHARGES (SDC): A fee charged to new development to help pay for the capital costs associated with new growth. A portion of the City of Eugene's SDC may help pay for the stormwater utility function, including the wetlands program.

TURBIDITY: Turbidity is an expression of the amount of light that is scattered and absorbed rather than transmitted in straight lines through a sample. Turbidity in water is caused by suspended matter such as clay, mud, algae, silica, rust bacteria, and other particulates.

UPLAND: Upland areas are natural resources of the metropolitan area without a significant water component as found in the wetland and riparian sites. Uplands include ridgelines and foothills, flat meadows, woodlands, parks, cemeteries and golf courses. Uplands provide four important functions and values to the metropolitan area 1) wildlife habitat; 2) open space and recreation; 3) scenic; and 4) water quality.

URBAN RESERVE: These are rural areas identified to accommodate future urban development beyond the planning period. Urban reserve lands are located beyond the current urban growth boundary. Capacity and financing plans for utilities, facilities, and services are designed and sized to serve urban reserve areas. Urban level services are not extended to urban reserve areas until they are included within the UGB and through future amendments or updates.

URBAN GROWTH BOUNDARY: A line on a map showing the outermost limit of urban development within the planning horizon. It is a site-specific line in the Metro Plan that separates existing and future urban development from rural lands. Urban levels and densities of development, complete with urban services, are planned within the UGB. Outside the UGB, rural lands are planned for farm and forest uses or for rural levels of development with accompanying rural levels of services.

USER FEE: Revenue source where by those people who use or benefit from services (such as storm water management) pay for those services.

WATERWAY CORRIDOR: Linear area adjacent to and including the course of a waterway, within which a variety of functions and values are found, such as flood control, water quality, natural resources, recreation and education opportunities.

WATER QUALITY: A term used to describe the chemical, physical and biological characteristics of water, usually with respect to its suitability for a particular purpose.

WEST EUGENE WETLANDS PLAN (WEWP): The Refinement Plan, adopted in 1992 by the City of Eugene and Lane County, which outlines mechanisms for balancing wetland protection with urban development.

WETLAND: Wetlands are areas where water exists at or near the land's surface in flooded or saturated soils in sufficient amounts during the March to October growing season to sustain wetland types of plants. Generally, three factors must be present in a wetland: (1) hydric soils (those soils officially identified as being wetland-type soils), (2) water (surface or groundwater within the root growing zone or upper 18 inches of soil), and (3) predominance of plants that are recognized as wetland species. There are several types of wetlands in west Eugene, including agricultural, marshes, ash forests, shrub-scrub, and prairie grasslands.

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APPENDIX A

CITY OF EUGENE ANALYSIS OF PRECIPITATION DATA FOR USE IN HYDROLOGIC/HYDRAULIC MODELING, APRIL 12, 1996

CITY OF EUGENE
ANALYSIS OF PRECIPITATION DATA
FOR USE IN HYDROLOGIC/HYDRAULIC MODELING
April 12, 1996

1.0 Introduction

The City of Eugene is currently developing multiple-objective storm drainage plans for seven major basins. Preparation of the plans requires the use of mathematical simulation models of basin hydrology and stream hydraulics. Long-term precipitation data is needed to use the models to best advantage. The only long-term precipitation data available is that from a rain gage at the Eugene Airport, approximately seven miles northwest of the city of Eugene. The rain gage at the airport has been operated by the National Weather Service since 1948. Short-term data, for periods of six years or less, are available from several rain gages located within the city of Eugene.

When long-term precipitation records are unavailable for a particular location to be analyzed, it is conventional practice to create a simulated long-term record. The simulated record is prepared by establishing the relationship between precipitation at the location with the long-term record and at the site to be analyzed, based on a comparison of short-term precipitation records. If, for example, annual rainfall in the last three years at the site to be analyzed has averaged 10% greater than at the long-term record site, then the long-term record can be adjusted upward by 10% to provide a simulated record for the site to be analyzed.

This memorandum describes precipitation data available for the Eugene area and indicates its limitations. A comparison is made between data gathered at the airport and data from rain gages in the city of Eugene and possible reasons for the differences are discussed. Some conclusions are drawn regarding the development of a simulated long-term precipitation record for the city of Eugene from the available data. Finally, recommendations are made regarding development of the long-term record together with some suggestions for improvement to the City of Eugene's current rain gaging practices and equipment.

2.0 Description and Evaluation of Eugene Rain Gages

Table 1 provides information on the various rain gages that were evaluated for this memo. For each gage, the table includes gage type, location, distance from the Airport, elevation, period of record, recording interval, and data limitations. The location of each gage is also shown on a map in Figure 1.

Airport Gage: The National Weather Service (NWS) compiled their measurements at the Airport from three gages: a non-recording gage and two recording gages (a weighing gage and an automated tipping bucket gage). The weighing gage is considered to be the most accurate gage, and its measurements were used most often. Increments of 0.02

inches of rainfall were recorded by this gage. The tipping bucket gage was used to verify the measurements recorded from the weighing gage. Rainfall data was measured in increments of 0.01 inches by the tipping bucket gage but the operation of the gage was considered to be less accurate than the weighing gage (based on measurements from the non-recording gage). The non-recording gage was also used intermittently to verify the measurements from the weighing gage. The non-recording gage consists of an 8-inch diameter copper collection cylinder and a 1-inch diameter measuring tube. Water depth in the measuring tube was measured with a stick to the nearest 0.01 to 0.02 inches.

Due to budget constraints, the NWS is in the process of closing their Eugene office. To reduce the need for staff, an Automated Surface Observation System (ASOS) was installed which includes a new tipping bucket rain gage. As of March 1, 1996, the ASOS gage is the official NWS gage for Eugene. Until the office closes, measurements from the old weighing gage will be used to verify measurements from the new ASOS gage. Initial results from this comparison have shown that the ASOS gage is under-estimating the amount of rain when compared to the weighing gage. As an example, for one storm in March, the weighing gage measured 0.75" while the ASOS gage measured 0.61".

City Gages: All of the other City gages used throughout the Eugene area are tipping bucket type gages. Maintenance of the three RG40 gages has recently increased. Paul Fagar from the City said that there have been problems in the past with these gages. The City used to get a lot of erroneous measurements from the gages which they attributed to low batteries. Battery replacements would help for a while, but the bad readings would appear again. The City then discovered that the cause of the problem was related to the gage's internal lithium batteries as opposed to the external batteries. Since the internal batteries have been replaced, the City has had better luck, however, other problems have also occurred. At the Willakenzie gage, moss, algae and insects have been found growing inside the bucket and clogging the orifice. The funnel at the Churchill gage was sometimes lying on the roof next to the tipping bucket gage. The funnel has now been secured in its proper place.

In order to check the accuracy of the three RG40 gages, Paul has been conducting calibration tests over the past year and a half at the tipping bucket gages. At first he poured a specified amount of water into the buckets to make sure that the readings were accurate. When he did this he was getting readings of 0.18" when he was expecting 0.20". He then adjusted the gages accordingly. Beginning February 16, 1996, he placed old fashioned manual gages at two of the sites (Donald and Willakenzie) to compare readings with the tipping buckets. In general, he has been measuring slightly higher amounts of rainfall from the tipping buckets than from the manual gages. This difference could be due to evaporation from the manual gages.

To date, similar calibration checks have not been conducted at the City's two ADS tipping bucket gages, however, Gary Cloyes from the Eugene WWTP said he is currently in the process of checking the gages. He is checking the gages by pouring a specified amount of water into the tipping buckets and checking the measurements. He completed

his check of I1 and found that it was accurately calibrated. He is planning to check M2 this week.

Paul Fagar stated that in the past the City has operated a couple of weighing gages (1980s). Due to time limitations, the data and information from those gages was not obtained for the evaluation provided in this report.

3.0 Comparison of Measurements Between the Airport and City Gages

To compare rainfall measurements between the gages listed in Table 1, all of the data were compiled into a spreadsheet. Due to time limitations, a thorough QA/QC review of the data was not conducted, however, a visual review of the data was made to identify and screen obvious problems. Figure 2 provides an example of a case where an obvious problem was noted. Where problems of this nature were encountered, the data were removed from the data set for all of the gages. A summary of the data that were removed from the data set is provided in Table 2. It is likely that there are other days when one or more of the City gages were not operating properly but it was not readily apparent based on a cursory review of the data.

Summaries of the data comparisons for average daily rainfall are provided in Figure 3 and Table 3 and for total annual rainfall amounts in Figure 4 and Table 4. For the period from October 1988 through September 1990, data from the Willow Creek gage was compared to the Airport gage. For the period from September 1990 through April 1992, a comparison was made between the City's three RG40 gages (Churchill, Willakenzie, and Donald) and the Airport gage. The year 1992 was broken into two sections because the two City gages were added at NPDES monitoring sites I1 and M2 in May of 1992. Therefore, from May 1992 through the end of 1995, a comparison was made between the City's five gages and the Airport gage. 1995 was also broken into two sections because for the period from January through April, the Churchill gage was out of service, and for May through December, the Donald gage was out of service.

As can be seen in Figures 3 and 4, the Airport gage recorded the highest rainfall measurements for each of the periods of record. The readings from the City gages were closer in value to each other than they were to the Airport gage readings. A summary of the percent differences between the Airport measurements and the City gage measurements is provided in Table 5 (the airport data was used as the base and the differences are expressed as a percentage of the base). As can be seen in the table, the average difference in readings between City and Airport gages ranged from 19% to 42%, with an overall average of 34%.

4.0 Interpretation of Results

Several phone interviews were conducted in an effort to determine the reason for the fairly large differences between rainfall measurements from the Eugene Airport and the City gages. The Oregon State Climatologist said that a strong west to east rainfall gradient does exist in the Willamette Valley. He said that as the rain moves over the coast

range (from west to east), a significant amount of moisture drops out of the system on the western side of the valley, and as the system moves to the east, it contains less moisture. As an example, he stated that the annual rainfall amounts in Philomath, Corvallis, and Albany are approximately 50", 45", and 40" respectively (over a total distance of 13 miles). However, there is also a fairly large difference in elevation between the Philomath and Corvallis gages (approximately 260 feet). The difference in elevation between the Airport gage in Eugene and the City gages is less significant (ranging from 25 to 110 feet). The Climatologist provided a copy of a rainfall isohyetal developed by the National Weather Service for Lane County (see Figure 5). The map was developed from a model called PRISM. This map does show a strong gradient from west to east in Eugene with approximately 60" shown at the Airport location and 48" shown for downtown Eugene; a difference of 25%.

Rick Wagner from the National Weather Service said that one possible interpretation of the lower rainfall amounts measured in Eugene is the fact that many of the winter storms come out of the southwest. This could result in some shadowing effects from the hills in south Eugene. However, if these effects do occur, it would seem that the measurements from the Willakenzie Pump station would more closely match the measurements from the Airport.

The State Climatologist said he was surprised to see a difference as large 30% - 40%. He would expect a difference which was more on the order of 5% to 10%. He said he has a lot of confidence in the measurements from the NWS weighing gage. He thinks the tipping bucket type gages commonly underestimate rainfall amounts and he feels this is generally due to a lack of maintenance, freezing conditions, leaking, wind, splashing, evaporation, and potential problems with the gage orifice (i.e. clogging). As discussed above, since the time the NWS switched from a weighing gage to a tipping bucket gage at the Eugene Airport, they are also noting significantly lower readings.

5.0 Conclusions

It is clear from the available data that annual precipitation at the Eugene Airport is higher than annual precipitation in the city of Eugene. the differences are probably partly real and partly a result of measurement inaccuracies. While it would obviously be desirable to determine the portion of the difference that is real, existing data does not allow this to be done with a high degree of certainty. However, some reasonable inferences can be drawn from the data.

The most reliable precipitation measurements made in the Eugene area are those made with a weighing rain gage at the Eugene Airport. It was used to compile the long-term records. Recently the NWS has been operating a tipping bucket gage side-by-side with the weighing gage. Measurements made by the NWS with the new tipping bucket gage, the same type of gage used in the City of Eugene, are only about 81% of those made with the weighing gage. This suggests that recorded values from the new tipping bucket gage should be multiplied by a factor of 1.2 to correct for inaccuracies attributable to technological problems.

On average, precipitation measurements made in the city of Eugene using tipping bucket gages are only 66 % of the measurements made at the airport with the weighing gage. Assuming the city's tipping bucket gages suffer from similar inaccuracies as the tipping bucket gage at the airport, then the city measurements should also be multiplied by 1.2 to account for the technological problems. After this adjustment, the measurements in the city are 81% of those made at the airport. In other words, the precipitation in the city is 19% less than that at the airport.

An isohyetal map of the Eugene area prepared by the Oregon State Climatologist indicates that there is a steep decline in precipitation from west to east in the vicinity of the city of Eugene. Although the level of precision of the computer-drawn map is not great enough to reliably estimate the actual difference in precipitation between the city and the airport, it suggests that a 19% drop off in annual precipitation between the airport and the city would not be unexpected. Furthermore, measurements elsewhere on the eastern slope of the Coast Range show marked precipitation gradients, although not as great as may be occurring near Eugene. Thus, based on the data available today, it would not be unreasonable to adjust the long-term records for the airport downward by 19% to create a long-term record for the city.

6.0 Recommendations

The following recommendations address both the precipitation assumption to be used in the hydrologic and hydraulic simulation models and possible improvements to the city of Eugene's data gathering program. It is recognized that improvements to the data gathering program are probably only of marginal benefit in helping to make the impending decision regarding the most appropriate precipitation assumption. The primary benefits of improvements to the data gathering program will accrue over a number of years as Eugene develops a reliable long-term record of precipitation within city boundaries.

Long-term precipitation records

It is obviously important to make as accurate an estimate of precipitation for the city of Eugene as is possible. If the estimated annual precipitation used in the hydrologic models is higher than actual precipitation, then the city's drainage facilities will be larger and more expensive than necessary. If the estimated annual precipitation is lower than the actual precipitation, flooding will occur more frequently than intended. Thus, if an estimation error is made, it is better that it be on the high side because the consequences of a high estimate (economic inefficiency) are less severe than those of a low estimate (frequent flooding).

Three possible courses-of-action are apparent:

1. The city could use the long-term precipitation data from the airport without adjustment.

2. The city could adjust the long-term precipitation record at the airport downward semi-arbitrarily on the basis of the data presented in this memorandum.
3. The city could further analyze the existing precipitation data to better define the relationship between precipitation at the airport and in the city.

The implications of the first course-of-action are that it could result in considerable economic inefficiency. If there is really an average of a 34% difference between the airport gage and the City gages, this would likely result in a storm drainage system that is over designed.

The second course-of-action would be a reasonable one. If it was selected, a 10% downward adjustment of the long-term record is recommended. This is a compromise between no downward adjustment and a 19% downward adjustment on the basis of the rather uncertain calculations described earlier in this memo.

The third course-of-action is our recommendation. Precipitation data is the most important data input parameter for hydrologic modeling. The cost of the additional data analysis may be modest compared to potential costs associated with constructing a stormwater drainage system which is over designed. In addition, this issue would be resolved for any future analyses which rely on precipitation data from Eugene.

Further evaluations would include:

1. Conducting a more thorough QA/QC review of the data from the City gages
2. Obtaining data from the weighing gages used by the City during the 1980's and comparing that data to the Airport data; if these City measurements compare more closely with Airport measurements, then part of the difference we're seeing now may be attributed to the difference in gage types
3. Obtaining historical rainfall data collected by the City prior to 1944 and comparing it to the early data collected by the NWS. This data is referenced in the February 1967 Storm Drainage Study conducted by CH2M.
4. Determine exactly when Paul Fagar calibrated the three RG40 gages and determine whether or not that made a difference in bringing measured rainfall amounts in the City closer to measured amounts at the Airport
5. Obtain and evaluate information from the WWTP regarding their current efforts to calibrate the ADS rain gages
6. Look at the differences between the Airport and City gage measurements to see if they vary by season
7. Use the City rainfall record and the Airport rainfall record to run the SWMM model for a small catchment (where we have flow data) for one or two storms. This could be used to see which record most closely predicts the flow volumes measured. This option also has cost implications to the City for the resources needed to conduct these evaluations.

Improvements to the data gathering program

In order to obtain additional information to increase confidence in measurements from the City gages, the following recommendations were made by Bill Flieder of the NWS, Suzanne Moffet of ADS Environmental Services, and Dennis Recla of Met One Instruments:

Immediate needs:

- Check for proper calibration. For an 8" bucket, fill one side of the bucket with 8.25 ml of water (enough for one tip). The tipping bucket should tip, spilling the water out. It is recommended that the bucket be filled with enough water for 10 tips (i.e. 82.5 ml). (Note, if the bucket is a different size, a different amount of water will be needed). Collect the data from the station and check to see that the amount of rain measured at the station is consistent with the amount of water poured into the gage. For every tip, 0.01 inches of rain should be measured. Repeat this process five times pouring the water on to different sides of the bucket. If the tipping bucket does not tip at the correct amount of water, an adjustment should be made by raising or lowering the adjustable resting points.

- Double check the measurements at each of the gages during one or more storm events by placing an older type manual gage at each of the sites and comparing measurements. These gages can be obtained for approximately $5 from Coast Farm Supply in Eugene.

Long term needs:

- Maintain the gages on a regular basis (at least every six months) including: checking the orifice for clogs, checking the bucket to ensure that it is level, calibrating the gage, and checking the pivot point of the bucket to ensure that it is well lubricated.

- Review the data output from each gage on a monthly basis and flag data that does not appear to be accurate. If data needs to be flagged, conduct a field check of the gage to identify and correct the problem.

As described in section 2.0, many of these tasks are currently being conducted by the City.

7.0 Persons Contacted

Paul Fagar, City of Eugene
Bill Flieder, National Weather Service
Suzanne Moffet, ADS Environmental Services
Dennis Recla, Met 1 Instruments
George Taylor, Oregon State Climatologist
Rick Wagner, National Weather Service

Table 1
Characteristics of Rain Gages in Eugene

Map ID # (Figure 1)	Rain Gage ID	Rain Gage Type	Location	Distance from the Airport	Approx. Elevation	Period of Record	Recording Intervals	Comments/Data Limitations
1	National Weather Service - 2709	Compiled from three gages: 1) non-recording 2) recording weighing 3) recording tipping bucket	Eugene Airport		360	7/48 - present	Hourly	None.
2	Fire Station	RG40 Tipping Bucket	Churchill Street near Bailey Hill	2.8 mi. E 5.3 mi N 5.9 mi. Direct	420	9/90 - present	Hourly	The data set has not received a QA/QC review.
3	South Eugene	RG40 Tipping Bucket	33rd Ave. near Donald	6 mi. E 6.2 mi N 8.6 mi Direct	470	9/90 - present	Hourly	The data set has not received a QA/QC review.
4	Willakenzie Pump Station	RG40 Tipping Bucket	Across the river from the Eugene Wastewater Treatment Plant	5.2 mi E 1.4 mi N 10.7 mi Direct	385	9/90 - present	Hourly	The data set has not received a QA/QC review.
5	M2	ADS Tipping Bucket (8")	Amazon Creek at 29th Street	6.4 mi E 5.9 mi N 8.7 mi Direct	435	5/92 - present	15 minute	The data set has not received a QA/QC review.
6	I1	ADS Tipping Bucket (8")	Bertelsen Slough at 5th and Wallis	2.9 mi E 3.9 mi N 4.9 mi Direct	395	5/92 - present	15 minute	The data set has not received a QA/QC review.
7	Willow Creek	Tipping Bucket	Willow Creek approximately 100 meters north of the 18th Ave. Bridge	2.2 mi E 5.0 mi N 5.4 mi Direct	400	10/88 - 9/90		Accuracy of the data has not been verified. There are a number of gaps in the data set.

Table 2
Data Removed from the Record Based on Obvious Problems

Year	Data Removed Based on Obvious Problems
1990	Data from the Willakenzie Gage was not included in the summary for 1990. This gage appeared to be significantly and unrealistically underestimating rainfall volumes when compared to the other gages. All other data from 1990 for the other gages was included.
1991	1/27,3/3 - 3/26, 4/23 - 4/28, 5/5 - 5/19, 6/27 - 6/28 (48 days total)
1992	4/23 - 4/25, 8/7, 9/11 - 9/14, 11/3 - 11/18, 11/20 - 11/26, 12/9 - 12/10 (33 days total) In addition, the Donald gage was not included in the comparison for the second half of 1992 due to the large number of readings which appeared to be erroneous.
1993	1/1 - 1/19, 2/6 - 3/1, 3/9 - 3/13, 3/17 - 3/18, 4/13 - 4/15, 4/29 - 5/3, 5/29 - 6/3, 6/9, 8/14, 11/11 (69 days total)
1994	2/13 - 2/15, 3/15 - 3/24, 4/18, 6/6 - 6/9, 9/29, 10/21, 10/25, 11/1 - 11/4, 12/7 - 12/19 (38 days total) In addition, the Willakenzie gage was not included in the comparison for this year due to the large number of readings which appeared to be erroneous.
1995	1/7 - 1/13, 3/20 - 3/22, 3/31 - 4/18, 4/27 - 5/3, 5/12 - 5/17, 6/4 - 6/16, 7/11 - 12/31 (229 days total) In addition, the Churchill gage was not included in the comparison for the first portion of 1995 as this gage was not operational for a large portion of this period; and the Donald gage was not included in the comparison for the second portion of 1995 for the same reason.

Table 3
Average Daily Rainfall Volumes

Period of Record	# of Days in Record	Willow Creek	NWS Airport	Willakenzie	Churchill	33rd/Donald	I1	M2
1988 (Oct - Dec)	92	0.130	0.213	na	na	na	na	na
1989	365	0.066	0.111	na	na	na	na	na
1990 (Jan - Sept)	273	0.073	0.131	na	na	na	na	na
1990 (Sept 1 - Dec 31)	122	na	0.163	na	0.133	0.137	na	na
1991	317	na	0.106	0.072	0.068	0.073	na	na
1992 (Jan 1 - April 30)	118	na	0.166	0.088	0.116	0.101	na	na
1992 (May 1 - Dec 31)	215	na	0.101	0.059	0.062	0.000	0.073	0.073
1993	296	na	0.140	0.090	0.050	0.090	0.090	0.090
1994	327	na	0.116	na	0.052	0.072	0.063	0.072
1995 (Jan 1 - April 26)	87	na	0.189	0.085	0.000	0.087	0.047	0.118
1995 (May 1 - July 10)	49	na	0.053	0.058	0.045	0.000	0.047	0.074

Table 4
Total Rainfall Amounts

Period of Record	# of Days in Record	Willow Creek	NWS Airport	Willakenzie	Churchill	33rd/Donald	I1	M2
1988 (Oct - Dec)	92	11.93	19.56	na	na	na	na	na
1989	365	24.04	40.66	na	na	na	na	na
1990 (Jan - Sept)	273	19.83	35.82	na	na	na	na	na
1990 (Sept 1 - Dec 31)	122	na	19.93	na	16.26	16.71	na	na
1991	317	na	33.52	22.92	21.65	23.25	na	na
1992 (Jan 1 - April 30)	118	na	19.63	10.33	13.69	11.88	na	na
1992 (May 1 - Dec 31)	215	na	21.74	12.70	13.37	0.00	15.78	15.73
1993	296	na	41.70	27.48	13.44	26.71	27.60	28.21
1994	327	na	37.93	na	17.12	23.53	20.64	23.71
1995 (Jan 1 - April 26)	87	na	16.44	7.42	0.00	7.53	4.13	10.28
1995 (May 1 - July 10)	49	na	2.58	2.82	2.20	0.00	2.28	3.62

Table 5
Data from City Gages as a Percent of NWS Measurements

	# of Days in Record	Willow Creek	NWS Airport	Willakenzie	Churchill	33rd/Donald	I1	M2
1988 (Oct - Dec)	92	-39%	0%	na	na	na	na	na
1989	365	-41%	0%	na	na	na	na	na
1990 (Jan - Sept)	273	-45%	0%	na	na	na	na	na
1990 (Sept 1 - Dec 31)	122	na	0%	na	-18%	-16%	na	na
1991	317	na	0%	-32%	-35%	-31%	na	na
1992 (Jan 1 - April 30)	118	na	0%	-47%	-30%	-39%	na	na
1992 (May 1 - Dec 31)	215	na	0%	-42%	-39%	na	-27%	-28%
1993	296	na	0%	-34%	-68%	-36%	-34%	-32%
1994	327	na	0%	na	-55%	-38%	-46%	-37%
1995 (Jan 1 - April 26)	87	na	0%	-55%	na	-54%	-75%	-37%
1995 (May 1 - July 10)	49	na	0%	9%	-15%	na	-12%	40%
Average Difference (Excluding May-July 1995)		-42%	0%	-33%	-37%	-36%	-39%	-19%

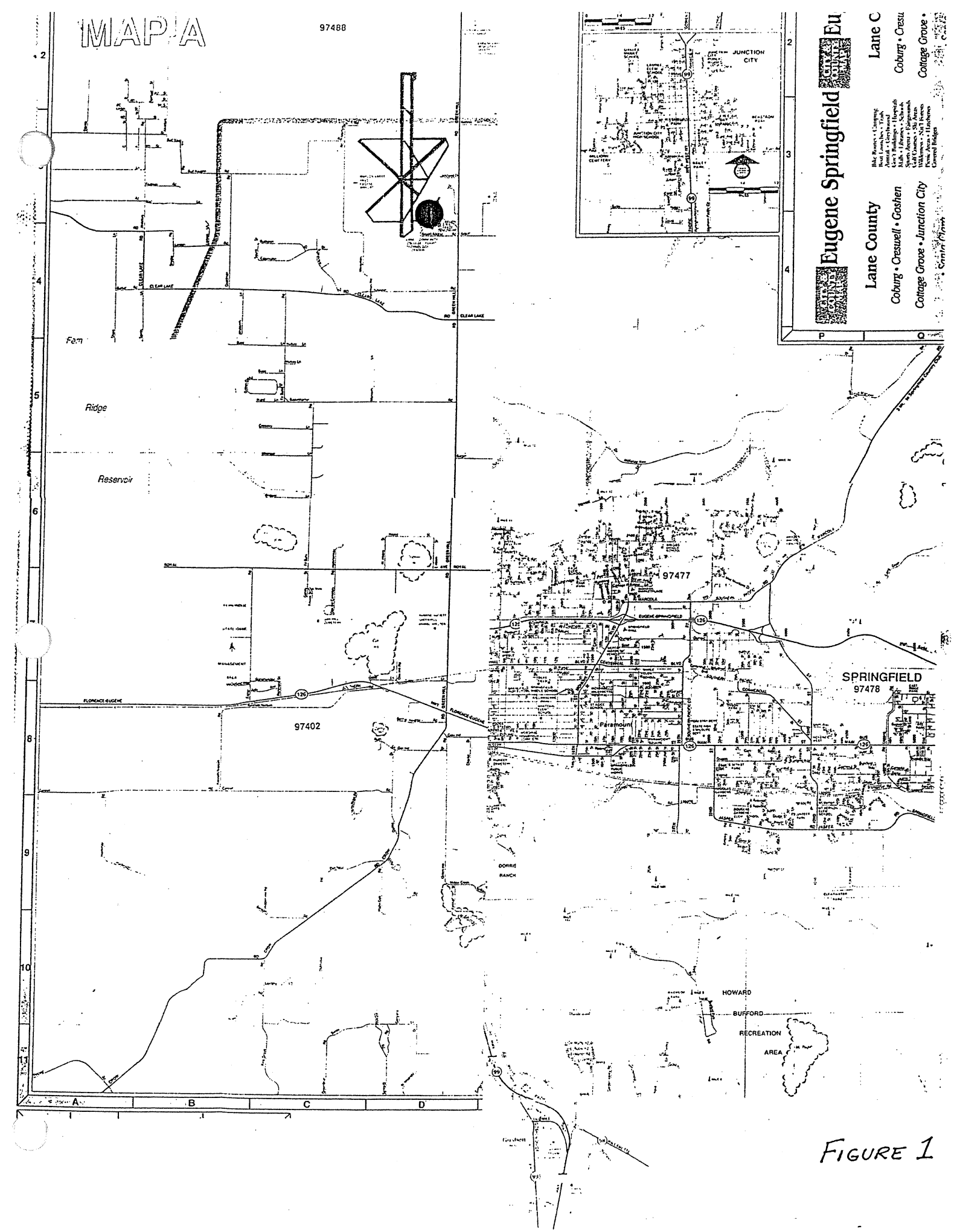

MAPPA
97488
Eugene Springfield
Lane County
Coburg • Creswell • Goshen
Cottage Grove • Junction City
JUNCTION CITY
Fern
Ridge
Reservoir
97477
SPRINGFIELD
97478
97402
Paramount
DORRE RANCH
HOWARD
BUFFORD
RECREATION
AREA
CLEAR LAKE
ROYAL
FLORENCE-EUGENE
A
B
C
D

FIGURE 1

DATE	Churchill	33rd/Donald	Willakenzie	NWS(Airport)	I1	M2
21-Oct-92	0.01	0.00	0.00	0.05	0.01	0.05
22-Oct-92	0.01	0.00	0.00	0.00	0	0
23-Oct-92	4.31	0.01	0.00	0.00	0	0
24-Oct-92	0.00	0.00	0.00	0.00	0	0
25-Oct-92	0.00	0.01	0.00	0.00	0	0
26-Oct-92	0.00	0.01	0.34	0.00	0	0
27-Oct-92	0.00	0.09	0.00	0.00	0	0
28-Oct-92	0.00	0.32	0.00	0.06	0.15	0
29-Oct-92	0.00	0.00	0.01	1.25	0.49	0.65
30-Oct-92	0.00	0.00	0.00	1.29	0.66	0.94
31-Oct-92	0.00	0.08	0.00	0.85	0.22	0.39
01-Nov-92	0.00	0.64	0.00	0.18	0.11	0.01
02-Nov-92	0.01	1.60	0.01	0.00	0.35	0
03-Nov-92	9.00	1.28	0.00	0.00	0.29	0
04-Nov-92	9.00	0.29	0.00	0.50	0.05	0
05-Nov-92	9.00	0.00	0.00	0.00	0.06	0
06-Nov-92	9.00	0.64	0.00	0.00	0.16	0.12
07-Nov-92	9.00	0.08	0.00	0.10	0.03	0.09
19-Nov-92	0.00	0.54	0.00	0.70	0.61	0
27-Nov-92	0.00	0.13	0.00	0.49	0.19	0.16
28-Nov-92	0.00	0.00	0.00	0.00	0	0
29-Nov-92	0.00	0.00	0.00	0.00	0	0
30-Nov-92	0.02	0.86	0.01	1.20	1	1.01
01-Dec-92	0.00	0.97	0.00	1.97	1.22	1.1
02-Dec-92	0.00	0.18	1.29	0.27	0.23	0.2
03-Dec-92	0.00	0.00	1.91	0.00	0	0
04-Dec-92	0.00	0.00	0.17	0.00	0.01	0
05-Dec-92	0.00	0.06	1.43	0.06	0.08	0
06-Dec-92	0.00	0.16	1.43	0.30	0.24	0.12
07-Dec-92	0.00	0.24	0.32	0.30	0.22	0.28
08-Dec-92	0.01	0.94	0.74	1.80	1.14	1.05
11-Dec-92	0.00	0.05	0.31	0.03	0.01	0.05
12-Dec-92	0.00	0.00	0.03	0.02	0	0
13-Dec-92	0.00	0.00	0.00	0.00	0	0
14-Dec-92	0.00	0.13	0.16	0.12	0.1	0.14
15-Dec-92	0.00	0.01	0.00	0.00	0	0.02
16-Dec-92	0.00	0.40	0.17	0.70	0.4	0.46
17-Dec-92	0.00	0.29	0.22	0.88	0.3	0.34
18-Dec-92	0.00	0.00	0.35	0.00	0	0
19-Dec-92	0.00	0.09	0.06	0.13	0.06	0.1
20-Dec-92	0.00	0.15	0.14	0.47	0.17	0.18
21-Dec-92	0.00	0.34	0.25	0.46	0.36	0.42

Data rejected as obviously incorrect.

FIGURE 2

Figure 3
Average Daily Rainfall

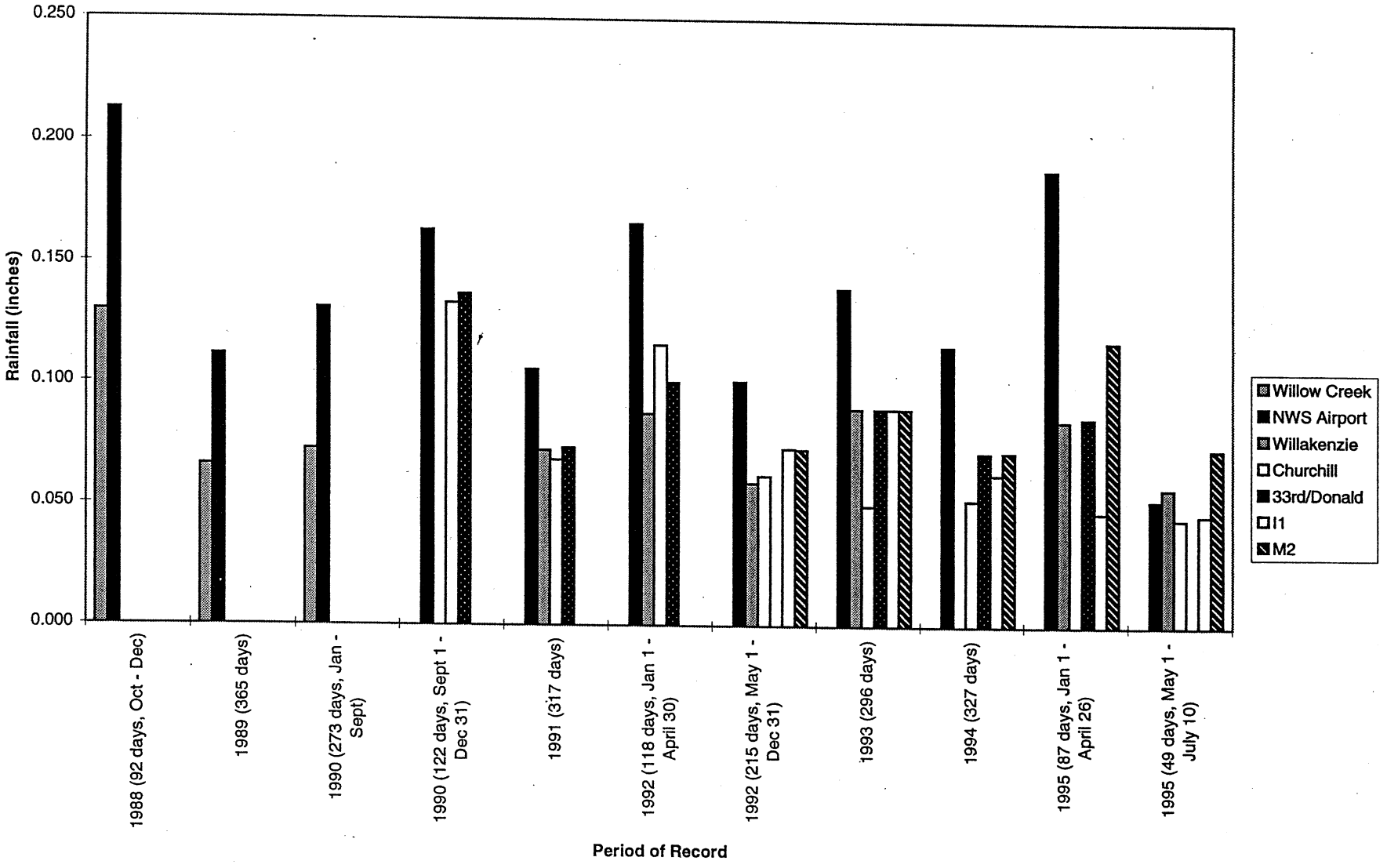
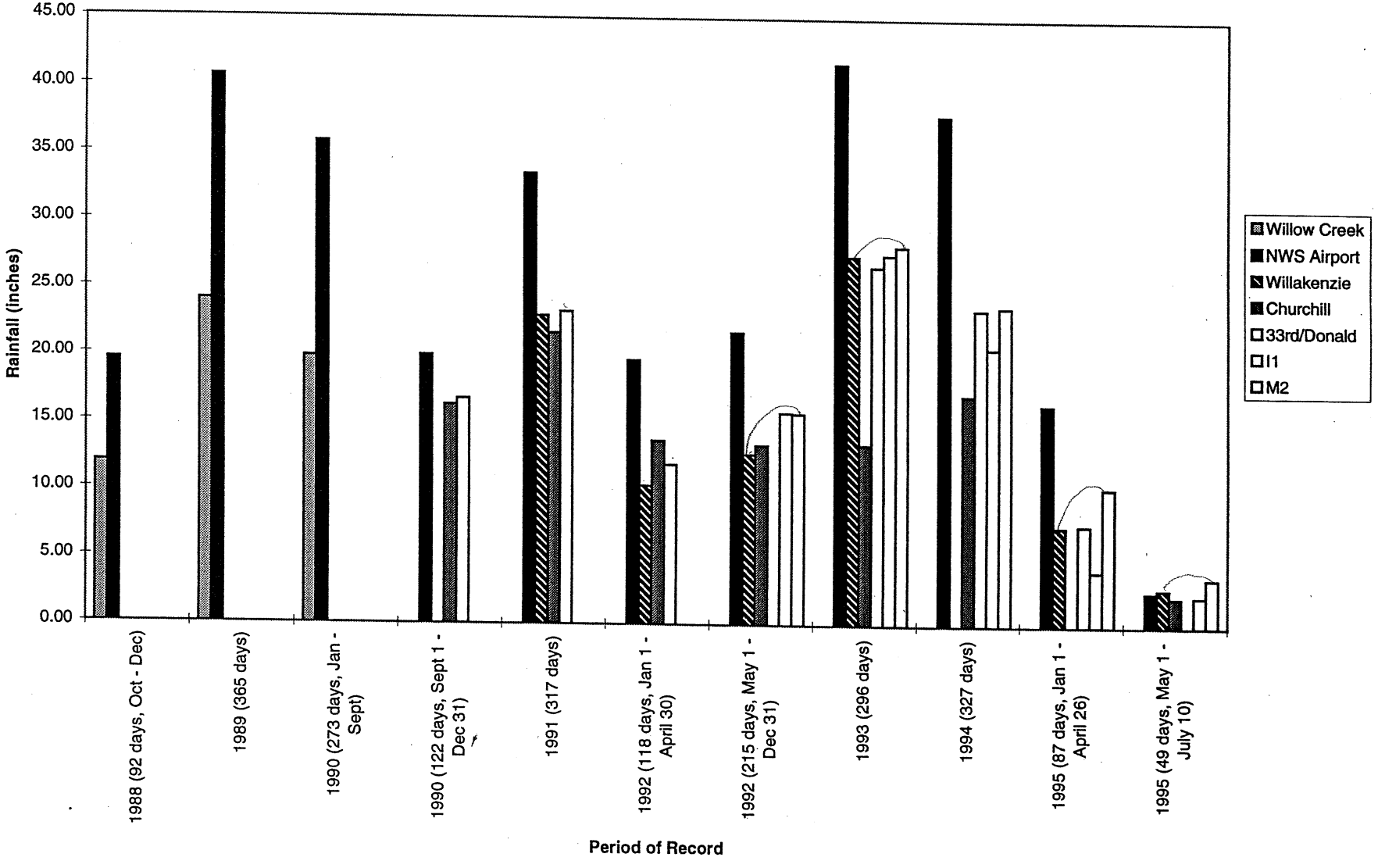


Figure 4
Total Annual Rainfall



Lane County, Oregon

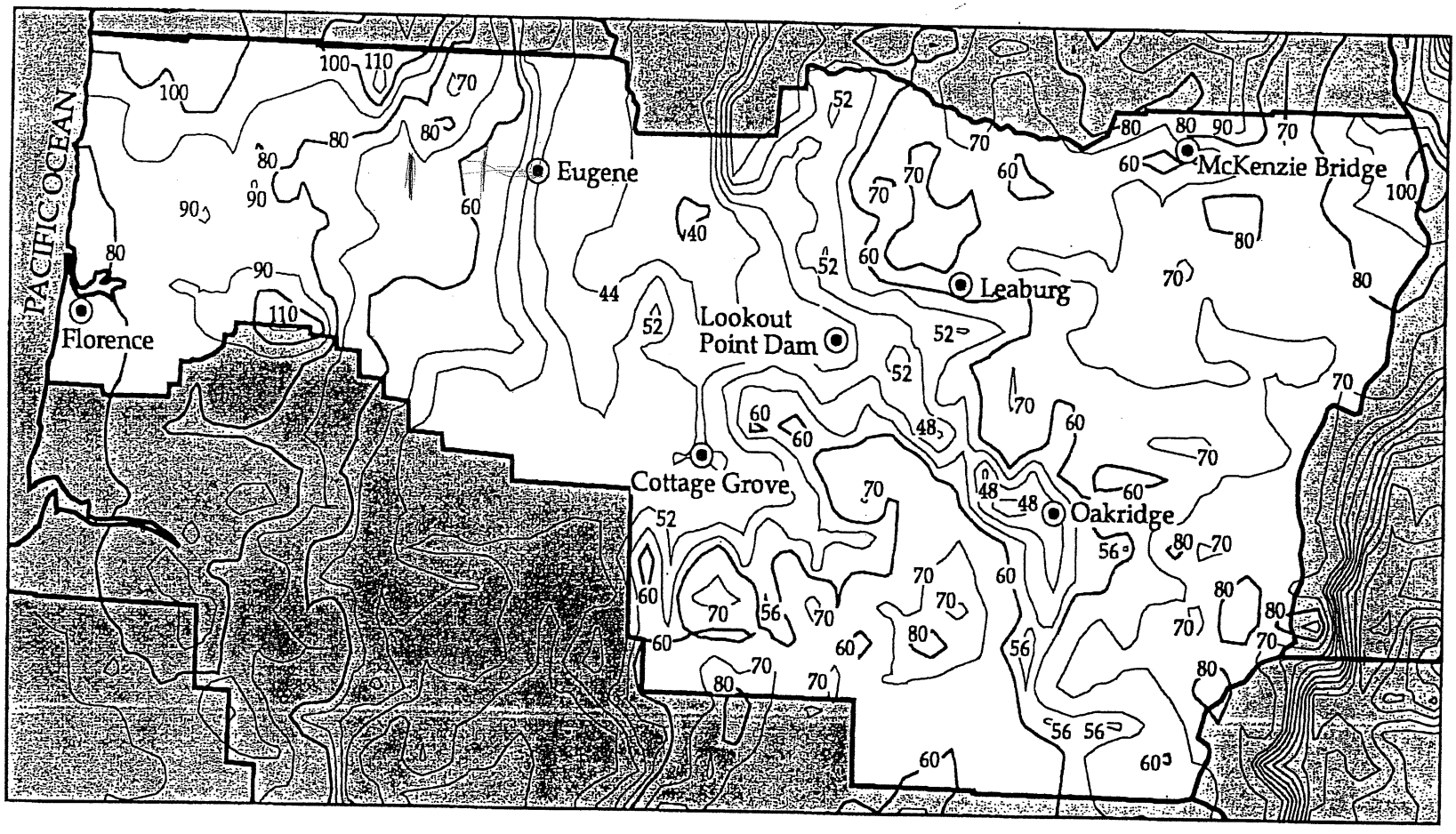


FIGURE 5

1" ≈ 19.2 miles

APPENDIX B

IMPERVIOUS SURFACE AREA FACTORS

Appendix B
Impervious Surface Area Factors

Metro Plan Designation		Buildout Land Use*	Existing Land Use (1998)
Residential	Low-density residential	LDR - 35%	LDR – 35%
	Medium-density residential	HDR -55%	HDR –55%
	High-density residential	HDR – 55%	HDR – 55%
Commercial	Major retail centers	COM – 70%	COM – 70%
	Community commercial	COM – 70%	COM – 70%
	Existing strip commercial	COM – 70%	COM – 70%
	Neighborhood	COM – 70%	COM – 70%
Industrial	Heavy industrial	IND - 60%	Basin Specific: AM: 60%; BD: 45%; LH: 35%; RS: 45%; WC: 60%; WK: 80%; WR: 90%
	Light-medium industrial	IND - 60%	
	Campus industrial	IND - 60%	
	Small-scale light industrial	IND - 60%	
	Special heavy industrial	IND - 60%	
Mixed Uses	Medium-density residential mixed use	HDR – 55%	HDR – 55%
	High-density res. mixed use	HDR – 55%	HDR – 55%
	Commercial mixed use	COM – 70%	COM – 70%
	Commercial/industrial mixed use	IND - 60%	IND – 60%
	Commercial/industrial/residential	COM – 60%	COM – 60%
Public and Semi- Public	Government	GOV – 45%	GOV – 45%
	Education	EDU - 45%	EDU - 45%
	Parks and open space	15%	Basin Specific: AM: 10%; BD: 40%; LH: 5%; RS: 15%; WC: 5%; WK: 5%; WR: 20%
Other	Agriculture	AGT - 0%	AGT - 0%
	Sand and Gravel	SAG - 0%	SAG - 0%
	University/Research	GOV – 45%	GOV – 45%
	Forest Lands	AGT - 0%	AGT - 0%
	Natural Resource	WET - 0%	WET - 0%
	Airport Reserve	GOV – 45%	GOV – 45%
	Rural Residential (Minimum lot size is 5 acres)	RR - 15%	AGT – 15%
	Rural commercial	COM – 70%	COM – 70%
	Rural industrial	IND - 60%	IND – 60%
	Urban reserve (Low-density residential)	LDR - 35%	LDR – 35%
	Cemetery	NA	6%
	Religious	NA	55%
	Streets and right-of-way	75%	75%
	Vacant	NA	0%
	Utility	NA	27%
	Railroad yard	NA	10%

* These factors assume buildout using traditional development practices (i.e., no site planning controls).

APPENDIX C

HYDROLOGIC/HYDRAULIC MODEL INPUT PARAMETERS

Appendix C
Hydrologic/Hydraulic Model Input Parameters

Input parameters generated for the RUNOFF and EXTRAN blocks of XP-SWMM were developed through the use of the City's GIS (geographic information system). The input parameters and their sources are described below for the following three categories of information: 1) meteorological data, 2) subbasin hydrologic data, and 3) storm drainage system hydraulic data.

Meteorological Data:

Precipitation (D1 – E3 Cards in SWMM)

Long-term precipitation data are required for long-term continuous simulation. The only local long-term precipitation data available are from a rain gage at the Eugene Airport, approximately seven miles northwest of Eugene. The rain gage at the airport has been operated by the National Weather Service (NWS) since 1948. The National Weather Service (NWS) compiled their measurements at the Airport from three gages: a non-recording gage and two recording gages (a weighing gage and an automated tipping bucket gage). The weighing gage is considered to be the most accurate gage, and its measurements were used most often. Increments of 0.02 inches of rainfall were recorded by this gage. Data are reported in hourly increments. The tipping bucket gage was used to verify the measurements recorded from the weighing gage. Rainfall data were measured in increments of 0.01 inches by the tipping bucket gage but the operation of the gage was considered to be less accurate than the weighing gage (based on measurements from the non-recording gage). The non-recording gage was also used intermittently to verify the measurements from the weighing gage. The non-recording gage consists of an 8-inch diameter copper collection cylinder and a 1-inch diameter measuring tube. Water depth in the measuring tube was measured with a stick to the nearest 0.01 to 0.02 inches.

Due to budget constraints, the NWS has recently closed their Eugene office. To reduce the need for staff, an Automated Surface Observation System (ASOS) was installed which includes a new tipping bucket rain gage. As of March 1, 1996, the ASOS gage is the official NWS gage for Eugene. When the office closed, measurements from the old weighing gage were used to verify measurements from the new ASOS gage. Initial results from this comparison showed that the ASOS gage is measuring smaller amounts of rain when compared to the weighing gage. As an example, for one March storm, the weighing gage measured 0.75" while the ASOS gage measured 0.61". This should be noted when any additional rainfall related studies are conducted in Eugene.

Short-term rainfall data, for periods of six years or less, were available from several rain gages operated by the City located within Eugene. All of the City gages used throughout the Eugene area are tipping bucket type gages. As mentioned above, tipping bucket gages are suspected of underestimating rainfall volumes. However, as these were the only data with 15 minute intervals reported (as opposed to hourly), some of these data were used in the analyses for conducting calibrations. To compensate for this potential underestimation, NWS data were used to run the models as described in the discussion that follows.

It is important to note that a comparison was made between the rainfall data gathered at the airport and the rainfall data gathered from six City gages and a significant difference was noted. The NWS gage consistently reported higher rainfall amounts with an overall average difference of 37% over a six year period. The difference is probably partly real based on location, and partly a result of measurement inaccuracies. An analysis of these rainfall data and their differences was conducted for this study. The results of the analysis are described in detail in a white paper titled *City of Eugene, Analysis of Precipitation Data for Use in Hydrologic/Hydraulic Modeling, April 12, 1996* (see Appendix C). As a result of the analysis, an attempt was made to calibrate the models using both of the data sets. Model adjustments that were needed to calibrate the model were more realistic when using the City's rainfall data. In order to get the model calibrated with the NWS data, calibration adjustments were not realistic. Therefore, a decision was made to use recent data from City gages to conduct the calibrations. However, a decision was also made to use National Weather Service data to run the models, identify problems, and design capital projects. The reason for this decision was that long term data were needed to select design storms. In addition, this decision was considered to add a desired level of conservatism or factor of safety to the model results.

Evaporation (F1 Card in SWMM)

Monthly evapotranspiration data are needed for long-term continuous modeling. Evapotranspiration data applicable for Eugene have been developed by the Oregon State Agricultural Extension for the Willamette Valley (Region 5). For grass, the monthly evapotranspiration rates are as follows:

- January = 0.71 inches
- February = 1.13 inches
- March = 1.54 inches
- April = 3.39 inches
- May = 4.61 inches
- June = 5.24 inches
- July = 6.38 inches
- August = 5.31 inches
- September = 4.06 inches
- October = 2.52 inches
- November = 0.47 inches
- December = 0.71 inches

These monthly evaporation rates represent the evaporation which would occur in a typical year (based on a probability of 19 out of every 20 years). The values were used in the model for the entire continuous simulation and were not varied from year to year.

Hydrologic Data:

Each of the major drainage basins was subdivided into smaller subbasins for modeling by XP-SWMM. Initial subbasins boundaries were delineated based on both topography and the storm drainage system layout. The subbasin boundaries were digitized into the City's GIS and the

subbasin hydrologic data were developed. The following parameters were required in the RUNOFF block for each subbasin:

- subbasin name or number
- channel or pipe inlet node number into the storm drainage system
- subbasin width (feet)
- subbasin area (acres)
- hydraulically connected impervious percentage (percent)
- average ground slope (dimensionless, ft/ft)
- Manning's roughness coefficient for impervious areas
- Manning's roughness coefficient for pervious areas
- Depression storage for impervious areas (inches of water over subbasin)
- Depression storage for pervious areas (inches of water over subbasin)
- Green-Ampt soil infiltration parameters: average capillary suction (inches), saturated hydraulic conductivity (inches/hour), and initial moisture deficit (volume air/volume voids)

For each of these parameters, a discussion is presented below describing the methods used to generate the values. For many of these parameters, the City's GIS was used to generate area-weighted average values for each subbasin.

Subbasin Name or Number

A seven-digit name was assigned to each subbasin. The first two digits represent a two-letter abbreviation for the major basin. The second two digits represent a two-letter abbreviation for the major subbasin. And the last three digits consist of numbers, starting with 010 and increasing in increments of 10 for each additional subbasin. For example, the first two subbasins in the headwaters subbasin within the Amazon Creek Basin are AMHW010 and AMHW020. The subbasins are numbered starting at the downstream end.

Channel or Pipe Inlet Number

The RUNOFF block of XP-SWMM was used to generate a stormwater runoff hydrograph for each subbasin. This hydrograph was routed by the EXTRAN block of XP-SWMM to model the storm drainage system. A node number for where the hydrograph enters the storm drainage system was identified for each subbasin.

Subbasin Width (units = feet)

The subbasin width was determined from the basin maps using one of two different methods, depending on the location of the subbasin within the major basin:

- For the furthest upstream subbasin on each drainage system, the subbasin width is the area of the subbasin divided by the average maximum distance from the subbasin boundary to the channel inlet or pipe inlet point.
- For the remaining subbasins, the subbasin width is the area of the subbasin divided by the average maximum distance from the subbasin boundary to the main flow path of the drainage system (pipe or open channel).

Subbasin Area (units = acres)

The subbasin areas were generated by the GIS using the delineated subbasin boundaries.

Subbasin Impervious Percentage

In order to determine stormwater utility fees, the City developed the following three user type categories for all developed land:

- Small residential category: applies to all developed residential properties where the building footprint is less than 1,000 square feet. In this category, it is assumed that each property has 1,800 square feet of impervious surfaces (e.g., driveway, home, patio, etc.).
- Medium residential category: applies to all developed residential properties where the building footprint is greater than 1,000 square feet but less than 3, 000 square feet. In this category, it is assumed that each property has 2,900 square feet of impervious surfaces (e.g., driveway, home, patio, etc.).
- General category: includes all developed commercial and industrial properties, as well as all developed residential properties where the building footprint is greater than 3,000 square feet. For all properties which fall into the general category, the actual impervious surfaces were digitized for each property.

The storm drainage system was evaluated under existing and full buildout land use conditions. For the existing land use conditions scenario, the user type categories listed above were used to generate the total impervious area within each subbasin.

The future buildout land use conditions were based on the 1987 Metropolitan Plan designations, which represent the planned land use necessary to accommodate anticipated growth over the next twenty years. For the full buildout land use scenario, the existing developed properties were used to generate typical impervious percentages for future residential, commercial, and industrial land uses. These typical impervious percentages were then applied to the vacant lands (according to their comprehensive plan designation) to develop the expected impervious area under the full buildout scenario.

For each subbasin, these impervious areas represent the "mapped" impervious areas. XP-SWMM requires the "effective" impervious areas, which is the portion of the "mapped" impervious area that is directly connected to the drainage system, such as streets and driveways. In order to estimate the "effective" impervious area, the "mapped" impervious areas were initially adjusted using the following methods (Sutherland, 1995):

- For subbasins which are predominately sewered with curbs and gutters, have no infiltration facilities (e.g., dry wells), and the residential rooftops are not directly connected to the drainage system:

$$\text{Effective Imp. \%} = 0.1 * (\text{Mapped Imp. \%})^{1.5}$$

- For subbasins which are predominately sewered with curbs and gutters, have no infiltration facilities (e.g., dry wells), and the residential rooftops are directly connected to the drainage system:

  Effective Imp. % = 0.4 * (Mapped Imp. %)$^{1.2}$

- For subbasins which are predominately sewered with curbs and gutters but a small portion of the subbasin drains to infiltration facilities (e.g., dry wells):

  Effective Imp. % = 0.04 * (Mapped Imp. %)$^{1.7}$

- For subbasins where a large portion (i.e., 70% or more) of the subbasin discharges to infiltration facilities (e.g., dry wells) and for the Willow Creek Basin, where only a small percentage of the subbasin is sewered:

  Effective Imp. % = 0.01 * (Mapped Imp. %)$^{2.0}$

The GIS was used to generate the "mapped" and "effective" impervious areas for each subbasin for the existing and anticipated full buildout land use conditions.

Subbasin Slope (units = dimensionless, ft/ft)

The subbasin slope equals the average slope along the pathway of overland flow to the inlet of the drainage system. The subbasin slope was determined using the digital topographic data that is now available in the City's GIS.

Manning's Roughness Coefficient for Impervious Areas (dimensionless)

The Manning's roughness for impervious surfaces was based on values presented in the EPA SWMM Manual. Based on the assumption that most, if not all, of the impervious surfaces are asphalt or concrete, the Manning's roughness coefficient for impervious areas was set equal to 0.012.

Manning's Roughness Coefficient for Pervious Areas (dimensionless)

Aerial photographs for each of the basins were used to estimate the average roughness coefficient value for the pervious areas within each subbasin based on the cover types and Manning's roughness coefficients listed in the following table:

Table 3-1
Manning's Roughness Coefficient for Pervious Areas

Cover Type	Manning's n
lawn or turf grass in urbanized areas	0.45
Pasture or cropland	0.20
Dense shrubs and/or forest	0.40

Depression Storage for Impervious Areas (units = inches)

Depression storage is the volume that must be filled prior to the occurrence of runoff (i.e., surface ponding, surface wetting, interception and evaporation). Depression storage is one of the primary calibration parameters for runoff volume. Initially, the depression storage was set equal to 0.05 inches for all impervious areas.

Depression Storage for Pervious Areas (units = inches)

Typically, the depression storage is based on USDA soil texture classification for pervious areas. In Eugene, the locations and specific information on soils are available in ArcInfo from the Soil Survey of Lane County produced in 1981 by the Natural Resources Conservation Service (formerly Soil Conservation Service). The 37 different soil series present in Eugene can be combined into 3 groups based on their USDA soil texture classification: sand, loam, and clay, as shown in the table presented below.

Table 3-2
Soil Classifications in Eugene

USDA Soil Texture Class	SCS Soil Names and Numbers in Eugene
Sand	Fluvents (48); Riverwash (114)
Loam	Awbrig (5,6); Bellpine (11C,11D,11E,11F); Camas (22,23); Chapman (24,25); Chehalis (26,27); Chehulpum (28C, 28E); Cloquato (29, 30); Coburg (31,32);Conser (33); Courtney (34); Dayton (38); Dixonville (41C, 41E, 41F, 42E, 43C, 43E, 127C); Dupee (45C); Hazelair (52B, 52D); Holcomb (56); Jory (63C); Malabon (75,76); McAlpin (78); McBee (79); Natroy (85, 87); Nekia (89C, 89D, 89E); Newburg (95, 96, 97); Ochrepts (99H); Oxley (100, 101); Panther (102, 103C); Pengra (105A, 106A); Ritner (113C, 113E, 113G); Salem (118, 119); Salkum (121B); Steiwer (125C, 125D, 125F); Waldo (130); Willakenzie (135C. 135D, 135E, 135F); Witzel (138E, 138G)
Clay	Bashaw (8,9); Philomath (107C, 108C, 108F, 109F)

As shown in the above table, loam is the predominant soil type in Eugene. Therefore, the depression storage was set equal to 0.15 inches (typical for loam) for each subbasin.

Green-Ampt Infiltration Parameters (units vary)

In order to estimate the infiltration losses associated with pervious areas, the Green-Ampt infiltration option requires estimation of three infiltration parameters: average capillary suction (derived from soil moisture – conductivity data in units of inches), saturated hydraulic conductivity (represents permeability in inches per hour), and initial moisture deficit (represents the fraction difference between soil porosity and actual moisture content and is a dimensionless ratio). The values for each of these three infiltration parameters are based on the soil types found in the Eugene area. The locations and specific information on the soils present in Eugene are available in ArcInfo from the Soil Survey of Lane County produced in 1981 by the Natural

Resources Conservation Service (formerly Soil Conservation Service). Approximately 37 different soil series are present in Eugene. The 37 soil series have been combined into 8 groups based on their USDA soil texture classification (e.g., sand, loam, silty clay, etc.). The soil texture groups present in Eugene, their corresponding SCS soil names and map numbers, and the values for the Green-Ampt infiltration parameters, which have been estimated from literature values presented by Rawls, et. Al. (1983), are summarized in the following table:

Table 3-3
Green-Ampt Infiltration Parameters

USDA Soil Texture Class	SCS Soil Names and Numbers in Eugene	Avg. Capillary Suction (in)	Saturated Hydraulic Conductivity (in/hr)	Initial Moisture Deficit
Sand	Fluvents (48); Riverwash (114)	1.9	9.3	0.42
Sandy loam	Camas (22,23); Newburg (95, 96, 97)	4.3	0.9	0.41
Loam	Chapman (24,25); Steiwer (125C, 125D, 125F); Witzel (138E, 138G)	3.5	0.3	0.43
Silt loam	Chehulpum (28C, 28E); Cloquato (29, 30); Dayton (38); Dupee (45C); Ochrepts (99H); Oxley (100, 101); Pengra (105A, 106A); Salem (118, 119)	6.6	0.5	0.49
Clay loam	Willakenzie (135C. 135D, 135E, 135F)	8.2	0.08	0.31
Silty clay loam	Awbrig (5,6); Bellpine (11C,11D,11E,11F); Chehalis (26,27); Coburg (31,32); Conser (33); Courtney (34); Dixonville (41C, 41E, 41F, 42E, 43C, 43E, 127C); Hazelair (52B, 52D); Holcomb (56); Jory (63C); Malabon (75,76); McAlpin (78); McBee (79); Natroy (85, 87); Nekia (89C, 89D, 89E); Panther (102, 103C); Ritner (113C, 113E, 113G); Salkum (121B); Waldo (130)	10.7	0.08	0.43
Silty clay	Philomath (107C, 108C, 108F, 109F)	11.5	0.04	0.42
Clay	Bashaw (8,9)	12.5	0.02	0.39

Based on the values presented in the above table, the City's GIS was used to generate area-weighted values for each subbasin for the three infiltration parameters.

Hydraulic Data:

The primary purpose of the modeling was to conduct a hydraulic analysis of the storm drainage system. The evaluation of the storm drainage system included a hydraulic analysis of the major

storm sewer pipes, culverts, and open channels which convey stormwater discharges. The information for the culverts and open channel segments was compiled from previous flood control and natural resource studies and supplemented with field surveys where deemed necessary. The evaluation of the storm sewer pipes concentrated on the significant components of the drainage system, typically all sewer pipes with a diameter of 36" or greater. The exception was the Willamette River basin. As the Willamette River basin is mostly built-out, only a couple of pipe segments were modeled based on known flooding related issues. Specific criteria were not established for the selection of open waterways that were modeled. Meetings were held to select open waterways for modeling based on use of the waterway for public drainage and based on expected development patterns.

In order to analyze the hydraulic capacity of the storm drainage systems, the EXTRAN block of SWMM required the following parameters for each modeled conduit.

- conduit name
- upstream node number
- downstream node number
- conduit shape (e.g., circular, shape of open channel cross-section, etc.)
- diameter for pipe sections (inches)
- conduit length (feet)
- invert elevation at upstream node (feet)
- ground surface elevation at upstream node for pipe conduits (feet)
- invert elevation at downstream node (feet)
- ground elevation at downstream node for pipe conduits (feet)
- conduit material (e.g., concrete, corrugated metal, vegetation, etc.)

For each of these parameters, a discussion is presented below describing the methods used to generate the values used in XP-SWMM.

Conduit Name or Number, Upstream Node Number, and Downstream Node Number

The extent of the storm sewer system to be modeled and the individual pipe and open channel sections were defined on the basin maps. In general, all sewer pipes with a diameter of 36" or greater and smaller pipes of special interest to the City were included in the evaluation. The locations of individual node points were also identified on the basin maps. Node points were assigned whenever the following criteria were met:

- change in conduit size
- change in conduit material
- significant change in conduit slope
- inlet point for subbasin hydrograph
- concentration point for multiple conduits

Therefore, each conduit may include several individual pipes or open channel sections if none of the above criteria are met. For example, several lengths of 36" diameter pipe were combined and evaluated as one pipe section if the pipe material was constant and the slope did not change significantly.

The name for each conduit is the subbasin name with a letter extension beginning with an A for the most upstream conduit in the subbasin. For each conduit, all of the following input parameters were needed.

Conduit Shape

Unless otherwise specified, each pipe section was assumed to be circular. For the Amazon Creek, the shape of open channel sections was based on cross-section information from previous modeling work (OTAK, 1990) and supplemented by additional field survey work conducted for this project. For all other open channels included in the models, the shape of the cross-sections was based on photographs of the channel or field survey work conducted for this project.

Pipe Diameter

The diameter for each pipe section, in inches, was available and downloaded from the GIS.

Conduit Length

The lengths of each pipe section were downloaded from the GIS. As described above, one pipe section may have included several lengths of individual pipes. Therefore, the length of each pipe section is the total length from the upstream node to the downstream node. Where available, the measured lengths were used. If the measured length was not available, the length was scaled from the maps. The open channel lengths were taken from previous modeling work (OTAK, 1990), field survey data for this project, or scaled from the maps.

Invert Elevations at Upstream and Downstream Nodes

The upstream and downstream invert elevations for each pipe section were available and downloaded from the GIS. Invert elevations for open channels were taken from previous modeling work (OTAK, 1990) or field survey data for this project.

Ground Surface Elevation at Upstream and Downstream Nodes

The ground surface elevation at each node location is necessary to accurately simulate possible surcharging of the sewer system. The elevation of the rim of each manhole was available and downloaded from the GIS. In some cases, field surveys were needed to verify or collect elevation data.

Conduit Material

In order to assign a Manning roughness coefficient for each pipe section, the pipe material must be specified. The pipe material was available and downloaded from the GIS and the roughness coefficient was assigned accordingly. For open channel sections, roughness coefficients were assigned based on photos of the vegetation conditions in each open channel.

APPENDIX D

CITY OF EUGENE SWMM CALIBRATION INFORMATION
SEPTEMBER 25, 1997

CITY OF EUGENE
SWMM CALIBRATION INFORMATION
September 25, 1997

EPA's Storm Water Management Model (SWMM) was the model recommended by Woodward-Clyde and selected by the City of Eugene for simulating the hydrologic and hydraulic performance of Eugene's storm drainage system. As with all mathematical models, the accuracy of the predictions is significantly improved if field measurements can be used to calibrate the model.

As a result of Eugene's foresight in establishing continuous monitoring stations, approximately five years of continuous flow and rainfall measurements are available for two of the major basins: the Amazon basin at Amazon Park (29th Street) and the Bethel-Danebo basin at the Bertelsen Slough. One year of continuously measured flow and rainfall data are also available from The Nature Conservancy (TNC) for the Willow Creek basin immediately downstream of West 18th St. From these records, storm events were selected to compare actual measured flows with model predictions. The model parameters were adjusted to reduce the differences between them. Finally, the model calibrations were verified by modeling several other storms.

Amazon Results - The results of the Amazon calibration are presented in Figures 1 - 6. Figure 1 provides a description of the two phases to the Amazon calibration including locations where flow information was available, drainage area characteristics, and a description of the storms which were used for the calibration. Figure 2 shows the results of the initial model run (no adjustments made to the model) using both the National Weather Service rain data and the City rain data. As can be seen from this graph, flows were significantly over-predicted when using the NWS rain data. Calibration adjustments which would be needed in order to use NWS rain data would not have been realistic (e.g., impervious areas would have to be reduced to unrealistic levels). Therefore, a decision was made to calibrate the models using City rain data.

Many runs were made to adjust model input parameters to calibrate modeled flows with measured flows. Figures 3 through 5 show the results of the final calibration runs for storms #1a, #1b, #2a, and #2b. Figure 6 shows the results of the model run that was used to verify the calibrations (storm #3). Calibration adjustments that were made to the model are provided in Figure 17.

Bethel-Danebo Results - The results of the Bethel-Danebo calibration are presented in Figures 7 - 13. Figure 7 provides a description of the Bethel-Danebo calibration including locations where flow information was available, drainage area characteristics, and a

description of the storms which were used for the calibration. Two calibration stations exist in this basin: I1 which is located at the upstream end of the Bertelsen Slough and I2 which is located at the downstream end of the Bertelsen Slough. Figures 8 and 9 show the results of the initial model runs (no adjustments made to the model) using both the National Weather Service rain data and the City rain data at stations I1 and I2. As can be seen from this graph, flows were actually somewhat under-predicted when using the NWS rain data. This is likely due to the fact that the NWS changed their rain gaging equipment in 1996 and these storms occurred after that change was made. To be consistent with the Amazon calibration, the Bethel-Danebo basin was calibrated using City rain data.

Many runs were made to adjust model input parameters to calibrate modeled flows with measured flows. Figures 10 and 11 show the results of the final calibration runs at stations I1 and I2 for the February 1997 storm. Figures 12 and 13 show the results of the model run that was used to verify the calibrations. Calibration adjustments that were made to the model are provided in Figure 17.

Willow Creek Results - The results of the Willow Creek calibration are presented in Figures 14 - 16. Figure 14 provides a description of the Willow Creek calibration including locations where flow information was available, drainage area characteristics, and a description of the storms which were used for the calibration. Figure 15 shows the results of the initial model run (no adjustments made to the model) using both the National Weather Service rain data and the Nature Conservancy rain data. Although the prediction of the peak flow was closer when using NWS data, it would have been impossible to bring the other peaks up in the model without increasing the highest peak as well (i.e., the shape of the hydrograph using NWS data was different than the measured shape of the hydrograph). The shape of the hydrograph using TNC rain data more closely matched the shape of the hydrograph for measured flow. Therefore, a decision was made to calibrate the models using TNC rain data.

Many runs were made to adjust model input parameters to calibrate modeled flows with measured flows. Figure 16 shows the results of the final calibration run for the January, 1990 storm. As the TNC flow and rainfall measurements were only collected for a period of one year, a verification storm was not available in this record. Calibration adjustments that were made to the model are provided in Figure 17.

FIGURE 1
AMAZON CREEK BASIN CALIBRATION

PHASE 1: UPPER AMAZON BASIN

Measured Flow: NPDES Station M1 (Amazon Park at 29th)
Data Available from April, 1992 through present

Drainage Area Characteristics:

- Mixture of sewer pipes and open channels
- Area = 3261 acres
- Mapped Impervious Percentage = 28%
- Average Slope = 0.22

Calibration and Verification Storms (City Rainfall Data from M2):

- January 12 to February 1, 1994 (two storms - total rainfall volume storm #1a = 2.83", total rainfall volume storm #1b = 1.99")
- December 1 to December 12, 1995 (two storms - total rainfall volume storm #2a = 1.89" total rainfall volume storm #2b = 0.88")
- January 26 to February 11, 1996 (total rainfall volume = 2.97 inches)

PHASE 2: ENTIRE AMAZON BASIN

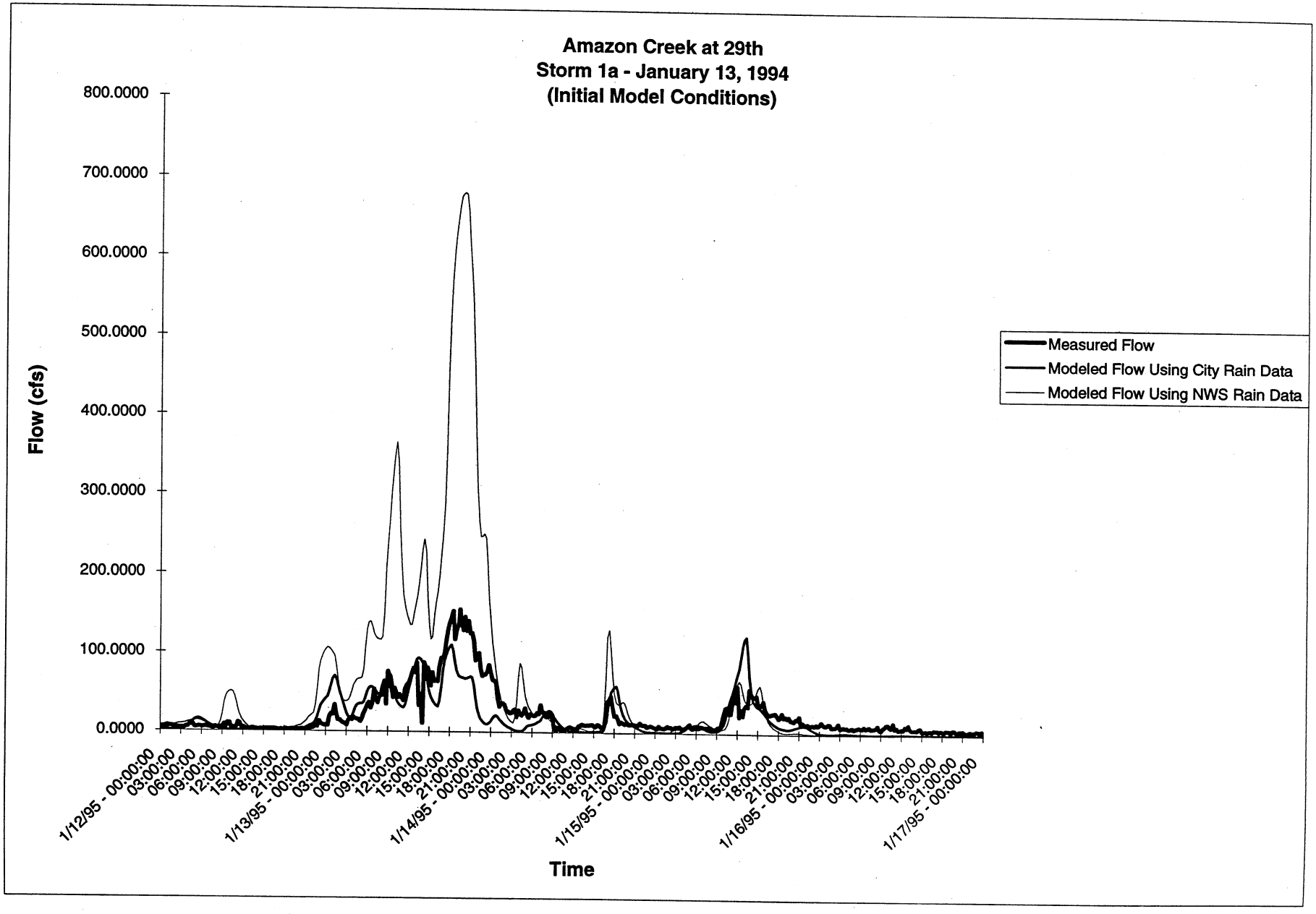
Instantaneous Peak Flow Measurements available from USGS at Amazon Creek approximately 250 feet upstream of the diversion structure.
Maximum Water Surface Elevations available from City for February 1996

Drainage Area Characteristics:

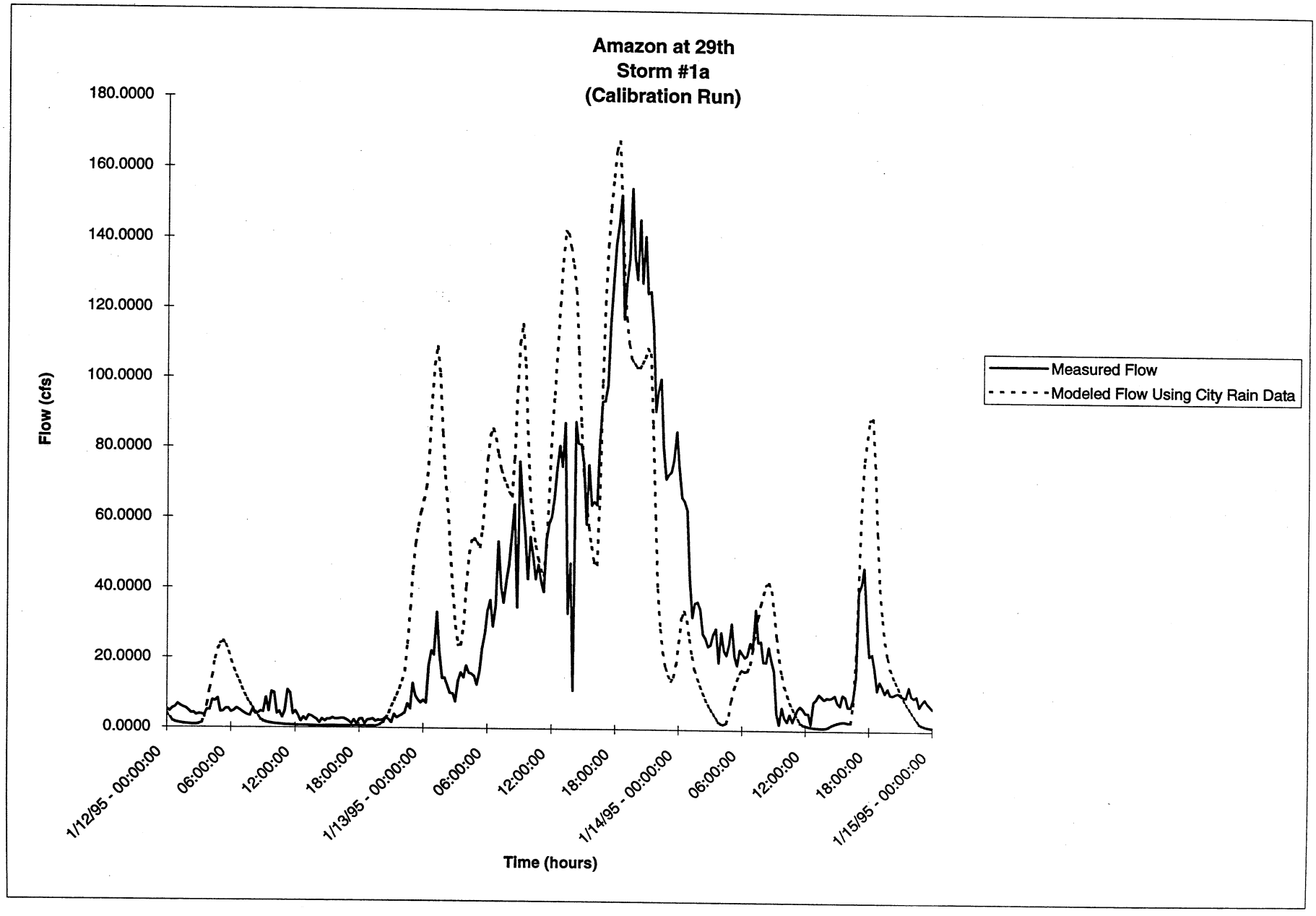
- Mixture of sewer pipes and open channels
- Area = 10,532 acres
- Mapped Impervious Percentage = 31%
- Average Slope = 0.13

Verification Storms (Peak flows tabulated in a USGS Report):

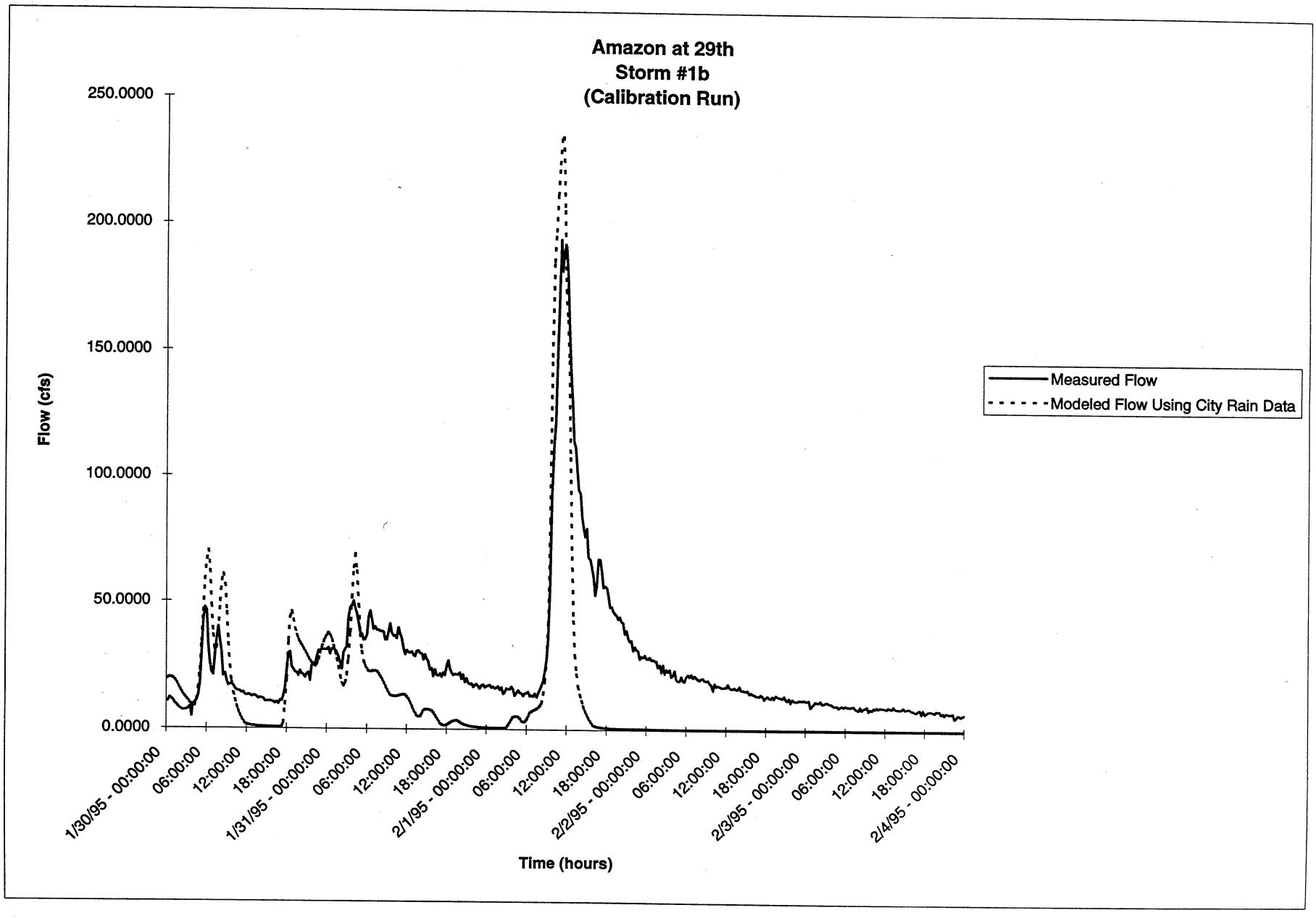
- December 1964
- December 1981
- February 1996



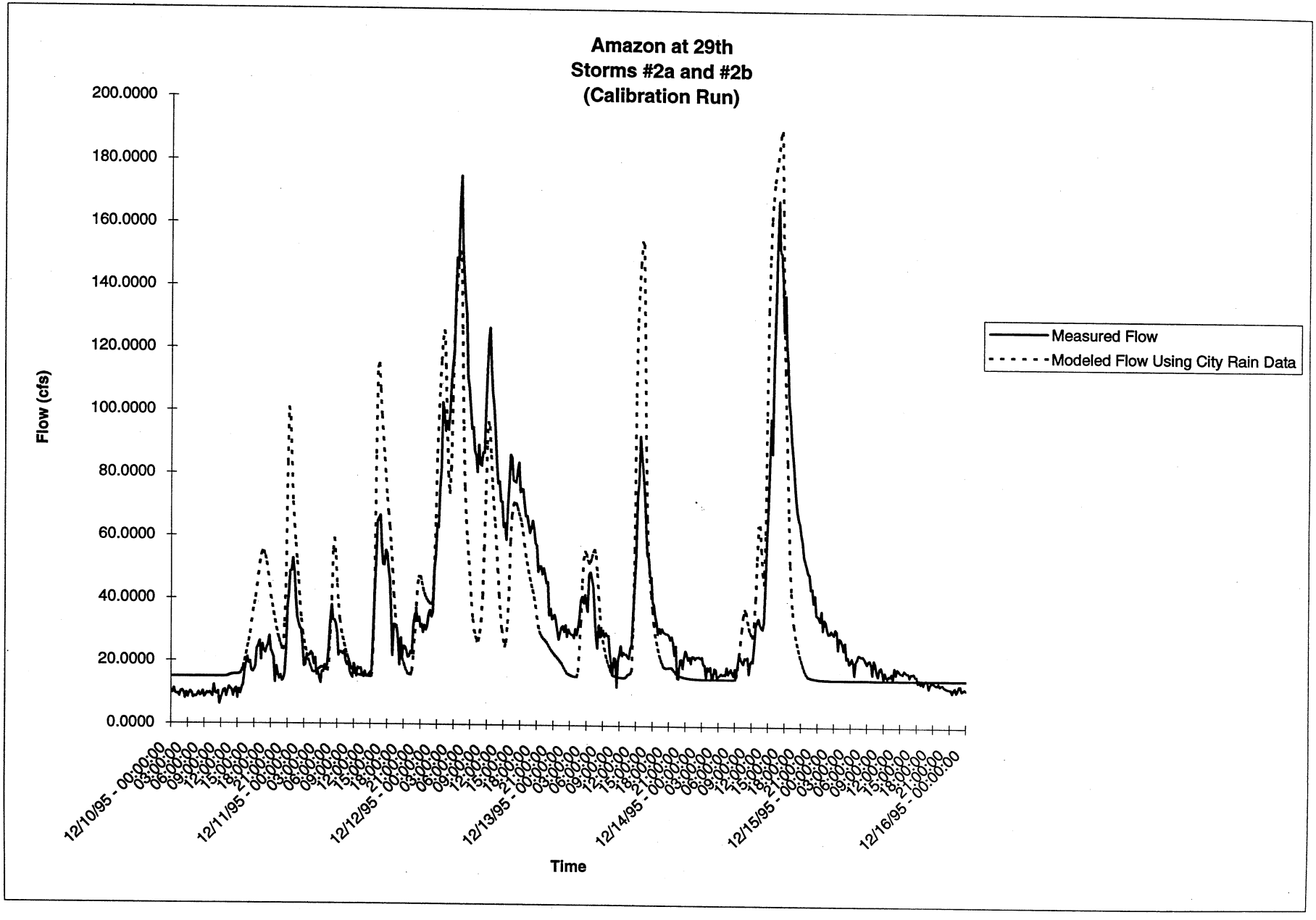
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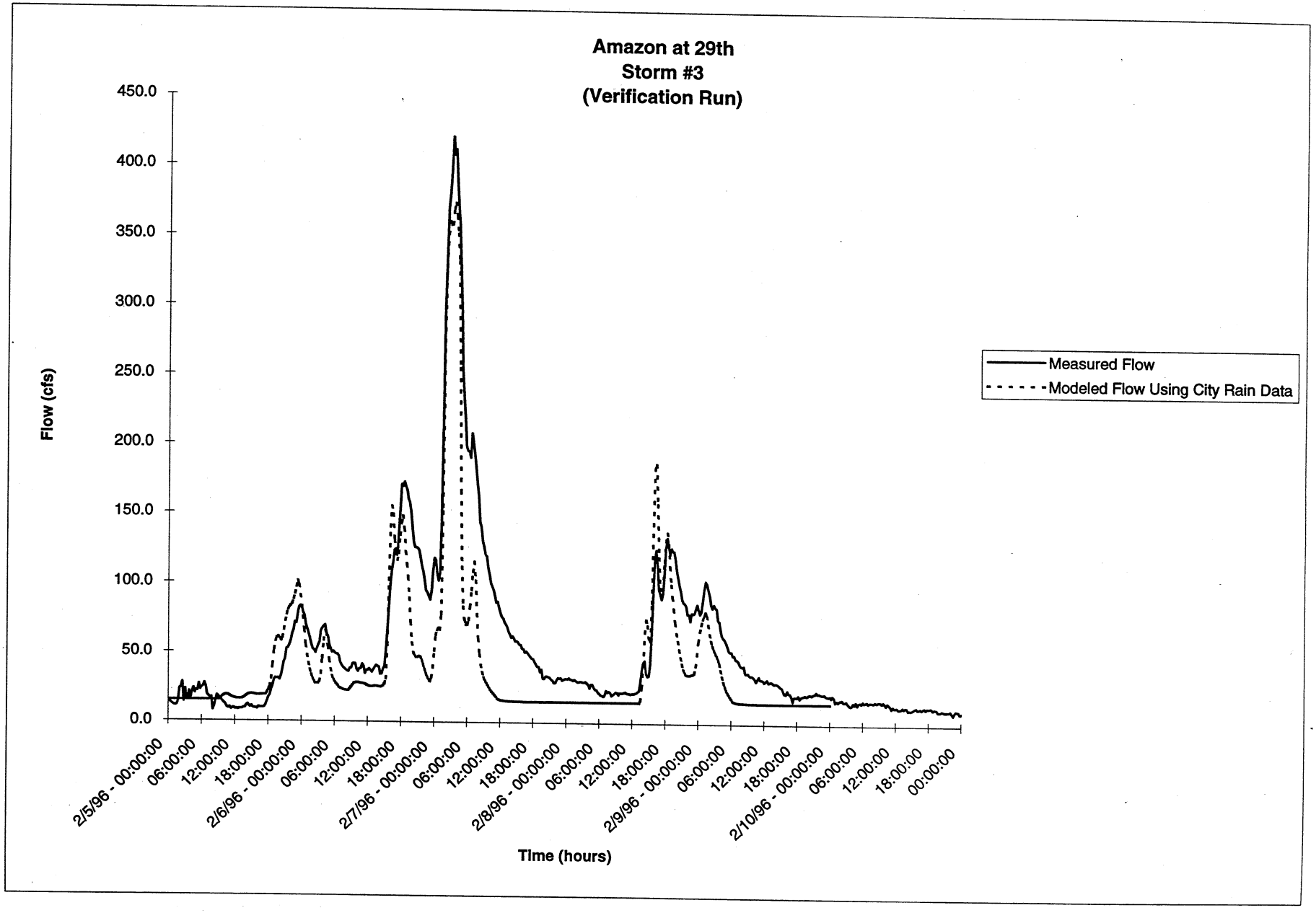
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s:\proj94\945042na\task0300\amazon\calib\storm2\run26grph.xls



s:\proj94\945042na\task0300\amazon\calib\storm3\run24grp.xls

FIGURE 7
BETHEL- DANEBO BASIN CALIBRATION

Measured Flow: NPDES Stations I1 and I2 (Bertlesen Slough at Wallis St. and Bertlesen Rd.)

Data Available from April, 1992 through present

Drainage Area Characteristics:

- Mixture of sewer pipes, open channels and a large wetland
- Area - I1- 925 acres, I2- 1031 acres
- Mapped Impervious Area Percentage - 20%
- Average Slope - 0.012

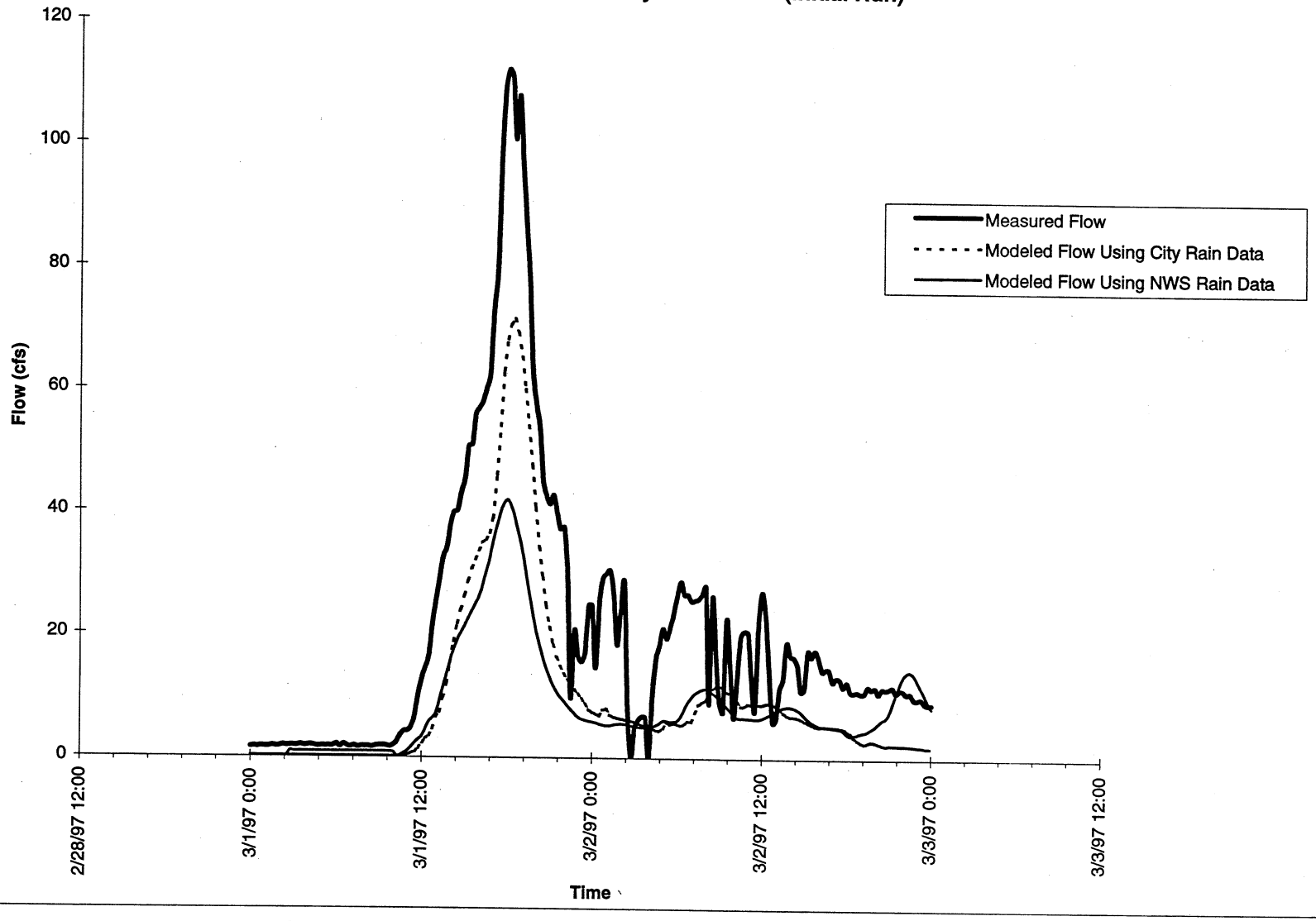
Calibration Storm: February, 1997, City Rain Data (I1)

- Total Volume - 2.6 inches
- Maximum Intensity - 0.39 inches/hr
- Duration - 6 days

Verification Storm: January, 1997, City Rain Data (I1)

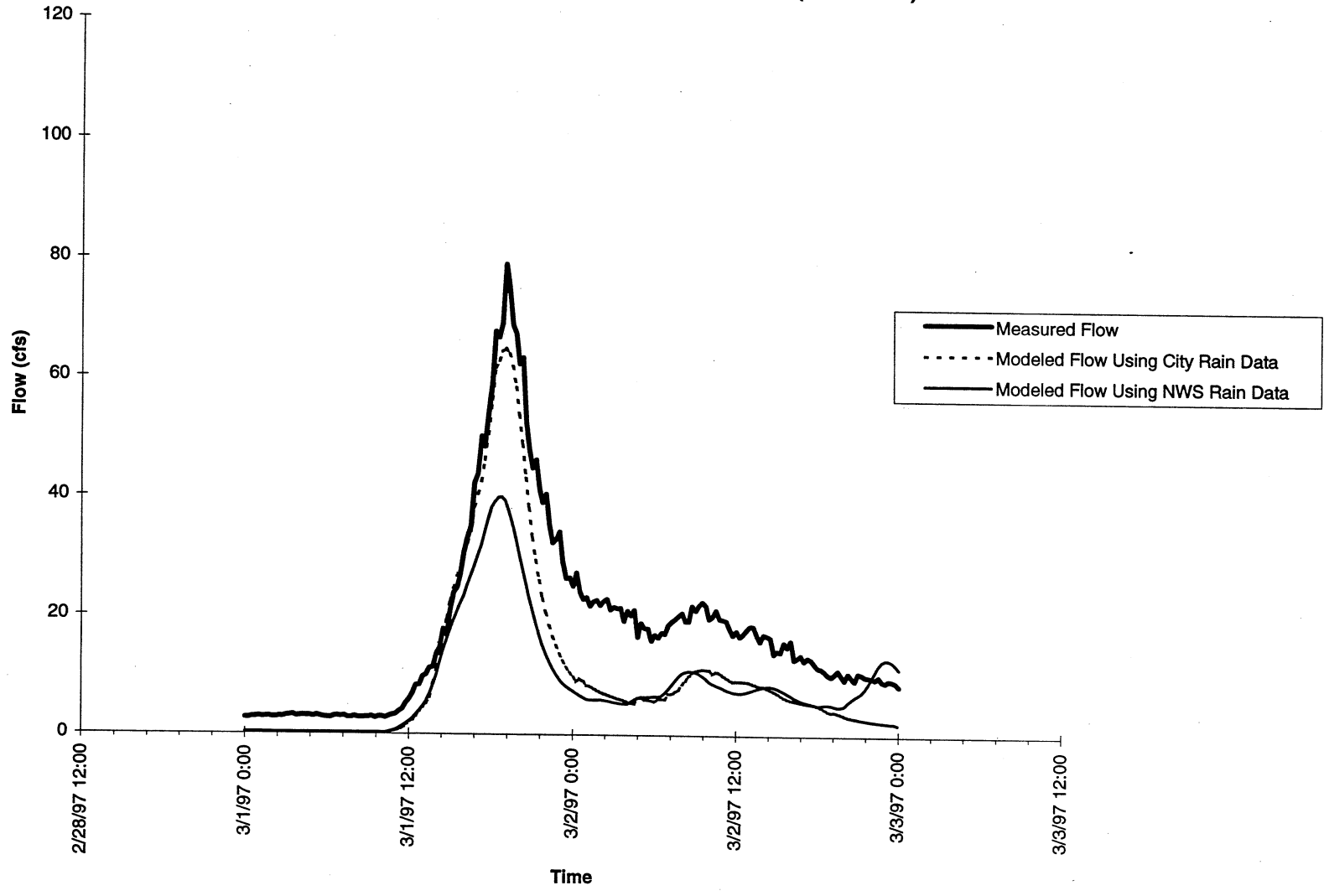
- Total Volume - 4.84 inches
- Maximum Intensity - 0.23 inches/hr
- Duration - 10 days

FIGURE 8
Bethel-Danebo - I1 Station
February 1997 Storm (Initial Run)



s:\proj94\945042na\task0300\present\bdcal1.xls

FIGURE 9
Bethel-Danebo- I2 Station
February 1997 Storm (Initial Run)



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FIGURE 10
Bethel-Danebo - Station I1
February 1997 Storm (Calibration Run)

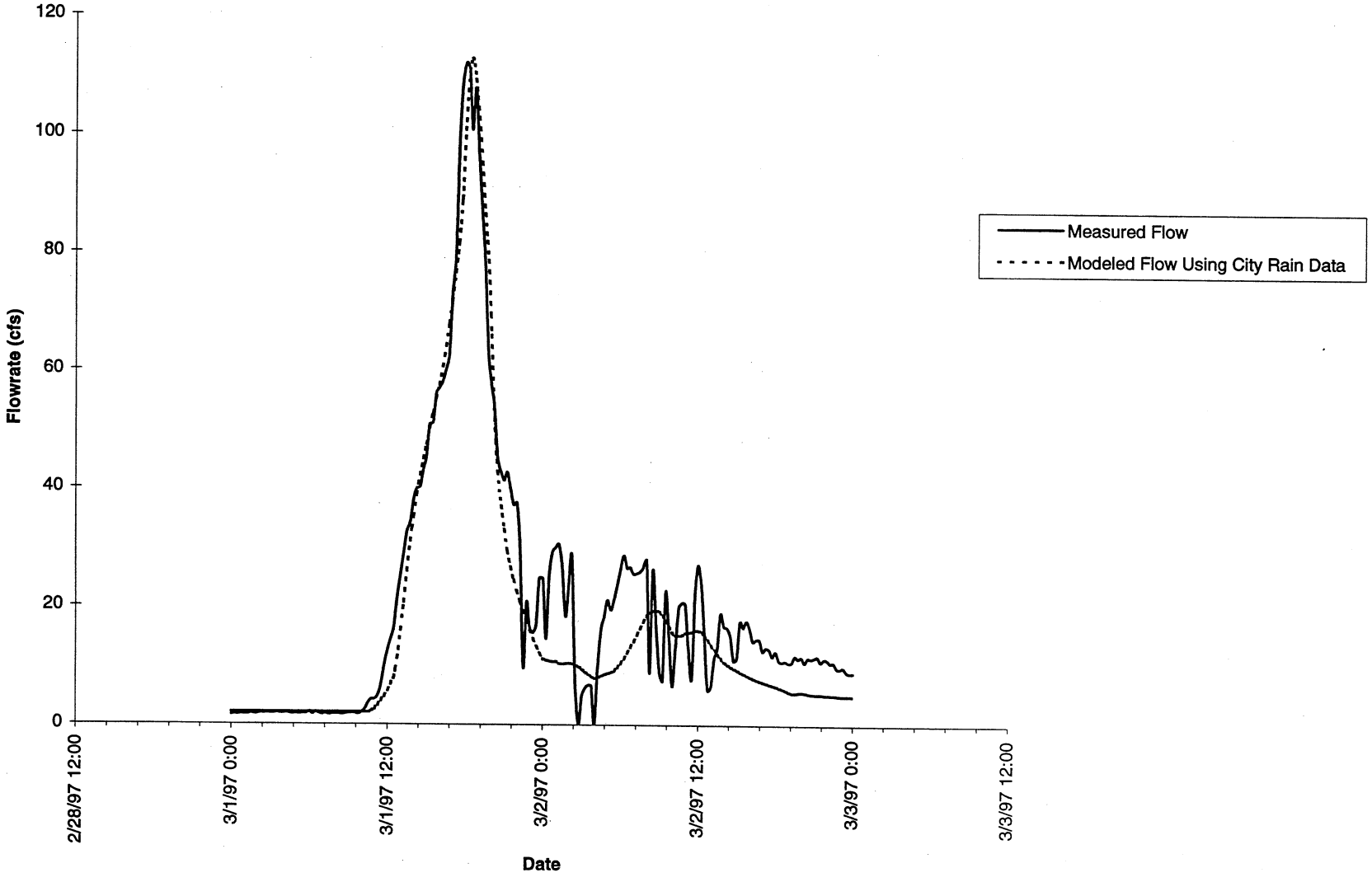
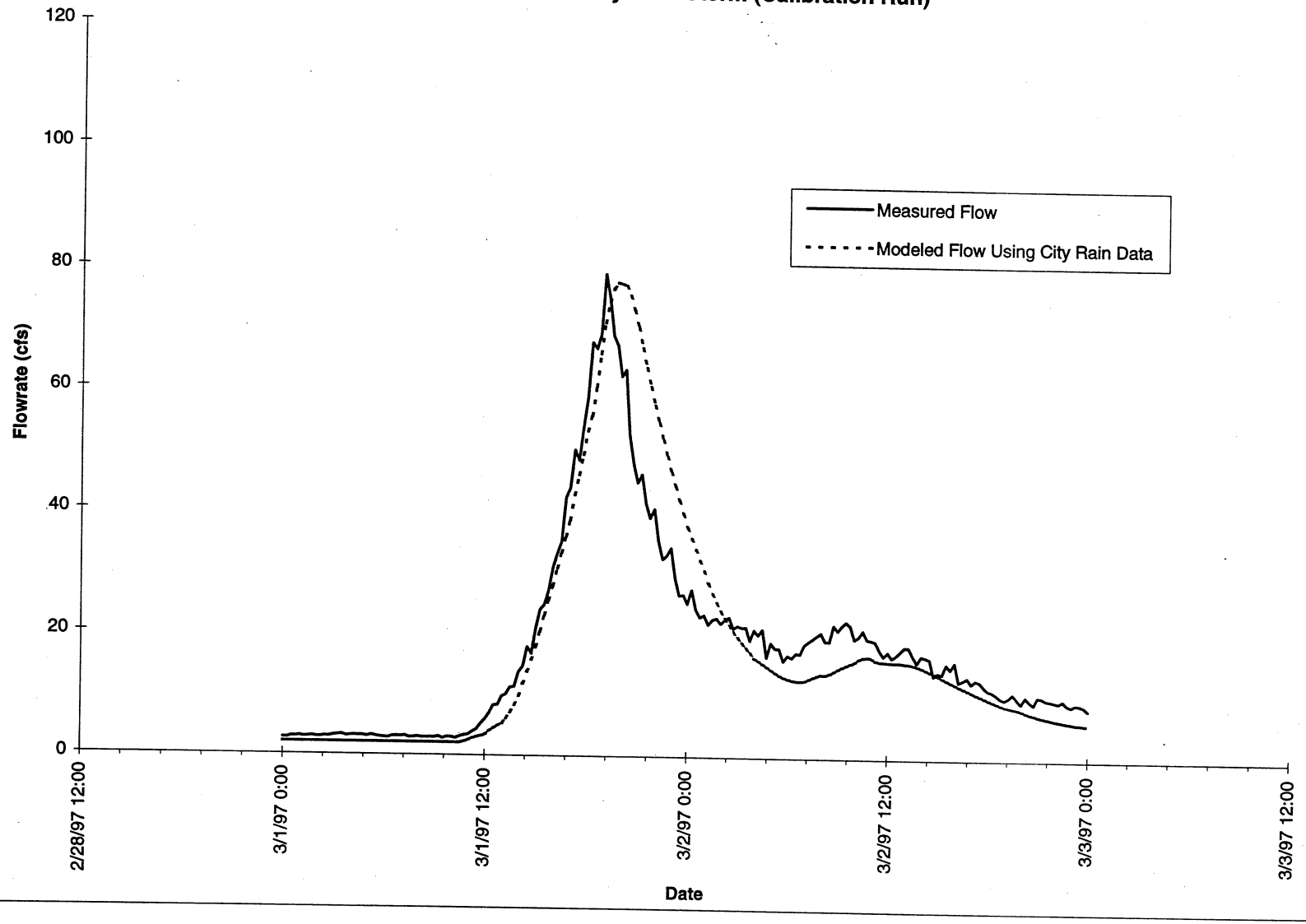


FIGURE 11
Bethel-Danebo - Station I2
February 1997 Storm (Calibration Run)



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FIGURE 12
Bethel Danebo -Station I1
January 1997 Storm (Verification Run)

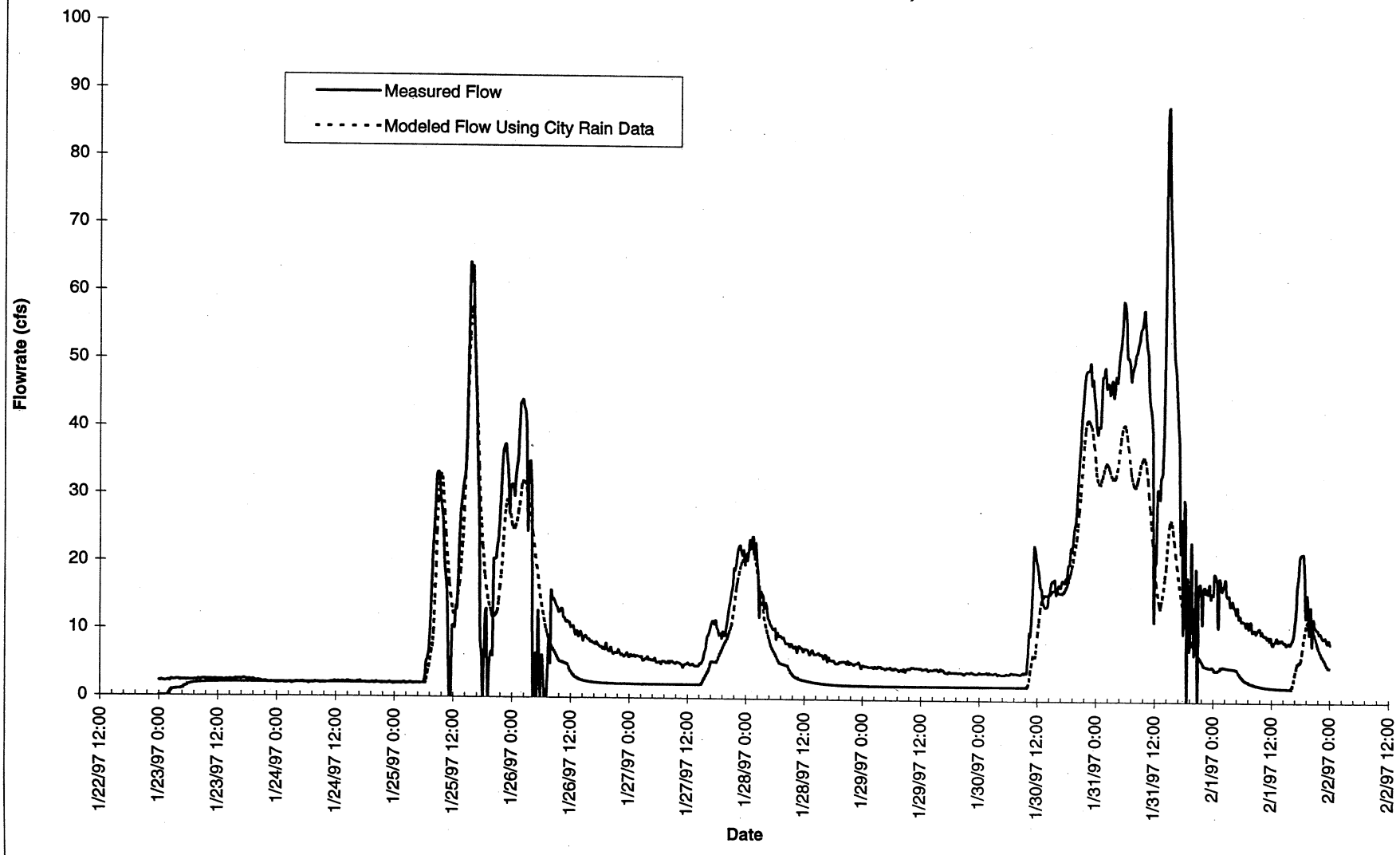


FIGURE 13
Bethel-Danebo - Station I2
January 1997 Storm (Verification Run)

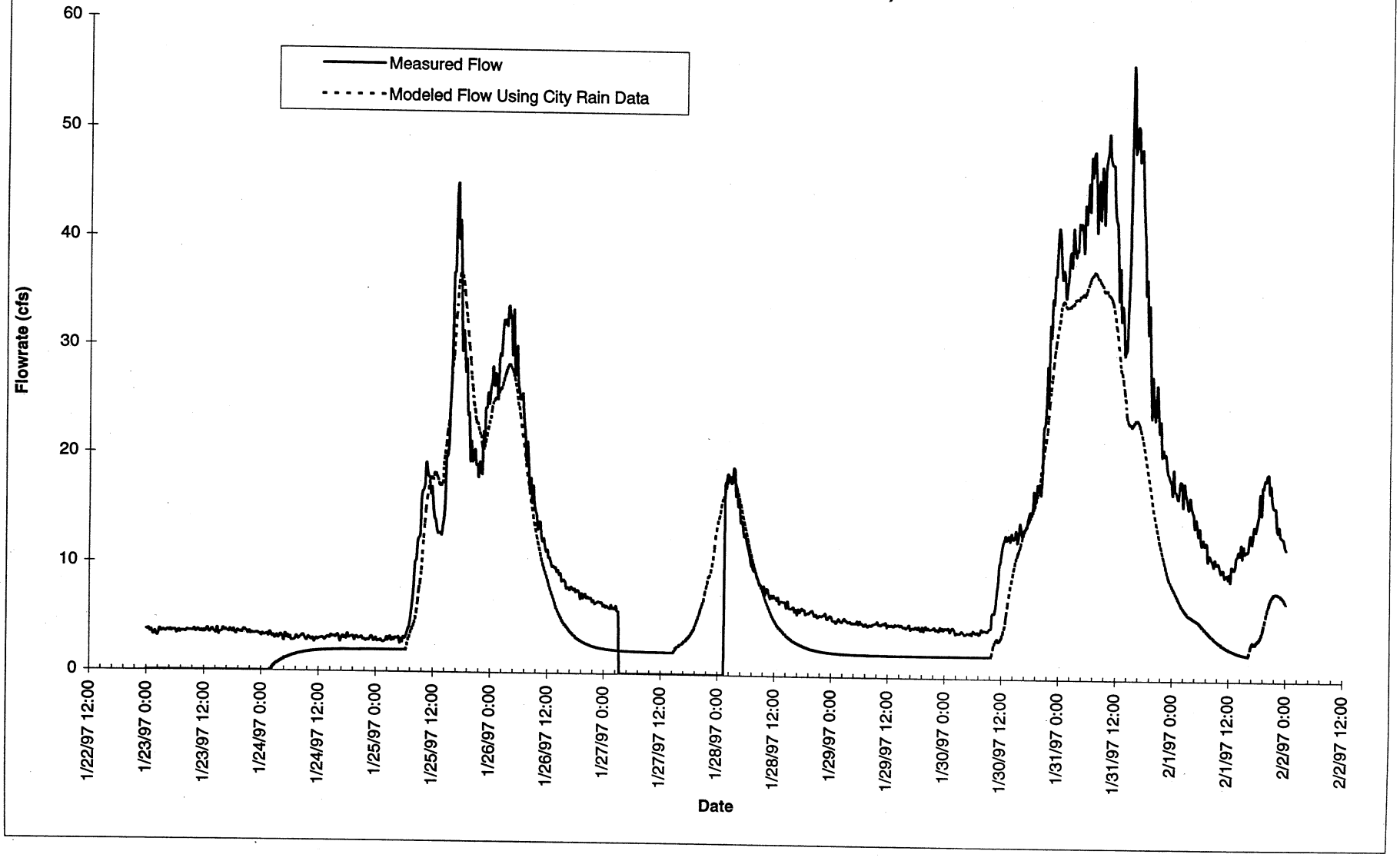


FIGURE 14
WILLOW CREEK BASIN CALIBRATION

Measured Flow: Nature Conservancy Data downstream of confluence at W. 18th Avenue

Data Available from September 1989 through June 1990

Drainage Area Characteristics:

- Primarily natural stream drainage system
- Area = 2375 acres
- Mapped Impervious Percentage = 6.5%
- Average Slope = 0.18

Calibration Storm: January 5 to January 13, 1990 (The Nature Conservancy Rain Gage)

- Total Volume = 3.45 inches
- Maximum Intensity = 0.20 in/hr
- Duration = 8 days

FIGURE 15
Willow Creek Basin Model Calibration
Initial Model Conditions

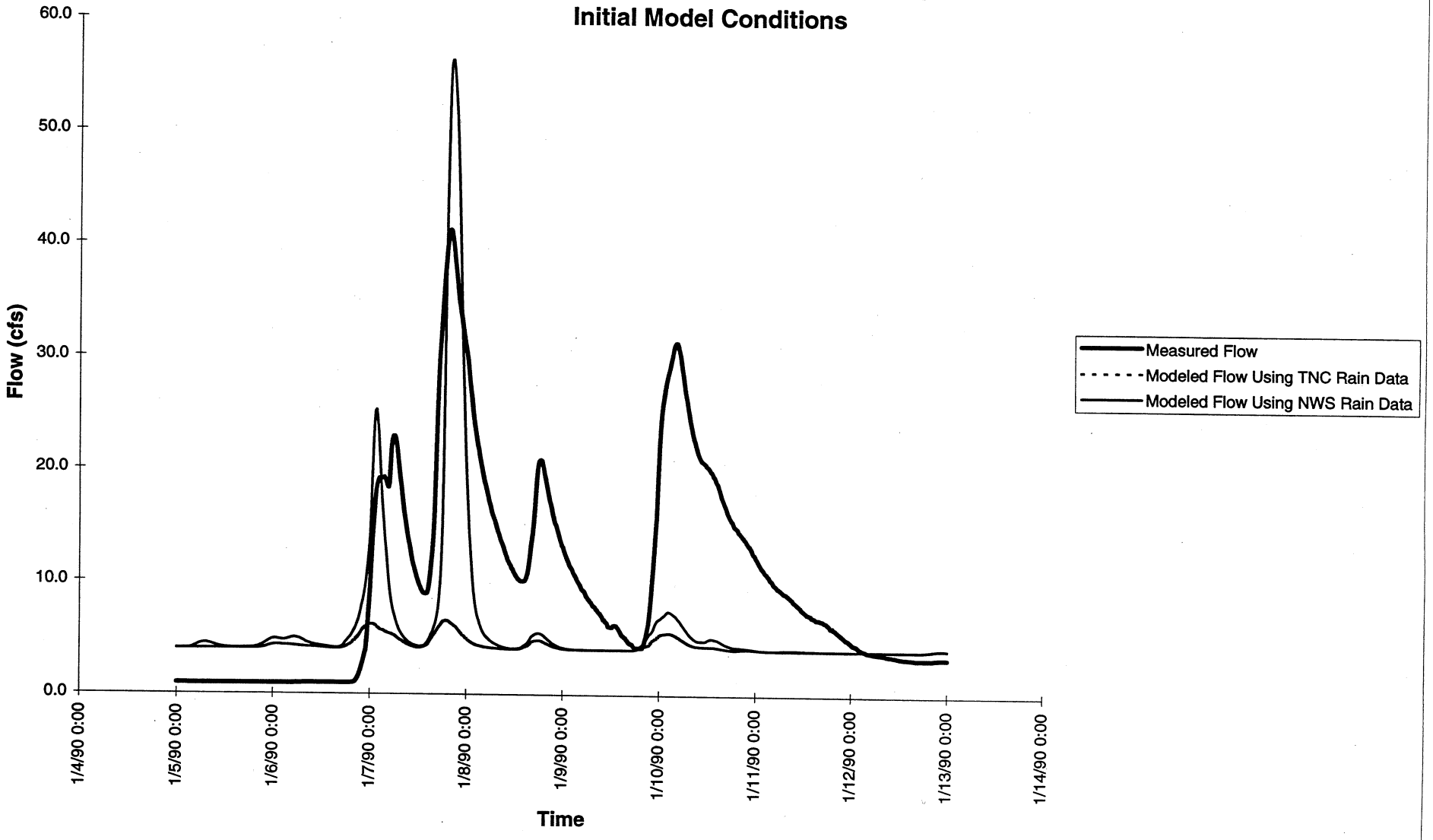


FIGURE 16
Willow Creek Basin Model Calibration
Calibrated Model

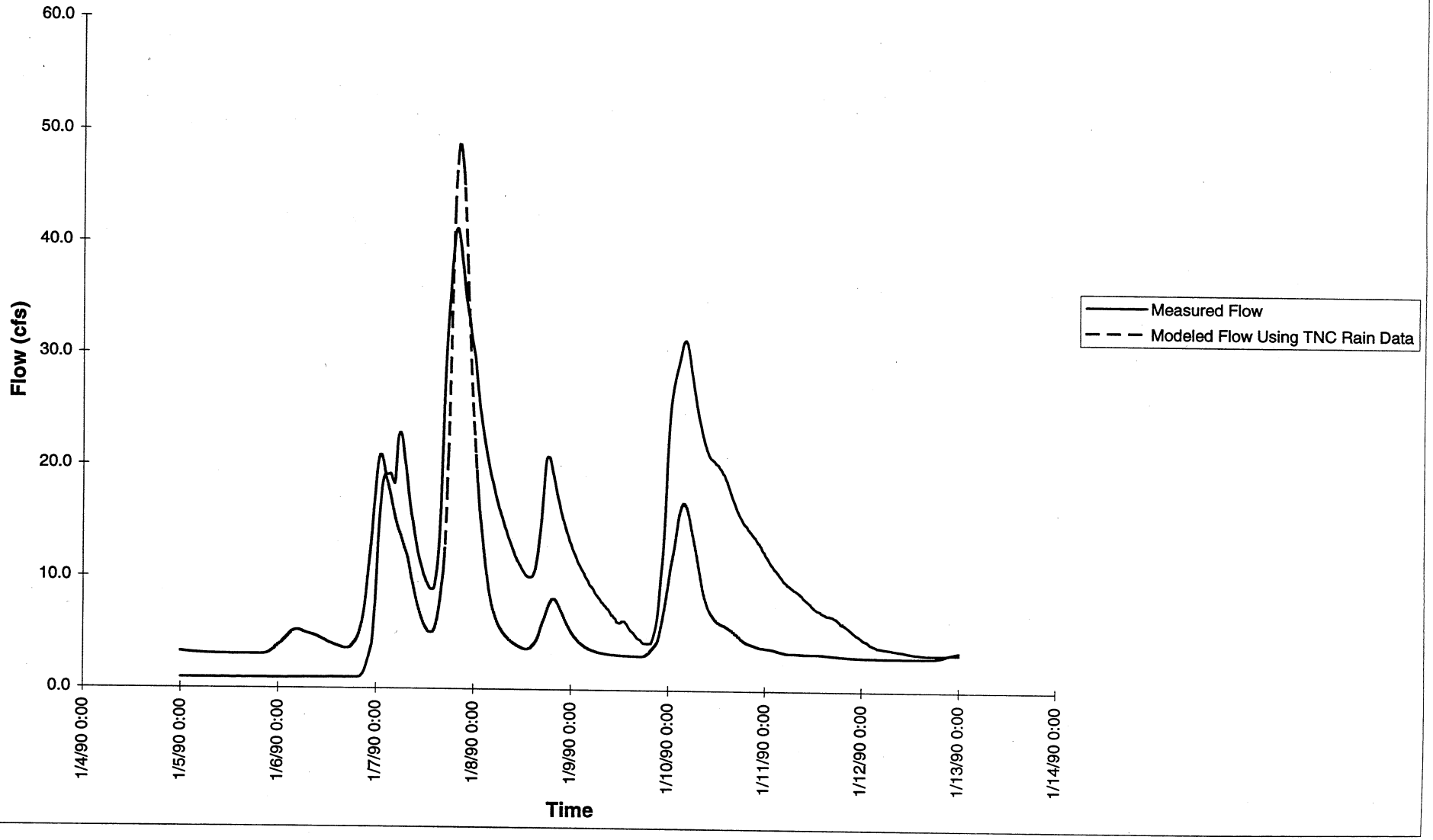


FIGURE 17
CALIBRATION SUMMARY

AMAZON CREEK (Using City Rainfall Data)

- Effective Impervious Area = 85% of Mapped Impervious Area (increases runoff volumes)
- Reduce soil infiltration parameters by 10% (increases peak flow)
- Increase Initial Subbasin Widths by 50% (increases peak flow)
- For subbasins that contain wetlands, the saturated hydraulic conductivity (SHC)was reduced to 0.02 inches/hour for the wetland areas and an area weighted SHC was computed for the subbasin.

BETHEL - DANEBO (Using City Rainfall Data)

- Same modifications as Amazon Creek

WILLOW CREEK (Using The Nature Conservancy Rainfall Data)

- Use the mapped impervious area for existing conditions.
- Use 85% of the mapped impervious area for future conditions.
- Reduce soil infiltration parameters by 40%.
- Reduce the saturated hydraulic conductivity in wetland areas to 0.02 inches/hour.

APPENDIX E

HYDROLOGIC/HYDRAULIC MODEL INPUT AND OUTPUT TABLES FOR EACH BASIN

APPENDIX E
TABLE E-1
MAJOR HYDROLOGIC INPUT DATA FOR THE AMAZON CREEK STORM DRAINAGE SYSTEM

Subbasin Name	Inlet Node	Subbasin Area (acres)	Impervious Area (%)				Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Overland Flow Roughness Coefficient		Depression Storage (inch)		Green-Ampt Infiltration Parameters		
			Existing Land Use		Future Land Use								Average Capillary Suction (in)	Initial Moisture Deficit (ft/ft)	Saturated Hydraulic Conductivity (inch/hour)
			Mapped	Effective	Mapped	Effective			Impervious	Pervious	Impervious	Pervious			
Amazon - Bailey Hill															
AMBH-010	54741	128.8	53.0	45.1	58.0	49.3	0.014	11222	0.012	0.45	0.05	0.15	7.84	0.39	0.13
AMBH-015	54854	68.6	36.0	30.6	48.0	40.8	0.047	3983	0.014	0.45	0.05	0.15	6.54	0.39	0.19
AMBH-020 & AMBH-030	71086	36.2	45.8	38.9	56.0	47.6	0.003	3000	0.012	0.45	0.05	0.15	7.68	0.41	0.24
AMBH-040	54772	97.5	42.0	35.7	46.0	39.1	0.115	1973	0.012	0.45	0.05	0.15	5.80	0.40	0.26
AMBH-050	54815	31.8	38.0	32.3	48.9	41.6	0.016	1790	0.012	0.45	0.05	0.15	6.22	0.42	0.41
AMBH-060	54773	61.9	36.0	30.6	47.1	40.0	0.137	1146	0.012	0.40	0.05	0.15	5.82	0.27	0.14
AMBH-070	52255	95.5	40.0	34.0	44.0	37.4	0.083	3329	0.012	0.45	0.05	0.15	8.26	0.37	0.14
AMBH-080	66465	90.9	32.0	27.2	42.0	35.7	0.138	19798	0.012	0.40	0.05	0.15	9.01	0.35	0.07
AMBH-090	52167	213.9	8.0	6.8	42.0	35.7	0.203	3442	0.012	0.40	0.05	0.15	8.21	0.32	0.04
AMBH-100	52214	230.0	14.0	11.9	41.1	34.9	0.189	3665	0.012	0.40	0.05	0.15	8.70	0.33	0.04
AMBH-110	52145	61.0	20.0	17.0	44.0	37.4	0.250	1394	0.012	0.40	0.05	0.15	8.00	0.32	0.06
AMBH-120	67805	96.6	27.0	23.0	42.9	36.5	0.205	2082	0.012	0.40	0.05	0.15	7.66	0.30	0.04
Amazon - Bertelsen Sub-Basin															
AMBT-010	63173	79.8	19.0	16.2	33.1	28.1	0.031	1982	0.012	0.45	0.05	0.15	9.34	0.38	0.06
AMBT-020	54522	73.9	37.0	31.5	67.1	57.0	0.005	7429	0.012	0.40	0.05	0.15	9.59	0.39	0.06
AMBT-030	63127	75.6	46.0	39.1	57.1	48.5	0.004	8232	0.012	0.40	0.05	0.15	8.06	0.41	0.21
AMBT-040	54747	39.1	30.0	25.5	57.1	48.5	0.004	5674	0.012	0.40	0.05	0.15	9.47	0.39	0.06
AMBT-050	71091	102.2	33.0	28.1	58.9	50.1	0.034	4023	0.012	0.40	0.05	0.15	9.60	0.39	0.06
AMBT-060	54909	48.3	44.0	37.4	47.1	40.0	0.004	1900	0.012	0.45	0.05	0.15	9.17	0.39	0.10
AMBT-070	54898	77.4	45.0	38.3	46.0	39.1	0.078	2000	0.012	0.45	0.05	0.15	6.58	0.37	0.29
AMBT-080	51995	50.0	9.0	7.7	41.1	34.9	0.149	1967	0.012	0.40	0.05	0.15	8.29	0.32	0.07
AMBT-090	68843	106.5	43.0	36.6	46.0	39.1	0.038	5060	0.012	0.45	0.05	0.15	7.42	0.31	0.12
AMBT-100	66971	91.1	12.0	10.2	52.0	44.2	0.005	2179	0.012	0.45	0.05	0.15	7.09	0.36	0.14
Amazon - City View Sub-Basin															
AMCV-010	71084	26.4	55.0	46.8	67.1	57.0	0.003	1325	0.012	0.45	0.05	0.15	9.62	0.38	0.06
AMCV-020	55283	41.0	61.0	51.9	65.1	55.3	0.000	2103	0.012	0.45	0.05	0.15	9.63	0.38	0.06
AMCV-030	55272	68.9	53.0	45.1	56.0	47.6	0.020	4500	0.012	0.45	0.05	0.15	9.63	0.39	0.07
AMCV-040	71004	80.1	44.0	37.4	47.1	40.0	0.080	1785	0.012	0.45	0.05	0.15	7.33	0.41	0.31
AMCV-050	55274	90.2	43.0	36.6	48.0	40.8	0.056	3854	0.012	0.45	0.05	0.15	7.43	0.41	0.28
AMCV-060	71081	55.2	40.0	34.0	45.1	38.3	0.084	974	0.012	0.45	0.05	0.15	8.32	0.41	0.19
AMCV-070	55294	95.0	41.0	34.9	46.0	39.1	0.032	3649	0.012	0.45	0.05	0.15	7.15	0.41	0.26
AMCV-080	55365	108.8	39.0	33.2	46.0	39.1	0.132	2707	0.012	0.40	0.05	0.15	9.22	0.39	0.09
AMCV-090	52730	39.8	40.0	34.0	46.0	39.1	0.155	1400	0.012	0.40	0.05	0.15	9.81	0.38	0.05
AMCV-100	52573	123.4	32.0	27.2	42.9	36.5	0.182	2179	0.012	0.40	0.05	0.15	9.54	0.38	0.06
Amazon - Headwaters Sub-Basin															
AMHW-010	67175	249.6	14.0	11.9	32.0	27.2	0.311	2765	0.012	0.40	0.05	0.15	9.21	0.37	0.06
AMHW-020	65344	214.1	14.0	11.9	35.1	29.8	0.270	3887	0.012	0.40	0.05	0.15	8.05	0.32	0.05
AMHW-030	65392	157.7	9.0	7.7	32.0	27.2	0.277	3873	0.012	0.40	0.05	0.15	8.38	0.33	0.05
Amazon - Lower Sub-Basin															
AMLW-010	71114	565.6	5.0	4.3	33.1	28.1	0.157	3422	0.012	0.40	0.05	0.15	7.95	0.41	0.19
AMLW-020	71113	189.3	2.0	1.7	9.1	7.7	0.016	4325	0.012	0.40	0.05	0.15	6.53	0.41	0.10
AMLW-030	63178	251.4	14.0	11.9	28.0	23.8	0.017	5299	0.012	0.40	0.05	0.15	9.37	0.39	0.06

APPENDIX E
TABLE E-1
MAJOR HYDROLOGIC INPUT DATA FOR THE AMAZON CREEK STORM DRAINAGE SYSTEM

Subbasin Name	Inlet Node	Subbasin Area (acres)	Impervious Area (%)				Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Overland Flow Roughness Coefficient		Depression Storage (inch)		Green-Ampt Infiltration Parameters		
			Existing Land Use		Future Land Use								Average Capillary Suction (in)	Initial Moisture Deficit (ft/ft)	Saturated Hydraulic Conductivity (inch/hour)
			Mapped	Effective	Mapped	Effective			Impervious	Pervious	Impervious	Pervious			
AMLW-040	71110	137.0	10.0	8.5	36.9	31.4	0.115	2772	0.012	0.40	0.05	0.15	9.53	0.39	0.06
AMLW-050	71105	224.5	12.0	10.2	48.0	40.8	0.077	3535	0.012	0.40	0.05	0.15	9.42	0.39	0.07
AMLW-060	71122	68.5	18.0	15.3	31.1	26.4	0.014	3551	0.012	0.40	0.05	0.15	9.63	0.38	0.06
Amazon - Middle Sub-Basin															
AMMD-010	51437	121.7	32.0	27.2	42.0	35.7	0.225	3313	0.012	0.40	0.05	0.15	9.42	0.37	0.06
AMMD-020	54260	196.9	26.0	22.1	32.0	27.2	0.196	6597	0.012	0.40	0.05	0.15	8.73	0.33	0.05
AMMD-030	54295	97.6	43.0	36.6	46.0	39.1	0.249	1904	0.012	0.45	0.05	0.15	9.94	0.38	0.05
AMMD-040	54330	165.1	41.0	34.9	44.0	37.4	0.108	13488	0.012	0.45	0.05	0.15	9.81	0.37	0.05
AMMD-050	54174	119.9	39.0	33.2	41.1	34.9	0.070	3013	0.012	0.45	0.05	0.15	10.30	0.37	0.04
AMMD-060	51751	130.9	44.0	37.4	46.0	39.1	0.082	3420	0.012	0.45	0.05	0.15	10.00	0.38	0.05
AMMD-070	71052	33.4	42.0	35.7	42.9	36.5	0.014	4848	0.012	0.45	0.05	0.15	10.30	0.37	0.04
AMMD-080	51303	85.0	51.0	43.4	52.9	45.0	0.120	4442	0.012	0.45	0.05	0.15	9.65	0.38	0.06
AMMD-090	51344	165.5	33.0	28.1	42.0	35.7	0.146	3546	0.012	0.43	0.05	0.15	8.96	0.35	0.06
AMMD-100	71053	135.1	44.0	37.4	47.1	40.0	0.084	3532	0.012	0.45	0.05	0.15	10.00	0.38	0.05
AMMD-110	66967	28.0	54.0	45.9	57.1	48.5	0.043	2154	0.012	0.45	0.05	0.15	10.40	0.37	0.04
AMMD-120	54175	15.3	39.0	33.2	44.0	37.4	0.011	4999	0.012	0.45	0.05	0.15	10.80	0.36	0.03
AMMD-130	57163	55.3	31.0	26.4	45.1	38.3	0.011	2580	0.012	0.45	0.05	0.15	11.20	0.34	0.02
AMMD-135	57428	122.7	51.0	43.4	54.0	45.9	0.034	2865	0.012	0.45	0.05	0.15	10.00	0.37	0.05
AMMD-140	57400	30.0	54.0	45.9	62.0	52.7	0.003	1400	0.012	0.45	0.05	0.15	9.62	0.38	0.07
AMMD-145	57427	46.5	47.0	40.0	55.1	46.8	0.035	1382	0.014	0.45	0.05	0.15	9.17	0.36	0.06
AMMD-150	71059	56.2	61.0	51.9	68.0	57.8	0.017	3340	0.012	0.45	0.05	0.15	9.63	0.39	0.07
AMMD-160	71063	52.0	56.0	47.6	58.9	50.1	0.058	1618	0.012	0.45	0.05	0.15	8.53	0.40	0.18
AMMD-165	56284	44.8	50.0	42.5	54.0	45.9	0.108	1330	0.012	0.45	0.05	0.15	9.59	0.38	0.10
AMMD-170	71075	171.0	47.0	40.0	50.0	42.5	0.077	4859	0.012	0.45	0.05	0.15	9.30	0.39	0.11
Amazon - Polk Street Sub-Basin															
AMPK-010	55432	71.6	55.0	46.8	61.1	51.9	0.001	2270	0.012	0.45	0.05	0.15	9.62	0.38	0.06
AMPK-020	66991	87.3	57.0	48.5	61.1	51.9	0.013	2654	0.012	0.45	0.05	0.15	9.63	0.38	0.07
AMPK-030	71080	81.6	45.0	38.3	51.1	43.4	0.013	1953	0.012	0.45	0.05	0.15	9.63	0.38	0.07
AMPK-040	56048	68.1	45.0	38.3	48.9	41.6	0.026	2021	0.012	0.45	0.05	0.15	9.53	0.39	0.08
AMPK-050	71079	66.9	46.0	39.1	47.1	40.0	0.026	1457	0.012	0.45	0.05	0.15	9.47	0.39	0.08
AMPK-060	52687	78.1	35.0	29.8	36.9	31.4	0.011	6183	0.012	0.45	0.05	0.15	7.89	0.41	0.24
AMPK-070	55256	36.7	33.0	28.1	36.0	30.6	0.006	2395	0.012	0.45	0.05	0.15	7.74	0.41	0.26
AMPK-080	71003	110.5	50.0	42.5	52.0	44.2	0.058	2982	0.012	0.45	0.05	0.15	8.19	0.41	0.22
AMPK-090	52685	33.7	46.0	39.1	47.1	40.0	0.115	2900	0.012	0.45	0.05	0.15	7.53	0.41	0.28
AMPK-100	52707	142.1	40.0	34.0	45.1	38.3	0.184	2920	0.012	0.40	0.05	0.15	9.15	0.36	0.06
AMPK-110	53441	121.0	38.0	32.3	44.0	37.4	0.171	2195	0.012	0.40	0.05	0.15	9.26	0.39	0.10
AMPK-120	53422	118.0	40.0	34.0	44.0	37.4	0.166	2773	0.012	0.40	0.05	0.15	9.65	0.38	0.06
AMPK-130	53408	106.0	32.0	27.2	42.0	35.7	0.181	2270	0.012	0.40	0.05	0.15	9.68	0.38	0.06
AMPK-140	53390	103.4	38.0	32.3	45.1	38.3	0.153	2371	0.012	0.45	0.05	0.15	9.69	0.38	0.06
AMPK-150	53358	47.6	46.0	39.1	47.1	40.0	0.126	1195	0.012	0.45	0.05	0.15	9.85	0.38	0.05
AMPK-160	53448	71.1	44.0	37.4	45.1	38.3	0.072	2214	0.012	0.45	0.05	0.15	9.68	0.38	0.06
AMPK-170	68813	70.3	45.0	38.3	46.0	39.1	0.032	19131	0.012	0.45	0.05	0.15	8.44	0.40	0.19
Amazon - Upper Sub-Basin															
AMUP-010	65582	172.4	20.0	17.0	40.0	34.0	0.242	4173	0.012	0.40	0.05	0.15	8.93	0.35	0.05
AMUP-020	65398	197.3	38.0	32.3	45.1	38.3	0.136	3224	0.012	0.45	0.05	0.15	9.81	0.38	0.06
AMUP-030	65396	182.7	25.0	21.3	42.9	36.5	0.258	4341	0.012	0.43	0.05	0.15	9.50	0.36	0.05

APPENDIX E
TABLE E-1
MAJOR HYDROLOGIC INPUT DATA FOR THE AMAZON CREEK STORM DRAINAGE SYSTEM

Subbasin Name	Inlet Node	Subbasin Area (acres)	Impervious Area (%)				Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Overland Flow Roughness Coefficient		Depression Storage (inch)		Green-Ampt Infiltration Parameters		
			Existing Land Use		Future Land Use								Average Capillary Suction (in)	Initial Moisture Deficit (ft/ft)	Saturated Hydraulic Conductivity (inch/hour)
			Mapped	Effective	Mapped	Effective			Impervious	Pervious	Impervious	Pervious			
AMUP-040	65370	218.9	19.0	16.2	38.9	33.1	0.274	7945	0.012	0.43	0.05	0.15	6.80	0.28	0.06
AMUP-050	67978	76.4	34.0	28.9	44.0	37.4	0.260	4076	0.012	0.43	0.05	0.15	9.62	0.37	0.06
AMUP-060	50653	97.0	41.0	34.9	45.1	38.3	0.159	6674	0.012	0.45	0.05	0.15	9.65	0.38	0.06
AMUP-070	50200	126.1	43.0	36.6	45.1	38.3	0.192	6863	0.012	0.45	0.05	0.15	9.32	0.37	0.06
AMUP-080	50090	114.8	33.0	28.1	40.0	34.0	0.295	4168	0.012	0.40	0.05	0.15	9.63	0.39	0.07
AMUP-090	50739	122.6	20.0	17.0	42.9	36.5	0.224	3641	0.012	0.40	0.05	0.15	8.81	0.35	0.06
AMUP-100	50109	151.9	27.0	23.0	40.0	34.0	0.302	2683	0.012	0.40	0.05	0.15	9.46	0.38	0.06
AMUP-110	99479	93.1	19.0	16.2	42.0	35.7	0.237	2482	0.012	0.40	0.05	0.15	9.41	0.38	0.06
AMUP-120	50660	181.3	33.0	28.1	42.9	36.5	0.100	3037	0.012	0.40	0.05	0.15	9.04	0.36	0.06
AMUP-130	50671	42.6	43.0	36.6	45.1	38.3	0.071	3198	0.012	0.45	0.05	0.15	9.62	0.38	0.06
AMUP-140	51763	101.6	34.0	28.9	42.9	36.5	0.120	3793	0.012	0.45	0.05	0.15	9.18	0.35	0.05
AMUP-150	50544	179.9	35.0	29.8	42.9	36.5	0.264	6186	0.012	0.45	0.05	0.15	10.30	0.37	0.04
AMUP-160	51757	150.7	39.0	33.2	46.0	39.1	0.238	3939	0.012	0.45	0.05	0.15	9.95	0.38	0.05
AMUP-170	51729	64.1	47.0	40.0	48.0	40.8	0.090	1102	0.012	0.45	0.05	0.15	9.95	0.38	0.05
AMUP-180	51841	93.7	42.0	35.7	45.1	38.3	0.150	9414	0.012	0.45	0.05	0.15	9.48	0.37	0.06
AMUP-190[1]	51239	49.4	32.0	27.2	42.0	35.7	0.214	5376	0.012	0.45	0.05	0.15	8.46	0.33	0.06
AMUP-200[1]	50163	92.9	23.0	19.6	42.9	36.5	0.203	2427	0.012	0.40	0.05	0.15	7.14	0.28	0.04

1. Modeling data for these subbasins have recently been updated and are available by contacting the City of Eugene Public Works Department, Engineering Division.

APPENDIX E
TABLE E-1
MAJOR HYDROLOGIC INPUT DATA FOR THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Subbasin Name	Inlet Node	Subbasin Area (acres)	Impervious Area (%)				Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Overland Flow Roughness Coefficient		Depression Storage (inch)		Green-Ampt Infiltration Parameters		
			Existing Land Use		Future Land Use								Average Capillary Suction (in)	Initial Moisture Deficit (ft/ft)	Saturated Hydraulic Conductivity (inch/hour)
			Mapped	Effective	Mapped	Effective			Impervious	Pervious	Impervious	Pervious			
Bethel Danebo - A2 Channel															
BDA2-010	58209	61.6	17.0	14.5	25.1	21.3	0.007	8050	0.012	0.450	0.05	0.15	9.23	0.39	0.14
BDA2-020	58709	37.5	40.0	34.0	42.0	35.7	0.003	1880	0.012	0.450	0.05	0.15	9.63	0.38	0.07
BDA2-030	58689	84.0	38.0	32.3	45.1	38.3	0.000	2290	0.012	0.450	0.05	0.15	9.63	0.38	0.07
BDA2-040	58205	39.2	33.0	28.1	38.9	33.1	0.008	2840	0.012	0.450	0.05	0.15	9.84	0.38	0.08
BDA2-050	58207	113.1	0.0	0.0	10.9	9.3	0.005	3080	0.012	0.450	0.05	0.15	9.35	0.39	0.13
BDA2-060	58673	40.7	44.0	37.4	45.1	38.3	0.005	2220	0.012	0.450	0.05	0.15	9.36	0.39	0.10
BDA2-070	58680	40.1	43.0	36.6	47.1	40.0	0.010	4030	0.012	0.450	0.05	0.15	9.42	0.39	0.09
BDA2-080	66164	110.7	38.0	32.3	38.9	33.1	0.003	4260	0.012	0.450	0.05	0.15	9.53	0.39	0.08
BDA2-090	58950	70.3	45.0	38.3	45.1	38.3	0.004	3530	0.012	0.450	0.05	0.15	9.37	0.39	0.12
BDA2-100	60245	56.1	45.0	38.3	47.1	40.0	0.005	1410	0.012	0.450	0.05	0.15	8.99	0.39	0.17
BDA2-110	58645	78.5	38.0	32.3	41.1	34.9	0.002	1600	0.012	0.450	0.05	0.15	8.66	0.40	0.17
BDA2-120	80004	51.4	14.0	11.9	23.1	19.6	0.009	5600	0.012	0.450	0.05	0.15	8.72	0.40	0.15
BDA2-130	80007	109.8	18.0	15.3	28.0	23.8	0.006	5980	0.012	0.450	0.05	0.15	5.63	0.23	0.06
BDA2-140	58946	68.0	35.0	29.8	45.1	38.3	0.001	2340	0.012	0.450	0.05	0.15	9.03	0.37	0.10
BDA2-150	58875	56.6	50.0	42.5	51.1	43.4	0.008	1060	0.012	0.450	0.05	0.15	9.72	0.38	0.10
BDA2-160	80009	70.4	41.0	34.9	60.0	51.0	0.001	1920	0.012	0.450	0.05	0.15	9.58	0.39	0.07
BDA2-170	80010	28.5	33.0	28.1	48.0	40.8	0.001	1330	0.012	0.450	0.05	0.15	9.12	0.39	0.12
BDA2-180	80015	13.5	32.0	27.2	46.0	39.1	0.003	740	0.012	0.450	0.05	0.15	9.63	0.39	0.07
BDA2-190	58894	56.3	37.0	31.5	48.0	40.8	0.001	3070	0.012	0.450	0.05	0.15	8.60	0.40	0.17
BDA2-200	58893	58.6	50.0	42.5	55.1	46.8	0.005	2130	0.012	0.450	0.05	0.15	8.03	0.41	0.23
BDA2-210	58853	49.2	16.0	13.6	60.0	51.0	0.003	2470	0.012	0.450	0.05	0.15	8.28	0.39	0.17
BDA2-220	80017	85.3	20.0	17.0	62.9	53.5	0.006	4640	0.012	0.450	0.05	0.15	7.04	0.34	0.18
BDA2-230	69700	13.9	40.0	34.0	54.0	45.9	0.000	1130	0.012	0.450	0.05	0.15	8.00	0.41	0.23
BDA2-240	69714	34.1	53.0	45.1	61.1	51.9	0.001	2230	0.012	0.450	0.05	0.15	9.61	0.38	0.06
BDA2-250	69732	211.5	34.0	28.9	62.0	52.7	0.001	3840	0.012	0.450	0.05	0.15	9.56	0.39	0.07
BDA2-260	80018	69.6	4.0	3.4	58.0	49.3	0.001	1890	0.012	0.450	0.05	0.15	8.65	0.40	0.17
BDA2-270	80022	26.3	59.0	50.2	58.9	50.1	0.001	2870	0.012	0.450	0.05	0.15	6.87	0.42	0.35
BDA2-280	66548	42.2	46.0	39.1	48.9	41.6	0.000	2510	0.012	0.450	0.05	0.15	9.14	0.39	0.12
BDA2-290	58883	77.9	38.0	32.3	44.0	37.4	0.001	3180	0.012	0.450	0.05	0.15	9.51	0.39	0.08
BDA2-300	60488	65.4	30.0	25.5	40.0	34.0	0.001	2850	0.012	0.450	0.05	0.15	9.33	0.37	0.06
BDA2-310	60565	60.7	40.0	34.0	45.1	38.3	0.001	1890	0.012	0.450	0.05	0.15	9.63	0.38	0.06
BDA2-320	60238	39.9	45.0	38.3	47.1	40.0	0.001	3260	0.012	0.450	0.05	0.15	8.12	0.40	0.26
BDA2-330	60216	56.9	44.0	37.4	45.1	38.3	0.002	1240	0.012	0.450	0.05	0.15	9.26	0.39	0.11
BDA2-340	60123	39.7	45.0	38.3	45.1	38.3	0.002	1080	0.012	0.450	0.05	0.15	8.00	0.41	0.25
BDA2-350	80025	12.6	41.0	34.9	42.9	36.5	0.002	2740	0.012	0.450	0.05	0.15	8.53	0.40	0.20
BDA2-360	60107	33.9	38.0	32.3	40.0	34.0	0.002	2770	0.012	0.450	0.05	0.15	8.85	0.40	0.14
BDA2-370	67069	54.5	35.0	29.8	45.1	38.3	0.000	3560	0.012	0.450	0.05	0.15	9.62	0.39	0.07
BDA2-380	66573	139.9	43.0	36.6	44.0	37.4	0.001	2280	0.012	0.450	0.05	0.15	9.63	0.39	0.07
BDA2-390	60461	41.1	44.0	37.4	44.0	37.4	0.002	3360	0.012	0.450	0.05	0.15	9.63	0.39	0.06
BDA2-395	60454	67.1	49.0	41.7	52.9	45.0	0.001	3370	0.012	0.450	0.05	0.15	9.63	0.38	0.07
BDA2-400	68451	66.1	46.0	39.1	47.1	40.0	0.001	6170	0.012	0.450	0.05	0.15	9.63	0.38	0.07
BDA2-405	60541	21.5	65.0	55.3	70.0	59.5	0.003	1560	0.012	0.450	0.05	0.15	9.63	0.39	0.06
BDA2-408	69935	63.8	52.0	44.2	58.9	50.1	0.001	1810	0.012	0.450	0.05	0.15	9.63	0.38	0.06
BDA2-410	80027	21.7	37.0	31.5	46.0	39.1	0.001	1010	0.012	0.450	0.05	0.15	9.63	0.39	0.07

APPENDIX E
TABLE E-1
MAJOR HYDROLOGIC INPUT DATA FOR THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Subbasin Name	Inlet Node	Subbasin Area (acres)	Impervious Area (%)				Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Overland Flow Roughness Coefficient		Depression Storage (inch)		Green-Ampt Infiltration Parameters		
			Existing Land Use		Future Land Use								Average Capillary Suction (in)	Initial Moisture Deficit (ft/ft)	Saturated Hydraulic Conductivity (inch/hour)
			Mapped	Effective	Mapped	Effective			Impervious	Pervious	Impervious	Pervious			
BDA2-420	60101	37.6	43.0	36.6	47.1	40.0	0.001	1450	0.012	0.450	0.05	0.15	9.60	0.39	0.07
BDA2-430	61733	61.2	40.0	34.0	44.0	37.4	0.001	1540	0.012	0.450	0.05	0.15	9.06	0.36	0.06
Bethel Danebo - A3 Channel															
BDA3-010	61607	71.8	1.0	0.9	4.0	3.4	0.002	2345	0.012	0.450	0.05	0.15	8.12	0.40	0.23
BDA3-020	61608	137.4	22.0	18.7	48.0	40.8	0.007	4079	0.012	0.450	0.05	0.15	9.14	0.39	0.12
BDA3-030	61694	67.0	19.0	16.2	38.0	32.3	0.003	2734	0.012	0.400	0.05	0.15	7.68	0.31	0.05
BDA3-040	80050	157.9	26.0	22.1	62.9	53.5	0.064	7369	0.012	0.400	0.05	0.15	8.32	0.35	0.09
BDA3-050	modpt	43.5	49.0	41.7	64.0	54.4	0.003	1291	0.012	0.400	0.05	0.15	9.01	0.40	0.13
BDA3-060	63147	36.3	65.0	55.3	68.9	58.6	0.008	2961	0.012	0.400	0.05	0.15	8.64	0.40	0.17
BDA3-070	63207	36.0	32.0	27.2	56.0	47.6	0.000	1177	0.012	0.400	0.05	0.15	9.62	0.39	0.07
BDA3-080	63129	105.9	14.0	11.9	22.0	18.7	0.008	3300	0.012	0.400	0.05	0.15	9.39	0.38	0.08
BDA3-090	67158	103.3	23.0	19.6	36.0	30.6	0.024	3555	0.012	0.450	0.05	0.15	9.23	0.39	0.11
BDA3-100	63276	63.4	18.0	15.3	58.0	49.3	0.001	5180	0.012	0.450	0.05	0.15	9.63	0.38	0.06
BDA3-110	63359	72.1	43.0	36.6	66.0	56.1	0.001	1890	0.012	0.450	0.05	0.15	9.63	0.38	0.06
BDA3-120	63326	73.0	30.0	25.5	44.0	37.4	0.038	1710	0.012	0.450	0.05	0.15	9.33	0.39	0.10
BDA3-130	63364	39.2	42.0	35.7	66.0	56.1	0.001	6450	0.012	0.450	0.05	0.15	9.37	0.37	0.06
BDA3-150	63349	76.8	54.0	45.9	67.1	57.0	0.004	1320	0.012	0.450	0.05	0.15	9.00	0.36	0.06
BDA3-160	66631	95.5	29.0	24.7	62.9	53.5	0.005	1485	0.012	0.450	0.05	0.15	6.90	0.27	0.04
BDA3-180	63369	67.9	52.0	44.2	66.0	56.1	0.001	3690	0.012	0.450	0.05	0.15	9.61	0.39	0.07
BDA3-190	63811	85.7	55.0	46.8	67.1	57.0	0.001	1560	0.012	0.450	0.05	0.15	9.63	0.38	0.07
BDA3-200	63822	43.8	40.0	34.0	65.1	55.3	0.003	3585	0.012	0.450	0.05	0.15	8.37	0.33	0.05
BDA3-210	63826	59.7	61.0	51.9	68.0	57.8	0.002	2595	0.012	0.450	0.05	0.15	9.63	0.38	0.07
BDA3-220	63800	88.9	60.0	51.0	68.9	58.6	0.001	2415	0.012	0.450	0.05	0.15	9.63	0.38	0.07
BDA3-230	63795	75.8	41.0	34.9	65.1	55.3	0.002	2070	0.012	0.450	0.05	0.15	7.31	0.29	0.05
Bethel Danebo - Greenhill Tributary															
BDGH-010[1&2]		38.9	2.6	2.2	4.3	3.7	0.001								
BDGH-020[2]	80029	110.9	4.0	3.4	42.4	36.0	0.001	1340	0.012	0.450	0.05	0.15	9.63	0.38	0.06
BDGH-030[2]	80031	182.9	1.0	0.9	41.2	35.0	0.001	1730	0.012	0.450	0.05	0.15	9.74	0.38	0.06
BDGH-040[2]	80033	26.5	2.0	1.7	41.2	35.0	0.003	910	0.012	0.450	0.05	0.15	9.63	0.39	0.07
BDGH-050	80037	45.2	0.0	0.0	41.2	35.0	0.000	4922	0.012	0.450	0.05	0.15	9.62	0.38	0.06
BDGH-060	80071	39.1	3.0	2.6	41.2	35.0	0.001	2129	0.012	0.450	0.05	0.15	9.62	0.39	0.07
BDGH-062	70559	72.1	3.0	2.6	41.2	35.0	0.001	1892	0.012	0.450	0.05	0.15	9.62	0.39	0.07
BDGH-064	80064	38.4	1.4	1.2	41.2	35.0	0.001	1673	0.012	0.450	0.05	0.15	9.62	0.39	0.07
BDGH-066	70560	5.7	54.1	46.0	54.1	46.0	0.003	553	0.012	0.450	0.05	0.15	9.74	0.38	0.06
BDGH-068	70539	15.8	54.1	46.0	54.1	46.0	0.003	457	0.012	0.450	0.05	0.15	9.74	0.38	0.06
BDGH-070	59949	18.1	34.0	28.9	37.6	32.0	0.001	917	0.012	0.450	0.05	0.15	9.63	0.38	0.07
BDGH-075	80069	39.3	34.0	28.9	41.2	35.0	0.001	1712	0.012	0.450	0.05	0.15	9.63	0.38	0.07
BDGH-080	70177	50.5	23.0	19.6	37.6	32.0	0.003	1650	0.012	0.450	0.05	0.15	9.20	0.39	0.11
BDGH-090	59945	80.8	29.0	24.7	43.5	37.0	0.003	4400	0.012	0.450	0.05	0.15	9.61	0.39	0.07
BDGH-100	60212	40.3	40.0	34.0	43.5	37.0	0.004	1550	0.012	0.450	0.05	0.15	8.64	0.40	0.17
BDGH-110	60196	108.3	28.0	23.8	49.4	42.0	0.002	2360	0.012	0.450	0.05	0.15	9.62	0.38	0.07
BDGH-120	80041	137.1	4.0	3.4	24.7	21.0	0.002	4480	0.012	0.450	0.05	0.15	8.41	0.40	0.18
BDGH-130	69068	54.3	36.0	30.6	41.2	35.0	0.004	1420	0.012	0.450	0.05	0.15	9.63	0.39	0.07
Bethel Danebo - Roosevelt Channel															
BDRC-010	61727	94.9	21.0	17.9	60.0	51.0	0.002	8861	0.012	0.450	0.05	0.15	8.94	0.35	0.06
BDRC-020	61741	54.6	44.0	37.4	62.9	53.5	0.001	1115	0.012	0.450	0.05	0.15	8.04	0.32	0.05

APPENDIX E
TABLE E-1
MAJOR HYDROLOGIC INPUT DATA FOR THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Subbasin Name	Inlet Node	Subbasin Area (acres)	Impervious Area (%)				Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Overland Flow Roughness Coefficient		Depression Storage (inch)		Green-Ampt Infiltration Parameters		
			Existing Land Use		Future Land Use								Average Capillary Suction (in)	Initial Moisture Deficit (ft/ft)	Saturated Hydraulic Conductivity (inch/hour)
			Mapped	Effective	Mapped	Effective			Impervious	Pervious	Impervious	Pervious			
BDRC-030	61743	38.9	35.0	29.8	47.1	40.0	0.002	4236	0.012	0.450	0.05	0.15	9.63	0.38	0.06
BDRC-040	61959	168.9	42.0	35.7	50.0	42.5	0.001	6897	0.012	0.450	0.05	0.15	9.61	0.38	0.06
BDRC-050	61977	63.3	40.0	34.0	58.0	49.3	0.001	4133	0.012	0.450	0.05	0.15	8.43	0.33	0.06
BDRC-055	69952	224.8	27.0	23.0	58.9	50.1	0.002	3264	0.012	0.450	0.05	0.15	9.63	0.39	0.06
BDRC-060	66603	28.2	54.0	45.9	64.0	54.4	0.001	3070	0.012	0.450	0.05	0.15	9.63	0.38	0.07
BDRC-070	62329	38.4	48.0	40.8	57.1	48.5	0.001	4181	0.012	0.450	0.05	0.15	9.62	0.38	0.06
BDRC-080	62317	92.2	53.0	45.1	65.1	55.3	0.011	1586	0.012	0.450	0.05	0.15	9.63	0.38	0.06
Bethel Danebo - A Channel															
BDAC-010[1]		176.8	2.0	1.7	28.0	23.8	0.0								

1. These subbasins were not included in the detailed model.
2. Subbasins have been refined in this area and updated hydrologic information is available by contacting the City of Eugene Public Works Department, Engineering Division.

APPENDIX E
TABLE E-1
MAJOR HYDROLOGIC INPUT DATA FOR THE LAUREL HILL STORM DRAINAGE SYSTEM

Subbasin Name	Inlet Node	Subbasin Area (acres)	Impervious Area (%)				Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Overland Flow Roughness Coefficient		Depression Storage (inch)		Green-Ampt Infiltration Parameters		
			Existing Land Use		Future Land Use								Average Capillary Suction (in)	Initial Moisture Deficit (ft/ft)	Saturated Hydraulic Conductivity (inch/hour)
			Mapped	Effective	Mapped	Effective			Impervious	Pervious	Impervious	Pervious			
Laurel Hill - Glenwood															
LHGL-010	72143	20.7	71.1	60.4	71.1	60.4	0.300	2255	0.012	0.40	0.05	0.15	6.91	0.41	0.36
LHGL-020[3]	72596	60.5	28.2	24.0	58.0	49.3	0.220	2824	0.012	0.42	0.05	0.15	8.35	0.38	0.23
LHGL-030[3]	56387	35.9	36.5	31.0	62.9	53.5	0.160	2342	0.012	0.43	0.05	0.15	7.25	0.38	0.37
LHGL-040[3]	72587	76.2	43.5	37.0	55.1	46.8	0.110	2075	0.012	0.45	0.05	0.15	8.52	0.38	0.22
LHGL-050[3]	56390	69.4	49.4	42.0	64.0	54.4	0.250	4533	0.012	0.44	0.05	0.15	8.89	0.35	0.06
LHGL-070[3]	72591	44.7	43.5	37.0	61.1	51.9	0.010	1082	0.012	0.33	0.05	0.15	5.44	0.37	0.60
LHGL-080[3]	72589	101.7	27.1	23.0	54.0	45.9	0.230	3021	0.012	0.35	0.05	0.15	7.19	0.38	0.38
LHGL-090	53485	89.4	8.2	7.0	48.9	41.6	0.220	2434	0.012	0.41	0.05	0.15	9.01	0.35	0.06
LHGL-060[3] & LHGL-100[2]	72585	91.8	21.2	18.0	53.1	45.1	0.170	1874	0.012	0.41	0.05	0.15	9.47	0.38	0.07
Laurel Hill - Riverview/Augusta															
LHRA-010	72139	39.5	37.6	32.0	45.1	38.3	0.230	1518	0.012	0.42	0.05	0.15	6.13	0.39	0.20
LHRA-020[3]	56522	40.3	43.5	37.0	62.0	52.7	0.120	1318	0.012	0.43	0.05	0.15	8.56	0.40	0.18
LHRA-030	53635	39.6	36.5	31.0	41.1	34.9	0.180	1231	0.012	0.42	0.05	0.15	3.90	0.38	0.25
LHRA-040	75473	56.2	28.2	24.0	49.1	41.7	0.120	2160	0.012	0.40	0.05	0.15	8.39	0.40	0.19
LHRA-050	53752	32.4	30.6	26.0	43.1	36.6	0.160	1176	0.012	0.43	0.05	0.15	7.61	0.40	0.20
LHRA-051	75484	26.6	30.6	26.0	43.5	37.0	0.160	1390	0.012	0.43	0.05	0.15	7.61	0.40	0.20
LHRA-060	53777	53.0	18.8	16.0	32.0	27.2	0.270	1385	0.012	0.42	0.05	0.15	6.94	0.36	0.14
LHRA-070	53783	23.9	24.7	21.0	42.0	35.7	0.140	1644	0.012	0.42	0.05	0.15	7.91	0.34	0.10
LHRA-071	75486	39.7	24.7	21.0	42.4	36.0	0.140	1853	0.012	0.42	0.05	0.15	7.91	0.34	0.10
LHRA-080	51387	106.6	0.0	0.0	32.0	27.2	0.230	2487	0.012	0.40	0.05	0.15	7.51	0.29	0.05
LHRA-090	53704	38.4	22.4	19.0	36.9	31.4	0.190	965	0.012	0.40	0.05	0.15	8.21	0.32	0.06
LHRA-100	99796	158.6	16.5	14.0	38.0	32.3	0.260	3239	0.012	0.40	0.05	0.15	6.77	0.29	0.06

Note.
1. Shading indicates that these subbasins are now under City of Springfield jurisdiction and have been excluded from this basin planning process.
2. Subbasins LHGL-060 and LHGL-100 were combined in the model. Subbasin LHGL-060 is under City of Springfield jurisdiction and subbasin LHGL-100 is under City of Eugene jurisdiction.
3. The drainage system originally modeled for this basin included Laurel Hill (south of I-5) and Glenwood (north of I-5). The Glenwood area has since been transferred to the City of Springfield. Users of this Plan should contact the City of Springfield for drainage information in the Glenwood area. The information provided here is for context purposes only.

APPENDIX E
TABLE E-1
MAJOR HYDROLOGIC INPUT DATA FOR THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM

Subbasin Name	Inlet Node	Subbasin Area (acres)	Impervious Area (%)				Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Overland Flow Roughness Coefficient		Depression Storage (inch)		Green-Ampt Infiltration Parameters		
			Existing Land Use		Future Land Use								Average Capillary Suction (in)	Initial Moisture Deficit (ft/ft)	Saturated Hydraulic Conductivity (inch/hour)
			Mapped	Effective	Mapped	Effective			Impervious	Pervious	Impervious	Pervious			
Willakenzie North - County Farm															
WKCF-020	58172	85.5	11.1	9.4	43.1	36.6	0.016	1862	0.012	0.20	0.05	0.15	9.60	0.38	0.07
WKCF-030	66533	98.9	13.1	11.1	43.1	36.6	0.012	2307	0.012	0.20	0.05	0.15	9.63	0.38	0.06
WKCF-040[1]	58356	154.5	13.1	11.1	43.1	36.6	0.002	4205	0.012	0.20	0.05	0.15	9.62	0.39	0.07
WKCF-050[1]	66196	96.4	5.1	4.3	42.0	35.7	0.002	2625	0.012	0.20	0.05	0.15	9.10	0.39	0.13
WKCF-060	59489	47.7	26.0	22.1	33.1	28.1	0.008	1733	0.012	0.20	0.05	0.15	9.92	0.38	0.07
WKCF-070	59511	75.8	41.1	34.9	58.0	49.3	0.002	6188	0.012	0.20	0.05	0.15	8.71	0.40	0.16
Willakenzie Noth - Gilham Road															
WKGL-010	71280	65.9	9.0	7.7	39.0	33.2	0.042	3600	0.012	0.45	0.05	0.15	8.95	0.38	0.33
WKGL-020	71281	110.4	18.0	15.3	49.1	41.7	0.017	6009	0.012	0.45	0.05	0.15	7.90	0.41	0.24
WKGL-030	58454	66.6	17.1	14.5	43.1	36.6	0.005	3108	0.012	0.33	0.05	0.15	8.30	0.41	0.21
WKGL-040	58511	50.9	33.1	28.1	44.0	37.4	0.018	2080	0.012	0.45	0.05	0.15	7.50	0.41	0.28
WKGL-050	58499	43.1	28.0	23.8	45.1	38.3	0.004	1761	0.012	0.45	0.05	0.15	8.10	0.41	0.23
WKGL-060	58463	93.6	38.0	32.3	46.0	39.1	0.013	2185	0.012	0.45	0.05	0.15	9.00	0.39	0.13
Willakenzie North - Delta Highway															
WKDH-020	58447	83.3	25.1	21.3	42.0	35.7	0.087	4537	0.012	0.45	0.05	0.15	4.02	0.27	1.16
WKDH-030	58450	71.6	32.6	27.7	53.9	45.8	0.024	1559	0.012	0.45	0.05	0.15	4.10	0.37	0.77
WKDH-050	59799	99.2	43.1	36.6	50.8	43.2	0.067	2025	0.012	0.45	0.05	0.15	7.17	0.41	0.34
Willakenzie North - North Beltline															
WKNB-010	58442	92.8	41.1	34.9	42.0	35.7	0.079	3791	0.012	0.45	0.05	0.15	8.30	0.39	0.50
WKNB-020	59755	63.1	48.0	40.8	48.0	40.8	0.008	2576	0.012	0.45	0.05	0.15	9.15	0.39	0.12
WKNB-030	69005	67.2	46.0	39.1	46.0	39.1	0.002	4393	0.012	0.45	0.05	0.15	8.46	0.40	0.19
WKNB-040	59772	83.7	50.0	42.5	51.1	43.4	0.003	3416	0.012	0.45	0.05	0.15	9.50	0.39	0.08
WKNB-050	59519	66.3	51.1	43.4	53.1	45.1	0.000	3610	0.012	0.45	0.05	0.15	8.60	0.40	0.17
WKNB-060	59426	61.9	54.0	45.9	55.1	46.8	0.005	2887	0.012	0.45	0.05	0.15	9.20	0.39	0.11
WKNB-070	59497	95.1	6.0	5.1	17.1	14.5	0.002	2588	0.012	0.20	0.05	0.15	9.60	0.38	0.06
WKNB-080	71239	253.3	43.1	36.6	47.1	40.0	0.010	3761	0.012	0.45	0.05	0.15	9.40	0.39	0.09
WKNB-090	61140	36.5	39.1	33.2	45.1	38.3	0.002	3977	0.012	0.45	0.05	0.15	7.50	0.41	0.29
WKNB-100	59462	29.0	51.1	43.4	56.0	47.6	0.006	4740	0.012	0.45	0.05	0.15	9.00	0.40	0.14
WKNB-110	59476	22.3	39.1	33.2	46.0	39.1	0.002	3635	0.012	0.45	0.05	0.15	9.40	0.39	0.09
WKNB-120	61133	32.1	38.0	32.3	43.1	36.6	0.003	10471	0.012	0.45	0.05	0.15	6.30	0.43	0.41
WKNB-130	69048	29.2	41.1	34.9	43.1	36.6	0.002	1194	0.012	0.45	0.05	0.15	7.40	0.41	0.30
WKNB-140	61213	59.0	52.0	44.2	55.1	46.8	0.002	1929	0.012	0.45	0.05	0.15	8.10	0.41	0.23
WKNB-150	66590	59.5	38.0	32.3	46.0	39.1	0.001	1766	0.012	0.45	0.05	0.15	8.90	0.40	0.14
WKNB-160	99575	38.6	38.0	32.3	43.1	36.6	0.001	3155	0.012	0.45	0.05	0.15	7.00	0.42	0.33
WKNB-170	61142	125.5	25.1	21.3	44.0	37.4	0.001	2928	0.012	0.45	0.05	0.15	7.30	0.41	0.31
WKNB-180	61199	40.2	44.0	37.4	45.1	38.3	0.001	4372	0.012	0.45	0.05	0.15	7.30	0.41	0.31
WKNB-190	61086	59.1	39.1	33.2	40.0	34.0	0.001	4829	0.012	0.45	0.05	0.15	8.20	0.41	0.21
WKNB-200	62750	110.9	45.1	38.3	46.0	39.1	0.003	3019	0.012	0.45	0.05	0.15	6.70	0.42	0.37
WKNB-210	61235	72.5	39.1	33.2	44.0	37.4	0.001	1973	0.012	0.45	0.05	0.15	6.70	0.42	0.37
Willakenzie South - Delta Ponds															
WKDP-080	66556	20.8	46.0	39.1	46.0	39.1	0.067	3403	0.012	0.45	0.05	0.15	5.40	0.41	2.27
WKDP-090	60844	26.2	40.0	34.0	42.0	35.7	0.040	2858	0.012	0.45	0.05	0.15	6.60	0.42	0.38
WKDP-100	59197	41.6	30.0	25.5	46.0	39.1	0.075	1132	0.012	0.45	0.05	0.15	6.16	0.43	0.42
WKDP-110	60771	37.1	36.0	30.6	45.1	38.3	0.016	1010	0.012	0.45	0.05	0.15	5.94	0.44	0.44

APPENDIX E
TABLE E-1
MAJOR HYDROLOGIC INPUT DATA FOR THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM

Subbasin Name	Inlet Node	Subbasin Area (acres)	Impervious Area (%)				Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Overland Flow Roughness Coefficient		Depression Storage (inch)		Green-Ampt Infiltration Parameters		
			Existing Land Use		Future Land Use								Average Capillary Suction (in)	Initial Moisture Deficit (ft/ft)	Saturated Hydraulic Conductivity (inch/hour)
			Mapped	Effective	Mapped	Effective			Impervious	Pervious	Impervious	Pervious			
WKDP-120	60804	38.9	40.0	34.0	44.0	37.4	0.035	2544	0.012	0.45	0.05	0.15	6.96	0.42	0.34
WKDP-130	60760	55.4	35.1	29.8	51.1	43.4	0.033	3618	0.012	0.45	0.05	0.15	9.62	0.38	0.06
WKDP-140	60828	48.0	32.0	27.2	42.0	35.7	0.196	1959	0.012	0.42	0.05	0.15	6.85	0.42	0.33
WKDP-150	60811	29.9	39.1	33.2	42.9	36.5	0.076	1629	0.012	0.45	0.05	0.15	9.44	0.39	0.09
WKDP-160	61595	47.7	43.1	36.6	46.0	39.1	0.072	2596	0.012	0.45	0.05	0.15	8.79	0.40	0.15
Willakenzie South - Debrick Slough															
WKDS-010	60786	76.9	68.0	57.8	71.1	60.4	0.015	3140	0.012	0.45	0.05	0.15	4.38	0.36	0.72
WKDS-020	60730	48.4	58.0	49.3	64.0	54.4	0.066	3164	0.012	0.45	0.05	0.15	8.10	0.40	0.21
WKDS-030	62474	68.6	29.1	24.7	61.1	51.9	0.105	2801	0.012	0.45	0.05	0.15	6.87	0.40	0.36
WKDS-040	99058	214.3	14.0	11.9	26.0	22.1	0.080	6364	0.012	0.45	0.05	0.15	8.65	0.39	0.14
WKDS-050	62914	78.7	27.1	23.0	33.1	28.1	0.025	2143	0.012	0.45	0.05	0.15	8.86	0.38	0.16
WKDS-060	62978	55.2	36.0	30.6	38.0	32.3	0.002	2253	0.012	0.45	0.05	0.15	4.69	0.38	0.68
WKDS-070	62946	75.2	41.1	34.9	42.9	36.5	0.014	4097	0.012	0.45	0.05	0.15	5.15	0.37	0.64
WKDS-080	62989	139.5	51.1	43.4	52.9	45.0	0.022	7596	0.012	0.45	0.05	0.15	5.49	0.38	0.43
WKDS-090	62713	44.5	43.1	36.6	43.1	36.6	0.003	2425	0.012	0.45	0.05	0.15	6.52	0.38	0.16
WKDS-100	71101	47.2	41.1	34.9	42.9	36.5	0.016	1102	0.012	0.45	0.05	0.15	6.06	0.41	0.30
Willakenzie South - Gilham-Norkenzie															
WKGN-010	59134	52.9	43.1	36.6	47.1	40.0	0.106	2880	0.012	0.45	0.05	0.15	6.56	0.42	0.38
WKGN-020	68175	41.2	44.0	37.4	44.0	37.4	0.169	1346	0.012	0.45	0.05	0.15	7.16	0.42	0.32
WKGN-030	59868	53.9	46.0	39.1	47.1	40.0	0.008	8808	0.012	0.45	0.05	0.15	7.40	0.41	0.30
WKGN-040	59878	37.8	41.1	34.9	42.0	35.7	0.003	1766	0.012	0.45	0.05	0.15	8.26	0.41	0.21
WKGN-050	59859	41.5	42.0	35.7	44.0	37.4	0.001	1508	0.012	0.45	0.05	0.15	6.13	0.43	0.42
WKGN-060	59889	61.9	42.0	35.7	42.9	36.5	0.005	2527	0.012	0.45	0.05	0.15	9.20	0.39	0.11
WKGN-070	61562	91.4	42.0	35.7	45.1	38.3	0.001	7462	0.012	0.45	0.05	0.15	7.43	0.41	0.30
WKGN-080	72432	53.8	38.0	32.3	56.0	47.6	0.002	2511	0.012	0.45	0.05	0.15	9.43	0.39	0.08
WKGN-090	99498	48.0	41.1	34.9	42.0	35.7	0.011	3921	0.012	0.45	0.05	0.15	7.46	0.41	0.29
WKGN-100	61423	54.6	44.0	37.4	45.1	38.3	0.001	1621	0.012	0.45	0.05	0.15	8.31	0.41	0.20

Note.
1. Modeling data for these subbasins has recently been updated and is available by contacting the City of Eugene Public Works Department, Engineering Division.

APPENDIX E
TABLE E-1
MAJOR HYDROLOGIC INPUT DATA FOR THE WILLAMETTE RIVER STORM DRAINAGE SYSTEM

Subbasin Name	Inlet Node	Subbasin Area (acres)	Impervious Area (%)				Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Overland Flow Roughness Coefficient		Depression Storage (inch)		Green-Ampt Infiltration Parameters		
			Existing Land Use		Future Land Use								Average Capillary Suction (in)	Initial Moisture Deficit (ft/ft)	Saturated Hydraulic Conductivity (inch/hour)
			Mapped	Effective	Mapped	Effective			Impervious	Pervious	Impervious	Pervious			
WRRR-010	59087	14.8	40.0	34.0	48.0	40.8	0.016	1205	0.012	0.450	0.05	0.15	7.23	0.38	1.12
WRRR-020	66178	40.9	40.0	34.0	50.0	42.5	0.005	2671	0.012	0.450	0.05	0.15	8.96	0.38	0.14
WRRR-030	59120	14.0	28.0	23.8	44.0	37.4	0.007	1141	0.012	0.450	0.05	0.15	8.03	0.38	0.68
WRRR-040	60606	27.8	38.0	32.3	48.0	40.8	0.000	1818	0.012	0.450	0.05	0.15	9.62	0.38	0.07
WRRR-050	60617	37.0	43.0	36.6	50.0	42.5	0.002	2838	0.012	0.450	0.05	0.15	8.96	0.38	0.09
WRRR-060	67889	34.8	35.0	29.8	41.1	34.9	0.023	3162	0.012	0.430	0.05	0.15	5.55	0.38	0.71
WRRR-070 & WRRR-080[1]	60580	49.5	49.1	41.7	59.5	50.6	0.009	5860	0.012	0.400	0.05	0.15	7.42	0.37	0.19
WRRR-090	60647	9.7	41.0	34.9	44.0	37.4	0.000	2121	0.012	0.450	0.05	0.15	9.62	0.38	0.06
WRRR-100	62222	14.6	50.0	42.5	60.0	51.0	0.004	4753	0.012	0.450	0.05	0.15	9.27	0.38	0.08

Note.
1. Subbasins WRRR-070 and WRRR-080 are combined into one subbasin.

APPENDIX E
TABLE E-1
MAJOR HYDROLOGIC INPUT DATA FOR THE WILLOW CREEK STORM DRAINAGE SYSTEM

Subbasin Name	Inlet Node	Subbasin Area (acres)	Impervious Area (%)				Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Overland Flow Roughness Coefficient		Depression Storage (inch)		Green-Ampt Infiltration Parameters		
			Existing Land Use		Future Land Use								Average Capillary Suction (in)	Initial Moisture Deficit (ft/ft)	Saturated Hydraulic Conductivity (inch/hour)
			Mapped	Effective	Mapped	Effective			Impervious	Pervious	Impervious	Pervious			
Willow Creek - East Branch															
WCEA-005	76015	12.4	0.0	0.0	0.0	0.0	0.003	1540	0.012	0.400	0.05	0.25	6.41	0.25	0.05
WCEA-010	73500	80.7	1.2	1.0	6.0	5.1	0.011	3514	0.014	0.300	0.05	0.25	4.82	0.23	0.03
WCEA-020	51998	134.2	4.7	4.0	39.1	33.2	0.200	1826	0.014	0.400	0.05	0.15	4.67	0.20	0.05
WCEA-030	71041	193.0	8.2	7.0	6.0	5.1	0.144	5189	0.014	0.300	0.05	0.25	3.40	0.22	0.03
WCEA-040	71016	37.7	16.5	14.0	37.1	31.5	0.240	1081	0.014	0.450	0.05	0.15	2.66	0.20	0.13
WCEA-050	71014	141.9	16.5	14.0	22.0	18.7	0.240	1627	0.014	0.400	0.05	0.15	4.35	0.18	0.04
WCEA-060	71044	67.9	18.8	16.0	32.0	27.2	0.110	1479	0.014	0.420	0.05	0.15	5.17	0.23	0.08
WCEA-070	71012	308.3	5.9	5.0	17.1	14.5	0.240	2919	0.014	0.400	0.05	0.15	5.51	0.22	0.05
WCEA-080	71008	229.4	9.4	8.0	17.1	14.5	0.223	2629	0.014	0.400	0.05	0.15	4.76	0.20	0.05
Willow Creek - Main Stem															
WCMN-010	71037	192.5	7.1	6.0	63.1	53.6	0.008	6350	0.014	0.200	0.05	0.25	5.48	0.23	0.02
WCMN-020	54495	31.0	36.5	31.0	37.1	31.5	0.057	485	0.014	0.200	0.05	0.15	6.43	0.26	0.05
Willow Creek - West Branch															
WCWE-010	76010	86.5	7.1	6.0	6.0	5.1	0.005	3365	0.014	0.400	0.05	0.25	5.62	0.25	0.03
WCWE-030	71030	247.2	3.5	3.0	12.0	10.2	0.230	2025	0.014	0.350	0.05	0.20	5.05	0.22	0.03
WCWE-040	71028	84.7	10.6	9.0	35.1	29.8	0.150	2426	0.014	0.200	0.05	0.15	4.96	0.23	0.09
WCWE-050	71024	88.7	2.4	2.0	15.1	12.8	0.270	986	0.014	0.400	0.05	0.15	5.84	0.24	0.05
WCWE-070	71020	339.4	10.6	9.0	18.0	15.3	0.224	3214	0.014	0.350	0.05	0.15	6.17	0.25	0.05
WCWE-020&60	71032	292.0	1.2	1.0	11.8	10.0	0.119	2355	0.014	0.200	0.05	0.20	4.48	0.24	0.03

APPENDIX E
TABLE E-2
HYDROLOGIC MODEL OUTPUT DATA UNDER EXISTING AND FUTURE CONDITIONS
FOR THE AMAZON CREEK BASIN

Subbasin Name	Inlet Node	Subbasin Area (acres)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year	10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year
Amazon - Bailey Hill												
AMBH-010	54741	128.8	51	52	68	124	147	55	55	74	134	158
AMBH-015	54854	68.6	14	18	24	44	55	19	22	32	57	69
AMBH-020 & AMBH-030	71086	36.2	9	9	16	26	30	11	11	20	31	35
AMBH-040	54772	97.5	23	23	40	65	76	25	25	44	71	83
AMBH-050	54815	31.8	7	7	12	19	21	9	9	15	24	27
AMBH-060	54773	61.9	20	21	24	44	54	24	24	31	54	65
AMBH-070	52255	95.5	29	31	38	71	85	31	33	41	76	92
AMBH-080	66465	90.9	49	50	65	124	147	51	51	71	132	155
AMBH-090	52167	213.9	72	80	53	106	134	101	101	121	209	247
AMBH-100	52214	230.0	82	89	66	128	160	107	107	125	217	256
AMBH-110	52145	61.0	25	24	22	43	54	30	30	36	64	76
AMBH-120	67805	96.6	43	43	47	82	99	48	48	61	103	121
Amazon - Bertelsen Sub-Basin												
AMBT-010	63173	79.8	23	27	18	36	44	28	31	29	52	63
AMBT-020	54522	73.9	31	31	32	59	71	39	38	53	89	104
AMBT-030	63127	75.6	20	20	34	56	65	24	24	42	68	79
AMBT-040	54747	39.1	16	16	15	29	36	20	20	25	44	52
AMBT-050	71091	102.2	42	42	41	77	93	52	51	66	114	134
AMBT-060	54909	48.3	15	17	21	33	38	16	18	22	34	40
AMBT-070	54898	77.4	20	20	34	55	63	20	20	35	56	64
AMBT-080	51995	50.0	18	18	13	29	38	23	24	28	52	62
AMBT-090	68843	106.5	41	41	49	91	109	42	43	52	96	114
AMBT-100	66971	91.1	10	12	11	20	25	30	31	46	65	75
Amazon - City View Sub-Basin												
AMCV-010	71084	26.4	11	12	15	22	26	13	13	18	26	30
AMCV-020	55283	41.0	16	17	23	29	34	17	18	24	30	35
AMCV-030	55272	68.9	32	32	40	71	84	33	33	42	74	87
AMCV-040	71004	80.1	20	20	34	55	62	21	21	37	58	66
AMCV-050	55274	90.2	22	22	38	62	72	24	24	42	68	80
AMCV-060	71081	55.2	12	13	21	35	41	14	15	24	39	46

APPENDIX E
TABLE E-2
HYDROLOGIC MODEL OUTPUT DATA UNDER EXISTING AND FUTURE CONDITIONS
FOR THE AMAZON CREEK BASIN

Subbasin Name	Inlet Node	Subbasin Area (acres)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year	10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year
AMCV-070	55294	95.0	22	22	38	61	71	25	25	42	68	80
AMCV-080	55365	108.8	42	44	44	87	105	45	46	52	98	117
AMCV-090	52730	39.8	19	19	22	40	48	20	20	24	43	52
AMCV-100	52573	123.4	50	51	48	91	111	56	55	61	111	133
Amazon - Headwaters Sub-Basin												
AMHW-010	67175	249.6	77	86	52	111	142	97	102	95	178	216
AMHW-020	65344	214.1	82	83	64	131	163	99	96	106	195	233
AMHW-030	65392	157.7	63	60	45	95	121	74	73	79	146	176
Amazon - Lower Sub-Basin												
AMLW-010	71114	565.6	16	23	27	52	70	105	112	181	282	331
AMLW-020	71113	189.3	22	34	6	23	34	29	40	19	44	57
AMLW-030	63178	251.4	59	75	42	87	108	77	90	77	137	165
AMLW-040	71110	137.0	41	45	23	52	69	57	58	59	108	131
AMLW-050	71105	224.5	58	67	35	77	97	94	99	114	192	228
AMLW-060	71122	68.5	23	25	17	36	45	27	28	26	49	59
Amazon - Middle Sub-Basin												
AMMD-010	51437	121.7	55	52	54	103	127	59	57	65	121	146
AMMD-020	54260	196.9	90	90	90	172	209	94	94	101	188	226
AMMD-030	54295	97.6	46	45	51	93	111	47	46	54	97	115
AMMD-040	54330	165.1	87	88	104	189	226	89	89	109	195	233
AMMD-050	54174	119.9	52	54	58	102	122	53	54	60	106	126
AMMD-060	51751	130.9	59	59	66	120	143	61	60	69	124	147
AMMD-070	71052	33.4	17	17	21	37	43	17	17	21	37	44
AMMD-080	51303	85.0	44	44	54	98	117	44	44	56	100	119
AMMD-090	51344	165.5	69	69	69	129	156	75	74	83	150	180
AMMD-100	71053	135.1	62	61	69	124	148	63	63	73	130	154
AMMD-110	66967	28.0	15	15	20	34	40	15	16	21	36	41
AMMD-120	54175	15.3	9	9	13	20	23	9	9	13	21	24
AMMD-130	57163	55.3	23	25	25	44	52	26	27	32	54	63
AMMD-135	57428	122.7	54	57	67	112	132	56	58	70	117	138
AMMD-140	57400	30.0	12	13	16	25	29	13	14	19	27	32
AMMD-145	57427	46.5	20	21	24	41	49	22	22	28	46	55

APPENDIX E
TABLE E-2
HYDROLOGIC MODEL OUTPUT DATA UNDER EXISTING AND FUTURE CONDITIONS
FOR THE AMAZON CREEK BASIN

Subbasin Name	Inlet Node	Subbasin Area (acres)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year	10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year
AMMD-150	71059	56.2	27	28	36	62	73	29	29	40	68	79
AMMD-160	71063	52.0	16	18	28	47	55	17	19	30	49	58
AMMD-165	56284	44.8	19	19	23	42	50	19	20	24	44	53
AMMD-170	71075	171.0	64	66	80	145	173	66	68	85	153	182
Amazon - Polk Street Sub-Basin												
AMPK-010	55432	71.6	27	30	38	50	59	29	31	42	54	63
AMPK-020	66991	87.3	37	40	51	80	94	39	41	54	84	99
AMPK-030	71080	81.6	29	32	37	60	70	31	35	42	66	77
AMPK-040	56048	68.1	25	28	31	54	64	27	29	34	58	69
AMPK-050	71079	66.9	24	27	31	52	61	24	27	31	52	62
AMPK-060	52687	78.1	15	15	27	44	52	16	16	28	47	55
AMPK-070	55256	36.7	7	7	12	19	22	7	7	13	21	24
AMPK-080	71003	110.5	31	31	54	88	101	32	32	56	91	105
AMPK-090	52685	33.7	9	9	15	25	30	9	9	15	25	31
AMPK-100	52707	142.1	64	63	69	127	153	67	65	76	137	164
AMPK-110	53441	121.0	43	46	47	89	108	46	49	54	100	120
AMPK-120	53422	118.0	54	52	57	106	128	55	54	62	112	135
AMPK-130	53408	106.0	45	44	43	82	100	49	47	53	97	117
AMPK-140	53390	103.4	45	44	46	86	104	48	47	53	97	116
AMPK-150	53358	47.6	23	22	26	46	55	23	22	26	47	56
AMPK-160	53448	71.1	32	32	36	65	77	32	32	36	66	79
AMPK-170	68813	70.3	18	21	31	60	77	18	22	31	61	79
Amazon - Upper Sub-Basin												
AMUP-010	65582	172.4	73	70	62	123	154	84	83	94	173	206
AMUP-020	65398	197.3	79	83	84	152	182	85	88	97	171	204
AMUP-030	65396	182.7	79	76	71	139	171	89	88	102	186	222
AMUP-040	65370	218.9	98	100	103	189	228	110	114	141	244	286
AMUP-050	67978	76.4	38	38	42	79	96	40	41	49	89	107
AMUP-060	50653	97.0	50	50	58	107	130	51	51	61	112	135
AMUP-070	50200	126.1	64	65	77	141	168	65	66	79	144	172
AMUP-080	50090	114.8	50	50	53	104	129	52	53	60	115	141
AMUP-090	50739	122.6	52	49	44	88	111	60	60	70	128	153

APPENDIX E
TABLE E-2
HYDROLOGIC MODEL OUTPUT DATA UNDER EXISTING AND FUTURE CONDITIONS
FOR THE AMAZON CREEK BASIN

Subbasin Name	Inlet Node	Subbasin Area (acres)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year	10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year
AMUP-100	50109	151.9	62	61	55	108	134	69	67	74	137	165
AMUP-110	99479	93.1	38	36	29	61	78	45	44	50	92	111
AMUP-120	50660	181.3	69	74	70	128	155	77	80	87	154	184
AMUP-130	50671	42.6	21	21	24	45	55	21	21	25	47	56
AMUP-140	51763	101.6	47	46	49	92	111	50	49	58	105	125
AMUP-150	50544	179.9	88	89	103	181	217	92	94	116	200	236
AMUP-160	51757	150.7	72	69	77	143	172	75	73	86	158	188
AMUP-170	51729	64.1	28	29	33	57	68	28	29	34	58	69
AMUP-180	51841	93.7	51	51	63	115	138	52	52	65	118	141
AMUP-190[3]	51239	49.4	27	27	34	61	72	28	28	37	66	78
AMUP-200[3]	50163	92.9	42	42	46	80	96	48	48	63	104	121

Note.
1. W = Winter
2. S = Summer
3. Modeling data for these subbasins have recently been updated and are available by contacting the City of Eugene Public Works Department, Engineering Division.

APPENDIX E
TABLE E-2
HYDROLOGIC MODEL OUTPUT DATA UNDER EXISTING AND FUTURE CONDITIONS
FOR THE BETHEL DANEBO BASIN

Subbasin Name	Inlet Node	Subbasin Area (acres)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year	10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year
Bethel Danebo - A2 Channel												
BDA2-010	58209	61.6	12	9	10	23	30	15	11	15	31	38
BDA2-020	58709	37.5	12	12	15	26	30	12	13	16	26	31
BDA2-030	58689	84.0	19	20	29	35	41	22	23	33	39	46
BDA2-040	58205	39.2	12	12	14	26	32	13	13	16	30	36
BDA2-050	58207	113.1	3	2	0	3	6	10	9	12	23	28
BDA2-060	58673	40.7	13	13	18	30	35	13	13	18	30	36
BDA2-070	58680	40.1	16	15	18	34	41	17	16	19	37	44
BDA2-080	66164	110.7	31	32	42	67	79	31	32	43	68	80
BDA2-090	58950	70.3	22	21	31	50	59	22	21	31	50	59
BDA2-100	60245	56.1	15	15	24	34	40	16	16	25	36	41
BDA2-110	58645	78.5	17	18	29	37	43	19	19	31	40	46
BDA2-120	80004	51.4	8	6	7	16	21	11	8	11	23	30
BDA2-130	80007	109.8	34	35	30	58	71	39	40	40	74	88
BDA2-140	58946	68.0	16	16	23	34	40	20	20	30	41	48
BDA2-150	58875	56.6	18	19	28	39	46	19	19	28	40	47
BDA2-160	80009	70.4	19	19	28	36	42	25	26	38	46	54
BDA2-170	80010	28.5	6	6	9	13	15	8	8	13	17	20
BDA2-180	80015	13.5	4	4	5	8	9	5	5	6	10	12
BDA2-190	58894	56.3	13	12	20	30	34	16	16	26	37	42
BDA2-200	58893	58.6	17	17	28	42	48	18	19	31	45	52
BDA2-210	58853	49.2	5	5	8	13	16	18	18	29	41	48
BDA2-220	80017	85.3	13	12	17	30	36	33	33	52	81	94
BDA2-230	69700	13.9	3	3	5	7	9	4	4	7	9	11
BDA2-240	69714	34.1	13	13	18	25	29	14	14	20	27	32
BDA2-250	69732	211.5	47	48	69	91	107	77	79	114	135	158
BDA2-260	80018	69.6	2	2	3	5	6	23	23	36	43	49
BDA2-270	80022	26.3	9	9	15	21	24	9	9	15	21	24
BDA2-280	66548	42.2	12	12	18	24	28	13	13	20	25	29
BDA2-290	58883	77.9	21	21	29	44	52	23	24	34	49	58
BDA2-300	60488	65.4	17	17	20	33	39	20	21	26	40	47
BDA2-310	60565	60.7	17	17	23	32	37	18	19	26	34	40

APPENDIX E
TABLE E-2
HYDROLOGIC MODEL OUTPUT DATA UNDER EXISTING AND FUTURE CONDITIONS
FOR THE BETHEL DANEBO BASIN

Subbasin Name	Inlet Node	Subbasin Area (acres)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year	10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year
BDA2-320	60238	39.9	10	11	17	25	29	11	11	18	26	30
BDA2-330	60216	56.9	15	16	24	31	36	16	16	24	31	37
BDA2-340	60123	39.7	10	11	17	22	25	10	11	17	22	25
BDA2-350	80025	12.6	3	3	5	9	10	3	3	5	9	11
BDA2-360	60107	33.9	9	8	13	20	24	9	9	13	21	25
BDA2-370	67069	54.5	13	13	19	26	31	16	16	24	31	37
BDA2-380	66573	139.9	37	38	55	69	81	38	39	56	70	82
BDA2-390	60461	41.1	15	15	19	32	38	15	15	19	32	38
BDA2-395	60454	67.1	22	23	32	44	51	23	24	35	46	54
BDA2-400	68451	66.1	23	24	31	51	60	24	24	32	52	61
BDA2-405	60541	21.5	10	10	14	23	26	11	11	15	24	28
BDA2-408	69935	63.8	21	21	30	36	43	23	23	33	39	46
BDA2-410	80027	21.7	6	6	8	12	14	7	7	10	14	16
BDA2-420	60101	37.6	11	12	16	23	27	12	12	17	25	29
BDA2-430	61733	61.2	17	17	23	30	36	18	18	25	32	38
Bethel Danebo - A3 Channel												
BDA3-010	61607	71.8	0	0	1	1	2	2	2	3	5	6
BDA3-020	61608	137.4	23	22	30	52	62	43	43	64	98	114
BDA3-030	61694	67.0	17	17	15	29	35	24	24	27	45	53
BDA3-040	80050	157.9	56	52	50	107	134	83	81	106	192	227
BDA3-050	modpt	43.5	13	13	21	29	34	17	17	27	36	41
BDA3-060	63147	36.3	15	14	23	38	44	16	15	24	40	47
BDA3-070	63207	36.0	7	7	11	13	16	11	12	16	19	23
BDA3-080	63129	105.9	18	18	16	33	42	22	23	24	46	56
BDA3-090	67158	103.3	22	21	24	46	57	29	28	37	67	80
BDA3-100	63276	63.4	13	13	12	23	28	26	27	37	53	62
BDA3-110	63359	72.1	21	21	29	38	45	29	29	42	50	59
BDA3-120	63326	73.0	19	18	22	40	49	24	24	32	55	65
BDA3-130	63364	39.2	15	15	18	31	37	19	19	27	44	51
BDA3-150	63349	76.8	28	28	40	52	61	33	34	48	60	70
BDA3-160	66631	95.5	28	27	30	49	57	43	44	59	77	90
BDA3-180	63369	67.9	23	24	35	48	56	28	30	43	57	66

APPENDIX E
TABLE E-2
HYDROLOGIC MODEL OUTPUT DATA UNDER EXISTING AND FUTURE CONDITIONS
FOR THE BETHEL DANEBO BASIN

Subbasin Name	Inlet Node	Subbasin Area (acres)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year	10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year
BDA3-190	63811	85.7	28	28	41	49	57	33	34	47	55	65
BDA3-200	63822	43.8	18	17	21	35	42	23	23	31	49	57
BDA3-210	63826	59.7	24	25	36	50	59	26	27	40	54	63
BDA3-220	63800	88.9	33	34	49	61	72	37	38	56	67	78
BDA3-230	63795	75.8	26	26	32	48	57	35	35	49	65	75
Bethel Danebo - Greenhill Tributary												
BDGH-010[3&4]		38.9										
BDGH-020[4]	80029	110.9	5	5	5	9	12	26	28	35	42	49
BDGH-030[4]	80031	182.9	6	5	2	8	12	44	45	61	72	85
BDGH-040[4]	80033	26.5	2	2	1	3	4	8	8	11	17	20
BDGH-050	80037	45.2	3	3	1	3	5	13	14	18	26	30
BDGH-060	80071	39.1	3	3	2	4	6	11	12	16	23	28
BDGH-062	70559	72.1	4	4	3	7	9	19	20	28	38	44
BDGH-064	80064	38.4	2	3	1	3	5	11	11	16	23	27
BDGH-066	70560	5.7	2	2	3	5	6	2	2	3	5	6
BDGH-068	70539	15.8	6	6	8	12	14	6	6	8	12	14
BDGH-070	59949	18.1	5	5	6	10	12	5	5	7	11	13
BDGH-075	80069	39.3	10	10	13	21	25	12	12	16	24	29
BDGH-080	70177	50.5	9	9	11	19	23	13	13	19	28	33
BDGH-090	59945	80.8	20	21	25	43	52	27	28	36	59	69
BDGH-100	60212	40.3	10	10	16	24	28	11	11	17	26	30
BDGH-110	60196	108.3	22	22	30	45	53	34	35	51	66	77
BDGH-120	80041	137.1	4	3	5	10	13	20	20	33	51	59
BDGH-130	69068	54.3	14	15	20	31	36	16	17	22	34	40
Bethel Danebo - Roosevelt Channel												
BDRC-010	61727	94.9	27	27	24	48	58	45	44	60	98	115
BDRC-020	61741	54.6	17	17	23	30	35	22	22	31	37	44
BDRC-030	61743	38.9	14	13	15	28	33	16	16	20	34	40
BDRC-040	61959	168.9	52	53	71	102	120	59	60	83	115	135
BDRC-050	61977	63.3	21	22	26	42	50	27	28	37	55	64
BDRC-055	69952	224.8	44	44	60	85	100	81	82	117	141	165

APPENDIX E
TABLE E-2
HYDROLOGIC MODEL OUTPUT DATA UNDER EXISTING AND FUTURE CONDITIONS
FOR THE BETHEL DANEBO BASIN

Subbasin Name	Inlet Node	Subbasin Area (acres)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year	10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year
BDRC-060	66603	28.2	11	11	16	25	29	13	13	18	28	33
BDRC-070	62329	38.4	15	15	19	31	37	16	17	23	36	42
BDRC-080	62317	92.2	35	36	49	71	84	41	42	59	82	96
Bethel Danebo - A Channel												
BDAC-010[3]		176.8										

Note.
1. W = Winter
2. S = Summer
3. These subbasins were not included in the detailed model.
4. Subbasins have been refined in this area and updated hydrologic information is available by contacting the City of Eugene Public Works Department, Engineering Division.

APPENDIX E
TABLE E-2
HYDROLOGIC MODEL OUTPUT DATA UNDER EXISTING AND FUTURE CONDITIONS
FOR THE LAUREL HILL BASIN

Subbasin Name	Inlet Node	Subbasin Area (acres)	Subbasin Peak Flow (cfs) Existing Land Use Conditions				Subbasin Peak Flow (cfs) Future Land Use Conditions			
			10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	10-Year	25-Year-W[1]	25-Year-S[2]	50-Year
Laurel Hill - Glenwood										
LHGL-010	72143	20.7	8	9	12	24	8	9	12	24
LHGL-020[3]	72596	60.5	10	10	13	30	20	21	27	58
LHGL-030[3]	56387	35.9	7	8	10	21	13	13	18	36
LHGL-040[3]	72587	76.2	19	20	26	54	24	25	33	67
LHGL-050[3]	56390	69.4	39	38	34	91	41	41	42	103
LHGL-070[3]	72591	44.7	11	12	15	28	15	16	21	37
LHGL-080[3]	72589	101.7	16	16	22	44	31	33	43	87
LHGL-090	53485	89.4	34	29	11	47	45	45	39	99
LHGL-060[3] & LHGL-100[4]	72585	91.8	33	26	17	52	45	41	40	95
Laurel Hill - Riverview/Augusta										
LHRA-010	72139	39.5	8	10	12	28	10	12	14	32
LHRA-020[3]	56522	40.3	10	11	14	30	14	15	20	42
LHRA-030	53635	39.6	8	10	11	26	9	11	13	29
LHRA-040	75473	56.2	9	9	12	28	16	16	22	47
LHRA-050	53752	32.4	6	6	8	18	8	8	11	24
LHRA-051	75484	26.6	5	5	6	15	7	7	9	21
LHRA-060	53777	53.0	13	12	8	25	17	16	13	36
LHRA-070	53783	23.9	9	9	5	19	11	11	9	25
LHRA-071	75486	39.7	15	14	8	28	17	17	14	39
LHRA-080	51387	106.6	39	37	12	52	50	51	38	100
LHRA-090	53704	38.4	16	15	9	28	18	18	14	36
LHRA-100	99796	158.6	64	63	35	108	75	77	61	156

Note.
1. W = Winter
2. S = Summer
3. The drainage system originally modeled for this basin included Laurel Hill (south of I-5) and Glenwood (north of I-5). The Glenwood area has since been transferred to the City of Springfield. Users of this Plan should contact the City of Springfield for drainage information in the Glenwood area. The information provided here is for context purposes only.
4. Subbasins LHGL-060 and LHGL-100 were combined in the model. Subbasin LHGL-060is under City of Springfield jurisdiction and subbasin LHGL-100 is under City of Eugene jurisdiction.

APPENDIX E
TABLE E-2
HYDROLOGIC MODEL OUTPUT DATA UNDER EXISTING AND FUTURE CONDITIONS
FOR THE WILLAKENZIE BASIN

Subbasin Name	Inlet Node	Subbasin Area (acres)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year	10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year
Willakenzie North - County Farm												
WKCF-020	58172	85.5	23	18	16	30	39	35	32	41	67	81
WKCF-030	66533	98.9	28	23	21	38	49	41	38	48	78	93
WKCF-040[3]	58356	154.5	31	26	25	44	55	54	51	67	95	114
WKCF-050[3]	66196	96.4	7	5	5	12	16	26	26	38	56	66
WKCF-060	59489	47.7	17	14	16	28	35	18	16	19	33	40
WKCF-070	59511	75.8	20	19	29	50	60	27	27	41	67	79
Willakenzie North - Gilham Road												
WKGL-010	71280	65.9	3	4	6	9	11	15	15	24	41	46
WKGL-020	71281	110.4	11	12	19	33	40	31	32	51	85	99
WKGL-030	58454	66.6	6	7	11	19	22	16	17	27	43	50
WKGL-040	58511	50.9	10	10	16	26	31	13	13	21	35	40
WKGL-050	58499	43.1	7	7	11	18	21	11	12	18	28	32
WKGL-060	58463	93.6	24	23	34	56	65	28	28	41	65	76
Willakenzie North - Delta Highway												
WKDH-020	58447	83.3	12	12	20	33	38	20	21	33	56	63
WKDH-030	58450	71.6	13	14	22	36	40	22	23	36	56	63
WKDH-050	59799	99.2	24	25	40	66	74	28	30	48	77	87
Willakenzie North - North Beltline												
WKNB-010	58442	92.8	22	23	36	61	68	22	23	37	62	70
WKNB-020	59755	63.1	20	20	29	48	56	20	20	29	48	56
WKNB-030	69005	67.2	17	18	29	45	52	17	18	29	45	52
WKNB-040	59772	83.7	30	30	41	63	74	31	30	42	64	75
WKNB-050	59519	66.3	19	20	30	39	45	19	20	31	40	47
WKNB-060	59426	61.9	22	23	32	52	61	23	23	33	53	62
WKNB-070	59497	95.1	18	15	11	21	27	23	21	20	35	44
WKNB-080	71239	253.3	75	75	105	154	180	80	80	114	164	192
WKNB-090	61140	36.5	8	9	13	22	25	9	10	16	25	29
WKNB-100	59462	29.0	11	10	14	27	32	11	11	16	29	34

APPENDIX E
TABLE E-2
HYDROLOGIC MODEL OUTPUT DATA UNDER EXISTING AND FUTURE CONDITIONS
FOR THE WILLAKENZIE BASIN

Subbasin Name	Inlet Node	Subbasin Area (acres)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year	10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year
WKNB-110	59476	22.3	8	7	9	16	20	9	8	11	19	22
WKNB-120	61133	32.1	7	7	12	19	22	8	8	13	22	25
WKNB-130	69048	29.2	7	7	11	16	19	7	7	12	17	20
WKNB-140	61213	59.0	17	18	28	38	44	18	19	30	40	46
WKNB-150	66590	59.5	13	14	21	29	34	16	16	25	34	39
WKNB-160	99575	38.6	8	9	14	20	23	9	10	16	23	26
WKNB-170	61142	125.5	18	19	29	42	47	31	32	50	64	74
WKNB-180	61199	40.2	10	11	17	27	30	10	11	17	27	31
WKNB-190	61086	59.1	13	14	22	34	39	13	14	22	35	40
WKNB-200	62750	110.9	28	30	47	65	74	29	30	48	66	75
WKNB-210	61235	72.5	16	17	26	34	39	18	19	29	37	42
Willakenzie South - Delta Ponds												
WKDP-080	66556	20.8	5	6	9	15	17	5	6	9	15	17
WKDP-090	60844	26.2	6	6	10	17	19	6	7	10	18	20
WKDP-100	59197	41.6	7	7	12	20	22	11	11	18	30	34
WKDP-110	60771	37.1	8	8	13	20	23	9	10	16	25	28
WKDP-120	60804	38.9	9	9	15	25	28	10	10	16	27	31
WKDP-130	60760	55.4	25	22	26	47	57	28	26	33	59	71
WKDP-140	60828	48.0	9	9	15	25	28	11	12	19	32	37
WKDP-150	60811	29.9	12	11	14	26	31	13	12	15	27	33
WKDP-160	61595	47.7	15	14	19	37	46	16	15	21	40	48
Willakenzie South - Debrick Slough												
WKDS-010	60786	76.9	30	31	49	77	88	31	33	52	80	91
WKDS-020	60730	48.4	16	17	27	47	55	18	19	29	52	60
WKDS-030	62474	68.6	11	12	19	32	36	24	25	40	66	75
WKDS-040	99058	214.3	32	26	30	66	87	46	41	54	107	132
WKDS-050	62914	78.7	13	13	20	36	43	16	16	25	43	51
WKDS-060	62978	55.2	11	12	19	28	32	12	13	20	30	34
WKDS-070	62946	75.2	17	18	29	48	54	18	19	31	50	57

APPENDIX E
TABLE E-2
HYDROLOGIC MODEL OUTPUT DATA UNDER EXISTING AND FUTURE CONDITIONS
FOR THE WILLAKENZIE BASIN

Subbasin Name	Inlet Node	Subbasin Area (acres)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year	10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year
WKDS-080	62989	139.5	40	43	67	111	126	42	44	70	115	130
WKDS-090	62713	44.5	12	13	18	30	35	12	13	18	30	35
WKDS-100	71101	47.2	11	12	18	29	33	11	12	19	30	34
Willakenzie South - Gilham-Norkenzie												
WKGN-010	59134	52.9	13	14	22	36	41	14	15	24	40	45
WKGN-020	68175	41.2	10	11	17	29	33	10	11	17	29	33
WKGN-030	59868	53.9	14	15	23	39	45	14	15	24	40	46
WKGN-040	59878	37.8	9	9	15	23	26	9	9	15	23	27
WKGN-050	59859	41.5	10	10	16	22	25	10	11	17	23	26
WKGN-060	59889	61.9	19	18	25	41	49	19	19	26	42	50
WKGN-070	61562	91.4	22	23	36	55	63	23	25	39	59	67
WKGN-080	72432	53.8	16	15	21	33	38	21	21	30	43	51
WKGN-090	99498	48.0	11	12	19	31	36	11	12	19	32	36
WKGN-100	61423	54.6	13	14	22	29	33	14	14	22	29	34

Note.

1. W = Winter
2. S = Summer
3. Modeling data for these subbasins has recently been updated and is available by contacting the City of Eugene Public Works Department, Engineering Division.

APPENDIX E
TABLE E-2
HYDROLOGIC MODEL OUTPUT DATA UNDER EXISTING AND FUTURE CONDITIONS FOR THE WILLAMETTE RIVER BASIN

Subbasin Name	Inlet Node	Subbasin Area (acres)	Subbasin Peak Flow (cfs) Existing Land Use Conditions			Subbasin Peak Flow (cfs) Future Land Use Conditions		
			10-Year	25-Year-W[1]	25-Year-S[2]	10-Year	25-Year-W[1]	25-Year-S[2]
WRRR-010	59087	14.8	3	3	6	4	4	7
WRRR-020	66178	40.9	11	12	16	13	14	20
WRRR-030	59120	14.0	2	2	4	3	3	6
WRRR-040	60606	27.8	7	8	10	8	9	12
WRRR-050	60617	37.0	13	14	16	14	15	18
WRRR-060	67889	34.8	7	7	12	8	8	14
WRRR-070 & WRRR-080[3]	60580	49.5	14	16	24	17	19	29
WRRR-090	60647	9.7	4	4	4	4	4	5
WRRR-100	62222	14.6	7	7	8	7	8	10

Note.
1. W = Winter
2. S = Summer
3. Subbasins WRRR-070 and WRRR-080 are combined into one subbasin.

APPENDIX E
TABLE E-2
HYDROLOGIC MODEL OUTPUT DATA UNDER EXISTING AND FUTURE CONDITIONS
FOR THE WILLOW CREEK BASIN

Subbasin Name	Inlet Node	Subbasin Area (acres)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year	10-Year	25-Year-W[1]	25-Year-S[2]	50-Year	100-Year
Willow Creek - East Branch												
WCEA-005	76015	12.4	3	4	2	5	6	3	4	2	5	6
WCEA-010	73500	80.7	26	32	16	38	47	28	33	20	44	53
WCEA-020	51998	134.2	42	51	33	66	82	61	63	77	129	151
WCEA-030	71041	193.0	87	91	90	158	186	86	90	86	153	180
WCEA-040	71016	37.7	13	13	14	26	32	16	16	21	37	44
WCEA-050	71014	141.9	51	60	52	97	115	55	62	59	107	126
WCEA-060	71044	67.9	23	26	20	42	52	27	29	29	55	66
WCEA-070	71012	308.3	88	112	64	131	164	103	123	96	182	220
WCEA-080	71008	229.4	73	88	63	122	149	80	93	79	147	177
Willow Creek - Main Stem												
WCMN-010	71037	192.5	72	81	51	112	134	108	108	151	227	262
WCMN-020	54495	31.0	14	14	16	28	33	14	14	16	28	33
Willow Creek - West Branch												
WCWE-010	76010	86.5	24	32	14	32	40	23	31	13	31	38
WCWE-030	71030	247.2	77	95	48	109	135	85	101	68	140	168
WCWE-040	71028	84.7	34	36	33	67	82	40	43	51	93	110
WCWE-050	71024	88.7	26	32	17	36	46	30	35	28	53	64
WCWE-070	71020	339.4	106	128	86	168	208	116	135	110	205	249
WCWE-COMP	71032	292.0	94	114	61	135	167	105	122	90	179	214

Note.
1. W = Winter
2. S = Summer

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
Amazon Main channel																						
SPRR-B	71110	71111	bridge	95	25	2740	3297	1498	2914	3444	372.0	372.0	382.4	382.3	382.9	382.7	380.9	380.8	382.6	382.5	382.9	382.8
SPRR-rd	71110	71111	Roadway	95		0	0	0	0	0	387.0	387.0	382.3	382.3	382.7	382.7	380.8	380.8	382.5	382.5	382.8	382.8
MainLW020E	71123	71110	Natural	978	25	2726	3284	1519	2897	3424	371.9	372.0	383.6	382.4	384.2	382.9	381.5	380.9	383.8	382.6	384.4	382.9
MainLW020F	63032	71123	Natural	300	25	2730	3286	1538	2899	3425	372.3	371.9	383.7	383.6	384.4	384.2	381.6	381.5	384.0	383.8	384.5	384.4
MainLW030A	71107	63032	Natural	1252	25	2700	3253	1557	2865	3386	374.0	372.3	384.8	383.7	385.8	384.4	382.4	381.6	385.2	384.0	385.9	384.5
SPB	71106	71107	bridge	118	25	2703	3253	1569	2869	3387	374.0	374.0	385.0	384.8	386.0	385.8	382.6	382.4	385.4	385.2	386.1	385.9
SPBrd	71106	71107	Roadway	118		0	0	0	0	0	388.0	388.0	384.8	384.8	385.8	385.8	382.4	382.4	385.2	385.2	385.9	385.9
MainLW030B	71105	71106	Natural	935	25	2705	3253	1576	2871	3388	373.8	374.0	385.9	385.0	387.2	386.0	383.4	382.6	386.6	385.4	387.4	386.1
MainLW030C	71104	71105	Natural	1300	25	2680	3227	1590	2846	3358	376.3	373.8	386.9	385.9	388.2	387.2	384.5	383.4	387.7	386.6	388.3	387.4
MainLW030D	71103	71104	Natural	240	25	2684	3229	1598	2847	3360	376.5	376.3	387.1	386.9	388.3	388.2	384.7	384.5	387.9	387.7	388.5	388.3
Danebo	71122	71103	bridge	75	25	2685	3229	1600	2848	3360	376.5	376.5	387.3	387.1	388.5	388.3	384.9	384.7	388.0	387.9	388.6	388.5
Danebord	71122	71103	Roadway	75		0	0	0	0	0	388.7	388.7	387.1	387.1	388.3	388.3	384.7	384.7	387.9	387.9	388.5	388.5
MainLW050A	71120	71122	Natural	1079	25	2677	3221	1605	2837	3349	376.5	376.5	388.4	387.3	389.8	388.5	386.0	384.9	388.9	388.0	390.0	388.6
MainLW060A	71100	71120	Natural	297	25	2201	2455	1435	2357	2548	377.5	376.5	388.5	388.4	389.9	389.8	386.1	386.0	389.1	388.9	390.1	390.0
Beltline	71099	71100	bridge	97	50	2203	2463	1437	2359	2554	377.5	377.5	388.6	388.5	390.0	389.9	386.2	386.1	389.1	389.1	390.1	390.1
Beltlinerd	71099	71100	Roadway	96		0	0	0	0	0	390.3	390.3	388.5	388.5	389.9	389.9	386.1	386.1	389.1	389.1	390.1	390.1
MainLW060B	71098	71099	Natural	205	25	2205	2468	1440	2360	2558	377.5	377.5	388.7	388.6	390.0	390.0	386.3	386.2	389.2	389.1	390.2	390.1
MainLW060C	63126	71098	Natural	1620	25	2237	2522	1458	2371	2595	380.4	377.5	389.5	388.7	390.6	390.0	387.0	386.3	390.0	389.2	390.7	390.2
MainBT020C	71097	63126	Natural	245	25	2230	2516	1479	2358	2583	380.8	380.4	389.8	389.5	390.9	390.6	387.6	387.0	390.3	390.0	391.1	390.7
MainBT020D	71096	71097	Natural	255	25	2232	2518	1482	2358	2585	380.8	380.8	390.2	389.8	391.2	390.9	388.1	387.6	390.6	390.3	391.4	391.1
MainBT030A	71095	71096	Natural	490	25	2234	2521	1487	2359	2588	381.0	380.8	391.1	390.2	392.0	391.2	389.1	388.1	391.5	390.6	392.2	391.4
Bertlesn	63127	71095	bridge	90	25	2133	2374	1489	2209	2438	381.0	381.0	391.2	391.1	392.1	392.0	389.3	389.1	391.6	391.5	392.3	392.2
Bertlesnrd	63127	71095	Roadway	90		108	155	0	153	161	390.3	390.3	391.2	391.1	392.1	392.0	389.1	389.1	391.6	391.5	392.3	392.2
MainBT010B	71094	63127	Natural	970	25	2192	2466	1485	2315	2523	381.5	381.0	392.8	391.2	393.4	392.1	390.8	389.3	393.0	391.6	393.6	392.3
W11th	54748	71094	bridge	162	50	2193	2468	1489	2315	2526	381.5	381.5	393.0	392.8	393.6	393.4	391.0	390.8	393.3	393.0	393.8	393.6
W11thrd	54748	71094	Roadway	162		0	0	0	0	0	395.4	395.4	392.8	392.8	393.4	393.4	390.8	390.8	393.0	393.0	393.6	393.6
MainBT050A	71093	54748	Natural	284	25	2176	2448	1489	2294	2497	381.0	381.5	393.2	393.0	393.9	393.6	391.2	391.0	393.5	393.3	394.0	393.8
MainBT050B	71092	71093	Natural	500	25	2178	2449	1502	2294	2501	381.1	380.9	393.2	393.2	393.9	393.9	391.3	391.2	393.5	393.5	394.1	394.0
MainBT050C	71091	71092	Natural	100	25	2181	2450	1513	2295	2505	381.1	381.1	393.3	393.2	394.0	393.9	391.3	391.3	393.6	393.5	394.1	394.1
MainBT050D	71090	71091	Natural	115	25	2160	2429	1513	2276	2477	381.1	381.1	393.4	393.3	394.1	394.0	391.5	391.3	393.7	393.6	394.3	394.1
MainBT050E	71089	71090	Natural	685	25	2162	2429	1518	2276	2479	382.2	381.1	394.1	393.4	394.8	394.1	392.1	391.5	394.4	393.7	394.9	394.3
MainBT050F	71088	71089	Natural	705	25	2165	2430	1528	2277	2483	383.4	382.2	394.5	394.1	395.3	394.8	392.6	392.1	394.9	394.4	395.5	394.9
MainBH030A	71087	71088	Natural	400	25	2168	2432	1538	2277	2487	384.5	383.4	395.2	394.5	396.2	395.3	393.3	392.6	395.6	394.9	396.3	395.5
MainBH030B	71086	71087	Natural	218	25	2169	2433	1542	2277	2488	385.5	384.5	395.5	395.2	396.5	396.2	393.6	393.3	395.9	395.6	396.6	396.3
BaileyHl	71085	71086	bridge	64	25	1964	2238	1480	2099	2265	385.5	385.5	395.5	395.5	396.5	396.5	393.7	393.6	395.9	395.9	396.6	396.6
BaileyHlrd	71085	71086	Roadway	64		0	0	0	0	0	400.0	400.0	395.5	395.5	396.5	396.5	393.6	393.6	395.9	395.9	396.6	396.6
MainBH010A	54741	71085	Natural	1275	25	2008	2235	1487	2109	2266	387.6	385.5	397.8	395.5	397.9	396.5	394.9	393.7	397.8	395.9	397.9	396.6
MainBH010B	54745	54741	Natural	725	25	1936	2216	1494	2093	2247	388.8	387.6	398.1	397.8	398.2	397.9	395.8	394.9	398.2	397.8	398.2	397.9
MainBH015A	71006	54745	Natural	550	25	1909	2206	1497	2087	2240	389.7	388.8	398.6	398.1	398.8	398.2	396.7	395.8	398.7	398.2	398.9	398.2
AcornPk	71007	71006	bridge	25	25	1907	2206	1499	2087	2239	390.0	389.7	398.7	398.6	399.0	398.8	396.9	396.7	398.9	398.7	399.0	398.9
MainBH010C	71124	71007	Natural	498	25	1907	2207	1502	2087	2240	391.4	390.0	399.3	398.7	399.7	399.0	397.8	396.9	399.5	398.9	399.7	399.0
MainBH010D	71084	71124	Natural	486	25	1906	2207	1504	2087	2241	392.8	391.4	400.1	399.3	400.6	399.7	398.9	397.8	400.4	399.5	400.6	399.7
OakPatch	71083	71084	bridge	52	25	1900	2199	1502	2082	2234	392.8	392.8	400.3	400.1	400.8	400.6	399.2	398.9	400.6	400.4	400.9	400.6

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
MainCV010	55294	71083	Natural	800	25	1899	2200	1504	2082	2236	393.8	392.8	401.7	400.3	402.3	400.8	400.7	399.2	402.1	400.6	402.4	400.9
MainCV070	55283	55294	Natural	800	25	1878	2159	1504	2054	2203	394.8	393.8	402.9	401.7	403.5	402.3	401.9	400.7	403.3	402.1	403.8	402.4
MainCV020	71082	55283	Natural	600	25	1871	2153	1497	2047	2196	395.5	394.8	403.7	402.9	404.5	403.5	402.8	401.9	404.1	403.3	405.4	403.8
CityView	71081	71082	bridge	58	25	1870	2150	1499	2047	2242	395.5	395.5	403.8	403.7	404.6	404.5	402.8	402.8	404.2	404.1	406.4	405.4
MainCV060	55272	71081	Natural	680	25	1868	2152	1500	2043	2262	395.3	395.5	404.5	403.8	405.3	404.6	403.5	402.8	405.0	404.2	406.6	406.4
MainCV050A	55274	55272	Natural	400	25	1845	2145	1485	2027	2328	395.4	395.3	405.0	404.5	406.2	405.3	403.9	403.5	406.0	405.0	406.9	406.6
MainCV050B	71005	55274	Natural	500	25	1805	2091	1465	2014	2301	395.4	395.4	405.8	405.0	406.7	406.2	404.2	403.9	406.5	406.0	407.2	406.9
Garfield	71004	71005	bridge	59	25	1808	2093	1467	2026	2316	394.7	395.4	405.9	405.8	406.8	406.7	404.4	404.2	406.7	406.5	407.3	407.2
MainCV040	71003	71004	Natural	1600	25	1838	2090	1489	2060	2349	398.9	394.7	407.1	405.9	407.7	406.8	406.3	404.4	407.5	406.7	408.0	407.3
Chambers#1	71002	71003	10'x9' CSP culvert	45	25	609	707	522	698	804	399.1	398.9	407.6	407.1	408.3	407.7	406.7	406.3	408.1	407.5	408.7	408.0
Chambers#2	71002	71003	10'x9' CSP culvert	45	25	609	707	522	698	804	399.1	398.9	407.6	407.1	408.3	407.7	406.7	406.3	408.1	407.5	408.7	408.0
Chamb-bike	71002	71003	13.3'x8' CSP culvert	45	25	615	661	512	661	737	400.0	400.0	407.6	407.1	408.3	407.7	406.7	406.3	408.1	407.5	408.7	408.0
MainPK080	55256	71002	Natural	500	25	1834	2076	1580	2058	2347	400.4	399.1	408.2	407.6	408.8	408.3	407.3	406.7	408.7	408.1	409.3	408.7
MainPK060	71080	55256	Natural	1000	25	1621	1835	1295	1875	2236	403.0	400.4	409.6	408.2	410.2	408.8	408.8	407.3	410.2	408.7	412.4	409.3
Polk	71079	71080	bridge	70	25	1610	1812	1288	1860	2066	403.0	403.0	410.2	409.6	410.8	410.2	409.4	408.8	410.8	410.2	412.7	412.4
Polkrd	71079	71080	Roadway	33		0	0	0	0	168	411.5	411.5	409.6	409.6	410.2	410.2	408.8	408.8	410.2	410.2	412.7	412.4
MainPK050	66991	71079	Natural	700	25	1601	1793	1283	1848	2091	403.8	403.0	411.3	410.2	411.8	410.8	410.4	409.4	411.9	410.8	413.3	412.7
MainPK020B	71128	66991	Natural	500	25	1589	1767	1267	1829	2085	404.4	403.8	411.9	411.3	412.4	411.8	411.1	410.4	412.5	411.9	413.7	413.3
MainPK020A	56048	71128	Natural	800	25	1588	1767	1277	1830	2106	405.4	404.4	413.0	411.9	413.5	412.4	412.1	411.1	413.6	412.5	414.6	413.7
MainPK040C	71127	56048	Natural	120	25	1580	1748	1271	1817	2096	405.5	405.4	413.3	413.0	413.8	413.5	412.5	412.1	413.9	413.6	414.8	414.6
MainPK040B	71125	71127	Natural	680	25	1580	1748	1277	1817	2100	406.1	405.5	414.8	413.3	415.3	413.8	413.9	412.5	415.4	413.9	416.2	414.8
MainPK040A	71078	71125	Natural	500	25	1580	1748	1286	1818	2114	406.6	406.1	414.9	414.8	415.3	415.3	414.0	413.9	415.5	415.4	416.4	416.2
Jefrsn#1	71077	71078	10.67' x 9.83' CSP culvert	46	25	790	874	648	909	1063	406.7	406.6	415.6	414.9	416.1	415.3	414.6	414.0	416.3	415.5	417.3	416.4
Jefrsn#2	71077	71078	10.67' x 9.83' CSP culvert	46	25	790	874	648	909	1063	406.7	406.6	415.6	414.9	416.1	415.3	414.6	414.0	416.3	415.5	417.3	416.4
Jefrsnrd	71077	71078	Roadway	46		0	0	0	0	0	418.0	418.0	414.9	414.9	415.3	415.3	414.0	414.0	415.5	415.5	416.4	416.4
MainMD170A	71076	71077	Natural	327	25	1581	1749	1299	1821	2133	407.0	406.7	416.7	415.6	416.9	416.1	414.9	414.6	416.9	416.3	417.6	417.3
Wash#1	71075	71076	7.9'x 10.67' CSP culvert	40	25	742	774	651	795	801	407.1	407.0	417.4	416.7	417.6	416.9	415.4	414.9	417.7	416.9	418.1	417.6
Wash#2	71075	71076	7.9'x 10.67' CSP culvert	40	25	742	774	651	795	801	407.1	407.0	417.4	416.7	417.6	416.9	415.4	414.9	417.7	416.9	418.1	417.6
Washngtnrd	71075	71076	Roadway	40		147	202	0	241	837	416.4	416.4	417.4	417.1	417.6	417.3	414.9	414.9	417.7	417.5	418.1	417.7
MainMD170B	71074	71075	Natural	332	25	1562	1707	1257	1792	2103	407.3	407.1	417.6	417.4	417.8	417.6	415.7	415.4	417.9	417.7	418.2	418.1
Lawren#1	71073	71074	9.7'x10.67' CSP culvert	46	25	781	854	628	896	1028	407.3	407.3	418.0	417.6	418.3	417.8	416.1	415.7	418.5	417.9	418.9	418.2
Lawren#2	71073	71074	9.7'x10.67' CSP culvert	46	25	781	854	628	896	1028	407.3	407.3	418.0	417.6	418.3	417.8	416.1	415.7	418.5	417.9	418.9	418.2
Lawrencerd	71073	71074	Roadway	46		0	0	0	1	51	418.4	418.4	417.6	417.6	417.8	417.8	415.7	415.7	418.5	418.4	418.9	418.8

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
MainMD170C	71072	71073	Natural	337	25	1562	1708	1258	1794	2109	407.7	407.3	418.3	418.0	418.6	418.3	416.3	416.1	418.8	418.5	419.3	418.9
Lincoln#1	71071	71072	9.4'x 10.67' CSP culvert	47	25	782	843	629	871	944	407.8	407.7	418.7	418.3	419.1	418.6	416.7	416.3	419.3	418.8	420.1	419.3
Lincoln#2	71071	71072	9.4'x 10.67' CSP culvert	47	25	782	843	629	871	944	407.8	407.7	418.7	418.3	419.1	418.6	416.7	416.3	419.3	418.8	420.1	419.3
Lincolnrd	71071	71072	Roadway	47		0	21	0	57	234	418.8	418.7	418.3	418.3	419.1	418.9	416.3	416.3	419.3	419.1	420.1	419.8
MainMD150A	71070	71071	Natural	363	25	1570	1709	1265	1800	2114	408.1	407.8	419.2	418.7	419.6	419.1	417.0	416.7	419.9	419.3	421.0	420.1
Charn#1	71069	71070	10.8'x 10.67' CSP culvert	60	25	789	855	631	903	985	408.2	408.1	419.6	419.2	420.1	419.6	417.4	417.0	420.4	419.9	421.5	421.0
Charn#2	71069	71070	10.8'x 10.67' CSP culvert	60	25	789	855	631	903	985	408.2	408.1	419.6	419.2	420.1	419.6	417.4	417.0	420.4	419.9	421.5	421.0
Charnltnrd	71069	71070	Roadway	60		0	0	0	0	190	420.4	420.3	419.2	419.2	419.6	419.6	417.0	417.0	419.9	419.9	421.5	421.2
MainMD150B	71068	71069	Natural	126	25	1583	1711	1270	1808	2126	408.4	408.2	419.6	419.6	420.1	420.1	418.0	417.4	420.4	420.4	421.5	421.5
15th	71067	71068	9.8'x22' CSP culvert	87	25	1587	1712	1280	1811	2110	408.4	408.4	419.7	419.6	420.2	420.1	418.1	418.0	420.5	420.4	421.6	421.5
15thrd	71067	71068	Roadway	87		0	0	0	0	40	421.2	421.1	419.6	419.6	420.1	420.1	418.0	418.0	420.4	420.4	421.6	421.5
MainMD150C	71066	71067	Natural	145	25	1593	1713	1285	1815	2144	408.7	408.4	419.7	419.7	420.2	420.2	418.1	418.1	420.5	420.5	421.7	421.6
Olive#1	71065	71066	10'x 10.67' CSP culvert	50	25	798	824	642	872	908	408.7	408.7	420.1	419.7	420.7	420.2	418.5	418.1	420.9	420.5	422.0	421.7
Olive#2	71065	71066	10'x 10.67' CSP culvert	50		798	824	642	872	908	408.7	408.7	420.1	419.7	420.7	420.2	418.5	418.1	420.9	420.5	422.0	421.7
Oliverd	71065	71066	Roadway	50		3	76	0	153	836	420.0	420.0	420.1	420.1	420.7	420.5	418.1	418.1	420.9	420.8	422.0	421.7
MainMD150D	71064	71065	Natural	376	25	1603	1716	1286	1829	2166	409.0	408.7	421.0	420.1	421.2	420.7	418.6	418.5	421.4	420.9	422.2	422.0
16th#1	71063	71064	10'x 10.67' CSP culvert	120	25	779	765	645	819	836	409.0	409.0	421.4	421.0	421.6	421.2	419.0	418.6	421.8	421.4	422.5	422.2
16th#2	71063	71064	10'x 10.67' CSP culvert	120	25	779	765	645	819	836	409.0	409.0	421.4	421.0	421.6	421.2	419.0	418.6	421.8	421.4	422.5	422.2
16thrd	71063	71064	Roadway	120		131	192	0	252	926	420.3	420.3	421.4	421.0	421.6	421.2	418.6	418.6	421.8	421.5	422.5	422.2
MainMD150E	71062	71063	Natural	423	25	1613	1708	1285	1834	2182	409.3	409.0	421.6	421.4	421.8	421.6	419.2	419.0	422.0	421.8	422.6	422.5
Oak#1	71061	71062	9.6'x 10.67' CSP culvert	54	25	692	668	643	732	735	409.5	409.3	421.8	421.6	422.0	421.8	419.6	419.2	422.2	422.0	422.8	422.6
Oak#2	71061	71062	9.6'x 10.67' CSP culvert	54	25	692	668	643	732	735	409.5	409.3	421.8	421.6	422.0	421.8	419.6	419.2	422.2	422.0	422.8	422.6
Oakrd	71061	71062	Roadway	54		496	655	0	800	1299	420.1	420.0	421.8	421.6	422.0	421.8	419.2	419.2	422.2	422.0	422.8	422.6
MainMD150F	71060	71061	Natural	350	25	1629	1710	1287	1842	2198	409.6	409.5	422.0	421.8	422.2	422.0	419.9	419.6	422.3	422.2	422.9	422.8
Pearl#1	71059	71060	8.4'x 10.67' CSP culvert	80	25	646	648	643	656	640	409.6	409.6	422.2	422.0	422.3	422.2	420.5	419.9	422.5	422.3	423.0	422.9
Pearl#2	71059	71060	8.4'x 10.67' CSP culvert	80	25	646	648	643	656	640	409.6	409.6	422.2	422.0	422.3	422.2	420.5	419.9	422.5	422.3	423.0	422.9
Pearlrd	71059	71060	Roadway	80		896	1049	24	1202	1666	420.1	420.0	422.2	422.0	422.3	422.2	420.5	420.2	422.5	422.3	423.0	422.9
MainMD150G	66998	71059	Natural	510	25	1639	1694	1339	1838	2198	410.2	409.6	422.3	422.2	422.5	422.3	421.3	420.5	422.6	422.5	423.1	423.0
18th#1	71057	66998	10.8'x 10.67' CSP culvert	50	25	793	798	677	870	919	410.2	410.2	422.8	422.3	423.0	422.5	421.6	421.3	423.2	422.6	423.7	423.1

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
18th#2	71057	66998	10.8'x 10.67' CSP culvert	50	25	793	798	677	870	919	410.2	410.2	422.8	422.3	423.0	422.5	421.6	421.3	423.2	422.6	423.7	423.1
18thrd	71057	66998	Roadway	50		116	170	0	189	560	422.1	422.0	422.8	422.6	423.0	422.8	421.3	421.3	423.2	422.9	423.7	423.4
MainMD030	57188	71057	Natural	350	25	1681	1681	1360	1927	2340	410.8	410.2	423.1	422.8	423.2	423.0	421.8	421.6	423.4	423.2	423.9	423.7
19th	57163	57188	10.5'x22' CSP culvert	53	25	1643	1668	1439	1842	2074	410.8	410.8	423.2	423.1	423.3	423.2	421.8	421.8	423.5	423.4	424.0	423.9
19thrd	57163	57188	Roadway	53		68	89	0	129	297	422.5	422.5	423.2	423.1	423.3	423.2	421.8	421.8	423.5	423.4	424.0	423.9
MainMD100A	71054	57163	Natural	1975	25	1660	1621	1414	2043	2488	414.7	410.8	424.7	423.2	424.9	423.3	423.2	421.8	425.9	423.5	428.2	424.0
24th#1	71053	71054	7'x9.68' CSP culverts	46	25	833	814	710	1034	1082	417.2	417.2	425.8	424.7	425.9	424.9	424.4	423.2	426.9	425.9	428.5	428.2
24th#2	71053	71054	7'x9.68' CSP culvert	46	25	833	814	710	1034	1082	417.2	417.2	425.8	424.7	425.9	424.9	424.4	423.2	426.9	425.9	428.5	428.2
24thrd	71053	71054	Roadway	46		0	0	0	0	1466	427.2	427.2	424.7	424.7	424.9	424.9	423.2	423.2	425.9	425.9	428.5	428.2
MainMD100B	54172	71053	Natural	650	25	1624	1578	1406	2032	2486	418.9	417.2	427.6	425.8	427.5	425.9	426.8	424.4	429.4	426.9	430.2	428.5
MainMD040	66967	54172	Natural	1300	25	1392	1365	1197	1811	2126	420.0	418.9	428.3	427.6	428.2	427.5	427.6	426.8	430.0	429.4	431.0	430.2
MainMD110	54174	66967	Natural	150	25	1314	1287	1129	1756	2009	420.2	420.0	428.4	428.3	428.3	428.2	427.7	427.6	430.1	430.0	431.1	431.0
MainUP050	65370	67978	Natural	1400	25	497	491	415	681	869	457.0	446.8	461.5	454.9	461.5	454.8	461.1	453.9	462.4	456.8	463.2	457.5
MainMD120	71052	54175	Natural	700	25	1257	1227	1092	1712	1921	422.2	421.0	429.1	428.5	429.1	428.4	428.5	427.8	430.6	430.1	431.6	431.2
29th	71051	71052	7.5'x15' CMP M baskhnd culvert	80	25	1236	1206	1075	1692	1847	425.0	425.0	432.5	431.0	432.4	430.9	431.9	430.4	434.2	432.3	434.7	432.8
29thrd	71051	71052	Roadway	80		0	0	0	0	64	434.5	434.5	429.1	429.1	429.1	429.1	428.5	428.5	430.6	430.6	434.7	434.5
MainMD060A	71001	71051	Natural	725	25	1236	1206	1077	1694	1931	426.7	425.0	434.0	432.5	433.9	432.4	433.5	431.9	435.4	434.2	436.0	434.7
30th	71000	71001	bridge	79	25	1237	1207	1081	1698	1933	426.8	426.7	434.4	434.0	434.3	433.9	433.9	433.5	435.7	435.4	436.3	436.0
MainMD060B	51750	71000	Natural	335	25	1237	1207	1083	1702	1938	427.5	426.8	435.0	434.4	434.9	434.3	434.5	433.9	436.3	435.7	436.9	436.3
31st	51751	51750	7.5'x15' CMP M baskhnd culvert	84	25	1238	1207	1086	1704	1936	427.5	427.5	435.9	435.0	435.8	434.9	435.3	434.5	437.5	436.3	438.2	436.9
31strd	51751	51750	Roadway	84		0	0	0	0	2	438.1	438.1	435.0	435.0	434.9	434.9	434.5	434.5	436.3	436.3	438.2	438.1
MainUP160A	51757	51751	Natural	415	25	1189	1158	1040	1647	1915	428.8	427.5	436.4	435.9	436.3	435.8	435.9	435.3	438.0	437.5	439.8	438.2
MainUP160B	51730	51757	Natural	268	25	1132	1102	1001	1573	1925	429.6	428.8	436.9	436.4	436.8	436.3	436.3	435.9	438.3	438.0	440.2	439.8
33rd	51729	51730	8'x15' CMP M baskhnd culvert	220	25	1034	1010	899	1408	1711	431.1	429.6	438.0	436.9	437.9	436.8	437.4	436.3	439.7	438.3	441.5	440.2
33rdrd	51729	51730	8'x15' CMP M baskhnd culvert	220	25	0	0	0	0	64	440.9	440.5	436.9	436.9	436.8	436.8	436.3	436.3	438.3	438.3	441.5	440.9
MainUP170	66944	51729	Natural	1390	25	1012	987	880	1389	1879	434.9	431.1	442.5	438.0	442.4	437.9	442.0	437.4	443.9	439.7	445.2	441.5
MainUP150A	50544	66944	Natural	1240	25	912	890	792	1274	1696	441.3	434.9	447.5	442.5	447.4	442.4	447.1	442.0	448.5	443.9	449.7	445.2
MainUP150B	50517	50544	Natural	1340	25	838	823	726	1169	1490	446.5	441.3	452.9	447.5	452.8	447.4	452.5	447.1	453.9	448.5	454.7	449.7
FoxHolw#1	67978	50517	72" CSP culverts	225	25	261	257	209	308	318	447.5	446.5	454.9	452.9	454.8	452.8	453.9	452.5	456.8	453.9	457.5	454.7

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
FoxHolw#2	67978	50517	72" CSP culvert	225	25	259	258	213	308	318	446.8	446.5	454.9	452.9	454.8	452.8	453.9	452.5	456.8	453.9	457.5	454.7
FoxHolwrd	67978	50517	Roadway	225		0	0	0	102	306	455.8	455.8	452.9	452.9	452.8	452.8	452.5	452.5	456.8	456.4	457.5	457.0
MainMD050	54175	54174	Natural	175	25	1274	1243	1108	1718	1954	421.0	420.2	428.5	428.4	428.4	428.3	427.8	427.7	430.1	430.1	431.2	431.1
MainUP020	65398	65370	Natural	1050	25	358	362	287	464	595	467.0	457.0	471.1	461.5	471.1	461.5	470.6	461.1	471.7	462.4	472.4	463.2
Snell	65396	65398	72" CSP culvert	37	25	290	292	215	349	356	467.0	467.0	473.2	471.1	473.3	471.1	472.4	470.6	474.5	471.7	474.9	472.4
Snellrd	65396	65398	Roadway	37		0	0	0	24	124	474.1	474.1	471.1	471.1	471.1	471.1	470.6	470.6	474.5	474.4	474.9	474.8
MainUP030	65379	65396	Natural	2100	25	221	225	162	275	353	502.4	467.0	506.3	473.2	506.4	473.3	505.8	472.4	506.7	474.5	507.2	474.9
Amazon - Lower Sub-Basin																						
AMLW030E	63042	63032	66" CSP	425	10	50	65	40	74	79	375.5	375.0	383.8	383.7	384.5	384.4	381.6	381.6	384.0	384.0	384.7	384.5
AMLW030Erd	63042	63032	Roadway	425		0	0	0	0	0	388.1	386.5	383.7	383.7	384.4	384.4	381.6	381.6	384.0	384.0	384.5	384.5
AMLW030F	69111	63042	60" CSP	1038	10	50	65	41	74	79	376.3	375.5	384.1	383.8	385.2	384.5	381.6	381.6	384.3	384.0	385.0	384.7
AMLW030Frd	69111	63042	Roadway	1038		0	0	0	0	0	385.2	385.1	383.8	383.8	384.5	384.5	381.6	381.6	384.0	384.0	384.7	384.7
AMLW030G	63178	69111	54" CSP	1351	10	50	54	42	75	79	377.2	376.3	385.2	384.1	385.8	385.2	381.7	381.6	384.9	384.3	385.6	385.0
AMLW030Grd	63178	69111	Roadway	1351		0	28	0	0	9	385.4	384.2	384.1	384.1	385.8	385.2	381.6	381.6	384.3	384.3	385.6	385.0
Amazon - Bertelsen Sub-basin																						
AMBT020A	54522	63126	48" CSP	1239	10	34	35	43	70	75	383.6	381.7	389.8	389.5	391.0	390.6	387.1	387.0	390.2	390.0	391.1	390.7
AMBT020Ard	54522	63126	Roadway	1239		0	0	0	0	0	391.0	394.8	389.8	389.8	391.0	391.0	387.1	387.1	390.2	390.2	391.1	391.1
AMBT020B	66971	54522	42" CSP	761	10	8	10	11	19	24	387.6	383.7	389.8	389.8	391.1	391.0	388.6	387.1	390.3	390.2	392.7	391.1
AMBT020Brd	66971	54522	Roadway	761		0	0	0	0	0	395.0	391.0	389.8	389.8	391.0	391.0	387.1	387.1	390.2	390.2	391.1	391.1
AMBT010A	63173	63127	36" CSP	77	10	20	24	18	32	40	383.2	383.0	391.3	391.2	392.3	392.1	389.3	389.3	391.7	391.6	392.4	392.3
AMBT030A	54486	63127	66" CSP	2250	10	50	49	59	87	94	386.7	384.4	391.4	391.2	392.5	392.1	389.9	389.3	391.8	391.6	392.7	392.3
AMBT030B	54488	54486	60" CSP	2208	10	51	50	57	97	98	389.8	386.7	392.6	391.4	393.3	392.5	392.9	389.9	394.3	391.8	395.7	392.7
AMBT030Brd	54488	54486	Roadway	2208		0	0	0	0	0	397.3	393.6	391.4	391.4	392.5	392.5	389.9	389.9	391.8	391.8	392.7	392.7
AMBT030C	54489	54488	54" CSP	358	10	52	51	58	98	104	391.3	389.8	393.4	392.6	393.6	393.3	393.5	392.9	395.2	394.3	396.8	395.7
AMBT030Crd	54489	54488	Roadway	358		0	0	0	0	0	400.1	397.3	392.6	392.6	393.3	393.3	392.9	392.9	394.3	394.3	395.7	395.7
AMBT030D	68843	54489	42" CSP	508	10	52	52	59	100	102	393.4	391.3	396.4	393.4	396.4	393.6	397.0	393.5	401.6	395.2	401.8	396.8
AMBT030Drd	68843	54489	Roadway	508		0	0	0	0	13	401.6	400.1	393.4	393.4	393.6	393.6	393.5	393.5	401.6	400.1	401.8	400.2
AMBT090A	54809	68843	30" CSP	1144	10	17	17	13	28	32	406.0	394.6	407.2	396.4	407.2	396.4	407.0	397.0	407.8	401.6	410.6	401.8
AMBT090Ard	54809	68843	Roadway	1144		0	0	0	0	0	410.6	401.6	396.4	396.4	396.4	396.4	397.0	397.0	401.6	401.6	410.6	401.8
AMBT090B	51993	54809	27" CSP	978	10	17	17	13	25	34	420.0	406.3	421.2	407.4	421.2	407.4	421.0	407.2	421.5	407.8	424.4	410.6
AMBT090Brd	51993	54809	Roadway	978		0	0	0	0	0	427.0	410.6	407.2	407.2	407.2	407.2	407.0	407.0	407.8	407.8	410.6	410.6
AMBT090C	51995	51993	24" CSP	690	10	17	18	13	26	35	444.4	420.6	445.4	421.5	445.4	421.5	445.2	421.4	445.7	421.8	446.0	424.4
AMBT090Crd	51995	51993	Roadway	690		0	0	0	0	0	452.2	427.0	421.2	421.2	421.2	421.2	421.0	421.0	421.5	421.5	424.4	424.4
AMBT040A	54747	54748	54" CSP	445	10	43	43	68	91	93	386.6	383.0	393.1	393.0	393.8	393.6	391.0	391.0	393.4	393.3	393.9	393.8
AMBT040Ard	54747	54748	Roadway	445		0	0	0	0	0	394.0	395.4	393.1	393.1	393.8	393.8	391.0	391.0	393.4	393.4	393.9	393.9
AMBT040B	66976	54747	Natural	500	10	33	31	55	68	68	387.6	386.6	393.1	393.1	393.8	393.8	391.3	391.0	393.4	393.4	394.0	393.9
AMBT040C	54813	66976	54" CSP	13	10	33	32	55	72	71	384.3	387.6	393.1	393.1	393.9	393.8	391.4	391.3	393.4	393.4	394.0	394.0
AMBT040Crd	54813	66976	Roadway	13		0	0	0	0	1	394.0	393.9	393.1	393.1	393.8	393.8	391.3	391.3	393.4	393.4	394.0	394.0
AMBT040D	54811	54813	54" CSP	596	10	33	32	55	72	71	384.9	384.3	393.2	393.1	394.0	393.9	392.0	391.4	393.9	393.4	394.9	394.0
AMBT040Drd	54811	54813	Roadway	596		0	0	0	0	0	395.9	394.0	393.1	393.1	393.9	393.9	391.4	391.4	393.4	393.4	394.0	394.0
AMBT040E	54909	54811	48" CSP	980	10	33	32	55	73	70	386.9	385.3	393.5	393.2	394.3	394.0	393.9	392.0	396.6	393.9	396.9	394.9

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMBT040Erd	54909	54811	Roadway	980		0	0	0	2	12	396.5	395.9	393.2	393.2	394.0	394.0	392.0	392.0	396.6	395.9	396.9	396.0
AMBT060A	54898	54909	48" CSP	604	10	20	20	34	55	63	388.7	386.9	393.6	393.5	394.4	394.3	394.4	393.9	397.8	396.6	398.3	396.9
Amazon Bailey Hill																						
AMBH020A	54773	71086	72" CSP	2886	25	156	162	166	228	228	392.7	386.2	399.8	395.5	401.2	396.5	397.6	393.6	404.5	395.9	405.0	396.6
AMBH020Ard	54773	71086	Roadway	2886		0	0	0	0	7	404.8	400.0	395.5	395.5	396.5	396.5	393.6	393.6	395.9	395.9	405.0	400.1
AMBH020B	54772	71086	72" CSP	2884	25	150	156	158	226	221	392.7	386.2	399.5	395.5	400.9	396.5	397.3	393.6	404.0	395.9	404.3	396.6
AMBH020Brd	54772	71086	Roadway	2884		0	0	0	0	13	404.0	400.0	395.5	395.5	396.5	396.5	393.6	393.6	404.0	400.0	404.3	400.1
AMBH050A	54815	54773	66" CSP	320	25	139	147	153	200	210	393.2	392.8	400.6	399.8	402.0	401.2	398.4	397.6	405.9	404.5	406.7	405.0
AMBH050Ard	54815	54773	Roadway	320		0	0	0	0	0	407.5	404.8	399.8	399.8	401.2	401.2	397.6	397.6	404.5	404.5	405.0	405.0
AMBH020C	54815	54772	66" CSP	312	25	133	139	130	176	203	393.2	392.7	400.6	399.5	402.0	400.9	398.4	397.3	405.9	404.0	406.7	404.3
AMBH020Crd	54815	54772	Roadway	312		0	0	0	0	0	407.5	404.0	399.5	399.5	400.9	400.9	397.3	397.3	404.0	404.0	404.3	404.3
AMBH050B	68846	54815	84" CSP	132	25	268	279	274	356	407	393.9	393.2	401.0	400.6	402.5	402.0	399.1	398.4	406.5	405.9	407.7	406.7
AMBH050Brd	68846	54815	Roadway	132		0	0	0	0	0	408.5	407.5	400.6	400.6	402.0	402.0	398.4	398.4	405.9	405.9	406.7	406.7
AMBH050C	52255	68846	72" CSP	528	25	267	279	274	361	346	397.3	394.7	403.4	401.0	405.1	402.5	402.3	399.3	410.2	406.5	411.5	407.7
AMBH050Crd	52255	68846	Roadway	528		0	0	0	0	83	411.0	408.5	401.0	401.0	402.5	402.5	399.1	399.1	406.5	406.5	411.5	409.0
AMBH070C	52243	52255	36" CSP	595	10	49	50	61	83	81	411.8	405.6	414.0	407.5	414.0	407.6	414.5	407.9	420.2	410.2	420.3	411.5
AMBH070Crd	52243	52255	Roadway	595		0	0	0	37	68	420.0	411.0	403.4	403.4	405.1	405.1	402.3	402.3	420.2	411.2	420.3	411.5
AMBH070D	52248	52243	33" CSP	515	10	49	50	61	72	72	421.8	413.6	423.7	415.4	423.7	415.4	424.1	415.8	427.3	420.2	427.4	420.3
AMBH070Drd	52248	52243	Roadway	515		0	0	0	62	86	427.0	420.0	414.0	414.0	414.0	414.0	414.5	414.5	427.3	420.3	427.4	420.4
AMBH070E	52240	52248	30" CSP	442	10	49	50	60	60	60	432.7	423.9	435.0	425.7	435.1	425.7	438.2	426.2	438.4	427.3	438.5	427.4
AMBH070Erd	52240	52248	Roadway	442		0	0	2	66	90	438.2	427.0	423.7	423.7	423.7	423.7	438.2	427.0	438.4	427.3	438.5	427.4
AMBH070F	66465	52240	27" CSP	290	10	49	50	57	58	61	445.3	434.2	447.8	435.8	447.9	435.8	451.9	438.2	452.0	438.4	452.1	438.5
AMBH070Frd	66465	52240	Roadway	290		0	0	9	68	91	451.8	438.2	435.0	435.0	435.1	435.1	451.9	438.3	452.0	438.4	452.1	438.5
AMBH070A	52163	52255	66" CSP	515	10	212	220	182	269	259	400.4	397.7	405.8	403.4	407.9	405.1	404.4	402.3	411.7	410.2	412.2	411.5
AMBH070Ard	52163	52255	Roadway	515		0	0	0	92	201	410.4	411.0	405.8	405.8	407.9	407.9	404.4	404.4	411.7	411.5	412.2	411.9
AMBH070B	67805	52163	54" CSP	1272	10	207	220	184	225	224	416.6	400.4	421.9	405.8	427.0	407.9	419.9	404.4	427.4	411.7	427.6	412.2
AMBH070Brd	67805	52163	Roadway	1272		0	0	0	106	179	427.0	410.4	405.8	405.8	427.0	410.4	404.4	404.4	427.4	411.7	427.6	412.2
AMBH120A	52213	67805	54" CSP	311	10	170	182	140	234	234	423.1	416.6	426.1	421.9	431.0	427.0	425.4	419.9	434.1	427.4	434.2	427.6
AMBH120Ard	52213	67805	Roadway	311		0	0	0	7	62	434.0	427.0	421.9	421.9	427.0	427.0	419.9	419.9	434.1	427.4	434.2	427.6
AMBH120E	52216	52213	36" CSP	170	10	24	25	22	44	50	428.9	423.1	429.8	426.1	431.3	431.0	429.8	425.4	435.4	434.1	435.5	434.2
AMBH120Erd	52216	52213	Roadway	170		0	0	0	0	1	435.5	434.0	426.1	426.1	431.0	431.0	425.4	425.4	434.1	434.1	435.5	434.2
AMBH120F	52217	52216	30" CSP	230	10	24	24	22	43	51	433.0	428.8	434.3	429.8	434.4	431.3	434.3	429.8	438.8	435.4	440.0	435.5
AMBH120Frd	52217	52216	Roadway	230		0	0	0	0	0	440.0	435.5	429.8	429.8	431.3	431.3	429.8	429.8	435.4	435.4	435.5	435.5
AMBH120G	52145	52217	27" CSP	372	10	24	24	22	46	51	459.0	434.0	459.9	434.9	459.9	434.9	459.9	434.8	460.2	438.8	460.2	440.0
AMBH120Grd	52145	52217	Roadway	372		0	0	0	0	0	466.0	440.0	434.3	434.3	434.4	434.4	434.3	434.3	438.8	438.8	440.0	440.0
AMBH120B	68649	52213	48" CSP	430	10	147	159	118	207	207	436.1	424.1	438.5	426.5	438.8	431.0	438.2	426.2	444.6	434.1	444.8	434.2
AMBH120Brd	68649	52213	Roadway	430		0	0	0	1	43	444.6	434.0	426.1	426.1	431.0	431.0	425.4	425.4	444.6	434.1	444.8	434.2
AMBH120C	52167	68649	36" CSP	1057	10	70	77	52	93	114	479.5	438.1	481.3	439.7	481.5	439.8	481.0	439.5	481.6	444.6	487.0	444.8
AMBH120Crd	52167	68649	Roadway	1057		0	0	0	0	4	487.0	444.6	438.5	438.5	438.8	438.8	438.2	438.2	444.6	444.6	487.0	444.8
AMBH120D	52214	68649	36" CSP	321	10	77	83	66	122	146	465.3	438.1	466.7	439.5	466.8	439.5	466.6	439.4	467.0	444.6	467.4	444.8
AMBH120Drd	52214	68649	Roadway	321		0	0	0	0	0	471.6	444.6	438.5	438.5	438.8	438.8	438.2	438.2	444.6	444.6	444.8	444.8
AMBH015A	54776	54745	36" CSP	13	10	14	15	24	42	48	390.7	392.0	398.1	398.1	398.2	398.2	395.8	395.8	398.2	398.2	398.2	398.2
AMBH015Ard	54776	54745	Roadway	13		3	7	0	4	8	398.0	398.0	398.1	398.1	398.2	398.2	395.8	395.8	398.2	398.2	398.2	398.2

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMBH015B	54867	54776	36" CSP	384	10	14	15	24	43	48	391.6	390.7	398.2	398.1	398.4	398.2	395.8	395.8	398.2	398.2	398.9	398.2
AMBH015Brd	54867	54776	Roadway	384		0	0	0	0	0	399.2	398.0	398.1	398.1	398.2	398.2	395.8	395.8	398.2	398.2	398.2	398.2
AMBH015C	54854	54867	30" CSP	278	10	14	15	24	43	42	393.7	391.0	398.3	398.2	398.7	398.4	395.9	395.8	400.8	398.2	401.1	398.9
AMBH015Crd	54854	54867	Roadway	278		0	0	0	0	14	401.0	399.2	398.2	398.2	398.4	398.4	395.8	395.8	398.2	398.2	401.1	399.3
Amazon - City View Sub-Basin																						
AMCV070A	68093	55294	48" CSP	766	10	41	42	42	72	68	396.8	395.2	402.5	401.7	403.2	402.3	400.8	400.7	402.9	402.1	403.5	402.4
AMCV070Ard	68093	55294	Roadway	766		0	0	0	0	6	403.2	403.0	401.7	401.7	403.2	403.0	400.7	400.7	402.1	402.1	403.5	403.1
AMCV070B	55344	68093	42" CSP	420	10	40	41	42	72	68	398.2	397.0	403.4	402.5	404.1	403.2	401.1	400.8	405.0	402.9	405.1	403.5
AMCV070Brd	55344	68093	Roadway	420		0	0	0	2	20	404.9	403.2	402.5	402.5	403.2	403.2	400.8	400.8	405.0	403.2	405.1	403.5
AMCV070C	55365	55344	36" CSP	1238	10	41	41	44	70	70	413.4	398.4	415.0	403.4	415.0	404.1	415.2	401.1	421.8	405.0	421.9	405.1
AMCV070Crd	55365	55344	Roadway	1238		0	0	0	4	23	421.7	404.9	403.4	403.4	404.1	404.1	401.1	401.1	421.8	405.0	421.9	405.1
AMCV030A	55432	55272	42" CSP	1773	10	19	20	30	37	36	399.1	396.2	405.0	404.5	405.9	405.3	404.9	403.5	406.4	405.0	406.6	406.6
AMCV030Ard	55432	55272	Roadway	1773		0	0	0	0	6	406.4	404.9	404.5	404.5	405.3	405.3	403.5	403.5	406.4	405.0	406.6	406.6
AMCV030B	55446	55272	30" CSP	440	10	5	7	8	9	15	398.6	395.3	404.5	404.5	405.3	405.3	403.6	403.5	405.1	405.0	406.6	406.6
AMCV030Brd	55446	55272	Roadway	440		0	4	0	0	35	405.2	404.9	404.5	404.5	405.3	405.3	403.5	403.5	405.0	405.0	406.6	406.6
AMCV030C	55432	55446	24" CSP	1540	10	5	5	8	9	9	400.6	398.6	405.0	404.5	405.9	405.3	404.9	403.6	406.4	405.1	406.6	406.6
AMCV030Crd	55432	55446	Roadway	1540		0	0	0	0	6	406.4	405.2	404.5	404.5	405.3	405.3	403.6	403.6	406.4	405.2	406.6	406.6
AMCV050A	55395	55274	48" CSP	650	10	62	63	64	92	103	400.3	396.0	406.3	405.0	407.2	406.2	405.2	403.9	407.9	406.0	409.5	406.9
AMCV050Ard	55395	55274	Roadway	650		0	0	0	0	6	409.2	409.0	405.0	405.0	406.2	406.2	403.9	403.9	406.0	406.0	409.5	409.1
AMCV050B	55396	55395	42" CSP	256	10	62	63	64	92	92	404.9	400.8	407.5	406.3	408.4	407.2	407.1	405.2	410.9	407.9	411.2	409.5
AMCV050Brd	55396	55395	Roadway	256		0	0	0	0	45	410.9	409.2	406.3	406.3	407.2	407.2	405.2	405.2	410.9	409.2	411.2	409.5
AMCV050C	55369	55396	36" CSP	11	10	25	26	26	29	33	405.0	404.9	407.6	407.5	408.5	408.4	407.3	407.1	411.0	410.9	411.4	411.2
AMCV050Crd	55369	55396	Roadway	11		0	0	0	0	6	411.3	410.9	407.5	407.5	408.4	408.4	407.1	407.1	410.9	410.9	411.4	411.2
AMCV050D	55382	55369	30" CSP	621	10	25	26	27	30	30	409.6	405.0	411.2	407.6	411.3	408.5	411.3	407.3	414.1	411.0	415.1	411.4
AMCV050Drd	55382	55369	Roadway	621		0	0	0	0	7	415.0	411.3	407.6	407.6	408.5	408.5	407.3	407.3	411.0	411.0	415.1	411.4
AMCV050H	55382	55396	42" CSP	613	10	37	38	40	66	75	409.6	404.9	411.2	407.5	411.3	408.4	411.3	407.1	414.1	410.9	415.1	411.2
AMCV050Hrd	55382	55396	Roadway	613		0	0	0	0	8	415.0	410.9	407.5	407.5	408.4	408.4	407.1	407.1	410.9	410.9	415.1	411.2
AMCV050I	68794	55382	36" CSP	1203	10	45	45	46	59	59	419.7	409.6	422.2	411.6	422.2	411.6	422.3	411.7	425.2	414.1	425.3	415.1
AMCV050Ird	68794	55382	Roadway	1203		0	0	0	9	33	425.1	415.0	411.2	411.2	411.3	411.3	411.3	411.3	425.2	415.1	425.3	415.2
AMCV050J	52716	68794	30" CSP	884	10	45	46	48	51	52	429.0	419.7	434.1	422.2	434.7	422.2	436.1	422.3	437.4	425.2	437.5	425.3
AMCV050Jrd	52716	68794	Roadway	884		0	0	0	27	50	437.2	425.1	422.2	422.2	422.2	422.2	422.3	422.3	437.4	425.3	437.5	425.4
AMCV050K	52713	52716	27" CSP	872	10	46	47	48	55	55	461.8	429.1	463.3	434.1	463.3	434.7	463.5	436.1	469.3	437.4	469.4	437.5
AMCV050Krd	52713	52716	Roadway	872		0	0	0	27	49	469.2	437.2	434.1	434.1	434.7	434.7	436.1	436.1	469.3	437.4	469.4	437.5
AMCV050L	52573	52713	30" CSP	115	10	45	46	48	85	86	470.0	463.0	471.3	464.2	471.4	464.2	471.4	464.3	476.1	469.3	476.3	469.4
AMCV050Lrd	52573	52713	Roadway	115		0	0	0	0	19	476.2	469.2	463.3	463.3	463.3	463.3	463.5	463.5	469.3	469.3	476.3	469.4
AMCV050E	52736	55382	30" CSP	1053	10	18	19	20	33	38	419.2	409.6	420.5	411.2	420.5	411.3	420.5	411.3	421.2	414.1	426.0	415.1
AMCV050Erd	52736	55382	Roadway	1053		0	0	0	0	1	426.0	415.0	411.2	411.2	411.3	411.3	411.3	411.3	414.1	414.1	426.0	415.1
AMCV050F	52733	52736	24" CSP	940	10	18	19	20	30	31	436.4	422.8	437.7	424.1	437.8	424.1	437.9	424.2	444.2	424.7	444.3	426.0
AMCV050Frd	52733	52736	Roadway	940		0	0	0	3	13	444.2	426.0	420.5	420.5	420.5	420.5	420.5	420.5	444.2	426.0	444.3	426.1
AMCV050G	52730	52733	18" CSP	617	10	18	19	21	21	21	462.5	436.6	463.7	437.7	463.7	437.8	466.2	437.9	467.1	444.2	467.1	444.3
AMCV050Grd	52730	52733	Roadway	617		0	0	0	19	27	467.0	444.2	437.7	437.7	437.8	437.8	437.9	437.9	467.1	444.3	467.1	444.3
Amazon - Polk Street Sub-Basin																						
AMPK070A	55289	55256	66" CSP	1262	10	131	133	148	175	178	406.1	401.1	410.1	408.2	410.5	408.8	410.0	407.3	411.2	408.7	412.2	409.3

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMPK070Ard	55289	55256	Roadway	1262		0	0	0	0	0	414.0	414.0	408.2	408.2	408.8	408.8	407.3	407.3	408.7	408.7	409.3	409.3
AMPK070B	52686	55289	60" CSP	905	10	131	136	151	181	184	408.5	406.1	413.0	410.1	413.2	410.5	414.0	410.0	415.6	411.2	416.7	412.2
AMPK070Brd	52686	55289	Roadway	905		0	0	0	0	8	416.5	414.1	410.1	410.1	410.5	410.5	410.0	410.0	411.2	411.2	416.7	414.2
AMPK070C	52685	52686	66" CSP	1555	10	131	138	151	181	193	413.7	408.5	417.2	413.0	417.3	413.2	417.9	414.0	421.1	415.6	422.7	416.7
AMPK070Crd	52685	52686	Roadway	1555		0	0	0	0	0	429.8	416.5	413.0	413.0	413.2	413.2	414.0	414.0	415.6	415.6	416.7	416.7
AMPK090A	52707	52685	36" CSP	1550	10	57	61	69	86	85	443.4	413.7	445.2	417.2	445.3	417.3	445.4	417.9	452.2	421.1	452.3	422.7
AMPK090Ard	52707	52685	Roadway	1550		0	0	0	25	53	452.0	429.8	417.2	417.2	417.3	417.3	417.9	417.9	452.2	430.0	452.3	430.1
AMPK060A	55290	55256	66" CSP	1263	10	79	82	105	158	162	405.9	400.7	408.8	408.2	409.4	408.8	408.8	407.3	410.8	408.7	411.8	409.3
AMPK060Ard	55290	55256	Roadway	1263		0	0	0	0	0	413.9	414.0	408.8	408.8	409.4	409.4	408.8	408.8	410.8	410.8	411.8	411.8
AMPK060B	52689	55290	60" CSP	1354	10	79	87	107	164	175	411.4	405.9	414.0	408.8	414.1	409.4	414.7	408.8	416.4	410.8	417.7	411.8
AMPK060C#1	66476	52689	48" CSP	1092	10	64	67	75	84	83	413.6	411.4	417.7	414.0	417.8	414.1	418.3	414.7	420.6	416.4	422.1	417.7
AMPK060C#2	66476	52689	60" CSP	855	10	92	98	121	167	169	414.5	411.4	417.7	414.0	417.8	414.1	418.3	414.7	420.6	416.4	422.1	417.7
AMPK060Crd	66476	52689	Roadway	1092		0	0	0	0	0	424.1	419.0	414.0	414.0	414.1	414.1	414.7	414.7	416.4	416.4	417.7	417.7
AMPK060D	52687	55256	54" CSP	1589	25	91	94	115	122	123	407.7	401.5	411.6	408.2	411.9	408.8	412.4	407.3	414.1	408.7	415.4	409.3
AMPK060Drd	52687	55256	Roadway	1589		0	0	0	0	0	416.0	413.0	408.2	408.2	408.8	408.8	407.3	407.3	408.7	408.7	409.3	409.3
AMPK060E	52689	52687	48" CSP	573	10	79	81	88	88	92	411.4	407.7	414.0	411.6	414.1	411.9	414.7	412.4	416.4	414.1	417.7	415.4
AMPK060Erd	52689	52687	Roadway	573		0	0	0	0	0	419.0	416.0	411.6	411.6	411.9	411.9	412.4	412.4	414.1	414.1	415.4	415.4
AMPK170A	53474	66476	60" CSP	256	10	94	96	110	157	155	415.0	414.5	418.6	417.7	418.7	417.8	419.1	418.3	421.8	420.6	423.1	422.1
AMPK090B	53474	52685	48" CSP	391	10	68	69	72	79	83	416.0	413.7	418.6	417.2	418.7	417.3	419.1	417.9	421.8	421.1	423.1	422.7
AMPK170B	53457	53474	48" CSP	28	10	162	165	180	219	220	416.2	416.1	421.5	419.8	421.6	419.8	422.0	419.9	424.4	421.8	425.5	423.1
AMPK170Brd	53457	53474	Roadway	28		0	0	0	0	0	426.0	426.0	418.6	418.6	418.7	418.7	419.1	419.1	421.8	421.8	423.1	423.1
AMPK170C	53441	53457	54" CSP	766	10	137	139	150	191	191	422.8	416.2	426.6	421.5	426.8	421.6	428.7	422.0	434.6	424.4	434.7	425.5
AMPK170Crd	53441	53457	Roadway	766		0	0	0	4	25	434.5	426.0	421.5	421.5	421.6	421.6	422.0	422.0	434.6	426.1	434.7	426.2
AMPK170D	53415	53441	54" CSP	1374	10	101	104	108	133	130	430.7	422.8	433.6	426.6	433.6	426.8	434.0	428.7	441.9	434.6	442.1	434.7
AMPK170Drd	53415	53441	Roadway	1374		0	0	0	0	0	443.3	434.5	426.6	426.6	426.8	426.8	428.7	428.7	434.6	434.6	434.7	434.7
AMPK170E	53405	53415	54" CSP	659	10	78	80	84	104	98	435.5	430.7	437.8	433.6	437.8	433.6	437.9	434.0	443.1	441.9	443.3	442.1
AMPK170Erd	53405	53415	Roadway	659		0	0	0	0	0	443.0	443.3	437.8	437.8	437.8	437.8	437.9	437.9	443.1	443.1	443.3	443.3
AMPK170F	53388	53405	54" CSP	779	10	40	42	46	92	97	438.8	435.2	440.6	437.8	440.6	437.8	440.7	437.9	446.9	443.1	447.8	443.3
AMPK170Frd	53388	53405	Roadway	779		0	0	0	0	0	447.8	443.0	437.8	437.8	437.8	437.8	437.9	437.9	443.1	443.1	443.3	443.3
AMPK170G	53390	53388	48" CSP	361	10	40	42	46	91	97	440.7	439.2	442.9	441.1	442.9	441.1	443.1	441.2	448.2	446.9	448.2	447.8
AMPK170Grd	53390	53388	Roadway	361		0	0	0	0	0	448.2	447.8	440.6	440.6	440.6	440.6	440.7	440.7	448.2	447.8	448.2	447.8
AMPK170H	53416	53415	54" CSP	26	10	23	24	26	49	60	430.7	430.7	433.6	433.6	433.6	433.6	434.0	434.0	442.0	441.9	442.2	442.1
AMPK170I	53422	53416	24" CSP	459	10	23	24	26	38	38	452.2	438.6	453.5	439.8	453.5	439.8	453.6	439.9	456.6	442.0	456.6	442.2
AMPK170Ird	53422	53416	Roadway	459		0	0	0	14	25	456.5	444.2	433.6	433.6	433.6	433.6	434.0	434.0	456.6	444.3	456.6	444.3
AMPK170J	68811	53457	36" CSP	358	10	25	26	30	51	58	417.5	416.3	422.1	421.5	422.3	421.6	422.9	422.0	424.8	424.4	425.8	425.5
AMPK170Jrd	68811	53457	Roadway	358		0	0	0	0	0	424.4	426.0	422.1	422.1	422.3	422.3	422.9	422.9	424.8	424.8	425.8	425.8
AMPK170K	53426	68811	27" CSP	1528	10	25	26	30	33	33	438.7	418.0	440.0	422.1	440.1	422.3	440.6	422.9	444.5	424.8	444.6	425.8
AMPK170Krd	53426	68811	Roadway	1528		0	0	0	10	23	444.4	424.4	422.1	422.1	422.3	422.3	422.9	422.9	444.5	424.8	444.6	425.8
AMPK170L	53422	53426	24" CSP	422	10	25	26	31	37	35	452.2	438.9	453.5	440.1	453.5	440.1	453.6	440.6	456.6	444.5	456.6	444.6
AMPK170Lrd	53422	53426	Roadway	422		0	0	0	14	26	456.5	444.4	440.0	440.0	440.1	440.1	440.6	440.6	456.6	444.5	456.6	444.6
AMPK170M	68813	66476	48" CSP	452	10	64	70	87	100	124	415.4	413.6	418.7	417.7	419.0	417.8	420.2	418.3	423.0	420.6	426.2	422.1
AMPK170N	53447	68813	42" CSP	1262	10	49	52	63	66	66	419.6	415.4	422.4	418.7	422.8	419.0	425.1	420.2	426.1	423.0	426.5	426.2
AMPK170Nrd	53447	68813	Roadway	1262		0	0	0	16	80	425.0	425.7	422.4	422.4	422.8	422.8	425.1	425.1	426.1	425.9	426.5	426.2
AMPK170O	53400	53447	30" CSP	290	10	8	10	18	18	18	421.4	419.6	422.5	422.4	423.0	422.8	425.8	425.1	426.1	426.1	426.5	426.5

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMPK170Ord	53400	53447	Roadway	290		0	0	0	18	45	425.8	425.0	422.4	422.4	422.8	422.8	425.8	425.1	426.1	426.1	426.5	426.5
AMPK170P	53401	53400	24" CSP	311	10	8	10	18	24	24	423.5	421.4	424.5	422.5	424.6	423.0	428.3	425.8	430.1	426.1	430.2	426.5
AMPK170Prd	53401	53400	Roadway	311		0	0	0	4	30	430.0	425.8	422.5	422.5	423.0	423.0	425.8	425.8	430.1	426.1	430.2	426.5
AMPK170Q	53405	53401	24" CSP	888	10	2	2	10	26	26	437.4	423.6	437.8	424.5	437.8	424.6	437.9	428.3	443.1	430.1	443.3	430.2
AMPK170Qrd	53405	53401	Roadway	888		0	0	0	16	59	443.0	430.0	424.5	424.5	424.6	424.6	428.3	428.3	443.1	430.1	443.3	430.3
AMPK170R	53408	53405	24" CSP	430	10	40	41	41	42	42	451.3	437.4	456.6	439.2	458.3	439.4	458.3	439.4	458.5	443.1	458.5	443.3
AMPK170Rrd	53408	53405	Roadway	430		0	0	1	38	57	458.3	443.0	437.8	437.8	458.3	443.0	458.3	443.0	458.5	443.2	458.5	443.3
AMPK170S	53448	53447	30" CSP	180	10	41	43	49	54	54	422.3	419.8	424.6	422.4	425.1	422.8	428.3	425.1	428.8	426.1	428.9	426.5
AMPK170Srd	53448	53447	Roadway	180		0	0	0	44	81	428.6	425.0	422.4	422.4	422.8	422.8	425.1	425.1	428.8	426.1	428.9	426.5
AMPK170U	53358	53448	36" CSP	580	10	14	14	18	16	17	423.8	422.3	425.2	424.6	425.5	425.1	428.6	428.3	429.2	428.8	429.4	428.9
AMPK170Urd	53358	53448	Roadway	580		0	0	0	29	52	428.6	428.6	424.6	424.6	425.1	425.1	428.6	428.6	429.2	428.9	429.4	429.0
AMPK170T	53358	53401	21" CSP	197	10	6	8	12	19	18	423.6	423.5	425.2	424.5	425.5	424.6	428.6	428.3	429.2	430.1	429.4	430.2
AMPK170Trd	53358	53401	Roadway	197		0	0	0	3	22	428.6	430.0	425.2	425.2	425.5	425.5	428.6	428.6	430.1	429.2	430.2	429.4
Amazon - Middle Sub-Basin																						
AMMD140A	57400	66998	48" CSP	575	10	59	57	55	51	48	413.0	412.6	422.3	422.3	422.5	422.5	421.3	421.3	422.6	422.6	423.1	423.1
AMMD140Ard	57400	66998	Roadway	575		53	57	3	63	97	421.2	420.8	422.3	422.3	422.5	422.5	421.3	421.3	422.6	422.6	423.1	423.1
AMMD140B	57422	57400	42" CSP	608	10	57	54	54	43	42	413.8	413.4	422.3	422.3	422.5	422.5	421.3	421.3	422.6	422.6	423.1	423.1
AMMD140Brd	57422	57400	Roadway	608		41	46	5	50	68	420.5	421.2	422.3	422.3	422.5	422.5	421.3	421.3	422.6	422.6	423.1	423.1
AMMD145A	57427	57422	36" CSP	767	10	21	21	24	31	27	415.5	414.2	422.3	422.3	422.5	422.5	421.8	421.3	422.6	422.6	423.1	423.1
AMMD145Ard	57427	57422	Roadway	767		15	17	0	21	28	421.8	420.5	422.3	422.3	422.5	422.5	421.8	421.3	422.6	422.6	423.1	423.1
AMMD165A	57436	57188	27" CSP	216	10	31	30	36	25	25	411.6	410.8	423.1	423.1	423.2	423.2	421.8	421.8	423.4	423.4	423.9	423.9
AMMD165Ard	57436	57188	Roadway	216		107	112	108	187	179	419.7	420.8	423.1	423.1	423.2	423.2	421.8	421.8	423.4	423.4	423.9	423.9
AMMD165B	56284	57436	24" CSP	294	10	15	14	22	18	14	413.6	411.6	423.1	423.1	423.2	423.2	421.8	421.8	423.4	423.4	423.9	423.9
AMMD165Brd	56284	57436	Roadway	294		38	38	40	80	77	420.0	419.7	423.1	423.1	423.2	423.2	421.8	421.8	423.4	423.4	423.9	423.9
AMMD135A	57433	57163	30" CSP	72	10	35	37	52	46	41	413.7	413.8	423.2	423.2	423.3	423.3	421.8	421.8	423.5	423.5	424.0	424.0
AMMD135Ard	57433	57163	Roadway	72		164	162	47	288	324	420.8	420.7	423.2	423.2	423.3	423.3	421.8	421.8	423.5	423.5	424.0	424.0
AMMD135B	57431	57433	30" CSP	704	10	29	27	31	28	26	415.4	413.7	423.2	423.2	423.3	423.3	421.9	421.8	423.5	423.5	424.0	424.0
AMMD135Brd	57431	57433	Roadway	704		111	111	56	219	240	421.2	420.8	423.2	423.2	423.3	423.3	421.8	421.9	423.5	423.5	424.0	424.0
AMMD135C	57428	57431	30" CSP	808	10	25	24	28	24	23	417.0	415.4	423.2	423.2	423.3	423.3	422.5	421.9	423.6	423.5	424.0	424.0
AMMD135Crd	57428	57431	Roadway	808		42	44	57	96	110	421.8	421.2	423.2	423.2	423.3	423.3	422.5	421.9	423.6	423.5	424.0	424.0
AMMD040A#1	54353	54172	60" CSP	961	10	110	111	113	129	123	421.0	419.5	429.6	427.6	429.4	427.5	429.0	426.8	430.3	429.4	430.8	430.2
AMMD040A#2	54353	54172	60" CSP	961	10	110	111	113	129	123	421.0	419.5	429.6	427.6	429.4	427.5	429.0	426.8	430.3	429.4	430.8	430.2
AMMD040Ard	54353	54172	Roadway	961		24	12	0	136	231	429.0	428.8	429.6	429.0	429.4	428.9	429.0	428.8	430.3	429.5	430.8	430.2
AMMD040B#1	54330	54353	83.04" elliptical CSP	486	10	161	161	161	176	169	422.9	422.1	430.5	429.6	430.4	429.4	430.3	429.0	431.1	430.3	431.3	430.8
AMMD040B#2	54330	54353	42" CSP	451	10	63	63	70	68	63	423.5	422.7	430.5	429.6	430.4	429.4	430.3	429.0	431.1	430.3	431.3	430.8
AMMD040Brd	54330	54353	Roadway	486		86	57	42	191	319	429.8	429.0	430.5	429.6	430.4	429.4	430.3	429.3	431.1	430.3	431.3	430.8
AMMD040C	54335	54330	83.04" CSP	646	10	131	132	131	138	134	422.9	421.9	431.1	430.5	431.1	430.4	431.0	430.3	431.6	431.1	431.7	431.3
AMMD040Crd	54335	54330	Roadway	646		24	17	10	91	99	430.8	429.8	431.1	430.5	431.1	430.4	431.0	430.3	431.6	431.1	431.7	431.3
AMMD040D	66486	54335	54" CSP	1157	10	141	146	147	191	197	435.7	423.9	439.1	431.1	439.3	431.1	439.3	431.0	445.5	431.6	446.4	431.7
AMMD040Drd	66486	54335	Roadway	1157		0	0	0	0	0	449.2	430.8	431.1	431.1	431.1	431.1	431.0	431.0	431.6	431.6	431.7	431.7
AMMD040L	54315	54330	42" CSP	612	10	31	31	30	41	40	424.8	423.5	431.4	430.5	431.2	430.4	431.1	430.3	432.3	431.1	432.7	431.3

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMMD040Lrd	54315	54330	Roadway	612		0	0	0	42	107	432.0	429.8	430.5	430.5	430.4	430.4	430.3	430.3	432.3	431.1	432.7	431.3
AMMD040M	66485	54315	36" CSP	836	10	31	31	30	55	55	431.8	424.8	433.8	431.4	433.7	431.2	433.6	431.1	439.0	432.3	439.3	432.7
AMMD040Mrd	66485	54315	Roadway	836		0	0	0	29	104	438.8	432.0	431.4	431.4	431.2	431.2	431.1	431.1	439.0	432.3	439.3	432.7
AMMD040N	54295	66485	30" CSP	777	10	31	31	31	43	44	437.4	431.8	440.0	433.8	440.3	433.7	440.4	433.6	446.3	439.0	446.5	439.3
AMMD040Nrd	54295	66485	Roadway	777		0	0	0	51	124	446.0	438.8	433.8	433.8	433.7	433.7	433.6	433.6	446.3	439.1	446.5	439.3
AMMD040H	54295	66486	42" CSP	384	10	40	43	46	73	67	438.0	435.7	440.0	439.1	440.3	439.3	440.4	439.3	446.3	445.5	446.5	446.4
AMMD040Hrd	54295	66486	Roadway	384		0	0	0	0	0	446.0	449.2	440.0	440.0	440.3	440.3	440.4	440.4	446.3	446.3	446.5	446.5
AMMD040I	54267	54295	30" CSP	1499	10	29	30	29	35	34	445.5	438.0	451.1	440.0	451.3	440.3	451.4	440.4	454.3	446.3	454.5	446.5
AMMD040Ird	54267	54295	Roadway	1499		0	0	0	43	81	454.0	446.0	440.0	440.0	440.3	440.3	440.4	440.4	454.3	446.3	454.5	446.5
AMMD040J	54271	54267	24" CSP	482	10	29	30	29	30	31	457.0	450.0	460.9	451.8	461.3	451.9	461.0	451.8	462.9	454.3	462.9	454.5
AMMD040Jrd	54271	54267	Roadway	482		0	0	0	60	92	462.6	454.0	451.1	451.1	451.3	451.3	451.4	451.4	462.9	454.3	462.9	454.5
AMMD040E	54325	66486	48" CSP	481	10	103	105	103	151	151	444.2	436.4	446.5	439.1	446.5	439.3	446.4	439.3	452.3	445.5	452.5	446.4
AMMD040Erd	54325	66486	Roadway	481		0	0	0	2	40	452.2	449.2	439.1	439.1	439.3	439.3	439.3	439.3	452.3	449.2	452.5	449.5
AMMD040F	54271	54325	42" CSP	712	10	103	105	103	126	126	455.1	444.2	460.9	446.5	461.3	446.5	461.0	446.4	462.9	452.3	462.9	452.5
AMMD040Frd	54271	54325	Roadway	712		0	0	0	54	83	462.6	452.2	446.5	446.5	446.5	446.5	446.4	446.4	462.9	452.5	462.9	452.5
AMMD040G#1	54254	54271	42" CSP	232	10	101	101	101	104	107	458.0	455.1	465.3	460.9	465.4	461.3	465.4	461.0	465.8	462.9	465.9	462.9
AMMD040G#2	54254	54271	24" CSP	166	10	31	31	31	32	32	458.0	457.0	465.3	460.9	465.4	461.3	465.4	461.0	465.8	462.9	465.9	462.9
AMMD040Grd	54254	54271	Roadway	232		2	10	3	142	201	465.3	462.6	465.3	462.6	465.4	462.7	465.4	462.6	465.8	463.1	465.9	463.2
AMMD040K	54260	54254	42" CSP	639	10	133	136	136	136	140	476.1	458.3	482.1	465.3	482.8	465.4	482.8	465.4	483.1	465.8	483.2	465.9
AMMD040Krd	54260	54254	Roadway	639		0	2	1	114	173	482.8	465.3	465.3	465.3	482.8	465.4	482.8	465.4	483.1	465.8	483.2	465.9
AMMD020A	66702	54260	42" CSP	475	10	51	52	53	96	111	483.7	476.2	485.3	482.1	485.5	482.8	485.5	482.8	488.5	483.1	490.3	483.2
AMMD020Ard	66702	54260	Roadway	475		0	0	0	0	0	490.3	482.8	482.1	482.1	482.8	482.8	482.8	482.8	483.1	483.1	490.3	483.2
AMMD020B	51411	66702	36" CSP	1442	10	50	52	53	98	109	530.0	483.7	531.4	485.3	531.4	485.5	531.5	485.5	532.1	488.5	534.9	490.3
AMMD020Brd	51411	66702	Roadway	1442		0	0	0	0	4	534.9	490.3	485.3	485.3	485.5	485.5	485.5	485.5	488.5	488.5	534.9	490.3
AMMD020C	51437	51411	30" CSP	526	10	50	52	54	81	82	551.3	530.0	552.9	531.4	553.0	531.4	553.0	531.5	557.6	532.1	557.7	534.9
AMMD020Crd	51437	51411	Roadway	526		0	0	0	15	44	557.5	534.9	531.4	531.4	531.4	531.4	531.5	531.5	557.6	535.0	557.7	535.1
AMMD110A	54362	66967	42" CSP	1291	10	63	63	67	65	64	423.4	420.0	433.7	428.3	433.7	428.2	433.6	427.6	434.1	430.0	434.3	431.0
AMMD110Ard	54362	66967	Roadway	1291		12	11	7	37	62	433.1	433.2	433.7	433.3	433.7	433.3	433.6	433.3	434.1	433.5	434.3	433.6
AMMD110B	66460	54362	36" CSP	772	10	49	48	55	48	48	428.5	423.4	435.4	433.7	435.5	433.7	435.5	433.6	435.8	434.1	435.9	434.3
AMMD110Brd	66460	54362	Roadway	772		48	50	59	121	175	435.0	433.1	435.4	433.7	435.5	433.7	435.5	433.6	435.8	434.1	435.9	434.3
AMMD080L	51307	66460	30" CSP	164	10	48	47	51	46	45	433.6	429.0	437.2	435.4	437.2	435.5	437.3	435.5	437.5	435.8	437.5	435.9
AMMD080Lrd	51307	66460	Roadway	164		40	45	53	122	163	437.0	435.0	437.2	435.4	437.2	435.5	437.3	435.5	437.5	435.8	437.5	435.9
AMMD080K#1	51306	51307	2-24" CSP	278	10	23	23	24	22	22	435.5	433.6	440.2	437.2	440.2	437.2	440.3	437.3	440.4	437.5	440.5	437.5
AMMD080K#2	51306	51307	24" CSP	235	10	25	25	26	24	24	435.5	433.6	440.2	437.2	440.2	437.2	440.3	437.3	440.4	437.5	440.5	437.5
AMMD080Krd	51306	51307	Roadway	278		31	35	43	112	153	440.0	437.0	440.2	437.2	440.2	437.2	440.3	437.3	440.4	437.5	440.5	437.5
AMMD080J#1	51305	51306	36" CSP	251	10	34	34	35	34	35	436.0	435.5	440.9	440.2	441.0	440.2	441.0	440.3	441.3	440.4	441.4	440.5
AMMD080J#2	51305	51306	27" CSP	250	10	16	16	17	16	17	436.0	435.5	440.9	440.2	441.0	440.2	441.0	440.3	441.3	440.4	441.4	440.5
AMMD080Jrd	51305	51306	Roadway	251		28	32	40	106	145	440.6	440.0	440.9	440.3	441.0	440.3	441.0	440.3	441.3	440.6	441.4	440.7
AMMD080I	51303	51305	48" CSP	473	10	61	63	65	65	63	436.7	436.0	442.2	440.9	442.2	441.0	442.3	441.0	442.6	441.3	442.7	441.4
AMMD080Ird	51303	51305	Roadway	473		14	19	27	96	136	442.0	440.6	442.2	440.9	442.2	441.0	442.3	441.0	442.6	441.3	442.7	441.4
AMMD080H	51344	51302	30" CSP	710	10	47	47	47	46	47	449.3	439.3	455.1	445.1	455.1	445.1	455.2	445.1	455.3	445.4	455.4	445.4
AMMD080Hrd	51344	51302	Roadway	710		18	20	23	76	103	455.0	445.0	455.1	445.1	455.1	445.1	455.2	445.2	455.3	445.4	455.4	445.4
AMMD080G	51302	51303	36" CSP	288	10	57	57	57	57	57	438.6	437.4	445.1	442.2	445.1	442.2	445.1	442.3	445.4	442.6	445.4	442.7
AMMD080Grd	51302	51303	Roadway	288		5	7	10	61	89	445.0	443.0	445.1	443.1	445.1	443.1	445.1	443.1	445.4	443.4	445.4	443.4

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMMD080F	51303	51309	36" CSP	32	10	24	27	31	50	57	437.4	437.3	442.2	442.1	442.2	442.1	442.3	442.1	442.6	442.2	442.7	442.2
AMMD080Frd	51303	51309	Roadway	32		0	0	0	0	0	443.0	442.0	442.1	442.1	442.1	442.1	442.1	442.1	442.2	442.2	442.2	442.2
AMMD080E	51309	51311	18" CSP	106	10	13	14	14	14	13	437.3	437.0	442.1	440.2	442.1	440.2	442.1	440.3	442.2	440.4	442.2	440.4
AMMD080Erd	51309	51311	Roadway	106		12	14	18	38	45	442.0	440.0	442.1	440.2	442.1	440.2	442.1	440.3	442.2	440.4	442.2	440.4
AMMD080D#1	51311	51313	18" CSP	489	10	6	6	6	6	6	437.0	435.9	440.2	439.7	440.2	439.6	440.3	439.7	440.4	439.8	440.4	439.9
AMMD080D#2	51311	51313	18" CSP	339	10	7	7	7	7	7	437.0	435.9	440.2	439.7	440.2	439.6	440.3	439.7	440.4	439.8	440.4	439.9
AMMD080Drd	51311	51313	Roadway	489		17	18	23	42	49	440.0	438.9	440.2	439.7	440.2	439.6	440.3	439.7	440.4	439.8	440.4	439.9
AMMD080C#1	51313	51314	18" CSP	31	10	10	10	10	10	10	435.9	436.0	439.7	439.5	439.6	439.4	439.7	439.6	439.8	439.7	439.9	439.7
AMMD080C#2	51313	51314	18" CSP	35	10	10	10	10	10	10	435.9	436.0	439.7	439.5	439.6	439.4	439.7	439.6	439.8	439.7	439.9	439.7
AMMD080Crd	51313	51314	Roadway	31		14	9	21	38	46	438.9	439.5	439.7	439.7	439.6	439.6	439.7	439.7	439.8	439.8	439.9	439.8
AMMD080B#1	51314	68667	18" CSP	182	10	11	11	11	11	11	436.0	435.4	439.5	437.2	439.4	437.0	439.6	437.8	439.7	438.0	439.7	438.0
AMMD080B#2	51314	68667	18" CSP	182	10	11	11	11	11	11	436.0	435.4	439.5	437.2	439.4	437.0	439.6	437.8	439.7	438.0	439.7	438.0
AMMD080Brd	51314	68667	Roadway	182		2	0	11	29	38	439.5	437.8	439.5	437.8	437.0	437.0	439.6	437.9	439.7	438.0	439.7	438.0
AMMD080A	68667	51963	27" CSP	150	10	24	21	29	35	36	435.4	433.2	437.2	434.3	437.0	434.2	437.8	434.4	438.0	434.8	438.0	435.2
AMMD080Ard	68667	51963	Roadway	150		0	0	0	13	20	437.8	437.0	434.3	434.3	434.2	434.2	437.8	437.0	438.0	437.1	438.0	437.2
AMMD080M	51963	51961	30" CSP	388	10	14	12	17	30	36	433.3	428.0	434.3	429.5	434.2	429.3	434.4	429.4	434.8	430.7	435.2	432.5
AMMD080Mrd	51963	51961	Roadway	388		0	0	0	0	0	437.0	435.0	429.5	429.5	429.3	429.3	429.4	429.4	430.7	430.7	432.5	432.5
AMMD120A	51961	54175	42" CSP	2445	10	13	13	16	24	32	428.0	421.0	429.5	428.5	429.3	428.4	429.4	427.8	430.7	430.1	432.5	431.2
AMMD120Ard	51961	54175	Roadway	2445		0	0	0	0	0	435.0	434.1	428.5	428.5	428.4	428.4	427.8	427.8	430.1	430.1	431.2	431.2
AMMD070B	51963	51964	27" CSP	731	10	10	9	12	19	21	433.2	428.8	434.3	430.2	434.2	430.0	434.4	430.2	434.8	431.5	435.2	432.7
AMMD070Brd	51963	51964	Roadway	731		0	0	0	0	0	437.0	433.5	430.2	430.2	430.0	430.0	430.2	430.2	431.5	431.5	432.7	432.7
AMMD070A	51964	71052	30" CSP	1051	10	10	9	12	16	18	428.8	426.0	430.2	429.1	430.0	429.1	430.2	428.5	431.5	430.6	432.7	431.6
AMMD070Ard	51964	71052	Roadway	1051		0	0	0	0	0	433.5	435.9	430.2	430.2	430.0	430.0	430.2	430.2	431.5	431.5	432.7	432.7
Amazon - Upper Sub-Basin																						
AMUP180A	51841	51730	36" CSP	1314	10	65	65	65	65	65	444.7	432.4	450.1	436.9	450.1	436.8	450.1	436.3	450.4	438.3	450.5	440.2
AMUP180Ard	51841	51730	Roadway	1314		45	48	55	135	191	449.8	440.5	450.1	440.8	450.1	440.8	450.1	440.8	450.4	441.1	450.5	441.2
AMUP180B	68653	51841	36" CSP	214	10	58	58	59	59	59	447.0	444.7	452.0	450.1	452.1	450.1	452.1	450.1	452.3	450.4	452.4	450.5
AMUP180Brd	68653	51841	Roadway	214		2	3	4	59	95	452.0	449.8	452.0	450.1	452.1	450.1	452.1	450.1	452.3	450.4	452.4	450.5
AMUP180C	51296	68653	30" CSP	1254	10	61	62	62	62	62	480.9	447.5	483.3	452.0	486.0	452.1	486.0	452.1	486.2	452.3	486.3	452.4
AMUP180Crd	51296	68653	Roadway	1254		0	1	3	60	95	486.0	452.0	452.0	452.0	486.0	452.1	486.0	452.1	486.2	452.3	486.3	452.4
AMUP180D	66447	51296	36" CSP	146	10	61	66	67	88	89	485.0	481.9	486.9	483.7	487.7	486.0	487.8	486.0	489.4	486.2	489.5	486.3
AMUP180Drd	66447	51296	Roadway	146		0	0	0	38	70	489.2	486.0	483.3	483.3	486.0	486.0	486.0	486.0	489.4	486.2	489.5	486.3
AMUP180E	51285	66447	30" CSP	321	10	61	67	67	92	92	499.0	485.4	500.8	487.1	500.8	487.7	500.8	487.8	509.1	489.4	509.2	489.5
AMUP180Erd	51285	66447	Roadway	321		0	0	0	36	67	509.0	489.2	486.9	486.9	487.7	487.7	487.8	487.8	509.1	489.4	509.2	489.5
AMUP180F	68670	51285	36" CSP	185	10	61	65	67	93	92	508.1	499.9	509.9	501.4	510.0	501.4	510.1	501.5	514.9	509.1	514.9	509.2
AMUP180Frd	68670	51285	Roadway	185		0	0	0	38	68	514.7	509.0	500.8	500.8	500.8	500.8	500.8	500.8	514.9	509.2	514.9	509.2
AMUP180G	68668	68670	30" CSP	41	10	61	65	67	89	89	510.0	508.1	512.1	509.9	512.2	510.0	512.3	510.1	515.3	514.9	515.4	514.9
AMUP180Grd	68668	68670	Roadway	41		0	0	0	97	126	514.0	514.7	512.1	512.1	512.2	512.2	512.3	512.3	515.3	515.3	515.4	515.4
AMUP180H	51271	68668	27" CSP	102	10	61	65	67	82	82	514.7	510.0	517.1	512.1	518.4	512.2	518.9	512.3	523.2	515.3	523.2	515.4
AMUP180Hrd	51271	68668	Roadway	102		0	0	0	59	87	523.0	514.0	512.1	512.1	512.2	512.2	512.3	512.3	523.2	515.3	523.2	515.4
AMUP180I	51284	51271	36" CSP	283	10	61	65	67	99	99	523.5	517.2	525.8	519.0	526.0	519.1	526.0	519.1	533.2	523.2	533.2	523.2
AMUP180Ird	51284	51271	Roadway	283		0	0	0	35	62	533.0	523.0	517.1	517.1	518.4	518.4	518.9	518.9	533.2	523.2	533.2	523.2
AMUP180J	51256	51284	33" CSP	178	10	61	65	68	93	93	531.2	523.9	532.8	525.8	532.8	526.0	532.9	526.0	540.2	533.2	540.2	533.2

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMUP180Jrd	51256	51284	Roadway	178		0	0	0	47	74	540.0	533.0	525.8	525.8	526.0	526.0	526.0	526.0	540.2	533.2	540.2	533.2
AMUP180K	51239	51256	30" CSP	92	10	61	65	67	94	93	543.0	531.9	544.8	533.1	544.9	533.1	545.0	533.1	546.2	540.2	546.2	540.2
AMUP180Krd	51239	51256	Roadway	92		0	0	0	65	92	546.0	540.0	532.8	532.8	532.8	532.8	532.9	532.9	546.2	540.2	546.2	540.2
AMUP190A	51204	51239	Natural	675	10	39	41	38	75	91	586.9	543.0	588.1	544.8	588.1	544.9	588.1	545.0	588.5	546.2	588.7	546.2
AMUP190B	50107	51204	24" CSP culvert	320	10	37	37	37	44	45	600.0	586.9	606.0	588.1	606.0	588.1	606.0	588.1	606.1	588.5	606.2	588.7
AMUP190Brd	50107	51204	Roadway	320		3	5	3	32	47	606.0	589.9	606.0	589.9	606.0	589.9	606.0	589.9	606.1	590.0	606.2	590.1
AMUP190C	50115	50107	Natural	75	10	39	42	44	76	92	601.6	600.0	606.2	606.0	606.2	606.0	606.2	606.0	606.8	606.1	607.1	606.2
AMUP190D	50163	50115	36" CSP culvert	655	10	39	42	46	76	92	621.2	601.6	622.5	606.2	622.5	606.2	622.6	606.2	623.4	606.8	627.8	607.1
AMUP190Drd	50163	50115	Roadway	655		0	0	0	0	0	630.4	608.6	606.2	606.2	606.2	606.2	606.2	606.2	606.8	606.8	607.1	607.1
AMUP140A	51469	66944	54" CSP	61	10	102	103	100	115	116	434.4	434.9	442.9	442.5	442.8	442.4	442.5	442.0	443.9	443.9	445.2	445.2
AMUP140Ard	51469	66944	Roadway	61		0	0	0	80	202	443.2	443.1	442.5	442.5	442.4	442.4	442.0	442.0	443.9	443.9	445.2	445.2
AMUP140B	51850	51469	54" CSP	582	10	102	103	100	132	133	436.7	434.7	444.8	442.9	444.8	442.8	444.3	442.5	446.7	443.9	447.0	445.2
AMUP140Brd	51850	51469	Roadway	582		0	0	0	29	76	446.5	443.2	442.9	442.9	442.8	442.8	442.5	442.5	446.7	443.9	447.0	445.2
AMUP140C	66678	51850	30" CSP	80	10	79	79	79	79	80	440.4	438.4	448.2	444.8	448.2	444.8	448.2	444.3	448.4	446.7	448.5	447.0
AMUP140Crd	66678	51850	Roadway	80		36	37	31	112	156	448.0	446.5	448.2	446.7	448.2	446.7	448.2	446.7	448.4	446.9	448.5	447.0
AMUP140D	51853	66678	36" CSP	125	10	72	72	74	71	71	443.2	442.0	448.6	448.2	448.6	448.2	448.6	448.2	448.9	448.4	449.1	448.5
AMUP140Drd	51853	66678	Roadway	125		67	68	65	121	156	448.0	447.9	448.6	448.3	448.6	448.3	448.6	448.3	448.9	448.6	449.1	448.7
AMUP140E	51763	51853	36" CSP	11	10	84	84	84	84	84	446.0	443.2	450.1	448.6	450.1	448.6	450.1	448.6	450.3	448.9	450.3	449.1
AMUP140Erd	51763	51853	Roadway	11		19	20	17	77	126	450.0	448.0	450.1	448.6	450.1	448.6	450.1	448.6	450.3	448.9	450.3	449.1
AMUP140F	50531	51763	Natural	1550	10	60	63	67	102	120	484.1	446.0	485.9	450.1	486.0	450.1	486.0	450.1	486.5	450.3	486.7	450.3
AMUP120A	50660	50531	36" CSP	314	10	61	64	70	117	120	493.8	484.1	495.5	485.9	495.6	486.0	495.7	486.0	501.2	486.5	501.3	486.7
AMUP120Ard	50660	50531	Roadway	314		0	0	0	2	25	501.2	491.5	485.9	485.9	486.0	486.0	486.0	486.0	501.2	491.5	501.3	491.6
AMUP060A	50629	50517	60" CSP	64	10	305	306	304	318	320	448.2	448.0	455.3	452.9	455.3	452.8	455.2	452.7	456.2	453.9	456.5	454.7
AMUP060Ard	50629	50517	Roadway	64		21	21	6	190	392	455.0	454.9	455.3	455.1	455.3	455.1	455.2	455.0	456.2	455.8	456.5	456.2
AMUP060B	50653	50629	54" CSP	623	10	322	329	320	388	388	473.0	448.3	476.9	455.3	477.6	455.3	476.8	455.2	487.8	456.2	488.0	456.5
AMUP060Brd	50653	50629	Roadway	623		0	0	0	123	284	487.5	455.0	455.3	455.3	455.3	455.3	455.2	455.2	487.8	456.2	488.0	456.5
AMUP060C	50671	50653	54" CSP	2580	10	257	260	256	260	260	521.4	473.0	530.9	476.9	531.0	477.6	530.9	476.8	531.4	487.8	531.6	488.0
AMUP060Crd	50671	50653	Roadway	2580		22	27	15	204	347	530.8	487.5	530.9	487.6	531.0	487.7	530.9	487.6	531.4	488.1	531.6	488.3
AMUP130A	50200	50671	54" CSP	882	10	215	215	214	229	229	533.8	521.4	542.3	530.9	542.3	531.0	542.3	530.9	542.6	531.4	542.8	531.6
AMUP130Ard	50200	50671	Roadway	882		69	75	64	216	360	542.0	530.8	542.3	531.1	542.3	531.1	542.3	531.1	542.6	531.4	542.8	531.6
AMUP070A	65601	50200	42" CSP	547	10	68	69	60	110	110	545.2	534.2	547.2	542.3	547.2	542.3	546.9	542.3	550.8	542.6	550.9	542.8
AMUP070Ard	65601	50200	Roadway	547		0	0	0	0	15	550.8	542.0	542.3	542.3	542.3	542.3	542.3	542.3	550.8	542.6	550.9	542.8
AMUP070B	65582	65601	36" CSP	2041	10	68	69	61	113	145	623.4	545.2	625.0	547.2	625.1	547.2	624.9	546.9	625.8	550.8	660.2	550.9
AMUP070Brd	65582	65601	Roadway	2041		0	0	0	0	0	662.0	550.8	547.2	547.2	547.2	547.2	546.9	546.9	550.8	550.8	550.9	550.9
AMUP070C	50238	50200	48" CSP	1133	10	139	139	132	172	172	551.7	534.2	555.5	542.3	555.4	542.3	555.0	542.3	563.7	542.6	563.9	542.8
AMUP070Crd	50238	50200	Roadway	1133		0	0	0	37	119	563.5	543.0	542.3	542.3	542.3	542.3	542.3	542.3	563.7	543.2	563.9	543.4
Willamte	50090	50238	42" CSP	128	10	140	139	132	145	144	558.0	551.7	561.6	555.5	561.6	555.4	561.0	555.0	564.8	563.7	565.0	563.9
Willamterd	50090	50238	Roadway	128		0	0	0	172	241	564.0	563.5	555.5	555.5	555.4	555.4	555.0	555.0	564.8	564.3	565.0	564.5
AMUP080A	50110	50090	Natural	950	10	98	97	84	145	181	590.0	558.0	594.6	561.6	594.6	561.6	594.5	561.0	594.7	564.8	595.0	565.0
Brooksd#1	50109	50110	48" CSP culverts	114	10	48	47	43	74	92	594.0	590.0	595.3	594.6	595.3	594.6	595.2	594.5	596.0	594.7	596.6	595.0

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
Brooksd#2	50109	50110	48" CSP culvert	114	10	48	47	43	74	92	594.0	590.0	595.3	594.6	595.3	594.6	595.2	594.5	596.0	594.7	596.6	595.0
AMUP100A	66910	50109	Natural	350	10	39	38	30	56	70	617.0	594.0	618.7	595.3	618.8	595.3	618.7	595.2	618.8	596.0	619.0	596.6
BraeBurn	50108	66910	36" CSP culvert	59	10	39	38	32	56	70	619.0	618.0	621.1	619.5	621.1	619.5	620.8	619.3	621.8	619.8	622.6	620.2
BraeBurnrd	50108	66910	Roadway	59		0	0	0	0	0	624.0	624.0	618.7	618.7	618.8	618.8	618.7	618.7	618.8	618.8	619.0	619.0
AMUP100C	71047	50108	Natural	460	10	39	39	32	58	75	650.4	619.0	651.8	621.1	651.8	621.1	651.7	620.8	652.1	621.8	652.3	622.6
AMUP100D	50130	71047	Natural	140	10	39	39	32	59	75	660.0	650.4	662.3	651.8	662.3	651.8	662.1	651.7	662.7	652.1	663.0	652.3
AMUP100E	50129	50130	36" CSP culvert	148	10	39	39	32	59	75	668.0	660.0	669.1	662.3	669.1	662.3	669.0	662.1	669.4	662.7	670.0	663.0
AMUP100Erd	50129	50130	Roadway	148		0	0	0	0	0	672.0	672.0	662.3	662.3	662.3	662.3	662.1	662.1	662.7	662.7	663.0	663.0
AMUP110A	99479	50129	Natural	600	10	35	35	28	55	72	703.5	668.0	707.0	669.1	707.0	669.1	706.6	669.0	707.6	669.4	707.9	670.0
AMUP040A#1	65533	65370	48" CSP	401	10	47	48	42	68	75	461.7	457.0	463.3	461.5	463.3	461.5	463.2	461.1	463.8	462.4	464.2	463.2
AMUP040A#2	65533	65370	36" CSP	382	10	1	1	0	11	27	463.0	457.8	463.3	461.5	463.3	461.5	463.2	461.1	463.8	462.4	464.2	463.2
AMUP040Ard	65533	65370	Roadway	401		0	0	0	0	0	473.0	464.1	461.5	461.5	461.5	461.5	461.1	461.1	462.4	462.4	463.2	463.2
AMUP040B	65310	65533	48" CSP	19	10	48	49	42	79	102	462.2	461.7	463.7	463.3	463.7	463.3	463.6	463.2	464.3	463.8	464.7	464.2
AMUP040C	50602	65310	48" CSP	1966	10	48	49	43	81	103	510.0	461.9	511.3	463.7	511.3	463.7	511.2	463.6	511.7	464.3	512.0	464.7
AMUP040D	50739	50602	36" CSP	845	10	49	49	44	82	105	542.4	510.0	543.8	511.3	543.8	511.3	543.7	511.2	544.5	511.7	545.1	512.0
AMUP040Drd	50739	50602	Roadway	845		0	0	0	0	0	550.0	518.0	511.3	511.3	511.3	511.3	511.2	511.2	511.7	511.7	512.0	512.0
Amazon - Headwaters Sub-Basin																						
Martin	66656	65379	48" CSP	45	10	222	226	169	282	322	504.8	502.4	511.9	506.3	512.1	506.4	509.1	505.8	515.4	506.7	518.2	507.2
Martinrd	66656	65379	Roadway	45		0	0	0	0	37	517.8	517.8	506.3	506.3	506.4	506.4	505.8	505.8	506.7	506.7	518.2	518.1
AMHW010A	67175	66656	36" CSP	79	10	75	83	55	99	106	510.7	506.6	513.8	511.9	514.2	512.1	512.0	509.1	517.8	515.4	518.5	518.2

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
Bethel Danebo - A2 Channel																						
BDA2010A	58209	80001	Natural	840	100	413	482	214	580	699	359.6	357.4	364.9	360.9	365.1	361.1	363.797	360.41	365.5	361.3	365.9	361.6
BDA2010E	58709	58209	48" CSP	1029	10	29	29	44	55	64	362.0	360.7	365.0	364.9	365.4	365.1	365.0	363.8	366.5	365.5	367.4	365.9
BDA2010Erd	58709	58209	Roadway	1029		0	0	0	0	0	374.0	372.0	364.9	364.9	365.1	365.1	363.8	363.8	365.5	365.5	365.9	365.9
BDA2020A	58689	58709	42" CSP	830	10	19	19	29	33	39	366.1	362.0	367.4	365.0	367.4	365.4	367.7	365.0	367.9	366.5	368.8	367.4
BDA2020Ard	58689	58709	Roadway	830		0	0	0	0	0	375.0	374.0	365.0	365.0	365.4	365.4	365.0	365.0	366.5	366.5	367.4	367.4
BDA2010B	80002	58209	Natural	1540	100	391	456	213	549	659	361.9	359.6	367.4	364.9	367.8	365.1	366.2	363.8	368.3	365.5	368.8	365.9
BDA2040A	58205	80002	60" CSP	390	10	13	12	11	23	32	362.0	361.9	367.4	367.4	367.8	367.8	366.2	366.2	368.3	368.3	368.8	368.8
BDA2040Ard	80002	58205	Roadway	390		0	0	0	0	0	376.3	376.2	367.4	367.4	367.8	367.8	366.2	366.2	368.3	368.3	368.8	368.8
BDA2040B	58204	58205	60" CSP	665	10	3	2	3	3	6	362.7	362.0	367.4	367.4	367.8	367.8	366.2	366.2	368.3	368.3	368.8	368.8
BDA2040Brd	58204	58205	Roadway	665		0	0	0	0	0	376.2	371.9	367.4	367.4	367.8	367.8	366.2	366.2	368.3	368.3	368.8	368.8
BDA2040C	58207	58204	48" CSP	250	10	3	2	1	3	6	363.5	362.7	367.4	367.4	367.8	367.8	366.2	366.2	368.3	368.3	368.9	368.8
BDA2040Crd	58207	58204	Roadway	250		0	0	0	0	0	371.9	371.9	367.4	367.4	367.8	367.8	366.2	366.2	368.3	368.3	368.8	368.8
BDA2060A	58673	80002	60" CSP	725	10	108	100	155	193	198	364.2	363.0	368.4	367.4	368.7	367.8	370.0	366.5	373.4	368.3	374.6	368.8
BDA2060Ard	58673	80002	Roadway	725		0	0	0	0	0	376.9	376.3	367.4	367.4	367.8	367.8	366.2	366.2	368.3	368.3	368.8	368.8
BDA2060B	58680	58673	72" CSP	884	10	96	89	138	165	165	367.4	364.2	370.4	368.4	370.3	368.7	372.9	370.0	377.7	373.4	377.8	374.6
BDA2060Brd	58680	58673	Roadway	884		0	0	0	0	0	377.8	376.9	368.4	368.4	368.7	368.7	370.0	370.0	373.4	373.4	377.8	376.9
BDA2110A	58658	58680	54" CSP	973	10	17	17	28	36	38	368.0	367.4	370.6	370.4	370.5	370.3	373.1	372.9	376.7	377.7	376.8	377.8
BDA2110Ard	58680	58658	Roadway	973		0	0	0	0	0	377.8	376.7	370.6	370.6	370.5	370.5	373.1	373.1	376.7	376.7	377.8	376.8
BDA2110B	58658	58645	24" CSP	166	10	17	18	29	35	9	369.0	371.4	370.6	372.5	370.5	372.6	373.1	376.1	376.7	377.3	396.6	396.3
BDA2110Brd	58658	58645	Roadway	166		0	0	0	20	29	376.7	377.0	370.6	370.6	370.5	370.5	373.1	373.1	376.9	377.3	396.6	396.5
BDA2070A	58683	58680	60' CSP	1641	10	64	60	94	130	130	369.4	367.4	372.9	370.4	372.8	370.3	375.7	372.9	380.0	377.7	380.1	377.8
BDA2070Ard	58683	58680	Roadway	1641		0	0	0	0	0	380.7	377.8	370.4	370.4	370.3	370.3	372.9	372.9	377.7	377.7	377.8	377.8
BDA2080A	66164	58683	48" CSP	40	10	64	60	96	136	143	372.8	372.4	374.9	374.4	374.8	374.3	376.0	375.7	380.2	380.0	380.4	380.1
BDA2080Ard	66164	58683	Roadway	40		0	0	0	0	0	380.7	380.7	372.9	372.9	372.8	372.8	375.7	375.7	380.0	380.0	380.1	380.1
BDA2080B	58668	66164	60" CSP	280	10	36	35	55	78	29	369.8	368.8	375.0	374.9	374.9	374.8	376.1	376.0	380.2	379.8	395.6	395.5
BDA2080Brd	58668	66164	Roadway	280		0	0	0	0	21	379.7	380.7	375.0	374.9	374.9	374.8	376.1	376.0	380.2	379.8	395.6	395.5
BDA2080C	68474	58668	60" CSP	1272	10	36	34	55	78	29	371.9	369.0	375.3	375.0	375.1	374.9	376.8	376.1	380.9	379.8	396.3	396.3
BDA2080Crd	68474	58668	Roadway	1272		0	0	0	0	14	381.6	379.7	375.0	375.0	374.9	374.9	376.1	376.1	379.8	379.8	396.3	396.3
BDA2080D	58950	68474	54" CSP	501	10	36	34	55	77	79	371.8	372.0	375.5	375.3	375.4	375.1	377.2	376.8	381.6	380.9	381.7	381.3
BDA2080Drd	58950	68474	Roadway	501		0	0	0	0	0	381.7	381.6	375.3	375.3	375.1	375.1	376.8	376.8	380.9	380.9	381.7	381.6
BDA2090A	60231	58950	42" CSP	960	10	15	16	24	35	36	373.1	371.8	375.8	375.5	375.7	375.4	377.9	377.2	382.2	381.6	382.6	381.7
BDA2090Ard	60231	58950	Roadway	960		0	0	0	0	0	383.2	381.7	375.5	375.5	375.4	375.4	377.2	377.2	381.6	381.6	381.7	381.7
BDA2090B	60245	60231	36" CSP	1068	10	15	15	24	35	36	375.2	373.3	377.0	375.8	377.0	375.7	380.0	377.9	383.3	382.2	383.5	382.6
BDA2090Brd	60245	60231	Roadway	1068		0	0	0	1	4	383.2	383.2	375.8	375.8	375.7	375.7	377.9	377.9	383.3	383.2	383.5	383.3
BDA2010C	80003	80002	Natural	56	100	324	376	206	455	536	361.7	361.9	367.5	367.4	367.8	367.8	366.3	366.2	368.3	368.3	368.8	368.8
BDA2010D	80004	80003	Natural	480	100	324	376	206	455	535	361.6	361.7	367.5	367.5	367.9	367.8	366.3	366.3	368.4	368.3	368.9	368.8
BDA2120A	80007	80004	Natural	2050	100	319	373	207	450	524	362.7	361.6	367.9	367.5	368.3	367.9	366.7	366.3	368.8	368.4	369.4	368.9
BDA2130B	80009	80007	Natural	1050	10	17	17	23	26	30	378.2	374.6	379.3	375.3	379.3	375.3	379.4	375.4	379.4	375.4	379.5	375.5
BDA2140A	58235	80007	Natural	200	10	33	32	51	71	82	369.4	365.7	370.7	367.9	370.7	368.3	370.9	367.2	371.2	368.8	371.2	369.4
BDA2140B	58946	58235	42" CSP	350	10	33	31	51	71	180	370.1	366.3	372.9	371.9	372.8	371.9	374.1	372.3	375.5	372.8	382.7	380.9
BDA2140Brd	58946	58235	Roadway	350		0	0	0	0	0	378.4	378.0	370.7	370.7	370.7	370.7	370.9	370.9	371.2	371.2	380.9	380.9
BDA2140C	58875	58946	42" CSP	1690	10	18	17	28	38	44	370.2	366.3	373.5	372.9	373.3	372.8	375.6	374.1	378.5	375.5	380.0	376.2
BDA2140Crd	58875	58946	Roadway	1690		0	0	0	0	0	380.0	378.4	372.9	372.9	372.8	372.8	374.1	374.1	375.5	375.5	380.0	378.4
BDA2130A	80010	80007	Natural	2000	100	281	328	225	398	463	366.7	364.6	371.1	367.9	371.4	368.3	370.9	366.7	371.7	368.8	372.0	369.4
BDA2170A	80014	80010	Natural	700	100	275	323	237	393	457	368.3	366.7	372.3	371.1	372.6	371.4	372.0	370.9	373.0	371.7	373.3	372.0

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
BDA2170B	80015	80014	Bridge	135	100	275	323	238	393	457	368.7	368.3	372.5	372.3	372.8	372.6	372.2	372.0	373.2	373.0	373.5	373.3
BDA2180A	58854	80015	Natural	550	100	273	321	238	390	454	367.4	368.7	372.7	372.5	373.0	372.8	372.4	372.2	373.4	373.2	373.7	373.5
BDA2190B	58894	58854	84" CSP	445	10	64	77	48	100	118	368.5	367.4	372.7	372.7	373.0	373.0	372.4	372.4	373.5	373.4	373.8	373.7
BDA2190Brd	58894	58854	Roadway	445		0	0	0	0	0	381.8	381.8	372.7	372.7	373.0	373.0	372.4	372.4	373.4	373.4	373.7	373.7
BDA2190C	58893	58894	84" CSP	2163	10	55	66	37	81	95	370.8	368.5	373.5	372.7	373.9	373.0	372.8	372.4	374.3	373.5	374.6	373.8
BDA2190Crd	58893	58894	Roadway	2163		0	0	0	0	0	384.6	381.8	372.7	372.7	373.0	373.0	372.4	372.4	373.5	373.5	373.8	373.8
BDA2200A	58853	58893	84" CSP	469	10	46	52	20	61	180	371.3	370.8	373.8	373.5	374.1	373.9	372.9	372.8	374.5	374.3	384.0	382.7
BDA2200Ard	58853	58893	Roadway	469		0	0	0	0	0	385.4	384.6	373.5	373.5	373.9	373.9	372.8	372.8	374.3	374.3	382.7	382.7
BDA2200B	72463	58853	72" CSP	590	10	43	50	19	57	57	372.7	372.3	375.2	374.0	375.4	374.1	374.4	373.4	375.6	374.5	380.0	378.1
BDA2200Brd	72463	58853	Roadway	590		0	0	0	0	0	385.6	385.4	373.8	373.8	374.1	374.1	372.9	372.9	374.5	374.5	378.1	378.1
BDA2200C	72470	72463	72" CSP	705	10	43	50	19	57	35	373.7	372.9	376.2	375.2	376.4	375.4	375.3	374.4	376.6	375.6	377.4	376.8
BDA2200Crd	72470	72463	Roadway	705		0	0	0	0	29	386.7	385.6	375.2	375.2	375.4	375.4	374.4	374.4	375.6	375.6	377.4	377.0
BDA2200D	72474	72470	72" CSP	440	10	43	50	20	57	79	374.2	373.7	376.6	376.2	376.8	376.4	375.8	375.3	377.1	376.6	381.3	380.1
BDA2200Drd	72470	72474	Roadway	440		0	0	0	0	0	386.7	385.2	376.6	376.6	376.8	376.8	375.8	375.8	377.1	377.1	380.1	380.1
BDA2210A1	72515	72474	36" CSP	20	10	22	25	10	29	81	377.1	382.9	377.6	383.5	377.7	383.6	377.5	383.3	377.7	383.6	380.1	380.4
BDA2210A2	72515	72474	36" CSP	20	10	22	25	10	29	0	382.9	377.1	383.5	377.6	383.6	377.7	383.3	377.5	383.6	377.7	380.1	380.1
BDA2210Ard	72515	72474	Roadway	20		0	0	0	0	69	386.1	385.6	376.6	376.6	376.8	376.8	375.8	375.8	377.1	377.1	374.8	374.6
BDA2210B1	58997	72515	36" CSP	40	10	22	25	10	29	32	382.7	382.9	385.5	383.5	385.8	383.6	384.5	383.3	386.2	383.6	386.7	383.7
BDA2210B2	58997	72515	36" CSP	40	10	22	25	10	29	32	382.7	382.9	385.5	383.5	385.8	383.6	384.5	383.3	386.2	383.6	386.7	383.7
BDA2210Brd	58997	72515	Roadway	40		0	0	0	0	0	388.1	388.1	383.5	383.5	383.6	383.6	383.3	383.3	383.6	383.6	383.7	383.7
BDA2210C	69700	58997	Natural	900	10	54	57	56	90	108	380.5	382.7	385.5	385.5	385.8	385.8	384.5	384.5	386.2	386.2	386.7	386.7
BDA2220A	80017	69700	36" CSP	146	10	13	11	17	29	34	385.9	384.0	386.7	385.5	386.7	385.8	386.9	385.0	387.3	386.2	387.4	386.7
BDA2220Ard	80017	69700	Roadway	146		0	0	0	0	0	392.2	392.2	385.5	385.5	385.8	385.8	384.5	384.5	386.2	386.2	386.7	386.7
BDA2230A	69714	69700	60" CSP	869	10	55	54	84	105	125	381.5	380.5	385.8	385.5	386.2	385.8	385.7	384.5	387.5	386.2	388.7	386.7
BDA2230Ard	69714	69700	Roadway	869		0	0	0	0	0	393.0	392.0	385.5	385.5	385.8	385.8	384.5	384.5	386.2	386.2	386.7	386.7
BDA2240A	69732	69714	60" CSP	809	10	44	43	68	83	98	382.4	381.5	386.2	385.8	386.5	386.2	386.6	385.7	388.7	387.5	390.5	388.7
BDA2240Ard	69732	69714	Roadway	809		0	0	0	0	0	394.0	393.0	385.8	385.8	386.2	386.2	385.7	385.7	387.5	387.5	388.7	388.7
BDA2260A	80018	58854	Natural	1160	25	213	247	217	306	357	369.8	367.4	373.5	372.7	373.9	373.0	373.5	372.4	374.3	373.4	374.7	373.7
BDA2260B	80019	80018	Natural	260	25	212	246	219	306	357	368.5	369.8	373.8	373.5	374.2	373.9	373.8	373.5	374.6	374.3	375.0	374.7
BDA2260C	80020	80019	15x24 M baskhnd culvert	110	25	212	247	219	306	357	368.5	368.5	373.9	373.8	374.2	374.2	373.8	373.8	374.7	374.6	375.1	375.0
BDA2260D	80021	80020	Trapezoid	400	25	213	247	220	307	358	368.4	368.5	374.1	373.9	374.5	374.2	374.1	373.8	375.0	374.7	375.4	375.1
BDA2270A	80022	80021	13x26 M baskhnd culvert	129	25	213	247	221	307	359	368.4	368.4	374.1	374.1	374.5	374.5	374.1	374.1	375.0	375.0	375.5	375.4
BDA2280A	66548	80022	66" CSP	776	10	60	57	85	108	124	371.3	368.4	374.4	374.1	374.8	374.5	374.6	374.1	375.7	375.0	376.3	375.5
BDA2280Ard	66548	80022	Roadway	776		0	0	0	0	0	383.1	382.0	374.1	374.1	374.5	374.5	374.1	374.1	375.0	375.0	375.5	375.5
BDA2280B	58883	66548	60" CSP	1303	10	50	47	71	89	101	372.9	371.3	375.7	374.4	375.7	374.8	376.4	374.6	377.2	375.7	378.1	376.3
BDA2280Brd	58883	66548	Roadway	1303		0	0	0	0	0	384.0	383.1	374.4	374.4	374.8	374.8	374.6	374.6	375.7	375.7	376.3	376.3
BDA2290A	69242	58883	60" CSP	27	10	31	29	43	53	3	379.2	372.9	379.8	375.7	379.8	375.7	379.9	376.4	380.0	377.2	398.3	396.6
BDA2290Ard	69242	58883	Roadway	27		0	0	0	0	9	384.0	384.0	375.7	375.7	375.7	375.7	376.4	376.4	377.2	377.2	396.6	396.3
BDA2290B	69021	69242	Natural	1500	10	31	29	43	53	58	382.2	379.2	385.5	379.8	385.4	379.8	385.9	379.9	386.3	380.0	386.4	380.0
BDA2290C	60488	69021	54" CSP	12	10	32	29	44	60	69	379.5	382.2	385.5	385.5	385.4	385.4	385.9	385.9	386.3	386.3	386.5	386.4
BDA2290Crd	60488	69021	Roadway	12		0	0	0	0	1	386.4	386.4	385.5	385.5	385.4	385.4	385.9	385.9	386.3	386.3	386.5	386.4
BDA2300A	68209	60488	48" CSP	1121	10	16	15	23	30	35	380.4	379.5	385.7	385.5	385.6	385.4	386.3	386.0	386.8	386.3	387.3	386.5

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
BDA2300Ard	68209	60488	Roadway	1121		0	0	0	0	0	388.4	386.4	385.5	385.5	385.4	385.4	386.0	386.0	386.3	386.3	386.5	386.5
BDA2300B	60565	68209	42"CSP	634	10	16	15	23	30	35	381.3	380.6	385.9	385.7	385.8	385.6	386.8	386.3	387.5	386.8	388.2	387.3
BDA2300Brd	60565	68209	Roadway	634		0	0	0	0	0	389.7	388.4	385.7	385.7	385.6	385.6	386.3	386.3	386.8	386.8	387.3	387.3
BDA2270B	80023	80022	Trapezoid	500	25	162	187	171	229	261	368.4	368.4	374.3	374.1	374.7	374.5	374.3	374.1	375.2	375.0	375.7	375.5
BDA2270C	80024	80023	15x24 M baskhnd culvert	90	25	162	186	170	228	260	368.4	368.4	374.3	374.3	374.7	374.7	374.3	374.3	375.2	375.2	375.7	375.7
BDA2270D	60115	80024	Natural	1300	25	162	186	166	226	256	371.9	368.4	375.9	374.3	376.1	374.7	375.9	374.3	376.4	375.2	376.7	375.7
BDA2320A	60238	60115	36" CSP	154	10	25	25	41	52	60	374.1	373.8	376.2	375.9	376.4	376.1	376.9	375.9	377.4	376.4	377.8	376.7
BDA2320Ard	60238	60115	Roadway	154		0	0	0	0	0	380.8	380.0	375.9	375.9	376.1	376.1	375.9	375.9	376.4	376.4	376.7	376.7
BDA2320B	60216	60238	36" CSP	1353	10	15	15	24	29	33	378.5	374.1	379.9	376.2	379.9	376.4	380.3	376.9	380.7	377.4	381.6	377.8
BDA2320Brd	60216	60238	Roadway	1353		0	0	0	0	0	384.5	380.8	376.2	376.2	376.4	376.4	376.9	376.9	377.4	377.4	377.8	377.8
BDA2320C	60123	60115	Natural	1290	25	146	165	155	203	228	372.7	371.9	378.3	375.9	378.5	376.1	378.4	375.9	378.8	376.4	379.1	376.7
BDA2340A	80025	60123	Natural	630	10	141	156	151	194	218	373.8	372.7	378.6	378.3	378.8	378.5	378.7	378.4	379.2	378.8	379.5	379.1
BDA2350A	60118	80025	Natural	840	10	119	128	141	164	180	375.9	373.8	380.0	378.6	380.1	378.8	380.3	378.7	380.7	379.2	380.9	379.5
BDA2350B	59972	60118	66" CSP	512	10	120	128	142	164	18	377.2	375.9	381.0	380.0	381.3	380.1	381.5	380.3	382.1	380.7	398.3	396.6
BDA2350Brd	59972	60118	Roadway	512		0	0	0	0	18	386.8	386.8	380.0	380.0	380.1	380.1	380.3	380.3	380.7	380.7	398.3	396.6
BDA2350C	60107	59972	60" CSP	97	10	120	128	142	164	34	377.5	377.2	381.9	381.0	382.1	381.3	382.5	381.5	383.3	382.1	400.7	398.3
BDA2350Crd	60107	59972	Roadway	97		0	0	0	0	8	386.8	386.8	381.0	381.0	381.3	381.3	381.5	381.5	382.1	382.1	400.7	398.4
BDA2360A	67069	60107	Natural	1250	10	115	122	140	160	177	378.5	376.8	383.1	381.9	383.3	382.1	383.7	382.5	384.2	383.3	384.8	384.0
BDA2380A	66573	67069	48" CSP	1309	10	35	35	55	65	77	380.9	379.3	383.9	383.1	384.2	383.3	385.6	383.7	386.5	384.2	388.0	384.8
BDA2380Ard	66573	67069	Roadway	1309		0	0	0	0	0	388.3	388.0	383.1	383.1	383.3	383.3	383.7	383.7	384.2	384.2	384.8	384.8
BDA2370A	60462	67069	Natural	600	10	77	79	95	106	117	380.8	378.5	383.3	383.1	383.5	383.3	383.8	383.7	384.4	384.2	384.9	384.8
BDA2370B	60463	60462	54" CSP culvert	55	10	76	79	94	106	117	380.9	380.8	384.5	383.3	384.6	383.5	385.1	383.8	385.7	384.4	386.2	384.9
BDA2370Brd	60463	60462	Roadway	55		0	0	0	0	0	390.2	390.2	383.3	383.3	383.5	383.5	383.8	383.8	384.4	384.4	384.9	384.9
BDA2370C	60460	60463	Natural	570	10	77	79	94	107	118	381.7	380.9	385.7	384.5	385.7	384.6	386.1	385.1	386.5	385.7	386.9	386.2
BDA2390A	60461	60460	54" CSP	102	10	77	79	95	108	119	382.1	381.7	386.2	385.7	386.3	385.7	386.9	386.1	387.4	386.5	388.1	386.9
BDA2390Ard	60461	60460	Roadway	102		0	0	0	0	0	390.0	390.0	385.7	385.7	385.7	385.7	386.1	386.1	386.5	386.5	386.9	386.9
BDA2390B	60455	60461	Natural	1000	10	65	66	84	93	103	382.9	382.1	387.2	386.2	387.3	386.3	387.8	386.9	388.2	387.4	388.7	388.1
BDA2395A	60454	60455	48" CSP culvert	45	10	65	67	86	97	109	383.5	383.5	387.7	387.2	387.8	387.3	388.6	387.8	389.2	388.2	389.9	388.7
BDA2395Ard	60454	60455	Roadway	45		0	0	0	0	0	392.0	392.0	387.2	387.2	387.3	387.3	387.8	387.8	388.2	388.2	388.7	388.7
BDA2395B	60456	60454	Natural	700	10	47	48	61	69	76	383.7	383.4	387.9	387.7	388.0	387.8	388.7	388.6	389.3	389.2	390.0	389.9
BDA2395C	68451	60456	48" CSP	1037	10	48	48	65	83	93	386.1	383.7	389.2	387.9	389.3	388.0	391.3	388.7	393.1	389.3	394.3	390.0
BDA2395Crd	68451	60456	Roadway	1037		0	0	0	0	0	394.7	393.0	387.9	387.9	388.0	388.0	388.7	388.7	389.3	389.3	390.0	390.0
BDA2400A	60541	68451	36" CSP	1086	10	10	9	15	23	26	388.0	387.0	389.7	389.2	389.7	389.3	392.1	391.3	394.9	393.1	396.2	394.3
BDA2400Ard	60541	68451	Roadway	1086		0	0	0	0	0	398.8	394.7	389.2	389.2	389.3	389.3	391.3	391.3	393.1	393.1	394.3	394.3
BDA2400B	60550	68451	36" CSP	472	10	18	19	26	27	32	387.1	386.2	389.6	389.2	389.7	389.3	391.9	391.3	393.4	393.1	394.5	394.3
BDA2400Brd	60550	68451	Roadway	472		0	0	0	0	0	394.8	394.3	389.2	389.2	389.3	389.3	391.3	391.3	393.1	393.1	394.3	394.3
BDA2400C	62088	60550	36" CSP	365	10	18	19	26	27	32	387.6	387.1	389.9	389.6	390.0	389.7	392.3	391.9	393.6	393.4	394.7	394.5
BDA2400Crd	62088	60550	Roadway	365		0	0	0	0	0	395.6	394.8	389.6	389.6	389.7	389.7	391.9	391.9	393.4	393.4	394.5	394.5
BDA2400D	62089	62088	36" CSP	336	10	18	18	25	27	32	388.1	387.6	390.3	389.9	390.4	390.0	392.8	392.3	393.8	393.6	395.5	394.7
BDA2400Drd	62089	62088	Roadway	336		0	0	0	0	0	395.6	395.3	390.3	390.3	390.4	390.4	392.8	392.8	393.8	393.8	395.5	395.5
BDA2400E	62090	62089	30" CSP	170	10	17	18	25	27	32	389.1	388.1	390.7	390.3	390.8	390.4	393.5	392.8	394.6	393.8	383.7	377.8
BDA2400Erd	62090	62089	Roadway	170		0	0	0	0	0	395.3	395.0	390.7	390.7	390.8	390.8	393.5	393.5	394.6	394.6	377.3	377.3

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
BDA2400F	62024	62090	30" CSP	275	10	17	18	25	26	26	392.3	389.1	393.4	390.7	393.5	390.8	394.7	393.5	395.4	394.6	395.7	395.6
BDA2400Frd	62024	62090	Roadway	275		0	0	0	8	27	395.2	395.0	390.7	390.7	390.8	390.8	393.5	393.5	395.4	395.1	395.7	395.6
BDA2400G	62023	62024	3.5' x 2' Box culvert	28	10	17	18	25	26	25	392.3	392.3	393.6	393.4	393.6	393.5	394.7	394.7	395.5	395.4	395.7	395.7
BDA2400Grd	62023	62024	Roadway	28		0	0	0	12	27	395.3	395.2	393.4	393.4	393.5	393.5	394.7	394.7	395.5	395.4	395.7	395.7
BDA2400H	62022	62023	30" CSP	311	10	17	18	24	25	25	392.8	392.3	394.9	393.6	395.0	393.6	395.9	394.7	396.2	395.5	396.3	395.7
BDA2400Hrd	62022	62023	Roadway	311		0	0	0	11	21	396.0	395.3	393.6	393.6	393.6	393.6	394.7	394.7	396.2	395.5	396.3	395.7
BDA2400I	62093	62022	3.5' x 2' Box culvert	28	10	17	18	24	28	0	392.9	392.8	394.9	394.9	395.0	395.0	396.0	395.9	396.3	396.2	377.3	377.3
BDA2400Ird	62093	62022	Roadway	28		0	0	0	6	32	396.2	396.0	394.9	394.9	395.0	395.0	395.9	395.9	396.3	396.2	383.7	377.8
BDA2400J1	62094	62093	21" CSP	308	10	9	9	9	9	64	392.9	392.1	396.0	394.9	396.1	395.0	396.4	396.0	396.5	396.3	376.8	375.8
BDA2400J2	62094	62093	21" CSP	308	10	9	9	9	9	0	392.9	392.1	396.0	394.9	396.1	395.0	396.4	396.0	396.5	396.3	375.8	375.8
BDA2400Jrd	62094	62093	Roadway	308		0	0	13	22	64	396.2	395.8	396.0	394.9	396.1	395.0	396.4	396.3	396.5	396.4	377.3	376.8
BDA2400K1	62025	62094	21" CSP	27	10	9	8	8	8	8	393.3	392.1	396.0	396.0	396.1	396.1	396.4	396.4	396.5	396.5	396.6	396.6
BDA2400K2	62025	62094	21" CSP	27	10	9	8	8	8	8	393.3	392.1	396.0	396.0	396.1	396.1	396.4	396.4	396.5	396.5	396.6	396.6
BDA2400Krd	62025	62094	Roadway	27		14	16	25	30	36	395.3	395.8	396.0	396.0	396.1	396.1	396.4	396.4	396.5	396.5	396.6	396.6
BDA2400L1	62095	62025	21" CSP	109	10	10	10	15	17	0	394.2	393.3	396.5	396.0	396.7	396.1	397.6	396.4	398.0	396.5	371.2	371.2
BDA2400L2	62095	62025	21" CSP	109	10	10	10	15	17	65	394.2	393.3	396.5	396.0	396.7	396.1	397.6	396.4	398.0	396.5	375.8	374.8
BDA2400Lrd	62095	62025	Roadway	109		0	0	0	0	0	398.3	395.3	396.0	396.0	396.1	396.1	396.4	396.4	396.5	396.5	374.8	374.8
BDA2400M	69935	62095	30" CSP	353	10	20	20	30	34	0	394.5	394.2	397.4	396.5	397.6	396.7	399.8	397.6	400.6	398.0	374.6	374.6
BDA2400Mrd	69935	62095	Roadway	353		0	0	0	0	82	398.3	400.6	396.5	396.5	396.7	396.7	397.6	397.6	398.3	400.6	376.2	372.9
BDA2410A	80027	80025	Natural	680	10	23	27	18	33	40	374.7	373.8	378.6	378.6	378.8	378.8	378.7	378.7	379.3	379.2	379.5	379.5
BDA2410B	60102	80027	Natural	580	10	19	23	23	32	37	375.0	374.7	378.7	378.6	378.9	378.8	378.7	378.7	379.3	379.3	379.5	379.5
BDA2420A1	60101	60102	48" CMP culverts	120	10	10	12	13	17	20	375.3	375.1	378.7	378.7	378.9	378.9	378.8	378.7	379.3	379.3	379.6	379.5
BDA2420A2	60101	60102	48" CMP culverts	120	10	10	12	13	18	20	375.4	375.0	378.7	378.7	378.9	378.9	378.8	378.7	379.3	379.3	379.6	379.5
BDA2420Ard	60101	60102	Roadway	120		0	0	0	0	0	384.9	384.9	378.7	378.7	378.9	378.9	378.7	378.7	379.3	379.3	379.5	379.5
BDA2430A	61733	60101	Natural	700	10	13	14	17	21	25	376.1	375.3	378.7	378.7	378.9	378.9	378.8	378.8	379.3	379.3	379.6	379.6
Bethel Danebo - A3 Channel																						
BDA3010A	61607	80044	Natural	2400	100	352	400	219	455	522	374.9	370.0	380.9	380.8	381.1	381.1	378.7	378.6	381.3	381.2	381.6	381.5
BDA3020A1	61608	61607	6' x 10' Concrete Box culvert	100	100	184	206	112	235	270	375.0	374.9	380.9	380.9	381.2	381.1	378.7	378.7	381.4	381.3	381.7	381.6
BDA3020A2	61608	61607	6' x 10' Concrete Box culvert	100	100	184	206	112	235	270	375.0	374.9	380.9	380.9	381.2	381.1	378.7	378.7	381.4	381.3	381.7	381.6
BDA3020Ard	61608	61607	Roadway	100		0	0	0	0	0	385.6	385.6	380.9	380.9	381.1	381.1	378.7	378.7	381.3	381.3	381.6	381.6
BDA3020B	67113	61608	Natural	2470	100	373	411	227	472	537	376.6	375.0	381.3	380.9	381.7	381.2	380.0	378.7	381.9	381.4	382.3	381.7

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
BDA3030A1	61694	67113	6' x 10' Concrete Box culvert	83	100	189	208	114	238	271	376.7	376.6	381.4	381.3	381.8	381.7	380.1	380.0	382.0	381.9	382.5	382.3
BDA3030A2	61694	67113	6' x 10' Concrete Box culvert	83	100	189	208	114	238	271	376.7	376.6	381.4	381.3	381.8	381.7	380.1	380.0	382.0	381.9	382.5	382.3
BDA3030Ard	61694	67113	Roadway	83		0	0	0	0	0	385.4	385.4	381.3	381.3	381.7	381.7	380.0	380.0	381.9	381.9	382.3	382.3
BDA3030B	80045	61694	Natural	850	100	367	405	227	463	528	376.6	376.7	381.8	381.4	382.2	381.8	380.7	380.1	382.4	382.0	382.9	382.5
BDA3030C	80050	80045	Natural	1600	100	211	249	125	271	321	380.6	376.6	383.5	381.8	383.7	382.2	383.5	380.7	384.4	382.4	384.6	382.9
BDA3040A	80051	80050	Natural	32	100	186	215	106	235	277	380.2	380.6	383.7	383.5	383.9	383.7	383.6	383.5	384.5	384.4	384.7	384.6
BDA3040B	80052	80051	Natural	350	100	186	215	107	235	277	380.6	380.2	384.1	383.7	384.4	383.9	383.7	383.6	384.8	384.5	385.1	384.7
BDA3040D	modpt	80052	Natural	1100	10	13	13	20	25	29	382.6	380.6	384.2	384.1	384.4	384.4	384.6	383.7	384.9	384.8	385.1	385.1
BDA3040C	63147	80052	Natural	2370	100	181	207	108	228	269	381.5	380.6	386.6	384.1	386.9	384.4	385.6	383.7	387.2	384.8	387.6	385.1
BDA3060A	63130	63147	Natural	470	100	173	195	108	218	257	383.0	381.5	386.8	386.6	387.1	386.9	385.8	385.6	387.4	387.2	387.8	387.6
BDA3070A	63207	63147	36" CSP	892	10	6	7	10	12	14	383.7	381.5	386.6	386.6	387.0	386.9	385.6	385.6	387.2	387.2	387.6	387.6
BDA3070Ard	63207	63147	Roadway	892		0	0	0	0	0	396.0	391.4	386.6	386.6	387.0	387.0	385.6	385.6	387.2	387.2	387.6	387.6
BDA3080A	63129	63130	7' x 10' Concrete Box culvert	96	100	173	196	108	218	257	382.9	383.0	387.0	386.8	387.4	387.1	386.0	385.8	387.6	387.4	388.1	387.8
BDA3080Ard	63129	63130	Roadway	96		0	0	0	0	0	391.8	391.8	386.8	386.8	387.1	387.1	385.8	385.8	387.4	387.4	387.8	387.8
BDA3080C1	80055	80054	Natural	750	100	164	185	141	210	245	383.6	382.2	389.7	389.6	390.0	389.9	388.9	388.8	390.3	390.2	390.7	390.7
BDA3080C2	80056	80055	Natural	750	100	192	201	237	267	301	384.5	383.6	389.7	389.7	390.0	390.0	388.9	388.9	390.3	390.3	390.8	390.7
BDA3080D	63309	80056	Natural	700	100	230	232	255	328	372	386.0	384.8	389.7	389.7	390.0	390.0	389.0	388.9	390.3	390.3	390.8	390.8
BDA3090A	67158	63309	7' x 10' Concrete Box culvert	96	100	250	249	289	360	408	386.5	386.3	390.0	389.7	390.3	390.0	390.2	389.3	390.8	390.3	391.2	390.8
BDA3090Ard	67158	63309	Roadway	96		0	0	0	0	0	395.5	395.0	389.7	389.7	390.0	390.0	389.0	389.0	390.3	390.3	390.8	390.8
BDA3090B	63276	67158	Natural	1300	100	238	236	286	341	381	386.8	385.2	391.7	390.0	391.6	390.3	392.0	390.2	392.3	390.8	392.6	391.2
BDA3110D	63359	63307	36" CSP	160	10	20	19	29	35	41	388.4	389.3	392.2	392.0	392.2	392.0	392.6	392.3	393.1	392.8	393.6	393.1
BDA3110DRD	63359	63307	Roadway	160		0	0	0	0	0	395.0	395.0	392.0	392.0	392.0	392.0	392.3	392.3	392.8	392.8	393.1	393.1
BDA3110C	63307	63275	Natural	1300	10	17	18	22	27	31	389.3	388.2	392.0	391.8	392.0	391.9	392.3	392.2	392.8	392.7	393.1	393.0
BDA3110A	63275	63276	42" CMP	160	10	18	19	21	26	27	388.2	388.1	391.8	391.7	391.9	391.6	392.2	392.0	392.7	392.3	393.0	392.6
BDA3110Ard	63275	63276	Roadway	160		0	0	0	0	0	396.6	396.6	391.7	391.7	391.6	391.6	392.0	392.0	392.3	392.3	392.6	392.6
BDA3100A	63303	63276	Natural	600	100	212	209	267	313	346	387.2	386.8	391.9	391.7	391.9	391.6	392.3	392.0	392.7	392.3	392.9	392.6
BDA3120A	63326	63303	42" CSP	140	10	18	16	21	36	43	387.7	387.2	392.0	391.9	392.0	391.9	392.3	392.3	392.7	392.7	393.0	392.9
BDA3120Ard	63326	63303	Roadway	140		0	0	0	0	0	397.0	397.0	391.9	391.9	391.9	391.9	392.3	392.3	392.7	392.7	392.9	392.9
BDA3100B	63305	63303	Natural	1900	100	199	195	270	310	337	388.6	387.2	393.3	391.9	393.3	391.9	393.9	392.3	394.2	392.7	394.4	392.9
BDA3150C	63349	63332	42" CSP	27	10	27	25	39	47	56	388.9	388.9	393.7	393.6	393.6	393.5	394.4	394.4	395.0	394.9	395.7	395.5
BDA3150Crd	63349	63332	Roadway	27		0	0	0	0	0	397.1	396.9	393.6	393.6	393.5	393.5	394.4	394.4	394.9	394.9	395.5	395.5
BDA3150B	63332	63335	60" CSP	275	10	53	47	68	87	105	388.6	388.2	393.6	393.5	393.5	393.4	394.4	394.1	394.9	394.5	395.5	394.9
BDA3150Brd	63332	63335	Roadway	275		0	0	0	0	0	396.9	396.0	393.5	393.5	393.4	393.4	394.1	394.1	394.5	394.5	394.9	394.9
BDA3150A	63335	63305	48" CSP	80	10	53	47	68	87	105	387.8	388.6	393.5	393.3	393.4	393.3	394.1	393.9	394.5	394.2	394.9	394.4

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
BDA3150Ard	63335	63305	Roadway	80		0	0	0	0	0	399.0	396.0	393.5	393.5	393.4	393.4	394.1	394.1	394.5	394.5	394.9	394.9
BDA3160A	66631	63332	48" CSP	693	10	26	22	29	40	49	391.0	388.7	393.9	393.6	393.7	393.5	394.7	394.4	395.5	394.9	396.6	395.5
BDA3160Ard	66631	63332	Roadway	693		0	0	0	0	0	398.6	398.4	393.6	393.6	393.5	393.5	394.4	394.4	394.9	394.9	395.5	395.5
BDA3180A	63351	63305	48" CSP	70	10	48	48	74	85	88	387.5	388.7	393.5	393.3	393.4	393.3	394.3	393.9	394.6	394.2	394.8	394.4
BDA3180Ard	63351	63305	Roadway	70		0	0	0	0	0	399.0	397.9	393.5	393.5	393.4	393.4	394.3	394.3	394.6	394.6	394.8	394.8
BDA3180B	63369	63351	48" CSP	889	10	48	48	74	85	88	390.7	387.5	394.6	393.5	394.6	393.4	397.2	394.3	398.2	394.6	398.7	394.8
BDA3180Brd	63369	63351	Roadway	889		0	0	0	0	0	398.6	397.9	393.5	393.5	393.4	393.4	394.3	394.3	394.6	394.6	398.7	397.9
BDA3180C	63810	63369	48" CSP	939	10	26	27	41	47	50	392.9	390.7	395.1	394.6	395.2	394.6	398.1	397.2	399.2	398.2	399.9	398.7
BDA3180Crd	63810	63369	Roadway	939		0	0	0	0	0	400.0	398.6	394.6	394.6	394.6	394.6	397.2	397.2	398.2	398.2	398.7	398.7
BDA3180D	63811	63810	42" CSP	400	10	27	27	41	47	49	393.7	392.9	395.8	395.1	395.9	395.2	398.9	398.1	400.1	399.2	400.5	399.9
BDA3180Drd	63811	63810	Roadway	400		0	0	0	0	14	400.0	400.0	395.1	395.1	395.2	395.2	398.1	398.1	400.1	400.0	400.5	400.2
BDA3130A	63364	63305	66" CSP	90	10	102	101	143	158	170	387.2	388.6	393.5	393.3	393.5	393.3	394.2	393.9	394.6	394.2	394.8	394.4
BDA3130Ard	63364	63305	Roadway	90		0	0	0	0	0	399.0	398.0	393.5	393.5	393.5	393.5	394.2	394.2	394.6	394.6	394.8	394.8
BDA3130B	63822	63364	60" CSP	2417	10	89	88	124	135	136	391.4	387.6	396.7	393.5	396.6	393.5	400.8	394.2	402.3	394.6	402.4	394.8
BDA3130Brd	63822	63364	Roadway	2417		0	0	0	0	1	402.3	398.0	393.5	393.5	393.5	393.5	394.2	394.2	402.3	398.0	402.4	398.0
BDA3200A	63826	63822	60" CSP	949	10	73	73	106	110	115	392.9	391.4	397.5	396.7	397.4	396.6	402.8	400.8	404.5	402.3	404.7	402.4
BDA3200Ard	63826	63822	Roadway	949		0	0	0	0	0	404.8	402.3	396.7	396.7	396.6	396.6	400.8	400.8	402.3	402.3	402.4	402.4
BDA3210A	63800	63826	60" CSP	1774	10	53	52	77	81	89	395.3	392.9	398.6	397.5	398.5	397.4	404.6	402.8	405.9	404.5	406.2	404.7
BDA3210Ard	63800	63826	Roadway	1774		0	0	0	0	4	405.9	404.8	397.5	397.5	397.4	397.4	402.8	402.8	405.9	404.8	406.2	404.9
BDA3220A	63797	63800	48" CSP	722	10	24	22	31	44	54	396.9	395.3	399.0	398.6	398.9	398.5	405.0	404.6	406.1	405.9	406.4	406.2
BDA3220Ard	63797	63800	Roadway	722		0	0	0	0	9	406.0	405.9	398.6	398.6	398.5	398.5	404.6	404.6	406.1	405.9	406.4	406.2
BDA3220B	63795	63797	42" CSP	713	10	25	22	30	44	47	398.3	396.9	400.3	399.0	400.2	398.9	405.8	405.0	406.4	406.1	406.7	406.4
BDA3220Brd	63795	63797	Roadway	713		0	0	0	8	20	406.0	406.0	399.0	399.0	398.9	398.9	405.0	405.0	406.4	406.1	406.7	406.4
Bethel Danebo - Greenhill Tributary																						
BDGH050A1	80036	80070	36" CMP	45	25	72	67	72	82	82	365.5	365.7	371.0	370.1	370.7	370.5	371.0	369.5	371.7	370.7	371.7	371.3
BDGH050A2	80036	80057	36" CMP	45	25	60	58	60	67	67	366.0	365.4	371.0	370.1	370.7	370.5	371.0	369.5	371.7	370.7	371.7	371.3
BDGH050B	80035	80036	Natural	30	25	107	100	107	124	133	366.4	365.4	370.0	370.1	370.5	370.5	369.0	369.5	370.7	370.7	371.3	371.3
BDGH050C	81000	80035	Natural	1875	10	85	90	91	117	138	369.0	366.4	371.7	370.0	371.7	370.5	371.8	369.0	372.0	370.7	372.3	371.3
BDGH050D	81001	81000	Natural	120	25	85	89	90	118	139	369.1	369.0	371.9	371.7	371.9	371.7	372.0	371.8	372.3	372.0	372.5	372.3
BDGH050E	80037	81001	Natural	20	25	85	89	90	118	139	368.5	369.1	371.9	371.9	372.0	371.9	372.0	372.0	372.3	372.3	372.6	372.5
BDGH064A1	81002	80037	3.4' x 5.1' Rectangle	15	10	47	50	51	65	76	369.0	368.5	372.0	371.9	372.0	372.0	372.1	372.0	372.4	372.3	372.8	372.6
BDGH064A2	81002	80037	3.4' x 5.1' Rectangle	15	10	35	37	38	50	61	369.0	368.5	372.0	371.9	372.0	372.0	372.1	372.0	372.4	372.3	372.8	372.6
BDGH064Ard	81002	80037	Roadway	2700		0	0	0	0	0	374.3	374.2	371.9	371.9	372.0	372.0	372.0	372.0	372.3	372.3	372.6	372.6
BDGH064B	81003	81002	Natural	22	10	82	88	90	116	136	369.2	369.0	372.0	372.0	372.1	372.0	372.1	372.1	372.5	372.4	372.8	372.8
BDGH064C	80038	81003	Natural	26	10	82	88	90	116	136	369.5	369.2	372.1	372.0	372.2	372.1	372.2	372.1	372.6	372.5	372.9	372.8
BDGH064D	81004	80038	Natural	32	10	68	73	80	97	113	369.8	369.5	372.2	372.1	372.2	372.2	372.2	372.2	372.6	372.6	372.9	372.9
BDGH064E	81015	81004	Natural	395	10	69	73	81	97	113	370.1	369.8	373.2	372.2	373.3	372.2	373.4	372.2	373.7	372.6	374.0	372.9
BDGH064F	80064	81015	Natural	437	10	69	73	81	98	114	370.2	370.1	373.6	373.2	373.7	373.3	373.8	373.4	374.1	373.7	374.4	374.0
BDGH060B	80040	80071	Natural	835	10	13	14	14	18	22	370.0	369.7	372.4	372.2	372.4	372.3	372.4	372.3	372.8	372.7	373.1	373.0
BDGH060	80071	80038	Natural	835	10	16	16	15	21	26	369.7	369.5	372.2	372.1	372.3	372.2	372.3	372.2	372.7	372.6	373.0	372.9
BDGH062A	80065	80064	Natural	205	10	67	71	81	96	111	370.6	370.2	373.7	373.6	373.8	373.7	374.0	373.8	374.3	374.1	374.6	374.4
BDGH062B	81005	80065	Natural	597	10	68	71	82	97	112	371.9	370.6	374.7	373.7	374.8	373.8	375.0	374.0	375.3	374.3	375.6	374.6
BDGH062C	70559	81005	Natural	58	10	68	72	82	97	112	371.5	371.9	374.8	374.7	374.9	374.8	375.1	375.0	375.4	375.3	375.7	375.6
BDGH066	70560	70559	24" CSP	117	10	2	2	3	4	3	371.7	371.4	374.9	374.8	375.0	374.9	375.1	375.1	375.4	375.4	375.7	375.7

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
BDGH066rd	70560	70559	Roadway	117		0	3	2	4	5	375.0	373.0	374.8	374.8	375.0	374.9	375.1	375.1	375.4	375.4	375.7	375.7
BDGH075A	81007	70559	Natural	545	10	64	67	80	92	106	371.2	371.5	375.2	374.8	375.3	374.9	375.5	375.1	375.9	375.4	376.2	375.7
BDGH075B	70538	81007	Natural	55	10	64	67	82	94	108	370.1	371.2	375.2	375.2	375.3	375.3	375.5	375.5	375.9	375.9	376.2	376.2
BDGH068	70539	70538	24" CSP	67	10	6	5	9	11	13	370.3	370.1	375.2	375.2	375.3	375.3	375.6	375.5	376.0	375.9	376.3	376.2
BDGH068rd	70539	70538	Roadway	67		0	0	0	0	0	377.5	375.0	375.2	375.2	375.3	375.3	375.5	375.5	375.9	375.9	376.2	376.2
BDGH070	59949	68192	27" CSP	335	10	4	4	6	9	11	373.1	372.9	375.3	375.2	375.4	375.3	375.7	375.6	376.1	375.9	376.5	376.3
BDGH070rd	59949	68192	Roadway	335		0	0	0	0	0	379.0	377.8	375.2	375.2	375.3	375.3	375.6	375.6	375.9	375.9	376.3	376.3
BDGH075C	81009	70538	Natural	173	10	60	62	75	87	100	371.1	370.1	375.2	375.2	375.3	375.3	375.5	375.5	375.9	375.9	376.2	376.2
BDGH075D	81010	81009	Natural	22	10	60	63	76	88	101	371.2	371.1	375.2	375.2	375.3	375.3	375.5	375.5	375.9	375.9	376.2	376.2
BDGH075E	80039	81010	Natural	35	10	60	63	76	90	103	370.9	371.2	375.2	375.2	375.3	375.3	375.5	375.5	375.9	375.9	376.2	376.2
BDGH075F1	68192	80039	54" CSP	57	10	20	21	24	29	33	371.2	370.9	375.2	375.2	375.3	375.3	375.6	375.5	375.9	375.9	376.3	376.2
BDGH075F2	68192	80039	48" CSP	57	10	15	16	19	23	25	371.2	371.1	375.2	375.2	375.3	375.3	375.6	375.5	375.9	375.9	376.3	376.2
BDGH075F3	68192	80039	54" CSP	57	10	18	19	23	27	32	371.2	371.2	375.2	375.2	375.3	375.3	375.6	375.5	375.9	375.9	376.3	376.2
BDGH075G	80069	68192	4' x 8' Concrete Box Culvert	549	10	50	52	62	73	83	371.8	371.2	375.3	375.2	375.4	375.3	375.7	375.6	376.1	375.9	376.5	376.3
BDGH075Grd	80069	68192	Roadway	549	10	0	0	0	0	0	378.2	378.1	375.2	375.2	375.3	375.3	375.6	375.6	375.9	375.9	376.3	376.3
BDGH080B	70177	70170	42" CSP	520	10	8	7	11	18	21	372.5	372.0	375.2	375.2	375.3	375.3	375.6	375.6	376.0	375.9	376.4	376.3
BDGH080Brd	70177	70170	Roadway	520		0	0	0	0	0	379.0	377.9	375.2	375.2	375.3	375.3	375.6	375.6	376.0	376.0	376.4	376.4
BDGH080A	70170	80039	42" CSP	520	10	8	7	11	17	20	372.0	371.5	375.2	375.2	375.3	375.3	375.6	375.5	375.9	375.9	376.3	376.2
BDGH080Ard	70170	80039	Roadway	520		0	0	0	0	0	380.0	378.5	375.2	375.2	375.3	375.3	375.5	375.5	375.9	375.9	376.2	376.2
BDGH090	59945	80069	Rectangle	296	10	42	44	54	61	69	372.2	371.8	375.4	375.3	375.5	375.4	375.8	375.7	376.2	376.1	376.7	376.5
BDGH090rd	59945	80069	Roadway	296		0	0	0	0	0	378.4	378.2	375.3	375.3	375.4	375.4	375.7	375.7	376.1	376.1	376.5	376.5
BDGH100A	60116	59945	Natural	990	10	8	9	13	13	15	373.3	371.6	375.4	375.4	375.5	375.5	375.8	375.8	376.2	376.2	376.7	376.7
BDGH100B	60210	60116	48" CSP Culvert	100	10	10	10	16	22	26	374.3	373.3	375.4	375.4	375.5	375.5	375.9	375.8	376.3	376.2	376.7	376.7
BDGH100Brd	60210	60116	Roadway	100		0	0	0	0	0	379.5	379.0	375.4	375.4	375.5	375.5	375.9	375.9	376.3	376.3	376.7	376.7
BDGH100C	60212	60210	36" CSP	632	10	10	10	16	23	27	375.0	374.3	376.5	375.4	376.5	375.5	377.0	375.9	377.5	376.3	377.8	376.7
BDGH100Crd	60212	60210	Roadway	632		0	0	0	0	0	381.7	379.0	375.4	375.4	375.5	375.5	375.9	375.9	376.3	376.3	376.7	376.7
BDGH110A	60111	59945	Natural	1660	10	20	19	27	34	37	374.0	371.8	375.9	375.4	375.9	375.5	376.2	375.8	376.5	376.2	376.9	376.7
BDGH110B	60196	60111	48" CMP Culvert	44	10	20	19	30	42	49	374.1	374.0	376.1	375.9	376.0	375.9	376.4	376.2	376.7	376.5	377.0	376.9
BDGH110BRD	60196	60111	Roadway	44		0	0	0	0	0	380.2	380.2	375.9	375.9	375.9	375.9	376.2	376.2	376.5	376.5	376.9	376.9
BDGH120A1	80041	80040	48" CMP Culvert	41	10	7	7	8	10	12	370.8	370.8	372.4	372.4	372.5	372.4	372.5	372.4	372.9	372.8	373.2	373.1
BDGH120A2	80041	80040	48" CMP Culvert	41	10	6	7	8	9	11	371.0	370.8	372.4	372.4	372.5	372.4	372.5	372.4	372.9	372.8	373.2	373.1
BDGH120B	80042	80041	Natural	2070	10	12	12	17	20	24	371.7	370.3	373.3	372.4	373.4	372.5	373.6	372.5	373.7	372.9	373.9	373.2
BDGH120C	80043	80042	72" CMP Culvert	24	10	13	13	19	26	30	371.7	371.7	373.4	373.3	373.4	373.4	373.7	373.6	373.8	373.7	374.0	373.9
BDGH120D	61605	80043	Natural	560	10	13	13	20	28	33	375.2	371.7	376.0	373.4	376.0	373.4	376.2	373.7	376.4	373.8	376.5	374.0
BDGH120E	61601	61605	42" CSP	50	10	14	13	20	29	34	373.6	375.2	376.2	376.0	376.2	376.0	376.5	376.2	376.8	376.4	376.9	376.5
BDGH120Erd	61601	61605	Roadway	50		0	0	0	0	0	379.5	378.8	376.2	376.2	376.2	376.2	376.5	376.5	376.8	376.8	376.9	376.9
BDGH130	69068	61601	42" CSP	152	10	14	13	20	29	34	374.1	373.6	376.2	376.2	376.2	376.2	376.5	376.5	376.9	376.8	377.2	376.9
BDGH130rd	69068	61601	Roadway	152		0	0	0	0	0	379.3	378.8	376.2	376.2	376.2	376.2	376.5	376.5	376.8	376.8	376.9	376.9

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
Bethel Danebo - Roosevelt Channel																						
BDRC010A	80046	80045	66" CSP	19	25	170	175	156	200	216	377.5	377.4	382.7	381.8	382.9	382.2	381.9	380.7	383.4	382.4	384.0	382.9
BDRC010Ard	80046	80045	Roadway	19		0	0	0	0	0	388.0	384.0	382.7	382.7	382.9	382.9	381.9	381.9	383.4	383.4	384.0	384.0
BDRC010B	67117	80046	Natural	450	25	171	176	156	201	216	378.4	377.5	383.1	382.7	383.2	382.9	382.6	381.9	383.7	383.4	384.2	384.0
BDRC010C1	61727	67117	60" CSP	132	50	85	88	78	101	107	378.4	378.5	383.5	383.1	383.7	383.2	383.0	382.6	384.3	383.7	384.8	384.2
BDRC010C2	61727	67117	60" CSP	132	50	86	88	78	101	109	378.7	378.4	383.5	383.1	383.7	383.2	383.0	382.6	384.3	383.7	384.8	384.2
BDRC010Crd	61727	67117	Roadway	132		0	0	0	0	0	388.4	388.4	383.1	383.1	383.2	383.2	382.6	382.6	383.7	383.7	384.2	384.2
BDRC010D	80047	61727	Natural	1360	25	152	158	156	181	193	379.5	378.4	384.2	383.5	384.4	383.7	384.1	383.0	384.9	384.3	385.4	384.8
BDRC020A	61732	80047	36" CSP	110	10	15	14	21	24	28	381.9	380.5	384.3	384.2	384.4	384.4	384.1	384.1	384.9	384.9	385.5	385.4
BDRC020Ard	61732	80047	Roadway	110		0	0	0	0	0	386.8	386.8	384.2	384.2	384.4	384.4	384.1	384.1	384.9	384.9	385.4	385.4
BDRC020B	80049	61732	Natural	520	10	16	15	23	25	30	383.3	381.6	384.6	384.3	384.6	384.4	385.0	384.1	385.1	384.9	385.6	385.5
BDRC020C	61741	80049	Natural	1300	10	16	15	22	26	30	384.7	383.3	386.7	384.6	386.6	384.6	387.0	385.0	387.2	385.1	387.4	385.6
BDRC010E1	80048	80047	6' X 6' Concrete box culvert	49	25	70	73	74	84	89	379.6	379.5	384.3	384.2	384.4	384.4	384.2	384.1	384.9	384.9	385.5	385.4
BDRC010E2	80048	80047	6' X 6' Concrete box culvert	49	25	71	74	75	86	91	379.6	379.5	384.3	384.2	384.4	384.4	384.2	384.1	384.9	384.9	385.5	385.4
BDRC010Erd	80048	80047	Roadway	49		0	0	0	0	0	386.8	386.8	384.2	384.2	384.4	384.4	384.1	384.1	384.9	384.9	385.4	385.4
BDRC010F	67120	80048	Natural	1130	25	143	148	149	171	181	380.0	379.6	384.8	384.3	384.9	384.4	384.7	384.2	385.3	384.9	385.8	385.5
BDRC030A	61743	67120	78" CSP	110	25	144	149	151	173	184	380.2	380.0	385.3	384.8	385.5	384.9	385.3	384.7	386.0	385.3	386.4	385.8
BDRC030Ard	61743	67120	Roadway	110		0	0	0	0	0	389.0	389.0	384.8	384.8	384.9	384.9	384.7	384.7	385.3	385.3	385.8	385.8
BDRC030B	61934	61743	Natural	1500	10	136	140	153	165	174	381.4	380.2	385.8	385.3	385.9	385.5	385.9	385.3	386.3	386.0	386.7	386.4
BDRC030C	61935	61934	48" CSP	105	10	139	141	159	169	176	381.1	381.4	388.4	385.8	388.6	385.9	389.3	385.9	390.3	386.3	391.1	386.7
BDRC030Crd	61935	61934	Roadway	105		0	0	0	0	1	391.0	391.0	385.8	385.8	385.9	385.9	385.9	385.9	386.3	386.3	391.1	391.0
BDRC030D	61959	61935	Natural	800	10	142	143	170	197	230	382.9	381.1	388.5	388.4	388.7	388.6	389.4	389.3	390.4	390.3	391.2	391.1
BDRC040A	61977	61959	Natural	2400	10	119	108	166	181	210	387.2	382.9	390.3	388.5	390.3	388.7	391.1	389.4	391.7	390.4	392.0	391.2
BDRC050B	69260	61977	54" CSP	126	10	41	38	59	69	84	387.5	387.7	390.5	390.3	390.4	390.3	391.2	391.1	391.9	391.7	392.3	392.0
BDRC050Brd	69260	61977	Roadway	126		0	0	0	0	0	397.8	397.5	390.3	390.3	390.3	390.3	391.1	391.1	391.7	391.7	392.0	392.0
BDRC050C	69952	69260	54" CSP	1973	10	41	38	59	71	85	389.4	387.5	392.3	390.5	392.1	390.4	393.3	391.2	394.5	391.9	396.6	392.3
BDRC050Crd	69952	69260	Roadway	1973		0	0	0	0	0	399.8	397.8	390.5	390.5	390.4	390.4	391.2	391.2	391.9	391.9	392.3	392.3
BDRC050A	66603	61977	60" CSP	1520	10	58	54	81	90	105	388.6	387.2	392.0	390.3	391.8	390.3	392.9	391.1	393.7	391.7	394.5	392.0
BDRC050Ard	66603	61977	Roadway	1520		0	0	0	0	0	400.3	397.5	390.3	390.3	390.3	390.3	391.1	391.1	391.7	391.7	392.0	392.0
BDRC060A	62329	66603	48" CSP	1336	10	48	44	66	74	82	393.1	388.6	395.1	392.0	395.0	391.8	396.2	392.9	397.8	393.7	400.6	394.5
BDRC060Ard	62329	66603	Roadway	1336		0	0	0	0	0	402.7	400.3	392.0	392.0	391.8	391.8	392.9	392.9	393.7	393.7	394.5	394.5
BDRC070A	62317	62329	48" CSP	2018	10	34	31	48	56	61	396.1	393.1	398.7	395.1	398.6	395.0	399.3	396.2	400.7	397.8	403.0	400.6
BDRC070Ard	62317	62329	Roadway	2018		0	0	0	0	0	402.9	402.7	395.1	395.1	395.0	395.0	396.2	396.2	397.8	397.8	403.0	402.7

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE LAUREL HILL STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Drainage Area (acres)	Design Storm	Peak Flow (cfs) Existing Land Use Conditions				Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)							
													10-Year		25-Year Winter		25-Year Summer		50-Year	
	US	DS					10-Year	25-Year-W	25-Year-S	50-Year	US	DS	US	DS	US	DS	US	DS	US	DS
Laurel Hill - Glenwood																				
LHGL010A	72145	72146	Natural	150	1246	25	117	119	88	128	419.8	415.1	425.1	425.0	425.1	425.0	425.1	425.0	425.1	425.0
LHGL010B	72144	72145	46" CSP culvert	120	1246	25	117	119	88	128	422.8	421.5	427.7	425.1	427.8	425.1	426.6	425.1	428.3	425.1
LHGL010BRD	72144	72145	Roadway	120			0	0	0	0	460.0	458.7	425.1	425.1	425.1	425.1	425.1	425.1	425.1	425.1
LHGL010C	72143	72144	Natural	90	1246	25	117	119	88	128	423.8	422.8	427.7	427.7	427.9	427.8	426.7	426.6	428.5	428.3
LHGL010D1	72142	72143	30" CMP culvert	70	1225	25	34	34	34	34	424.9	424.5	429.2	427.7	429.3	427.9	428.9	426.7	429.4	428.5
LHGL010D2	72142	72143	30" CMP culvert	70	1225	25	33	33	33	33	424.8	424.6	429.2	427.7	429.3	427.9	428.9	426.7	429.4	428.5
LHGL010DRD	72142	72143	Roadway	70			209	232	64	319	428.6	428.2	429.2	428.8	429.3	428.9	428.9	428.5	429.4	429.0
LHGL010E	72597	72598	Natural	150	1246	25	152	171	52	240	424.8	420.8	426.7	425.0	426.8	425.0	425.9	425.0	427.1	425.0
LHGL010F	72143	72597	Natural	340	1246	25	152	171	52	240	425.5	424.8	427.7	426.7	427.9	426.8	426.7	425.9	428.5	427.1
LHGL020A	72596	72142	Natural	110	1225	25	264	285	130	363	426.2	424.3	429.7	429.2	429.8	429.3	429.0	428.9	430.1	429.4
LHGL020B	56526	72596	Natural	70	656	25	160	182	120	250	426.5	426.2	430.4	429.7	430.5	429.8	429.8	429.0	430.9	430.1
LHGL020C	56525	56526	60" CMP culvert	79	656	25	160	182	120	250	427.6	426.8	432.9	430.5	433.5	430.7	431.8	430.0	436.0	431.3
LHGL020CRD	56525	56526	Roadway	79			0	0	0	0	442.9	442.2	430.4	430.4	430.5	430.5	429.8	429.8	430.9	430.9
Laurel Hill - Riverview/Augusta																				
LHRA020A	72139	56525	Natural	350	656	25	160	182	120	252	431.5	427.6	434.7	432.9	434.9	433.5	434.2	431.8	436.3	436.0
LHRA020B	72138	72139	6'x6' CSP culvert	68	616	25	154	174	111	244	432.1	431.5	435.7	434.7	436.1	434.9	435.0	434.2	437.4	436.3
LHRA020BRD	72138	72139	Roadway	68			0	0	0	0	447.6	446.9	434.7	434.7	434.9	434.9	434.2	434.2	436.3	436.3
LHRA020C	56522	72138	Natural	500	616	10	154	174	111	249	435.6	432.1	438.9	435.7	439.0	436.1	438.6	435.0	439.5	437.4
LHRA020D	66993	56522	6'x6' CSP culvert	285	576	25	147	167	99	233	438.1	435.7	440.8	438.9	441.1	439.0	440.0	438.6	442.2	439.5
LHRA020DRD	66993	56522	Roadway	285			0	0	0	0	450.0	447.7	438.9	438.9	439.0	439.0	438.6	438.6	439.5	439.5
LHRA030A	53635	66993	Natural	230	576	10	147	167	98.797	233	442.5	438.1	444.4	440.8	444.5	441.1	444.3	440.0	444.7	442.2
LHRA030B1	75474	53635	7'x4' CSP culverts	75	536	10	74	84	49	114	443.7	442.5	445.2	444.4	445.3	444.5	444.7	444.3	445.8	444.7
LHRA030B2	75474	53635	7'x4' CSP culverts	75	536	10	66	75	42	105	443.8	442.7	445.2	444.4	445.3	444.5	444.7	444.3	445.8	444.7
LHRA030BRD	75474	53635	Roadway	75			0	0	0	0	455.1	453.9	444.4	444.4	444.5	444.5	444.3	444.3	444.7	444.7
LHRA040A	75473	75474	Natural	400	536	10	96	112	55	171	446.2	443.7	450.3	445.2	450.5	445.3	449.6	444.7	451.2	445.8
LHRA040B	53662	75473	Natural	250	480	10	90	105	47	158	447.7	446.2	451.2	450.3	451.4	450.5	450.4	449.6	452.1	451.2
LHRA040C	53649	53662	66" CSP culvert	350	480	10	90	105	47	159	453.1	447.7	454.9	451.2	455.0	451.4	454.3	450.4	455.7	452.1
LHRA040CRD	53649	53662	Roadway	350			0	0	0	0	456.9	451.5	451.2	451.2	451.4	451.4	450.4	450.4	452.1	452.1
LHRA040D	72125	53649	Natural	105	480	10	90	105	47	159	453.8	453.1	456.4	454.9	456.6	455.0	455.8	454.3	457.3	455.7
LHRA040E	72124	72125	72" CMP culvert	40	480	10	90	105	47	159	453.7	453.8	457.2	456.4	457.5	456.6	456.3	455.8	458.5	457.3
LHRA040ERD	72124	72125	Roadway	40			0	0	0	0	460.6	460.6	456.4	456.4	456.6	456.6	455.8	455.8	457.3	457.3
LHRA040F	72123	72124	Natural	310	480	10	90	105	47	159	457.3	454.9	460.2	457.3	460.4	457.5	459.5	456.7	461.1	458.5

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE LAUREL HILL STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Drainage Area (acres)	Design Storm	Peak Flow (cfs) Existing Land Use Conditions				Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)							
													10-Year		25-Year Winter		25-Year Summer		50-Year	
	US	DS					10-Year	25-Year-W	25-Year-S	50-Year	US	DS	US	DS	US	DS	US	DS	US	DS
LHRA040G	72122	72123	60" CMP culvert	30	480	10	90	105	47	159	457.7	457.3	461.2	460.2	461.6	460.4	460.1	459.5	462.7	461.1
LHRA040GRD	72122	72123	Roadway	30			0	0	0	0	463.6	463.2	460.2	460.2	460.4	460.4	459.5	459.5	461.1	461.1
LHRA040H	53655	72122	Natural	110	480	10	90	105	47	159	458.7	457.7	461.5	461.2	461.8	461.6	460.5	460.1	462.9	462.7
LHRA040I	53755	53655	72" CMP	140	480	10	91	105	47	159	460.0	458.7	462.2	461.5	462.4	461.8	461.5	460.5	463.3	462.9
LHRA040J1	75482	53755	36" CSP	95	480	10	36	44	12	80	461.9	460.0	463.3	462.2	463.5	462.4	462.7	461.5	465.0	463.3
LHRA040J2	75482	53755	36" CSP	95	480	10	55	61	36	79	461.0	460.0	463.3	462.2	463.5	462.4	462.7	461.5	465.0	463.3
LHRA050E	75483	75482	36" CSP	388	173	10	55	55	26	81	466.9	461.0	468.8	463.3	468.8	463.5	468.1	462.7	472.5	465.0
LHRA050F	75484	75483	36" CSP	210	173	10	55	55	26	81	469.6	467.0	471.7	469.0	471.7	469.0	470.9	468.2	476.2	472.5
LHRA050G	75485	75484	36" CSP	250	146	10	52	50	19	73	477.6	469.7	479.1	471.7	479.0	471.7	478.5	470.9	480.0	476.2
LHRA070R	75486	75485	36" CSP	253	146	10	52	50	19	73	484.9	477.7	486.4	479.2	486.4	479.1	485.7	478.5	486.7	480.0
LHRA070S	75487	75486	36" CSP	284	107	10	39	37	12	53	492.3	484.9	493.6	486.4	493.5	486.4	493.0	485.7	493.8	486.7
LHRA070T	75488	75487	36" CSP	363	107	10	39	37	12	53	496.9	492.2	498.7	493.6	498.6	493.5	497.8	493.0	499.1	493.8
LHRA070U	53703	75488	36" CSP	92	107	10	39	37	12	53	499.1	496.9	500.4	498.7	500.4	498.6	499.8	497.8	500.7	499.1
LHRA090D	51387	53703	42" CSP	158	107	10	39	37	12	53	500.4	499.3	502.1	501.1	502.1	501.0	501.3	500.2	502.5	501.4
LHRA040K	75475	75474	36" CSP	86	307	10	45	46	36	49	446.3	446.0	449.3	448.2	449.4	448.2	448.8	447.9	449.5	448.2
LHRA040L	75476	75475	36" CSP	212	307	10	45	46	36	49	452.1	446.3	453.5	449.3	453.5	449.4	453.3	448.8	453.6	449.5
LHRA040M	75477	75476	36" CSP	429	307	10	45	46	36	49	453.9	452.3	457.5	454.5	457.6	454.5	456.5	454.3	457.9	454.6
LHRA040N	75478	75477	36" CSP	413	307	10	46	46	36	49	455.4	453.9	460.0	457.5	460.3	457.6	458.0	456.5	460.8	457.9
LHRA040O	75479	75478	36" CSP	120	307	10	46	47	36	50	456.0	455.4	460.7	460.0	461.0	460.3	458.4	458.0	461.6	460.8
LHRA040P	75480	75479	36" CSP	347	307	10	46	47	36	50	459.1	456.0	462.5	460.7	463.0	461.0	460.8	458.4	463.8	461.6
LHRA040Q	75481	75480	36" CSP	150	307	10	46	47	36	51	461.1	459.3	463.3	462.5	463.7	463.0	462.7	460.8	464.8	463.8
LHRA040R	53754	75481	36" CSP	43	307	10	46	46	36	53	461.1	461.2	463.7	463.4	464.0	463.7	463.4	463.1	465.1	464.8
LHRA040S	53754	75482	65" CSP	189	307	10	37	50	22	83	462.3	461.0	463.7	463.3	464.0	463.5	463.4	462.7	465.1	465.0
LHRA050A1	53753	53754	36" CSP	45	307	10	42	48	29	66	461.1	460.9	464.0	463.7	464.3	464.0	463.5	463.4	465.7	465.1
LHRA050A2	53753	53754	36" CSP	45	307	10	42	48	29	66	461.1	460.9	464.0	463.7	464.3	464.0	463.5	463.4	465.7	465.1
LHRA050ARD	53753	53754	Roadway	45			0	0	0	0	466.9	466.9	463.7	463.7	464.0	464.0	463.4	463.4	465.1	465.1
LHRA050B	53752	53753	65" CMP	189	307	10	83	97	57	131	462.3	461.1	465.4	464.0	465.7	464.3	464.8	463.5	466.8	465.7
LHRA050C	66483	53752	48" CSP	667	274	10	78	91	50	124	467.6	462.4	470.0	465.4	470.3	465.7	469.4	464.8	472.4	466.8
LHRA050CRD	66483	53752	Roadway	667			0	0	0	0	479.1	471.9	465.4	465.4	465.7	465.7	464.8	464.8	466.8	466.8
LHRA050D	53777	66483	42" CSP	193	274	10	79	91	50	124	472.2	467.6	474.0	470.0	474.2	470.3	473.6	469.4	476.2	472.4
LHRA050DRD	53777	66483	Roadway	193			0	0	0	0	481.8	479.1	470.0	470.0	470.3	470.3	469.4	469.4	472.4	472.4
LHRA060A	68603	53777	42" CSP	140	221	10	69	80	43	111	474.8	473.0	477.0	475.1	477.2	475.3	476.4	474.6	478.1	476.2
LHRA060ARD	68603	53777	Roadway	140			0	0	0	0	484.0	481.8	474.0	474.0	474.2	474.2	473.6	473.6	476.2	476.2
LHRA070A	53783	68603	42" CSP	160	221	10	54	35	23	56	476.6	474.8	478.5	477.0	478.0	477.2	477.7	476.4	478.7	478.1
LHRA070ARD	53783	68603	Roadway	160			0	0	0	0	484.5	483.0	477.0	477.0	477.2	477.2	476.4	476.4	478.1	478.1
LHRA070B	53704	53783	42" CSP	732	197	10	46	26	18	39	489.2	476.6	490.7	478.5	490.3	478.0	490.1	477.7	490.5	478.7
LHRA070BRD	53704	53783	Roadway	732			0	0	0	0	499.2	484.5	478.5	478.5	478.0	478.0	477.7	477.7	478.7	478.7
LHRA090B	75490	75489	30" CSP	292	159	10	35	12	9	13	496.7	492.6	498.7	494.0	497.7	493.3	497.6	493.2	497.8	493.3
LHRA090A	75489	53704	30" CSP	38	159	10	35	12	9	13	492.6	491.0	494.0	492.2	493.3	491.7	493.2	491.6	493.3	491.7
LHRA090C1	76212	75490	18" CSP	18	159	10	20	6	4	7	498.2	497.3	501.0	498.7	499.0	497.8	498.9	497.7	499.0	497.8
LHRA090C2	76212	75490	18" CSP	18	159	10	16	6	4	6	498.2	497.3	501.0	498.7	499.0	498.0	498.9	497.8	499.0	498.0

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE LAUREL HILL STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Drainage Area (acres)	Design Storm	Peak Flow (cfs) Existing Land Use Conditions				Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)							
													10-Year		25-Year Winter		25-Year Summer		50-Year	
	US	DS					10-Year	25-Year-W	25-Year-S	50-Year	US	DS	US	DS	US	DS	US	DS	US	DS
LHRA070C	53646	68603	42" CSP culvert	50	159	10	24	48	25	70	478.0	474.8	478.7	477.0	479.1	477.2	478.7	476.4	479.7	478.1
LHRA070CRD	53646	68603	Roadway	50			0	0	0	0	485.3	484.0	477.0	477.0	477.2	477.2	476.4	476.4	478.1	478.1
LHRA070D	72119	53646	Natural	160	159	10	24	48	25	70	482.4	478.0	483.7	478.7	484.2	479.1	483.7	478.7	484.4	479.7
LHRA070E	72118	72119	36" CSP culvert	15	159	10	24	48	25	70	483.1	482.9	485.0	484.3	486.1	485.0	485.0	484.3	487.2	485.6
LHRA070ERD	72118	72119	Roadway	15			0	0	0	0	487.9	487.7	483.7	483.7	484.2	484.2	483.7	483.7	484.4	484.4
LHRA070F	72117	72118	Natural	52	159	10	24	48	25	70	484.5	483.1	485.6	485.0	486.1	486.1	485.6	485.0	487.2	487.2
LHRA070G	72116	72117	Bridge	9	159	10	24	48	25	71	484.5	484.5	485.8	485.6	486.4	486.1	485.8	485.6	487.4	487.2
LHRA070GRD	72116	72117	Roadway	9			0	0	0	0	488.3	488.3	485.6	485.6	486.1	486.1	485.6	485.6	487.2	487.2
LHRA070H	72115	72116	Natural	150	159	10	24	48	25	73	485.6	484.5	486.8	485.8	487.0	486.4	486.8	485.8	487.5	487.4
LHRA070I	72114	72115	Bridge	12	159	10	24	48	25	73	485.9	485.6	486.9	486.8	487.3	487.0	486.9	486.8	487.8	487.5
LHRA070IRD	72114	72115	Roadway	12			0	0	0	0	491.6	491.4	486.8	486.8	487.0	487.0	486.8	486.8	487.5	487.5
LHRA070J	72113	72114	Natural	65	159	10	24	48	25	73	486.0	485.9	487.9	486.9	488.5	487.3	487.9	486.9	489.0	487.8
LHRA070K	72112	72113	42" CSP culvert	17	159	10	24	48	25	73	486.6	486.0	488.2	487.9	489.2	488.5	488.2	487.9	490.1	489.0
LHRA070KRD	72112	72113	Roadway	17			0	0	0	0	490.3	489.8	487.9	487.9	488.5	488.5	487.9	487.9	489.0	489.0
LHRA070L	72111	72112	Natural	60	159	10	24	48	25	74	487.1	486.6	489.6	488.2	490.6	489.2	489.6	488.2	491.2	490.1
LHRA070M	72110	72111	5'x3.5' CSP culvert	20	159	10	24	48	25	74	487.4	487.1	489.7	489.6	490.7	490.6	489.7	489.6	491.4	491.2
LHRA070MRD	72110	72111	Roadway	20			0	0	0	0	491.7	491.4	489.6	489.6	490.6	490.6	489.6	489.6	491.2	491.2
LHRA070N	72109	72110	Natural	177	159	10	26	49	26	74	489.7	487.4	490.6	489.7	491.1	490.7	490.6	489.7	492.0	491.4
LHRA070O	72108	72109	3'x2.7' CSP culvert	20	159	10	26	49	26	75	489.4	489.7	491.4	490.6	492.3	491.1	491.4	490.6	493.7	492.0
LHRA070ORD	72108	72109	Roadway	20			0	0	0	0	493.8	493.8	490.6	490.6	491.1	491.1	490.6	490.6	492.0	492.0
LHRA070P	72107	72108	Natural	66	159	10	26	49	26	76	491.1	489.4	492.4	491.4	492.8	492.3	492.4	491.4	493.8	493.7
LHRA070Q	72106	72107	36" CSP	32	159	10	26	49	26	78	492.3	491.1	493.7	492.4	494.5	492.8	493.7	492.4	495.9	493.8
LHRA070QRD	72106	72107	Roadway	32			0	0	0	0	495.9	494.7	492.4	492.4	492.8	492.8	492.4	492.4	493.8	493.8
LHRA100A	72105	72106	Natural	100	159	10	27	49	26	83	493.3	492.3	494.4	493.7	494.8	494.5	494.3	493.7	495.9	495.9
LHRA100B	72104	72105	36" CSP	118	159	10	27	49	26	59	496.6	493.7	498.3	495.2	499.2	495.9	498.2	495.1	500.3	496.2
LHRA100BRD	72104	72105	Roadway	118			0	0	0	28	500.1	497.2	494.4	494.4	494.8	494.8	494.3	494.3	500.3	497.3
LHRA100C	51409	72104	Natural	56	159	10	28	49	26	87	498.5	496.6	500.3	498.3	501.0	499.2	500.3	498.2	501.8	500.3
LHRA100D	99796	51409	30" CSP culvert	31	159	10	29	50	26	56	498.8	498.5	501.0	500.3	502.3	501.0	500.8	500.3	503.0	501.8
LHRA100DRD	99796	51409	Roadway	31			0	0	0	41	502.8	502.4	500.3	500.3	501.0	501.0	500.3	500.3	503.0	502.6

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Existing Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
Willakenzie North - Delta Highway																						
WKDH010A	72606	72603	Natural	880	25	281	305	283	325	362	375.4	376.1	383.5	383.4	383.5	383.4	383.5	383.4	383.5	383.4	383.5	383.4
WKDH010G	72605	72606	Natural	1080	25	13	14	22	35	40	377.8	374.8	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5
WKDH010H	72604	72605	Natural	10	25	13	14	22	36	40	377.9	377.8	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5
WKDH010I	67019	72604	Natural	80	25	13	14	22	36	40	378.8	377.9	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5
WKDH010J	58450	67019	72" CSP	85	25	13	14	22	36	40	377.3	377.0	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5
WKDH010JRD	58450	67019	Roadway	85		0	0	0	0	0	389.0	389.0	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5
WKDH010B	72602	72606	Natural	10	25	276	297	281	319	356	375.5	375.4	383.6	383.5	383.6	383.5	383.6	383.5	383.6	383.5	383.7	383.5
WKDH010C	72601	72602	Natural	410	25	276	297	281	319	356	376.2	375.5	383.6	383.6	383.7	383.6	383.6	383.6	383.7	383.6	383.8	383.7
WKDH010D	72600	72601	Natural	10	25	276	297	281	319	356	376.2	376.2	383.8	383.6	383.9	383.7	383.9	383.6	384.0	383.7	384.1	383.8
WKDH010E	58446	72600	Natural	230	25	276	297	281	319	356	377.0	376.2	383.8	383.8	383.9	383.9	383.9	383.9	384.0	384.0	384.1	384.1
WKDH010F1	58447	58446	84"CMP	83	50	138	148	140	160	178	377.3	377.0	384.1	383.8	384.2	383.9	384.1	383.9	384.3	384.0	384.5	384.1
WKDH010F2	58447	58446	84"CMP	83	50	138	148	140	160	178	377.3	377.0	384.1	383.8	384.2	383.9	384.1	383.9	384.3	384.0	384.5	384.1
WKDH010FRD	58447	58446	Roadway	83		0	0	0	0	0	390.5	390.5	383.8	383.8	383.9	383.9	383.9	383.9	384.0	384.0	384.1	384.1
WKDH020A	58442	58447	Natural	2500	25	285	304	303	338	373	378.1	377.3	384.1	384.1	384.2	384.2	384.1	384.1	384.3	384.3	384.5	384.5
Willakenzie North - North Beltline																						
WKNB010D	59792	58442	Natural	1000	25	24	25	40	63	72	381.6	378.1	384.1	384.1	384.2	384.2	384.1	384.1	384.3	384.3	384.5	384.5
WKNB010E	59799	59792	48" CMP	365	25	24	26	40	66	74	382.6	381.6	384.8	384.1	384.9	384.2	385.8	384.1	388.0	384.3	388.8	384.5
WKNB010ERD	59799	59792	Roadway	365		0	0	0	0	0	399.0	398.0	384.1	384.1	384.2	384.2	384.1	384.1	384.3	384.3	384.5	384.5
WKNB010A1	58441	58442	72" CMP	83	25	142	152	166	179	196	395.7	395.6	399.7	398.8	399.9	399.0	400.1	399.1	400.3	399.2	400.5	399.4
WKNB010A2	58441	58442	72" CMP	83	25	142	152	166	179	196	395.7	395.6	399.7	398.8	399.9	399.0	400.1	399.1	400.3	399.2	400.5	399.4
WKNB010ARD	58441	58442	Roadway	83		0	0	0	0	0	407.0	405.0	384.1	384.1	384.2	384.2	384.1	384.1	384.3	384.3	384.5	384.5
WKNB010B	58371	58441	Natural	2250	25	284	305	333	358	393	396.4	393.8	402.8	399.7	403.0	399.9	403.2	400.1	403.5	400.3	403.7	400.5
WKNB010C1	59755	58371	72" CMP	329	25	142	153	167	180	197	397.9	396.4	404.1	402.8	404.5	403.0	405.1	403.2	405.7	403.5	406.5	403.7
WKNB010C2	59755	58371	72" CMP	329	25	142	153	167	180	197	397.9	396.4	404.1	402.8	404.5	403.0	405.1	403.2	405.7	403.5	406.5	403.7
WKNB010CRD	59755	58371	Roadway	329		0	0	0	0	0	410.0	409.0	402.8	402.8	403.0	403.0	403.2	403.2	403.5	403.5	403.7	403.7
WKNB020A	59766	59755	Natural	1220	25	272	293	322	352	382	399.5	397.9	405.2	404.1	405.5	404.5	405.9	405.1	406.4	405.7	407.1	406.5
WKNB020B1	59753	59766	72" CSP	85	25	136	147	163	179	195	399.6	399.4	405.6	405.2	406.0	405.5	406.5	405.9	407.0	406.4	407.9	407.1
WKNB020B2	59753	59766	72" CSP	85	25	136	147	163	179	195	399.6	399.4	405.6	405.2	406.0	405.5	406.5	405.9	407.0	406.4	407.9	407.1
WKNB020BRD	59753	59766	Roadway	85		0	0	0	0	0	412.1	411.0	405.2	405.2	405.5	405.5	405.9	405.9	406.4	406.4	407.1	407.1
WKNB020C	59778	59753	Natural	530	25	273	295	328.483	363	395	400.0	399.4	406.3	405.6	406.6	406.0	407.1	406.5	407.6	407.0	408.3	407.9
WKNB020D1	69005	59778	72" CMP	85	25	136	148	165	183	200	401.1	400.9	406.9	406.3	407.4	406.6	407.9	407.1	408.5	407.6	409.5	408.3
WKNB020D2	69005	59778	72" CMP	85	25	136	148	165	183	200	401.1	400.9	406.9	406.3	407.4	406.6	407.9	407.1	408.5	407.6	409.5	408.3
WKNB020DRD	69005	59778	Roadway	85		0	0	0	0	0	412.1	412.1	406.3	406.3	406.6	406.6	407.1	407.1	407.6	407.6	408.3	408.3
WKNB030A	59774	69005	Natural	1350	25	261	283	325	364	404	403.0	400.6	408.5	406.9	408.8	407.4	409.3	407.9	409.8	408.5	410.5	409.5
WKNB040A1	59772	59774	30"CMP	89	25	13	13	20	30	35	409.2	409.1	411.2	410.3	411.2	410.3	411.9	410.6	413.1	411.0	413.8	411.1
WKNB040A2	59772	59774	30"CMP	89	25	13	13	20	30	35	409.2	409.1	411.2	410.3	411.2	410.3	411.9	410.6	413.1	411.0	413.8	411.1
WKNB040ARD	59772	59774	Roadway	89		0	0	0	0	0	416.0	416.0	408.5	408.5	408.8	408.8	409.3	409.3	409.8	409.8	410.5	410.5
WKNB030B	59425	59774	Natural	1300	25	240	261	313	352	397	405.7	403.0	410.0	408.5	410.2	408.8	410.6	409.3	411.0	409.8	411.4	410.5
WKNB030C1	59426	59425	72" CSP	603	25	121	131	158	179	202	407.1	406.0	411.3	410.0	411.6	410.2	412.2	410.6	412.8	411.0	413.6	411.4
WKNB030C2	59426	59425	72" CSP	603	25	121	131	158	179	202	407.1	406.0	411.3	410.0	411.6	410.2	412.2	410.6	412.8	411.0	413.6	411.4
WKNB030CRD	59426	59425	Roadway	603		0	0	0	0	0	417.7	416.0	410.0	410.0	410.2	410.2	410.6	410.6	411.0	411.0	411.4	411.4
WKNB060A	67893	59426	66" CSP	340	25	82	89	105	121	131	407.6	407.1	411.6	411.3	411.9	411.6	412.5	412.2	413.2	412.8	414.0	413.6

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Existing Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WKNB060ARD	59426	67893	Roadway	340		0	0	0	0	0	417.7	417.4	411.6	411.6	411.9	411.9	412.5	412.5	413.2	413.2	414.0	414.0
WKNB060B	59519	67893	66" CSP	1043	10	83	90	107	123	132	407.7	407.6	412.7	411.6	413.0	411.9	413.9	412.5	414.6	413.2	415.5	414.0
WKNB060BRD	59519	67893	Roadway	1043		0	0	0	0	0	417.9	417.4	411.6	411.6	411.9	411.9	412.5	412.5	413.2	413.2	414.0	414.0
WKNB050A	59518	59519	42" CSP	105	10	25	27	33	24	23	410.9	408.0	412.9	412.7	413.1	413.0	413.9	413.9	414.6	414.6	415.5	415.5
WKNB050ARD	59518	59519	Roadway	105		0	0	0	0	0	418.3	417.9	412.7	412.7	413.0	413.0	413.9	413.9	414.6	414.6	415.5	415.5
WKNB050B	59546	59518	36" CSP	436	10	7	8	13	14	12	412.2	410.9	413.2	412.9	413.2	413.1	414.0	413.9	414.8	414.6	415.7	415.5
WKNB050BRD	59518	59546	Roadway	436		0	0	0	0	0	418.3	418.0	413.2	413.2	413.2	413.2	414.0	414.0	414.8	414.8	415.7	415.7
WKNB050C	59495	59546	42" CSP	656	10	7	7	12	15	14	413.5	412.6	414.6	413.4	414.7	413.4	415.0	414.0	415.2	414.8	415.8	415.7
WKNB050CRD	59495	59546	Roadway	656		0	0	0	0	0	420.0	418.0	413.2	413.2	413.2	413.2	414.0	414.0	414.8	414.8	415.7	415.7
WKNB050D	59545	59495	36" CSP	34	10	7	7	11	15	15	413.6	413.5	414.7	414.6	414.7	414.7	415.0	415.0	415.2	415.2	415.8	415.8
WKNB050DRD	59495	59545	Roadway	34		0	0	0	0	0	420.0	419.6	414.7	414.7	414.7	414.7	415.0	415.0	415.2	415.2	415.8	415.8
WKNB050E	67912	59545	3' X 5' Conc. Box	148	10	7	7	11	15	16	414.0	413.6	414.7	414.7	414.8	414.7	415.1	415.0	415.2	415.2	415.8	415.8
WKNB050ERD	67912	59545	Roadway	148		0	0	0	0	0	419.6	419.6	414.7	414.7	414.7	414.7	415.0	415.0	415.2	415.2	415.8	415.8
WKNB050F	68227	67912	3' X 5' Conc. Box	920	10	7	7	11	16	18	415.2	414.0	415.8	414.7	415.8	414.8	416.0	415.1	416.2	415.2	416.3	415.8
WKNB050FRD	68227	67912	Roadway	920		0	0	0	0	0	420.7	419.6	414.7	414.7	414.8	414.8	415.1	415.1	415.2	415.2	415.8	415.8
WKNB050G	69048	68227	42" CSP	169	10	7	7	11	16	19	418.5	415.2	419.0	415.8	419.1	415.8	419.2	416.0	419.3	416.2	419.4	416.3
WKNB050GRD	69048	68227	Roadway	169		0	0	0	0	0	421.0	420.7	415.8	415.8	415.8	415.8	416.0	416.0	416.2	416.2	416.3	416.3
WKNB050H	61213	59519	54" CSP	2545	10	59	64	70	80	84	412.4	407.7	415.6	412.7	416.2	413.0	417.7	413.9	420.2	414.6	420.8	415.5
WKNB050HRD	61213	59519	Roadway	2545		0	0	0	0	0	422.1	417.9	412.7	412.7	413.0	413.0	413.9	413.9	414.6	414.6	415.5	415.5
WKNB140A	61212	61213	54" CSP	701	10	44	48	53	55	58	413.2	412.5	416.3	415.6	416.8	416.2	418.2	417.7	420.7	420.2	421.3	420.8
WKNB140ARD	61212	61213	Roadway	701		0	0	0	0	0	424.0	422.1	415.6	415.6	416.2	416.2	417.7	417.7	420.2	420.2	420.8	420.8
WKNB140B	66590	61212	42" CSP	591	10	44	48	52	54	57	413.9	413.2	417.7	416.3	418.4	416.8	419.8	418.2	422.2	420.7	422.4	421.3
WKNB140BRD	61212	66590	Roadway	591		0	0	0	0	0	424.0	422.4	417.7	417.7	418.4	418.4	419.8	419.8	422.2	422.2	422.4	422.4
WKNB150A	61030	66590	42" CSP	532	10	34	37	44	45	49	418.5	413.9	420.0	417.7	420.1	418.4	420.8	419.8	421.3	422.2	421.8	422.4
WKNB150ARD	61030	66590	Roadway	532		0	0	0	0	0	427.0	422.4	417.7	417.7	418.4	418.4	419.8	419.8	422.2	422.2	422.4	422.4
WKNB150B	71108	61030	Natural	250	10	34	37	42	44	47	418.3	418.5	420.5	420.0	420.6	420.1	421.0	420.8	421.4	421.3	421.9	421.8
WKNB150C	71109	71108	Natural	620	10	34	36	40	41	44	418.2	418.3	421.4	420.5	421.6	420.6	421.9	421.0	422.1	421.4	422.5	421.9
WKNB150D	61085	71109	Natural	350	10	34	37	40	40	40	418.3	418.2	421.5	421.4	421.7	421.6	422.0	421.9	422.2	422.1	422.6	422.5
WKNB150E	61086	61085	42" CSP	68	10	34	37	41	41	43	418.4	418.3	421.8	421.5	422.0	421.7	422.4	422.0	422.5	422.2	422.9	422.6
WKNB150ERD	61085	61086	Roadway	68		0	0	0	0	0	423.3	422.7	421.8	421.8	422.0	422.0	422.4	422.4	422.5	422.5	422.9	422.9
WKNB190A	61087	61086	Natural	620	10	25	27	33	34	37	419.0	418.4	421.9	421.8	422.2	422.0	422.6	422.4	422.8	422.5	423.2	422.9
WKNB190B	61049	61087	Natural	340	10	27	29	44	52	57	420.7	419.0	422.1	421.9	422.3	422.2	422.7	422.6	422.9	422.8	423.3	423.2
WKNB190C1	67095	61049	48" CSP	42	10	14	15	22	27	30	420.9	420.7	422.3	422.1	422.5	422.3	422.8	422.7	423.0	422.9	423.4	423.3
WKNB190C2	67095	61049	48" CSP	42	10	14	15	22	27	30	420.9	420.7	422.3	422.1	422.5	422.3	422.8	422.7	423.0	422.9	423.4	423.3
WKNB190CRD	67095	61049	Roadway	42		0	0	0	0	0	426.0	426.0	422.1	422.1	422.3	422.3	422.7	422.7	422.9	422.9	423.3	423.3
WKNB190D	62684	67095	Natural	400	10	28	29	45	55	61	421.5	420.9	423.6	422.3	423.6	422.5	424.1	422.8	424.3	423.0	424.5	423.4
WKNB190E1	62685	62684	48" CSP	75	10	9	10	15	18	21	421.6	421.5	423.6	423.6	423.6	423.6	424.1	424.1	424.4	424.3	424.5	424.5
WKNB190E2	62685	62684	48" CSP	75	10	9	10	15	18	21	421.6	421.5	423.6	423.6	423.6	423.6	424.1	424.1	424.4	424.3	424.5	424.5
WKNB190E3	62685	62684	48" CSP	75	10	9	10	15	18	21	421.6	421.5	423.6	423.6	423.6	423.6	424.1	424.1	424.4	424.3	424.5	424.5
WKNB190ERD	62685	62684	Roadway	75		0	0	0	0	0	429.0	428.0	423.6	423.6	423.6	423.6	424.1	424.1	424.3	424.3	424.5	424.5
WKNB190F	62688	62685	Natural	470	10	28	30	46	60	63	422.3	421.6	424.1	423.6	424.2	423.6	424.6	424.1	424.9	424.4	425.0	424.5

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Existing Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WKNB190G1	62712	62688	60" CMP	100	10	14	15	23	31	32	422.4	422.3	424.3	424.1	424.3	424.2	424.8	424.6	425.2	424.9	425.3	425.0
WKNB190G2	62712	62688	60" CMP	100	10	14	15	23	31	32	422.4	422.3	424.3	424.1	424.3	424.2	424.8	424.6	425.2	424.9	425.3	425.0
WKNB190GRD	62712	62688	Roadway	100		0	0	0	0	0	429.0	429.0	424.1	424.1	424.2	424.2	424.6	424.6	424.9	424.9	425.0	425.0
WKNB190H	62750	62712	36" CSP	262	10	28	30	47	63	65	422.8	422.4	425.2	424.3	425.3	424.3	426.5	424.8	427.9	425.2	428.1	425.3
WKNB190HRD	62712	62750	Roadway	262		0	0	0	0	0	429.0	427.9	425.2	425.2	425.3	425.3	426.5	426.5	427.9	427.9	428.1	428.1
WKNB060C	59428	59426	Natural	580	25	144	154	197	232	269	408.8	407.5	413.5	411.3	413.7	411.6	414.2	412.2	414.6	412.8	415.0	413.6
WKNB060D	59401	59428	Natural	1100	25	144	155	199	234	273	410.2	408.8	415.2	413.5	415.4	413.7	416.0	414.2	416.4	414.6	416.9	415.0
WKNB070A	59497	59401	54" CSP	880	10	17	14	8	14	20	411.7	410.6	415.2	415.2	415.4	415.4	416.0	416.0	416.5	416.4	417.0	416.9
WKNB070ARD	59497	59401	Roadway	880		0	0	0	0	0	418.2	417.1	415.2	415.2	415.4	415.4	416.0	416.0	416.4	416.4	416.9	416.9
WKNB060E	59385	59401	Natural	900	25	135	145	198	230	263	411.3	410.2	416.4	415.2	416.6	415.4	417.3	416.0	417.8	416.4	418.2	416.9
WKNB110A	59476	59385	72" CSP	120	25	43	46	64	73	84	410.3	409.9	416.4	416.4	416.6	416.6	417.4	417.3	417.8	417.8	418.3	418.2
WKNB110ARD	59476	59385	Roadway	120		0	0	0	0	0	421.3	420.4	416.4	416.4	416.6	416.6	417.3	417.3	417.8	417.8	418.2	418.2
WKNB110B	59420	59476	72" CSP	110	10	37	40	57	63	72	411.4	410.3	416.4	416.4	416.6	416.6	417.4	417.4	417.9	417.8	418.4	418.3
WKNB110BRD	59476	59420	Roadway	110		0	0	0	0	0	421.3	418.5	416.4	416.4	416.6	416.6	417.4	417.4	417.9	417.9	418.4	418.4
WKNB110C	61133	59420	72" CSP	1337	10	38	40	57	64	73	413.0	411.2	416.6	416.4	416.8	416.6	417.7	417.4	418.2	417.9	418.8	418.4
WKNB110CRD	61133	59420	Roadway	1337		0	0	0	0	0	423.8	418.5	416.4	416.4	416.6	416.6	417.4	417.4	417.9	417.9	418.4	418.4
WKNB120A	60890	61133	66" CSP	130	10	32	34	49	56	62	413.5	413.0	416.6	416.6	416.8	416.8	417.8	417.7	418.3	418.2	418.9	418.8
WKNB120ARD	60890	61133	Roadway	130		0	0	0	0	0	424.0	423.8	416.6	416.6	416.8	416.8	417.7	417.7	418.2	418.2	418.8	418.8
WKNB120B	99575	60890	66" CMP	1458	10	33	35	50	58	64	414.3	413.5	417.7	416.6	417.8	416.8	418.9	417.8	419.6	418.3	420.6	418.9
WKNB120BRD	99575	60890	Roadway	1458		0	0	0	0	0	425.6	424.0	416.6	416.6	416.8	416.8	417.8	417.8	418.3	418.3	418.9	418.9
WKNB160A	61199	99575	60" CSP	1201	10	25	27	39	46	50	415.4	414.3	418.0	417.7	418.2	417.8	419.3	418.9	420.0	419.6	421.1	420.6
WKNB160ARD	61199	99575	Roadway	1201		0	0	0	0	0	426.4	425.6	417.7	417.7	417.8	417.8	418.9	418.9	419.6	419.6	420.6	420.6
WKNB180A	61183	61199	48" CSP	1214	10	16	17	25	31	32	418.1	416.4	419.6	418.0	419.7	418.2	420.2	419.3	420.6	420.0	421.7	421.1
WKNB180Ard	61183	61199	Roadway	1214		0	0	0	0	0	427.9	426.4	418.0	418.0	418.2	418.2	419.3	419.3	420.0	420.0	421.1	421.1
WKNB180B	61235	61183	42" CSP	480	10	16	17	26	34	38	419.6	418.1	420.9	419.6	421.0	419.7	421.4	420.2	421.8	420.6	422.2	421.7
WKNB180Brd	61183	61235	Roadway	480		0	0	0	0	0	427.9	426.8	420.9	420.9	421.0	421.0	421.4	421.4	421.8	421.8	422.2	422.2
WKNB100A	66880	67043	72" CSP	130	25	33	34	54	78	99	410.8	410.5	416.7	416.7	416.9	416.8	417.6	417.6	418.1	418.1	418.6	418.5
WKNB100ARD	67043	66880	Roadway	130		0	0	0	0	0	420.9	420.0	416.7	416.7	416.9	416.9	417.6	417.6	418.1	418.1	418.6	418.6
WKNB100B	59462	66880	60" CSP	47	10	33	34	54	78	99	411.4	410.8	416.7	416.7	416.9	416.9	417.7	417.6	418.1	418.1	418.6	418.6
WKNB100BRD	59462	66880	Roadway	47		0	0	0	0	0	422.5	420.0	416.7	416.7	416.9	416.9	417.6	417.6	418.1	418.1	418.6	418.6
WKNB100C	59421	59462	66" CSP	30	10	24	25	40	56	70	412.5	412.3	416.7	416.7	416.9	416.9	417.7	417.7	418.1	418.1	418.6	418.6
WKNB100CRD	59462	59421	Roadway	30		0	0	0	0	0	422.5	421.0	416.7	416.7	416.9	416.9	417.7	417.7	418.1	418.1	418.6	418.6
WKNB100D	61140	59421	60" CSP	905	10	24	26	41	58	71	413.8	412.5	416.8	416.7	417.0	416.9	417.9	417.7	418.4	418.1	419.0	418.6
WKNB100DRD	61140	59421	Roadway	905		0	0	0	0	0	422.8	421.0	416.7	416.7	416.9	416.9	417.7	417.7	418.1	418.1	418.6	418.6
WKNB090A	61142	61140	48" CSP	1037	10	17	18	29	40	48	414.6	413.7	417.1	416.8	417.3	417.0	418.4	417.9	419.2	418.4	420.6	419.0
WKNB090ARD	61142	61140	Roadway	1037		0	0	0	0	0	424.8	422.8	416.8	416.8	417.0	417.0	417.9	417.9	418.4	418.4	419.0	419.0
WKNB110D	67043	59385	Natural	400	25	93	99	139	164	187	411.8	411.3	416.7	416.4	416.8	416.6	417.6	417.3	418.1	417.8	418.5	418.2
WKNB100E	71240	67043	Natural	1930	25	65	66	101	131	150	415.9	411.8	418.2	416.7	418.2	416.8	418.8	417.6	419.2	418.1	419.5	418.5
WKNB100F	71239	71240	Natural	150	25	66	66	103	149	173	421.2	415.9	423.6	418.2	423.6	418.2	424.0	418.8	424.5	419.2	424.7	419.5
Willakenzie North - Gilham Road																						
WKGL010A	71280	71279	Natural	1200	10	55	59	83	84	93	389.2	379.5	391.2	385.6	391.3	385.6	391.7	385.6	391.7	385.7	391.8	385.7
WKGL010B	71281	71280	48" CMP	30	10	53	56	79	81	89	389.3	389.2	392.2	391.2	392.3	391.3	393.0	391.7	393.0	391.7	393.3	391.8
WKGL010BRD	71281	71280	Roadway	30		0	0	0	0	0	395.4	395.4	391.2	391.2	391.3	391.3	391.7	391.7	391.7	391.7	391.8	391.8

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Existing Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WKGL020A	71282	71281	Natural	920	10	43	45	65	70	74	392.7	389.3	395.2	392.2	395.3	392.3	395.9	393.0	396.1	393.0	396.7	393.3
WKGL020B	73036	71282	Natural	1280	10	43	45	67	75	84	394.3	392.7	397.5	395.2	397.6	395.3	398.2	395.9	398.4	396.1	398.6	396.7
WKGL020C	70865	73036	48" CSP	15	10	43	45	68	76	85	385.1	394.3	397.7	397.5	397.7	397.6	398.5	398.2	398.7	398.4	398.9	398.6
WKGL020D	70862	70865	72" CSP	1015	10	43	45	68	76	85	387.2	385.1	397.8	397.7	397.9	397.7	398.8	398.5	399.1	398.7	399.5	398.9
WKGL030A	58511	70862	42" CSP	610	10	10	10	16	26	30	392.1	390.4	397.9	397.8	398.0	397.9	399.0	398.8	399.4	399.1	399.9	399.5
WKGL030ARD	70862	58511	Roadway	610		0	0	0	0	0	404.2	403.3	397.9	397.9	398.0	398.0	399.0	399.0	399.4	399.4	399.9	399.9
WKGL030G	58499	70862	54" CMP	562	10	7	7	11	18	21	388.3	387.2	397.8	397.8	397.9	397.9	398.9	398.8	399.2	399.1	399.6	399.5
WKGL030GRD	58499	70862	Roadway	562		0	0	0	0	0	406.2	404.2	397.8	397.8	397.9	397.9	398.8	398.8	399.1	399.1	399.5	399.5
WKGL030B	58454	70862	42" CSP	70	10	28	29	45	53	60	396.3	390.4	397.7	397.8	397.8	397.9	399.1	398.8	399.7	399.1	400.3	399.5
WKGL030BRD	58454	70862	Roadway	70		0	0	0	0	0	410.2	404.2	397.8	397.8	397.9	397.9	398.8	398.8	399.1	399.1	399.5	399.5
WKGL030C	70121	58454	Natural	1650	10	21	22	33	45	52	399.0	396.4	400.9	397.7	400.9	397.8	401.1	399.1	401.4	399.7	401.6	400.3
WKGL030D	70120	70121	48" CSP	85	10	21	21	34	51	59	399.1	399.0	401.1	400.9	401.2	400.9	401.6	401.1	402.1	401.4	402.4	401.6
WKGL030DRD	70120	70121	Roadway	85		0	0	0	0	0	406.0	406.0	400.9	400.9	400.9	400.9	401.1	401.1	401.4	401.4	401.6	401.6
WKGL030E	71289	70120	Natural	400	10	21	21	34	52	60	400.6	399.5	402.2	401.1	402.2	401.2	402.6	401.6	403.0	402.1	403.1	402.4
WKGL030F	58463	71289	Natural	410	10	21	21	34	53	62	401.8	400.6	404.1	402.2	404.1	402.2	404.6	402.6	405.1	403.0	405.3	403.1
Willakenzie North - County Farm																						
WKCF020A	58172	58169	78" CSP	2866	10	104	85	88	133	169	393.2	389.9	397.3	392.5	396.8	392.3	396.9	392.3	398.0	392.9	399.0	393.3
WKCF020ARD	58172	58169	Roadway	2866		0	0	0	0	0	407.9	405.0	388.0	388.0	388.0	388.0	388.0	388.0	388.0	388.0	388.1	388.1
WKCF020B	66533	58172	78" CSP	1596	10	85	72	81	124	154	396.7	393.2	399.4	397.3	399.2	396.8	399.4	396.9	400.1	398.0	400.7	399.0
WKCF020BRD	58172	66533	Roadway	1596		0	0	0	0	0	407.9	406.0	399.4	399.4	399.2	399.2	399.4	399.4	400.1	400.1	400.7	400.7
WKCF030A	58356	66533	66" CSP	1085	10	60	53	66	98	121	398.6	396.6	401.2	399.4	401.0	399.2	401.4	399.4	402.2	400.1	402.7	400.7
WKCF030ARD	58356	66533	Roadway	1085		0	0	0	0	0	410.2	406.0	399.4	399.4	399.2	399.2	399.4	399.4	400.1	400.1	400.7	400.7
WKCF040A	59511	58356	60" CSP	2093	10	35	34	46	69	83	403.5	398.6	405.4	401.2	405.3	401.0	405.7	401.4	406.2	402.2	406.6	402.7
WKCF040ARD	59511	58356	Roadway	2093		0	0	0	0	0	414.8	410.2	401.2	401.2	401.0	401.0	401.4	401.4	402.2	402.2	402.7	402.7
WKCF070D	66196	59511	54" CSP	2465	10	5	4	5	8	10	405.7	403.9	406.7	405.4	406.6	405.3	406.6	405.7	406.9	406.2	407.1	406.6
WKCF070DRD	66196	59511	Roadway	2465		0	0	0	0	0	417.7	414.8	405.4	405.4	405.3	405.3	405.7	405.7	406.2	406.2	406.6	406.6
WKCF070A	68994	59511	54" CSP	467	10	15	13	13	24	30	404.4	403.5	405.7	405.4	405.6	405.3	405.8	405.7	406.5	406.2	406.8	406.6
WKCF070ARD	68994	59511	Roadway	467		0	0	0	0	0	415.4	414.8	405.4	405.4	405.3	405.3	405.7	405.7	406.2	406.2	406.6	406.6
WKCF070B	59487	68994	42" CSP	581	10	15	13	13	25	31	405.7	404.4	407.2	405.7	407.1	405.6	407.1	405.8	407.7	406.5	408.1	406.8
WKCF070BRD	59487	68994	Roadway	581		0	0	0	0	0	415.7	415.4	405.7	405.7	405.6	405.6	405.8	405.8	406.5	406.5	406.8	406.8
WKCF070C	59489	59487	36" CSP	533	10	15	13	13	25	31	406.7	405.7	408.4	407.2	408.2	407.1	408.2	407.1	409.0	407.7	409.6	408.1
WKCF070CRD	59487	59489	Roadway	533		0	0	0	0	0	415.7	415.6	408.4	408.4	408.2	408.2	408.2	408.2	409.0	409.0	409.6	409.6
Willakenzie South - Debrick Slough																						
WKDS010A	60730	71171	Natural	1200	25	117	126	117	187	212	387.2	384.6	389.8	388.8	389.9	388.8	389.8	388.8	390.2	388.8	390.4	388.8
WKDS010B	60786	60730	54" CSP	486	10	30	31	49	76	86	392.6	392.0	394.8	393.6	394.9	393.6	395.5	394.0	396.4	394.5	396.8	394.7
WKDS010BRD	60786	60730	Roadway	486		0	0	0	0	0	402.3	399.3	389.8	389.8	389.9	389.9	389.8	389.8	390.2	390.2	390.4	390.4
WKDS020A	71172	60730	Natural	600	25	93	98	83	115	148	388.6	387.2	391.0	389.8	391.0	389.9	390.9	389.8	391.1	390.2	391.3	390.4
WKDS020B	71173	71172	72" CSP	640	50	93	98	83	115	148	390.3	388.6	393.5	391.0	393.6	391.0	393.3	390.9	394.0	391.1	394.6	391.3
WKDS020BRD	71173	71172	Roadway	640		0	0	0	0	0	399.5	399.5	391.0	391.0	391.0	391.0	390.9	390.9	391.1	391.1	391.3	391.3
WKDS020C	62475	71173	Natural	200	25	93	98	83	115	148	391.0	390.3	394.2	393.5	394.3	393.6	394.0	393.3	394.6	394.0	395.1	394.6
WKDS020D	62474	62475	72" CSP culvert	316	50	93	98	83	115	148	392.4	391.0	395.4	394.2	395.5	394.3	395.2	394.0	395.8	394.6	396.5	395.1
WKDS020DRD	62474	62475	Roadway	316		0	0	0	0	0	404.0	404.0	394.2	394.2	394.3	394.3	394.0	394.0	394.6	394.6	395.1	395.1

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Existing Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WKDS030A	71176	62474	Natural	1300	25	88	92	82	111	145	393.0	392.9	397.0	395.4	397.1	395.5	396.9	395.2	397.3	395.8	397.7	396.5
WKDS030B	99056	71176	Natural	380	25	88	92	84	113	149	393.8	393.0	397.3	397.0	397.4	397.1	397.2	396.9	397.7	397.3	398.1	397.7
WKDS030C1	99058	99056	3.75'x6' CSP culvert	49	25	46	48	43	59	76	394.1	393.8	397.4	397.3	397.4	397.4	397.3	397.2	397.7	397.7	398.2	398.1
WKDS030C2	99058	99056	3.75'x6' CSP culvert	49	25	43	44	40	55	74	394.0	393.8	397.4	397.3	397.4	397.4	397.3	397.2	397.7	397.7	398.2	398.1
WKDS030CRD	99058	99056	Roadway	49		0	0	0	0	0	400.2	400.2	397.3	397.3	397.4	397.4	397.2	397.2	397.7	397.7	398.1	398.1
WKDS040A	71179	99058	Natural	220	10	65	76	82	91	110	396.5	394.0	399.2	397.4	399.4	397.4	399.464	397.258	399.6	397.7	399.9	398.2
WKDS040B	71180	71179	Natural	40	10	65	76	82	91	110	396.7	396.5	399.2	399.2	399.4	399.4	399.5	399.5	399.7	399.6	400.0	399.9
WKDS040BRD	71180	71179	Roadway	40		0	0	0	0	0	403.7	403.7	399.2	399.2	399.4	399.4	399.5	399.5	399.6	399.6	399.9	399.9
WKDS040C	71182	71180	Natural	2370	10	66	78	88	97	118	398.8	396.7	401.1	399.2	401.3	399.4	401.4	399.5	401.5	399.7	401.8	400.0
WKDS040D	71183	71182	36" CMP culvert	49	10	66	72	73	74	74	398.5	398.8	404.5	401.1	404.9	401.3	405.0	401.4	405.0	401.5	405.1	401.8
WKDS040DRD	71183	71182	Roadway	49		0	9	18	27	48	404.8	404.8	401.1	401.1	404.9	404.9	405.0	404.9	405.0	404.9	405.1	405.0
WKDS040E	71185	71183	Natural	430	10	69	80	91	101	123	397.3	396.8	404.5	404.5	405.0	404.9	405.0	405.0	405.1	405.0	405.2	405.1
WKDS040F	71186	71185	72" CMP culvert	20	10	75	80	97	110	119	397.5	397.3	404.6	404.5	405.1	405.0	405.2	405.0	405.3	405.1	405.5	405.2
WKDS040FRD	71186	71185	Roadway	20		0	0	0	0	0	411.2	411.2	404.5	404.5	405.0	405.0	405.0	405.0	405.1	405.1	405.2	405.2
WKDS040G	71187	71186	Natural	220	10	83	87	115	127	135	397.3	397.5	404.6	404.6	405.1	405.1	405.2	405.2	405.3	405.3	405.5	405.5
WKDS040H	71188	71187	72" CMP culvert	99	10	86	90	122	137	146	397.5	397.3	404.8	404.6	405.3	405.1	405.5	405.2	405.7	405.3	406.1	405.5
WKDS040HRD	71188	71187	Roadway	99		0	0	0	0	0	410.2	410.2	404.6	404.6	405.1	405.1	405.2	405.2	405.3	405.3	405.5	405.5
WKDS040I	62914	71188	Natural	430	10	90	93	129	146	158	399.9	397.5	404.8	404.8	405.4	405.3	405.5	405.5	405.7	405.7	406.1	406.1
WKDS050A	62978	62914	72" CSP	716	10	81	85	116	125	133	400.1	399.5	405.0	404.8	405.7	405.4	406.0	405.5	406.3	405.7	406.8	406.1
WKDS050ARD	62978	62914	Roadway	716		0	0	0	0	0	412.8	412.8	404.8	404.8	405.4	405.4	405.5	405.5	405.7	405.7	406.1	406.1
WKDS060A	62946	62978	66" CSP	1100	10	72	75	100	102	104	401.6	400.0	405.6	405.0	406.4	405.7	406.7	406.0	407.4	406.3	408.2	406.8
WKDS060ARD	62946	62978	Roadway	1100		0	0	0	0	0	414.2	414.2	405.0	405.0	405.7	405.7	406.0	406.0	406.3	406.3	406.8	406.8
WKDS070A	62915	62946	60" CSP	1640	10	57	59	77	77	79	403.6	401.5	406.8	405.6	407.4	406.4	408.2	406.7	409.1	407.4	410.0	408.2
WKDS070ARD	62915	62946	Roadway	1640		0	0	0	0	0	410.4	410.4	405.6	405.6	406.4	406.4	406.7	406.7	407.4	407.4	408.2	408.2
WKDS070B	71121	62915	Natural	450	10	58	60	81	95	93	405.3	403.6	407.1	406.8	407.5	407.4	408.3	408.2	409.1	409.1	410.0	410.0
WKDS070C	62891	71121	Natural	420	10	59	62	90	130	145	406.8	405.3	409.6	407.1	409.7	407.5	410.0	408.3	410.6	409.1	410.7	410.0
WKDS070D	62989	62891	48" CSP	30	10	59	62	89	131	145	408.2	407.8	411.0	410.1	411.1	410.2	411.8	410.7	412.9	411.2	413.5	411.4
WKDS070DRD	62989	62891	Roadway	30		0	0	0	0	0	416.0	415.5	409.6	409.6	409.7	409.7	410.0	410.0	410.6	410.6	410.7	410.7
WKDS080A	62986	62989	36" CSP	650	10	20	21	24	27	29	412.2	408.2	413.5	411.0	413.6	411.1	413.7	411.8	414.0	412.9	414.4	413.5
WKDS080ARD	62986	62989	Roadway	650		0	0	0	0	0	420.3	416.0	411.0	411.0	411.1	411.1	411.8	411.8	412.9	412.9	413.5	413.5
WKDS080B	62760	62986	42" CSP	738	10	20	21	24	26	28	413.0	412.1	415.1	413.5	415.2	413.6	415.3	413.7	415.4	414.0	415.5	414.4
WKDS080BRD	62760	62986	Roadway	738		0	0	0	0	0	421.2	420.3	413.5	413.5	413.6	413.6	413.7	413.7	414.0	414.0	414.4	414.4
WKDS080C	62758	62760	36" CSP	242	10	20	21	24	26	28	413.6	413.2	415.6	415.1	415.7	415.2	415.9	415.3	416.1	415.4	416.2	415.5
WKDS080CRD	62758	62760	Roadway	242		0	0	0	0	0	421.9	421.2	415.1	415.1	415.2	415.2	415.3	415.3	415.4	415.4	415.5	415.5
WKDS080D	62713	62758	30" CSP	48	10	20	21	24	26	28	414.1	414.1	416.4	415.6	416.5	415.7	416.8	415.9	417.0	416.1	417.2	416.2
WKDS080DRD	62713	62758	Roadway	48		0	0	0	0	0	420.0	420.0	415.6	415.6	415.7	415.7	415.9	415.9	416.1	416.1	416.2	416.2

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Existing Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WKDS090A	62715	62713	Natural	457	10	10	12	14	14	15	415.4	415.0	416.5	416.4	416.6	416.5	416.9	416.8	417.0	417.0	417.2	417.2
WKDS090B	62716	62715	30" CSP culvert	442	10	10	11	13	13	13	414.6	414.0	416.8	416.5	417.0	416.6	417.4	416.9	417.6	417.0	417.8	417.2
WKDS090BRD	62716	62715	Roadway	442		0	0	0	0	0	420.5	420.5	416.5	416.5	416.6	416.6	416.9	416.9	417.0	417.0	417.2	417.2
WKDS090C	71102	62716	Natural	310	10	11	12	18	21	20	416.1	414.6	416.9	416.8	417.0	417.0	417.4	417.4	417.6	417.6	417.8	417.8
WKDS090D	71101	71102	Natural	364	10	11	12	19	28	33	417.4	416.1	418.2	416.9	418.2	417.0	418.4	417.4	418.5	417.6	418.6	417.8
Willakenzie South - Delta Ponds																						
WKDP130A	71156	71157	Natural	330	10	40	40	47	79	108	395.6	386.2	397.3	387.5	397.3	387.5	397.4	387.6	397.8	387.9	398.1	388.2
WKDP130B	60760	71156	Natural	320	10	40	40	47	79	108	400.0	396.0	403.7	398.2	403.7	398.2	403.9	398.4	404.6	399.2	405.1	399.6
WKDP130C	66584	60760	54" CSP	1332	10	19	19	26	43	60	400.4	400.0	403.8	403.7	403.8	403.7	404.2	403.9	405.4	404.6	406.7	405.1
WKDP130CRD	66584	60760	Roadway	1332		0	0	0	0	0	410.1	409.5	403.7	403.7	403.7	403.7	403.9	403.9	404.6	404.6	405.1	405.1
WKDP130D	60840	66584	48" CSP	553	10	19	19	26	43	60	401.9	400.6	404.0	403.8	404.0	403.8	404.4	404.2	406.0	405.4	407.8	406.7
WKDP130DRD	66584	60840	Roadway	553		0	0	0	0	0	410.1	407.8	404.0	404.0	404.0	404.0	404.4	404.4	406.0	406.0	407.8	407.8
WKDP130E	60828	60840	36" CSP	558	10	9	9	15	24	28	404.1	402.5	405.2	404.0	405.3	404.0	405.6	404.4	406.6	406.0	409.2	407.8
WKDP130ERD	60828	60840	Roadway	558		0	0	0	0	0	413.0	407.8	404.0	404.0	404.0	404.0	404.4	404.4	406.0	406.0	407.8	407.8
WKDP130F	60811	60840	36" CSP	548	10	11	11	12	23	30	403.3	402.5	404.8	404.0	404.7	404.0	404.9	404.4	406.6	406.0	409.3	407.8
WKDP130FRD	60811	60840	Roadway	548		0	0	0	0	0	414.1	407.8	404.0	404.0	404.0	404.0	404.4	404.4	406.0	406.0	407.8	407.8
WKDP080A	66556	59213	36" CSP	313	10	46	48	56	57	58	389.2	383.6	394.1	388.6	394.8	388.6	398.1	388.2	398.2	388.6	398.2	388.6
WKDP080ARD	66556	59213	Roadway	313		0	0	17	24	41	398.0	392.0	388.6	388.6	388.6	388.6	398.1	392.1	398.2	392.1	398.2	392.2
WKDP080B	60844	66556	54" CSP	635	10	34	36	55	69	81	392.9	391.8	395.2	394.1	395.4	394.8	398.8	398.1	399.3	398.2	399.7	398.2
WKDP080BRD	60844	66556	Roadway	635		0	0	0	0	0	400.9	398.0	394.1	394.1	394.8	394.8	398.1	398.1	398.2	398.2	398.2	398.2
WKDP090C	60771	60844	24" CSP	786	10	8	8	13	16	15	399.1	393.4	399.7	395.2	399.8	395.4	401.7	398.8	402.1	399.3	402.1	399.7
WKDP090CRD	60771	60844	Roadway	786		0	0	0	2	4	402.0	400.9	395.2	395.2	395.4	395.4	398.8	398.8	402.1	400.9	402.1	401.0
WKDP090A	60856	60844	48" CSP	119	10	21	23	33	42	53	393.7	393.4	395.4	395.2	395.5	395.4	398.9	398.8	399.4	399.3	399.9	399.7
WKDP090ARD	60856	60844	Roadway	119		0	0	0	0	0	401.0	400.9	395.2	395.2	395.4	395.4	398.8	398.8	399.3	399.3	399.7	399.7
WKDP090B	60804	60856	42" CSP	1801	10	21	22	35	42	53	397.9	393.7	399.7	395.4	399.7	395.5	401.2	398.9	403.7	399.4	406.2	399.9
WKDP090BRD	60804	60856	Roadway	1801		0	0	0	0	0	407.3	401.0	395.4	395.4	395.5	395.5	398.9	398.9	399.4	399.4	399.9	399.9
WKDP120A	61595	60804	42" CSP	1894	10	13	13	20	30	34	400.7	398.0	402.1	399.7	402.1	399.7	402.5	401.2	404.8	403.7	409.1	406.2
WKDP120ARD	61595	60804	Roadway	1894		0	0	0	0	0	416.7	407.3	399.7	399.7	399.7	399.7	401.2	401.2	403.7	403.7	406.2	406.2
WKDP080C	59248	66556	30" CSP	439	10	8	9	13	11	12	392.3	389.2	394.2	394.1	395.0	394.8	398.3	398.1	398.4	398.2	398.4	398.2
WKDP080CRD	59248	66556	Roadway	439		0	0	3	4	6	398.2	398.0	394.1	394.1	394.8	394.8	398.3	398.1	398.4	398.2	398.4	398.2
WKDP080D	59218	59248	24" CSP	209	10	7	7	11	13	15	395.5	392.3	396.2	394.2	396.2	395.0	398.9	398.3	399.2	398.4	399.5	398.4
WKDP080DRD	59218	59248	Roadway	209		0	0	0	0	0	400.5	398.2	394.2	394.2	395.0	395.0	398.3	398.3	398.4	398.4	398.4	398.4
WKDP080E	59181	59218	30" CSP	150	10	7	7	12	13	15	395.6	395.5	396.9	396.2	396.9	396.2	399.1	398.9	399.4	399.2	399.8	399.5
WKDP080ERD	59218	59181	Roadway	150		0	0	0	0	0	400.5	400.2	396.9	396.9	396.9	396.9	399.1	399.1	399.4	399.4	399.8	399.8
WKDP080F	59198	59181	Natural	175	10	7	7	12	16	18	396.5	395.6	397.4	396.9	397.5	396.9	399.2	399.1	399.5	399.4	399.8	399.8
WKDP080G	59197	59198	21" CSP	216	10	7	7	12	17	16	398.3	396.5	399.2	397.4	399.2	397.5	400.7	399.2	401.1	399.5	401.2	399.8
WKDP080GRD	59197	59198	Roadway	216		0	0	0	5	9	401.0	400.2	397.4	397.4	397.5	397.5	399.2	399.2	401.1	400.3	401.2	400.3
Willakenzie South - Gilham-Norkenzie																						
WKGN010A	59134	59192	72" CSP	264	10	127	132	197	212	238	390.4	389.3	393.9	389.4	394.0	389.4	395.0	389.5	395.2	389.5	395.7	389.5
WKGN010ARD	59134	59192	Roadway	264		0	0	0	0	0	400.0	399.0	389.4	389.4	389.4	389.4	389.5	389.5	389.5	389.5	389.5	389.5
WKGN010B	68175	59134	36" CSP	895	10	11	11	18	28	31	395.6	392.0	396.5	393.9	396.6	394.0	397.0	395.0	397.5	395.2	397.9	395.7
WKGN010BRD	68175	59134	Roadway	895		0	0	0	0	0	404.6	400.0	393.9	393.9	394.0	394.0	395.0	395.0	395.2	395.2	395.7	395.7

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Existing Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WKGN010C	59868	59134	72" CSP	2151	10	105	109	163	181	201	396.5	390.4	399.5	393.9	399.6	394.0	400.6	395.0	401.0	395.2	401.6	395.7
WKGN010CRD	59868	59134	Roadway	2151		0	0	0	0	0	414.2	400.0	393.9	393.9	394.0	394.0	395.0	395.0	395.2	395.2	395.7	395.7
WKGN030D	59862	59868	36 "CSP	1880	10	10	10	17	21	23	402.2	398.6	403.6	399.5	403.7	399.6	403.9	400.6	404.2	401.0	404.3	401.6
WKGN030DRD	59868	59862	Roadway	1880		0	0	0	0	0	414.2	413.3	403.6	403.6	403.7	403.7	403.9	403.9	404.2	404.2	404.3	404.3
WKGN030E	59859	59862	42" CSP	606	10	10	10	16	22	25	403.4	402.2	404.6	403.6	404.6	403.7	405.0	403.9	405.4	404.2	405.5	404.3
WKGN030ERD	59862	59859	Roadway	606		0	0	0	0	0	413.3	413.1	404.6	404.6	404.6	404.6	405.0	405.0	405.4	405.4	405.5	405.5
WKGN030A	59896	59868	66 " CSP	793	10	82	85	126	144	159	398.6	396.9	401.8	399.5	401.8	399.6	402.7	400.6	403.2	401.0	403.8	401.6
WKGN030ARD	59868	59896	Roadway	793		0	0	0	0	0	414.2	411.3	401.8	401.8	401.8	401.8	402.7	402.7	403.2	403.2	403.8	403.8
WKGN030B	59889	59896	66" CSP	1460	10	74	76	113	128	140	401.3	398.6	404.3	401.8	404.3	401.8	405.3	402.7	405.9	403.2	406.7	403.8
WKGN030BRD	59889	59896	Roadway	1460		0	0	0	0	0	413.7	411.3	401.8	401.8	401.8	401.8	402.7	402.7	403.2	403.2	403.8	403.8
WKGN030C	59878	59896	30 " CSP	509	10	9	9	15	21	23	403.8	401.9	405.0	402.9	405.0	402.9	405.4	403.2	405.9	403.4	406.1	403.8
WKGN030CRD	59896	59878	Roadway	509		0	0	0	0	0	411.3	409.9	405.0	405.0	405.0	405.0	405.4	405.4	405.9	405.9	406.1	406.1
WKGN040A	59875	59878	36" CSP	411	10	0	0	0	1	2	405.2	404.7	405.2	405.0	405.2	405.0	405.4	405.4	405.9	405.9	406.2	406.1
WKGN040ARD	59875	59878	Roadway	411		0	0	0	0	0	411.3	409.9	405.0	405.0	405.0	405.0	405.4	405.4	405.9	405.9	406.1	406.1
WKGN040B	59873	59875	27" CSP	258	10	0	0	0	0	0	406.4	405.8	406.4	405.8	406.4	405.8	406.4	405.8	406.4	405.9	406.4	406.2
WKGN040BRD	59873	59875	Roadway	258		0	0	0	0	0	413.9	411.3	405.2	405.2	405.2	405.2	405.4	405.4	405.9	405.9	406.2	406.2
WKGN040C	59889	59873	24" CSP	364	10	0	0	0	0	0	407.8	406.6	406.4	406.4	406.4	406.4	406.4	406.4	406.4	406.4	406.4	406.4
WKGN040CRD	59873	59889	Roadway	364		0	0	0	0	0	413.9	413.7	404.3	404.3	404.3	404.3	405.3	405.3	405.9	405.9	406.7	406.7
WKGN060A	61562	59889	66" CSP	1506	10	58	60	90	102	110	402.3	401.3	405.7	404.3	405.8	404.3	406.9	405.3	407.5	405.9	408.5	406.7
WKGN060ARD	59889	61562	Roadway	1506		0	0	0	0	0	413.7	412.7	405.7	405.7	405.8	405.8	406.9	406.9	407.5	407.5	408.5	408.5
WKGN070C	61554	61562	42" CSP	1014	10	13	13	19	24	29	405.7	403.5	406.8	405.7	406.8	405.8	407.5	406.9	408.2	407.5	409.5	408.5
WKGN070CRD	61554	61562	Roadway	1014		0	0	0	0	0	415.7	412.7	405.7	405.7	405.8	405.8	406.9	406.9	407.5	407.5	408.5	408.5
WKGN070D	61444	61554	36" CSP	43	10	13	13	19	24	28	410.6	406.2	411.2	406.8	411.2	406.8	411.2	407.5	411.3	408.2	411.5	409.5
WKGN070DRD	61554	61444	Roadway	43		0	0	0	0	0	415.7	415.0	411.2	411.2	411.2	411.2	411.2	411.2	411.3	411.3	411.5	411.5
WKGN070E	71196	61444	Natural	500	10	13	13	19	24	29	411.7	410.6	413.5	411.2	413.5	411.2	413.8	411.2	414.1	411.3	414.2	411.5
WKGN070F	71197	71196	36" CSP culvert	31	10	13	13	19	24	28	411.8	411.7	413.6	413.5	413.7	413.5	414.1	413.8	414.3	414.1	414.5	414.2
WKGN070FRD	71197	71196	Roadway	31		0	0	0	0	0	417.0	417.0	413.5	413.5	413.5	413.5	413.8	413.8	414.1	414.1	414.2	414.2
WKGN070G	71198	71197	Natural	340	10	13	13	19	27	32	412.2	411.8	413.8	413.6	413.8	413.7	414.2	414.1	414.4	414.3	414.6	414.5
WKGN070H	72432	71198	36" CSP culvert	17	10	13	13	20	31	36	412.2	412.2	414.0	413.8	414.0	413.8	414.4	414.2	414.8	414.4	415.1	414.6
WKGN070HRD	71198	72432	Roadway	17		0	0	0	0	0	417.8	417.6	414.0	414.0	414.0	414.0	414.4	414.4	414.8	414.8	415.1	415.1
WKGN070A	61565	61562	48" CSP	1999	10	24	26	38	43	46	405.7	403.5	407.8	405.7	407.9	405.8	408.7	406.9	409.3	407.5	410.4	408.5
WKGN070ARD	61565	61562	Roadway	1999		0	0	0	0	0	417.9	412.7	405.7	405.7	405.8	405.8	406.9	406.9	407.5	407.5	408.5	408.5
WKGN070B	99498	61565	42" CSP	695	10	24	26	39	47	51	408.2	405.8	409.8	407.8	409.9	407.9	410.5	408.7	411.0	409.3	411.9	410.4
WKGN070BRD	99498	61565	Roadway	695		0	0	0	0	0	420.0	417.9	407.8	407.8	407.9	407.9	408.7	408.7	409.3	409.3	410.4	410.4
WKGN090A	99495	99498	36" CSP	597	10	13	14	21	26	29	409.3	408.2	410.8	409.8	410.9	409.9	411.4	410.5	411.9	411.0	412.8	411.9
WKGN090ARD	99495	99498	Roadway	597		0	0	0	0	0	421.0	420.0	409.8	409.8	409.9	409.9	410.5	410.5	411.0	411.0	411.9	411.9
WKGN090B	61437	99495	48" CSP	122	10	13	14	21	26	28	409.6	409.4	411.1	410.8	411.2	410.9	411.7	411.4	412.1	411.9	412.9	412.8
WKGN090BRD	99495	61437	Roadway	122		0	0	0	0	0	421.0	415.6	411.1	411.1	411.2	411.2	411.7	411.7	412.1	412.1	412.9	412.9
WKGN090C	61423	61437	Natural	800	10	13	14	22	29	34	412.0	409.6	413.8	411.1	413.8	411.2	414.0	411.7	414.3	412.1	414.4	412.9

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE WILLAMETTE RIVER BASIN STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions			Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)					
											10-Year		25-Year Winter		25-Year Summer	
	US	DS				10-Year	25-Year-W	25-Year-S	US	DS	US	DS	US	DS	US	DS
Outfall A																
WRRR010E	76425	59065	48" CSP	48	10	32	32	51	378.1	383.1	392.1	392.1	392.1	392.1	392.192	392.1
WRRR010D	76424	76425	48" CSP	100	10	32	32	51	378.3	378.1	392.2	392.1	392.2	392.1	392.4	392.2
WRRR010DRD	76424	76425	Roadway	100		0	0	0	396.4	381.8	392.1	392.1	392.1	392.1	392.2	392.2
WRRR010C	59082	76424	48" CSP	45	10	32	32	51	387.4	378.3	392.2	392.2	392.2	392.2	392.4	392.4
WRRR010CRD	76424	59082	Roadway	45		0	0	0	396.4	396.0	392.2	392.2	392.2	392.2	392.4	392.4
WRRR010B	59080	59082	54" CSP	635	10	32	32	51	387.8	387.4	392.4	392.2	392.4	392.2	392.9	392.4
WRRR010BRD	59080	59082	Roadway	635		0	0	0	397.6	396.0	392.2	392.2	392.2	392.2	392.4	392.4
WRRR010A	59087	59080	54" CSP	247	10	32	32	51	388.0	387.8	392.5	392.4	392.5	392.4	393.1	392.9
WRRR010ARD	59080	59087	Roadway	247		0	0	0	397.6	397.0	392.5	392.5	392.5	392.5	393.1	393.1
WRRR020A	66178	59087	54" CSP	22	10	29	29	45	388.0	388.0	392.5	392.5	392.6	392.5	393.2	393.1
WRRR020ARD	66178	59087	Roadway	22		0	0	0	397.0	397.0	392.5	392.5	392.5	392.5	393.1	393.1
WRRR030A	59120	66178	48" CSP	1241	10	19	20	30	389.4	388.3	392.8	392.5	392.8	392.6	393.7	393.2
WRRR030ARD	59120	66178	Roadway	1241		0	0	0	398.6	397.0	392.5	392.5	392.6	392.6	393.2	393.2
WRRR040A	60606	59120	48" CSP	775	10	17	17	26	390.0	389.4	392.9	392.8	392.9	392.8	394.0	393.7
WRRR040ARD	60606	59120	Roadway	775		0	0	0	399.2	398.6	392.8	392.8	392.8	392.8	393.7	393.7
WRRR050B	60626	60606	42" CSP	600	10	11	11	16	392.4	390.8	393.5	392.9	393.5	392.9	394.2	394.0
WRRR050BRD	60626	60606	Roadway	600		0	0	0	401.0	399.2	392.9	392.9	392.9	392.9	394.0	394.0
WRRR050A	60617	60626	36" CSP	355	10	11	11	16	393.2	392.7	394.6	393.7	394.7	393.7	395.0	394.2
WRRR050ARD	60626	60617	Roadway	355		0	0	0	401.0	400.6	394.6	394.6	394.7	394.7	395.0	395.0
Outfall B																
WRRR060F	66175	59066	30" CSP	10	10	7	7	12	383.4	382.5	393.3	392.9	393.0	392.9	392.977	392.9
WRRR060E	66552	66175	30" CSP	41	10	7	7	12	381.3	383.4	393.4	393.3	393.0	393.0	393.1	393.0
WRRR060D	76421	66552	30" CSP	130	10	7	7	12	381.6	381.3	393.1	393.4	393.0	393.0	393.1	393.1
WRRR060C	59084	76421	30" CSP	38	10	7	7	12	389.2	381.6	393.1	393.1	393.0	393.0	393.1	393.1
WRRR060B	59083	59084	30" CSP	109	10	7	7	12	390.7	389.2	393.0	393.1	393.0	393.0	393.3	393.1
WRRR060BRD	59083	59084	Roadway	109		0	0	0	402.0	400.0	393.1	393.1	393.0	393.0	393.1	393.1
WRRR060A	67889	59083	30" CSP	998	10	7	7	12	393.8	391.4	394.9	393.0	394.9	393.0	395.2	393.3
WRRR060ARD	67889	59083	Roadway	998		0	0	0	404.0	402.0	393.0	393.0	393.0	393.0	393.3	393.3
Outfall C																
WRRR090D	76423	60612	30" CSP	588	10	10	10	12	399.2	398.4	400.8	399.6	400.8	399.6	401.0	399.6
WRRR090C	76422	76423	30" CSP	43	10	10	10	12	397.8	399.2	400.8	400.8	400.9	400.8	401.1	401.0
WRRR090CRD	76422	76423	Roadway	43		0	0	0	406.0	405.0	400.8	400.8	400.8	400.8	401.0	401.0
WRRR090B	60647	76422	30" CSP	12	10	10	10	12	399.2	397.8	400.7	400.8	400.8	400.9	401.1	401.1
WRRR090BRD	60647	76422	Roadway	12		0	0	0	406.5	405.0	400.8	400.8	400.9	400.9	401.1	401.1
WRRR090A	60658	60647	30" CSP	413	10	7	7	8	395.3	399.3	400.9	400.7	401.0	400.8	401.3	401.1
WRRR090ARD	60647	60658	Roadway	413		0	0	0	405.5	405.3	400.9	400.9	401.0	401.0	401.3	401.3
WRRR100A	62222	60658	27" CSP	700	10	7	7	8	400.8	399.8	402.1	400.9	402.1	401.0	402.3	401.3
WRRR100ARD	62222	60658	Roadway	700		0	0	0	406.0	404.3	400.9	400.9	401.0	401.0	401.3	401.3

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE WILLOW CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
Willow Creek - Main Stem																						
WCMN010A	71038	71120	Natural	400	25	549	821	188	676	842	381.4	376.5	388.1	388.1	390.0	389.8	386.0	386.0	389.0	388.9	390.1	390.0
WCMN010B	71037	71038	bridge	34	50	543	821	184	670	833	381.4	381.4	388.1	388.1	390.0	390.0	386.0	386.0	389.0	389.0	390.1	390.1
WCMN010C	71049	71037	Natural	900	25	491	780	167	559	777	383.3	381.4	389.3	388.1	390.3	390.0	386.6	386.0	389.4	389.0	390.4	390.1
WCMN010D	73754	71049	Natural	3000	25	492	814	170	622	793	390.1	383.3	395.2	389.3	397.7	390.3	392.7	386.6	397.1	389.4	397.6	390.4
Willow Creek - West Branch																						
WCMN010H	54462	73754	Natural	1500	10	14	13	13	26	28	398.5	392.1	399.5	395.2	399.5	397.7	399.7	392.7	399.9	397.1	399.9	397.6
WCMN020A	54494	54462	48" CSP	125	10	14	14	16	26	32	396.4	398.5	399.6	399.5	399.6	399.5	399.8	399.7	400.1	399.9	400.2	399.9
WCMN020Ard	54494	54462	Roadway	125		0	0	0	0	0	403.0	403.0	399.5	399.5	399.5	399.5	399.7	399.7	399.9	399.9	399.9	399.9
WCMN020B	54495	54494	48" CSP	450	10	14	14	16	26	32	399.1	396.4	400.1	399.6	400.1	399.6	400.2	399.8	400.5	400.1	400.6	400.2
WCMN020Brd	54495	54494	Roadway	450		0	0	0	0	0	407.2	403.0	399.6	399.6	399.6	399.6	399.8	399.8	400.1	400.1	400.2	400.2
WCMN010E#1	76010	73754	4'x12' box culvert	64	25	160	189	69	192	235	392.4	392.1	395.5	395.2	398.0	397.7	393.6	393.0	397.3	397.1	397.8	397.6
WCMN010E#2	76010	73754	4'x12' box culvert	64	25	160	189	69	192	235	392.4	392.1	395.5	395.2	398.0	397.7	393.6	393.0	397.3	397.1	397.8	397.6
WCMN010Erd	76010	73754	Roadway	64		0	0	0	0	0	398.1	398.0	395.2	395.2	397.7	397.7	392.7	392.7	397.1	397.1	397.6	397.6
WCWE100A	71034	76010	Natural	676	25	308	381	134	387	480	394.0	390.4	397.5	395.5	398.2	398.0	396.6	393.6	397.7	397.3	398.1	397.8
WCWE100B	71033	71034	Natural	960	10	98	113	54	131	160	400.5	394.0	405.6	397.5	405.7	398.2	405.1	396.6	405.9	397.7	406.1	398.1
WCWE100C#1	71032	71033	42"x27" CMP elliptical culvert	47	10	27	28	27	29	29	400.6	400.6	405.8	405.6	405.9	405.7	405.3	405.1	406.1	405.9	406.4	406.1
WCWE100C#2	71032	71033	42"x27" CMP elliptical culvert	47	10	27	29	28	30	30	400.6	400.6	405.8	405.6	405.9	405.7	405.3	405.1	406.1	405.9	406.4	406.1
WCWE100Crd	71032	71033	Roadway	47		47	62	5	80	108	405.1	405.0	405.8	405.6	405.9	405.7	405.3	405.1	406.1	405.9	406.4	406.1
WCWE100D	71040	71034	Natural	417	25	218	270	90	273	339	396.0	394.0	401.0	397.5	401.2	398.2	400.3	396.6	401.2	397.7	401.5	398.1
WCWE100E	71031	71040	Natural	1200	25	219	270	91	275	341	402.7	396.0	409.3	401.0	409.6	401.2	407.3	400.3	409.6	401.2	409.9	401.5
WCWE100F	71030	71031	48" CSP culvert	32	25	149	149	91	152	154	404.6	403.4	411.3	409.3	411.5	409.6	408.1	407.3	411.5	409.6	411.6	409.9
WCWE100Frd	71030	71031	Roadway	32		84	139	0	148	218	410.8	410.8	411.3	411.1	411.5	411.2	407.3	407.3	411.5	411.2	411.6	411.3
WCWE110A	71050	71030	Natural	450	10	148	178	62	188	232	407.1	404.5	411.8	411.3	412.0	411.5	409.7	408.1	412.1	411.5	412.4	411.6
WCWE110B	71029	71050	Natural	800	10	148	178	63	188	233	411.6	407.1	415.4	411.8	415.8	412.0	414.2	409.7	415.9	412.1	416.9	412.4
WCWE110C#1	71028	71029	12" CSP culverts	19	10	7	7	7	7	7	413.7	413.7	417.0	415.4	417.1	415.8	416.7	414.7	417.1	415.9	417.2	416.9
WCWE110C#2	71028	71029	15" CSP culvert	19	10	12	12	11	12	12	413.7	413.7	417.0	415.4	417.1	415.8	416.7	415.0	417.1	415.9	417.2	416.9
WCWE110Crd	71028	71029	Roadway	19		131	162	46	174	226	416.3	416.3	417.0	416.7	417.1	416.7	416.7	416.5	417.1	416.8	417.2	416.9
WCWE120A	71027	71028	Natural	1300	10	124	150	60	155	192	424.4	413.6	427.6	417.0	427.9	417.1	426.7	416.7	428.0	417.1	428.5	417.2
WCWE120B	71026	71027	42" CSP culvert	32	10	103	105	62	106	108	425.1	426.3	431.5	429.4	431.6	429.4	429.7	428.8	431.6	429.4	431.7	429.4
WCWE120Brd	71026	71027	Roadway	32		22	45	0	50	84	431.2	431.2	431.5	431.3	431.6	431.4	426.7	426.7	431.6	431.4	431.7	431.5

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE WILLOW CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WCWE120C	71025	71026	Natural	320	10	126	150	73	156	193	431.6	425.1	434.8	431.5	434.9	431.6	433.9	429.7	434.9	431.6	435.1	431.7
WCWE120D#1	71024	71025	18" CSP culverts	20	10	17	17	17	17	17	432.2	431.6	435.4	434.8	435.4	434.9	435.1	433.9	435.4	434.9	435.5	435.1
WCWE120D#2	71024	71025	24" CSP culvert	20	10	27	27	27	28	27	432.2	431.6	435.4	434.8	435.4	434.9	435.1	433.9	435.4	434.9	435.5	435.1
WCWE120Drd	71024	71025	Roadway	20		97	123	33	130	168	434.7	434.7	435.4	435.0	435.4	435.1	435.1	434.8	435.4	435.1	435.5	435.1
WCWE130A	71023	71024	Natural	700	10	100	119	70	124	152	439.8	432.2	442.0	435.4	442.1	435.4	441.8	435.1	442.1	435.4	442.2	435.5
WCWE130B	71022	71023	48" CMP culvert	30	10	101	119	74	124	152	443.1	442.3	447.3	445.0	448.2	445.4	446.4	444.5	448.5	445.5	450.0	445.9
WCWE130C	71021	71022	Natural	500	10	108	121	82	143	181	454.0	443.1	457.0	447.3	457.1	448.2	456.7	446.4	457.2	448.5	457.5	450.0
WCWE130D	71020	71021	48" CMP culvert	31	10	109	121	85	133	136	457.0	456.3	461.7	459.4	462.4	459.6	460.8	458.8	463.0	459.7	463.2	459.8
WCWE130Drd	71020	71021	Roadway	31		0	0	0	15	51	462.8	462.8	457.0	457.0	457.1	457.1	456.7	456.7	463.0	462.9	463.2	463.0
Willow Creek - East Branch																						
WCMN10F1	73761	73754	Natural	290	25	209	432	59	310	439	390.3	390.1	395.6	395.2	398.1	397.7	393.1	392.7	397.4	397.1	398.0	397.6
WCEA005A	76015	73761	48" CSP culvert	50	25	6	49	2	27	51	392.1	391.2	395.6	395.6	398.4	398.1	393.1	393.1	397.5	397.4	398.3	398.0
WCEA005Ard	76015	73761	Roadway	33		0	28	0	0	22	398.0	398.0	395.6	395.6	398.4	398.2	393.1	393.1	397.4	397.4	398.3	398.2
WCEA005B	73501	76015	Natural	550	25	5	65	0	25	66	395.4	392.1	396.2	395.6	398.4	398.4	393.1	393.1	397.5	397.5	398.4	398.3
WCEA005C	73500	73501	Natural	2000	25	8	71	0	32	70	403.6	396.0	403.9	396.2	404.4	398.4	395.4	395.4	404.1	397.5	404.4	398.4
WCMN10F2	73768	73761	Natural	535	25	203	364	58	286	369	390.6	390.3	396.1	395.6	398.7	398.1	393.7	393.1	397.7	397.4	398.6	398.0
WCMN010G#1	76016	73768	6'x8' box culvert	64	25	101	175	29	143	178	392.2	390.6	396.2	396.1	399.0	398.7	393.7	393.7	397.8	397.7	398.8	398.6
WCMN010G#2	76016	73768	6'x8' box culvert	64	25	101	175	29	143	178	392.2	390.6	396.2	396.1	399.0	398.7	393.7	393.7	397.8	397.7	398.8	398.6
WCMN010Grd	76016	73768	Roadway	64		0	35	0	0	19	398.6	398.5	396.1	396.1	399.0	398.8	393.7	393.7	397.7	397.7	398.8	398.7
WCEA10A1	73500	76016	Natural	1300	25	202	385	58	293	374	398.7	392.2	403.9	396.2	404.4	399.0	402.2	393.7	404.1	397.8	404.4	398.8
WCEA10A2	71041	73500	Natural	1322	25	222	434	55	319	449	405.0	398.7	410.5	403.9	410.8	404.4	408.1	402.2	410.7	404.1	410.9	404.4
WCEA030A	51997	71041	Natural	1774	10	28	48	15	38	51	435.8	405.0	437.5	410.5	437.6	410.8	437.2	408.1	437.5	410.7	437.6	410.9
WCEA030B	51998	51997	24" CSP culvert	164	10	39	40	28	40	40	439.1	435.8	445.5	437.5	445.6	437.6	442.2	437.2	445.7	437.5	445.8	437.6
WCEA030Brd	51998	51997	Roadway	164		5	9	0	24	38	445.3	445.3	445.5	445.3	445.6	445.4	437.2	437.2	445.7	445.4	445.8	445.5
WCEA030C	71042	71041	Natural	1200	25	228	273	123	277	361	418.0	405.0	424.7	410.5	424.7	410.8	424.3	408.1	424.8	410.7	424.9	410.9
WCEA030D	71017	71042	Natural	2000	25	226	274	142	275	356	426.7	418.0	437.3	424.7	437.9	424.7	435.8	424.3	438.2	424.8	438.6	424.9
WCEA030E	71016	71017	bridge	35	25	227	279	164	297	368	427.6	426.7	437.3	437.3	438.0	437.9	435.8	435.8	438.2	438.2	438.7	438.6
WCEA050A	71043	71016	Natural	414	25	223	271	167	297	367	435.1	427.6	438.6	437.3	438.9	438.0	438.1	435.8	439.1	438.2	439.6	438.7
WCEA050B	71015	71043	Natural	364	10	55	56	51	64	72	442.6	435.1	444.9	438.6	445.0	438.9	444.8	438.1	450.1	439.1	453.1	439.6
WCEA050C	71014	71015	30"x42" CMP elliptical culvert	51	10	54	55	52	58	59	448.0	446.9	451.8	449.3	451.8	449.3	451.6	449.2	452.2	450.1	453.1	453.1
WCEA050Crd	71014	71015	Roadway	51		1	1	0	32	77	451.7	451.7	451.8	451.7	451.8	451.7	444.8	444.8	452.2	452.0	453.1	453.1
WCEA050D	71044	71043	Natural	250	10	176	216	130	236	301	436.8	435.1	440.1	438.6	440.2	438.9	440.1	438.1	440.3	439.1	440.4	439.6

APPENDIX E
TABLE E-3
HYDRAULIC PERFORMANCE OF THE WILLOW CREEK STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WCEA060A	71013	71044	Natural	647	10	91	109	61	111	142	445.6	436.8	447.5	440.1	447.7	440.2	447.2	440.1	447.7	440.3	447.9	440.4
WCEA060B	71012	71013	36" CSP culvert	82	10	92	109	64	114	136	448.7	446.6	453.6	448.9	455.4	449.6	451.4	448.3	456.0	449.6	458.6	449.6
WCEA060Brd	71012	71013	Roadway	82		0	0	0	0	7	458.4	458.4	447.5	447.5	447.7	447.7	447.2	447.2	447.7	447.7	458.6	458.5
WCEA060C	71011	71044	Natural	600	10	72	84	52	100	126	450.0	436.8	452.5	440.1	452.5	440.2	451.8	440.1	452.6	440.3	452.7	440.4
WCEA060D#1	71010	71011	27"x42" CMP elliptical culvert	23	10	48	49	35	52	52	450.1	450.0	453.9	452.5	453.9	452.5	453.0	451.8	454.1	452.6	454.2	452.7
WCEA060D#2	71010	71011	18" CMP culvert	23	10	11	11	10	12	12	450.1	450.0	453.9	452.5	453.9	452.5	453.0	451.8	454.1	452.6	454.2	452.7
WCEA060D#3	71010	71011	18" CMP culvert	23	10	11	11	10	12	12	450.1	450.0	453.9	452.5	453.9	452.5	453.0	451.8	454.1	452.6	454.2	452.7
WCEA060Drd	71010	71011	Roadway	23		6	15	0	32	54	453.7	453.7	453.9	453.7	453.9	453.8	451.8	451.8	454.1	453.8	454.2	453.9
WCEA060E	71045	71010	Natural	228	10	76	84	55	107	128	452.3	450.1	455.0	453.9	455.1	453.9	454.4	453.0	455.5	454.1	456.1	454.2
WCEA060F	71046	71045	36" CMP culvert	41	10	62	63	56	64	65	456.8	456.3	461.7	458.8	461.7	458.8	461.0	458.7	461.9	458.9	462.0	458.9
WCEA060Frd	71046	71045	Roadway	41		15	22	0	43	69	461.4	461.4	461.7	461.5	461.7	461.5	454.4	454.4	461.9	461.6	462.0	461.7
WCEA060G	71048	71046	Natural	100	10	77	84	57	107	134	458.1	456.0	461.7	461.7	461.8	461.7	461.1	461.0	461.9	461.9	462.0	462.0
WCEA060H	71009	71048	Natural	400	10	77	84	62	107	135	466.3	458.1	468.9	461.7	469.0	461.8	468.7	461.1	469.3	461.9	469.6	462.0
WCEA060I	71008	71009	36" CSP culvert	24	10	78	84	63	105	110	468.7	468.1	472.8	470.1	473.3	470.2	471.9	469.8	474.9	471.1	475.2	471.1
WCEA060Ird	71008	71009	Roadway	24		0	0	0	2	26	474.7	474.7	468.9	468.9	469.0	469.0	468.7	468.7	474.9	474.7	475.2	474.9

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
Amazon Main channel																						
SPRR-B	71110	71111	bridge	95	25	2874	3484	1722	3127	3577	372.0	372.0	382.6	382.4	383.0	382.8	381.5	381.4	382.8	382.6	383.0	382.8
SPRR-rd	71110	71111	Roadway	95		0	0	0	0	0	387.0	387.0	382.4	382.4	382.8	382.8	381.4	381.4	382.6	382.6	382.8	382.8
MainLW020E	71123	71110	Natural	978	25	2861	3469	1736	3109	3553	371.9	372.0	383.8	382.6	384.4	383.0	382.1	381.5	384.1	382.8	384.5	383.0
MainLW020F	63032	71123	Natural	300	25	2863	3471	1754	3110	3554	372.3	371.9	383.9	383.8	384.6	384.4	382.2	382.1	384.2	384.1	384.7	384.5
MainLW030A	71107	63032	Natural	1252	25	2830	3424	1774	3075	3507	374.0	372.3	385.1	383.9	385.9	384.6	383.0	382.2	385.7	384.2	386.0	384.7
SPB	71106	71107	bridge	118	25	2830	3426	1791	3075	3508	374.0	374.0	385.2	385.1	386.1	385.9	383.1	383.0	385.9	385.7	386.2	386.0
SPBrd	71106	71107	Roadway	118		0	0	0	0	0	388.0	388.0	385.1	385.1	385.9	385.9	383.0	383.0	385.7	385.7	386.0	386.0
MainLW030B	71105	71106	Natural	935	25	2831	3427	1803	3075	3508	373.8	374.0	386.4	385.2	387.4	386.1	383.9	383.1	387.0	385.9	387.6	386.2
MainLW030C	71104	71105	Natural	1300	25	2807	3405	1823	3041	3464	376.3	373.8	387.6	386.4	388.4	387.4	385.0	383.9	388.0	387.0	388.6	387.6
MainLW030D	71103	71104	Natural	240	25	2811	3409	1835	3042	3470	376.5	376.3	387.7	387.6	388.5	388.4	385.3	385.0	388.2	388.0	388.7	388.6
Danebo	71122	71103	bridge	75	25	2813	3410	1838	3042	3472	376.5	376.5	387.9	387.7	388.7	388.5	385.4	385.3	388.3	388.2	388.8	388.7
Danebord	71122	71103	Roadway	75		0	0	0	0	3	388.7	388.7	387.7	387.7	388.5	388.5	385.3	385.3	388.2	388.2	388.8	388.8
MainLW050A	71120	71122	Natural	1079	25	2808	3401	1848	3031	3463	376.5	376.5	388.8	387.9	390.0	388.7	386.5	385.4	389.6	388.3	390.1	388.8
MainLW060A	71100	71120	Natural	297	25	2337	2578	1648	2480	2677	377.5	376.5	389.0	388.8	390.1	390.0	386.7	386.5	389.7	389.6	390.2	390.1
Beltline	71099	71100	bridge	97	50	2340	2587	1653	2482	2688	377.5	377.5	389.0	389.0	390.1	390.1	386.7	386.7	389.7	389.7	390.2	390.2
Beltlinerd	71099	71100	Roadway	96		0	0	0	0	0	390.3	390.3	389.0	389.0	390.1	390.1	386.7	386.7	389.7	389.7	390.2	390.2
MainLW060B	71098	71099	Natural	205	25	2344	2590	1656	2483	2691	377.5	377.5	389.1	389.0	390.2	390.1	386.8	386.7	389.8	389.7	390.3	390.2
MainLW060C	63126	71098	Natural	1620	25	2382	2622	1693	2501	2744	380.4	377.5	389.8	389.1	390.8	390.2	387.6	386.8	390.4	389.8	390.9	390.3
MainBT020C	71097	63126	Natural	245	25	2359	2610	1719	2474	2717	380.8	380.4	390.2	389.8	391.1	390.8	388.1	387.6	390.7	390.4	391.2	390.9
MainBT020D	71096	71097	Natural	255	25	2361	2614	1725	2475	2720	380.8	380.8	390.5	390.2	391.5	391.1	388.6	388.1	391.1	390.7	391.6	391.2
MainBT030A	71095	71096	Natural	490	25	2364	2618	1731	2476	2722	381.0	380.8	391.4	390.5	392.2	391.5	389.6	388.6	391.9	391.1	392.3	391.6
Bertlesn	63127	71095	bridge	90	25	2211	2471	1734	2328	2573	381.0	381.0	391.5	391.4	392.3	392.2	389.8	389.6	392.0	391.9	392.5	392.3
Bertlesnrd	63127	71095	Roadway	90		157	156	0	158	161	390.3	390.3	391.5	391.4	392.3	392.2	389.6	389.6	392.0	391.9	392.5	392.3
MainBT010B	71094	63127	Natural	970	25	2303	2542	1732	2422	2649	381.5	381.0	393.0	391.5	393.6	392.3	391.5	389.8	393.3	392.0	393.7	392.5
W11th	54748	71094	bridge	162	50	2303	2545	1738	2423	2650	381.5	381.5	393.2	393.0	393.8	393.6	391.7	391.5	393.5	393.3	393.9	393.7
W11thrd	54748	71094	Roadway	162		0	0	0	0	0	395.4	395.4	393.0	393.0	393.6	393.6	391.5	391.5	393.3	393.3	393.7	393.7
MainBT050A	71093	54748	Natural	284	25	2285	2513	1737	2398	2619	381.0	381.5	393.4	393.2	394.1	393.8	391.9	391.7	393.7	393.5	394.3	393.9
MainBT050B	71092	71093	Natural	500	25	2285	2516	1753	2400	2622	381.1	380.9	393.5	393.4	394.2	394.1	392.0	391.9	393.8	393.7	394.3	394.3
MainBT050C	71091	71092	Natural	100	25	2285	2520	1778	2401	2623	381.1	381.1	393.5	393.5	394.2	394.2	392.0	392.0	393.8	393.8	394.4	394.3
MainBT050D	71090	71091	Natural	115	25	2265	2487	1777	2378	2591	381.1	381.1	393.7	393.5	394.4	394.2	392.2	392.0	394.0	393.8	394.5	394.4
MainBT050E	71089	71090	Natural	685	25	2265	2488	1795	2378	2594	382.2	381.1	394.3	393.7	395.0	394.4	392.8	392.2	394.6	394.0	395.2	394.5
MainBT050F	71088	71089	Natural	705	25	2265	2492	1826	2380	2600	383.4	382.2	394.8	394.3	395.5	395.0	393.3	392.8	395.2	394.6	395.7	395.2
MainBH030A	71087	71088	Natural	400	25	2266	2496	1851	2381	2605	384.5	383.4	395.5	394.8	396.4	395.5	394.0	393.3	396.0	395.2	396.6	395.7
MainBH030B	71086	71087	Natural	218	25	2266	2497	1860	2382	2606	385.5	384.5	395.8	395.5	396.6	396.4	394.4	394.0	396.3	396.0	396.8	396.6
BaileyHl	71085	71086	bridge	64	25	2107	2281	1667	2187	2304	385.5	385.5	395.9	395.8	396.7	396.6	394.4	394.4	396.3	396.3	396.9	396.8
BaileyHlrd	71085	71086	Roadway	64		0	0	0	0	0	400.0	400.0	395.8	395.8	396.6	396.6	394.4	394.4	396.3	396.3	396.8	396.8
MainBH010A	54741	71085	Natural	1275	25	2075	2250	1658	2206	2282	387.6	385.5	397.8	395.9	397.9	396.7	395.5	394.4	397.8	396.3	397.9	396.9
MainBH010B	54745	54741	Natural	725	25	2063	2228	1648	2203	2268	388.8	387.6	398.1	397.8	398.2	397.9	396.4	395.5	398.2	397.8	398.2	397.9
MainBH015A	71006	54745	Natural	550	25	2060	2213	1647	2196	2261	389.7	388.8	398.7	398.1	398.8	398.2	397.1	396.4	398.8	398.2	398.9	398.2
AcornPk	71007	71006	bridge	25	25	2060	2213	1650	2196	2261	390.0	389.7	398.8	398.7	399.0	398.8	397.4	397.1	399.0	398.8	399.0	398.9
MainBH010C	71124	71007	Natural	498	25	2060	2213	1655	2196	2261	391.4	390.0	399.5	398.8	399.7	399.0	398.2	397.4	399.6	399.0	399.7	399.0
MainBH010D	71084	71124	Natural	486	25	2060	2213	1660	2196	2261	392.8	391.4	400.3	399.5	400.6	399.7	399.3	398.2	400.6	399.6	400.7	399.7
OakPatch	71083	71084	bridge	52	25	2055	2204	1658	2190	2255	392.8	392.8	400.6	400.3	400.8	400.6	399.5	399.3	400.8	400.6	400.9	400.7
MainCV010	55294	71083	Natural	800	25	2055	2204	1662	2191	2256	393.8	392.8	402.0	400.6	402.3	400.8	401.1	399.5	402.3	400.8	402.4	400.9

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
MainCV070	55283	55294	Natural	800	25	2037	2173	1660	2161	2228	394.8	393.8	403.2	402.0	403.5	402.3	402.3	401.1	403.5	402.3	404.3	402.4
MainCV020	71082	55283	Natural	600	25	2031	2165	1655	2158	2226	395.5	394.8	404.0	403.2	405.0	403.5	403.1	402.3	404.9	403.5	405.8	404.3
CityView	71081	71082	bridge	58	25	2031	2229	1658	2207	2240	395.5	395.5	404.1	404.0	405.5	405.0	403.2	403.1	405.2	404.9	406.9	405.8
MainCV060	55272	71081	Natural	680	25	2028	2216	1660	2188	2334	395.3	395.5	404.9	404.1	406.1	405.5	403.9	403.2	405.9	405.2	407.0	406.9
MainCV050A	55274	55272	Natural	400	25	2015	2209	1643	2244	2446	395.4	395.3	405.8	404.9	406.6	406.1	404.3	403.9	406.4	405.9	407.2	407.0
MainCV050B	71005	55274	Natural	500	25	1998	2156	1601	2210	2417	395.4	395.4	406.4	405.8	407.0	406.6	404.6	404.3	406.9	406.4	407.5	407.2
Garfield	71004	71005	bridge	59	25	2008	2158	1602	2217	2428	394.7	395.4	406.6	406.4	407.1	407.0	404.8	404.6	407.0	406.9	407.6	407.5
MainCV040	71003	71004	Natural	1600	25	2044	2164	1659	2228	2483	398.9	394.7	407.5	406.6	407.8	407.1	406.7	404.8	407.8	407.0	409.3	407.6
Chambers#1	71002	71003	10'x9' CSP culvert	45	25	693	735	543	759	902	399.1	398.9	408.1	407.5	408.5	407.8	407.1	406.7	408.5	407.8	409.8	409.3
Chambers#2	71002	71003	10'x9' CSP culvert	45	25	693	735	543	759	902	399.1	398.9	408.1	407.5	408.5	407.8	407.1	406.7	408.5	407.8	409.8	409.3
Chamb-bike	71002	71003	13.3'x8' CSP culvert	45	25	659	682	564	701	835	400.0	400.0	408.1	407.5	408.5	407.8	407.1	406.7	408.5	407.8	409.8	409.3
MainPK080	55256	71002	Natural	500	25	2047	2151	1663	2219	2773	400.4	399.1	408.7	408.1	409.0	408.5	407.7	407.1	409.1	408.5	410.1	409.8
MainPK060	71080	55256	Natural	1000	25	1825	1905	1347	2033	2342	403.0	400.4	410.2	408.7	410.6	409.0	409.1	407.7	410.9	409.1	412.7	410.1
Polk	71079	71080	bridge	70	25	1810	1883	1331	2019	2086	403.0	403.0	410.7	410.2	411.1	410.6	409.5	409.1	411.4	410.9	412.9	412.7
Polkrd	71079	71080	Roadway	33		0	0	0	0	281	411.5	411.5	410.2	410.2	410.6	410.6	409.1	409.1	410.9	410.9	412.9	412.7
MainPK050	66991	71079	Natural	700	25	1799	1865	1319	2008	2190	403.8	403.0	411.8	410.7	412.1	411.1	410.6	409.5	412.4	411.4	413.5	412.9
MainPK020B	71128	66991	Natural	500	25	1782	1839	1317	1991	2169	404.4	403.8	412.4	411.8	412.7	412.1	411.2	410.6	413.0	412.4	414.0	413.5
MainPK020A	56048	71128	Natural	800	25	1782	1840	1319	1995	2193	405.4	404.4	413.5	412.4	413.7	412.7	412.2	411.2	414.0	413.0	414.8	414.0
MainPK040C	71127	56048	Natural	120	25	1771	1821	1319	1982	2180	405.5	405.4	413.8	413.5	414.0	413.7	412.6	412.2	414.3	414.0	415.1	414.8
MainPK040B	71125	71127	Natural	680	25	1770	1821	1320	1983	2183	406.1	405.5	415.3	413.8	415.5	414.0	414.1	412.6	415.8	414.3	416.6	415.1
MainPK040A	71078	71125	Natural	500	25	1770	1821	1321	1985	2237	406.6	406.1	415.4	415.3	415.5	415.5	414.1	414.1	415.9	415.8	417.5	416.6
Jefrsn#1	71077	71078	10.67' x 9.83' CSP culvert	46	25	885	911	661	993	1159	406.7	406.6	416.2	415.4	416.4	415.5	414.7	414.1	416.8	415.9	418.3	417.5
Jefrsn#2	71077	71078	10.67' x 9.83' CSP culvert	46	25	885	911	661	993	1159	406.7	406.6	416.2	415.4	416.4	415.5	414.7	414.1	416.8	415.9	418.3	417.5
Jefrsnrd	71077	71078	Roadway	46		0	0	0	0	13	418.0	418.0	415.4	415.4	415.5	415.5	414.1	414.1	415.9	415.9	418.3	418.1
MainMD170A	71076	71077	Natural	327	25	1772	1822	1323	1988	2335	407.0	406.7	416.9	416.2	417.0	416.4	415.0	414.7	417.2	416.8	418.4	418.3
Wash#1	71075	71076	7.9'x 10.67' CSP culvert	40	25	781	791	662	802	807	407.1	407.0	417.6	416.9	417.7	417.0	415.6	415.0	417.9	417.2	418.5	418.4
Wash#2	71075	71076	7.9'x 10.67' CSP culvert	40	25	781	791	662	802	807	407.1	407.0	417.6	416.9	417.7	417.0	415.6	415.0	417.9	417.2	418.5	418.4
Washngtnrd	71075	71076	Roadway	40		219	249	0	513	1576	416.4	416.4	417.6	417.5	417.7	417.5	415.0	415.0	417.9	417.6	418.5	418.4
MainMD170B	71074	71075	Natural	332	25	1746	1778	1324	1959	2331	407.3	407.1	417.8	417.6	417.9	417.7	416.4	415.6	418.1	417.9	418.7	418.5
Lawren#1	71073	71074	9.7'x10.67' CSP culvert	46	25	873	889	668	971	1112	407.3	407.3	418.4	417.8	418.5	417.9	416.8	416.4	418.7	418.1	419.3	418.7

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
Lawren#2	71073	71074	9.7'x10.67' CSP culvert	46	25	873	889	668	971	1112	407.3	407.3	418.4	417.8	418.5	417.9	416.8	416.4	418.7	418.1	419.3	418.7
Lawrencerd	71073	71074	Roadway	46		0	1	0	19	147	418.4	418.4	417.8	417.8	418.5	418.4	416.4	416.4	418.7	418.6	419.3	419.1
MainMD170C	71072	71073	Natural	337	25	1746	1779	1352	1962	2346	407.7	407.3	418.7	418.4	418.8	418.5	417.5	416.8	419.1	418.7	419.8	419.3
Lincoln#1	71071	71072	9.4'x 10.67' CSP culvert	47	25	857	862	677	910	962	407.8	407.7	419.2	418.7	419.3	418.8	417.9	417.5	419.7	419.1	420.5	419.8
Lincoln#2	71071	71072	9.4'x 10.67' CSP culvert	47	25	857	862	677	910	962	407.8	407.7	419.2	418.7	419.3	418.8	417.9	417.5	419.7	419.1	420.5	419.8
Lincolnrd	71071	71072	Roadway	47		34	54	0	166	595	418.8	418.7	419.2	419.0	419.3	419.1	417.5	417.5	419.7	419.5	420.5	420.1
MainMD150A	71070	71071	Natural	363	25	1749	1779	1362	1970	2357	408.1	407.8	419.8	419.2	419.9	419.3	418.2	417.9	420.4	419.7	421.5	420.5
Charn#1	71069	71070	10.8'x 10.67' CSP culvert	60	25	876	890	684	964	1024	408.2	408.1	420.2	419.8	420.4	419.9	418.6	418.2	420.9	420.4	422.0	421.5
Charn#2	71069	71070	10.8'x 10.67' CSP culvert	60	25	876	890	684	964	1024	408.2	408.1	420.2	419.8	420.4	419.9	418.6	418.2	420.9	420.4	422.0	421.5
Charnltnrd	71069	71070	Roadway	60		0	0	0	68	676	420.4	420.3	419.8	419.8	419.9	419.9	418.2	418.2	420.9	420.7	422.0	421.6
MainMD150B	71068	71069	Natural	126	25	1753	1781	1374	1984	2364	408.4	408.2	420.2	420.2	420.4	420.4	418.7	418.6	421.0	420.9	422.0	422.0
15th	71067	71068	9.8'x22' CSP culvert	87	25	1754	1781	1377	1988	2239	408.4	408.4	420.3	420.2	420.5	420.4	418.7	418.7	421.1	421.0	422.2	422.0
15thrd	71067	71068	Roadway	87		0	0	0	0	152	421.2	421.1	420.2	420.2	420.4	420.4	418.7	418.7	421.0	421.0	422.2	422.0
MainMD150C	71066	71067	Natural	145	25	1757	1782	1381	1996	2368	408.7	408.4	420.3	420.3	420.5	420.5	418.9	418.7	421.1	421.1	422.2	422.2
Olive#1	71065	71066	10'x 10.67' CSP culvert	50	25	848	832	692	907	951	408.7	408.7	420.8	420.3	420.9	420.5	419.3	418.9	421.6	421.1	422.5	422.2
Olive#2	71065	71066	10'x 10.67' CSP culvert	50		848	832	692	907	951	408.7	408.7	420.8	420.3	420.9	420.5	419.3	418.9	421.6	421.1	422.5	422.2
Oliverd	71065	71066	Roadway	50		106	142	0	399	1165	420.0	420.0	420.8	420.6	420.9	420.7	418.9	418.9	421.6	421.3	422.5	422.2
MainMD150D	71064	71065	Natural	376	25	1767	1784	1384	2018	2394	409.0	408.7	421.3	420.8	421.3	420.9	419.5	419.3	421.8	421.6	422.6	422.5
16th#1	71063	71064	10'x 10.67' CSP culvert	120	25	793	783	692	845	860	409.0	409.0	421.7	421.3	421.7	421.3	419.9	419.5	422.2	421.8	422.9	422.6
16th#2	71063	71064	10'x 10.67' CSP culvert	120	25	793	783	692	845	860	409.0	409.0	421.7	421.3	421.7	421.3	419.9	419.5	422.2	421.8	422.9	422.6
16thrd	71063	71064	Roadway	120		229	231	0	614	1311	420.3	420.3	421.7	421.4	421.7	421.4	419.5	419.5	422.2	421.8	422.9	422.6
MainMD150E	71062	71063	Natural	423	25	1767	1776	1386	2050	2425	409.3	409.0	421.8	421.7	421.9	421.7	420.6	419.9	422.3	422.2	423.0	422.9
Oak#1	71061	71062	9.6'x 10.67' CSP culvert	54	25	708	693	677	734	734	409.5	409.3	422.1	421.8	422.2	421.9	420.9	420.6	422.5	422.3	423.2	423.0

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
Oak#2	71061	71062	9.6'x 10.67' CSP culvert	54	25	708	693	677	734	734	409.5	409.3	422.1	421.8	422.2	421.9	420.9	420.6	422.5	422.3	423.2	423.0
Oakrd	71061	71062	Roadway	54		714	759	121	1082	1591	420.1	420.0	422.1	421.8	422.2	421.9	420.9	420.7	422.5	422.3	423.2	423.0
MainMD150F	71060	71061	Natural	350	25	1773	1777	1412	2071	2454	409.6	409.5	422.2	422.1	422.3	422.2	421.2	420.9	422.7	422.5	423.3	423.2
Pearl#1	71059	71060	8.4'x 10.67' CSP culvert	80	25	650	652	666	644	636	409.6	409.6	422.4	422.2	422.4	422.3	421.6	421.2	422.8	422.7	423.4	423.3
Pearl#2	71059	71060	8.4'x 10.67' CSP culvert	80	25	650	652	666	644	636	409.6	409.6	422.4	422.2	422.4	422.3	421.6	421.2	422.8	422.7	423.4	423.3
Pearlrd	71059	71060	Roadway	80		1114	1146	334	1474	1957	420.1	420.0	422.4	422.2	422.4	422.3	421.6	421.2	422.8	422.7	423.4	423.3
MainMD150G	66998	71059	Natural	510	25	1763	1760	1551	2077	2466	410.2	409.6	422.5	422.4	422.6	422.4	421.8	421.6	422.9	422.8	423.5	423.4
18th#1	71057	66998	10.8'x 10.67' CSP culvert	50	25	820	799	833	913	961	410.2	410.2	423.1	422.5	423.2	422.6	422.2	421.8	423.6	422.9	424.0	423.5
18th#2	71057	66998	10.8'x 10.67' CSP culvert	50	25	820	799	833	913	961	410.2	410.2	423.1	422.5	423.2	422.6	422.2	421.8	423.6	422.9	424.0	423.5
18thrd	71057	66998	Roadway	50		190	190	6	376	902	422.1	422.0	423.1	422.9	423.2	422.9	422.2	422.1	423.6	423.3	424.0	423.6
MainMD030	57188	71057	Natural	350	25	1793	1745	1701	2163	2682	410.8	410.2	423.3	423.1	423.4	423.2	422.9	422.2	423.7	423.6	424.1	424.0
19th	57163	57188	10.5'x22' CSP culvert	53	25	1705	1662	1763	2008	2264	410.8	410.8	423.4	423.3	423.4	423.4	422.9	422.9	423.8	423.7	424.3	424.1
19thrd	57163	57188	Roadway	53		108	114	25	191	503	422.5	422.5	423.4	423.3	423.4	423.4	422.9	422.9	423.8	423.7	424.3	424.1
MainMD100A	71054	57163	Natural	1975	25	1777	1734	1795	2277	2980	414.7	410.8	425.4	423.4	425.3	423.4	424.6	422.9	427.0	423.8	428.4	424.3
24th#1	71053	71054	7'x9.68' CSP culverts	46	25	895	874	901	1063	1087	417.2	417.2	426.4	425.4	426.3	425.3	425.9	424.6	428.0	427.0	428.7	428.4
24th#2	71053	71054	7'x9.68' CSP culvert	46	25	895	874	901	1063	1087	417.2	417.2	426.4	425.4	426.3	425.3	425.9	424.6	428.0	427.0	428.7	428.4
24thrd	71053	71054	Roadway	46		0	0	0	573	1943	427.2	427.2	425.4	425.4	425.3	425.3	424.6	424.6	428.0	427.6	428.7	428.4
MainMD100B	54172	71053	Natural	650	25	1744	1710	1787	2335	2928	418.9	417.2	427.9	426.4	427.8	426.3	427.9	425.9	430.1	428.0	430.4	428.7
MainMD040	66967	54172	Natural	1300	25	1503	1483	1567	2020	2559	420.0	418.9	428.7	427.9	428.5	427.8	428.7	427.9	430.9	430.1	431.7	430.4
MainMD110	54174	66967	Natural	150	25	1420	1412	1497	1913	2423	420.2	420.0	428.7	428.7	428.6	428.5	428.7	428.7	431.0	430.9	431.8	431.7
MainUP050	65370	67978	Natural	1400	25	547	572	626	920	1034	457.0	446.8	461.8	455.6	461.9	455.7	462.1	456.2	463.9	457.5	464.9	457.9
MainMD120	71052	54175	Natural	700	25	1359	1362	1460	1872	2353	422.2	421.0	429.5	428.8	429.3	428.7	429.5	428.8	431.5	431.0	432.4	431.9
29th	71051	71052	7.5'x15' CMP M baskhnd culvert	80	25	1336	1342	1443	1832	1923	425.0	425.0	432.9	431.3	432.9	431.3	433.3	431.6	434.6	432.7	434.9	433.0
29thrd	71051	71052	Roadway	80		0	0	0	31	409	434.5	434.5	429.5	429.5	429.3	429.3	429.5	429.5	434.6	434.5	434.9	434.7
MainMD060A	71001	71051	Natural	725	25	1336	1343	1446	1865	2332	426.7	425.0	434.3	432.9	434.4	432.9	434.7	433.3	435.9	434.6	436.6	434.9
30th	71000	71001	bridge	79	25	1337	1344	1451	1866	2332	426.8	426.7	434.7	434.3	434.7	434.4	435.0	434.7	436.2	435.9	436.9	436.6

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
MainMD060B	51750	71000	Natural	335	25	1337	1345	1455	1868	2332	427.5	426.8	435.3	434.7	435.3	434.7	435.6	435.0	436.8	436.2	437.7	436.9
31st	51751	51750	7.5'x15' CMP M baskhnd culvert	84	25	1337	1346	1458	1868	2212	427.5	427.5	436.3	435.3	436.3	435.3	436.7	435.6	438.1	436.8	439.1	437.7
31strd	51751	51750	Roadway	84		0	0	0	0	144	438.1	438.1	435.3	435.3	435.3	435.3	435.6	435.6	436.8	436.8	439.1	438.8
MainUP160A	51757	51751	Natural	415	25	1286	1300	1405	1824	2293	428.8	427.5	436.8	436.3	436.8	436.3	437.2	436.7	438.8	438.1	440.1	439.1
MainUP160B	51730	51757	Natural	268	25	1223	1243	1350	1775	2214	429.6	428.8	437.2	436.8	437.2	436.8	437.6	437.2	439.5	438.8	440.6	440.1
33rd	51729	51730	8'x15' CMP M baskhnd culvert	220	25	1119	1130	1219	1649	1874	431.1	429.6	438.4	437.2	438.5	437.2	438.9	437.6	440.9	439.5	442.0	440.6
33rdrd	51729	51730	8'x15' CMP M baskhnd culvert	220	25	0	0	0	0	174	440.9	440.5	437.2	437.2	437.2	437.2	437.6	437.6	439.5	439.5	442.0	441.3
MainUP170	66944	51729	Natural	1390	25	1095	1108	1194	1705	2094	434.9	431.1	442.7	438.4	442.7	438.5	443.0	438.9	445.2	440.9	445.3	442.0
MainUP150A	50544	66944	Natural	1240	25	987	997	1071	1622	1835	441.3	434.9	447.7	442.7	447.7	442.7	447.9	443.0	449.7	445.2	450.0	445.3
MainUP150B	50517	50544	Natural	1340	25	909	921	993	1485	1720	446.5	441.3	453.1	447.7	453.2	447.7	453.4	447.9	454.7	449.7	456.3	450.0
FoxHolw#1	67978	50517	72" CSP culverts	225	25	288	290	300	318	319	447.5	446.5	455.6	453.1	455.7	453.2	456.2	453.4	457.5	454.7	457.9	456.3
FoxHolw#2	67978	50517	72" CSP culvert	225	25	284	289	300	318	319	446.8	446.5	455.6	453.1	455.7	453.2	456.2	453.4	457.5	454.7	457.9	456.3
FoxHolwrd	67978	50517	Roadway	225		0	0	15	308	607	455.8	455.8	453.1	453.1	453.2	453.2	456.2	456.0	457.5	457.0	457.9	457.2
MainMD050	54175	54174	Natural	175	25	1378	1376	1474	1870	2372	421.0	420.2	428.8	428.7	428.7	428.6	428.8	428.7	431.0	431.0	431.9	431.8
MainUP020	65398	65370	Natural	1050	25	397	408	435	681	843	467.0	457.0	471.3	461.8	471.4	461.9	471.6	462.1	473.0	463.9	474.5	464.9
Snell	65396	65398	72" CSP culvert	37	25	326	334	345	358	358	467.0	467.0	473.8	471.3	474.0	471.4	474.2	471.6	475.2	473.0	475.6	474.5
Snellrd	65396	65398	Roadway	37		0	0	2	215	454	474.1	474.1	471.3	471.3	471.4	471.4	474.2	474.2	475.2	475.1	475.6	475.1
MainUP030	65379	65396	Natural	2100	25	251	261	270	421	531	502.4	467.0	506.6	473.8	506.6	474.0	506.7	474.2	507.6	475.2	508.2	475.6
Amazon - Lower Sub-Basin																						
AMLW030E	63042	63032	66" CSP	425	10	62	70	75	87	92	375.5	375.0	384.0	383.9	384.7	384.6	382.2	382.2	384.3	384.2	384.8	384.7
AMLW030Erd	63042	63032	Roadway	425		0	0	0	0	0	388.1	386.5	383.9	383.9	384.6	384.6	382.2	382.2	384.2	384.2	384.7	384.7
AMLW030F	69111	63042	60" CSP	1038	10	62	70	76	87	92	376.3	375.5	384.5	384.0	385.3	384.7	382.2	382.2	384.6	384.3	385.3	384.8
AMLW030Frd	69111	63042	Roadway	1038		0	3	0	0	2	385.2	385.1	384.0	384.0	385.3	385.1	382.2	382.2	384.3	384.3	385.3	385.1
AMLW030G	63178	69111	54" CSP	1351	10	62	70	76	73	69	377.2	376.3	385.6	384.5	385.9	385.3	382.9	382.2	385.9	384.6	386.2	385.3
AMLW030Grd	63178	69111	Roadway	1351		7	39	0	27	73	385.4	384.2	385.6	384.5	385.9	385.3	382.2	382.2	385.9	384.6	386.2	385.3
Amazon - Bertelsen Sub-basin																						
AMBT020A	54522	63126	48" CSP	1239	10	63	65	91	75	70	383.6	381.7	391.0	389.8	391.8	390.8	391.2	387.6	391.9	390.4	392.8	390.9
AMBT020Ard	63126	54522	Roadway	1239		0	0	0	0	0	394.8	391.0	391.0	391.0	391.8	391.8	391.2	391.2	391.9	391.9	392.8	392.8
AMBT020B	66971	54522	42" CSP	761	10	27	28	46	63	63	387.6	383.7	391.5	391.0	394.7	391.8	393.1	391.2	395.0	391.9	395.1	392.8
AMBT020Brd	66971	54522	Roadway	761		0	0	0	0	7	395.0	391.0	391.0	391.0	391.8	391.8	391.2	391.2	395.0	391.9	395.1	392.8
AMBT010A	63173	63127	36" CSP	77	10	24	26	29	49	59	383.2	383.0	391.7	391.5	392.6	392.3	389.8	389.8	392.1	392.0	392.6	392.5
AMBT030A	54486	63127	66" CSP	2250	10	55	53	76	93	106	386.7	384.4	391.9	391.5	392.8	392.3	390.4	389.8	392.7	392.0	393.7	392.5
AMBT030B	54488	54486	60" CSP	2208	10	57	58	77	97	110	389.8	386.7	392.9	391.9	393.7	392.8	393.5	390.4	395.7	392.7	397.5	393.7

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMBT030Brd	54488	54486	Roadway	2208		0	0	0	0	5	397.3	393.6	391.9	391.9	392.8	392.8	390.4	390.4	392.7	392.7	397.5	393.7
AMBT030C	54489	54488	54" CSP	358	10	58	59	78	103	123	391.3	389.8	393.5	392.9	393.9	393.7	394.2	393.5	396.8	395.7	399.1	397.5
AMBT030Crd	54489	54488	Roadway	358		0	0	0	0	0	400.1	397.3	392.9	392.9	393.7	393.7	393.5	393.5	395.7	395.7	397.5	397.5
AMBT030D	68843	54489	42" CSP	508	10	58	60	79	101	100	393.4	391.3	396.8	393.5	397.0	393.9	398.5	394.2	401.8	396.8	402.1	399.1
AMBT030Drd	68843	54489	Roadway	508		0	0	0	12	57	401.6	400.1	393.5	393.5	393.9	393.9	394.2	394.2	401.8	400.2	402.1	400.5
AMBT090A	54809	68843	30" CSP	1144	10	22	24	28	37	32	406.0	394.6	407.4	396.8	407.4	397.0	407.6	398.5	410.7	401.8	410.8	402.1
AMBT090Ard	54809	68843	Roadway	1144		0	0	0	8	18	410.6	401.6	396.8	396.8	397.0	397.0	398.5	398.5	410.7	401.8	410.8	402.1
AMBT090B	51993	54809	27" CSP	978	10	22	24	28	36	36	420.0	406.3	421.4	407.6	421.4	407.7	421.6	407.8	427.1	410.7	427.1	410.8
AMBT090Brd	51993	54809	Roadway	978		0	0	0	7	18	427.0	410.6	407.4	407.4	407.4	407.4	407.6	407.6	427.1	410.7	427.1	410.8
AMBT090C	51995	51993	24" CSP	690	10	22	24	28	42	42	444.4	420.6	445.6	421.7	445.6	421.7	445.8	421.8	452.3	427.1	452.3	427.1
AMBT090Crd	51995	51993	Roadway	690		0	0	0	8	21	452.2	427.0	421.4	421.4	421.4	421.4	421.6	421.6	452.3	427.1	452.3	427.1
AMBT040A	54747	54748	54" CSP	445	10	47	48	80	96	94	386.6	383.0	393.4	393.2	394.1	393.8	391.7	391.7	393.9	393.5	394.4	393.9
AMBT040Ard	54748	54747	Roadway	445		0	0	0	0	0	395.4	394.0	393.4	393.4	394.1	394.1	391.7	391.7	393.9	393.9	394.4	394.4
AMBT040B	66976	54747	Natural	500	10	33	32	57	63	63	387.6	386.6	393.4	393.4	394.1	394.1	391.7	391.7	393.9	393.9	394.5	394.4
AMBT040C	54813	66976	54" CSP	13	10	33	34	57	67	62	384.3	387.6	393.5	393.4	394.1	394.1	391.7	391.7	394.0	393.9	394.5	394.5
AMBT040Crd	54813	66976	Roadway	13		0	5	0	1	56	394.0	393.9	393.4	393.4	394.1	394.1	391.7	391.7	394.0	393.9	394.5	394.5
AMBT040D	54811	54813	54" CSP	596	10	33	34	57	67	74	384.9	384.3	393.5	393.5	394.2	394.1	392.2	391.7	394.8	394.0	395.4	394.5
AMBT040Drd	54811	54813	Roadway	596		0	0	0	0	0	395.9	394.0	393.5	393.5	394.1	394.1	391.7	391.7	394.0	394.0	394.5	394.5
AMBT040E	54909	54811	48" CSP	980	10	33	34	57	67	62	386.9	385.3	393.8	393.5	394.6	394.2	394.2	392.2	396.8	394.8	397.0	395.4
AMBT040Erd	54909	54811	Roadway	980		0	0	0	8	23	396.5	395.9	393.5	393.5	394.2	394.2	392.2	392.2	396.8	396.0	397.0	396.1
AMBT060A	54898	54909	48" CSP	604	10	20	20	35	56	64	388.7	386.9	393.9	393.8	394.7	394.6	394.8	394.2	398.0	396.8	398.5	397.0
Amazon Bailey Hill																						
AMBH020A	54773	71086	72" CSP	2886	25	186	191	222	229	224	392.7	386.2	401.8	395.8	402.4	396.6	402.5	394.4	405.1	396.3	405.4	396.8
AMBH020Ard	54773	71086	Roadway	2886		0	0	0	18	62	404.8	400.0	395.8	395.8	396.6	396.6	394.4	394.4	405.1	400.2	405.4	400.4
AMBH020B	54772	71086	72" CSP	2884	25	179	184	216	220	214	392.7	386.2	401.4	395.8	402.0	396.6	402.2	394.4	404.4	396.3	404.7	396.8
AMBH020Brd	54772	71086	Roadway	2884		0	0	0	22	62	404.0	400.0	395.8	395.8	396.6	396.6	394.4	394.4	404.4	400.2	404.7	400.4
AMBH050A	54815	54773	66" CSP	320	25	165	171	193	235	251	393.2	392.8	402.8	401.8	403.3	402.4	404.0	402.5	407.2	405.1	407.7	405.4
AMBH050Ard	54815	54773	Roadway	320		0	0	0	0	23	407.5	404.8	401.8	401.8	402.4	402.4	402.5	402.5	405.1	405.1	407.7	405.4
AMBH020C	54815	54772	66" CSP	312	25	158	163	180	221	232	393.2	392.7	402.8	401.4	403.3	402.0	404.0	402.2	407.2	404.4	407.7	404.7
AMBH020Crd	54815	54772	Roadway	312		0	0	0	0	27	407.5	404.0	401.4	401.4	402.0	402.0	402.2	402.2	404.4	404.4	407.7	404.7
AMBH050B	68846	54815	84" CSP	132	25	312	323	366	445	444	393.9	393.2	403.5	402.8	403.9	403.3	404.8	404.0	408.4	407.2	408.9	407.7
AMBH050Brd	68846	54815	Roadway	132		0	0	0	0	74	408.5	407.5	402.8	402.8	403.3	403.3	404.0	404.0	407.2	407.2	408.9	407.9
AMBH050C	52255	68846	72" CSP	528	25	312	322	366	347	342	397.3	394.7	406.9	403.5	407.4	403.9	409.1	404.8	411.7	408.4	411.8	408.9
AMBH050Crd	52255	68846	Roadway	528		0	0	0	143	221	411.0	408.5	403.5	403.5	403.9	403.9	404.8	404.8	411.7	409.2	411.8	409.3
AMBH070C	52243	52255	36" CSP	595	10	51	51	68	76	76	411.8	405.6	414.0	407.6	414.1	407.6	416.9	409.1	420.3	411.7	420.3	411.8
AMBH070Crd	52243	52255	Roadway	595		0	0	0	55	80	420.0	411.0	406.9	406.9	407.4	407.4	409.1	409.1	420.3	411.7	420.3	411.8
AMBH070D	52248	52243	33" CSP	515	10	51	51	68	72	72	421.8	413.6	423.7	415.4	423.8	415.5	426.8	416.9	427.3	420.3	427.4	420.3
AMBH070Drd	52248	52243	Roadway	515		0	0	0	71	95	427.0	420.0	414.0	414.0	414.1	414.1	416.9	416.9	427.3	420.3	427.4	420.4
AMBH070E	52240	52248	30" CSP	442	10	51	51	60	60	60	432.7	423.9	435.4	425.8	435.5	425.8	438.3	426.8	438.5	427.3	438.5	427.4
AMBH070Erd	52240	52248	Roadway	442		0	0	10	75	98	438.2	427.0	423.7	423.7	423.8	423.8	438.3	427.1	438.5	427.3	438.5	427.4
AMBH070F	66465	52240	27" CSP	290	10	51	51	57	61	61	445.3	434.2	448.7	435.8	448.9	435.8	451.9	438.3	452.0	438.5	452.1	438.5
AMBH070Frd	66465	52240	Roadway	290		0	0	15	77	100	451.8	438.2	435.4	435.4	435.5	435.5	451.9	438.3	452.0	438.5	452.1	438.5
AMBH070A	52163	52255	66" CSP	515	10	254	266	312	268	256	400.4	397.7	410.5	406.9	411.0	407.4	411.6	409.1	412.5	411.7	412.8	411.8
AMBH070Ard	52163	52255	Roadway	515		0	0	60	217	274	410.4	411.0	410.5	410.5	411.0	411.0	411.6	411.4	412.5	412.1	412.8	412.2
AMBH070B	67805	52163	54" CSP	1272	10	230	234	234	235	232	416.6	400.4	427.2	410.5	427.3	411.0	427.5	411.6	427.9	412.5	428.2	412.8

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMBH070Brd	67805	52163	Roadway	1272		47	76	128	291	398	427.0	410.4	427.2	410.6	427.3	411.0	427.5	411.6	427.9	412.5	428.2	412.8
AMBH120A	52213	67805	54" CSP	311	10	210	232	235	237	237	423.1	416.6	432.6	427.2	433.9	427.3	434.2	427.5	434.5	427.9	434.7	428.2
AMBH120Ard	52213	67805	Roadway	311		0	0	37	222	317	434.0	427.0	427.2	427.2	427.3	427.3	434.2	427.5	434.5	427.9	434.7	428.2
AMBH120E	52216	52213	36" CSP	170	10	28	31	41	47	46	428.9	423.1	433.0	432.6	434.4	433.9	434.9	434.2	435.6	434.5	435.7	434.7
AMBH120Erd	52216	52213	Roadway	170		0	0	0	15	29	435.5	434.0	432.6	432.6	433.9	433.9	434.2	434.2	435.6	434.5	435.7	434.7
AMBH120F	52217	52216	30" CSP	230	10	28	31	36	53	53	433.0	428.8	434.5	433.0	435.8	434.4	437.0	434.9	440.1	435.6	440.1	435.7
AMBH120Frd	52217	52216	Roadway	230		0	0	0	7	20	440.0	435.5	433.0	433.0	434.4	434.4	434.9	434.9	440.1	435.6	440.1	435.7
AMBH120G	52145	52217	27" CSP	372	10	28	30	36	62	74	459.0	434.0	460.0	435.0	460.0	435.8	460.1	437.0	460.6	440.1	465.9	440.1
AMBH120Grd	52145	52217	Roadway	372		0	0	0	0	0	466.0	440.0	434.5	434.5	435.8	435.8	437.0	437.0	440.1	440.1	440.1	440.1
AMBH120B	68649	52213	48" CSP	430	10	183	204	207	208	208	436.1	424.1	440.6	432.6	444.2	433.9	444.8	434.2	445.1	434.5	445.2	434.7
AMBH120Brd	68649	52213	Roadway	430		0	0	32	193	272	444.6	434.0	432.6	432.6	433.9	433.9	444.8	434.2	445.1	434.5	445.2	434.7
AMBH120C	52167	68649	36" CSP	1057	10	92	99	114	114	114	479.5	438.1	481.7	440.6	481.7	444.2	487.0	444.8	487.3	445.1	487.3	445.2
AMBH120Crd	52167	68649	Roadway	1057		0	0	5	85	124	487.0	444.6	440.6	440.6	444.2	444.2	487.0	444.8	487.3	445.1	487.3	445.2
AMBH120D	52214	68649	36" CSP	321	10	94	114	125	172	172	465.3	438.1	466.9	440.6	466.9	444.2	467.0	444.8	471.7	445.1	471.8	445.2
AMBH120Drd	52214	68649	Roadway	321		0	0	0	35	75	471.6	444.6	440.6	440.6	444.2	444.2	444.8	444.8	471.7	445.1	471.8	445.2
AMBH015A	54776	54745	36" CSP	13	10	19	20	32	52	59	390.7	392.0	398.1	398.1	398.2	398.2	396.4	396.4	398.2	398.2	398.2	398.2
AMBH015Ard	54776	54745	Roadway	13		4	9	0	6	13	398.0	398.0	398.1	398.1	398.2	398.2	396.4	396.4	398.2	398.2	398.2	398.2
AMBH015B	54867	54776	36" CSP	384	10	19	20	32	52	49	391.6	390.7	398.3	398.1	398.5	398.2	396.4	396.4	399.2	398.2	399.4	398.2
AMBH015Brd	54867	54776	Roadway	384		0	0	0	0	17	399.2	398.0	398.1	398.1	398.2	398.2	396.4	396.4	399.2	398.2	399.4	398.2
AMBH015C	54854	54867	30" CSP	278	10	19	20	32	42	40	393.7	391.0	398.7	398.3	399.0	398.5	398.0	396.4	401.2	399.2	401.3	399.4
AMBH015Crd	54854	54867	Roadway	278		0	0	0	21	34	401.0	399.2	398.3	398.3	398.5	398.5	396.4	396.4	401.2	399.4	401.3	399.5
Amazon - City View Sub-Basin																						
AMCV070A	68093	55294	48" CSP	766	10	42	44	50	68	65	396.8	395.2	402.7	402.0	403.2	402.3	401.5	401.1	403.4	402.3	403.7	402.4
AMCV070Ard	68093	55294	Roadway	766		0	0	0	2	16	403.2	403.0	402.0	402.0	403.2	403.0	401.1	401.1	403.4	403.0	403.7	403.2
AMCV070B	55344	68093	42" CSP	420	10	42	43	50	68	64	398.2	397.0	403.6	402.7	404.1	403.2	402.7	401.5	405.1	403.4	405.2	403.7
AMCV070Brd	55344	68093	Roadway	420		0	0	0	13	36	404.9	403.2	402.7	402.7	403.2	403.2	401.5	401.5	405.1	403.4	405.2	403.7
AMCV070C	55365	55344	36" CSP	1238	10	42	45	52	70	70	413.4	398.4	415.1	403.6	415.1	404.1	415.4	402.7	421.8	405.1	421.9	405.2
AMCV070Crd	55365	55344	Roadway	1238		0	0	0	15	38	421.7	404.9	403.6	403.6	404.1	404.1	402.7	402.7	421.8	405.1	421.9	405.2
AMCV030A	55432	55272	42" CSP	1773	10	21	22	33	35	34	399.1	396.2	405.3	404.9	406.5	406.1	406.0	403.9	406.5	405.9	407.0	407.0
AMCV030Ard	55432	55272	Roadway	1773		0	1	0	1	25	406.4	404.9	404.9	404.9	406.5	406.1	403.9	403.9	406.5	405.9	407.0	407.0
AMCV030B	55446	55272	30" CSP	440	10	5	13	8	12	19	398.6	395.3	404.9	404.9	406.1	406.1	404.0	403.9	405.9	405.9	407.0	407.0
AMCV030Brd	55272	55446	Roadway	440		0	23	0	18	59	404.9	405.2	404.9	404.9	406.1	406.1	403.9	403.9	405.9	405.9	407.0	407.0
AMCV030C	55432	55446	24" CSP	1540	10	5	6	8	9	8	400.6	398.6	405.3	404.9	406.5	406.1	406.0	404.0	406.5	405.9	407.0	407.0
AMCV030Crd	55432	55446	Roadway	1540		0	1	0	1	28	406.4	405.2	404.9	404.9	406.5	406.1	404.0	404.0	406.5	405.9	407.0	407.0
AMCV050A	55395	55274	48" CSP	650	10	66	67	75	103	103	400.3	396.0	406.7	405.8	407.7	406.6	406.4	404.3	409.3	406.4	409.8	407.2
AMCV050Ard	55395	55274	Roadway	650		0	0	0	1	27	409.2	409.0	405.8	405.8	406.6	406.6	404.3	404.3	409.3	409.0	409.8	409.2
AMCV050B	55396	55395	42" CSP	256	10	66	67	75	92	90	404.9	400.8	408.1	406.7	409.1	407.7	408.5	406.4	411.2	409.3	411.3	409.8
AMCV050Brd	55396	55395	Roadway	256		0	0	0	36	73	410.9	409.2	406.7	406.7	407.7	407.7	406.4	406.4	411.2	409.5	411.3	409.8
AMCV050C	55369	55396	36" CSP	11	10	27	27	29	32	35	405.0	404.9	408.3	408.1	409.2	409.1	408.6	408.5	411.3	411.2	411.4	411.3
AMCV050Crd	55369	55396	Roadway	11		0	0	0	2	23	411.3	410.9	408.1	408.1	409.1	409.1	408.5	408.5	411.3	411.2	411.4	411.3
AMCV050D	55382	55369	30" CSP	621	10	27	27	29	30	30	409.6	405.0	411.3	408.3	411.4	409.2	411.6	408.6	415.1	411.3	415.2	411.4
AMCV050Drd	55382	55369	Roadway	621		0	0	0	3	20	415.0	411.3	408.3	408.3	409.2	409.2	408.6	408.6	415.1	411.4	415.2	411.5
AMCV050H	55382	55396	42" CSP	613	10	41	41	51	75	75	409.6	404.9	411.3	408.1	411.4	409.1	411.6	408.5	415.1	411.2	415.2	411.3
AMCV050Hrd	55382	55396	Roadway	613		0	0	0	4	21	415.0	410.9	408.1	408.1	409.1	409.1	408.5	408.5	415.1	411.2	415.2	411.3
AMCV050I	68794	55382	36" CSP	1203	10	48	49	57	59	59	419.7	409.6	422.4	411.7	422.8	411.8	425.1	412.0	425.3	415.1	425.4	415.2

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMCV050Ird	68794	55382	Roadway	1203		0	0	0	33	57	425.1	415.0	411.3	411.3	411.4	411.4	411.6	411.6	425.3	415.2	425.4	415.3
AMCV050J	52716	68794	30" CSP	884	10	49	50	50	52	52	429.0	419.7	436.3	422.4	437.2	422.8	437.3	425.1	437.5	425.3	437.5	425.4
AMCV050Jrd	52716	68794	Roadway	884		0	0	12	50	74	437.2	425.1	422.4	422.4	437.2	425.1	437.3	425.2	437.5	425.4	437.5	425.4
AMCV050K	52713	52716	27" CSP	872	10	49	51	55	55	55	461.8	429.1	463.6	436.3	465.2	437.2	469.3	437.3	469.4	437.5	469.4	437.5
AMCV050Krd	52713	52716	Roadway	872		0	0	6	49	71	469.2	437.2	436.3	436.3	437.2	437.2	469.3	437.3	469.4	437.5	469.4	437.5
AMCV050L	52573	52713	30" CSP	115	10	49	53	61	86	86	470.0	463.0	471.4	464.3	471.5	465.2	472.7	469.3	476.3	469.4	476.3	469.4
AMCV050Lrd	52573	52713	Roadway	115		0	0	0	19	41	476.2	469.2	463.6	463.6	465.2	465.2	469.3	469.3	476.3	469.4	476.3	469.4
AMCV050E	52736	55382	30" CSP	1053	10	19	20	22	37	38	419.2	409.6	420.5	411.3	420.5	411.4	420.6	411.6	425.0	415.1	426.1	415.2
AMCV050Erd	52736	55382	Roadway	1053		0	0	0	0	6	426.0	415.0	411.3	411.3	411.4	411.4	411.6	411.6	415.1	415.1	426.1	415.2
AMCV050F	52733	52736	24" CSP	940	10	19	20	22	30	31	436.4	422.8	437.8	424.1	437.8	424.2	438.0	424.3	444.3	425.0	444.3	426.1
AMCV050Frd	52733	52736	Roadway	940		0	0	0	7	18	444.2	426.0	420.5	420.5	420.5	420.5	420.6	420.6	444.3	426.1	444.3	426.1
AMCV050G	52730	52733	18" CSP	617	10	19	20	21	21	21	462.5	436.6	463.8	437.8	463.8	437.8	467.0	438.1	467.1	444.3	467.1	444.3
AMCV050Grd	52730	52733	Roadway	617		0	0	1	22	31	467.0	444.2	437.8	437.8	437.8	437.8	467.0	444.2	467.1	444.3	467.1	444.3
Amazon - Polk Street Sub-Basin																						
AMPK070A	55289	55256	66" CSP	1262	10	134	141	158	177	177	406.1	401.1	410.4	408.7	410.8	409.0	410.5	407.7	412.0	409.1	412.8	410.1
AMPK070Ard	55289	55256	Roadway	1262		0	0	0	0	0	414.0	414.0	408.7	408.7	409.0	409.0	407.7	407.7	409.1	409.1	410.1	410.1
AMPK070B	52686	55289	60" CSP	905	10	137	142	160	182	179	408.5	406.1	413.2	410.4	413.7	410.8	414.5	410.5	416.5	412.0	416.8	412.8
AMPK070Brd	52686	55289	Roadway	905		0	0	0	0	22	416.5	414.1	410.4	410.4	410.8	410.8	410.5	410.5	416.5	414.1	416.8	414.3
AMPK070C	52685	52686	66" CSP	1555	10	138	144	161	182	205	413.7	408.5	417.3	413.2	417.4	413.7	418.4	414.5	421.9	416.5	423.5	416.8
AMPK070Crd	52685	52686	Roadway	1555		0	0	0	0	0	429.8	416.5	413.2	413.2	413.7	413.7	414.5	414.5	416.5	416.5	416.8	416.8
AMPK090A	52707	52685	36" CSP	1550	10	60	64	75	85	86	443.4	413.7	445.3	417.3	445.3	417.4	445.8	418.4	452.2	421.9	452.3	423.5
AMPK090Ard	52707	52685	Roadway	1550		0	0	0	36	66	452.0	429.8	417.3	417.3	417.4	417.4	418.4	418.4	452.2	430.0	452.3	430.1
AMPK060A	55290	55256	66" CSP	1263	10	84	92	121	159	164	405.9	400.7	409.2	408.7	409.8	409.0	409.6	407.7	411.3	409.1	412.1	410.1
AMPK060Ard	55256	55290	Roadway	1263		0	0	0	0	0	414.0	413.9	409.2	409.2	409.8	409.8	409.6	409.6	411.3	411.3	412.1	412.1
AMPK060B	52689	55290	60" CSP	1354	10	87	94	130	170	170	411.4	405.9	414.1	409.2	414.2	409.8	415.0	409.6	416.8	411.3	418.4	412.1
AMPK060C#1	66476	52689	48" CSP	1092	10	67	69	76	83	84	413.6	411.4	417.8	414.1	417.9	414.2	418.6	415.0	421.1	416.8	422.8	418.4
AMPK060C#2	66476	52689	60" CSP	855	10	97	104	135	167	169	414.5	411.4	417.8	414.1	417.9	414.2	418.6	415.0	421.1	416.8	422.8	418.4
AMPK060Crd	66476	52689	Roadway	1092		0	0	0	0	0	424.1	419.0	414.1	414.1	414.2	414.2	415.0	415.0	416.8	416.8	418.4	418.4
AMPK060D	52687	55256	54" CSP	1589	25	94	95	117	121	123	407.7	401.5	411.7	408.7	412.3	409.0	413.0	407.7	414.8	409.1	416.0	410.1
AMPK060Drd	52687	55256	Roadway	1589		0	0	0	0	0	416.0	413.0	408.7	408.7	409.0	409.0	407.7	407.7	409.1	409.1	416.0	413.0
AMPK060E	52689	52687	48" CSP	573	10	81	81	89	88	94	411.4	407.7	414.1	411.7	414.2	412.3	415.0	413.0	416.8	414.8	418.4	416.0
AMPK060Erd	52689	52687	Roadway	573		0	0	0	0	0	419.0	416.0	411.7	411.7	412.3	412.3	413.0	413.0	414.8	414.8	416.0	416.0
AMPK170A	53474	66476	60" CSP	256	10	98	103	127	159	156	415.0	414.5	418.7	417.8	418.8	417.9	419.6	418.6	422.3	421.1	423.9	422.8
AMPK090B	53474	52685	48" CSP	391	10	70	73	74	83	88	416.0	413.7	418.7	417.3	418.8	417.4	419.6	418.4	422.3	421.9	423.9	423.5
AMPK170B	53457	53474	48" CSP	28	10	168	176	199	223	223	416.2	416.1	421.7	419.8	421.9	419.8	422.6	420.0	424.9	422.3	426.2	423.9
AMPK170Brd	53457	53474	Roadway	28		0	0	0	0	12	426.0	426.0	418.7	418.7	418.8	418.8	419.6	419.6	422.3	422.3	426.2	426.1
AMPK170C	53441	53457	54" CSP	766	10	143	148	168	192	192	422.8	416.2	427.3	421.7	428.1	421.9	430.9	422.6	434.7	424.9	434.7	426.2
AMPK170Crd	53441	53457	Roadway	766		0	0	0	20	43	434.5	426.0	421.7	421.7	421.9	421.9	422.6	422.6	434.7	426.2	434.7	426.2
AMPK170D	53415	53441	54" CSP	1374	10	105	109	123	132	131	430.7	422.8	433.6	427.3	433.9	428.1	436.7	430.9	442.0	434.7	442.3	434.7
AMPK170Drd	53415	53441	Roadway	1374		0	0	0	0	0	443.3	434.5	427.3	427.3	428.1	428.1	430.9	430.9	434.7	434.7	434.7	434.7
AMPK170E	53405	53415	54" CSP	659	10	82	87	93	105	106	435.5	430.7	437.8	433.6	437.9	433.9	438.4	436.7	443.2	442.0	443.4	442.3
AMPK170Erd	53405	53415	Roadway	659		0	0	0	0	1	443.0	443.3	437.8	437.8	437.9	437.9	438.4	438.4	443.2	443.2	443.4	443.3
AMPK170F	53388	53405	54" CSP	779	10	42	45	53	96	101	438.8	435.2	440.6	437.8	440.7	437.9	440.9	438.4	447.5	443.2	447.8	443.4
AMPK170Frd	53388	53405	Roadway	779		0	0	0	0	0	447.8	443.0	437.8	437.8	437.9	437.9	438.4	438.4	443.2	443.2	447.8	443.4
AMPK170G	53390	53388	48" CSP	361	10	42	45	53	96	97	440.7	439.2	443.0	441.1	443.0	441.2	443.3	441.4	448.2	447.5	448.4	447.8

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMPK170Grd	53390	53388	Roadway	361		0	0	0	0	9	448.2	447.8	440.6	440.6	440.7	440.7	440.9	440.9	448.2	447.8	448.4	447.9
AMPK170H	53416	53415	54" CSP	26	10	24	25	29	53	64	430.7	430.7	433.7	433.6	433.9	433.9	436.7	436.7	442.1	442.0	442.4	442.3
AMPK170I	53422	53416	24" CSP	459	10	24	25	30	38	38	452.2	438.6	453.5	439.8	453.5	439.8	453.8	440.0	456.6	442.1	456.7	442.4
AMPK170Ird	53422	53416	Roadway	459		0	0	0	18	29	456.5	444.2	433.7	433.7	433.9	433.9	436.7	436.7	456.6	444.3	456.7	444.3
AMPK170J	68811	53457	36" CSP	358	10	26	28	32	55	62	417.5	416.3	422.3	421.7	422.6	421.9	423.5	422.6	425.3	424.9	426.3	426.2
AMPK170Jrd	68811	53457	Roadway	358		0	0	0	0	28	424.4	426.0	422.3	422.3	422.6	422.6	423.5	423.5	425.3	425.3	426.3	426.2
AMPK170K	53426	68811	27" CSP	1528	10	26	28	31	33	33	438.7	418.0	440.1	422.3	440.3	422.6	442.7	423.5	444.5	425.3	444.6	426.3
AMPK170Krd	53426	68811	Roadway	1528		0	0	0	15	28	444.4	424.4	422.3	422.3	422.6	422.6	423.5	423.5	444.5	425.3	444.6	426.3
AMPK170L	53422	53426	24" CSP	422	10	26	28	33	36	36	452.2	438.9	453.5	440.1	453.5	440.3	453.8	442.7	456.6	444.5	456.7	444.6
AMPK170Lrd	53422	53426	Roadway	422		0	0	0	18	31	456.5	444.4	440.1	440.1	440.3	440.3	442.7	442.7	456.6	444.5	456.7	444.6
AMPK170M	68813	66476	48" CSP	452	10	66	71	86	100	133	415.4	413.6	418.9	417.8	419.2	417.9	420.7	418.6	423.5	421.1	426.4	422.8
AMPK170N	53447	68813	42" CSP	1262	10	50	53	66	66	65	419.6	415.4	422.5	418.9	423.2	419.2	425.3	420.7	426.2	423.5	426.6	426.4
AMPK170Nrd	53447	68813	Roadway	1262		0	0	0	34	94	425.0	425.7	422.5	422.5	423.2	423.2	425.3	425.3	426.2	426.0	426.6	426.4
AMPK170O	53400	53447	30" CSP	290	10	9	12	18	18	18	421.4	419.6	422.7	422.5	423.5	423.2	425.9	425.3	426.2	426.2	426.6	426.6
AMPK170Ord	53400	53447	Roadway	290		0	0	2	32	66	425.8	425.0	422.5	422.5	423.2	423.2	425.9	425.3	426.2	426.2	426.6	426.6
AMPK170P	53401	53400	24" CSP	311	10	9	12	20	24	24	423.5	421.4	424.5	422.7	424.8	423.5	428.6	425.9	430.1	426.2	430.3	426.6
AMPK170Prd	53401	53400	Roadway	311		0	0	0	20	49	430.0	425.8	422.7	422.7	423.5	423.5	425.9	425.9	430.1	426.2	430.3	426.6
AMPK170Q	53405	53401	24" CSP	888	10	3	4	15	26	26	437.4	423.6	437.8	424.5	437.9	424.8	438.4	428.6	443.2	430.1	443.4	430.3
AMPK170Qrd	53405	53401	Roadway	888		0	0	0	42	91	443.0	430.0	424.5	424.5	424.8	424.8	428.6	428.6	443.2	430.2	443.4	430.4
AMPK170R	53408	53405	24" CSP	430	10	41	41	41	42	42	451.3	437.4	458.3	439.4	458.3	439.4	458.4	439.4	458.5	443.2	458.5	443.4
AMPK170Rrd	53408	53405	Roadway	430		2	4	11	54	75	458.3	443.0	458.3	443.0	458.3	443.0	458.4	443.1	458.5	443.2	458.5	443.4
AMPK170S	53448	53447	30" CSP	180	10	42	42	49	51	52	422.3	419.8	424.6	422.5	425.5	423.2	428.5	425.3	428.8	426.2	428.9	426.6
AMPK170Srd	53448	53447	Roadway	180		0	0	0	53	95	428.6	425.0	422.5	422.5	423.2	423.2	425.3	425.3	428.8	426.2	428.9	426.6
AMPK170U	53358	53448	36" CSP	580	10	14	14	26	16	18	423.8	422.3	425.3	424.6	425.8	425.5	428.8	428.5	429.3	428.8	429.5	428.9
AMPK170Urd	53358	53448	Roadway	580		0	0	1	38	65	428.6	428.6	424.6	424.6	425.5	425.5	428.8	428.6	429.3	428.9	429.5	429.0
AMPK170T	53358	53401	21" CSP	197	10	7	9	11	18	18	423.6	423.5	425.3	424.5	425.8	424.8	428.8	428.6	429.3	430.1	429.5	430.3
AMPK170Trd	53401	53358	Roadway	197		0	0	0	14	35	430.0	428.6	425.3	425.3	425.8	425.8	428.8	428.8	430.1	429.3	430.3	429.5
Amazon - Middle Sub-Basin																						
AMMD140A	57400	66998	48" CSP	575	10	60	58	66	48	47	413.0	412.6	422.6	422.5	422.6	422.6	421.8	421.8	422.9	422.9	423.5	423.5
AMMD140Ard	66998	57400	Roadway	575		62	61	30	88	191	420.8	421.2	422.5	422.6	422.6	422.6	421.8	421.8	422.9	422.9	423.5	423.5
AMMD140B	57422	57400	42" CSP	608	10	58	54	65	43	42	413.8	413.4	422.6	422.6	422.6	422.6	421.8	421.8	422.9	422.9	423.5	423.5
AMMD140Brd	57400	57422	Roadway	608		51	50	33	58	137	421.2	420.5	422.6	422.6	422.6	422.6	421.8	421.8	422.9	422.9	423.5	423.5
AMMD145A	57427	57422	36" CSP	767	10	21	22	28	28	25	415.5	414.2	422.6	422.6	422.6	422.6	421.9	421.8	422.9	422.9	423.5	423.5
AMMD145Ard	57422	57427	Roadway	767		19	19	6	22	45	420.5	421.8	422.6	422.6	422.6	422.6	421.8	421.9	422.9	422.9	423.5	423.5
AMMD165A	57436	57188	27" CSP	216	10	32	30	38	25	25	411.6	410.8	423.3	423.3	423.4	423.4	422.9	422.9	423.7	423.7	424.1	424.1
AMMD165Ard	57188	57436	Roadway	216		120	132	174	185	182	420.8	419.7	423.3	423.3	423.4	423.4	422.9	422.9	423.7	423.7	424.1	424.1
AMMD165B	56284	57436	24" CSP	294	10	15	14	23	15	14	413.6	411.6	423.3	423.3	423.4	423.4	422.9	422.9	423.7	423.7	424.1	424.1
AMMD165Brd	57436	56284	Roadway	294		40	48	64	77	69	419.7	420.0	423.3	423.3	423.4	423.4	422.9	422.9	423.7	423.7	424.1	424.1
AMMD135A	57433	57163	30" CSP	72	10	33	35	52	38	35	413.7	413.8	423.4	423.4	423.4	423.4	422.9	422.9	423.9	423.8	424.3	424.3
AMMD135Ard	57163	57433	Roadway	72		207	207	243	305	337	420.7	420.8	423.4	423.4	423.4	423.4	422.9	422.9	423.8	423.9	424.3	424.3
AMMD135B	57431	57433	30" CSP	704	10	27	26	31	26	24	415.4	413.7	423.4	423.4	423.4	423.4	422.9	422.9	423.9	423.9	424.3	424.3
AMMD135Brd	57433	57431	Roadway	704		146	148	141	237	236	420.8	421.2	423.4	423.4	423.4	423.4	422.9	422.9	423.9	423.9	424.3	424.3
AMMD135C	57428	57431	30" CSP	808	10	24	23	28	21	22	417.0	415.4	423.4	423.4	423.4	423.4	423.0	422.9	423.9	423.9	424.3	424.3
AMMD135Crd	57428	57431	Roadway	808		45	46	60	100	119	421.8	421.2	423.4	423.4	423.4	423.4	423.0	422.9	423.9	423.9	424.3	424.3
AMMD040A#1	54353	54172	60" CSP	961	10	108	109	112	122	116	421.0	419.5	429.8	427.9	429.6	427.8	429.6	427.9	430.6	430.1	430.9	430.4

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMMD040A#2	54353	54172	60" CSP	961	10	108	109	112	122	116	421.0	419.5	429.8	427.9	429.6	427.8	429.6	427.9	430.6	430.1	430.9	430.4
AMMD040Ard	54353	54172	Roadway	961		43	27	30	164	286	429.0	428.8	429.8	429.1	429.6	429.0	429.6	429.1	430.6	430.1	430.9	430.4
AMMD040B#1	54330	54353	83.04" elliptical CSP	486	10	158	161	166	168	160	422.9	422.1	430.6	429.8	430.5	429.6	430.6	429.6	431.2	430.6	431.4	430.9
AMMD040B#2	54330	54353	42" CSP	451	10	61	59	76	62	59	423.5	422.7	430.6	429.8	430.5	429.6	430.6	429.6	431.2	430.6	431.4	430.9
AMMD040Brd	54330	54353	Roadway	486		106	88	96	242	353	429.8	429.0	430.6	429.8	430.5	429.6	430.6	429.6	431.2	430.6	431.4	430.9
AMMD040C	54335	54330	83.04" CSP	646	10	131	133	136	136	134	422.9	421.9	431.2	430.6	431.2	430.5	431.2	430.6	431.6	431.2	431.8	431.4
AMMD040Crd	54335	54330	Roadway	646		30	29	33	95	101	430.8	429.8	431.2	430.6	431.2	430.5	431.2	430.6	431.6	431.2	431.8	431.4
AMMD040D	66486	54335	54" CSP	1157	10	145	153	157	195	198	435.7	423.9	439.3	431.2	439.7	431.2	440.5	431.2	446.0	431.6	446.6	431.8
AMMD040Drd	66486	54335	Roadway	1157		0	0	0	0	0	449.2	430.8	431.2	431.2	431.2	431.2	431.2	431.2	431.6	431.6	431.8	431.8
AMMD040L	54315	54330	42" CSP	612	10	32	33	34	40	40	424.8	423.5	431.5	430.6	431.5	430.5	431.6	430.6	432.5	431.2	432.8	431.4
AMMD040Lrd	54315	54330	Roadway	612		0	0	0	76	133	432.0	429.8	430.6	430.6	430.5	430.5	430.6	430.6	432.5	431.2	432.8	431.4
AMMD040M	66485	54315	36" CSP	836	10	32	33	34	55	55	431.8	424.8	434.0	431.5	434.0	431.5	434.2	431.6	439.1	432.5	439.4	432.8
AMMD040Mrd	66485	54315	Roadway	836		0	0	0	64	140	438.8	432.0	431.5	431.5	431.5	431.5	431.6	431.6	439.1	432.5	439.4	432.8
AMMD040N	54295	66485	30" CSP	777	10	32	33	35	44	44	437.4	431.8	440.2	434.0	440.5	434.0	441.4	434.2	446.4	439.1	446.6	439.4
AMMD040Nrd	54295	66485	Roadway	777		0	0	0	84	161	446.0	438.8	434.0	434.0	434.0	434.0	434.2	434.2	446.4	439.2	446.6	439.4
AMMD040H	54295	66486	42" CSP	384	10	42	43	48	70	63	438.0	435.7	440.2	439.3	440.5	439.7	441.4	440.5	446.4	446.0	446.6	446.6
AMMD040Hrd	66486	54295	Roadway	384		0	0	0	0	0	449.2	446.0	440.2	440.2	440.5	440.5	441.4	441.4	446.4	446.4	446.6	446.6
AMMD040I	54267	54295	30" CSP	1499	10	30	32	33	35	34	445.5	438.0	451.2	440.2	452.0	440.5	453.6	441.4	454.4	446.4	454.5	446.6
AMMD040Ird	54267	54295	Roadway	1499		0	0	0	62	99	454.0	446.0	440.2	440.2	440.5	440.5	441.4	441.4	454.4	446.4	454.5	446.6
AMMD040J	54271	54267	24" CSP	482	10	30	32	32	31	32	457.0	450.0	461.5	451.9	462.6	452.0	462.7	453.6	462.9	454.4	463.0	454.5
AMMD040Jrd	54271	54267	Roadway	482		0	0	5	79	105	462.6	454.0	451.2	451.2	462.6	454.0	462.7	454.1	462.9	454.4	463.0	454.5
AMMD040E	54325	66486	48" CSP	481	10	106	113	119	152	151	444.2	436.4	446.5	439.3	446.6	439.7	446.7	440.5	452.4	446.0	452.5	446.6
AMMD040Erd	54325	66486	Roadway	481		0	0	0	23	56	452.2	449.2	439.3	439.3	439.7	439.7	440.5	440.5	452.4	449.4	452.5	449.5
AMMD040F	54271	54325	42" CSP	712	10	106	113	115	126	126	455.1	444.2	461.5	446.5	462.6	446.6	462.7	446.7	462.9	452.4	463.0	452.5
AMMD040Frd	54271	54325	Roadway	712		0	0	4	72	95	462.6	452.2	446.5	446.5	462.6	452.2	462.7	452.3	462.9	452.5	463.0	452.6
AMMD040G#1	54254	54271	42" CSP	232	10	101	101	101	106	106	458.0	455.1	465.4	461.5	465.5	462.6	465.6	462.7	465.9	462.9	466.0	463.0
AMMD040G#2	54254	54271	24" CSP	166	10	31	31	31	32	32	458.0	457.0	465.4	461.5	465.5	462.6	465.6	462.7	465.9	462.9	466.0	463.0
AMMD040Grd	54254	54271	Roadway	232		14	40	53	178	225	465.3	462.6	465.4	462.7	465.5	462.8	465.6	462.9	465.9	463.2	466.0	463.3
AMMD040K	54260	54254	42" CSP	639	10	136	136	136	139	139	476.1	458.3	482.8	465.4	482.9	465.5	482.9	465.6	483.2	465.9	483.3	466.0
AMMD040Krd	54260	54254	Roadway	639		3	13	26	150	198	482.8	465.3	482.8	465.4	482.9	465.5	482.9	465.6	483.2	465.9	483.3	466.0
AMMD020A	66702	54260	42" CSP	475	10	54	57	64	109	111	483.7	476.2	485.5	482.8	485.6	482.9	485.9	482.9	490.2	483.2	490.4	483.3
AMMD020Ard	66702	54260	Roadway	475		0	0	0	0	15	490.3	482.8	482.8	482.8	482.9	482.9	482.9	482.9	483.2	483.2	490.4	483.3
AMMD020B	51411	66702	36" CSP	1442	10	55	57	65	109	109	530.0	483.7	531.5	485.5	531.5	485.6	531.6	485.9	534.9	490.2	535.0	490.4
AMMD020Brd	51411	66702	Roadway	1442		0	0	0	0	20	534.9	490.3	485.5	485.5	485.6	485.6	485.9	485.9	534.9	490.3	535.0	490.4
AMMD020C	51437	51411	30" CSP	526	10	55	57	65	82	82	551.3	530.0	553.1	531.5	553.1	531.5	553.4	531.6	557.6	534.9	557.7	535.0
AMMD020Crd	51437	51411	Roadway	526		0	0	0	34	64	557.5	534.9	531.5	531.5	531.5	531.5	531.6	531.6	557.6	535.0	557.7	535.1
AMMD110A	54362	66967	42" CSP	1291	10	63	63	70	63	62	423.4	420.0	433.8	428.7	433.7	428.5	433.9	428.7	434.2	430.9	434.4	431.7
AMMD110Ard	54362	66967	Roadway	1291		18	13	22	43	80	433.1	433.2	433.8	433.4	433.7	433.4	433.9	433.4	434.2	433.5	434.4	433.7
AMMD110B	66460	54362	36" CSP	772	10	48	48	56	47	47	428.5	423.4	435.5	433.8	435.5	433.7	435.5	433.9	435.8	434.2	436.2	434.4
AMMD110Brd	66460	54362	Roadway	772		53	58	72	150	190	435.0	433.1	435.5	433.8	435.5	433.7	435.5	433.9	435.8	434.2	436.2	434.4
AMMD080L	51307	66460	30" CSP	164	10	46	45	51	45	45	433.6	429.0	437.2	435.5	437.3	435.5	437.3	435.5	437.5	435.8	437.6	436.2
AMMD080Lrd	51307	66460	Roadway	164		46	50	65	144	188	437.0	435.0	437.2	435.5	437.3	435.5	437.3	435.5	437.5	435.8	437.6	436.2
AMMD080K#1	51306	51307	2-24" CSP	278	10	23	23	25	22	21	435.5	433.6	440.2	437.2	440.2	437.3	440.3	437.3	440.5	437.5	440.6	437.6

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMMD080K#2	51306	51307	24" CSP	235	10	25	25	27	24	23	435.5	433.6	440.2	437.2	440.2	437.3	440.3	437.3	440.5	437.5	440.6	437.6
AMMD080Krd	51306	51307	Roadway	278		36	40	55	133	177	440.0	437.0	440.2	437.2	440.2	437.3	440.3	437.3	440.5	437.5	440.6	437.6
AMMD080J#1	51305	51306	36" CSP	251	10	34	33	35	35	36	436.0	435.5	441.0	440.2	441.0	440.2	441.1	440.3	441.4	440.5	441.5	440.6
AMMD080J#2	51305	51306	27" CSP	250	10	16	16	18	17	17	436.0	435.5	441.0	440.2	441.0	440.2	441.1	440.3	441.4	440.5	441.5	440.6
AMMD080Jrd	51305	51306	Roadway	251		33	37	51	126	168	440.6	440.0	441.0	440.3	441.0	440.3	441.1	440.4	441.4	440.7	441.5	440.8
AMMD080I	51303	51305	48" CSP	473	10	63	64	66	63	64	436.7	436.0	442.2	441.0	442.3	441.0	442.3	441.1	442.7	441.4	442.8	441.5
AMMD080Ird	51303	51305	Roadway	473		19	24	39	117	160	442.0	440.6	442.2	441.0	442.3	441.0	442.3	441.1	442.7	441.4	442.8	441.5
AMMD080H	51344	51302	30" CSP	710	10	47	47	48	47	47	449.3	439.3	455.2	445.1	455.2	445.1	455.2	445.2	455.4	445.4	455.4	445.5
AMMD080Hrd	51344	51302	Roadway	710		22	26	38	98	128	455.0	445.0	455.2	445.2	455.2	445.2	455.2	445.2	455.4	445.4	455.4	445.5
AMMD080G	51302	51303	36" CSP	288	10	57	57	57	57	57	438.6	437.4	445.1	442.2	445.1	442.3	445.2	442.3	445.4	442.7	445.5	442.8
AMMD080Grd	51302	51303	Roadway	288		9	14	25	84	114	445.0	443.0	445.1	443.1	445.1	443.1	445.2	443.2	445.4	443.4	445.5	443.5
AMMD080F	51303	51309	36" CSP	32	10	27	29	35	54	60	437.4	437.3	442.2	442.1	442.3	442.1	442.3	442.1	442.7	442.2	442.8	442.2
AMMD080Frd	51303	51309	Roadway	32		0	0	0	0	0	443.0	442.0	442.1	442.1	442.1	442.1	442.1	442.1	442.2	442.2	442.2	442.2
AMMD080E	51309	51311	18" CSP	106	10	14	14	13	13	14	437.3	437.0	442.1	440.2	442.1	440.3	442.1	440.3	442.2	440.4	442.2	440.5
AMMD080Erd	51309	51311	Roadway	106		14	17	23	42	48	442.0	440.0	442.1	440.2	442.1	440.3	442.1	440.3	442.2	440.4	442.2	440.5
AMMD080D#1	51311	51313	18" CSP	489	10	6	6	6	6	6	437.0	435.9	440.2	439.7	440.3	439.7	440.3	439.8	440.4	439.9	440.5	439.9
AMMD080D#2	51311	51313	18" CSP	339	10	7	7	8	7	7	437.0	435.9	440.2	439.7	440.3	439.7	440.3	439.8	440.4	439.9	440.5	439.9
AMMD080Drd	51311	51313	Roadway	489		19	22	28	46	53	440.0	438.9	440.2	439.7	440.3	439.7	440.3	439.8	440.4	439.9	440.5	439.9
AMMD080C#1	51313	51314	18" CSP	31	10	10	10	10	10	10	435.9	436.0	439.7	439.6	439.7	439.6	439.8	439.6	439.9	439.7	439.9	439.8
AMMD080C#2	51313	51314	18" CSP	35	10	10	10	10	10	10	435.9	436.0	439.7	439.6	439.7	439.6	439.8	439.6	439.9	439.7	439.9	439.8
AMMD080Crd	51313	51314	Roadway	31		17	20	26	43	49	438.9	439.5	439.7	439.7	439.7	439.7	439.8	439.7	439.9	439.8	439.9	439.9
AMMD080B#1	51314	68667	18" CSP	182	10	11	11	11	11	11	436.0	435.4	439.6	437.3	439.6	437.6	439.6	437.9	439.7	438.0	439.8	438.1
AMMD080B#2	51314	68667	18" CSP	182	10	11	11	11	11	11	436.0	435.4	439.6	437.3	439.6	437.6	439.6	437.9	439.7	438.0	439.8	438.1
AMMD080Brd	51314	68667	Roadway	182		5	9	17	34	41	439.5	437.8	439.6	437.9	439.6	437.9	439.6	437.9	439.7	438.0	439.8	438.1
AMMD080A	68667	51963	27" CSP	150	10	25	28	31	35	36	435.4	433.2	437.3	434.3	437.6	434.4	437.9	434.5	438.0	434.9	438.1	437.0
AMMD080Ard	68667	51963	Roadway	150		0	0	4	17	35	437.8	437.0	434.3	434.3	434.4	434.4	437.9	437.1	438.0	437.2	438.1	437.3
AMMD080M	51963	51961	30" CSP	388	10	15	17	21	32	38	433.3	428.0	434.3	429.8	434.4	429.7	434.5	430.2	434.9	431.5	437.0	433.9
AMMD080Mrd	51963	51961	Roadway	388		0	0	0	0	0	437.0	435.0	429.8	429.8	429.7	429.7	430.2	430.2	431.5	431.5	437.0	435.0
AMMD120A	51961	54175	42" CSP	2445	10	15	15	19	28	36	428.0	421.0	429.8	428.8	429.7	428.7	430.2	428.8	431.5	431.0	433.9	431.9
AMMD120Ard	51961	54175	Roadway	2445		0	0	0	0	0	435.0	434.1	428.8	428.8	428.7	428.7	428.8	428.8	431.0	431.0	431.9	431.9
AMMD070B	51963	51964	27" CSP	731	10	11	12	14	20	21	433.2	428.8	434.3	430.4	434.4	430.4	434.5	430.9	434.9	432.4	437.0	433.5
AMMD070Brd	51963	51964	Roadway	731		0	0	0	0	0	437.0	433.5	430.4	430.4	430.4	430.4	430.9	430.9	432.4	432.4	437.0	433.5
AMMD070A	51964	71052	30" CSP	1051	10	11	11	13	18	20	428.8	426.0	430.4	429.5	430.4	429.3	430.9	429.5	432.4	431.5	433.5	432.4
AMMD070Ard	71052	51964	Roadway	1051		0	0	0	0	0	435.9	433.5	430.4	430.4	430.4	430.4	430.9	430.9	432.4	432.4	433.5	433.5
Amazon - Upper Sub-Basin																						
AMUP180A	51841	51730	36" CSP	1314	10	65	65	65	65	65	444.7	432.4	450.1	437.2	450.2	437.2	450.2	437.6	450.5	439.5	450.6	440.6
AMUP180Ard	51841	51730	Roadway	1314		54	62	85	178	233	449.8	440.5	450.1	440.8	450.2	440.8	450.2	440.9	450.5	441.2	450.6	441.3
AMUP180B	68653	51841	36" CSP	214	10	58	59	60	59	58	447.0	444.7	452.1	450.1	452.1	450.2	452.2	450.2	452.4	450.5	452.5	450.6
AMUP180Brd	68653	51841	Roadway	214		10	14	27	98	125	452.0	449.8	452.1	450.1	452.1	450.2	452.2	450.2	452.4	450.5	452.5	450.6
AMUP180C	51296	68653	30" CSP	1254	10	62	62	62	62	62	480.9	447.5	486.1	452.1	486.1	452.1	486.1	452.2	486.3	452.4	486.4	452.5
AMUP180Crd	51296	68653	Roadway	1254		8	11	25	98	123	486.0	452.0	486.1	452.1	486.1	452.1	486.1	452.2	486.3	452.4	486.4	452.5
AMUP180D	66447	51296	36" CSP	146	10	71	73	86	89	89	485.0	481.9	488.1	486.1	488.2	486.1	489.2	486.1	489.5	486.3	489.5	486.4
AMUP180Drd	66447	51296	Roadway	146		0	0	0	73	97	489.2	486.0	486.1	486.1	486.1	486.1	486.1	486.1	489.5	486.3	489.5	486.4
AMUP180E	51285	66447	30" CSP	321	10	71	73	86	92	92	499.0	485.4	500.9	488.1	501.0	488.2	506.6	489.2	509.2	489.5	509.2	489.5
AMUP180Erd	51285	66447	Roadway	321		0	0	0	69	93	509.0	489.2	488.1	488.1	488.2	488.2	489.2	489.2	509.2	489.5	509.2	489.5

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMUP180F	68670	51285	36" CSP	185	10	71	73	90	92	92	508.1	499.9	510.2	501.5	510.2	501.6	511.8	506.6	514.9	509.2	515.0	509.2
AMUP180Frd	68670	51285	Roadway	185		0	0	0	71	95	514.7	509.0	500.9	500.9	501.0	501.0	506.6	506.6	514.9	509.2	515.0	509.3
AMUP180G	68668	68670	30" CSP	41	10	71	73	86	88	88	510.0	508.1	512.6	510.2	512.7	510.2	514.8	511.8	515.4	514.9	515.5	515.0
AMUP180Grd	68668	68670	Roadway	41		0	0	4	129	151	514.0	514.7	512.6	512.6	512.7	512.7	514.8	514.8	515.4	515.4	515.5	515.5
AMUP180H	51271	68668	27" CSP	102	10	71	73	82	82	82	514.7	510.0	519.7	512.6	520.1	512.7	523.1	514.8	523.2	515.4	523.2	515.5
AMUP180Hrd	51271	68668	Roadway	102		0	0	19	90	114	523.0	514.0	512.6	512.6	512.7	512.7	523.1	514.8	523.2	515.4	523.2	515.5
AMUP180I	51284	51271	36" CSP	283	10	73	73	97	99	99	523.5	517.2	526.1	519.7	526.1	520.1	532.7	523.1	533.2	523.2	533.3	523.2
AMUP180Ird	51284	51271	Roadway	283		0	0	0	65	88	533.0	523.0	519.7	519.7	520.1	520.1	523.1	523.1	533.2	523.2	533.3	523.3
AMUP180J	51256	51284	33" CSP	178	10	71	73	93	93	93	531.2	523.9	533.1	526.1	533.2	526.1	540.1	532.7	540.2	533.2	540.3	533.3
AMUP180Jrd	51256	51284	Roadway	178		0	0	8	77	100	540.0	533.0	526.1	526.1	526.1	526.1	540.1	533.1	540.2	533.2	540.3	533.3
AMUP180K	51239	51256	30" CSP	92	10	71	73	94	95	95	543.0	531.9	545.1	533.2	545.2	533.2	546.1	540.1	546.2	540.2	546.3	540.3
AMUP180Krd	51239	51256	Roadway	92		0	0	29	95	118	546.0	540.0	533.1	533.1	533.2	533.2	546.1	540.1	546.2	540.2	546.3	540.3
AMUP190A	51204	51239	Natural	675	10	44	46	62	98	115	586.9	543.0	588.1	545.1	588.2	545.2	588.4	546.1	588.7	546.2	588.9	546.3
AMUP190B	50107	51204	24" CSP culvert	320	10	38	38	42	45	45	600.0	586.9	606.0	588.1	606.1	588.2	606.1	588.4	606.2	588.7	606.2	588.9
AMUP190Brd	50107	51204	Roadway	320		6	8	20	53	71	606.0	589.9	606.0	589.9	606.1	590.0	606.1	590.0	606.2	590.1	606.2	590.1
AMUP190C	50115	50107	Natural	75	10	45	50	62	98	115	601.6	600.0	606.3	606.0	606.4	606.1	606.5	606.1	607.3	606.2	607.7	606.2
AMUP190D	50163	50115	36" CSP culvert	655	10	51	53	62	98	98	621.2	601.6	622.5	606.3	622.5	606.4	622.8	606.5	630.4	607.3	630.5	607.7
AMUP190Drd	50163	50115	Roadway	655		0	0	0	0	18	630.4	608.6	606.3	606.3	606.4	606.4	606.5	606.5	630.4	608.6	630.5	608.7
AMUP140A	51469	66944	54" CSP	61	10	109	113	119	119	120	434.4	434.9	443.2	442.7	443.3	442.7	443.5	443.0	445.2	445.2	445.3	445.3
AMUP140Ard	51469	66944	Roadway	61		0	1	21	167	212	443.2	443.1	443.2	443.1	443.3	443.1	443.5	443.3	445.2	445.2	445.3	445.3
AMUP140B	51850	51469	54" CSP	582	10	109	116	130	132	132	436.7	434.7	445.4	443.2	445.7	443.3	446.6	443.5	446.9	445.2	447.2	445.3
AMUP140Brd	51850	51469	Roadway	582		0	0	6	66	119	446.5	443.2	443.2	443.2	443.3	443.3	446.6	443.5	446.9	445.2	447.2	445.3
AMUP140C	66678	51850	30" CSP	80	10	79	79	77	79	80	440.4	438.4	448.2	445.4	448.3	445.7	448.3	446.6	448.4	446.9	448.5	447.2
AMUP140Crd	66678	51850	Roadway	80		49	60	90	145	197	448.0	446.5	448.2	446.7	448.3	446.8	448.3	446.8	448.4	446.9	448.5	447.2
AMUP140D	51853	66678	36" CSP	125	10	73	73	77	71	71	443.2	442.0	448.7	448.2	448.7	448.3	448.8	448.3	449.1	448.4	449.3	448.5
AMUP140Drd	51853	66678	Roadway	125		74	81	101	149	195	448.0	447.9	448.7	448.4	448.7	448.4	448.8	448.5	449.1	448.7	449.3	448.8
AMUP140E	51763	51853	36" CSP	11	10	84	84	84	84	84	446.0	443.2	450.1	448.7	450.2	448.7	450.2	448.8	450.3	449.1	450.4	449.3
AMUP140Erd	51763	51853	Roadway	11		26	33	55	116	170	450.0	448.0	450.1	448.7	450.2	448.7	450.2	448.8	450.3	449.1	450.4	449.3
AMUP140F	50531	51763	Natural	1550	10	66	69	82	120	144	484.1	446.0	486.0	450.1	486.1	450.2	486.3	450.2	486.7	450.3	487.0	450.4
AMUP120A	50660	50531	36" CSP	314	10	67	73	87	120	122	493.8	484.1	495.6	486.0	495.8	486.1	496.2	486.3	501.3	486.7	501.4	487.0
AMUP120Ard	50660	50531	Roadway	314		0	0	0	26	53	501.2	491.5	486.0	486.0	486.1	486.1	486.3	486.3	501.3	491.6	501.4	491.7
AMUP060A	50629	50517	60" CSP	64	10	304	301	303	311	311	448.2	448.0	455.4	453.1	455.5	453.2	455.6	453.4	456.5	454.7	456.7	456.3
AMUP060Ard	50629	50517	Roadway	64		45	53	91	374	559	455.0	454.9	455.4	455.2	455.5	455.3	455.6	455.4	456.5	456.2	456.7	456.3
AMUP060B	50653	50629	54" CSP	623	10	341	352	386	388	387	473.0	448.3	480.5	455.4	482.1	455.5	487.5	455.6	488.0	456.5	488.1	456.7
AMUP060Brd	50653	50629	Roadway	623		0	0	2	261	345	487.5	455.0	455.4	455.4	455.5	455.5	487.5	455.6	488.0	456.5	488.1	456.7
AMUP060C	50671	50653	54" CSP	2580	10	260	260	260	260	260	521.4	473.0	531.0	480.5	531.1	482.1	531.2	487.5	531.5	488.0	531.6	488.1
AMUP060Crd	50671	50653	Roadway	2580		51	62	112	338	413	530.8	487.5	531.0	487.7	531.1	487.8	531.2	487.9	531.5	488.2	531.6	488.3
AMUP130A	50200	50671	54" CSP	882	10	216	218	227	230	218	533.8	521.4	542.4	531.0	542.4	531.1	542.5	531.2	542.8	531.5	543.2	531.6
AMUP130Ard	50200	50671	Roadway	882		88	96	141	360	433	542.0	530.8	542.4	531.2	542.4	531.2	542.5	531.3	542.8	531.6	543.2	532.0
AMUP070A	65601	50200	42" CSP	547	10	77	82	92	111	111	545.2	534.2	547.5	542.4	547.7	542.4	548.2	542.5	551.0	542.8	551.1	543.2
AMUP070Ard	65601	50200	Roadway	547		0	0	0	39	75	550.8	542.0	542.4	542.4	542.4	542.4	542.5	542.5	551.0	542.8	551.1	543.2
AMUP070B	65582	65601	36" CSP	2041	10	77	82	94	146	146	623.4	545.2	625.1	547.5	625.2	547.7	625.4	548.2	662.1	551.0	662.2	551.1
AMUP070Brd	65582	65601	Roadway	2041		0	0	0	11	48	662.0	550.8	547.5	547.5	547.7	547.7	548.2	548.2	662.1	551.0	662.2	551.1

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE AMAZON CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
AMUP070C	50238	50200	48" CSP	1133	10	150	145	171	172	172	551.7	534.2	558.5	542.4	557.5	542.4	563.4	542.5	563.9	542.8	564.0	543.2
AMUP070Crd	50238	50200	Roadway	1133		0	0	0	118	186	563.5	543.0	542.4	542.4	542.4	542.4	542.5	542.5	563.9	543.4	564.0	543.5
Willamte	50090	50238	42" CSP	128	10	144	144	144	144	144	558.0	551.7	564.2	558.5	564.1	557.5	564.6	563.4	565.0	563.9	565.2	564.0
Willamterd	50090	50238	Roadway	128		18	4	111	241	300	564.0	563.5	564.2	563.7	564.1	563.6	564.6	564.1	565.0	564.5	565.2	564.5
AMUP080A	50110	50090	Natural	950	10	116	117	123	195	233	590.0	558.0	594.7	564.2	594.7	564.1	594.7	564.6	595.1	565.0	595.3	565.2
Brooksd#1	50109	50110	48" CSP culverts	114	10	53	56	62	100	118	594.0	590.0	595.4	594.7	595.5	594.7	595.7	594.7	596.8	595.1	597.4	595.3
Brooksd#2	50109	50110	48" CSP culvert	114	10	53	56	62	100	118	594.0	590.0	595.4	594.7	595.5	594.7	595.7	594.7	596.8	595.1	597.4	595.3
AMUP100A	66910	50109	Natural	350	10	45	46	51	81	100	617.0	594.0	618.8	595.4	618.9	595.5	619.1	595.7	619.1	596.8	619.4	597.4
BraeBurn	50108	66910	36" CSP culvert	59	10	45	47	52	82	89	619.0	618.0	621.3	619.6	621.4	619.6	621.6	619.8	623.6	620.5	624.2	620.8
BraeBurnrd	50108	66910	Roadway	59		0	0	0	0	11	624.0	624.0	618.8	618.8	618.9	618.9	619.1	619.1	619.1	619.1	624.2	624.1
AMUP100C	71047	50108	Natural	460	10	46	47	53	89	105	650.4	619.0	651.9	621.3	651.9	621.4	652.0	621.6	652.4	623.6	652.6	624.2
AMUP100D	50130	71047	Natural	140	10	46	47	53	90	105	660.0	650.4	662.4	651.9	662.5	651.9	662.6	652.0	663.2	652.4	663.4	652.6
AMUP100E	50129	50130	36" CSP culvert	148	10	46	47	53	90	98	668.0	660.0	669.2	662.4	669.2	662.5	669.3	662.6	670.8	663.2	672.3	663.4
AMUP100Erd	50129	50130	Roadway	148		0	0	0	0	8	672.0	672.0	662.4	662.4	662.5	662.5	662.6	662.6	663.2	663.2	672.3	672.1
AMUP110A	99479	50129	Natural	600	10	42	43	49	88	113	703.5	668.0	707.2	669.2	707.3	669.2	707.5	669.3	708.1	670.8	708.2	672.3
AMUP040A#1	65533	65370	48" CSP	401	10	54	56	63	78	93	461.7	457.0	463.4	461.8	463.4	461.9	463.6	462.1	464.9	463.9	466.4	464.9
AMUP040A#2	65533	65370	36" CSP	382	10	3	3	6	34	45	463.0	457.8	463.4	461.8	463.4	461.9	463.6	462.1	464.9	463.9	466.4	464.9
AMUP040Ard	65533	65370	Roadway	401		0	0	0	0	0	473.0	464.1	461.8	461.8	461.9	461.9	462.1	462.1	463.9	463.9	464.9	464.9
AMUP040B	65310	65533	48" CSP	19	10	57	59	69	113	138	462.2	461.7	463.9	463.4	463.9	463.4	464.1	463.6	465.2	464.9	466.8	466.4
AMUP040C	50602	65310	48" CSP	1966	10	57	60	69	119	146	510.0	461.9	511.4	463.9	511.5	463.9	511.6	464.1	512.2	465.2	512.5	466.8
AMUP040D	50739	50602	36" CSP	845	10	58	60	70	116	124	542.4	510.0	544.0	511.4	544.0	511.5	544.2	511.6	550.0	512.2	550.1	512.5
AMUP040Drd	50739	50602	Roadway	845		0	0	0	4	24	550.0	518.0	511.4	511.4	511.5	511.5	511.6	511.6	550.0	518.0	550.1	518.1
Amazon - Headwaters Sub-Basin																						
Martin	66656	65379	48" CSP	45	10	252	263	277	324	325	504.8	502.4	513.6	506.6	514.3	506.6	515.1	506.7	518.6	507.6	519.0	508.2
Martinrd	66656	65379	Roadway	45		0	0	0	118	242	517.8	517.8	506.6	506.6	506.6	506.6	506.7	506.7	518.6	518.4	519.0	518.8
AMHW010A	67175	66656	36" CSP	79	10	90	93	97	102	106	510.7	506.6	516.2	513.6	517.1	514.3	517.9	515.1	518.9	518.6	519.1	519.0

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
Bethel Danebo - A2 Channel																						
BDA2010A	58209	80001	Natural	840	100	509	604	307	732	901	359.6	357.4	365.2	361.1	365.6	361.3	364.4	360.6	366.0	361.6	366.5	362.0
BDA2010E	58709	58209	48" CSP	1029	10	32	32	48	60	75	362	360.7	365.5	365.2	366.0	365.6	365.3	364.4	367.3	366.0	369.2	366.5
BDA2010Erd	58709	58209	Roadway	1029		0	0	0	0	0	374	372.0	365.2	365.2	365.6	365.6	364.4	364.4	366.0	366.0	366.5	366.5
BDA2020A	58689	58709	42" CSP	830	10	22	22	33	37	45	366	362.0	367.5	365.5	367.5	366.0	367.8	365.3	368.6	367.3	371.3	369.2
BDA2020Ard	58689	58709	Roadway	830		0	0	0	0	0	375	374.0	365.5	365.5	366.0	366.0	365.3	365.3	367.3	367.3	369.2	369.2
BDA2010B	80002	58209	Natural	1540	100	482	573	303	695	855	361.9	359.6	368.0	365.2	368.4	365.6	366.9	364.4	369.0	366.0	369.7	366.5
BDA2040A	58205	80002	60" CSP	390	10	22	20	25	48	58	362	361.9	368.0	368.0	368.4	368.4	366.9	366.9	369.0	369.0	369.7	369.7
BDA2040Ard	80002	58205	Roadway	390		0	0	0	0	0	376	376.2	368.0	368.0	368.4	368.4	366.9	366.9	369.0	369.0	369.7	369.7
BDA2040B	58204	58205	60" CSP	665	10	9	8	11	21	25	363	362.0	368.0	368.0	368.4	368.4	366.9	366.9	369.0	369.0	369.7	369.7
BDA2040Brd	58204	58205	Roadway	665		0	0	0	0	0	376	371.9	368.0	368.0	368.4	368.4	366.9	366.9	369.0	369.0	369.7	369.7
BDA2040C	58207	58204	48" CSP	250	10	10	8	12	21	25	363	362.7	368.0	368.0	368.5	368.4	366.9	366.9	369.0	369.0	369.7	369.7
BDA2040Crd	58207	58204	Roadway	250		0	0	0	0	0	372	371.9	368.0	368.0	368.4	368.4	366.9	366.9	369.0	369.0	369.7	369.7
BDA2060A	58673	80002	60" CSP	725	10	110	102	163	195	191	364	363.0	368.7	368.0	369.5	368.4	370.4	366.9	375.6	369.0	375.3	369.7
BDA2060Ard	58673	80002	Roadway	725		0	0	0	0	0	377	376.3	368.0	368.0	368.4	368.4	366.9	366.9	369.0	369.0	369.7	369.7
BDA2060B	58680	58673	72" CSP	884	10	98	91	146	165	159	367	364.2	370.5	368.7	370.9	369.5	373.8	370.4	377.8	375.6	377.8	375.3
BDA2060Brd	58680	58673	Roadway	884		0	0	0	0	0	378	376.9	368.7	368.7	369.5	369.5	370.4	370.4	377.8	376.9	377.8	376.9
BDA2110A	58658	58680	54" CSP	973	10	18	19	31	39	36	368	367.4	370.7	370.5	371.0	370.9	374.1	373.8	376.7	377.8	377.0	377.8
BDA2110Ard	58680	58658	Roadway	973		0	0	0	0	0	378	376.7	370.7	370.7	371.0	371.0	374.1	374.1	377.8	376.7	377.8	377.0
BDA2110B	58658	58645	24" CSP	166	10	19	19	31	35	35	371	369.0	372.6	370.7	372.6	371.0	377.1	374.1	377.3	376.7	377.4	377.0
BDA2110Brd	58658	58645	Roadway	166		0	0	1	26	32	377	376.7	370.7	370.7	371.0	371.0	377.1	376.7	377.3	376.9	377.4	377.0
BDA2070A	58683	58680	60' CSP	1641	10	65	61	98	127	120	369	367.4	373.0	370.5	372.8	370.9	377.1	373.8	380.2	377.8	380.4	377.8
BDA2070Ard	58683	58680	Roadway	1641		0	0	0	0	0	381	377.8	370.5	370.5	370.9	370.9	373.8	373.8	377.8	377.8	377.8	377.8
BDA2080A	66164	58683	48" CSP	40	10	66	62	98	137	137	373	372.4	374.9	374.4	374.8	374.4	377.4	377.1	380.4	380.2	380.6	380.4
BDA2080Ard	66164	58683	Roadway	40		0	0	0	0	0	381	380.7	373.0	373.0	372.8	372.8	377.1	377.1	380.2	380.2	380.4	380.4
BDA2080B	58668	66164	60" CSP	280	10	37	35	57	78	78	369	369.8	375.0	374.9	374.9	374.8	377.6	377.4	379.9	380.4	380.3	380.6
BDA2080Brd	58668	66164	Roadway	280		0	0	0	0	0	381	379.7	375.0	375.0	374.9	374.9	377.6	377.6	379.9	379.9	380.3	380.3
BDA2080C	68474	58668	60" CSP	1272	10	36	35	56	78	78	372	369.0	375.3	375.0	375.2	374.9	378.3	377.6	381.4	379.9	381.2	380.3
BDA2080Crd	68474	58668	Roadway	1272		0	0	0	0	0	382	379.7	375.0	375.0	374.9	374.9	377.6	377.6	379.9	379.9	380.3	380.3
BDA2080D	58950	68474	54" CSP	501	10	36	35	56	77	77	372	372.0	375.5	375.3	375.4	375.2	378.8	378.3	381.7	381.4	381.7	381.2
BDA2080Drd	58950	68474	Roadway	501		0	0	0	0	0	382	381.6	375.3	375.3	375.2	375.2	378.3	378.3	381.7	381.6	381.7	381.6
BDA2090A	60231	58950	42" CSP	960	10	16	16	25	36	32	373	371.8	375.8	375.5	375.7	375.4	379.7	378.8	382.7	381.7	382.9	381.7
BDA2090Ard	60231	58950	Roadway	960		0	0	0	0	0	383	381.7	375.5	375.5	375.4	375.4	378.8	378.8	381.7	381.7	381.7	381.7
BDA2090B	60245	60231	36" CSP	1068	10	16	16	25	36	31	375	373.3	377.1	375.8	377.0	375.7	381.8	379.7	383.4	382.7	383.5	382.9
BDA2090Brd	60245	60231	Roadway	1068		0	0	0	1	5	383	383.2	375.8	375.8	375.7	375.7	379.7	379.7	383.4	383.2	383.5	383.3
BDA2010C	80003	80002	Natural	56	100	406	482	294	591	716	361.7	361.9	368.0	368.0	368.4	368.4	366.9	366.9	369.0	369.0	369.7	369.7
BDA2010D	80004	80003	Natural	480	100	405	482	294	590	717	361.6	361.7	368.1	368.0	368.5	368.4	367.0	366.9	369.1	369.0	369.8	369.7
BDA2120A	80007	80004	Natural	2050	100	399	477	295	582	704	363	361.6	368.5	368.1	369.0	368.5	367.5	367.0	369.6	369.1	370.3	369.8
BDA2130B	80009	80007	Natural	1050	10	23	24	30	34	40	378	374.6	379.4	375.4	379.4	375.4	379.5	375.5	379.5	375.6	379.6	375.6
BDA2140A	58235	80007	Natural	200	10	37	36	58	79	87	369.4	365.7	370.8	368.5	370.8	369.0	371.0	367.5	371.2	369.6	371.3	370.3
BDA2140B	58946	58235	42" CSP	350	10	37	36	58	79	88	366	370.1	373.2	372.0	373.1	372.0	374.5	372.5	376.0	372.9	376.7	373.0
BDA2140Brd	58946	58235	Roadway	350		0	0	0	0	0	378	378.0	370.8	370.8	370.8	370.8	371.0	371.0	371.2	371.2	371.3	371.3
BDA2140C	58875	58946	42" CSP	1690	10	18	17	28	39	43	370	366.3	373.8	373.2	373.7	373.1	376.1	374.5	379.2	376.0	380.0	376.7
BDA2140Crd	58875	58946	Roadway	1690		0	0	0	0	0	380	378.4	373.2	373.2	373.1	373.1	374.5	374.5	376.0	376.0	380.0	378.4
BDA2130A	80010	80007	Natural	2000	100	355	418	326	516	652	367	364.6	371.5	368.5	371.8	369.0	371.6	367.5	372.3	369.6	372.9	370.3
BDA2170A	80014	80010	Natural	700	100	347	412	342	508	648	368	366.7	372.8	371.5	373.1	371.8	372.7	371.6	373.6	372.3	374.2	372.9

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
BDA2170B	80015	80014	Bridge	135	100	347	412	344	509	650	369	368.3	372.9	372.8	373.2	373.1	372.9	372.7	373.7	373.6	374.3	374.2
BDA2180A	58854	80015	Natural	550	100	345	409	345	505	647	367	368.7	373.1	372.9	373.5	373.2	373.1	372.9	374.0	373.7	374.6	374.3
BDA2190B	58894	58854	84" CSP	445	10	106	125	109	163	261	369	367.4	373.2	373.1	373.7	373.5	373.2	373.1	374.2	374.0	375.5	374.6
BDA2190Brd	58894	58854	Roadway	445		0	0	0	0	0	382	381.8	373.1	373.1	373.5	373.5	373.1	373.1	374.0	374.0	374.6	374.6
BDA2190C	58893	58894	84" CSP	2163	10	93	111	93	140	243	371	368.5	374.5	373.2	375.0	373.7	374.4	373.2	375.7	374.2	379.3	375.5
BDA2190Crd	58893	58894	Roadway	2163		0	0	0	0	0	385	381.8	373.2	373.2	373.7	373.7	373.2	373.2	374.2	374.2	375.5	375.5
BDA2200A	58853	58893	84" CSP	469	10	79	95	70	127	247	371	370.8	374.8	374.5	375.3	375.0	374.7	374.4	376.1	375.7	380.1	379.3
BDA2200Ard	58853	58893	Roadway	469		0	0	0	0	0	385	384.6	374.5	374.5	375.0	375.0	374.4	374.4	375.7	375.7	379.3	379.3
BDA2200B	72463	58853	72" CSP	590	10	70	84	59	115	228	373	372.3	375.9	374.8	376.2	375.3	375.6	374.7	377.0	376.1	381.8	380.1
BDA2200Brd	72463	58853	Roadway	590		0	0	0	0	0	386	385.4	374.8	374.8	375.3	375.3	374.7	374.7	376.1	376.1	380.1	380.1
BDA2200C	72470	72463	72" CSP	705	10	70	84	59	115	228	374	372.9	376.9	375.9	377.3	376.2	376.6	375.6	378.2	377.0	384.4	381.8
BDA2200Crd	72470	72463	Roadway	705		0	0	0	0	0	387	385.6	375.9	375.9	376.2	376.2	375.6	375.6	377.0	377.0	381.8	381.8
BDA2200D	72474	72470	72" CSP	440	10	70	84	59	115	231	374	373.7	377.4	376.9	377.8	377.3	377.1	376.6	378.7	378.2	385.3	384.4
BDA2200Drd	72470	72474	Roadway	440		0	0	0	0	0	387	385.2	377.4	377.4	377.8	377.8	377.1	377.1	378.7	378.7	385.3	385.3
BDA2210A1	72515	72474	36" CSP	20	10	35	42	30	58	115	383	377.1	383.7	377.8	383.8	377.8	383.6	377.7	383.8	378.7	386.3	385.3
BDA2210A2	72515	72474	36" CSP	20	10	35	42	30	58	115	383	377.1	383.7	377.8	383.8	377.8	383.6	377.7	383.8	378.7	386.3	385.3
BDA2210Ard	72515	72474	Roadway	20		0	0	0	0	27	386	385.6	377.4	377.4	377.8	377.8	377.1	377.1	378.7	378.7	386.3	385.7
BDA2210B1	58997	72515	36" CSP	40	10	35	42	30	43	84	383	382.9	387.0	383.7	387.8	383.8	386.3	383.6	388.3	383.8	388.5	386.3
BDA2210B2	58997	72515	36" CSP	40	10	35	42	30	43	84	383	382.9	387.0	383.7	387.8	383.8	386.3	383.6	388.3	383.8	388.5	386.3
BDA2210Brd	58997	72515	Roadway	40		0	0	0	29	69	388	388.1	383.7	383.7	383.8	383.8	383.6	383.6	388.3	388.2	388.5	388.3
BDA2210C	69700	58997	Natural	900	10	92	101	119	152	228	381	382.7	387.0	387.0	387.8	387.8	386.3	386.3	388.3	388.3	388.5	388.5
BDA2220A	80017	69700	36" CSP	146	10	33	32	52	80	92	386	384.0	387.4	387.0	387.8	387.8	388.0	386.3	389.9	388.3	391.1	388.5
BDA2220Ard	80017	69700	Roadway	146		0	0	0	0	0	392	392.2	387.0	387.0	387.8	387.8	386.3	386.3	388.3	388.3	388.5	388.5
BDA2230A	69714	69700	60" CSP	869	10	88	88	132	149	158	381	380.5	388.0	387.0	389.0	387.8	389.1	386.3	391.5	388.3	393.0	388.5
BDA2230Ard	69714	69700	Roadway	869		0	0	0	0	0	393	392.0	387.0	387.0	387.8	387.8	386.3	386.3	388.3	388.3	388.5	388.5
BDA2240A	69732	69714	60" CSP	809	10	74	76	113	123	120	382	381.5	389.0	388.0	390.1	389.0	391.4	389.1	394.1	391.5	394.5	393.0
BDA2240Ard	69732	69714	Roadway	809		0	0	0	1	41	394	393.0	388.0	388.0	389.0	389.0	389.1	389.1	394.1	393.0	394.5	393.3
BDA2260A	80018	58854	Natural	1160	25	247	286	259	364	408	370	367.4	373.9	373.1	374.3	373.5	374.0	373.1	374.9	374.0	375.3	374.6
BDA2260B	80019	80018	Natural	260	25	231	267	241	336	378	368	369.8	374.2	373.9	374.5	374.3	374.2	374.0	375.1	374.9	375.5	375.3
BDA2260C	80020	80019	15x24 M baskhnd culvert	110	25	231	267	242	337	379	368	368.5	374.2	374.2	374.6	374.5	374.3	374.2	375.1	375.1	375.6	375.5
BDA2260D	80021	80020	Trapezoid	400	25	231	267	242	337	380	368	368.5	374.5	374.2	374.8	374.6	374.5	374.3	375.5	375.1	375.9	375.6
BDA2270A	80022	80021	13x26 M baskhnd culvert	129	25	231	267	243	337	380	368.4	368.4	374.5	374.5	374.9	374.8	374.6	374.5	375.5	375.5	375.9	375.9
BDA2280A	66548	80022	66" CSP	776	10	68	66	99	119	134	371	368.4	374.8	374.5	375.2	374.9	375.1	374.6	376.3	375.5	377.1	375.9
BDA2280Ard	66548	80022	Roadway	776		0	0	0	0	0	383	382.0	374.5	374.5	374.9	374.9	374.6	374.6	375.5	375.5	375.9	375.9
BDA2280B	58883	66548	60" CSP	1303	10	58	55	84	99	112	373	371.3	376.0	374.8	376.1	375.2	376.9	375.1	378.1	376.3	379.4	377.1
BDA2280Brd	58883	66548	Roadway	1303		0	0	0	0	0	384	383.1	374.8	374.8	375.2	375.2	375.1	375.1	376.3	376.3	377.1	377.1
BDA2290A	69242	58883	60" CSP	27	10	36	34	51	58	60	379	372.9	379.8	376.0	379.8	376.1	380.0	376.9	380.0	378.1	380.0	379.4
BDA2290Ard	69242	58883	Roadway	27		0	0	0	0	0	384	384.0	376.0	376.0	376.1	376.1	376.9	376.9	378.1	378.1	379.4	379.4
BDA2290B	69021	69242	Natural	1500	10	36	34	51	58	60	382	379.2	385.7	379.8	385.6	379.8	386.2	380.0	386.4	380.0	386.6	380.0
BDA2290C	60488	69021	54" CSP	12	10	37	34	53	69	71	379	382.2	385.7	385.7	385.6	385.6	386.2	386.2	386.5	386.4	386.6	386.6
BDA2290Crd	60488	69021	Roadway	12		0	0	0	1	13	386	386.4	385.7	385.7	385.6	385.6	386.2	386.2	386.5	386.4	386.6	386.6
BDA2300A	68209	60488	48" CSP	1121	10	18	17	26	33	38	380	379.5	385.9	385.7	385.8	385.6	386.7	386.2	387.1	386.5	387.5	386.6

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
BDA2300Ard	68209	60488	Roadway	1121		0	0	0	0	0	388	386.4	385.7	385.7	385.6	385.6	386.2	386.2	386.5	386.5	386.6	386.6
BDA2300B	60565	68209	42"CSP	634	10	18	17	26	33	38	381	380.6	386.1	385.9	386.0	385.8	387.2	386.7	388.0	387.1	388.6	387.5
BDA2300Brd	60565	68209	Roadway	634		0	0	0	0	0	390	388.4	385.9	385.9	385.8	385.8	386.7	386.7	387.1	387.1	387.5	387.5
BDA2270B	80023	80022	Trapezoid	500	25	173	199	183	243	275	368	368.4	374.6	374.5	375.0	374.9	374.7	374.6	375.7	375.5	376.1	375.9
BDA2270C	80024	80023	15x24 M baskhnd culvert	90	25	172	198	182	242	273	368	368.4	374.6	374.6	375.0	375.0	374.7	374.7	375.7	375.7	376.1	376.1
BDA2270D	60115	80024	Natural	1300	25	171	197	176	238	268	372	368.4	376.0	374.6	376.2	375.0	376.0	374.7	376.5	375.7	376.8	376.1
BDA2320A	60238	60115	36" CSP	154	10	26	26	42	54	61	374	373.8	376.3	376.0	376.5	376.2	376.9	376.0	377.5	376.5	377.9	376.8
BDA2320Ard	60238	60115	Roadway	154		0	0	0	0	0	381	380.0	376.0	376.0	376.2	376.2	376.0	376.0	376.5	376.5	376.8	376.8
BDA2320B	60216	60238	36" CSP	1353	10	15	15	24	29	34	379	374.1	379.9	376.3	379.9	376.5	380.3	376.9	380.8	377.5	381.9	377.9
BDA2320Brd	60216	60238	Roadway	1353		0	0	0	0	0	385	380.8	376.3	376.3	376.5	376.5	376.9	376.9	377.5	377.5	377.9	377.9
BDA2320C	60123	60115	Natural	1290	25	155	175	164	214	239	372.7	371.9	378.4	376.0	378.6	376.2	378.5	376.0	378.9	376.5	379.2	376.8
BDA2340A	80025	60123	Natural	630	10	149	167	160	205	228	373.8	372.7	378.7	378.4	378.9	378.6	378.8	378.5	379.4	378.9	379.6	379.2
BDA2350A	60118	80025	Natural	840	10	125	136	147	171	185	376	373.8	380.1	378.7	380.3	378.9	380.4	378.8	380.8	379.4	381.0	379.6
BDA2350B	59972	60118	66" CSP	512	10	126	136	148	171	185	377	375.9	381.2	380.1	381.4	380.3	381.7	380.4	382.3	380.8	382.9	381.0
BDA2350Brd	59972	60118	Roadway	512		0	0	0	0	0	387	386.8	380.1	380.1	380.3	380.3	380.4	380.4	380.8	380.8	381.0	381.0
BDA2350C	60107	59972	60" CSP	97	10	126	136	148	171	185	378	377.2	382.0	381.2	382.3	381.4	382.7	381.7	383.5	382.3	384.4	382.9
BDA2350Crd	60107	59972	Roadway	97		0	0	0	0	0	387	386.8	381.2	381.2	381.4	381.4	381.7	381.7	382.3	382.3	382.9	382.9
BDA2360A	67069	60107	Natural	1250	10	121	129	147	167	183	379	376.8	383.3	382.0	383.5	382.3	383.8	382.7	384.4	383.5	385.0	384.4
BDA2380A	66573	67069	48" CSP	1309	10	36	36	56	68	78	381	379.3	384.1	383.3	384.4	383.5	385.8	383.8	387.2	384.4	388.3	385.0
BDA2380Ard	66573	67069	Roadway	1309		0	0	0	0	0	388	388.0	383.3	383.3	383.5	383.5	383.8	383.8	384.4	384.4	385.0	385.0
BDA2370A	60462	67069	Natural	600	10	79	84	98	109	119	381	378.5	383.4	383.3	383.6	383.5	384.0	383.8	384.5	384.4	385.1	385.0
BDA2370B	60463	60462	54" CSP culvert	55	10	79	83	97	109	119	381	380.8	384.6	383.4	384.8	383.6	385.3	384.0	385.8	384.5	386.4	385.1
BDA2370Brd	60463	60462	Roadway	55		0	0	0	0	0	390	390.2	383.4	383.4	383.6	383.6	384.0	384.0	384.5	384.5	385.1	385.1
BDA2370C	60460	60463	Natural	570	10	79	83	97	110	120	382	380.9	385.7	384.6	385.9	384.8	386.2	385.3	386.6	385.8	387.1	386.4
BDA2390A	60461	60460	54" CSP	102	10	80	83	98	111	121	382	381.7	386.3	385.7	386.5	385.9	387.0	386.2	387.6	386.6	388.3	387.1
BDA2390Ard	60461	60460	Roadway	102		0	0	0	0	0	390	390.0	385.7	385.7	385.9	385.9	386.2	386.2	386.6	386.6	387.1	387.1
BDA2390B	60455	60461	Natural	1000	10	68	71	88	97	106	383	382.1	387.3	386.3	387.5	386.5	387.9	387.0	388.3	387.6	388.8	388.3
BDA2395A	60454	60455	48" CSP culvert	45	10	68	71	91	101	112	383	383.5	387.9	387.3	388.0	387.5	388.8	387.9	389.4	388.3	390.1	388.8
BDA2395Ard	60454	60455	Roadway	45		0	0	0	0	0	392	392.0	387.3	387.3	387.5	387.5	387.9	387.9	388.3	388.3	388.8	388.8
BDA2395B	60456	60454	Natural	700	10	48	51	63	71	76	384	383.4	388.1	387.9	388.2	388.0	388.9	388.8	389.5	389.4	390.2	390.1
BDA2395C	68451	60456	48" CSP	1037	10	49	52	69	86	93	386	383.7	389.4	388.1	389.6	388.2	391.7	388.9	393.2	389.5	394.3	390.2
BDA2395Crd	68451	60456	Roadway	1037		0	0	0	0	0	395	393.0	388.1	388.1	388.2	388.2	388.9	388.9	389.5	389.5	390.2	390.2
BDA2400A	60541	68451	36" CSP	1086	10	10	10	16	24	27	388	387.0	389.8	389.4	389.9	389.6	392.5	391.7	395.2	393.2	396.5	394.3
BDA2400Ard	60541	68451	Roadway	1086		0	0	0	0	0	399	394.7	389.4	389.4	389.6	389.6	391.7	391.7	393.2	393.2	394.3	394.3
BDA2400B	60550	68451	36" CSP	472	10	19	22	29	30	33	387	386.2	389.8	389.4	390.2	389.6	392.4	391.7	393.5	393.2	394.5	394.3
BDA2400Brd	60550	68451	Roadway	472		0	0	0	0	0	395	394.3	389.4	389.4	389.6	389.6	391.7	391.7	393.2	393.2	394.3	394.3
BDA2400C	62088	60550	36" CSP	365	10	19	22	28	30	33	388	387.1	390.1	389.8	390.7	390.2	392.9	392.4	393.8	393.5	395.1	394.5
BDA2400Crd	62088	60550	Roadway	365		0	0	0	0	0	396	394.8	389.8	389.8	390.2	390.2	392.4	392.4	393.5	393.5	394.5	394.5
BDA2400D	62089	62088	36" CSP	336	10	19	22	28	30	33	388	387.6	390.5	390.1	391.2	390.7	393.4	392.9	394.5	393.8	395.8	395.1
BDA2400Drd	62089	62088	Roadway	336		0	0	0	0	7	395	395.6	390.5	390.5	391.2	391.2	393.4	393.4	394.5	394.5	395.8	395.7
BDA2400E	62090	62089	30" CSP	170	10	18	22	28	30	29	389	388.1	390.8	390.5	391.7	391.2	394.0	393.4	395.4	394.5	395.8	395.8
BDA2400Erd	62090	62089	Roadway	170		0	0	0	3	27	395	395.3	390.8	390.8	391.7	391.7	394.0	394.0	395.4	395.4	395.8	395.8

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
BDA2400F	62024	62090	30" CSP	275	10	18	22	28	27	26	392	389.1	393.5	390.8	393.6	391.7	395.2	394.0	395.6	395.4	395.8	395.8
BDA2400Frd	62024	62090	Roadway	275		0	0	0	22	33	395	395.0	390.8	390.8	391.7	391.7	395.2	395.0	395.6	395.4	395.8	395.8
BDA2400G	62023	62024	3.5' x 2' Box culvert	28	10	18	22	28	26	25	392	392.3	393.6	393.5	393.8	393.6	395.3	395.2	395.6	395.6	395.8	395.8
BDA2400Grd	62023	62024	Roadway	28		0	0	1	23	33	395	395.2	393.5	393.5	393.6	393.6	395.3	395.2	395.6	395.6	395.8	395.8
BDA2400H	62022	62023	30" CSP	311	10	18	22	27	26	26	393	392.3	395.0	393.6	395.4	393.8	396.2	395.3	396.2	395.6	396.3	395.8
BDA2400Hrd	62022	62023	Roadway	311		0	0	8	18	25	396	395.3	393.6	393.6	393.8	393.8	396.2	395.4	396.2	395.6	396.3	395.8
BDA2400I	62093	62022	3.5' x 2' Box culvert	28	10	18	22	28	29	30	393	392.8	395.0	395.0	395.5	395.4	396.3	396.2	396.3	396.2	396.4	396.3
BDA2400Ird	62093	62022	Roadway	28		0	0	3	12	19	396	396.0	395.0	395.0	395.4	395.4	396.3	396.2	396.3	396.2	396.4	396.3
BDA2400J1	62094	62093	21" CSP	308	10	9	9	9	9	9	392	392.9	396.2	395.0	396.3	395.5	396.5	396.3	396.6	396.3	396.6	396.4
BDA2400J2	62094	62093	21" CSP	308	10	9	9	9	9	9	392	392.9	396.2	395.0	396.3	395.5	396.5	396.3	396.6	396.3	396.6	396.4
BDA2400Jrd	62094	62093	Roadway	308		0	6	20	27	34	396	396.2	396.2	396.2	396.3	396.3	396.5	396.4	396.6	396.4	396.6	396.5
BDA2400K1	62025	62094	21" CSP	27	10	9	9	9	8	8	393	392.1	396.2	396.2	396.3	396.3	396.5	396.5	396.6	396.6	396.6	396.6
BDA2400K2	62025	62094	21" CSP	27	10	9	9	9	8	8	393	392.1	396.2	396.2	396.3	396.3	396.5	396.5	396.6	396.6	396.6	396.6
BDA2400Krd	62025	62094	Roadway	27		18	20	29	33	40	395	395.8	396.2	396.2	396.3	396.3	396.5	396.5	396.6	396.6	396.6	396.6
BDA2400L1	62095	62025	21" CSP	109	10	11	11	16	18	18	394	393.3	396.8	396.2	397.0	396.3	398.0	396.5	398.3	396.6	398.4	396.6
BDA2400L2	62095	62025	21" CSP	109	10	11	11	16	18	18	394	393.3	396.8	396.2	397.0	396.3	398.0	396.5	398.3	396.6	398.4	396.6
BDA2400Lrd	62095	62025	Roadway	109		0	0	0	0	7	398	395.3	396.2	396.2	396.3	396.3	396.5	396.5	398.3	396.6	398.4	396.6
BDA2400M	69935	62095	30" CSP	353	10	22	22	33	34	34	395	394.2	398.0	396.8	398.2	397.0	400.6	398.0	400.7	398.3	400.7	398.4
BDA2400Mrd	69935	62095	Roadway	353		0	0	0	5	12	401	398.3	396.8	396.8	397.0	397.0	400.6	398.3	400.7	398.4	400.7	398.4
BDA2410A	80027	80025	Natural	680	10	25	30	19	38	45	374.7	373.8	378.7	378.7	379.0	378.9	378.8	378.8	379.4	379.4	379.6	379.6
BDA2410B	60102	80027	Natural	580	10	21	25	24	34	40	375.0	374.7	378.8	378.7	379.0	379.0	378.9	378.8	379.4	379.4	379.6	379.6
BDA2420A1	60101	60102	48" CMP culverts	120	10	11	13	14	19	22	375	375.1	378.8	378.8	379.0	379.0	378.9	378.9	379.4	379.4	379.7	379.6
BDA2420A2	60101	60102	48" CMP culverts	120	10	11	13	14	19	22	375	375.0	378.8	378.8	379.0	379.0	378.9	378.9	379.4	379.4	379.7	379.6
BDA2420Ard	60101	60102	Roadway	120		0	0	0	0	0	385	384.9	378.8	378.8	379.0	379.0	378.9	378.9	379.4	379.4	379.6	379.6
BDA2430A	61733	60101	Natural	700	10	14	15	18	23	27	376.1	375.3	378.8	378.8	379.0	379.0	378.9	378.9	379.5	379.4	379.7	379.7
Bethel Danebo - A3 Channel																						
BDA3010A	61607	80044	Natural	2400	100	457	541	336	584	665	374.9	370.0	381.1	381.0	381.4	381.2	379.2	379.1	381.5	381.4	381.7	381.6
BDA3020A1	61608	61607	6' x 10' Concrete Box culvert	100	100	236	275	170	298	337	375.0	374.9	381.2	381.1	381.5	381.4	379.2	379.2	381.6	381.5	382.0	381.7
BDA3020A2	61608	61607	6' x 10' Concrete Box culvert	100	100	236	275	170	298	337	375.0	374.9	381.2	381.1	381.5	381.4	379.2	379.2	381.6	381.5	382.0	381.7
BDA3020Ard	61608	61607	Roadway	100		0	0	0	0	0	385.6	385.6	381.1	381.1	381.4	381.4	379.2	379.2	381.5	381.5	381.7	381.7
BDA3020B	67113	61608	Natural	2470	100	467	537	349	588	658	376.6	375.0	381.8	381.2	382.3	381.5	380.8	379.2	382.4	381.6	382.9	382.0

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
BDA3030A1	61694	67113	6' x 10' Concrete Box culvert	83	100	236	271	175	297	332	376.7	376.6	382.0	381.8	382.5	382.3	381.0	380.8	382.7	382.4	383.1	382.9
BDA3030A2	61694	67113	6' x 10' Concrete Box culvert	83	100	236	271	175	297	332	376.7	376.6	382.0	381.8	382.5	382.3	381.0	380.8	382.7	382.4	383.1	382.9
BDA3030Ard	61694	67113	Roadway	83		0	0	0	0	0	385.4	385.4	381.8	381.8	382.3	382.3	380.8	380.8	382.4	382.4	382.9	382.9
BDA3030B	80045	61694	Natural	850	100	460	528	349	579	646	376.6	376.7	382.4	382.0	383.0	382.5	381.6	381.0	383.1	382.7	383.6	383.1
BDA3030C	80050	80045	Natural	1600	100	263	323	198	381	446	380.6	376.6	383.8	382.4	384.2	383.0	384.0	381.6	384.9	383.1	385.1	383.6
BDA3040A	80051	80050	Natural	32	100	233	280	171	303	347	380.2	380.6	384.0	383.8	384.4	384.2	384.0	384.0	384.9	384.9	385.2	385.1
BDA3040B	80052	80051	Natural	350	100	233	279	171	303	346	380.6	380.2	384.5	384.0	384.9	384.4	384.2	384.0	385.2	384.9	385.5	385.2
BDA3040D	modpt	80052	Natural	1100	10	16	16	26	31	35	382.6	380.6	384.5	384.5	384.9	384.9	384.9	384.2	385.5	385.2	385.7	385.5
BDA3040C	63147	80052	Natural	2370	100	226	269	171	294	336	381.5	380.6	387.1	384.5	387.6	384.9	386.5	384.2	387.8	385.2	388.2	385.5
BDA3060A	63130	63147	Natural	470	100	216	253	168	280	321	383.0	381.5	387.3	387.1	387.8	387.6	386.7	386.5	388.0	387.8	388.4	388.2
BDA3070A	63207	63147	36" CSP	892	10	11	11	16	18	21	383.7	381.5	387.2	387.1	387.7	387.6	386.5	386.5	388.0	387.8	388.6	388.2
BDA3070Ard	63207	63147	Roadway	892		0	0	0	0	0	396.0	391.4	387.2	387.2	387.7	387.7	386.5	386.5	388.0	388.0	388.6	388.6
BDA3080A	63129	63130	7' x 10' Concrete Box culvert	96	100	216	254	168	280	321	382.9	383.0	387.6	387.3	388.0	387.8	386.9	386.7	388.3	388.0	388.7	388.4
BDA3080Ard	63129	63130	Roadway	96		0	0	0	0	0	391.8	391.8	387.3	387.3	387.8	387.8	386.7	386.7	388.0	388.0	388.4	388.4
BDA3080C1	80055	80054	Natural	750	100	208	241	209	276	310	383.6	382.2	390.2	390.2	390.7	390.7	389.7	389.7	391.1	391.1	391.5	391.5
BDA3080C2	80056	80055	Natural	750	100	247	273	359	340	378	384.5	383.6	390.3	390.2	390.8	390.7	389.8	389.7	391.1	391.1	391.5	391.5
BDA3080D	63309	80056	Natural	700	100	303	320	400	423	470	386.0	384.8	390.3	390.3	390.8	390.8	389.8	389.8	391.1	391.1	391.6	391.5
BDA3090A	67158	63309	7' x 10' Concrete Box culvert	96	100	331	344	424	464	516	386.5	386.3	390.7	390.3	391.1	390.8	391.3	390.1	391.6	391.1	392.1	391.6
BDA3090Ard	67158	63309	Roadway	96		0	0	0	0	0	395.5	395.0	390.3	390.3	390.8	390.8	389.8	389.8	391.1	391.1	391.6	391.6
BDA3090B	63276	67158	Natural	1300	100	313	325	404	436	480	386.8	385.2	392.1	390.7	392.3	391.1	392.7	391.3	392.9	391.6	393.2	392.1
BDA3110D	63359	63307	36" CSP	160	10	28	28	41	47	55	388.4	389.3	393.0	392.6	393.2	392.9	394.1	393.3	394.5	393.7	395.1	394.1
BDA3110DRD	63359	63307	Roadway	160		0	0	0	0	1	395.0	395.0	392.6	392.6	392.9	392.9	393.3	393.3	393.7	393.7	395.1	395.0
BDA3110C	63307	63275	Natural	1300	10	25	27	32	36	42	389.3	388.2	392.6	392.5	392.9	392.7	393.3	393.2	393.7	393.6	394.1	394.0
BDA3110A	63275	63276	42" CMP	160	10	26	28	34	34	37	388.2	388.1	392.5	392.1	392.7	392.3	393.2	392.7	393.6	392.9	394.0	393.2
BDA3110Ard	63275	63276	Roadway	160		0	0	0	0	0	396.6	396.6	392.1	392.1	392.3	392.3	392.7	392.7	392.9	392.9	393.2	393.2
BDA3100A	63303	63276	Natural	600	100	270	278	355	379	415	387.2	386.8	392.4	392.1	392.6	392.3	393.0	392.7	393.2	392.9	393.5	393.2
BDA3120A	63326	63303	42" CSP	140	10	23	21	31	50	60	387.7	387.2	392.5	392.4	392.6	392.6	393.1	393.0	393.4	393.2	393.7	393.5
BDA3120Ard	63326	63303	Roadway	140		0	0	0	0	0	397.0	397.0	392.4	392.4	392.6	392.6	393.0	393.0	393.2	393.2	393.5	393.5
BDA3100B	63305	63303	Natural	1900	100	254	259	341	364	387	388.6	387.2	393.8	392.4	393.9	392.6	394.5	393.0	394.6	393.2	394.8	393.5
BDA3150C	63349	63332	42" CSP	27	10	32	31	48	56	67	388.9	388.9	394.4	394.4	394.5	394.4	395.9	395.7	396.5	396.3	397.0	396.8
BDA3150Crd	63349	63332	Roadway	27		0	0	0	0	0	397.1	396.9	394.4	394.4	394.4	394.4	395.7	395.7	396.3	396.3	396.8	396.8
BDA3150B	63332	63335	60" CSP	275	10	74	70	106	127	135	388.6	388.2	394.4	394.1	394.4	394.2	395.7	395.1	396.3	395.4	396.8	395.8
BDA3150Brd	63332	63335	Roadway	275		0	0	0	0	0	396.9	396.0	394.1	394.1	394.2	394.2	395.1	395.1	395.4	395.4	395.8	395.8
BDA3150A	63335	63305	48" CSP	80	10	74	70	106	127	135	387.8	388.6	394.1	393.8	394.2	393.9	395.1	394.5	395.4	394.6	395.8	394.8

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
BDA3150Ard	63335	63305	Roadway	80		0	0	0	0	0	399.0	396.0	394.1	394.1	394.2	394.2	395.1	395.1	395.4	395.4	395.8	395.8
BDA3160A	66631	63332	48" CSP	693	10	42	39	59	71	71	391.0	388.7	395.2	394.4	395.1	394.4	397.3	395.7	398.6	396.3	398.9	396.8
BDA3160Ard	66631	63332	Roadway	693		0	0	0	0	5	398.6	398.4	394.4	394.4	394.4	394.4	395.7	395.7	398.6	398.4	398.9	398.5
BDA3180A	63351	63305	48" CSP	70	10	59	61	83	86	94	387.5	388.7	394.1	393.8	394.2	393.9	394.9	394.5	395.1	394.6	395.4	394.8
BDA3180Ard	63351	63305	Roadway	70		0	0	0	0	0	399.0	397.9	394.1	394.1	394.2	394.2	394.9	394.9	395.1	395.1	395.4	395.4
BDA3180B	63369	63351	48" CSP	889	10	58	60	83	86	86	390.7	387.5	395.8	394.1	396.0	394.2	398.6	394.9	398.7	395.1	399.0	395.4
BDA3180Brd	63369	63351	Roadway	889		0	0	0	2	12	398.6	397.9	394.1	394.1	394.2	394.2	394.9	394.9	398.7	397.9	399.0	398.0
BDA3180C	63810	63369	48" CSP	939	10	32	33	49	50	49	392.9	390.7	396.3	395.8	396.6	396.0	399.5	398.6	400.0	398.7	400.2	399.0
BDA3180Crd	63810	63369	Roadway	939		0	0	0	0	8	400.0	398.6	395.8	395.8	396.0	396.0	398.6	398.6	400.0	398.7	400.2	399.0
BDA3180D	63811	63810	42" CSP	400	10	31	33	49	50	51	393.7	392.9	396.7	396.3	397.0	396.6	400.2	399.5	400.5	400.0	400.7	400.2
BDA3180Drd	63811	63810	Roadway	400		0	0	2	16	27	400.0	400.0	396.3	396.3	396.6	396.6	400.2	400.0	400.5	400.2	400.7	400.2
BDA3130A	63364	63305	66" CSP	90	10	128	132	161	175	182	387.2	388.6	394.1	393.8	394.2	393.9	394.8	394.5	395.0	394.6	395.3	394.8
BDA3130Ard	63364	63305	Roadway	90		0	0	0	0	0	399.0	398.0	394.1	394.1	394.2	394.2	394.8	394.8	395.0	395.0	395.3	395.3
BDA3130B	63822	63364	60" CSP	2417	10	109	113	135	136	136	391.4	387.6	399.2	394.1	399.6	394.2	402.3	394.8	402.4	395.0	402.6	395.3
BDA3130Brd	63822	63364	Roadway	2417		0	0	0	2	13	402.3	398.0	394.1	394.1	394.2	394.2	402.3	398.0	402.4	398.0	402.6	398.2
BDA3200A	63826	63822	60" CSP	949	10	89	92	116	115	117	392.9	391.4	400.6	399.2	401.1	399.6	404.4	402.3	404.7	402.4	405.0	402.6
BDA3200Ard	63826	63822	Roadway	949		0	0	0	0	9	404.8	402.3	399.2	399.2	399.6	399.6	402.3	402.3	402.4	402.4	405.0	402.6
BDA3210A	63800	63826	60" CSP	1774	10	66	68	98	92	95	395.3	392.9	402.0	400.6	402.6	401.1	406.0	404.4	406.3	404.7	406.6	405.0
BDA3210Ard	63800	63826	Roadway	1774		0	0	1	8	23	405.9	404.8	400.6	400.6	401.1	401.1	406.0	404.8	406.3	404.9	406.6	405.0
BDA3220A	63797	63800	48" CSP	722	10	32	32	67	58	60	396.9	395.3	402.5	402.0	403.0	402.6	406.4	406.0	406.5	406.3	406.7	406.6
BDA3220Ard	63797	63800	Roadway	722		0	0	7	16	26	406.0	405.9	402.0	402.0	402.6	402.6	406.4	406.0	406.5	406.3	406.7	406.6
BDA3220B	63795	63797	42" CSP	713	10	32	32	59	50	51	398.3	396.9	403.4	402.5	403.9	403.0	406.7	406.4	406.8	406.5	407.0	406.7
BDA3220Brd	63795	63797	Roadway	713		0	0	24	30	41	406.0	406.0	402.5	402.5	403.0	403.0	406.7	406.4	406.8	406.5	407.0	406.7
Bethel Danebo - Greenhill Tributary																						
BDGH050A1	80036	80070	36" CMP	45	25	84	91	89	102	109	365.7	365.5	371.0	371.0	371.7	370.7	371.4	371.0	372.5	371.7	373.3	371.7
BDGH050A2	80036	80057	36" CMP	45	25	61	68	66	79	85	365.4	366.0	371.0	371.0	371.7	370.7	371.4	371.0	372.5	371.7	373.3	371.7
BDGH050B	80035	80036	Natural	30	25	145	162	158	180	194	366.4	365.4	371.0	371.0	371.7	371.7	371.3	371.4	372.5	372.5	373.3	373.3
BDGH050C	81000	80035	Natural	1875	10	151	162	178	201	216	369.0	366.4	372.3	371.0	372.6	371.7	372.6	371.3	373.2	372.5	373.7	373.3
BDGH050D	81001	81000	Natural	120	25	152	164	177	206	228	369.1	369.0	372.6	372.3	372.8	372.6	372.9	372.6	373.3	373.2	373.8	373.7
BDGH050E	80037	81001	Natural	20	25	152	164	177	206	229	368.5	369.1	372.7	372.6	372.8	372.8	373.0	372.9	373.4	373.3	373.9	373.8
BDGH064A1	81002	80037	3.4' x 5.1' Rectangle	15	10	78	84	93	106	117	369.0	368.5	372.9	372.7	373.2	372.8	373.3	373.0	373.8	373.4	374.3	373.9
BDGH064A2	81002	80037	3.4' x 5.1' Rectangle	15	10	64	70	75	86	94	369.0	368.5	372.9	372.7	373.2	372.8	373.3	373.0	373.8	373.4	374.3	373.9
BDGH064Ard	81002	80037	Roadway	2700		0	0	0	0	0	374.3	374.2	372.7	372.7	372.8	372.8	373.0	373.0	373.4	373.4	373.9	373.9
BDGH064B	81003	81002	Natural	22	10	142	154	167	192	212	369.2	369.0	372.9	372.9	373.2	373.2	373.3	373.3	373.8	373.8	374.3	374.3
BDGH064C	80038	81003	Natural	26	10	142	154	167	192	212	369.5	369.2	373.0	372.9	373.2	373.2	373.4	373.3	373.8	373.8	374.3	374.3
BDGH064D	81004	80038	Natural	32	10	109	117	128	148	167	369.8	369.5	373.0	373.0	373.3	373.2	373.4	373.4	373.8	373.8	374.3	374.3
BDGH064E	81015	81004	Natural	395	10	109	117	128	149	168	370.1	369.8	374.0	373.0	374.1	373.3	374.3	373.4	374.6	373.8	375.0	374.3
BDGH064F	80064	81015	Natural	437	10	109	118	128	149	169	370.2	370.1	374.4	374.0	374.5	374.1	374.7	374.3	375.1	374.6	375.5	375.0
BDGH060B	80040	80071	Natural	835	10	26	29	31	37	42	370.0	369.7	373.3	373.2	373.5	373.4	373.6	373.5	374.0	373.9	374.4	374.4
BDGH060	80071	80038	Natural	835	10	34	37	40	47	54	369.7	369.5	373.2	373.0	373.4	373.2	373.5	373.4	373.9	373.8	374.4	374.3
BDGH062A	80065	80064	Natural	205	10	101	109	119	138	157	370.6	370.2	374.5	374.4	374.7	374.5	374.9	374.7	375.3	375.1	375.7	375.5
BDGH062B	81005	80065	Natural	597	10	101	109	119	139	159	371.9	370.6	375.4	374.5	375.6	374.7	375.9	374.9	376.3	375.3	376.7	375.7
BDGH062C	70559	81005	Natural	58	10	101	109	120	140	160	371.5	371.9	375.5	375.4	375.7	375.6	375.9	375.9	376.4	376.3	376.8	376.7
BDGH066	70560	70559	24" CSP	117	10	2	2	3	2	2	371.7	371.4	375.5	375.5	375.7	375.7	375.9	375.9	376.4	376.4	376.8	376.8

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
BDGH066rd	70560	70559	Roadway	117		4	3	2	3	3	375.0	373.0	375.5	375.5	375.7	375.7	375.9	375.9	376.4	376.4	376.8	376.8
BDGH075A	81007	70559	Natural	545	10	84	90	99	116	132	371.2	371.5	375.9	375.5	376.1	375.7	376.3	375.9	376.8	376.4	377.1	376.8
BDGH075B	70538	81007	Natural	55	10	84	90	102	118	134	370.1	371.2	375.9	375.9	376.1	376.1	376.4	376.3	376.8	376.8	377.1	377.1
BDGH068	70539	70538	24" CSP	67	10	6	5	8	11	13	370.3	370.1	375.9	375.9	376.1	376.1	376.4	376.4	376.9	376.8	377.2	377.1
BDGH068rd	70539	70538	Roadway	67		0	0	0	0	0	377.5	375.0	375.9	375.9	376.1	376.1	376.4	376.4	376.8	376.8	377.1	377.1
BDGH070	59949	68192	27" CSP	335	10	5	5	7	10	12	373.1	372.9	376.0	376.0	376.2	376.2	376.5	376.5	377.0	376.9	377.4	377.3
BDGH070rd	59949	68192	Roadway	335		0	0	0	0	0	379.0	377.8	376.0	376.0	376.2	376.2	376.5	376.5	376.9	376.9	377.3	377.3
BDGH075C	81009	70538	Natural	173	10	80	86	98	113	127	371.1	370.1	375.9	375.9	376.1	376.1	376.4	376.4	376.8	376.8	377.1	377.1
BDGH075D	81010	81009	Natural	22	10	80	86	99	114	130	371.2	371.1	375.9	375.9	376.1	376.1	376.4	376.4	376.8	376.8	377.1	377.1
BDGH075E	80039	81010	Natural	35	10	81	86	101	116	131	370.9	371.2	375.9	375.9	376.1	376.1	376.4	376.4	376.8	376.8	377.1	377.1
BDGH075F1	68192	80039	54" CSP	57	10	26	28	31	36	40	371.2	370.9	376.0	375.9	376.2	376.1	376.5	376.4	376.9	376.8	377.3	377.1
BDGH075F2	68192	80039	48" CSP	57	10	20	21	24	28	31	371.2	371.1	376.0	375.9	376.2	376.1	376.5	376.4	376.9	376.8	377.3	377.1
BDGH075F3	68192	80039	54" CSP	57	10	24	26	31	35	39	371.2	371.2	376.0	375.9	376.2	376.1	376.5	376.4	376.9	376.8	377.3	377.1
BDGH075G	80069	68192	4' x 8' Concrete Box Culvert	549	10	66	71	79	92	104	371.8	371.2	376.1	376.0	376.3	376.2	376.7	376.5	377.2	376.9	377.6	377.3
BDGH075Grd	80069	68192	Roadway	549	10	0	0	0	0	0	378.2	378.1	376.0	376.0	376.2	376.2	376.5	376.5	376.9	376.9	377.3	377.3
BDGH080B	70177	70170	42" CSP	520	10	12	11	18	28	32	372.5	372.0	376.0	376.0	376.3	376.2	376.7	376.5	377.2	376.9	377.9	377.3
BDGH080BRD	70177	70170	Roadway	520		0	0	0	0	0	379.0	377.9	376.0	376.0	376.3	376.3	376.7	376.7	377.2	377.2	377.9	377.9
BDGH080A	70170	80039	42" CSP	520	10	12	11	18	28	32	372.0	371.5	376.0	375.9	376.2	376.1	376.5	376.4	376.9	376.8	377.3	377.1
BDGH080ARD	70170	80039	Roadway	520		0	0	0	0	0	380.0	378.5	375.9	375.9	376.1	376.1	376.4	376.4	376.8	376.8	377.1	377.1
BDGH090	59945	80069	Rectangle	296	10	57	61	71	80	91	372.2	371.8	376.2	376.1	376.4	376.3	376.8	376.7	377.4	377.2	377.9	377.6
BDGH090rd	59945	80069	Roadway	296		0	0	0	0	0	378.4	378.2	376.1	376.1	376.3	376.3	376.7	376.7	377.2	377.2	377.6	377.6
BDGH100A	60116	59945	Natural	990	10	8	9	12	12	13	373.3	371.6	376.2	376.2	376.4	376.4	376.8	376.8	377.4	377.4	377.9	377.9
BDGH100B	60210	60116	48" CSP Culvert	100	10	10	10	16	23	28	374.3	373.3	376.2	376.2	376.4	376.4	376.8	376.8	377.4	377.4	377.9	377.9
BDGH100Brd	60210	60116	Roadway	100		0	0	0	0	0	379.5	379.0	376.2	376.2	376.4	376.4	376.8	376.8	377.4	377.4	377.9	377.9
BDGH100C	60212	60210	36" CSP	632	10	11	10	17	25	29	375.0	374.3	376.6	376.2	376.7	376.4	377.2	376.8	377.7	377.4	378.4	377.9
BDGH100Crd	60212	60210	Roadway	632		0	0	0	0	0	381.7	379.0	376.2	376.2	376.4	376.4	376.8	376.8	377.4	377.4	377.9	377.9
BDGH110A	60111	59945	Natural	1660	10	30	31	43	47	53	374.0	371.8	376.5	376.2	376.7	376.4	377.1	376.8	377.6	377.4	378.1	377.9
BDGH110B	60196	60111	48" CMP Culvert	44	10	33	32	51	63	74	374.1	374.0	376.7	376.5	376.8	376.7	377.3	377.1	377.7	377.6	378.3	378.1
BDGH110BRD	60196	60111	Roadway	44		0	0	0	0	0	380.2	380.2	376.5	376.5	376.7	376.7	377.1	377.1	377.6	377.6	378.1	378.1
BDGH120A1	80041	80040	48" CMP Culvert	41	10	14	15	17	21	23	370.8	370.8	373.4	373.3	373.6	373.5	373.7	373.6	374.1	374.0	374.5	374.4
BDGH120A2	80041	80040	48" CMP Culvert	41	10	14	15	17	20	23	371.0	370.8	373.4	373.3	373.6	373.5	373.7	373.6	374.1	374.0	374.5	374.4
BDGH120B	80042	80041	Natural	2070	10	12	13	15	18	20	371.7	370.3	373.6	373.4	373.7	373.6	373.9	373.7	374.2	374.1	374.5	374.5
BDGH120C	80043	80042	72" CMP Culvert	24	10	14	14	21	27	32	371.7	371.7	373.6	373.6	373.8	373.7	373.9	373.9	374.2	374.2	374.5	374.5
BDGH120D	61605	80043	Natural	560	10	15	14	22	31	37	375.2	371.7	376.1	373.6	376.1	373.8	376.3	373.9	376.5	374.2	376.6	374.5
BDGH120E	61601	61605	42" CSP	50	10	15	14	22	32	38	373.6	375.2	376.3	376.1	376.2	376.1	376.6	376.3	376.9	376.5	377.1	376.6
BDGH120Erd	61601	61605	Roadway	50		0	0	0	0	0	379.5	378.8	376.3	376.3	376.2	376.2	376.6	376.6	376.9	376.9	377.1	377.1
BDGH130	69068	61601	42" CSP	152	10	15	14	22	32	38	374.1	373.6	376.3	376.3	376.3	376.2	376.6	376.6	377.1	376.9	377.4	377.1
BDGH130rd	69068	61601	Roadway	152		0	0	0	0	0	379.3	378.8	376.3	376.3	376.2	376.2	376.6	376.6	376.9	376.9	377.1	377.1

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
Bethel Danebo - Roosevelt Channel																						
BDRC010A	80046	80045	66" CSP	19	25	206	216	197	242	262	377.5	377.4	383.5	382.4	384.1	383.0	382.8	381.6	384.4	383.1	385.3	383.6
BDRC010Ard	80046	80045	Roadway	19		0	0	0	0	0	388.0	384.0	383.5	383.5	384.1	384.1	382.8	382.8	384.4	384.4	385.3	385.3
BDRC010B	67117	80046	Natural	450	25	207	216	198	243	263	378.4	377.5	383.8	383.5	384.3	384.1	383.3	382.8	384.6	384.4	385.4	385.3
BDRC010C1	61727	67117	60" CSP	132	50	103	108	100	123	132	378.4	378.5	384.4	383.8	384.9	384.3	383.8	383.3	385.5	384.6	386.4	385.4
BDRC010C2	61727	67117	60" CSP	132	50	104	109	98	121	132	378.7	378.4	384.4	383.8	384.9	384.3	383.8	383.3	385.5	384.6	386.4	385.4
BDRC010Crd	61727	67117	Roadway	132		0	0	0	0	0	388.4	388.4	383.8	383.8	384.3	384.3	383.3	383.3	384.6	384.6	385.4	385.4
BDRC010D	80047	61727	Natural	1360	25	182	191	192	232	245	379.5	378.4	384.9	384.4	385.5	384.9	384.7	383.8	386.2	385.5	387.2	386.4
BDRC020A	61732	80047	36" CSP	110	10	19	19	27	28	33	381.9	380.5	385.0	384.9	385.6	385.5	384.8	384.7	386.3	386.2	387.2	387.2
BDRC020Ard	61732	80047	Roadway	110		0	0	0	0	12	386.8	386.8	384.9	384.9	385.5	385.5	384.7	384.7	386.2	386.2	387.2	387.2
BDRC020B	80049	61732	Natural	520	10	20	19	29	30	34	383.3	381.6	385.1	385.0	385.6	385.6	385.2	384.8	386.3	386.3	387.2	387.2
BDRC020C	61741	80049	Natural	1300	10	21	21	30	34	40	384.7	383.3	387.0	385.1	386.9	385.6	387.4	385.2	387.6	386.3	387.8	387.2
BDRC010E1	80048	80047	6' X 6' Concrete box culvert	49	25	84	88	89	110	128	379.6	379.5	385.0	384.9	385.5	385.5	384.8	384.7	386.3	386.2	387.2	387.2
BDRC010E2	80048	80047	6' X 6' Concrete box culvert	49	25	85	89	90	112	130	379.6	379.5	385.0	384.9	385.5	385.5	384.8	384.7	386.3	386.2	387.2	387.2
BDRC010Erd	80048	80047	Roadway	49		0	0	0	0	49	386.8	386.8	384.9	384.9	385.5	385.5	384.7	384.7	386.2	386.2	387.2	387.2
BDRC010F	67120	80048	Natural	1130	25	170	178	178	225	266	380.0	379.6	385.4	385.0	385.8	385.5	385.3	384.8	386.5	386.3	387.4	387.2
BDRC030A	61743	67120	78" CSP	110	25	171	178	178	227	274	380.2	380.0	386.0	385.4	386.4	385.8	386.0	385.3	387.4	386.5	388.4	387.4
BDRC030Ard	61743	67120	Roadway	110		0	0	0	0	0	389.0	389.0	385.4	385.4	385.8	385.8	385.3	385.3	386.5	386.5	387.4	387.4
BDRC030B	61934	61743	Natural	1500	10	162	169	178	226	271	381.4	380.2	386.4	386.0	386.7	386.4	386.4	386.0	387.6	387.4	388.6	388.4
BDRC030C	61935	61934	48" CSP	105	10	165	171	181	179	179	381.1	381.4	390.2	386.4	390.9	386.7	391.1	386.4	391.8	387.6	392.0	388.6
BDRC030Crd	61935	61934	Roadway	105		0	0	1	65	122	391.0	391.0	386.4	386.4	386.7	386.7	391.1	391.0	391.8	391.4	392.0	391.7
BDRC030D	61959	61935	Natural	800	10	185	187	239	249	289	382.9	381.1	390.3	390.2	391.0	390.9	391.2	391.1	391.8	391.8	392.1	392.0
BDRC040A	61977	61959	Natural	2400	10	162	157	231	247	267	387.2	382.9	391.1	390.3	391.5	391.0	392.2	391.2	392.5	391.8	392.8	392.1
BDRC050B	69260	61977	54" CSP	126	10	77	77	109	113	123	387.5	387.7	391.5	391.1	391.8	391.5	392.8	392.2	393.0	392.5	393.5	392.8
BDRC050Brd	69260	61977	Roadway	126		0	0	0	0	0	397.8	397.5	391.1	391.1	391.5	391.5	392.2	392.2	392.5	392.5	392.8	392.8
BDRC050C	69952	69260	54" CSP	1973	10	78	77	110	112	111	389.4	387.5	394.9	391.5	395.2	391.8	399.8	392.8	400.0	393.0	400.3	393.5
BDRC050Crd	69952	69260	Roadway	1973		0	0	0	4	18	399.8	397.8	391.5	391.5	391.8	391.8	399.8	397.8	400.0	397.8	400.3	398.0
BDRC050A	66603	61977	60" CSP	1520	10	66	63	91	103	114	388.6	387.2	392.5	391.1	392.5	391.5	394.3	392.2	395.0	392.5	395.8	392.8
BDRC050Ard	66603	61977	Roadway	1520		0	0	0	0	0	400.3	397.5	391.1	391.1	391.5	391.5	392.2	392.2	392.5	392.5	392.8	392.8
BDRC060A	62329	66603	48" CSP	1336	10	55	52	73	81	83	393.1	388.6	395.5	392.5	395.4	392.5	398.4	394.3	400.7	395.0	401.3	395.8
BDRC060Ard	62329	66603	Roadway	1336		0	0	0	0	0	402.7	400.3	392.5	392.5	392.5	392.5	394.3	394.3	395.0	395.0	395.8	395.8
BDRC070A	62317	62329	48" CSP	2018	10	40	38	55	60	59	396.1	393.1	398.9	395.5	398.8	395.4	401.8	398.4	403.0	400.7	403.3	401.3
BDRC070Ard	62317	62329	Roadway	2018		0	0	0	0	4	402.9	402.7	395.5	395.5	395.4	395.4	398.4	398.4	403.0	402.7	403.3	402.8

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE LAUREL HILL STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions				Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)							
												10-Year		25-Year Winter		25-Year Summer		50-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	US	DS	US	DS	US	DS	US	DS	US	DS
Laurel Hill - Glenwood																			
LHGL010A	72145	72146	Natural	150	25	127	134	118	142	419.8	415.1	425.1	425.0	425.2	425.0	425.1	425.0	425.2	425.0
LHGL010B	72144	72145	46" CSP culvert	120	25	127	134	118	142	422.8	421.5	428.3	425.1	428.7	425.2	427.7	425.1	429.1	425.2
LHGL010BRD	72144	72145	Roadway	120		0	0	0	0	460.0	458.7	425.1	425.1	425.2	425.2	425.1	425.1	425.2	425.2
LHGL010C	72143	72144	Natural	90	25	127	135	118	142	423.8	422.8	428.4	428.3	428.8	428.7	427.8	427.7	429.3	429.1
LHGL010D1	72142	72143	30" CMP culvert	70	25	34	34	34	34	424.9	424.5	429.4	428.4	429.5	428.8	429.3	427.8	429.7	429.3
LHGL010D2	72142	72143	30" CMP culvert	70	25	33	33	34	33	424.8	424.6	429.4	428.4	429.5	428.8	429.3	427.8	429.7	429.3
LHGL010DRD	72142	72143	Roadway	70		308	364	221	463	428.6	428.2	429.4	429.0	429.5	429.1	429.3	428.9	429.7	429.3
LHGL010E	72597	72598	Natural	150	25	233	273	162	354	424.8	420.8	427.1	425.0	427.3	425.0	426.7	425.0	427.6	425.0
LHGL010F	72143	72597	Natural	340	25	233	273	162	354	425.5	424.8	428.4	427.1	428.8	427.3	427.8	426.7	429.3	427.6
LHGL020A	72596	72142	Natural	110	25	353	402	275	492	426.2	424.3	430.2	429.4	430.2	429.5	430.0	429.3	430.5	429.7
LHGL020B	56526	72596	Natural	70	25	194	229	214	297	426.5	426.2	430.7	430.2	430.9	430.2	430.8	430.0	431.2	430.5
LHGL020C	56525	56526	60" CMP culvert	79	25	194	229	215	297	427.6	426.8	433.9	430.8	435.2	431.1	434.6	431.0	438.0	431.5
LHGL020CRD	56525	56526	Roadway	79		0	0	0	0	442.9	442.2	430.7	430.7	430.9	430.9	430.8	430.8	431.2	431.2
Laurel Hill - Riverview/Augusta																			
LHRA020A	72139	56525	Natural	350	25	194	230	215	299	431.5	427.6	435.0	433.9	435.6	435.2	435.2	434.6	438.1	438.0
LHRA020B	72138	72139	6'x6' CSP culvert	68	25	187	221	204	289	432.1	431.5	436.3	435.0	436.9	435.6	436.5	435.2	439.1	438.1
LHRA020BRD	72138	72139	Roadway	68		0	0	0	0	447.6	446.9	435.0	435.0	435.6	435.6	435.2	435.2	438.1	438.1
LHRA020C	56522	72138	Natural	500	10	187	222	205	305	435.6	432.1	439.1	436.3	439.3	436.9	439.2	436.5	440.0	439.1
LHRA020D	66993	56522	6'x6' CSP culvert	285	25	176	209	187	278	438.1	435.7	441.3	439.1	441.8	439.3	441.5	439.2	442.8	440.0
LHRA020DRD	66993	56522	Roadway	285		0	0	0	0	450.0	447.7	439.1	439.1	439.3	439.3	439.2	439.2	440.0	440.0
LHRA030A	53635	66993	Natural	230	10	176	209	187	278	442.5	438.1	444.8	441.3	444.6	441.8	445.0	441.5	444.8	442.8
LHRA030B1	75474	53635	7'x4' CSP culverts	75	10	89	105	92	138	443.7	442.5	445.4	444.8	445.6	444.6	445.6	445.0	446.1	444.8
LHRA030B2	75474	53635	7'x4' CSP culverts	75	10	80	96	84	129	443.8	442.7	445.4	444.8	445.6	444.6	445.6	445.0	446.1	444.8
LHRA030BRD	75474	53635	Roadway	75		0	0	0	0	455.1	453.9	444.8	444.8	444.6	444.6	445.0	445.0	444.8	444.8
LHRA040A	75473	75474	Natural	400	10	123	153	130	212	446.2	443.7	450.7	445.4	451.1	445.6	450.8	445.6	451.6	446.1
LHRA040B	53662	75473	Natural	250	10	111	141	113	194	447.7	446.2	451.5	450.7	451.9	451.1	451.5	450.8	452.5	451.6
LHRA040C	53649	53662	66" CSP culvert	350	10	112	141	113	194	453.1	447.7	455.1	451.5	455.4	451.9	455.1	451.5	456.3	452.5
LHRA040CRD	53649	53662	Roadway	350		0	0	0	0	456.9	451.5	451.5	451.5	451.9	451.9	451.5	451.5	452.5	452.5
LHRA040D	72125	53649	Natural	105	10	112	141	113	194	453.8	453.1	456.7	455.1	457.1	455.4	456.7	455.1	457.6	456.3
LHRA040E	72124	72125	72" CMP culvert	40	10	112	141	113	194	453.7	453.8	457.7	456.7	458.2	457.1	457.7	456.7	459.1	457.6
LHRA040ERD	72124	72125	Roadway	40		0	0	0	0	460.6	460.6	456.7	456.7	457.1	457.1	456.7	456.7	457.6	457.6
LHRA040F	72123	72124	Natural	310	10	112	141	113	195	457.3	454.9	460.5	457.7	460.8	458.2	460.5	457.7	461.2	459.1

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE LAUREL HILL STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions				Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)							
												10-Year		25-Year Winter		25-Year Summer		50-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	US	DS	US	DS	US	DS	US	DS	US	DS
LHRA040G	72122	72123	60" CMP culvert	30	10	111	141	113	194	457.7	457.3	461.7	460.5	462.3	460.8	461.7	460.5	463.4	461.2
LHRA040GRD	72122	72123	Roadway	30		0	0	0	0	463.6	463.2	460.5	460.5	460.8	460.8	460.5	460.5	461.2	461.2
LHRA040H	53655	72122	Natural	110	10	111	141	113	194	458.7	457.7	461.9	461.7	462.6	462.3	461.9	461.7	463.6	463.4
LHRA040I	53755	53655	72" CMP	140	10	112	141	113	195	460.0	458.7	462.5	461.9	463.0	462.6	462.5	461.9	464.0	463.6
LHRA040J1	75482	53755	36" CSP	95	10	48	69	49	97	461.9	460.0	463.6	462.5	464.4	463.0	463.6	462.5	466.6	464.0
LHRA040J2	75482	53755	36" CSP	95	10	64	72	65	97	461.0	460.0	463.6	462.5	464.4	463.0	463.6	462.5	466.6	464.0
LHRA050E	75483	75482	36" CSP	388	10	67	72	60	82	466.9	461.0	469.2	463.6	469.9	464.4	468.9	463.6	473.5	466.6
LHRA050F	75484	75483	36" CSP	210	10	67	72	60	99	469.6	467.0	472.1	469.3	472.5	469.9	471.8	469.1	479.1	473.5
LHRA050G	75485	75484	36" CSP	250	10	61	66	51	100	477.6	469.7	479.2	472.1	479.3	472.5	479.0	471.8	485.7	479.1
LHRA070R	75486	75485	36" CSP	253	10	61	66	51	101	484.9	477.7	486.5	479.3	486.6	479.4	486.4	479.1	492.5	485.7
LHRA070S	75487	75486	36" CSP	284	10	46	50	38	86	492.3	484.9	493.7	486.5	493.8	486.6	493.5	486.4	496.8	492.5
LHRA070T	75488	75487	36" CSP	363	10	46	50	38	87	496.9	492.2	498.9	493.7	499.0	493.8	498.7	493.5	503.3	496.8
LHRA070U	53703	75488	36" CSP	92	10	46	50	38	88	499.1	496.9	500.6	498.9	500.6	499.0	500.4	498.7	505.1	503.3
LHRA090D	51387	53703	42" CSP	158	10	46	50	38	97	500.4	499.3	502.3	501.3	502.4	501.4	502.1	501.0	506.5	505.2
LHRA040K	75475	75474	36" CSP	86	10	46	47	46	57	446.3	446.0	449.4	448.2	449.4	448.2	449.4	448.2	449.9	448.4
LHRA040L	75476	75475	36" CSP	212	10	46	47	46	57	452.1	446.3	453.5	449.4	453.6	449.4	453.5	449.4	453.7	449.9
LHRA040M	75477	75476	36" CSP	429	10	46	47	46	57	453.9	452.3	457.6	454.5	457.7	454.6	457.7	454.5	459.1	454.8
LHRA040N	75478	75477	36" CSP	413	10	47	48	47	57	455.4	453.9	460.3	457.6	460.5	457.7	460.3	457.7	463.0	459.1
LHRA040O	75479	75478	36" CSP	120	10	47	48	47	53	456.0	455.4	461.0	460.3	461.3	460.5	461.1	460.3	463.1	463.0
LHRA040P	75480	75479	36" CSP	347	10	46	47	47	50	459.1	456.0	463.0	461.0	463.4	461.3	463.0	461.1	464.5	463.1
LHRA040Q	75481	75480	36" CSP	150	10	47	48	47	63	461.1	459.3	463.6	463.0	464.2	463.4	463.7	463.0	466.2	464.5
LHRA040R	53754	75481	36" CSP	43	10	47	48	48	63	461.1	461.2	463.9	463.6	464.5	464.2	464.0	463.7	466.7	466.2
LHRA040S	53754	75482	65" CSP	189	10	48	70	53	102	462.3	461.0	463.9	463.6	464.5	464.4	464.0	463.6	466.7	466.6
LHRA050A1	53753	53754	36" CSP	45	10	47	59	50	76	461.1	460.9	464.3	463.9	465.0	464.5	464.4	464.0	467.3	466.7
LHRA050A2	53753	53754	36" CSP	45	10	47	59	50	76	461.1	460.9	464.3	463.9	465.0	464.5	464.4	464.0	467.3	466.7
LHRA050ARD	53753	53754	Roadway	45		0	0	0	34	466.9	466.9	463.9	463.9	464.5	464.5	464.0	464.0	467.3	467.2
LHRA050B	53752	53753	65" CMP	189	10	95	117	100	161	462.3	461.1	465.7	464.3	466.3	465.0	465.8	464.4	469.0	467.3
LHRA050C	66483	53752	48" CSP	667	10	90	110	89	153	467.6	462.4	470.2	465.7	470.8	466.3	470.2	465.8	478.1	469.0
LHRA050CRD	66483	53752	Roadway	667		0	0	0	0	479.1	471.9	465.7	465.7	466.3	466.3	465.8	465.8	469.0	469.0
LHRA050D	53777	66483	42" CSP	193	10	91	110	89	144	472.2	467.6	474.2	470.2	474.6	470.8	474.2	470.2	482.0	478.1
LHRA050DRD	53777	66483	Roadway	193		0	0	0	29	481.8	479.1	470.2	470.2	470.8	470.8	470.2	470.2	482.0	479.3
LHRA060A	68603	53777	42" CSP	140	10	80	95	76	129	474.8	473.0	477.2	475.3	477.5	475.6	477.1	475.2	484.2	482.0
LHRA060ARD	68603	53777	Roadway	140		0	0	0	26	484.0	481.8	474.2	474.2	474.6	474.6	474.2	474.2	484.2	482.0
LHRA070A	53783	68603	42" CSP	160	10	58	40	33	64	476.6	474.8	478.6	477.2	478.2	477.5	478.0	477.1	484.5	484.2
LHRA070ARD	53783	68603	Roadway	160		0	0	0	6	484.5	483.0	477.2	477.2	477.5	477.5	477.1	477.1	484.5	484.2
LHRA070B	53704	53783	42" CSP	732	10	49	29	25	49	489.2	476.6	490.7	478.6	490.3	478.2	490.2	478.0	490.7	484.5
LHRA070BRD	53704	53783	Roadway	732		0	0	0	0	499.2	484.5	478.6	478.6	478.2	478.2	478.0	478.0	484.5	484.5
LHRA090B	75490	75489	30" CSP	292	10	36	12	11	13	496.7	492.6	498.8	494.0	497.8	493.3	497.7	493.3	497.8	493.3
LHRA090A	75489	53704	30" CSP	38	10	37	12	11	13	492.6	491.0	494.0	492.2	493.3	491.7	493.3	491.7	493.3	491.7
LHRA090C1	76212	75490	18" CSP	18	10	21	6	6	7	498.2	497.3	501.1	498.8	499.0	497.8	499.0	497.8	499.1	497.8
LHRA090C2	76212	75490	18" CSP	18	10	16	6	5	6	498.2	497.3	501.1	498.8	499.0	498.0	499.0	497.9	499.1	498.0

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE LAUREL HILL STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions				Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)							
												10-Year		25-Year Winter		25-Year Summer		50-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	US	DS	US	DS	US	DS	US	DS	US	DS
LHRA070C	53646	68603	42" CSP culvert	50	10	28	58	46	93	478.0	474.8	478.8	477.2	479.4	477.5	479.1	477.1	485.3	484.2
LHRA070CRD	53646	68603	Roadway	50		0	0	0	5	485.3	484.0	477.2	477.2	477.5	477.5	477.1	477.1	485.3	484.2
LHRA070D	72119	53646	Natural	160	10	28	58	46	100	482.4	478.0	483.8	478.8	484.3	479.4	484.1	479.1	485.5	485.3
LHRA070E	72118	72119	36" CSP culvert	15	10	28	58	46	84	483.1	482.9	485.2	484.4	486.6	485.4	486.0	484.9	488.0	485.7
LHRA070ERD	72118	72119	Roadway	15		0	0	0	19	487.9	487.7	483.8	483.8	484.3	484.3	484.1	484.1	488.0	487.9
LHRA070F	72117	72118	Natural	52	10	28	59	46	102	484.5	483.1	485.7	485.2	486.6	486.6	486.1	486.0	488.0	488.0
LHRA070G	72116	72117	Bridge	9	10	28	59	46	98	484.5	484.5	485.9	485.7	486.8	486.6	486.3	486.1	488.4	488.0
LHRA070GRD	72116	72117	Roadway	9		0	0	0	13	488.3	488.3	485.7	485.7	486.6	486.6	486.1	486.1	488.4	488.4
LHRA070H	72115	72116	Natural	150	10	28	59	46	113	485.6	484.5	486.9	485.9	487.2	486.8	487.1	486.3	488.5	488.4
LHRA070I	72114	72115	Bridge	12	10	28	59	46	120	485.9	485.6	487.0	486.9	487.4	487.2	487.3	487.1	489.1	488.5
LHRA070IRD	72114	72115	Roadway	12		0	0	0	0	491.6	491.4	486.9	486.9	487.2	487.2	487.1	487.1	488.5	488.5
LHRA070J	72113	72114	Natural	65	10	28	59	46	121	486.0	485.9	488.0	487.0	488.8	487.4	488.5	487.3	489.9	489.1
LHRA070K	72112	72113	42" CSP culvert	17	10	28	59	46	81	486.6	486.0	488.4	488.0	489.6	488.8	489.1	488.5	490.5	489.9
LHRA070KRD	72112	72113	Roadway	17		0	0	0	59	490.3	489.8	488.0	488.0	488.8	488.8	488.5	488.5	490.5	489.9
LHRA070L	72111	72112	Natural	60	10	28	59	46	121	487.1	486.6	489.8	488.4	490.9	489.6	490.5	489.1	491.6	490.5
LHRA070M	72110	72111	5'x3.5' CSP culvert	20	10	29	59	46	93	487.4	487.1	489.9	489.8	491.0	490.9	490.6	490.5	491.9	491.6
LHRA070MRD	72110	72111	Roadway	20		0	0	0	47	491.7	491.4	489.8	489.8	490.9	490.9	490.5	490.5	491.9	491.6
LHRA070N	72109	72110	Natural	177	10	31	59	48	124	489.7	487.4	490.7	489.9	491.5	491.0	491.0	490.6	493.4	491.9
LHRA070O	72108	72109	3'x2.7' CSP culvert	20	10	31	60	48	85	489.4	489.7	491.6	490.7	492.9	491.5	492.3	491.0	494.3	493.4
LHRA070ORD	72108	72109	Roadway	20		0	0	0	68	493.8	493.8	490.7	490.7	491.5	491.5	491.0	491.0	494.3	494.2
LHRA070P	72107	72108	Natural	66	10	31	60	48	136	491.1	489.4	492.5	491.6	493.1	492.9	492.8	492.3	494.4	494.3
LHRA070Q	72106	72107	36" CSP	32	10	31	60	48	80	492.3	491.1	493.9	492.5	494.9	493.1	494.5	492.8	496.1	494.4
LHRA070QRD	72106	72107	Roadway	32		0	0	0	65	495.9	494.7	492.5	492.5	493.1	493.1	492.8	492.8	496.1	494.9
LHRA100A	72105	72106	Natural	100	10	31	60	48	137	493.3	492.3	494.4	493.9	495.1	494.9	494.8	494.5	496.3	496.1
LHRA100B	72104	72105	36" CSP	118	10	31	59	48	60	496.6	493.7	498.4	495.3	500.2	496.2	499.2	495.8	500.4	496.3
LHRA100BRD	72104	72105	Roadway	118		0	2	0	78	500.1	497.2	494.4	494.4	500.2	497.2	494.8	494.8	500.4	497.5
LHRA100C	51409	72104	Natural	56	10	32	63	49	137	498.5	496.6	500.4	498.4	501.5	500.2	501.0	499.2	502.2	500.4
LHRA100D	99796	51409	30" CSP culvert	31	10	32	56	49	56	498.8	498.5	501.1	500.4	502.9	501.5	502.3	501.0	503.2	502.2
LHRA100DRD	99796	51409	Roadway	31		0	12	0	95	502.8	502.4	500.4	500.4	502.9	502.5	501.0	501.0	503.2	502.8

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
Willakenzie North - Delta Highway																						
WKDH010A	72606	72603	Natural	880	25	311	343	309	360	396	375.4	376.1	383.5	383.4	383.5	383.4	383.5	383.4	383.5	383.4	383.5	383.4
WKDH010G	72605	72606	Natural	1080	25	21	22	36	55	63	377.8	374.8	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5
WKDH010H	72604	72605	Natural	10	25	22	23	36	56	64	377.9	377.8	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5
WKDH010I	67019	72604	Natural	80	25	22	23	36	56	64	378.8	377.9	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5
WKDH010J	58450	67019	72" CSP	85	25	22	23	36	56	64	377.3	377.0	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.6	383.5
WKDH010JRD	58450	67019	Roadway	85		0	0	0	0	0	389.0	389.0	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5	383.5
WKDH010B	72602	72606	Natural	10	25	303	330	306	350	386	375.5	375.4	383.6	383.5	383.7	383.5	383.6	383.5	383.7	383.5	383.7	383.5
WKDH010C	72601	72602	Natural	410	25	303	330	306	350	386	376.2	375.5	383.7	383.6	383.7	383.7	383.7	383.6	383.8	383.7	383.8	383.7
WKDH010D	72600	72601	Natural	10	25	303	330	306	350	386	376.2	376.2	383.9	383.7	384.0	383.7	383.9	383.7	384.1	383.8	384.3	383.8
WKDH010E	58446	72600	Natural	230	25	303	330	306	350	386	377.0	376.2	383.9	383.9	384.0	384.0	383.9	383.9	384.1	384.1	384.3	384.3
WKDH010F1	58447	58446	84"CMP	83	50	151	165	153	175	193	377.3	377.0	384.2	383.9	384.4	384.0	384.2	383.9	384.5	384.1	384.7	384.3
WKDH010F2	58447	58446	84"CMP	83	50	151	165	153	175	193	377.3	377.0	384.2	383.9	384.4	384.0	384.2	383.9	384.5	384.1	384.7	384.3
WKDH010FRD	58447	58446	Roadway	83		0	0	0	0	0	390.5	390.5	383.9	383.9	384.0	384.0	383.9	383.9	384.1	384.1	384.3	384.3
WKDH020A	58442	58447	Natural	2500	25	311	334	331	365	399	378.1	377.3	384.2	384.2	384.4	384.4	384.2	384.2	384.5	384.5	384.7	384.7
Willakenzie North - North Beltline																						
WKNB010D	59792	58442	Natural	1000	25	28	29	47	74	83	381.6	378.1	384.2	384.2	384.4	384.4	384.2	384.2	384.5	384.5	384.7	384.7
WKNB010E	59799	59792	48" CMP	365	25	28	30	48	77	87	382.6	381.6	385.1	384.2	385.2	384.4	386.2	384.2	389.1	384.5	390.3	384.7
WKNB010ERD	59799	59792	Roadway	365		0	0	0	0	0	399.0	398.0	384.2	384.2	384.4	384.4	384.2	384.2	384.5	384.5	384.7	384.7
WKNB010A1	58441	58442	72" CMP	83	25	157	168	181	192	207	395.7	395.6	400.0	399.0	400.1	399.1	400.3	399.3	400.5	399.4	400.7	399.5
WKNB010A2	58441	58442	72" CMP	83	25	157	168	181	192	207	395.7	395.6	400.0	399.0	400.1	399.1	400.3	399.3	400.5	399.4	400.7	399.5
WKNB010ARD	58441	58442	Roadway	83		0	0	0	0	0	407.0	405.0	384.2	384.2	384.4	384.4	384.2	384.2	384.5	384.5	384.7	384.7
WKNB010B	58371	58441	Natural	2250	25	315	337	362	384	414	396.4	393.8	403.1	400.0	403.3	400.1	403.5	400.3	403.7	400.5	403.9	400.7
WKNB010C1	59755	58371	72" CMP	329	25	158	169	182	193	207	397.9	396.4	404.7	403.1	405.2	403.3	405.8	403.5	406.3	403.7	407.0	403.9
WKNB010C2	59755	58371	72" CMP	329	25	158	169	182	193	207	397.9	396.4	404.7	403.1	405.2	403.3	405.8	403.5	406.3	403.7	407.0	403.9
WKNB010CRD	59755	58371	Roadway	329		0	0	0	0	0	410.0	409.0	403.1	403.1	403.3	403.3	403.5	403.5	403.7	403.7	403.9	403.9
WKNB020A	59766	59755	Natural	1220	25	302	327	352	377	400	399.5	397.9	405.6	404.7	406.0	405.2	406.5	405.8	406.9	406.3	407.5	407.0
WKNB020B1	59753	59766	72" CSP	85	25	151	164	179	192	203	399.6	399.4	406.2	405.6	406.6	406.0	407.1	406.5	407.7	406.9	408.4	407.5
WKNB020B2	59753	59766	72" CSP	85	25	151	164	179	192	203	399.6	399.4	406.2	405.6	406.6	406.0	407.1	406.5	407.7	406.9	408.4	407.5
WKNB020BRD	59753	59766	Roadway	85		0	0	0	0	0	412.1	411.0	405.6	405.6	406.0	406.0	406.5	406.5	406.9	406.9	407.5	407.5
WKNB020C	59778	59753	Natural	530	25	303	329	363	388	410	400.0	399.4	406.8	406.2	407.2	406.6	407.7	407.1	408.2	407.7	408.8	408.4
WKNB020D1	69005	59778	72" CMP	85	25	152	165	183	196	206	401.1	400.9	407.5	406.8	408.0	407.2	408.6	407.7	409.4	408.2	410.1	408.8
WKNB020D2	69005	59778	72" CMP	85	25	152	165	183	196	206	401.1	400.9	407.5	406.8	408.0	407.2	408.6	407.7	409.4	408.2	410.1	408.8
WKNB020DRD	69005	59778	Roadway	85		0	0	0	0	0	412.1	412.1	406.8	406.8	407.2	407.2	407.7	407.7	408.2	408.2	408.8	408.8
WKNB030A	59774	69005	Natural	1350	25	293	319	363	399	418	403.0	400.6	409.0	407.5	409.3	408.0	409.7	408.6	410.3	409.4	411.1	410.1
WKNB040A1	59772	59774	30"CMP	89	25	13	14	20	31	36	409.2	409.1	411.2	410.4	411.2	410.4	411.9	410.7	413.1	411.0	413.9	411.2
WKNB040A2	59772	59774	30"CMP	89	25	13	14	20	31	36	409.2	409.1	411.2	410.4	411.2	410.4	411.9	410.7	413.1	411.0	413.9	411.2
WKNB040ARD	59772	59774	Roadway	89		0	0	0	0	0	416.0	416.0	409.0	409.0	409.3	409.3	409.7	409.7	410.3	410.3	411.1	411.1
WKNB030B	59425	59774	Natural	1300	25	274	297	355	393	415	405.7	403.0	410.3	409.0	410.6	409.3	411.0	409.7	411.4	410.3	411.8	411.1
WKNB030C1	59426	59425	72" CSP	603	25	137	149	180	200	211	407.1	406.0	411.7	410.3	412.1	410.6	412.8	411.0	413.5	411.4	414.0	411.8
WKNB030C2	59426	59425	72" CSP	603	25	137	149	180	200	211	407.1	406.0	411.7	410.3	412.1	410.6	412.8	411.0	413.5	411.4	414.0	411.8
WKNB030CRD	59426	59425	Roadway	603		0	0	0	0	0	417.7	416.0	410.3	410.3	410.6	410.6	411.0	411.0	411.4	411.4	411.8	411.8
WKNB060A	67893	59426	66" CSP	340	25	86	93	109	126	127	407.6	407.1	412.0	411.7	412.3	412.1	413.2	412.8	413.9	413.5	414.4	414.0

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WKNB060ARD	59426	67893	Roadway	340		0	0	0	0	0	417.7	417.4	412.0	412.0	412.3	412.3	413.2	413.2	413.9	413.9	414.4	414.4
WKNB060B	59519	67893	66" CSP	1043	10	87	93	111	127	129	407.7	407.6	413.0	412.0	413.5	412.3	414.5	413.2	415.4	413.9	416.1	414.4
WKNB060BRD	59519	67893	Roadway	1043		0	0	0	0	0	417.9	417.4	412.0	412.0	412.3	412.3	413.2	413.2	413.9	413.9	414.4	414.4
WKNB050A	59518	59519	42" CSP	105	10	26	26	33	22	24	410.9	408.0	413.1	413.0	413.5	413.5	414.5	414.5	415.4	415.4	416.1	416.1
WKNB050ARD	59518	59519	Roadway	105		0	0	0	0	0	418.3	417.9	413.0	413.0	413.5	413.5	414.5	414.5	415.4	415.4	416.1	416.1
WKNB050B	59546	59518	36" CSP	436	10	8	8	13	14	13	412.2	410.9	413.2	413.1	413.6	413.5	414.6	414.5	415.5	415.4	416.2	416.1
WKNB050BRD	59518	59546	Roadway	436		0	0	0	0	0	418.3	418.0	413.2	413.2	413.6	413.6	414.6	414.6	415.5	415.5	416.2	416.2
WKNB050C	59495	59546	42" CSP	656	10	7	7	12	14	13	413.5	412.6	414.7	413.4	414.7	413.6	415.0	414.6	415.6	415.5	416.4	416.2
WKNB050CRD	59495	59546	Roadway	656		0	0	0	0	0	420.0	418.0	413.2	413.2	413.6	413.6	414.6	414.6	415.5	415.5	416.2	416.2
WKNB050D	59545	59495	36" CSP	34	10	7	7	12	15	14	413.6	413.5	414.7	414.7	414.7	414.7	415.1	415.0	415.6	415.6	416.4	416.4
WKNB050DRD	59495	59545	Roadway	34		0	0	0	0	0	420.0	419.6	414.7	414.7	414.7	414.7	415.1	415.1	415.6	415.6	416.4	416.4
WKNB050E	67912	59545	3' X 5' Conc. Box	148	10	7	7	12	15	15	414.0	413.6	414.7	414.7	414.8	414.7	415.1	415.1	415.6	415.6	416.4	416.4
WKNB050ERD	67912	59545	Roadway	148		0	0	0	0	0	419.6	419.6	414.7	414.7	414.7	414.7	415.1	415.1	415.6	415.6	416.4	416.4
WKNB050F	68227	67912	3' X 5' Conc. Box	920	10	7	7	12	16	19	415.2	414.0	415.8	414.7	415.8	414.8	416.0	415.1	416.3	415.6	416.5	416.4
WKNB050FRD	68227	67912	Roadway	920		0	0	0	0	0	420.7	419.6	414.7	414.7	414.8	414.8	415.1	415.1	415.6	415.6	416.4	416.4
WKNB050G	69048	68227	42" CSP	169	10	7	7	12	17	19	418.5	415.2	419.1	415.8	419.1	415.8	419.2	416.0	419.4	416.3	419.4	416.5
WKNB050GRD	69048	68227	Roadway	169		0	0	0	0	0	421.0	420.7	415.8	415.8	415.8	415.8	416.0	416.0	416.3	416.3	416.5	416.5
WKNB050H	61213	59519	54" CSP	2545	10	62	67	74	84	83	412.4	407.7	416.0	413.0	417.1	413.5	418.9	414.5	420.7	415.4	420.8	416.1
WKNB050HRD	61213	59519	Roadway	2545		0	0	0	0	0	422.1	417.9	413.0	413.0	413.5	413.5	414.5	414.5	415.4	415.4	416.1	416.1
WKNB140A	61212	61213	54" CSP	701	10	47	51	56	57	58	413.2	412.5	416.6	416.0	417.6	417.1	419.4	418.9	421.3	420.7	421.3	420.8
WKNB140ARD	61212	61213	Roadway	701		0	0	0	0	0	424.0	422.1	416.0	416.0	417.1	417.1	418.9	418.9	420.7	420.7	420.8	420.8
WKNB140B	66590	61212	42" CSP	591	10	47	50	54	56	58	413.9	413.2	418.1	416.6	419.4	417.6	420.7	419.4	422.4	421.3	422.4	421.3
WKNB140BRD	61212	66590	Roadway	591		0	0	0	0	0	424.0	422.4	418.1	418.1	419.4	419.4	420.7	420.7	422.4	422.4	422.4	422.4
WKNB150A	61030	66590	42" CSP	532	10	34	39	47	47	48	418.5	413.9	420.0	418.1	420.5	419.4	421.3	420.7	421.7	422.4	422.1	422.4
WKNB150ARD	61030	66590	Roadway	532		0	0	0	0	0	427.0	422.4	418.1	418.1	419.4	419.4	420.7	420.7	422.4	422.4	422.4	422.4
WKNB150B	71108	61030	Natural	250	10	34	38	45	45	47	418.3	418.5	420.5	420.0	420.8	420.5	421.4	421.3	421.7	421.7	422.2	422.1
WKNB150C	71109	71108	Natural	620	10	34	37	41	41	44	418.2	418.3	421.4	420.5	421.7	420.8	422.1	421.4	422.3	421.7	422.7	422.2
WKNB150D	61085	71109	Natural	350	10	34	37	39	38	39	418.3	418.2	421.5	421.4	421.8	421.7	422.2	422.1	422.4	422.3	422.8	422.7
WKNB150E	61086	61085	42" CSP	68	10	35	37	40	39	41	418.4	418.3	421.8	421.5	422.1	421.8	422.5	422.2	422.7	422.4	423.1	422.8
WKNB150ERD	61085	61086	Roadway	68		0	0	0	0	0	423.3	422.7	421.8	421.8	422.1	422.1	422.5	422.5	422.7	422.7	423.1	423.1
WKNB190A	61087	61086	Natural	620	10	25	27	32	34	37	419.0	418.4	422.0	421.8	422.3	422.1	422.7	422.5	422.9	422.7	423.3	423.1
WKNB190B	61049	61087	Natural	340	10	28	29	45	53	57	420.7	419.0	422.1	422.0	422.4	422.3	422.8	422.7	423.0	422.9	423.4	423.3
WKNB190C1	67095	61049	48" CSP	42	10	14	15	23	27	30	420.9	420.7	422.3	422.1	422.5	422.4	422.9	422.8	423.1	423.0	423.4	423.4
WKNB190C2	67095	61049	48" CSP	42	10	14	15	23	27	30	420.9	420.7	422.3	422.1	422.5	422.4	422.9	422.8	423.1	423.0	423.4	423.4
WKNB190CRD	67095	61049	Roadway	42		0	0	0	0	0	426.0	426.0	422.1	422.1	422.4	422.4	422.8	422.8	423.0	423.0	423.4	423.4
WKNB190D	62684	67095	Natural	400	10	28	30	46	56	62	421.5	420.9	423.6	422.3	423.6	422.5	424.1	422.9	424.3	423.1	424.5	423.4
WKNB190E1	62685	62684	48" CSP	75	10	9	10	15	19	21	421.6	421.5	423.6	423.6	423.7	423.6	424.2	424.1	424.4	424.3	424.6	424.5
WKNB190E2	62685	62684	48" CSP	75	10	9	10	15	19	21	421.6	421.5	423.6	423.6	423.7	423.6	424.2	424.1	424.4	424.3	424.6	424.5
WKNB190E3	62685	62684	48" CSP	75	10	9	10	15	19	21	421.6	421.5	423.6	423.6	423.7	423.6	424.2	424.1	424.4	424.3	424.6	424.5
WKNB190ERD	62685	62684	Roadway	75		0	0	0	0	0	429.0	428.0	423.6	423.6	423.6	423.6	424.1	424.1	424.3	424.3	424.5	424.5
WKNB190F	62688	62685	Natural	470	10	29	30	47	60	63	422.3	421.6	424.1	423.6	424.2	423.7	424.6	424.2	424.9	424.4	425.0	424.6

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WKNB190G1	62712	62688	60" CMP	100	10	14	15	24	31	32	422.4	422.3	424.3	424.1	424.4	424.2	424.9	424.6	425.2	424.9	425.3	425.0
WKNB190G2	62712	62688	60" CMP	100	10	14	15	24	31	32	422.4	422.3	424.3	424.1	424.4	424.2	424.9	424.6	425.2	424.9	425.3	425.0
WKNB190GRD	62712	62688	Roadway	100		0	0	0	0	0	429.0	429.0	424.1	424.1	424.2	424.2	424.6	424.6	424.9	424.9	425.0	425.0
WKNB190H	62750	62712	36" CSP	262	10	29	30	48	63	65	422.8	422.4	425.3	424.3	425.4	424.4	426.5	424.9	427.9	425.2	428.2	425.3
WKNB190HRD	62712	62750	Roadway	262		0	0	0	0	0	429.0	427.9	425.3	425.3	425.4	425.4	426.5	426.5	427.9	427.9	428.2	428.2
WKNB060C	59428	59426	Natural	580	25	173	186	238	270	294	408.8	407.5	413.9	411.7	414.0	412.1	414.6	412.8	415.0	413.5	415.3	414.0
WKNB060D	59401	59428	Natural	1100	25	173	186	241	277	298	410.2	408.8	415.6	413.9	415.8	414.0	416.5	414.6	417.1	415.0	417.6	415.3
WKNB070A	59497	59401	54" CSP	880	10	19	17	16	30	38	411.7	410.6	415.7	415.6	415.9	415.8	416.5	416.5	417.2	417.1	417.8	417.6
WKNB070ARD	59497	59401	Roadway	880		0	0	0	0	0	418.2	417.1	415.6	415.6	415.8	415.8	416.5	416.5	417.1	417.1	417.6	417.6
WKNB060E	59385	59401	Natural	900	25	159	171	232	266	291	411.3	410.2	416.8	415.6	417.0	415.8	417.8	416.5	418.3	417.1	418.7	417.6
WKNB110A	59476	59385	72" CSP	120	25	47	51	70	80	94	410.3	409.9	416.9	416.8	417.1	417.0	417.9	417.8	418.3	418.3	418.8	418.7
WKNB110ARD	59476	59385	Roadway	120		0	0	0	0	0	421.3	420.4	416.8	416.8	417.0	417.0	417.8	417.8	418.3	418.3	418.7	418.7
WKNB110B	59420	59476	72" CSP	110	10	41	44	62	69	77	411.4	410.3	416.9	416.9	417.1	417.1	417.9	417.9	418.4	418.3	418.8	418.8
WKNB110BRD	59476	59420	Roadway	110		0	0	0	0	0	421.3	418.5	416.9	416.9	417.1	417.1	417.9	417.9	418.4	418.4	418.8	418.8
WKNB110C	61133	59420	72" CSP	1337	10	41	44	62	69	103	413.0	411.2	417.1	416.9	417.3	417.1	418.3	417.9	418.8	418.4	419.8	418.8
WKNB110CRD	61133	59420	Roadway	1337		0	0	0	0	0	423.8	418.5	416.9	416.9	417.1	417.1	417.9	417.9	418.4	418.4	418.8	418.8
WKNB120A	60890	61133	66" CSP	130	10	35	37	53	59	86	413.5	413.0	417.1	417.1	417.3	417.3	418.4	418.3	418.9	418.8	420.0	419.8
WKNB120ARD	60890	61133	Roadway	130		0	0	0	0	0	424.0	423.8	417.1	417.1	417.3	417.3	418.3	418.3	418.8	418.8	419.8	419.8
WKNB120B	99575	60890	66" CMP	1458	10	35	37	53	60	87	414.3	413.5	418.0	417.1	418.2	417.3	419.5	418.4	420.4	418.9	423.7	420.0
WKNB120BRD	99575	60890	Roadway	1458		0	0	0	0	0	425.6	424.0	417.1	417.1	417.3	417.3	418.4	418.4	418.9	418.9	420.0	420.0
WKNB160A	61199	99575	60" CSP	1201	10	27	28	41	46	65	415.4	414.3	418.3	418.0	418.5	418.2	419.8	419.5	420.8	420.4	424.7	423.7
WKNB160ARD	61199	99575	Roadway	1201		0	0	0	0	0	426.4	425.6	418.0	418.0	418.2	418.2	419.5	419.5	420.4	420.4	423.7	423.7
WKNB180A	61183	61199	48" CSP	1214	10	18	19	27	32	43	418.1	416.4	419.7	418.3	419.8	418.5	420.5	419.8	421.4	420.8	426.1	424.7
WKNB180Ard	61183	61199	Roadway	1214		0	0	0	0	0	427.9	426.4	418.3	418.3	418.5	418.5	419.8	419.8	420.8	420.8	424.7	424.7
WKNB180B	61235	61183	42" CSP	480	10	18	19	29	37	44	419.6	418.1	421.0	419.7	421.0	419.8	421.5	420.5	422.0	421.4	426.8	426.1
WKNB180Brd	61183	61235	Roadway	480		0	0	0	0	0	427.9	426.8	421.0	421.0	421.0	421.0	421.5	421.5	422.0	422.0	426.8	426.8
WKNB100A	66880	67043	72" CSP	130	25	48	50	79	114	136	410.8	410.5	417.1	417.1	417.3	417.3	418.2	418.1	418.6	418.6	419.1	419.0
WKNB100ARD	67043	66880	Roadway	130		0	0	0	0	0	420.9	420.0	417.1	417.1	417.3	417.3	418.2	418.2	418.6	418.6	419.1	419.1
WKNB100B	59462	66880	60" CSP	47	10	48	50	79	114	136	411.4	410.8	417.2	417.1	417.4	417.3	418.3	418.2	418.7	418.6	419.2	419.1
WKNB100BRD	59462	66880	Roadway	47		0	0	0	0	0	422.5	420.0	417.1	417.1	417.3	417.3	418.2	418.2	418.6	418.6	419.1	419.1
WKNB100C	59421	59462	66" CSP	30	10	38	41	64	88	103	412.5	412.3	417.2	417.2	417.4	417.4	418.3	418.3	418.8	418.7	419.3	419.2
WKNB100CRD	59462	59421	Roadway	30		0	0	0	0	0	422.5	421.0	417.2	417.2	417.4	417.4	418.3	418.3	418.8	418.8	419.3	419.3
WKNB100D	61140	59421	60" CSP	905	10	39	41	65	89	103	413.8	412.5	417.4	417.2	417.7	417.4	418.9	418.3	419.8	418.8	421.1	419.3
WKNB100DRD	61140	59421	Roadway	905		0	0	0	0	0	422.8	421.0	417.2	417.2	417.4	417.4	418.3	418.3	418.8	418.8	419.3	419.3
WKNB090A	61142	61140	48" CSP	1037	10	30	32	50	64	75	414.6	413.7	418.0	417.4	418.3	417.7	420.6	418.9	422.5	419.8	424.8	421.1
WKNB090ARD	61142	61140	Roadway	1037		0	0	0	0	0	424.8	422.8	417.4	417.4	417.7	417.7	418.9	418.9	419.8	419.8	424.8	422.8
WKNB110D	67043	59385	Natural	400	25	113	120	167	192	228	411.8	411.3	417.1	416.8	417.3	417.0	418.1	417.8	418.6	418.3	419.0	418.7
WKNB100E	71240	67043	Natural	1930	25	71	71	110	136	142	415.9	411.8	418.3	417.1	418.3	417.3	418.9	418.1	419.4	418.6	419.9	419.0
WKNB100F	71239	71240	Natural	150	25	72	72	112	159	186	421.2	415.9	423.7	418.3	423.7	418.3	424.1	418.9	424.6	419.4	424.8	419.9
Willakenzie North - Gilham Road																						
WKGL010A	71280	71279	Natural	1200	10	103	109	139	156	171	389.2	379.5	391.9	385.7	392.0	385.7	392.4	385.7	392.6	385.7	392.7	385.7
WKGL010B	71281	71280	48" CMP	30	10	89	95	117	126	136	389.3	389.2	393.4	391.9	393.5	392.0	394.4	392.4	394.8	392.6	395.3	392.7
WKGL010BRD	71281	71280	Roadway	30		0	0	0	0	0	395.4	395.4	391.9	391.9	392.0	392.0	392.4	392.4	392.6	392.6	392.7	392.7

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WKGL020A	71282	71281	Natural	920	10	62	65	81	84	88	392.7	389.3	396.0	393.4	396.2	393.5	398.1	394.4	398.3	394.8	399.0	395.3
WKGL020B	73036	71282	Natural	1280	10	63	66	93	100	108	394.3	392.7	398.1	396.0	398.1	396.2	398.9	398.1	399.0	398.3	399.5	399.0
WKGL020C	70865	73036	48" CSP	15	10	63	66	97	104	115	385.1	394.3	398.3	398.1	398.4	398.1	399.3	398.9	399.5	399.0	400.0	399.5
WKGL020D	70862	70865	72" CSP	1015	10	63	66	97	104	115	387.2	385.1	398.6	398.3	398.7	398.4	400.0	399.3	400.3	399.5	400.8	400.0
WKGL030A	58511	70862	42" CSP	610	10	13	13	21	35	40	392.1	390.4	398.7	398.6	398.8	398.7	400.3	400.0	400.9	400.3	401.7	400.8
WKGL030ARD	70862	58511	Roadway	610		0	0	0	0	0	404.2	403.3	398.7	398.7	398.8	398.8	400.3	400.3	400.9	400.9	401.7	401.7
WKGL030G	58499	70862	54" CMP	562	10	11	12	18	28	32	388.3	387.2	398.7	398.6	398.8	398.7	400.2	400.0	400.5	400.3	401.1	400.8
WKGL030GRD	58499	70862	Roadway	562		0	0	0	0	0	406.2	404.2	398.6	398.6	398.7	398.7	400.0	400.0	400.3	400.3	400.8	400.8
WKGL030B	58454	70862	42" CSP	70	10	41	44	63	69	71	396.3	390.4	398.9	398.6	399.0	398.7	400.9	400.0	401.3	400.3	401.9	400.8
WKGL030BRD	58454	70862	Roadway	70		0	0	0	0	0	410.2	404.2	398.6	398.6	398.7	398.7	400.0	400.0	400.3	400.3	400.8	400.8
WKGL030C	70121	58454	Natural	1650	10	25	26	40	51	50	399.0	396.4	400.8	398.9	400.9	399.0	401.3	400.9	401.7	401.3	402.1	401.9
WKGL030D	70120	70121	48" CSP	85	10	25	26	41	60	68	399.1	399.0	401.2	400.8	401.3	400.9	401.8	401.3	402.4	401.7	402.7	402.1
WKGL030DRD	70120	70121	Roadway	85		0	0	0	0	0	406.0	406.0	400.8	400.8	400.9	400.9	401.3	401.3	401.7	401.7	402.1	402.1
WKGL030E	71289	70120	Natural	400	10	25	26	41	61	70	400.6	399.5	402.3	401.2	402.3	401.3	402.7	401.8	403.1	402.4	403.3	402.7
WKGL030F	58463	71289	Natural	410	10	25	26	41	63	72	401.8	400.6	404.3	402.3	404.3	402.3	404.8	402.7	405.3	403.1	405.5	403.3
Willakenzie North - County Farm																						
WKCF020A	58172	58169	78" CSP	2866	10	166	167	206	248	258	393.2	389.9	398.9	393.3	398.9	393.3	401.0	393.7	403.5	394.1	404.4	394.2
WKCF020ARD	58172	58169	Roadway	2866		0	0	0	0	0	407.9	405.0	388.1	388.1	388.1	388.1	388.1	388.1	388.1	388.1	388.1	388.1
WKCF020B	66533	58172	78" CSP	1596	10	140	141	180	220	240	396.7	393.2	400.6	398.9	400.6	398.9	402.9	401.0	406.3	403.5	407.1	404.4
WKCF020BRD	58172	66533	Roadway	1596		0	0	0	0	0	407.9	406.0	400.6	400.6	400.6	400.6	402.9	402.9	406.3	406.3	407.1	407.1
WKCF030A	58356	66533	66" CSP	1085	10	107	107	141	190	191	398.6	396.6	402.4	400.6	402.4	400.6	404.9	402.9	410.2	406.3	410.4	407.1
WKCF030ARD	58356	66533	Roadway	1085		0	0	0	0	19	410.2	406.0	400.6	400.6	400.6	400.6	402.9	402.9	410.2	406.3	410.4	407.1
WKCF040A	59511	58356	60" CSP	2093	10	63	63	85	113	110	403.5	398.6	406.1	402.4	406.1	402.4	407.5	404.9	414.8	410.2	415.0	410.4
WKCF040ARD	59511	58356	Roadway	2093		0	0	0	0	13	414.8	410.2	402.4	402.4	402.4	402.4	404.9	404.9	414.8	410.2	415.0	410.4
WKCF070D	66196	59511	54" CSP	2465	10	24	24	37	58	61	405.7	403.9	407.9	406.1	408.0	406.1	408.7	407.5	417.7	414.8	417.8	415.0
WKCF070DRD	66196	59511	Roadway	2465		0	0	0	0	3	417.7	414.8	406.1	406.1	406.1	406.1	407.5	407.5	417.7	414.8	417.8	415.0
WKCF070A	68994	59511	54" CSP	467	10	16	15	16	32	40	404.4	403.5	406.2	406.1	406.2	406.1	407.6	407.5	415.1	414.8	415.4	415.0
WKCF070ARD	68994	59511	Roadway	467		0	0	0	0	0	415.4	414.8	406.1	406.1	406.1	406.1	407.5	407.5	414.8	414.8	415.4	415.0
WKCF070B	59487	68994	42" CSP	581	10	16	15	15	32	39	405.7	404.4	407.2	406.2	407.1	406.2	407.8	407.6	415.3	415.1	415.7	415.4
WKCF070BRD	59487	68994	Roadway	581		0	0	0	0	0	415.7	415.4	406.2	406.2	406.2	406.2	407.6	407.6	415.1	415.1	415.7	415.4
WKCF070C	59489	59487	36" CSP	533	10	16	15	16	32	40	406.7	405.7	408.4	407.2	408.3	407.1	408.4	407.8	415.7	415.3	416.0	415.7
WKCF070CRD	59487	59489	Roadway	533		0	0	0	0	-6	415.7	415.6	408.4	408.4	408.3	408.3	408.4	408.4	415.7	415.7	415.8	416.0
Willakenzie South - Debrick Slough																						
WKDS010A	60730	71171	Natural	1200	25	141	156	163	229	258	387.2	384.6	390.0	388.8	390.1	388.8	390.1	388.8	390.5	388.8	390.6	388.8
WKDS010B	60786	60730	54" CSP	486	10	31	33	52	79	89	392.6	392.0	394.9	393.6	394.9	393.6	395.6	394.1	396.5	394.6	397.0	394.8
WKDS010BRD	60786	60730	Roadway	486		0	0	0	0	0	402.3	399.3	390.0	390.0	390.1	390.1	390.1	390.1	390.5	390.5	390.6	390.6
WKDS020A	71172	60730	Natural	600	25	110	122	103	145	171	388.6	387.2	391.1	390.0	391.2	390.1	391.0	390.1	391.3	390.5	391.5	390.6
WKDS020B	71173	71172	72" CSP	640	50	110	122	104	145	172	390.3	388.6	393.9	391.1	394.1	391.2	393.8	391.0	394.5	391.3	395.0	391.5
WKDS020BRD	71173	71172	Roadway	640		0	0	0	0	0	399.5	399.5	391.1	391.1	391.2	391.2	391.0	391.0	391.3	391.3	391.5	391.5
WKDS020C	62475	71173	Natural	200	25	110	122	104	145	172	391.0	390.3	394.5	393.9	394.7	394.1	394.4	393.8	395.0	394.5	395.4	395.0
WKDS020D	62474	62475	72" CSP culvert	316	50	110	122	104	145	172	392.4	391.0	395.7	394.5	396.0	394.7	395.6	394.4	396.4	395.0	397.0	395.4
WKDS020DRD	62474	62475	Roadway	316		0	0	0	0	0	404.0	404.0	394.5	394.5	394.7	394.7	394.4	394.4	395.0	395.0	395.4	395.4

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WKDS030A	71176	62474	Natural	1300	25	98	109	95	128	161	393.0	392.9	397.2	395.7	397.3	396.0	397.1	395.6	397.5	396.4	397.9	397.0
WKDS030B	99056	71176	Natural	380	25	99	110	100	144	170	393.8	393.0	397.5	397.2	397.6	397.3	397.4	397.1	397.9	397.5	398.3	397.9
WKDS030C1	99058	99056	3.75'x6' CSP culvert	49	25	52	57	52	76	88	394.1	393.8	397.5	397.5	397.7	397.6	397.5	397.4	398.0	397.9	398.4	398.3
WKDS030C2	99058	99056	3.75'x6' CSP culvert	49	25	47	53	49	72	86	394.0	393.8	397.5	397.5	397.7	397.6	397.5	397.4	398.0	397.9	398.4	398.3
WKDS030CRD	99058	99056	Roadway	49		0	0	0	0	0	400.2	400.2	397.5	397.5	397.6	397.6	397.4	397.4	397.9	397.9	398.3	398.3
WKDS040A	71179	99058	Natural	220	10	68	85	92	100	118	396.5	394.0	399.2	397.5	399.5	397.7	399.6	397.5	399.8	398.0	400.0	398.4
WKDS040B	71180	71179	Natural	40	10	68	85	92	100	118	396.7	396.5	399.3	399.2	399.6	399.5	399.7	399.6	399.8	399.8	400.1	400.0
WKDS040BRD	71180	71179	Roadway	40		0	0	0	0	0	403.7	403.7	399.2	399.2	399.5	399.5	399.6	399.6	399.8	399.8	400.0	400.0
WKDS040C	71182	71180	Natural	2370	10	69	88	99	107	127	398.8	396.7	401.1	399.3	401.4	399.6	401.5	399.7	401.6	399.8	401.9	400.1
WKDS040D	71183	71182	36" CMP culvert	49	10	69	73	74	74	75	398.5	398.8	404.8	401.1	405.0	401.4	405.0	401.5	405.1	401.6	405.1	401.9
WKDS040DRD	71183	71182	Roadway	49		0	20	27	38	60	404.8	404.8	401.1	401.1	405.0	404.9	405.0	404.9	405.1	405.0	405.1	405.0
WKDS040E	71185	71183	Natural	430	10	72	93	101	112	134	397.3	396.8	404.8	404.8	405.1	405.0	405.1	405.0	405.2	405.1	405.3	405.1
WKDS040F	71186	71185	72" CMP culvert	20	10	78	89	101	115	131	397.5	397.3	404.9	404.8	405.2	405.1	405.3	405.1	405.4	405.2	405.6	405.3
WKDS040FRD	71186	71185	Roadway	20		0	0	0	0	0	411.2	411.2	404.8	404.8	405.1	405.1	405.1	405.1	405.2	405.2	405.3	405.3
WKDS040G	71187	71186	Natural	220	10	87	94	120	131	141	397.3	397.5	404.9	404.9	405.2	405.2	405.3	405.3	405.4	405.4	405.6	405.6
WKDS040H	71188	71187	72" CMP culvert	99	10	91	96	128	142	154	397.5	397.3	405.1	404.9	405.5	405.2	405.7	405.3	405.9	405.4	406.3	405.6
WKDS040HRD	71188	71187	Roadway	99		0	0	0	0	0	410.2	410.2	404.9	404.9	405.2	405.2	405.3	405.3	405.4	405.4	405.6	405.6
WKDS040I	62914	71188	Natural	430	10	94	98	135	153	167	399.9	397.5	405.1	405.1	405.6	405.5	405.7	405.7	405.9	405.9	406.3	406.3
WKDS050A	62978	62914	72" CSP	716	10	83	87	119	127	136	400.1	399.5	405.3	405.1	406.0	405.6	406.2	405.7	406.5	405.9	407.1	406.3
WKDS050ARD	62978	62914	Roadway	716		0	0	0	0	0	412.8	412.8	405.1	405.1	405.6	405.6	405.7	405.7	405.9	405.9	406.3	406.3
WKDS060A	62946	62978	66" CSP	1100	10	74	77	101	101	104	401.6	400.0	405.9	405.3	406.7	406.0	407.1	406.2	407.8	406.5	408.7	407.1
WKDS060ARD	62946	62978	Roadway	1100		0	0	0	0	0	414.2	414.2	405.3	405.3	406.0	406.0	406.2	406.2	406.5	406.5	407.1	407.1
WKDS070A	62915	62946	60" CSP	1640	10	58	60	77	76	81	403.6	401.5	406.9	405.9	407.7	406.7	408.5	407.1	409.4	407.8	410.4	408.7
WKDS070ARD	62915	62946	Roadway	1640		0	0	0	0	0	410.4	410.4	405.9	405.9	406.7	406.7	407.1	407.1	407.8	407.8	408.7	408.7
WKDS070B	71121	62915	Natural	450	10	60	62	83	93	91	405.3	403.6	407.1	406.9	407.8	407.7	408.5	408.5	409.4	409.4	410.4	410.4
WKDS070C	62891	71121	Natural	420	10	61	64	92	134	149	406.8	405.3	409.6	407.1	409.7	407.8	410.0	408.5	410.6	409.4	410.7	410.4
WKDS070D	62989	62891	48" CSP	30	10	61	64	92	135	150	408.2	407.8	411.0	410.1	411.1	410.2	411.9	410.7	413.1	411.3	413.6	411.4
WKDS070DRD	62989	62891	Roadway	30		0	0	0	0	0	416.0	415.5	409.6	409.6	409.7	409.7	410.0	410.0	410.6	410.6	410.7	410.7
WKDS080A	62986	62989	36" CSP	650	10	20	22	25	27	29	412.2	408.2	413.5	411.0	413.6	411.1	413.7	411.9	414.1	413.1	414.6	413.6
WKDS080ARD	62986	62989	Roadway	650		0	0	0	0	0	420.3	416.0	411.0	411.0	411.1	411.1	411.9	411.9	413.1	413.1	413.6	413.6
WKDS080B	62760	62986	42" CSP	738	10	20	22	25	26	28	413.0	412.1	415.1	413.5	415.2	413.6	415.4	413.7	415.4	414.1	415.6	414.6
WKDS080BRD	62760	62986	Roadway	738		0	0	0	0	0	421.2	420.3	413.5	413.5	413.6	413.6	413.7	413.7	414.1	414.1	414.6	414.6
WKDS080C	62758	62760	36" CSP	242	10	20	22	25	26	28	413.6	413.2	415.6	415.1	415.8	415.2	416.0	415.4	416.1	415.4	416.2	415.6
WKDS080CRD	62758	62760	Roadway	242		0	0	0	0	0	421.9	421.2	415.1	415.1	415.2	415.2	415.4	415.4	415.4	415.4	415.6	415.6
WKDS080D	62713	62758	30" CSP	48	10	20	22	25	26	28	414.1	414.1	416.4	415.6	416.6	415.8	416.8	416.0	417.0	416.1	417.2	416.2
WKDS080DRD	62713	62758	Roadway	48		0	0	0	0	0	420.0	420.0	415.6	415.6	415.8	415.8	416.0	416.0	416.1	416.1	416.2	416.2

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WKDS090A	62715	62713	Natural	457	10	11	12	14	14	15	415.4	415.0	416.5	416.4	416.6	416.6	416.9	416.8	417.0	417.0	417.2	417.2
WKDS090B	62716	62715	30" CSP culvert	442	10	11	11	13	13	13	414.6	414.0	416.9	416.5	417.0	416.6	417.4	416.9	417.6	417.0	417.9	417.2
WKDS090BRD	62716	62715	Roadway	442		0	0	0	0	0	420.5	420.5	416.5	416.5	416.6	416.6	416.9	416.9	417.0	417.0	417.2	417.2
WKDS090C	71102	62716	Natural	310	10	11	12	19	21	20	416.1	414.6	416.9	416.9	417.1	417.0	417.5	417.4	417.6	417.6	417.9	417.9
WKDS090D	71101	71102	Natural	364	10	11	12	20	29	34	417.4	416.1	418.2	416.9	418.2	417.1	418.4	417.5	418.5	417.6	418.6	417.9
Willakenzie South - Delta Ponds																						
WKDP130A	71156	71157	Natural	330	10	47	47	61	111	124	395.6	386.2	397.4	387.6	397.4	387.6	397.6	387.8	398.2	388.2	398.3	388.3
WKDP130B	60760	71156	Natural	320	10	47	47	61	111	124	400.0	396.0	403.9	398.4	403.9	398.4	404.2	398.8	405.1	399.7	405.3	399.8
WKDP130C	66584	60760	54" CSP	1332	10	22	22	32	60	59	400.4	400.0	404.1	403.9	404.1	403.9	404.6	404.2	406.8	405.1	406.9	405.3
WKDP130CRD	66584	60760	Roadway	1332		0	0	0	0	0	410.1	409.5	403.9	403.9	403.9	403.9	404.2	404.2	405.1	405.1	405.3	405.3
WKDP130D	60840	66584	48" CSP	553	10	22	22	32	60	59	401.9	400.6	404.3	404.1	404.3	404.1	405.0	404.6	407.8	406.8	407.9	406.9
WKDP130DRD	66584	60840	Roadway	553		0	0	0	0	0	410.1	407.8	404.3	404.3	404.3	404.3	405.0	405.0	407.8	407.8	407.9	407.9
WKDP130E	60828	60840	36" CSP	558	10	12	12	19	32	37	404.1	402.5	405.4	404.3	405.4	404.3	405.8	405.0	409.7	407.8	410.2	407.9
WKDP130ERD	60828	60840	Roadway	558		0	0	0	0	0	413.0	407.8	404.3	404.3	404.3	404.3	405.0	405.0	407.8	407.8	407.9	407.9
WKDP130F	60811	60840	36" CSP	548	10	11	11	13	26	32	403.3	402.5	404.8	404.3	404.8	404.3	405.3	405.0	408.9	407.8	409.4	407.9
WKDP130FRD	60811	60840	Roadway	548		0	0	0	0	0	414.1	407.8	404.3	404.3	404.3	404.3	405.0	405.0	407.8	407.8	407.9	407.9
WKDP080A	66556	59213	36" CSP	313	10	52	53	57	57	58	389.2	383.6	396.3	388.6	397.1	388.6	398.2	388.2	398.2	388.6	398.2	388.6
WKDP080ARD	66556	59213	Roadway	313		0	0	28	38	55	398.0	392.0	388.6	388.6	388.6	388.6	398.2	392.2	398.2	392.2	398.2	392.2
WKDP080B	60844	66556	54" CSP	635	10	37	38	61	77	89	392.9	391.8	396.6	396.3	397.4	397.1	399.0	398.2	399.6	398.2	400.1	398.2
WKDP080BRD	60844	66556	Roadway	635		0	0	0	0	0	400.9	398.0	396.3	396.3	397.1	397.1	398.2	398.2	398.2	398.2	398.2	398.2
WKDP090C	60771	60844	24" CSP	786	10	9	10	14	16	15	399.1	393.4	400.0	396.6	400.1	397.4	402.1	399.0	402.2	399.6	402.2	400.1
WKDP090CRD	60771	60844	Roadway	786		0	0	3	5	9	402.0	400.9	396.6	396.6	397.4	397.4	402.1	401.0	402.2	401.0	402.2	401.0
WKDP090A	60856	60844	48" CSP	119	10	23	27	36	49	57	393.7	393.4	396.7	396.6	397.5	397.4	399.2	399.0	399.8	399.6	400.3	400.1
WKDP090ARD	60856	60844	Roadway	119		0	0	0	0	0	401.0	400.9	396.6	396.6	397.4	397.4	399.0	399.0	399.6	399.6	400.1	400.1
WKDP090B	60804	60856	42" CSP	1801	10	24	25	36	49	57	397.9	393.7	399.7	396.7	399.7	397.5	401.9	399.2	405.4	399.8	407.3	400.3
WKDP090BRD	60804	60856	Roadway	1801		0	0	0	0	0	407.3	401.0	396.7	396.7	397.5	397.5	399.2	399.2	399.8	399.8	407.3	401.0
WKDP120A	61595	60804	42" CSP	1894	10	13	13	21	29	36	400.7	398.0	402.2	399.7	402.2	399.7	402.9	401.9	407.6	405.4	410.6	407.3
WKDP120ARD	61595	60804	Roadway	1894		0	0	0	0	0	416.7	407.3	399.7	399.7	399.7	399.7	401.9	401.9	405.4	405.4	407.3	407.3
WKDP080C	59248	66556	30" CSP	439	10	11	11	17	17	15	392.3	389.2	396.6	396.3	397.5	397.1	398.4	398.2	398.4	398.2	398.5	398.2
WKDP080CRD	59248	66556	Roadway	439		0	0	7	8	10	398.2	398.0	396.3	396.3	397.1	397.1	398.4	398.2	398.4	398.2	398.5	398.2
WKDP080D	59218	59248	24" CSP	209	10	11	11	17	18	20	395.5	392.3	397.1	396.6	398.0	397.5	399.8	398.4	399.9	398.4	400.3	398.5
WKDP080DRD	59218	59248	Roadway	209		0	0	0	0	0	400.5	398.2	396.6	396.6	397.5	397.5	398.4	398.4	398.4	398.4	398.5	398.5
WKDP080E	59181	59218	30" CSP	150	10	11	11	17	18	18	395.6	395.5	397.3	397.1	398.1	398.0	400.2	399.8	400.4	399.9	400.6	400.3
WKDP080ERD	59218	59181	Roadway	150		0	0	0	0	-5	400.5	400.2	397.3	397.3	398.1	398.1	400.2	400.2	400.4	400.4	400.6	400.6
WKDP080F	59198	59181	Natural	175	10	11	11	17	25	28	396.5	395.6	397.8	397.3	398.3	398.1	400.2	400.2	400.4	400.4	400.7	400.6
WKDP080G	59197	59198	21" CSP	216	10	11	11	16	17	17	398.3	396.5	399.5	397.8	399.6	398.3	401.1	400.2	401.2	400.4	401.3	400.7
WKDP080GRD	59197	59198	Roadway	216		0	0	9	19	28	401.0	400.2	397.8	397.8	398.3	398.3	401.1	400.3	401.2	400.4	401.3	400.7
Willakenzie South - Gilham-Norkenzie																						
WKGN010A	59134	59192	72" CSP	264	10	136	142	210	223	247	390.4	389.3	394.1	389.4	394.2	389.4	395.2	389.5	395.4	389.5	396.1	389.5
WKGN010ARD	59134	59192	Roadway	264		0	0	0	0	0	400.0	399.0	389.4	389.4	389.4	389.4	389.5	389.5	389.5	389.5	389.5	389.5
WKGN010B	68175	59134	36" CSP	895	10	11	11	18	28	31	395.6	392.0	396.5	394.1	396.6	394.2	397.0	395.2	397.6	395.4	398.0	396.1
WKGN010BRD	68175	59134	Roadway	895		0	0	0	0	0	404.6	400.0	394.1	394.1	394.2	394.2	395.2	395.2	395.4	395.4	396.1	396.1

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE WILLAKENZIE BASIN STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WKGN010C	59868	59134	72" CSP	2151	10	113	118	174	191	210	396.5	390.4	399.7	394.1	399.7	394.2	400.8	395.2	401.3	395.4	402.1	396.1
WKGN010CRD	59868	59134	Roadway	2151		0	0	0	0	0	414.2	400.0	394.1	394.1	394.2	394.2	395.2	395.2	395.4	395.4	396.1	396.1
WKGN030D	59862	59868	36 "CSP	1880	10	10	11	17	22	23	402.2	398.6	403.6	399.7	403.7	399.7	403.9	400.8	404.2	401.3	404.4	402.1
WKGN030DRD	59868	59862	Roadway	1880		0	0	0	0	0	414.2	413.3	403.6	403.6	403.7	403.7	403.9	403.9	404.2	404.2	404.4	404.4
WKGN030E	59859	59862	42" CSP	606	10	10	11	17	22	26	403.4	402.2	404.6	403.6	404.7	403.7	405.1	403.9	405.4	404.2	405.6	404.4
WKGN030ERD	59862	59859	Roadway	606		0	0	0	0	0	413.3	413.1	404.6	404.6	404.7	404.7	405.1	405.1	405.4	405.4	405.6	405.6
WKGN030A	59896	59868	66 " CSP	793	10	90	93	137	153	169	398.6	396.9	401.9	399.7	402.0	399.7	403.0	400.8	403.5	401.3	404.5	402.1
WKGN030ARD	59868	59896	Roadway	793		0	0	0	0	0	414.2	411.3	401.9	401.9	402.0	402.0	403.0	403.0	403.5	403.5	404.5	404.5
WKGN030B	59889	59896	66" CSP	1460	10	81	83	123	137	151	401.3	398.6	404.5	401.9	404.5	402.0	405.7	403.0	406.3	403.5	407.9	404.5
WKGN030BRD	59889	59896	Roadway	1460		0	0	0	0	0	413.7	411.3	401.9	401.9	402.0	402.0	403.0	403.0	403.5	403.5	404.5	404.5
WKGN030C	59878	59896	30 " CSP	509	10	9	9	15	21	24	403.8	401.9	405.0	402.9	405.0	402.9	405.4	403.2	405.9	403.5	406.2	404.5
WKGN030CRD	59896	59878	Roadway	509		0	0	0	0	0	411.3	409.9	405.0	405.0	405.0	405.0	405.4	405.4	405.9	405.9	406.2	406.2
WKGN040A	59875	59878	36" CSP	411	10	0	0	0	1	2	405.2	404.7	405.2	405.0	405.2	405.0	405.4	405.4	406.0	405.9	406.2	406.2
WKGN040ARD	59875	59878	Roadway	411		0	0	0	0	0	411.3	409.9	405.0	405.0	405.0	405.0	405.4	405.4	405.9	405.9	406.2	406.2
WKGN040B	59873	59875	27" CSP	258	10	0	0	0	0	0	406.4	405.8	406.4	405.8	406.4	405.8	406.4	405.8	406.4	406.0	406.5	406.2
WKGN040BRD	59873	59875	Roadway	258		0	0	0	0	0	413.9	411.3	405.2	405.2	405.2	405.2	405.4	405.4	406.0	406.0	406.2	406.2
WKGN040C	59889	59873	24" CSP	364	10	0	0	0	0	0	407.8	406.6	406.4	406.4	406.4	406.4	406.4	406.4	406.4	406.4	407.9	406.7
WKGN040CRD	59873	59889	Roadway	364		0	0	0	0	0	413.9	413.7	404.5	404.5	404.5	404.5	405.7	405.7	406.3	406.3	407.9	407.9
WKGN060A	61562	59889	66" CSP	1506	10	65	68	100	111	123	402.3	401.3	405.9	404.5	406.0	404.5	407.3	405.7	408.1	406.3	410.2	407.9
WKGN060ARD	59889	61562	Roadway	1506		0	0	0	0	0	413.7	412.7	405.9	405.9	406.0	406.0	407.3	407.3	408.1	408.1	410.2	410.2
WKGN070C	61554	61562	42" CSP	1014	10	18	18	28	34	42	405.7	403.5	407.2	405.9	407.2	406.0	408.3	407.3	409.5	408.1	412.1	410.2
WKGN070CRD	61554	61562	Roadway	1014		0	0	0	0	0	415.7	412.7	405.9	405.9	406.0	406.0	407.3	407.3	408.1	408.1	410.2	410.2
WKGN070D	61444	61554	36" CSP	43	10	18	18	27	34	42	410.6	406.2	411.3	407.2	411.3	407.2	411.3	408.3	411.6	409.5	412.7	412.1
WKGN070DRD	61554	61444	Roadway	43		0	0	0	0	0	415.7	415.0	411.3	411.3	411.3	411.3	411.3	411.3	411.6	411.6	412.7	412.7
WKGN070E	71196	61444	Natural	500	10	18	18	27	34	42	411.7	410.6	413.8	411.3	413.8	411.3	414.2	411.3	414.4	411.6	414.4	412.7
WKGN070F	71197	71196	36" CSP culvert	31	10	18	19	28	34	41	411.8	411.7	414.0	413.8	414.0	413.8	414.5	414.2	414.8	414.4	415.0	414.4
WKGN070FRD	71197	71196	Roadway	31		0	0	0	0	0	417.0	417.0	413.8	413.8	413.8	413.8	414.2	414.2	414.4	414.4	414.4	414.4
WKGN070G	71198	71197	Natural	340	10	18	19	28	37	43	412.2	411.8	414.1	414.0	414.1	414.0	414.6	414.5	414.9	414.8	415.1	415.0
WKGN070H	72432	71198	36" CSP culvert	17	10	19	19	29	42	49	412.2	412.2	414.3	414.1	414.4	414.1	414.9	414.6	415.4	414.9	415.7	415.1
WKGN070HRD	71198	72432	Roadway	17		0	0	0	0	0	417.8	417.6	414.3	414.3	414.4	414.4	414.9	414.9	415.4	415.4	415.7	415.7
WKGN070A	61565	61562	48" CSP	1999	10	25	26	39	42	46	405.7	403.5	407.8	405.9	407.9	406.0	408.9	407.3	409.9	408.1	411.6	410.2
WKGN070ARD	61565	61562	Roadway	1999		0	0	0	0	0	417.9	412.7	405.9	405.9	406.0	406.0	407.3	407.3	408.1	408.1	410.2	410.2
WKGN070B	99498	61565	42" CSP	695	10	25	26	40	48	51	408.2	405.8	409.9	407.8	409.9	407.9	410.6	408.9	411.2	409.9	412.8	411.6
WKGN070BRD	99498	61565	Roadway	695		0	0	0	0	0	420.0	417.9	407.8	407.8	407.9	407.9	408.9	408.9	409.9	409.9	411.6	411.6
WKGN090A	99495	99498	36" CSP	597	10	14	14	22	26	31	409.3	408.2	410.8	409.9	410.9	409.9	411.5	410.6	412.1	411.2	413.4	412.8
WKGN090ARD	99495	99498	Roadway	597		0	0	0	0	0	421.0	420.0	409.9	409.9	409.9	409.9	410.6	410.6	411.2	411.2	412.8	412.8
WKGN090B	61437	99495	48" CSP	122	10	14	14	22	26	31	409.6	409.4	411.1	410.8	411.2	410.9	411.7	411.5	412.3	412.1	413.5	413.4
WKGN090BRD	99495	61437	Roadway	122		0	0	0	0	0	421.0	415.6	411.1	411.1	411.2	411.2	411.7	411.7	412.3	412.3	413.5	413.5
WKGN090C	61423	61437	Natural	800	10	14	14	22	29	35	412.0	409.6	413.8	411.1	413.8	411.2	414.0	411.7	414.3	412.3	414.4	413.5

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE WILLAMETTE RIVER BASIN STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions			Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)					
											10-Year		25-Year Winter		25-Year Summer	
	US	DS				10-Year	25-Year-W	25-Year-S	US	DS	US	DS	US	DS	US	DS
WRRR010E	76425	59065	48" CSP	48	10	39	39	63	378.1	383.1	392.2	392.1	392.2	392.1	392.2	392.1
WRRR010D	76424	76425	48" CSP	100	10	39	39	63	378.3	378.1	392.3	392.2	392.3	392.2	392.5	392.2
WRRR010DRD	76424	76425	Roadway	100		0	0	0	396.4	381.8	392.2	392.2	392.2	392.2	392.2	392.2
WRRR010C	59082	76424	48" CSP	45	10	39	39	63	387.4	378.3	392.3	392.3	392.3	392.3	392.6	392.5
WRRR010CRD	76424	59082	Roadway	45		0	0	0	396.4	396.0	392.3	392.3	392.3	392.3	392.6	392.6
WRRR010B	59080	59082	54" CSP	635	10	39	39	63	387.8	387.4	392.6	392.3	392.6	392.3	393.4	392.6
WRRR010BRD	59080	59082	Roadway	635		0	0	0	397.6	396.0	392.3	392.3	392.3	392.3	392.6	392.6
WRRR010A	59087	59080	54" CSP	247	10	39	39	63	388.0	387.8	392.7	392.6	392.7	392.6	393.7	393.4
WRRR010ARD	59080	59087	Roadway	247		0	0	0	397.6	397.0	392.7	392.7	392.7	392.7	393.7	393.7
WRRR020A	66178	59087	54" CSP	22	10	35	35	56	388.0	388.0	392.8	392.7	392.8	392.7	393.8	393.7
WRRR020ARD	66178	59087	Roadway	22		0	0	0	397.0	397.0	392.7	392.7	392.7	392.7	393.7	393.7
WRRR030A	59120	66178	48" CSP	1241	10	23	24	37	389.4	388.3	393.1	392.8	393.1	392.8	394.7	393.8
WRRR030ARD	59120	66178	Roadway	1241		0	0	0	398.6	397.0	392.8	392.8	392.8	392.8	393.8	393.8
WRRR040A	60606	59120	48" CSP	775	10	20	20	31	390.0	389.4	393.2	393.1	393.3	393.1	395.1	394.7
WRRR040ARD	60606	59120	Roadway	775		0	0	0	399.2	398.6	393.1	393.1	393.1	393.1	394.7	394.7
WRRR050B	60626	60606	42" CSP	600	10	12	12	19	392.4	390.8	393.6	393.2	393.6	393.3	395.4	395.1
WRRR050BRD	60626	60606	Roadway	600		0	0	0	401.0	399.2	393.2	393.2	393.3	393.3	395.1	395.1
WRRR050A	60617	60626	36" CSP	355	10	12	12	18	393.2	392.7	394.7	393.8	394.7	393.8	395.6	395.4
WRRR050ARD	60626	60617	Roadway	355		0	0	0	401.0	400.6	394.7	394.7	394.7	394.7	395.6	395.6
Outfall B																
WRRR060F	66175	59066	30" CSP	10	10	8	8	14	383.4	382.5	392.9	392.9	393.0	392.9	393.1	392.9
WRRR060E	66552	66175	30" CSP	41	10	8	8	14	381.3	383.4	393.1	392.9	393.0	393.0	393.0	393.1
WRRR060D	76421	66552	30" CSP	130	10	8	8	14	381.6	381.3	393.1	393.1	393.0	393.0	393.2	393.0
WRRR060C	59084	76421	30" CSP	38	10	8	8	14	389.2	381.6	393.0	393.1	393.0	393.0	393.2	393.2
WRRR060B	59083	59084	30" CSP	109	10	8	8	14	390.7	389.2	393.1	393.0	393.1	393.0	393.4	393.2
WRRR060BRD	59083	59084	Roadway	109		0	0	0	402.0	400.0	393.0	393.0	393.0	393.0	393.2	393.2
WRRR060A	67889	59083	30" CSP	998	10	8	8	14	393.8	391.4	395.0	393.1	395.0	393.1	395.4	393.4
WRRR060ARD	67889	59083	Roadway	998		0	0	0	404.0	402.0	393.1	393.1	393.1	393.1	393.4	393.4
Outfall C																
WRRR090D	76423	60612	30" CSP	588	10	11	11	14	399.2	398.4	400.8	399.6	400.9	399.6	401.2	399.6
WRRR090C	76422	76423	30" CSP	43	10	11	11	14	397.8	399.2	400.9	400.8	400.9	400.9	401.3	401.2
WRRR090CRD	76422	76423	Roadway	43		0	0	0	406.0	405.0	400.8	400.8	400.9	400.9	401.2	401.2
WRRR090B	60647	76422	30" CSP	12	10	11	11	14	399.2	397.8	400.8	400.9	400.9	400.9	401.3	401.3
WRRR090BRD	60647	76422	Roadway	12		0	0	0	406.5	405.0	400.9	400.9	400.9	400.9	401.3	401.3
WRRR090A	60658	60647	30" CSP	413	10	7	7	9	395.3	399.3	401.1	400.8	401.1	400.9	401.5	401.3
WRRR090ARD	60647	60658	Roadway	413		0	0	0	405.5	405.3	401.1	401.1	401.1	401.1	401.5	401.5
WRRR100A	62222	60658	27" CSP	700	10	7	7	10	400.8	399.8	402.2	401.1	402.2	401.1	402.5	401.5
WRRR100ARD	62222	60658	Roadway	700		0	0	0	406.0	404.3	401.1	401.1	401.1	401.1	401.5	401.5

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE WILLOW CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
Willow Creek - Main Stem																						
WCMN010A	71038	71120	Natural	400	25	598	870	225	804	902	381.4	376.5	388.5	388.5	390.2	390.0	386.5	386.5	389.6	389.6	390.3	390.1
WCMN010B	71037	71038	bridge	34	50	591	870	224	798	902	381.4	381.4	388.5	388.5	390.2	390.2	386.5	386.5	389.7	389.6	390.3	390.3
WCMN010C	71049	71037	Natural	900	25	514	836	206	701	849	383.3	381.4	389.3	388.5	390.5	390.2	387.1	386.5	389.9	389.7	390.6	390.3
WCMN010D	73754	71049	Natural	3000	25	516	869	211	657	862	390.1	383.3	395.6	389.3	397.7	390.5	393.1	387.1	397.5	389.9	397.6	390.6
Willow Creek - West Branch																						
WCMN010H	54462	73754	Natural	1500	10	14	13	14	23	28	398.5	392.1	399.5	395.6	399.5	397.7	399.7	393.1	399.8	397.5	399.9	397.6
WCMN020A	54494	54462	48" CSP	125	10	14	14	16	27	32	396.4	398.5	399.6	399.5	399.6	399.5	399.8	399.7	400.0	399.8	400.2	399.9
WCMN020Ard	54494	54462	Roadway	125		0	0	0	0	0	403.0	403.0	399.5	399.5	399.5	399.5	399.7	399.7	399.8	399.8	399.9	399.9
WCMN020B	54495	54494	48" CSP	450	10	14	14	16	27	32	399.1	396.4	400.1	399.6	400.1	399.6	400.2	399.8	400.5	400.0	400.6	400.2
WCMN020Brd	54495	54494	Roadway	450		0	0	0	0	0	407.2	403.0	399.6	399.6	399.6	399.6	399.8	399.8	400.0	400.0	400.2	400.2
WCMN010E#1	76010	73754	4'x12' box culvert	64	25	166	200	89	204	249	392.4	392.1	395.8	395.6	398.0	397.7	393.9	393.2	397.6	397.5	397.9	397.6
WCMN010E#2	76010	73754	4'x12' box culvert	64	25	166	200	89	204	249	392.4	392.1	395.8	395.6	398.0	397.7	393.9	393.2	397.6	397.5	397.9	397.6
WCMN010Erd	76010	73754	Roadway	64		0	0	0	0	0	398.1	398.0	395.6	395.6	397.7	397.7	393.1	393.1	397.5	397.5	397.6	397.6
WCWE100A	71034	76010	Natural	676	25	328	389	173	419	512	394.0	390.4	397.5	395.8	398.3	398.0	396.9	393.9	397.8	397.6	398.2	397.9
WCWE100B	71033	71034	Natural	960	10	108	115	84	149	180	400.5	394.0	405.7	397.5	405.7	398.3	405.4	396.9	406.0	397.8	406.2	398.2
WCWE100C#1	71032	71033	42"x27" CMP elliptical culvert	47	10	27	28	27	30	31	400.6	400.6	405.9	405.7	406.0	405.7	405.7	405.4	406.3	406.0	406.5	406.2
WCWE100C#2	71032	71033	42"x27" CMP elliptical culvert	47	10	28	29	28	31	32	400.6	400.6	405.9	405.7	406.0	405.7	405.7	405.4	406.3	406.0	406.5	406.2
WCWE100Crd	71032	71033	Roadway	47		59	65	35	101	137	405.1	405.0	405.9	405.7	406.0	405.7	405.7	405.4	406.3	406.0	406.5	406.2
WCWE100D	71040	71034	Natural	417	25	234	279	119	298	364	396.0	394.0	401.1	397.5	401.3	398.3	400.5	396.9	401.4	397.8	401.6	398.2
WCWE100E	71031	71040	Natural	1200	25	235	279	120	301	366	402.7	396.0	409.4	401.1	409.6	401.3	408.5	400.5	409.7	401.4	410.0	401.6
WCWE100F	71030	71031	48" CSP culvert	32	25	149	149	128	155	152	404.6	403.4	411.4	409.4	411.5	409.6	410.1	408.5	411.5	409.7	411.7	410.0
WCWE100Frd	71030	71031	Roadway	32		102	149	0	174	247	410.8	410.8	411.4	411.1	411.5	411.2	408.5	408.5	411.5	411.3	411.7	411.4
WCWE110A	71050	71030	Natural	450	10	162	185	89	207	253	407.1	404.5	411.9	411.4	412.1	411.5	410.5	410.1	412.2	411.5	412.6	411.7
WCWE110B	71029	71050	Natural	800	10	162	185	95	208	253	411.6	407.1	415.6	411.9	415.9	412.1	414.7	410.5	416.3	412.2	417.1	412.6
WCWE110C#1	71028	71029	12" CSP culverts	19	10	7	7	7	7	7	413.7	413.7	417.0	415.6	417.1	415.9	416.9	414.7	417.1	416.3	417.3	417.1
WCWE110C#2	71028	71029	15" CSP culvert	19	10	12	12	11	12	12	413.7	413.7	417.0	415.6	417.1	415.9	416.9	415.0	417.1	416.3	417.3	417.1
WCWE110Crd	71028	71029	Roadway	19		146	170	80	196	247	416.3	416.3	417.0	416.7	417.1	416.7	416.9	416.6	417.1	416.8	417.3	417.1
WCWE120A	71027	71028	Natural	1300	10	135	155	83	172	209	424.4	413.6	427.7	417.0	428.0	417.1	427.1	416.9	428.2	417.1	428.7	417.3
WCWE120B	71026	71027	42" CSP culvert	32	10	104	106	84	107	109	425.1	426.3	431.5	429.4	431.6	429.4	430.7	429.2	431.7	429.4	431.8	429.5
WCWE120Brd	71026	71027	Roadway	32		32	49	0	67	101	431.2	431.2	431.5	431.3	431.6	431.4	427.1	427.1	431.7	431.4	431.8	431.5

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE WILLOW CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WCWE120C	71025	71026	Natural	320	10	137	155	105	175	210	431.6	425.1	434.8	431.5	434.9	431.6	434.6	430.7	435.0	431.7	435.2	431.8
WCWE120D#1	71024	71025	18" CSP culverts	20	10	17	17	17	17	17	432.2	431.6	435.4	434.8	435.4	434.9	435.3	434.6	435.5	435.0	435.6	435.2
WCWE120D#2	71024	71025	24" CSP culvert	20	10	27	27	27	27	27	432.2	431.6	435.4	434.8	435.4	434.9	435.3	434.6	435.5	435.0	435.6	435.2
WCWE120Drd	71024	71025	Roadway	20		109	128	74	149	186	434.7	434.7	435.4	435.0	435.4	435.1	435.3	435.0	435.5	435.1	435.6	435.2
WCWE130A	71023	71024	Natural	700	10	110	123	92	138	166	439.8	432.2	442.0	435.4	442.1	435.4	441.9	435.3	442.2	435.5	442.3	435.6
WCWE130B	71022	71023	48" CMP culvert	30	10	111	123	94	139	167	443.1	442.3	447.7	445.2	448.4	445.5	447.1	444.9	449.3	445.8	450.9	446.0
WCWE130C	71021	71022	Natural	500	10	119	124	107	180	222	454.0	443.1	457.1	447.7	457.1	448.4	457.0	447.1	457.5	449.3	457.7	450.9
WCWE130D	71020	71021	48" CMP culvert	31	10	120	124	109	136	139	457.0	456.3	462.3	459.6	462.5	459.6	461.7	459.4	463.2	459.8	463.3	459.8
WCWE130Drd	71020	71021	Roadway	31		0	0	0	50	91	462.8	462.8	457.1	457.1	457.1	457.1	457.0	457.0	463.2	463.0	463.3	463.1
Willow Creek - East Branch																						
WCMN10F1	73761	73754	Natural	290	25	250	442	74	369	480	390.3	390.1	395.9	395.6	398.2	397.7	393.3	393.1	397.8	397.5	398.1	397.6
WCEA005A	76015	73761	48" CSP culvert	50	25	11	52	1	45	53	392.1	391.2	395.9	395.9	398.4	398.2	393.3	393.3	398.0	397.8	398.5	398.1
WCEA005Ard	76015	73761	Roadway	33		0	32	0	0	44	398.0	398.0	395.9	395.9	398.4	398.3	393.3	393.3	398.0	398.0	398.5	398.3
WCEA005B	73501	76015	Natural	550	25	9	69	0	42	89	395.4	392.1	396.5	395.9	398.4	398.4	393.3	393.3	398.1	398.0	398.5	398.5
WCEA005C	73500	73501	Natural	2000	25	16	73	0	49	93	403.6	396.0	403.9	396.5	404.5	398.4	395.4	395.4	404.3	398.1	404.6	398.5
WCMN10F2	73768	73761	Natural	535	25	243	369	74	325	388	390.6	390.3	396.5	395.9	398.7	398.2	394.0	393.3	398.2	397.8	398.8	398.1
WCMN010G#1	76016	73768	6'x8' box culvert	64	25	121	179	37	163	181	392.2	390.6	396.6	396.5	399.0	398.7	394.0	394.0	398.4	398.2	399.1	398.8
WCMN010G#2	76016	73768	6'x8' box culvert	64	25	121	179	37	163	181	392.2	390.6	396.6	396.5	399.0	398.7	394.0	394.0	398.4	398.2	399.1	398.8
WCMN010Grd	76016	73768	Roadway	64		0	40	0	0	53	398.6	398.5	396.5	396.5	399.0	398.8	394.0	394.0	398.2	398.2	399.1	398.9
WCEA10A1	73500	76016	Natural	1300	25	240	390	74	332	395	398.7	392.2	403.9	396.6	404.5	399.0	402.4	394.0	404.3	398.4	404.6	399.1
WCEA10A2	71041	73500	Natural	1322	25	249	445	73	381	510	405.0	398.7	410.6	403.9	410.8	404.5	408.5	402.4	410.8	404.3	411.0	404.6
WCEA030A	51997	71041	Natural	1774	10	41	54	47	60	79	435.8	405.0	437.5	410.6	437.6	410.8	437.6	408.5	437.6	410.8	437.6	411.0
WCEA030B	51998	51997	24" CSP culvert	164	10	40	40	41	41	41	439.1	435.8	445.7	437.5	445.7	437.6	445.8	437.6	446.0	437.6	446.1	437.6
WCEA030Brd	51998	51997	Roadway	164		23	21	35	82	102	445.3	445.3	445.7	445.4	445.7	445.4	445.8	445.5	446.0	445.6	446.1	445.6
WCEA030C	71042	71041	Natural	1200	25	247	273	149	314	392	418.0	405.0	424.7	410.6	424.7	410.8	424.7	408.5	424.8	410.8	424.9	411.0
WCEA030D	71017	71042	Natural	2000	25	246	274	182	308	389	426.7	418.0	437.5	424.7	438.3	424.7	436.8	424.7	438.5	424.8	438.8	424.9
WCEA030E	71016	71017	bridge	35	25	251	285	202	341	417	427.6	426.7	437.5	437.5	438.3	438.3	436.8	436.8	438.5	438.5	438.8	438.8
WCEA050A	71043	71016	Natural	414	25	254	279	221	346	419	435.1	427.6	438.8	437.5	439.0	438.3	438.6	436.8	439.4	438.5	439.9	438.8
WCEA050B	71015	71043	Natural	364	10	58	57	57	67	73	442.6	435.1	445.0	438.8	445.1	439.0	445.0	438.6	451.4	439.4	453.6	439.9
WCEA050C	71014	71015	30"x42" CMP elliptical culvert	51	10	55	55	55	59	60	448.0	446.9	451.9	449.3	451.8	449.3	451.9	449.3	452.2	451.4	453.6	453.6
WCEA050Crd	71014	71015	Roadway	51		3	2	4	42	86	451.7	451.7	451.9	451.7	451.8	451.7	451.9	451.7	452.2	452.0	453.6	453.6
WCEA050D	71044	71043	Natural	250	10	203	223	172	290	362	436.8	435.1	440.2	438.8	440.3	439.0	440.1	438.6	440.4	439.4	440.6	439.9

APPENDIX E
TABLE E-4
HYDRAULIC PERFORMANCE OF THE WILLOW CREEK STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Segment ID	Node ID		Segment Size/Type	Segment Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)									
													10-Year		25-Year Winter		25-Year Summer		50-Year		100-Year	
	US	DS				10-Year	25-Year-W	25-Year-S	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
WCEA060A	71013	71044	Natural	647	10	106	113	94	157	198	445.6	436.8	447.6	440.2	447.7	440.3	447.5	440.1	448.1	440.4	448.3	440.6
WCEA060B	71012	71013	36" CSP culvert	82	10	107	113	97	137	139	448.7	446.6	455.2	449.6	455.8	449.6	454.0	449.0	458.8	449.6	459.0	449.6
WCEA060Brd	71012	71013	Roadway	82		0	0	0	28	64	458.4	458.4	447.6	447.6	447.7	447.7	447.5	447.5	458.8	458.6	459.0	458.8
WCEA060C	71011	71044	Natural	600	10	81	86	58	120	150	450.0	436.8	452.5	440.2	452.5	440.3	452.3	440.1	452.7	440.4	452.8	440.6
WCEA060D#1	71010	71011	27"x42" CMP elliptical culvert	23	10	49	49	49	52	53	450.1	450.0	453.9	452.5	454.0	452.5	453.8	452.3	454.1	452.7	454.3	452.8
WCEA060D#2	71010	71011	18" CMP culvert	23	10	11	11	11	12	12	450.1	450.0	453.9	452.5	454.0	452.5	453.8	452.3	454.1	452.7	454.3	452.8
WCEA060D#3	71010	71011	18" CMP culvert	23	10	11	11	11	12	12	450.1	450.0	453.9	452.5	454.0	452.5	453.8	452.3	454.1	452.7	454.3	452.8
WCEA060Drd	71010	71011	Roadway	23		14	16	1	50	85	453.7	453.7	453.9	453.8	454.0	453.8	453.8	453.7	454.1	453.9	454.3	454.0
WCEA060E	71045	71010	Natural	228	10	84	86	76	125	161	452.3	450.1	455.1	453.9	455.1	454.0	454.9	453.8	456.1	454.1	456.3	454.3
WCEA060F	71046	71045	36" CMP culvert	41	10	63	63	62	65	66	456.8	456.3	461.7	458.8	461.8	458.8	461.7	458.8	462.0	458.9	462.1	458.9
WCEA060Frd	71046	71045	Roadway	41		21	24	15	68	96	461.4	461.4	461.7	461.5	461.8	461.5	461.7	461.5	462.0	461.7	462.1	461.8
WCEA060G	71048	71046	Natural	100	10	84	86	78	134	163	458.1	456.0	461.8	461.7	461.8	461.8	461.7	461.7	462.0	462.0	462.2	462.1
WCEA060H	71009	71048	Natural	400	10	85	86	79	134	163	466.3	458.1	469.0	461.8	469.0	461.8	468.9	461.7	469.6	462.0	470.0	462.2
WCEA060I	71008	71009	36" CSP culvert	24	10	85	87	79	110	112	468.7	468.1	473.3	470.3	473.4	470.3	473.0	470.1	475.2	471.1	475.4	471.1
WCEA060Ird	71008	71009	Roadway	24		0	0	0	26	53	474.7	474.7	469.0	469.0	469.0	469.0	468.9	468.9	475.2	474.9	475.4	475.0

APPENDIX F

CITY OF EUGENE FIELD RECONNAISSANCE FOR POTENTIAL CIP SITES DATA COLLECTION FORMS

City of Eugene
Field Reconnaissance for Potential CIP Sites
Data Collection Forms

Nature Resource/Field Method

Assessment questions: terrestrial wildlife habitat

1. Is the site generally known to be of local importance for migratory birds or other terrestrial wildlife?
   - *Goal 5 Report*
   - *Natural Resources Special Study Rpt.*
   - *(Wildlife biologist/ODFW)*

   a. Yes.
   b. Unknown.
   c. No.
   List which species:

2. Is the site protected in a local wetland conservation plan or a local comprehensive plan as a Goal 5 resource?
   - *Goal 5 Report*

   a. Yes.
   b. Unknown.
   c. No.

3. Does the watershed provide a natural corridor for fish and wildlife movement? *List whether for fish, wildlife, or both. Consider fences, dams and other barriers to travel. Fragmented systems have barriers to movement or a section where the natural area is broken by developed area. A corridor is a landscape feature that enables fish and wildlife species to travel between broad geographical areas. See diagram below. (See guidelines.)*

   a. There are contiguous natural areas that allow species movement, and if barriers exist, they do not stop animal or fish movement.
   b. The natural areas are fragmented, but species movement is still possible.
   c. The habitat system is fragmented, and there are barriers to species movement.

   - *Aerial photo*
   - *Field check*

INSERT DIAGRAM

4. What are the landscape features at both ends of the movement corridor? *From an aerial photo, observation or local knowledge, determine whether there are large natural areas at either end of the movement corridor. (See guidelines.)*

   a. Large natural habitat areas at both ends.
   b. One end has a natural habitat area and the other end is developed.
   c. Both ends are developed, no connections to large natural areas.

   - *Aerial*
   - *Field check*

5. What is the water quality condition of water bodies in the watershed upstream from the site?
   - *305b Report*

   a. No main stream reaches within the watershed or bodies of water upstream from the site are listed in severe water quality condition from nonpoint sources.
   b. Either main stream reaches within the watershed or bodies of water upstream from the site, but not both, are listed as in severe water quality condition from nonpoint sources.
   c. Both main stream reaches within the watershed and bodies of water upstream from the site are listed as in severe water quality condition from nonpoint sources.

6. How many habitat types are present? *(Note types in shorthand; see guidelines.):*
UFC - conifer upland forest
UFD - deciduous upland forest
UFM - mixed upland forest
RIP - riparian forest
WFO - wetland forest
USS - upland scrub-shrub
WSS - wetland scrub-shrub
OW - open water
UM - upland meadow
UP - upland prairie
WP - wet prairie
EM - emergent wetland
UAM - agricultural upland meadow
WAM - agricultural wetland meadow

a. Two or more.
b. One type with more than one dominant plant species.
c. One type with only one dominant plant species.

- *NWI maps*
- *Aerial photos*
- *Field check*

7. What is the area of open water or type of stream associated with the site?
- *Aerial*
- *Field check*

Wetlands:
a. More than 3 acres or connected to a stream, lake or pond.
b. Between 0.5 and 3 acres.
c. Less than 0.5 acres.

Streams:
a. Perennial.
b. Intermittent.
c. Stormwater/irrigation drainage only.

8. What is the dominant (>50%) existing land use surrounding the site?
- *Eugene land use map*
- *Field check*
-*Aerials*
-*NPDES Maps*

a. Forested lands or open space.
b. Agriculture.
c. Developed: residential, commercial or industrial.

9. What is the average width of the vegetative buffer surrounding the site?
- *Aerial*
- *Field check*

a. Greater than 50 feet.
b. Between 25 and 50 feet.
c. Less than 25 feet.

10. What is the quality of the dominant habitat type?
- *Field*

a. Intact habitat vegetated with mostly native species.
b. Some disturbance, mixed native and non-native species.
c. Disturbed habitat of mostly invasive species.

11. When is there water at the site and/or in a connected stream, lake or pond?
-*Field*
-*Aerials*

a. All year.
b. During fall, winter and/or spring.
c. Only in winter.

Assessment questions: aquatic wildlife habitat

Part A: Answer only if a stream is present - Go to Part B if lakes and ponds are present

1. Repeat Question # 5 from Terrestrial Wildlife Habitat section.

Repeat Answer # 5 from Wildlife Habitat section.

2.	Repeat Question # 8 from Terrestrial Wildlife Habitat section.	Repeat Answer # 8 from Terrestrial Wildlife Habitat section.
3.	What species of the following aquatic organisms are potentially present in the stream. Fish, herpetiles, or aquatic mammals? *(ODFW list)*	a. Two of the above. b. One of the above. c. None of the above or unknown status.
4.	What percentage of the stream on the site is shaded by streamside (riparian) vegetation during full leaf conditions? - *Field*	a. Greater than 75%. b. Between 25% and 75%. c. Less than 25%.
5.	What is the physical character of the stream channel? - *Field*	a. The stream is in a natural channel, or modified portions of the stream have returned to a natural channel. b. Only portions of the stream channel have been modified, or if extensive modification has been done in the past, the stream has regained some natural channel features through meandering, the re-growth of in-stream vegetation or the addition of cover objects such as rocks or snags, or the stream is a natural channel with down cutting apparent. c. Extensive modifications have been made to the channel, or the stream is confined in a non-vegetated channel or pipe.
6.	What percentage of the stream contains cover such as submerged logs, overhanging banks, floating or submerged vegetation, large rocks or boulders? - *Field*	a. More than 25%. b. Between 10% and 25%. c. Less than 10%.

Part B: Answer only if lakes and ponds are present

1.	Repeat Question # 5 from Terrestrial Wildlife Habitat section.	Repeat Answer # 5 from Terrestrial Wildlife Habitat section.
2.	Repeat Question # 2 from Aquatic Wildlife Habitat Part A.	Repeat Answer # 2 from Aquatic Wildlife Habitat Part A.
3.	How does the water depth vary in the lake or pond? - *Field* - *Oregon Atlas of Lakes*	a. The water has more than two depths. b. There is a mixture of two depths. c. All water is roughly of uniform depth or depth cannot be determined.
4.	What percentage of the entire lake or pond contains cover objects such as submerged logs, overhanging banks, floating submerged vegetation, large rocks or boulders? - *Field*	a. More than 25%. b. Between 10% and 25%. c. Less than 10%.
5.	What percentage of the shoreline is vegetated to the water's edge (include any wetland area)? - *Field*	a. Greater than 75%. b. Between 25% and 75%. c. Less than 25%.

Assessment questions: water quality part 1

Note: questions attempt to identify opportunities to improve water quality.

1. What is the site's area in acres?
   - *Map 1 base*
   a. Greater than 5 acres.
   b. Between 0.1 and 5 acres
   c. Less than 0.1 acres.

2. What is the dominant, existing land use in the portion of the sub-basin draining to the site?
   - *Eugene land use map*
   - *Eugene drainage basin maps*
   - *Field check*
   a. Urban: e.g. Residential, commercial or industrial.
   b. Agriculture.
   c. Forested lands or open space.

3. What is the site's primary source of water? *For "c," note the specific answer.*
   - *NWI/USGS*
   - *Field*
   a. Precipitation or overland flow.
   b. Perennial or intermittent stream (includes irrigation ditches).
   c. Springs, seeps, or cannot be determined.

4. Is there evidence that the site floods or ponds?
   - *Field*
   -*Aerial*
   -*Maintenance list, photos, log*
   a. Evidence of flooding or ponding exists.
   b. Unable to observe because of water level at time of observation.
   c. No evidence of flooding or ponding exists.

5. Does the site currently appear to be providing water quality treatment?
   - *Field*
   a. Vegetation filters drainage before it reaches a downstream water feature.
   b. A water body on site provides settling for drainage.
   c. None.
   d. Cannot determine.

Assessment questions: water quality part 2

6. Where is the site located within the sub-basin? *Sketch lines which divide sub-basin into thirds and note whether stream confluences are nearby, upstream or downstream.*
   a. Lower third, or site includes the lower third.
   b. Middle third, or site includes the middle third.
   c. Upper third.

   - *Eugene drainage basin maps*
   - *Map 1 Base*

7. How large an area does the site drain?
   - *USGS or other topo map*
   - *SWMM Model*
   a. Greater than 25 acres.
   b. 10 to 25 acres.
   c. Less than 10 acres.

8. Which best represents the shape of the site?
   - *Map 1 base*
   a. Linear
   b. Non-linear

9. What is the general site slope?
   - *USGS or other topo map*
   - *Field check*
   - *Sensitive areas map*
   - *Soil survey*
   a. Less than 4% - "flat".
   b. 4 to 15% - "moderate slope".
   c. Over 15% - "steep".

10. What is the visual nature of the water on site?
    - *Field*
    a. Water appears clear.
    b. Water appears muddy.
    c. Algal or evidence of pollutants or debris are present.

11. Are there visible sources of pollutants or litter near the site?
    - *Field*
    a. None.
    b. Downcutting observed.
    c. Stormwater outfalls or nonpoint sources (i.e., Construction or new development, construction or manufacturing materials, dumping of debris, farm uses).

12. What is the degree of tillage or compaction of the soils?
    - *Field*
    a. Soils show little or no sign of tillage or compaction.
    b. Cannot determine.
    c. Soils show signs of tillage or compaction.

Assessment questions: hydrologic control functions

1. Is the site located within the 100-year floodplain?
    - *Map 1 base*
    a. Yes.
    b. No.

2. Repeat Question # 4 from Water Quality Part 1.
    Repeat Answer # 4 from Water Quality Part 1.

3. Repeat Question # 1 from Water Quality Part 1.
    Repeat Answer # 1 from Water Quality Part 1.

4. What percent of impervious area lies upstream of the site, within the sub-basin?
    - *SWMM model*
    a. Greater than 30% impervious.
    b. 10% to 30%.
    c. Less than 10% impervious.

5. What is the projected increase in impervious area draining to the site?
    - *GIS input data for SWMM model*
    a. Greater than 10%.
    b. 5% to 10%.
    c. < 5%.

6. Repeat Question #7 from Water Quality Part 2.
    Repeat Answer #7 from Water Quality Part 2.

7. Repeat Question # 9 from Water Quality Part 2.
    Repeat Answer # 9 from Water Quality Part 2.

8. What is the site's dominant type of vegetation?
    - *Aerial/NWI*
    - *Field check*
    a. Greater than 70% forested or scrub-shrub.
    b. Between 50% and 70% forested or scrub-shrub.
    c. 50% or less is forested or scrub-shrub.

9. What is the dominant comprehensive plan land-use designation within 500 feet *downstream* of the site?
    - *Eugene land use map*
    - *Field check*
    a. Urban: e.g. Industrial, residential and commercial.
    b. Agriculture.
    c. Forested land and open space.

10. Is water flow out of the wetland/water feature restricted (e.g., by a beaver dam or concrete structure)?
    - *Field*

    a. Yes, the outlet is restricted or the wetland/water feature has no outlet.
    b. No, the outlet has unrestricted flow.

Assessment questions: sensitivity to impact

1. Is the hydrologic system upstream of the site modified?
   Individual knowledgeable about basin.

   a. Stream reaches within 1 mile above the site are dammed, channelized, leveed, or otherwise physically altered, and diking, drainage or irrigation withdrawals are active within the watershed upstream of the site.
   b. Main stream reaches upstream of the site are dammed, channelized or leveed, but no diking, drainage or irrigation withdrawals are active within the watershed upstream of the site.
   c. Hydrologic modifications do not fit criteria for responses "a" or "b". *Explain in notes.*

2. Does the site contain threatened , endangered or sensitive species of wildlife, plants, invertebrates or fish? (Either federal- or state-listed. Include species.) If yes, list species.
   - *Database printout*
   - *Goal 5 Report*

   a. Yes.
   b. Unknown.
   c. No.
   List:

3. Is the site a locally-designated or proposed natural area protected under the Comprehensive Plan, or a Nature Conservancy Preserve?
   - *West Eugene Wetlands report*
   - *The Nature Conservancy*

   a. Yes.
   b. Unknown.
   c. No.
   List which it is:

4. Is the site a mitigation site for a remove-fill permit, federal 404 fill permit or enforcement action?
   - *Mitigation site database*

   a. Yes.
   b. Unknown.
   c. No.

5. Is the site considered rare or unique in Oregon? Examples include wet prairies, bogs, vernal pools and old growth forested wetlands.
   - *Goal 5/Natural Resources Special Study Reports*
   - *Natural Heritage Database*
   - *The Nature Conservancy*

   a. Yes.
   b. Unknown.
   c. No.

6. Repeat Question # 5 from Hydrologic Control Functions.

   Repeat Answer # 5 from Hydrologic Control Functions.

7. What is the dominant (>50%) existing land use surrounding the site?
   - *Eugene land use map*
   - *Field check*
   - *Aerials*
   - *NPDES Maps*

   a. Forested lands or open space.
   b. Agriculture.
   c. Developed: residential, commercial or industrial.

8. What is the dominant vegetation type?
   - *NWI/Aerial*
   - *Field check*

   a. Forested, scrub-shrub, or wet-prairie.
   b. Emergent or grasses/forbs.
   c. Invasive species.

9. What type of stormwater discharges are entering the site?
   - *Map 1 base*
   - *Field*

   a. Overland flow.
   b. Overland flow and one direct stormwater discharge (i.e., outfall).
   c. Overland flow and more than one direct stormwater discharges (i.e., outfalls).

Assessment questions: education potential

1. What is the potential for fish and wildlife habitat study based on the Fish Habitat and Wildlife Habitat evaluation criteria?
   - *Previous questions*

   a. The site provides diverse habitat for wildlife or contributes to fish habitat.
   b. The site provides habitat for some wildlife species or potentially contributes to fish habitat.
   c. The site does not provide wildlife habitat and does not contribute to fish habitat.

2. Is the site part of a study in progress or is a study proposed for the site?
   - *Individual knowledgeable about basin*

   a. A study is in progress.
   b. A study is proposed.
   c. No.

3. How far is the site from the nearest school?
   - *City street map*

   a. Less than 1000 feet.
   b. Between 1000 feet and .5 mile.
   c. Over .5 mile.

4. Is the site open to the public for direct access or observation?
   - *Field*

   a. Access is allowed only by permission of the landowner or managing entity.
   b. The site is open to the public.
   c. The site is not open to the public.

5. Are there visible hazards to the public at the site? Examples: sharp litter or other objects, unstable slopes, blackberry thickets, etc.
   - *Field*

   a. No visible safety hazards exist.
   b. One or more visible safety hazards exist.
   c. More than two visible safety hazards exist.

6. Is there existing physical public access from the site to habitats different from those on the site, such as a stream, lake, pond, forest or agricultural land? If not, can such other habitats be observed from the site?
   - *Field*
   - *Map 2*

   a. Public access exists or can be created easily.
   b. Public access does not exist and cannot be created easily, but observation of other feature can be made from the site.
   c. Access does not exist and cannot be created easily. In addition, observation of other features cannot be made from the site.

7. Does it appear that access to a viewing spot or wetland/water feature edge is difficult for individuals with limited mobility?
   - *Field*

   a. No.
   b. Yes. (List physical barriers.)

Assessment questions: recreation

1. Repeat Question # 4 from Education Potential.	Repeat Answer # 4 from Education Potential.
2. Is the site publicly owned? - *Map 3*	a. Yes. b. No.
3. Is any of the site within an existing park? - *Map 3*	a. Yes. b. No.
4. Are there maintained trails, viewing areas or other structures adjacent to or on the site that guide user movement to a particular area or areas? - *Map 2* - *Field check*	a. Developed or maintained trails or viewing areas exist. b. Trail or viewing area opportunities exist that will not disrupt wildlife or plant habitat. c. No trails or viewing areas exist. d. Unknown.
5. Is there a public boat launch or water-based access area on or near the site? - *Field* - *Map 3*	a. Boat launching areas or access points exist on site or within 1/2 mile on a connected lake, river, bay or other body of water. b. Potential to develop boat launching areas or access points exist or such features are more than 1/2 mile but less than 1 mile from the wetland. c. No boat launching areas or access points exist.
6. What is the opportunity for nonconsumptive uses such as wildlife observation and photography? - *Field*	a. The site provides diverse habitat for wildlife. b. The site provides habitat for some wildlife species. c. The site does not provide wildlife habitat or has limited use by wildlife.
7. Is fishing allowed on or adjacent to the site? - *Field*	a. Allowed. b. Prohibited.

Assessment questions: aesthetic quality

1. How many types of vegetation and water features are visible from the primary viewing location? *The access point is usually the primary viewing location.* - *Field*	a. There are two or more types visible from the view point. b. One type is visible, and the whole site or a large portion can be viewed. c. One type is visible and only a small portion of the site can be viewed.
2. What is the general appearance of the site as visible from primary viewing location? - *Field*	a. No visual detractors (abandoned cars, litter, shopping carts, etc.). b. Visual detractors, if any, can be removed easily. c. Visual detractors cannot be removed easily.
3. What is the visual character of the surrounding area? - *Field*	a. Open space or naturally landscaped areas. b. Areas landscaped by people. c. Developed with no landscaping.

4. What odors are present at the primary viewing location?
   - *Field*

   a. Natural odors only.
   b. Unnatural odors such as automobile exhaust, industrial smells, or stench from a sewage treatment plant are present at certain times.
   c. Unnatural odors are distinct and continuously present.

5. What noises are audible at the primary viewing location?
   - *Field*

   a. Bird and wildlife noises and other naturally occurring sounds.
   b. Some traffic and other similar background sounds are audible in addition to naturally occurring sounds.
   c. Continuous traffic or other intrusive noise is audible in addition to naturally occurring sounds.
   d. Traffic or other intrusive noise is continuous throughout the day.

Terrestrial wildlife habitat: assessment criteria	
Site provides valuable wildlife habitat features and diverse habitat. Should be preserved.	At least five questions are answered "a" or "b," and no more than two are answered "c."
Site provides habitat for some wildlife species, but habitat could be enhanced.	Answers do not satisfy the above- or below-listed criteria.
Site has limited wildlife habitat or use.	Nine questions are answered "c."

Aquatic wildlife habitat: assessment criteria	
Fish habitat is intact and should be preserved.	Any three questions are answered "a," and no more than one is answered "c."
Site potentially provides fish habitat, but could be enhanced.	Answers do not satisfy the above- or below-listed criteria.
Site has limited fish habitat or use - significant enhancements would be needed..	All questions are answered "c."

Water quality part 1: assessment criteria	
Site currently provides water quality benefits; much improvement not possible. Protection may be desirable.	Questions 1 and 2 are answered "a" or "b," and questions 3 and 5 are answered "a."
Site has the potential to provide water quality benefits.	Answers do not satisfy the above- or below-listed criteria.
Site has limited or no potential to provide water quality benefits.	Question 1 is answered "c."

Water quality part 2: assessment criteria	
Site could provide water quality benefits and could accommodate a large BMP.	Questions 6, 7 and 9 are answered "a."
Site has the potential to provide water quality benefits and could accommodate a small BMP.	Answers do not satisfy the above- or below-listed criteria.
Site is not likely to provide opportunities for water quality benefits.	Questions 6, 7, and 9 are answered "c."

Hydrologic control: assessment criteria	
Site currently provides hydrologic control; much improvement not possible. Protection may be desirable.	Questions 1 and 2 are answered "a," and question 3 is answered "a" or "b."
Site has the potential to provide hydrologic control.	Answers do not satisfy the above- or below-listed criteria.
Site is not likely to provide opportunities for hydrologic control.	Questions 3, 4, 5, 6, and 7 are answered "c."

Sensitivity to impact: assessment criteria	
Site is likely sensitive to effects of disturbance. Protection may be desirable.	Any of questions 2 through 6 are answered "a."
Site is not likely sensitive to effects of disturbance.	None of questions 2 through 6 are answered "a."

Education: assessment criteria	
The site could be used for educational purposes.	Question 5 is answered "a," and at least one of questions 1, 4 and 6 is answered "a" or "b."
The site has some potential for educational uses.	Answers do not satisfy the above- or below-listed criteria.
The site has little potential for educational uses.	The answer to 1, 4 or 5 is "c."

Recreation: assessment criteria	
The site could be used for recreational purposes.	Question 1 is answered "a" or "b" and the answer to 2, 4, 5, 6 or 7 is "a."
The site has some potential for recreational uses.	Answers do not satisfy the above- or below-listed criteria.
The site has little potential for recreational uses.	Question 1 is answered "c"; or questions 4 and 6 are answered "c," and 2 and 7 are answered "b."

Aesthetic quality: assessment criteria	
The site is considered aesthetically pleasing.	Questions 1 and 2 are answered "a," and all other questions are answered "a" or "b."
The site has potential to be aesthetically pleasing.	Answers do not satisfy the above- or below listed criteria.
The site is not aesthetically pleasing.	Two or more questions are answered "c" or "d."

EUGENE STORMWATER BASIN PLANNING CIP INVENTORY FIELD DATA SHEETS
OREGON FRESHWATER WETLAND ASSESSMENT TYPE METHODOLOGY

Date:		Investigator(s):	
Sub-basin:		Site Location:	
Site I.D.:			
Approximate Area (acres):			

Terrestrial Wildlife Habitat		Aquatic Wildlife Habitat		Water Quality Part 1		Water Quality Part 2		Hydrologic Control		Sensitivity to Impact	
Q	A	Q	A	Q	A	Q	A	Q	A	Q	A
Q-1		Part A:		Q-1		Q-6		Q-1		Q-1	
Q-2		Q-1		Q-2		Q-7		Q-2		Q-2	
Q-3		Q-2		Q-3		Q-8		Q-3		Q-3	
Q-4		Q-3		Q-4		Q-9		Q-4		Q-4	
Q-5		Q-4		Q-5		Q-10		Q-5		Q-5	
Q-6		Q-5				Q-11		Q-6		Q-6	
Q-7		Q-6				Q-12		Q-7		Q-7	
Q-8		Part B:						Q-8		Q-8	
Q-9		Q-1						Q-9		Q-9	
Q 10		Q-2						Q-10			
Q-11		Q-3									
		Q-4									
		Q-5									

Education		Recreation		Aesthetic Quality	
Q	A	Q	A	Q	A
Q-1		Q-1		Q-1	
Q-2		Q-2		Q-2	
Q-3		Q-3		Q-3	
Q-4		Q-4		Q-4	
Q-5		Q-5		Q-5	
Q-6		Q-6			
Q-7		Q-7			

GENERAL COMMENTS/SKETCH:

EUGENE BASIN PLANNING CIP INVENTORY FIELD DATA SHEETS Site I.D.:

COMMENTS:

Wildlife Habitat

Fish Habitat

Water Quality

Hydrologic Control

Sensitivity to Impact

Education

Recreation

Aesthetic Quality

EUGENE BASIN PLANNING CIP INVENTORY
OREGON FRESHWATER WETLAND ASSESSMENT TYPE METHODOLOGY

-- Assessment Summary --

Site I.D.:	

Function	Results	Rationale
Wildlife Habitat		
Fish Habitat		
Water Quality Part 1		
Water Quality Part 2		
Hydrologic Control		
Sensitivity to Impact		
ducation		
Recreation		
Aesthetic Quality		

APPENDIX F

CITY OF EUGENE FIELD RECONNAISSANCE FOR POTENTIAL CIP SITES DATA COLLECTION FORMS

City of Eugene
Field Reconnaissance for Potential CIP Sites
Data Collection Forms

Nature Resource/Field Method

Assessment questions: terrestrial wildlife habitat

1. Is the site generally known to be of local importance for migratory birds or other terrestrial wildlife?
   - *Goal 5 Report*
   - *Natural Resources Special Study Rpt.*
   - *(Wildlife biologist/ODFW)*

   a. Yes.
   b. Unknown.
   c. No.
   List which species:

2. Is the site protected in a local wetland conservation plan or a local comprehensive plan as a Goal 5 resource?
   - *Goal 5 Report*

   a. Yes.
   b. Unknown.
   c. No.

3. Does the watershed provide a natural corridor for fish and wildlife movement? *List whether for fish, wildlife, or both. Consider fences, dams and other barriers to travel. Fragmented systems have barriers to movement or a section where the natural area is broken by developed area. A corridor is a landscape feature that enables fish and wildlife species to travel between broad geographical areas. See diagram below. (See guidelines.)*

   a. There are contiguous natural areas that allow species movement, and if barriers exist, they do not stop animal or fish movement.
   b. The natural areas are fragmented, but species movement is still possible.
   c. The habitat system is fragmented, and there are barriers to species movement.

   - *Aerial photo*
   - *Field check*

INSERT DIAGRAM

4. What are the landscape features at both ends of the movement corridor? *From an aerial photo, observation or local knowledge, determine whether there are large natural areas at either end of the movement corridor. (See guidelines.)*

   a. Large natural habitat areas at both ends.
   b. One end has a natural habitat area and the other end is developed.
   c. Both ends are developed, no connections to large natural areas.

   - *Aerial*
   - *Field check*

5. What is the water quality condition of water bodies in the watershed upstream from the site?
   - *305b Report*

   a. No main stream reaches within the watershed or bodies of water upstream from the site are listed in severe water quality condition from nonpoint sources.
   b. Either main stream reaches within the watershed or bodies of water upstream from the site, but not both, are listed as in severe water quality condition from nonpoint sources.
   c. Both main stream reaches within the watershed and bodies of water upstream from the site are listed as in severe water quality condition from nonpoint sources.

6. How many habitat types are present? *(Note types in shorthand; see guidelines.):*
UFC - conifer upland forest
UFD - deciduous upland forest
UFM - mixed upland forest
RIP - riparian forest
WFO - wetland forest
USS - upland scrub-shrub
WSS - wetland scrub-shrub
OW - open water
UM - upland meadow
UP - upland prairie
WP - wet prairie
EM - emergent wetland
UAM - agricultural upland meadow
WAM - agricultural wetland meadow

a. Two or more.
b. One type with more than one dominant plant species.
c. One type with only one dominant plant species.

- *NWI maps*
- *Aerial photos*
- *Field check*

7. What is the area of open water or type of stream associated with the site?
- *Aerial*
- *Field check*

Wetlands:
a. More than 3 acres or connected to a stream, lake or pond.
b. Between 0.5 and 3 acres.
c. Less than 0.5 acres.

Streams:
a. Perennial.
b. Intermittent.
c. Stormwater/irrigation drainage only.

8. What is the dominant (>50%) existing land use surrounding the site?
- *Eugene land use map*
- *Field check*
-*Aerials*
-*NPDES Maps*

a. Forested lands or open space.
b. Agriculture.
c. Developed: residential, commercial or industrial.

9. What is the average width of the vegetative buffer surrounding the site?
- *Aerial*
- *Field check*

a. Greater than 50 feet.
b. Between 25 and 50 feet.
c. Less than 25 feet.

10. What is the quality of the dominant habitat type?
- *Field*

a. Intact habitat vegetated with mostly native species.
b. Some disturbance, mixed native and non-native species.
c. Disturbed habitat of mostly invasive species.

11. When is there water at the site and/or in a connected stream, lake or pond?
-*Field*
-*Aerials*

a. All year.
b. During fall, winter and/or spring.
c. Only in winter.

Assessment questions: aquatic wildlife habitat

Part A: Answer only if a stream is present - Go to Part B if lakes and ponds are present

1. Repeat Question # 5 from Terrestrial Wildlife Habitat section.

Repeat Answer # 5 from Wildlife Habitat section.

2.	Repeat Question # 8 from Terrestrial Wildlife Habitat section.	Repeat Answer # 8 from Terrestrial Wildlife Habitat section.
3.	What species of the following aquatic organisms are potentially present in the stream. Fish, herpetiles, or aquatic mammals? *(ODFW list)*	a. Two of the above. b. One of the above. c. None of the above or unknown status.
4.	What percentage of the stream on the site is shaded by streamside (riparian) vegetation during full leaf conditions? - *Field*	a. Greater than 75%. b. Between 25% and 75%. c. Less than 25%.
5.	What is the physical character of the stream channel? - *Field*	a. The stream is in a natural channel, or modified portions of the stream have returned to a natural channel. b. Only portions of the stream channel have been modified, or if extensive modification has been done in the past, the stream has regained some natural channel features through meandering, the re-growth of in-stream vegetation or the addition of cover objects such as rocks or snags, or the stream is a natural channel with down cutting apparent. c. Extensive modifications have been made to the channel, or the stream is confined in a non-vegetated channel or pipe.
6.	What percentage of the stream contains cover such as submerged logs, overhanging banks, floating or submerged vegetation, large rocks or boulders? - *Field*	a. More than 25%. b. Between 10% and 25%. c. Less than 10%.

Part B: Answer only if lakes and ponds are present

1.	Repeat Question # 5 from Terrestrial Wildlife Habitat section.	Repeat Answer # 5 from Terrestrial Wildlife Habitat section.
2.	Repeat Question # 2 from Aquatic Wildlife Habitat Part A.	Repeat Answer # 2 from Aquatic Wildlife Habitat Part A.
3.	How does the water depth vary in the lake or pond? - *Field* - *Oregon Atlas of Lakes*	a. The water has more than two depths. b. There is a mixture of two depths. c. All water is roughly of uniform depth or depth cannot be determined.
4.	What percentage of the entire lake or pond contains cover objects such as submerged logs, overhanging banks, floating submerged vegetation, large rocks or boulders? - *Field*	a. More than 25%. b. Between 10% and 25%. c. Less than 10%.
5.	What percentage of the shoreline is vegetated to the water's edge (include any wetland area)? - *Field*	a. Greater than 75%. b. Between 25% and 75%. c. Less than 25%.

Assessment questions: water quality part 1

Note: questions attempt to identify opportunities to improve water quality.

1. What is the site's area in acres?
   - *Map 1 base*
   a. Greater than 5 acres.
   b. Between 0.1 and 5 acres
   c. Less than 0.1 acres.

2. What is the dominant, existing land use in the portion of the sub-basin draining to the site?
   - *Eugene land use map*
   - *Eugene drainage basin maps*
   - *Field check*
   a. Urban: e.g. Residential, commercial or industrial.
   b. Agriculture.
   c. Forested lands or open space.

3. What is the site's primary source of water? *For "c," note the specific answer.*
   - *NWI/USGS*
   - *Field*
   a. Precipitation or overland flow.
   b. Perennial or intermittent stream (includes irrigation ditches).
   c. Springs, seeps, or cannot be determined.

4. Is there evidence that the site floods or ponds?
   - *Field*
   -*Aerial*
   -*Maintenance list, photos, log*
   a. Evidence of flooding or ponding exists.
   b. Unable to observe because of water level at time of observation.
   c. No evidence of flooding or ponding exists.

5. Does the site currently appear to be providing water quality treatment?
   - *Field*
   a. Vegetation filters drainage before it reaches a downstream water feature.
   b. A water body on site provides settling for drainage.
   c. None.
   d. Cannot determine.

Assessment questions: water quality part 2

6. Where is the site located within the sub-basin? *Sketch lines which divide sub-basin into thirds and note whether stream confluences are nearby, upstream or downstream.*
   a. Lower third, or site includes the lower third.
   b. Middle third, or site includes the middle third.
   c. Upper third.

   - *Eugene drainage basin maps*
   - *Map 1 Base*

7. How large an area does the site drain?
   - *USGS or other topo map*
   - *SWMM Model*
   a. Greater than 25 acres.
   b. 10 to 25 acres.
   c. Less than 10 acres.

8. Which best represents the shape of the site?
   - *Map 1 base*
   a. Linear
   b. Non-linear

9. What is the general site slope?
   - *USGS or other topo map*
   - *Field check*
   - *Sensitive areas map*
   - *Soil survey*
   a. Less than 4% - "flat".
   b. 4 to 15% - "moderate slope".
   c. Over 15% - "steep".

10. What is the visual nature of the water on site?
    - *Field*
    a. Water appears clear.
    b. Water appears muddy.
    c. Algal or evidence of pollutants or debris are present.

11. Are there visible sources of pollutants or litter near the site?
    - *Field*
    a. None.
    b. Downcutting observed.
    c. Stormwater outfalls or nonpoint sources (i.e., Construction or new development, construction or manufacturing materials, dumping of debris, farm uses).

12. What is the degree of tillage or compaction of the soils?
    - *Field*
    a. Soils show little or no sign of tillage or compaction.
    b. Cannot determine.
    c. Soils show signs of tillage or compaction.

Assessment questions: hydrologic control functions

1. Is the site located within the 100-year floodplain?
    - *Map 1 base*
    a. Yes.
    b. No.

2. Repeat Question # 4 from Water Quality Part 1.
    Repeat Answer # 4 from Water Quality Part 1.

3. Repeat Question # 1 from Water Quality Part 1.
    Repeat Answer # 1 from Water Quality Part 1.

4. What percent of impervious area lies upstream of the site, within the sub-basin?
    - *SWMM model*
    a. Greater than 30% impervious.
    b. 10% to 30%.
    c. Less than 10% impervious.

5. What is the projected increase in impervious area draining to the site?
    - *GIS input data for SWMM model*
    a. Greater than 10%.
    b. 5% to 10%.
    c. < 5%.

6. Repeat Question #7 from Water Quality Part 2.
    Repeat Answer #7 from Water Quality Part 2.

7. Repeat Question # 9 from Water Quality Part 2.
    Repeat Answer # 9 from Water Quality Part 2.

8. What is the site's dominant type of vegetation?
    - *Aerial/NWI*
    - *Field check*
    a. Greater than 70% forested or scrub-shrub.
    b. Between 50% and 70% forested or scrub-shrub.
    c. 50% or less is forested or scrub-shrub.

9. What is the dominant comprehensive plan land-use designation within 500 feet *downstream* of the site?
    - *Eugene land use map*
    - *Field check*
    a. Urban: e.g. Industrial, residential and commercial.
    b. Agriculture.
    c. Forested land and open space.

10. Is water flow out of the wetland/water feature restricted (e.g., by a beaver dam or concrete structure)?
    - *Field*

    a. Yes, the outlet is restricted or the wetland/water feature has no outlet.
    b. No, the outlet has unrestricted flow.

Assessment questions: sensitivity to impact

1. Is the hydrologic system upstream of the site modified?
   Individual knowledgeable about basin.

   a. Stream reaches within 1 mile above the site are dammed, channelized, leveed, or otherwise physically altered, and diking, drainage or irrigation withdrawals are active within the watershed upstream of the site.
   b. Main stream reaches upstream of the site are dammed, channelized or leveed, but no diking, drainage or irrigation withdrawals are active within the watershed upstream of the site.
   c. Hydrologic modifications do not fit criteria for responses "a" or "b". *Explain in notes.*

2. Does the site contain threatened , endangered or sensitive species of wildlife, plants, invertebrates or fish? (Either federal- or state-listed. Include species.) If yes, list species.
   - *Database printout*
   - *Goal 5 Report*

   a. Yes.
   b. Unknown.
   c. No.
   List:

3. Is the site a locally-designated or proposed natural area protected under the Comprehensive Plan, or a Nature Conservancy Preserve?
   - *West Eugene Wetlands report*
   - *The Nature Conservancy*

   a. Yes.
   b. Unknown.
   c. No.
   List which it is:

4. Is the site a mitigation site for a remove-fill permit, federal 404 fill permit or enforcement action?
   - *Mitigation site database*

   a. Yes.
   b. Unknown.
   c. No.

5. Is the site considered rare or unique in Oregon? Examples include wet prairies, bogs, vernal pools and old growth forested wetlands.
   - *Goal 5/Natural Resources Special Study Reports*
   - *Natural Heritage Database*
   - *The Nature Conservancy*

   a. Yes.
   b. Unknown.
   c. No.

6. Repeat Question # 5 from Hydrologic Control Functions.

   Repeat Answer # 5 from Hydrologic Control Functions.

7. What is the dominant (>50%) existing land use surrounding the site?
   - *Eugene land use map*
   - *Field check*
   - *Aerials*
   - *NPDES Maps*

   a. Forested lands or open space.
   b. Agriculture.
   c. Developed: residential, commercial or industrial.

8. What is the dominant vegetation type?
   - *NWI/Aerial*
   - *Field check*

   a. Forested, scrub-shrub, or wet-prairie.
   b. Emergent or grasses/forbs.
   c. Invasive species.

9. What type of stormwater discharges are entering the site?
   - *Map 1 base*
   - *Field*

   a. Overland flow.
   b. Overland flow and one direct stormwater discharge (i.e., outfall).
   c. Overland flow and more than one direct stormwater discharges (i.e., outfalls).

Assessment questions: education potential

1. What is the potential for fish and wildlife habitat study based on the Fish Habitat and Wildlife Habitat evaluation criteria?
   - *Previous questions*

   a. The site provides diverse habitat for wildlife or contributes to fish habitat.
   b. The site provides habitat for some wildlife species or potentially contributes to fish habitat.
   c. The site does not provide wildlife habitat and does not contribute to fish habitat.

2. Is the site part of a study in progress or is a study proposed for the site?
   - *Individual knowledgeable about basin*

   a. A study is in progress.
   b. A study is proposed.
   c. No.

3. How far is the site from the nearest school?
   - *City street map*

   a. Less than 1000 feet.
   b. Between 1000 feet and .5 mile.
   c. Over .5 mile.

4. Is the site open to the public for direct access or observation?
   - *Field*

   a. Access is allowed only by permission of the landowner or managing entity.
   b. The site is open to the public.
   c. The site is not open to the public.

5. Are there visible hazards to the public at the site? Examples: sharp litter or other objects, unstable slopes, blackberry thickets, etc.
   - *Field*

   a. No visible safety hazards exist.
   b. One or more visible safety hazards exist.
   c. More than two visible safety hazards exist.

6. Is there existing physical public access from the site to habitats different from those on the site, such as a stream, lake, pond, forest or agricultural land? If not, can such other habitats be observed from the site?
   - *Field*
   - *Map 2*

   a. Public access exists or can be created easily.
   b. Public access does not exist and cannot be created easily, but observation of other feature can be made from the site.
   c. Access does not exist and cannot be created easily. In addition, observation of other features cannot be made from the site.

7. Does it appear that access to a viewing spot or wetland/water feature edge is difficult for individuals with limited mobility?
   - *Field*

   a. No.
   b. Yes. (List physical barriers.)

Assessment questions: recreation

1. Repeat Question # 4 from Education Potential.	Repeat Answer # 4 from Education Potential.
2. Is the site publicly owned? - *Map 3*	a. Yes. b. No.
3. Is any of the site within an existing park? - *Map 3*	a. Yes. b. No.
4. Are there maintained trails, viewing areas or other structures adjacent to or on the site that guide user movement to a particular area or areas? - *Map 2* - *Field check*	a. Developed or maintained trails or viewing areas exist. b. Trail or viewing area opportunities exist that will not disrupt wildlife or plant habitat. c. No trails or viewing areas exist. d. Unknown.
5. Is there a public boat launch or water-based access area on or near the site? - *Field* - *Map 3*	a. Boat launching areas or access points exist on site or within 1/2 mile on a connected lake, river, bay or other body of water. b. Potential to develop boat launching areas or access points exist or such features are more than 1/2 mile but less than 1 mile from the wetland. c. No boat launching areas or access points exist.
6. What is the opportunity for nonconsumptive uses such as wildlife observation and photography? - *Field*	a. The site provides diverse habitat for wildlife. b. The site provides habitat for some wildlife species. c. The site does not provide wildlife habitat or has limited use by wildlife.
7. Is fishing allowed on or adjacent to the site? - *Field*	a. Allowed. b. Prohibited.

Assessment questions: aesthetic quality

1. How many types of vegetation and water features are visible from the primary viewing location? *The access point is usually the primary viewing location.* - *Field*	a. There are two or more types visible from the view point. b. One type is visible, and the whole site or a large portion can be viewed. c. One type is visible and only a small portion of the site can be viewed.
2. What is the general appearance of the site as visible from primary viewing location? - *Field*	a. No visual detractors (abandoned cars, litter, shopping carts, etc.). b. Visual detractors, if any, can be removed easily. c. Visual detractors cannot be removed easily.
3. What is the visual character of the surrounding area? - *Field*	a. Open space or naturally landscaped areas. b. Areas landscaped by people. c. Developed with no landscaping.

4. What odors are present at the primary viewing location?
   - *Field*

   a. Natural odors only.
   b. Unnatural odors such as automobile exhaust, industrial smells, or stench from a sewage treatment plant are present at certain times.
   c. Unnatural odors are distinct and continuously present.

5. What noises are audible at the primary viewing location?
   - *Field*

   a. Bird and wildlife noises and other naturally occurring sounds.
   b. Some traffic and other similar background sounds are audible in addition to naturally occurring sounds.
   c. Continuous traffic or other intrusive noise is audible in addition to naturally occurring sounds.
   d. Traffic or other intrusive noise is continuous throughout the day.

Terrestrial wildlife habitat: assessment criteria	
Site provides valuable wildlife habitat features and diverse habitat. Should be preserved.	At least five questions are answered "a" or "b," and no more than two are answered "c."
Site provides habitat for some wildlife species, but habitat could be enhanced.	Answers do not satisfy the above- or below-listed criteria.
Site has limited wildlife habitat or use.	Nine questions are answered "c."

Aquatic wildlife habitat: assessment criteria	
Fish habitat is intact and should be preserved.	Any three questions are answered "a," and no more than one is answered "c."
Site potentially provides fish habitat, but could be enhanced.	Answers do not satisfy the above- or below-listed criteria.
Site has limited fish habitat or use - significant enhancements would be needed..	All questions are answered "c."

Water quality part 1: assessment criteria	
Site currently provides water quality benefits; much improvement not possible. Protection may be desirable.	Questions 1 and 2 are answered "a" or "b," and questions 3 and 5 are answered "a."
Site has the potential to provide water quality benefits.	Answers do not satisfy the above- or below-listed criteria.
Site has limited or no potential to provide water quality benefits.	Question 1 is answered "c."

Water quality part 2: assessment criteria	
Site could provide water quality benefits and could accommodate a large BMP.	Questions 6, 7 and 9 are answered "a."
Site has the potential to provide water quality benefits and could accommodate a small BMP.	Answers do not satisfy the above- or below-listed criteria.
Site is not likely to provide opportunities for water quality benefits.	Questions 6, 7, and 9 are answered "c."

Hydrologic control: assessment criteria	
Site currently provides hydrologic control; much improvement not possible. Protection may be desirable.	Questions 1 and 2 are answered "a," and question 3 is answered "a" or "b."
Site has the potential to provide hydrologic control.	Answers do not satisfy the above- or below-listed criteria.
Site is not likely to provide opportunities for hydrologic control.	Questions 3, 4, 5, 6, and 7 are answered "c."

Sensitivity to impact: assessment criteria	
Site is likely sensitive to effects of disturbance. Protection may be desirable.	Any of questions 2 through 6 are answered "a."
Site is not likely sensitive to effects of disturbance.	None of questions 2 through 6 are answered "a."

Education: assessment criteria	
The site could be used for educational purposes.	Question 5 is answered "a," and at least one of questions 1, 4 and 6 is answered "a" or "b."
The site has some potential for educational uses.	Answers do not satisfy the above- or below-listed criteria.
The site has little potential for educational uses.	The answer to 1, 4 or 5 is "c."

Recreation: assessment criteria	
The site could be used for recreational purposes.	Question 1 is answered "a" or "b" and the answer to 2, 4, 5, 6 or 7 is "a."
The site has some potential for recreational uses.	Answers do not satisfy the above- or below-listed criteria.
The site has little potential for recreational uses.	Question 1 is answered "c"; or questions 4 and 6 are answered "c," and 2 and 7 are answered "b."

Aesthetic quality: assessment criteria	
The site is considered aesthetically pleasing.	Questions 1 and 2 are answered "a," and all other questions are answered "a" or "b."
The site has potential to be aesthetically pleasing.	Answers do not satisfy the above- or below listed criteria.
The site is not aesthetically pleasing.	Two or more questions are answered "c" or "d."

EUGENE STORMWATER BASIN PLANNING CIP INVENTORY FIELD DATA SHEETS
OREGON FRESHWATER WETLAND ASSESSMENT TYPE METHODOLOGY

Date:		Investigator(s):	
Sub-basin:		Site Location:	
Site I.D.:			
Approximate Area (acres):			

Terrestrial Wildlife Habitat		Aquatic Wildlife Habitat		Water Quality Part 1		Water Quality Part 2		Hydrologic Control		Sensitivity to Impact	
Q	A	Q	A	Q	A	Q	A	Q	A	Q	A
Q-1		Part A:		Q-1		Q-6		Q-1		Q-1	
Q-2		Q-1		Q-2		Q-7		Q-2		Q-2	
Q-3		Q-2		Q-3		Q-8		Q-3		Q-3	
Q-4		Q-3		Q-4		Q-9		Q-4		Q-4	
Q-5		Q-4		Q-5		Q-10		Q-5		Q-5	
Q-6		Q-5				Q-11		Q-6		Q-6	
Q-7		Q-6				Q-12		Q-7		Q-7	
Q-8		Part B:						Q-8		Q-8	
Q-9		Q-1						Q-9		Q-9	
Q 10		Q-2						Q-10			
Q-11		Q-3									
		Q-4									
		Q-5									

Education		Recreation		Aesthetic Quality	
Q	A	Q	A	Q	A
Q-1		Q-1		Q-1	
Q-2		Q-2		Q-2	
Q-3		Q-3		Q-3	
Q-4		Q-4		Q-4	
Q-5		Q-5		Q-5	
Q-6		Q-6			
Q-7		Q-7			

GENERAL COMMENTS/SKETCH:

EUGENE BASIN PLANNING CIP INVENTORY FIELD DATA SHEETS Site I.D.:

COMMENTS:

Wildlife Habitat

Fish Habitat

Water Quality

Hydrologic Control

Sensitivity to Impact

Education

Recreation

Aesthetic Quality

EUGENE BASIN PLANNING CIP INVENTORY
OREGON FRESHWATER WETLAND ASSESSMENT TYPE METHODOLOGY

-- Assessment Summary --

Site I.D.:	

Function	Results	Rationale
Wildlife Habitat		
Fish Habitat		
Water Quality Part 1		
Water Quality Part 2		
Hydrologic Control		
Sensitivity to Impact		
ducation		
Recreation		
Aesthetic Quality		

APPENDIX G

EUGENE BASIN MASTER PLANNING UNIT COST TABLES FOR ESTIMATING CAPITAL PROJECT COSTS

APPENDIX G
Eugene Basin Planning
Unit Cost Tables for Estimating Capital Project (CP) Costs
January 1999

INTRODUCTION

This section of the binder includes a copy of the unit cost tables prepared to estimate planning level capital and maintenance costs for the storm system capital projects. Estimated costs for each capital project are provided in the CP fact sheets. The capital costs in the fact sheets are based on unit cost information provided in these tables plus a +20% contingency for engineering/design and administrative/legal services. The cost tables that are included in this section of the binder are as follows:

Tables 1 through 4 – Tables 1 through 4 provide estimated capital/construction costs for each CP type. Table 1 provides cost estimates for all of the CP types except for pipes and water quality structures. Table 2 provides cost estimates for pipes based on pipe size and depth of cover. Table 3 provides more detailed back-up information regarding estimated construction costs for storm drain installation. Table 4 provides cost estimates for six different types of structural water quality facilities. For many of the CPs in Table 1, and the pipe costs in Table 2, the unit cost must be multiplied by a quantity such as acre-feet, square yards, or lineal feet to come up with the total estimated capital cost for that CP.

Tables 5 through 7 – Tables 5 through 7 provide the back-up information that was used to estimate the unit costs for CP types listed in Table 1. Table 5 provides unit costs for the various elements that comprise each CP (e.g., labor, excavation, etc.). Table 6 provides the quantities of each element that comprise the CPs (e.g., 1 hour of labor, 6 cubic yards of excavation, etc.). Table 7 provides the detailed back-up capital/construction cost information for each CP based on Tables 5 and 6. (Note: a revision was made to the Natural Resource Enhancement and Open Waterway Improvement Construction unit costs November 2001. See the attached addendum pp. 13-15 for updated unit costs.)

Table 8 – Table 8 provides the estimated maintenance costs for each CP type. For many of the CPs, the maintenance cost must be multiplied by a unit such as acre-feet or square yards in order to come up with the total estimated maintenance cost.

Table 9 – Table 9 provides the detailed back-up information for estimating the maintenance costs for each CP type except for increased pipe sizes. A maintenance cost is not provided for capital projects to increase the pipe sizes based on the assumption that maintenance of piped systems typically includes catch basin/manhole cleaning and that this cleaning is probably already being conducted for the existing piped system.

Tables 1, 2, 4, and 8 were used to estimate capital and maintenance costs that are provided in the draft CP fact sheets. Tables 3, 5, 6, 7 and 9 are only provided to show back-up for information presented in tables 1, 2, 4, and 8.

REVISIONS

Based on comments received from the City during our meeting on December 17th and additional discussions with City maintenance and engineering staff, several changes have been made to the tables. The following text provides a summary of the items that have been modified since the first draft:

Table 1 – A category was added for Natural Resource Revegetation which includes regrading and revegetation. The purpose of adding this category was to distinguish between natural resource enhancement projects that just include revegetation and natural resource enhancement projects that include revegetation and regrading activities. A change was also made to the construction costs for flood control facilities (which were previously referred to as regional detention facilities). This change was made to more closely reflect the typical sizes of the flood control facilities in the CPs. (Note: a revision was later made to the Natural Resource Enhancement and Open Waterway Improvement Construction unit costs November 2001. See the attached addendum pp. 13-15 for updated unit costs.)

Table 2 – A clarification was provided regarding the assumptions made in developing cost estimates for storm sewer pipes (i.e., assumed pipes will be in improved areas).

Table 3 – This table was added to provide additional back-up information regarding the cost estimates that were developed for storm sewer pipes.

Table 5 – The contractor manual labor rate was modified from $20 to $30 per hour. The tree and shrub unit cost was modified from $15 to $50 to include temporary irrigation. We also clarified that the unit cost for trees is for bare root stock not established street trees.

Tables 7 and 8 – Based on the change made to Table 1, the additional natural resource revegetation category was also added to these tables. In addition, a change was made to the maintenance costs for flood control facilities (which were previously referred to as regional detention facilities). This change was made to more closely reflect the typical sizes of the flood control facilities in the CPs. (Note: a revision was made to the Natural Resource Enhancement and Open Waterway Improvement Construction unit costs November 2001. See the attached addendum pp. 13-15 for updated unit costs.)

Table 9 – The labor rate for maintenance activities was modified from $15 to $40 per hour.

The purpose of these tables is to provide general guidance with respect to CP costs and to allow for cost comparisons between CPs. These costs are only applicable to the scale of projects in the City of Eugene's preliminary storm system CP lists. They are not applicable to projects that are of a much smaller or larger scale than those preliminary CPs.

STORMWATER FACILITIES
ESTIMATED CONSTRUCTION COSTS PER UNIT
Table 1

Stormwater Facility Type	Unit	$/Unit	Description of Stormwater Facility Construction Activities
Trash Rack Inlet (Type 1)	EA	$5,170	Cone shaped rebar cage bolted to an inlet structure (manhole or vault), inlet protection (riprap, geotextile fabric), clearing of invasive vegetation, grading and revegetation .
Trash Rack Inlet (Type 2)	EA	$8,670	Steel trash rack approximately 15 ft wide and 4 ft high placed in the channel with concrete foundation walls on both banks. Also includes inlet protection, clearing of invasive vegetation, grading and revegetation.
Garbage and Debris Removal	CY	$110	Hand collected debris not requiring mechanical means to lift, hauled in 10 CY truck to disposal.
Sediment Removal	CY	$220	Removal of sediment from channels and culverts with heavy equipment. Includes hydroseeding for revegetation.
Streambank Stabilization	SY	$80	Grading, geotextile, toe reinforcement, revegetation and erosion control.
Open Channel Improvements (Type 1)	LF	$300	Traffic control, excavation (0 to10 ft bottom width, 4 to 6 ft depth, 3:1 side slopes), hydroseed, erosion protection at inlet and outlet. Modification of existing channel.
Open Channel Improvements (Type 2)	LF	$630	Same as above except 10 to 20 ft bottom width, 6 to 10 ft depth.
Dry Extended Pond	Ac-Ft	$51,900	Gravel access road (25 ft long x 12 ft width), clearing & grubbing, excavation (3 ft depth), grading, erosion protection at inlet & outlet, hydroseed, trees & shrubs, safety fence, erosion control.
Wet Extended Pond	Ac-Ft	$51,900	Gravel access road (25 ft long x 12 ft width), clearing & grubbing, excavation (3-6 ft depth), grading, erosion protection at inlet & outlet, hydroseed, trees & shrubs, safety fence, erosion control. No lining has been included.
Stormwater Marsh/Wetland	AC	$76,800	Gravel access road (25 ft long x 12 ft width), grading (1-2 ft depth, no removal from site), erosion protection at inlet & outlet, hydroseed, vegetation and erosion control.
Flood Control Facility	Ac-Ft	$51,900	Gravel access road (25 ft long x 12 ft width), clearing & grubbing, excavation (3 ft depth), grading, erosion protection at inlet & outlet, hydroseed, trees & shrubs, safety fence, erosion control.
Outfall Protection	EA	$6,670	Precast concrete outlet structure, erosion protection, geotextile fabric, clearing of vegetation around structure, grading and revegetation.
Vegetated Swale	LF	$15	Traffic control, clearing & grubbing, excavation (4ft bottom width, 2 ft depth, 4:1 side slopes), hydroseed, erosion protection at inlet and outlet.
Infiltration Trench	LF	$40	Clearing & grubbing, excavation (2ft bottom width, 4 ft depth), geotextile fabric, 4"-8" perforated pipe, drain rock, and hydroseed.
Natural Resource Enhancement*	SY	$10	Add additional vegetation
Natural Resource Revegetation*	SY	$49	Remove invasive vegetation, grade and revegetate.
Recreational Trail	SF	$5	Clearing & grubbing, grading (up to 1 ft depth), erosion control, cedar shavings. Does not include storm drainage, signage, benches or other recreational amenities.

Note: Construction costs presented in this table are planning level estimates (1998 dollars). They are reflective of average facilities constructed under typical conditions. Each facility will vary depending on site conditions, the size and number of facilities constructed, and depending on the local construction market at the time of bidding. Contingencies should be reflected for budgeting purposes based on the variety of possible conditions.

*These 2 categories have been combined and called Natural Resource Enhancement (make $13/sy) see attached addendum dated 11/01.

Reference:
Table 1 summarizes data in Table 7.
Table 5 (Unit Cost) x Table 6 (Quantities) = Table 7 (Cost per CIP)

STORMWATER FACILITIES
ESTIMATED CONSTRUCTION COSTS
FOR STORM DRAIN INSTALLATION IN IMPROVED AREAS

Table 2

	Storm Drain Pipe Construction Cost per Linear Foot										
	Diameter (inches)										
Cover Depth (feet)	24	30	36	42	48	54	60	66	72	84	96
2-5	$110	$150	$190	$220	$260	$300	$350	$420	$450	$600	$720
5-10	$130	$180	$220	$250	$290	$340	$390	$470	$510	$660	$800
10-15	$150	$200	$240	$280	$330	$390	$440	$520	$560	$730	$870
15-20	$160	$220	$270	$320	$370	$430	$480	$570	$620	$790	$950

Note: Construction costs presented in this table are planning level estimates. These estimated costs include concrete pipe installation with minor stream management, traffic control costs associated with typical in-stream culvert projects, average utility relocation and pavement restoration costs in improved areas. Trench excavation is assumed to be by excavator or backhoe (mechanical means or blasting not included). Utility easement or other land acquisition costs are excluded. Information presented in this table is a summary of Table 3.

STORMWATER FACILITIES
ESTIMATED CONSTRUCTION COSTS
FOR STORM DRAIN INSTALLATION IN IMPROVED AREAS
BACK UP INFORMATION

Table 3

	Storm Drain Pipe Construction Cost per Linear Foot										
	Diameter (inch)										
Depth of Cover (ft)	24	30	36	42	48	54	60	66	72	84	96
Sub Task											
Pipe + Bed (ft)	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7.5	8.5
Width (ft)	4	5	6	7	8	9	10	11	12	14	16
Bedding (ft)	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.6
Shoring (lf)	$10.80	$12.96	$15.55	$18.66	$22.39	$26.87	$26.87	$32.25	$38.70	$46.44	$55.73
Excavation (CY)	$10.00	$10.00	$10.00	$10.00	$10.00	$10.00	$10.00	$10.00	$10.00	$10.00	$10.00
Backfill and Air Tamped Compaction	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00
Piping (lf)	$25.50	$52.00	$69.00	$79.00	$94.00	$114.00	$134.00	$178.00	$177.00	$265.00	$330.00
Pavement Restoration	$7.43	$9.28	$11.14	$12.99	$14.85	$16.71	$18.56	$20.42	$22.28	$25.99	$29.70
Traffic Control	$20.00	$22.00	$24.20	$26.62	$29.28	$32.21	$35.43	$38.97	$42.87	$47.16	$51.87
Stream Management	$12.50	$14.38	$16.53	$19.01	$21.86	$25.14	$28.91	$33.25	$38.24	$43.97	$50.57
Cover (CY)											
2-5	1.1	1.5	1.9	2.3	2.8	3.3	3.9	4.5	5.1	6.5	8.0
5-10	1.9	2.4	3.0	3.6	4.3	5.0	5.7	6.5	7.3	9.1	11.0
10-15	2.6	3.3	4.1	4.9	5.8	6.7	7.6	8.6	9.6	11.7	13.9
15-20	3.3	4.3	5.2	6.2	7.3	8.3	9.4	10.6	11.8	14.3	16.9
2-5	$109.00	$152.65	$188.64	$219.62	$257.76	$303.27	$346.00	$419.93	$451.86	$595.59	$722.87
5-10	$127.52	$175.80	$216.42	$252.03	$294.80	$344.93	$392.30	$470.85	$507.42	$660.41	$796.94
10-15	$146.04	$198.95	$244.20	$284.44	$331.83	$386.60	$438.60	$521.78	$562.97	$725.22	$871.02
15-20	$164.56	$222.10	$271.98	$316.84	$368.87	$428.27	$484.89	$572.71	$618.53	$790.04	$945.09

Note: Construction costs presented in this table are planning level estimates. These estimated costs include minor stream management, traffic control costs associated with typical in-stream culvert projects, average utility relocation and pavement restoration costs in improved areas. Utility easement or other land acquisition costs are excluded. Information presented in this table is summarized in Table 2.

STORMWATER FACILITIES
ESTIMATED CONSTRUCTION COSTS
FOR WATER QUALITY STRUCTURES

Table 4

Device/Model	Flow Capacity (cfs)	Total Installed Cost
Vortechnics Function: Primarily sediment and large debris removal		
Vortechnics 1000	1.6	$21,000
Vortechnics 2000	2.8	$24,000
Vortechnics 3000	4.5	$28,000
Vortechnics 4000	6	$32,000
Vortechnics 5000	8.5	$36,000
Vortechnics 7000	11	$40,000
Vortechnics 9000	14	$44,000
Vortechnics 11000	17.5	$48,000
Vortechnics 16000	25	$52,000
StormCeptor Function: Primarily sediment, large debris and oil removal.		
StormCeptor 900	0.635	$15,200
StormCeptor 1200	0.635	$18,120
StormCeptor 1800	0.635	$21,620
StormCeptor 2400	1.058	$27,930
StormCeptor 3600	1.058	$33,400
StormCeptor 4800	1.782	$43,240
StormCeptor 6000	1.782	$51,770
StormCeptor 7200	2.473	$67,120
Compost Storm Filter (CSF) Function: Primarily metals uptake and oil & grease removal. Commonly used with sediment manhole.		
CSF 8x6	0.17	$30,000
CSF 12x6	0.30	$35,000
CSF 12x8	0.47	$40,000
CSF 14x8	0.60	$45,000
CSF 16x8	0.74	$50,000
CSF 18x8	0.87	$55,000
CSF 18x8	1	$60,000
CDS Function: Primarily large debris removal.		
CDS 30	3	$24,000
CDS 50	8.5	$70,000
CDS 70	26	$115,000
CDS 100	62	$225,000
CDS 150	148	$429,000
CDS 200	270	$600,000
CDS 240	300	$630,000
Oil/Water Separator Function: Primarily oil and sediment removal.		
Oil/Water Separator 253	0.01	$1,600
Oil/Water Separator 660	0.07	$3,000
Oil/Water Separator 576	0.15	$4,000
Oil/Water Separator 5106	0.30	$6,800
Oil/Water Separator 612	0.45	$10,400
Oil/Water Separator 816	0.74	$13,200
Sedimentation Vault Function: Primarily sediment and oil removal.		
Sedimentation Vault 1000	0.15	$2,400
Sedimentation Vault 2000	0.30	$4,400
Sedimentation MH Function: Primarily oil and sediment removal.		
	Maximum Diameter of Storm Drain Entering MH	
Sedimentation MH 48	30"	$2,000
Sedimentation MH 54	48"	$2,700
Sedimentation MH 60	54"	$5,000
Sedimentation MH 72	60"	$6,000

Note: Construction costs presented in this table are planning level estimates. Costs represent installation of average facilities under typical conditions. Estimates reflect vaults installed in public right of way, in an existing residential paved street, with average utility conflicts and restoration costs.

STORMWATER FACILITIES
CONSTRUCTION COST ESTIMATE
BACK-UP INFORMATION
Table 5

Construction Activity/Materials	Units	$/Unit
Manual Labor	Labor-Hr	$30
Traffic Control	Labor-Hr	$28
Gravel Access Road	SF	$3.80
Clearing & Grubbing	AC	$2,000
General Excavation	CY	$15
Grading	CY	$5
Inlet Cone & Structure	EA	$3,500
Trash Rack Structure	EA	$7,000
Pond Outlet	EA	$5,000
Curb & Gutter	LF	$12
Hydroseed	AC	$2,000
Trees & Shrubs	EA	$50
Geotextile Fabric	SY	$1.75
Rip Rap	TN	$60
Chain Link Fence	LF	$17
Erosion Control	AC	$2,000
Drain Rock	CY	$26
Crushed Rock	CY	$22
Truck Haul (Disposal)	CY	$18
Perforated Drain Pipe	LF	$26
Cedar Savings	CY	$22

Note 1: The above are representative unit costs based on information collected from bid tabulation sheets in the past two years in the Eugene, Lebanon and Portland areas. These costs are representative of average conditions and assume that the CIP projects are competitively bid. Unit costs include materials and installation. Actual construction cost will vary with site conditions and local factors at time of bidding.

Unit cost for trees assumes bare root stock with temporary water for 2-3 years.

Note 2: With respect to Natural Resource Enhancement and Open Waterway Improvement Construction Costs, unit costs were revised (Nov. 2001) for clearing & grubbing, hydroseeding, trees & shrubs, and erosion control. See attached addendum.

Reference:
Table 5 (Unit Cost) x Table 6 (Quantities) = Table 7 (Cost per CIP)

STORMWATER FACILITIES
CONSTRUCTION EFFORT/QUANTITIES ESTIMATE
BACK-UP INFORMATION
Table 6

Construction Activity/ Materials	Unit	Trash Rack Inlet (Type 1)	Trash Rack Inlet (Type 2)	Garbage and Debris Removal	Sediment Removal	Streambank Stabilization	Open Channel Improvements (Type 1)	Open Channel Improvements (Type 2)	Dry Extended Pond	Wet Extended Pond	Stormwater Marsh/Wetland	Flood Control Facility	Outfall Protection	Vegetated Swale	Infiltration Trench	Natural Resource Revegetation*	Natural Resource Enhancement*	Recreational Trail
		EA	EA	CY	CY	SY	LF	LF	Ac-Ft	Ac-Ft	AC	Ac-Ft	EA	LF	LF	SY	SY	SF
Manual Labor	Lb-Hr			3														
Traffic Control	Lb-Hr						0.6	1.2						0.16				
Gravel Access Road	SF								350	350	350	350						
Clearing & Grubbing	AC	0.1	0.1		0.0002				0.33	0.33		0.33	0.1	0.0002	0.0002			0.00002
General Excavation	CY				8		2	6	1600	1600	500	1600		0.3	0.3	0.5		
Grading	CY	8	8			0.6			100	100	1000	100	8					0.4
Inlet Cone & Structure	EA	1							1	1	1	1						
Trash Rack Structure	EA		1															
Pond Outlet Structure	EA								1	1	1	1	1					
Curb & Gutter	LF								20	20	20	20						
Hydroseed	AC	0.1	0.1		0.0002	0.0002	0.008	0.02	0.33	0.33	1	0.33	0.1	0.0002	0.0002	0.0002		
Trees & Shrubs	EA	5	5		2	1	4	8	100	100	1000	100	5	0.1		0.5	0.21	
Geotextile Fabric	SY	45	45			1							45		1.1			
Rip Rap	CY	15	15			0.33	0.28	0.5	3	3	3	3	15					
Chain Link Fence	LF								600	600		600						
Erosion Control	AC				0.0002	0.0002	0.008	0.016	0.33	0.33	1	0.33		0.0002		0.008		0.00002
Drain Rock	CY														0.3			
Crushed Rock	CY																	
Truck Haul	CY			1														
Perforated Drain Pipe	LF														1			
Cedar Shavings	CY																	0.11

Note: The above are representative quantities based on average construction conditions. Actual construction quantities will vary with site conditions. The quantities above represent the volume and effort to construct/perform each unit of water quality facility (i.e. 1 CY of Sediment Removal). Volumes of excavation are assumed to include hauling offsite (approximately 10 mile round trip) and disposal.

*The Natural Resource Revegetation and Natural Resource Enhancement columns were combined into one column called Natural Resources Enhancement and associated quantities were also revised. See attached memo dated 11/01.

Reference:
Table 5 (Unit Cost) x Table 6 (Quantities) = Table 7 (Cost per CIP)

STORMWATER FACILITIES
CONSTRUCTION COST ESTIMATE
BACK-UP INFORMATION
Table 7

Construction Activity/ Materials	Unit	Trash Rack Inlet (Type 1)	Trash Rack Inlet (Type 2)	Garbage and Debris Removal	Sediment Removal	Streambank Stabilization	Open Channel Improvements (Type 1)	Open Channel Improvements (Type 2)	Dry Extended Pond	Wet Extended Pond	Stormwater Marsh/Wetland	Flood Control Facility	Outfall Protection	Vegetated Swale	Infiltration Trench	Natural Resource Revegetation*	Natural Resource Enhancement*	Recreational Trail
		EA	EA	CY	CY	SY	LF	LF	Ac-Ft	Ac-Ft	AC	Ac-Ft	EA	LF	LF	SY	SY	SF
Manual Labor	Lb-Hr	$ -	$ -	$ 90.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Traffic Control	Lb-Hr	$ -	$ -	$ -	$ -	$ -	$ 16.80	$ 33.60	$ -	$ -	$ -	$ -	$ -	$ 4.48	$ -	$ -	$ -	$ -
Gravel Access Road	SF	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,330.00	$ 1,330.00	$ 1,330.00	$ 1,330.00	$ -	$ -	$ -	$ -	$ -	$ -
Clearing & Grubbing	AC	$ 200.00	$ 200.00	$ -	$ 0.40	$ -	$ -	$ -	$ 660.00	$ 660.00	$ -	$ 660.00	$ 200.00	$ 0.40	$ 0.40	$ -	$ -	$ 0.04
General Excavation	CY	$ -	$ -	$ -	$ 120.00	$ -	$ 30.00	$ 90.00	$ 24,000.00	$24,000.00	$ 7,500.00	$ 24,000.00	$ -	$ 4.50	$ 4.50	$ 7.50	$ -	$ -
Grading	CY	$ 40.00	$ 40.00	$ -	$ -	$ 3.00	$ -	$ -	$ 500.00	$ 500.00	$ 5,000.00	$ 500.00	$ 40.00	$ -	$ -	$ -	$ -	$ 2.00
Inlet Cone & Structure	EA	$ 3,500.00	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,500.00	$ 3,500.00	$ 3,500.00	$ 3,500.00	$ -	$ -	$ -	$ -	$ -	$ -
Trash Rack Structure	EA	$ -	$ 7,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pond Outlet Structure	EA	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ -	$ -	$ -	$ -	$ -
Curb & Gutter	LF	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 240.00	$ 240.00	$ 240.00	$ 240.00	$ -	$ -	$ -	$ -	$ -	$ -
Hydroseed	AC	$ 200.00	$ 200.00	$ -	$ 0.40	$ 0.40	$ 16.00	$ 40.00	$ 660.00	$ 660.00	$ 2,000.00	$ 660.00	$ 200.00	$ 0.40	$ 0.40	$ 0.40	$ -	$ -
Trees & Shrubs	EA	$ 250.00	$ 250.00	$ -	$ 100.00	$ 50.00	$ 200.00	$ 400.00	$ 5,000.00	$ 5,000.00	$ 50,000.00	$ 5,000.00	$ 250.00	$ 5.00	$ -	$ 25.00	$ 10.50	$ -
Geotextile Fabric	SY	$ 78.75	$ 78.75	$ -	$ -	$ 1.75	$ -	$ -	$ -	$ -	$ -	$ -	$ 78.75	$ -	$ 1.93	$ -	$ -	$ -
Rip Rap	CY	$ 900.00	$ 900.00	$ -	$ -	$ 19.80	$ 16.80	$ 30.00	$ 180.00	$ 180.00	$ 180.00	$ 180.00	$ 900.00	$ -	$ -	$ -	$ -	$ -
Chain Link Fence	LF	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,200.00	$10,200.00	$ -	$ 10,200.00	$ -	$ -	$ -	$ -	$ -	$ -
Erosion Control	AC	$ -	$ -	$ -	$ 0.40	$ 0.40	$ 16.00	$ 32.00	$ 660.00	$ 660.00	$ 2,000.00	$ 660.00	$ -	$ 0.40	$ -	$ 16.00	$ -	$ 0.04
Drain Rock	CY	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.80	$ -	$ -	$ -
Crushed Rock	CY	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Truck Haul	CY	$ -	$ -	$ 18.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Perforated Drain Pipe	LF	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 26.00	$ -	$ -	$ -
Cedar Shavings	CY	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.42
Total $/Unit CIP		$ 5,168.75	$ 8,668.75	$ 108.00	$ 221.20	$ 75.35	$ 295.60	$ 625.60	$ 51,930.00	$51,930.00	$ 76,750.00	$ 51,930.00	$ 6,668.75	$ 15.18	$ 41.03	$ 48.90	$ 10.50	$ 4.50

Note: *The Natural Resource Revegetation and Natural Resource Enhancement columns were combined into one column called Natural Resources Enhancement and associated quantities were also revised. See attached memo dated 11/01.

Reference:
Table 5 (Unit Cost) x Table 6 (Quantities) = Table 7 (Cost per CIP)
Table 7 Total Cost per Unit of CIP is Summarized in Table 1

STORMWATER FACILITIES
ESTIMATED ANNUAL MAINTENANCE COSTS
Table 8

Stormwater Facility Type	Unit	Annual $/Unit	Description of Stormwater Facility Maintenance Activities
Trash Rack Inlet (Type 1 & 2)	1 EA	$2,680	Inspect and clean inlet, inspect vegetation and slope protection, remove debris.
Open Channel (Type 1 & 2)	500 LF	$3,300	Inspect sediment loading and vegetation, remove sediment and debris.
Dry Extended Pond	5 AC-FT	$5,640	Inspect and clean inlet and outlet, maintain vegetation, inspect sediment loading, remove sediment, remove debris, inspect separation berm.
Wet Extended Pond	5 AC-FT	$5,240	Inspect and clean inlet and outlet, maintain vegetation, inspect sediment loading, remove sediment, remove debris, inspect and repair separation berm.
Flood Control Facility	5 AC-FT	$4,180	Inspect and clean inlet and outlet, maintain vegetation, inspect sediment loading, remove sediment, remove debris, inspect and repair separation berm.
Stormwater Marsh/Wetland	5 AC	$2,880	Inspect and clean inlet and outlet, inspect & maintain vegetation, remove debris.
Vegetated Swale	500 LF	$3,560	Inspect and clean inlet and outlet, remove debris, remove sediment, maintain vegetation.
Infiltration Trench	500 LF	$2,350	Inspect and clean inlet, remove debris, remove sediment.
Water Quality Structures	1 EA	$1,020	Inspect and remove debris and sediment from structures.
Natural Resource Enhancement	5 AC	$560	Inspect vegetation, remove debris.
Natural Resource Revegetation	5 AC	$880	Inspect vegetation, remove debris.
Recreational Trail	1,000 LF	$2,000	Inspect trail, remove debris and maintain vegetation.

Note: Maintenance costs presented in this table are planning level estimates and are based on information provided by the Unified Sewerage Agency of Washington County. They are representative of average facilities maintained under typical conditions. Each facility will vary depending on site conditions and the size of the facility.

Reference:
Table 8 is a summary of data presented in Table 9.

STORMWATER FACILITIES
ESTIMATED ANNUAL MAINTENANCE COSTS
Calculation Table 9

	Frequency Times/Year	Effort/Time Lb-Hr	$ @ $40/hr	Hours	Equip./Time $/hr Rate	$ Total	Comments
Trash Rack Inlet (Type 1 & 2)							
Emergency Response	10	1	$ 400.00	0	$ -	$ -	
Inspect & Clean Inlet/Outlet	4	4	$ 640.00	2	$ 150.00	$ 1,200.00	Vactor Truck & Operator
Routine Repair			$ -		$ -	$ -	
Maintain Vegetation	4	2	$ 320.00	2	$ 10.00	$ 80.00	Mower, Weedeater, Etc.
Disposal Costs	4		$ 40.00		$ -	$ -	
Subtotals			*$ 1,400.00*			*$ 1,280.00*	
Total Estimate Annual Maintenance				***$ 2,680.00***			
Open Channel (Type 1 & 2)							
Inspect Vegetation & Sediment Loading	2	1	$ 80.00	0	$ -	$ -	
Maintain Vegetation			$ -		$ -	$ -	
Remove Debris/Garbage	4	2	$ 320.00	0	$ -	$ -	
Remove Sediment	1	8	$ 320.00	4	$ 300.00	$ 1,200.00	Tractor Shovel, 10 CY Dump & Operators
Disposal Costs	1		$ 800.00		$ -	$ -	Assumes 10 CY/Year
Inspect Slopes	2	1	$ 80.00	0	$ -	$ -	
Repair Slopes (On Going Activity)			$ 500.00	0	$ -	$ -	Annual Misc. Cost
Subtotals			*$ 2,100.00*			*$ 1,200.00*	
Total Estimate Annual Maintenance				***$ 3,300.00***			
Dry Extended Pond							
Inspect & Clean Inlet/Outlet	4	4	$ 640.00	2	$ 150.00	$ 1,200.00	Vactor Truck & Operator
Inspect Vegetation	2	1	$ 80.00	0	$ -	$ -	
Remove Debris/Garbage	4	2	$ 320.00	0	$ -	$ -	
Maintain Vegetation	4	4	$ 640.00	4	$ 10.00	$ 160.00	Mower, Weedeater, Etc.
Inspect Sediment Loading	2	1	$ 80.00	0	$ -	$ -	
Remove Sediment	0.5	12	$ 240.00	6	$ 300.00	$ 900.00	Tractor Shovel, 10 CY Dump & Operators
Disposal Costs	0.5		$ 800.00		$ -	$ -	Assumes 10 CY Every Two Years
Inspect slopes	2	1	$ 80.00	0	$ -	$ -	
Repair Slopes (On Going Activity)			$ 500.00		$ -	$ -	Annual Misc. Cost
Subtotals			*$ 3,380.00*			*$ 2,260.00*	
Total Estimate Annual Maintenance				***$ 5,640.00***			
Wet Extended Pond							
Inspect & Clean Inlet/Outlet	4	4	$ 640.00	2	$ 150.00	$ 1,200.00	Vactor Truck & Operator
Inspect Vegetation	2	1	$ 80.00	0	$ -	$ -	
Remove Debris/Garbage	4	2	$ 320.00	0	$ -	$ -	
Maintain Vegetation	4	4	$ 640.00	4	$ 10.00	$ 160.00	Mower, Weedeater, Etc.
Inspect Sediment Loading	2	1	$ 80.00	0	$ -	$ -	
Remove Sediment	0.5	12	$ 240.00	6	$ 300.00	$ 900.00	Tractor Shovel, 10 CY Dump & Operators
Disposal Costs	0.5		$ 400.00		$ -	$ -	Assumes 10 CY Every TwoYears
Inspect slopes	2	1	$ 80.00	0	$ -	$ -	
Repair Slopes			$ 500.00		$ -	$ -	Annual Misc. Cost
Subtotals			*$ 2,980.00*			*$ 2,260.00*	
Total Estimate Annual Maintenance				***$ 5,240.00***			
Flood Control Facility							
Inspect & Clean Inlet/Outlet	4	2	$ 320.00	2	$ 150.00	$ 1,200.00	Vactor Truck & Operator
Inspect Vegetation	2	1	$ 80.00	0	$ -	$ -	
Remove Debris/Garbage	4	1	$ 160.00	0	$ -	$ -	
Maintain Vegetation	4	4	$ 640.00	4	$ 10.00	$ 160.00	Mower, Weedeater, Etc.
Inspect Sediment Loading	2	1	$ 80.00	0	$ -	$ -	
Remove Sediment	0.5	8	$ 160.00	4	$ 300.00	$ 600.00	Tractor Shovel, 10 CY Dump & Operators
Disposal Costs	0.5		$ 200.00			$ -	Assumes 5 CY Every two Years
Inspect slopes	2	1	$ 80.00	0	$ -	$ -	
Slope Repair (On Going Activity)			$ 500.00		$ -	$ -	Annual Misc. Cost
Subtotals			*$ 2,220.00*			*$ 1,960.00*	
Total Estimate Annual Maintenance				***$ 4,180.00***			
Stormwater Marsh/Wetland							
Inspect & Clean Inlet/Outlet	4	4	$ 640.00	2	$ 150.00	$ 1,200.00	Vactor Truck & Operator
Inspect Vegetation	2	1	$ 80.00	0	$ -	$ -	
Remove Debris/Garbage	2	2	$ 160.00	0	$ -	$ -	
Maintain Vegetation	4	4	$ 640.00	4	$ 10.00	$ 160.00	Mower, Weedeater, Etc.
Subtotals			*$ 1,520.00*			*$ 1,360.00*	
Total Estimate Annual Maintenance				***$ 2,880.00***			
Vegetated Swale							
Inspect & Clean Inlet/Outlet	4	2	$ 320.00	1	$ 150.00	$ 600.00	Vactor Truck & Operator
Remove Debris/Garbage	2	2	$ 160.00	0	$ -	$ -	
Maintain Vegetation	4	4	$ 640.00	4	$ 10.00	$ 160.00	Mower, Weedeater, Etc.
Inspect Sediment Loading	2	1	$ 80.00	0	$ -	$ -	
Remove Sediment/Regrade	1	8	$ 320.00	4	$ 300.00	$ 1,200.00	Tractor Shovel, 10 CY Dump & Operators
Disposal Costs	1		$ 80.00		$ -	$ -	Assumes 2 CY Per Year
Subtotals			*$ 1,600.00*			*$ 1,960.00*	
Total Estimate Annual Maintenance				***$ 3,560.00***			

	Frequency Times/Year	Effort/Time Lb-Hr	$ @ $40/hr	Equip./Time Hours	$/hr Rate	$ Total	Comments
Infiltration Trench							
Inspect & Clean Inlet/Outlet	4	4	$ 640.00	2	$ 150.00	$ 1,200.00	Vactor Truck & Operator
Remove Debris/Garbage	2	2	$ 160.00	0	$ -	$ -	
Inspect Sediment Loading	2	2	$ 160.00	0	$ -	$ -	
Remove Sediment	0.3	8	$ 96.00	4	$ 75.00	$ 90.00	Water Truck (Flush lines) & Operator
Disposal Costs	0.3		$ 25.00		$ -	$ -	Assumes 2 CY Every Three Years
Subtotals			*$ 1,056.00*			*$ 1,290.00*	
Total Estimate Annual Maintenance				***$ 2,346.00***			
Water Quality Structures							
Remove Debris/Garbage	2	2	$ 160.00	0	$ -	$ -	
Inspect Sediment Loading	2	2	$ 160.00	0	$ -	$ -	
Remove Sediment	0.3	8	$ 96.00	4	$ 150.00	$ 600.00	Vactor Truck & Operator
Disposal Costs	4		$ 240.00		$ -	$ -	Assumes 3 CY a Year
Subtotals			*$ 416.00*			*$ 600.00*	
Total Estimate Annual Maintenance				***$ 1,016.00***			
Natural Resource Enhancement							
Inspect Vegetation	1	1	$ 40.00	0	$ -	$ -	
Routine Repair			$ 200.00		$ -	$ -	Annual Misc. Cost
Remove Debris/Garbage	2	4	$ 320.00	0	$ -	$ -	
Subtotals			*$ 560.00*			*$ -*	
Total Estimate Annual Maintenance				***$ 560.00***			
Natural Resource Revegetation							
Inspect Vegetation	2	2	$ 160.00	0	$ -	$ -	
Routine Repair			$ 400.00		$ -	$ -	Annual Misc. Cost
Remove Debris/Garbage	2	4	$ 320.00	0	$ -	$ -	
Subtotals			*$ 880.00*			*$ -*	
Total Estimate Annual Maintenance				***$ 880.00***			
Recreational Trail							
Inspect Vegetation	2	2	$ 160.00	0	$ -	$ -	
Remove Debris/Garbage	4	4	$ 640.00	0	$ -	$ -	
Maintain Vegetation	2	12	$ 960.00	12	$ 10.00	$ 240.00	Mower, Weedeater, Etc.
Subtotals			*$ 1,760.00*			*$ 240.00*	
Total Estimate Annual Maintenance				***$ 2,000.00***			

Note: Labor rate of $40/hr is based information provided by the Unified Sewerage Agency of Washington County. Labor for maintenance activities is assumed to be City maintenance staff averaged for maintenance and supervisor effort. Effort shown includes travel time and office documentation time.

Reference:
Table 9 information is summarized in Table 8.

November 1, 2001

Addendum to Natural Resource Enhancement and Open Waterway Improvement Construction Unit Costs

As requested by the City, URS has reviewed and recommended revisions to the construction activity/material unit costs developed for the Storm Drainage Master Planning project for open channel improvements (Types 1 and 2), natural resource enhancement, and natural resource revegetation. The distinction between these project types for basin planning was as follows:

- Open channel improvements (Type 1) – Modify existing channels. Construction activities and materials included traffic control, excavation (0 to 10 foot bottom width, 4 to 6 foot depth, 3:1 side slopes), hydroseed, and erosion protection at inlets and outlets.
- Open channel improvements (Type 2) – Modify existing channels. Construction activities and materials included the same elements as for Type 1 except channel excavation was increased to a 10 to 20 foot bottom width and 6 to 10 foot depth.
- Natural resource enhancement – Plant additional vegetation.
- Natural resource revegetation – Remove invasive vegetation, grade and revegetate.

For each of these project types, overall unit costs were developed based on unit costs for construction activities and materials including: traffic control, general excavation, hydroseeding, trees and shrubs, riprap, and erosion control. In this letter, we revised our unit costs for the project construction activities and materials based on a review of bid tabulations from two recently completed enhancement projects in Eugene (i.e., the 1135 and ACE projects), the Longfellow Creek Habitat Improvement Project in Seattle, Washington, the Oregon Department of Transportation Historical Bid Price Listings, and the RS Means 2000 Heavy Construction Cost Data book. This letter report includes a description of how the specific construction activities/materials unit costs were revised, a discussion of how recommended unit costs were identified, a recommended new unit cost for natural resource enhancement, and a recommendation for computing construction costs for open waterway improvements.

Unit Costs Compiled from Other Projects/Sources

Table 1 presents the unit costs from the above mentioned projects and sources for each of the appropriate construction activities/materials. Clearing and grubbing, and grading were added to the list of construction activities and materials because it is likely that with most natural resource enhancement projects some clearing and grubbing of invasive vegetation or dead trees will be necessary and that regrading of the top soil will also be necessary. The range of unit costs, which can be compared with the existing basin planning unit costs, is provided in Table 1. From this range, we developed new recommended unit costs to be used for the construction activities/materials elements of the project types. For those elements that had unit costs from more than two projects/sources (i.e., general excavation, hydroseeding, trees, shrubs, and riprap) the average of the unit costs was recommended. For elements that had only two sources (i.e., clearing and grubbing, grading, and erosion control), the numbers were compared with the existing basin planning costs and an average was taken of all three. The recommended unit costs (rounded up to the nearest dollar) are presented in Table 1.

Natural Resource Enhancement

The natural resource enhancement and natural resource revegetation project types were combined into one type of improvement "natural resource enhancement". For earlier basin planning, natural resource enhancement included planting of trees/shrubs only, while natural resource revegetation included general excavation, hydroseeding, planting trees/shrubs, and erosion control. During this review it was determined that it would be unlikely that a capital project would include only tree/shrub planting, and that if the natural resources of an area were designated to be enhanced, that enhancement would likely include some clearing and grubbing, grading, hydroseeding, planting trees/shrubs and erosion control. Clearing and grubbing, and grading were added because it is likely that with most natural resource enhancement projects some clearing and grubbing of invasive vegetation or dead trees would be necessary and that regrading of the top soil would also be necessary. For a strictly natural resource enhancement project (i.e., no channel modifications) it is unlikely that much excavation would be necessary, therefore excavation was removed from the cost estimate. The construction activities/materials that comprise natural resource enhancement now include clearing and grubbing, grading, hydroseeding, planting trees/shrubs, and erosion control.

The original basin planning costs for natural resource enhancement and natural resource revegetation were $10/square yard (SY) and $49/SY respectively. After combining the two types of projects into one type, natural resource enhancement, the new recommended unit cost is $13/SY, as presented in the table below.

Natural Resource Enhancement Unit Cost

Construction Activity/Material	Units	Unit Costs	Units	Unit Costs	Comments
Clearing and Grubbing	AC	$4,300	SY	$0.90	
Grading	CY	$5	SY	$5	Assume a maximum depth of 1 foot to be regraded.
Hydroseed	AC	$3,200	SY	$0.66	
Trees/Shrubs	EA	$120/$36	SY	$6	Assume trees planted at 20-foot spacing on-center (O.C.) and shrubs planted at 10 feet O.C.
Erosion Control	AC	$3,800	SY	$0.62	
Total for Natural Resource Enhancement			**SY**	**$13**	

Although the construction activity and material unit costs for clearing and grubbing, hydroseed and erosion control increased, they are being applied on a square yard basis. Therefore, these increases did not have much impact on the unit cost for natural resource enhancement. The greatest factor that led to the decrease in the unit cost for natural resource enhancement is the modification to the quantity of trees/shrubs per square yard. In the calculations for the basin planning costs, the quantity of trees/shrubs was 0.5 each per SY, which corresponds to a tree/shrub planted approximately every 4 feet O.C. During this review, it was determined that a more appropriate spacing for shrubs would be every 8 feet O.C. and every 20 feet O.C. for trees. For example, on a 100 foot long, 25 foot wide buffer the revised spacing would allow for planting of either 12 trees at a unit cost of $120/tree or 52 shrubs at a unit cost of $36/shrub, while the original basin planning allowed approximately 139 trees/shrubs to be planted. On a

square yard basis, the basin planning costs for trees/shrubs as part of natural resource enhancement were approximately $25/SY, while the recommended unit costs would be approximately $6/SY for either trees or shrubs. Another significant factor in the decrease of the natural resource enhancement unit cost was the quantity of erosion control per SY in the basin planning quantity tables. The basin planning quantity tables indicated that 0.008 acres (38.7 SY) of erosion control would be applied every SY. It appears that this quantity was an error and that the correct quantity for erosion control per SY would be 0.0002 AC (1 SY) per SY.

Open Waterway Improvements

Before this review, open channel improvements were divided into two different types (i.e., Type 1 and Type 2). Both the Type 1 and Type 2 improvements included traffic control, excavation, hydroseeding, trees and shrubs, riprap, and erosion control. The estimated construction costs per unit were based on lineal feet. During this review, it was determined that there was a need to determine quantities for each open waterway improvement project specifically, rather than rely on general quantities for the various construction activities/materials. The quantities that are input into the cost tables have a significant impact on the overall cost of open waterway improvements. The quantity of excavation, the area to be hydroseeded and the area disturbed for which erosion control would be needed vary greatly between projects. Therefore, we are not recommending a general construction unit cost for open waterway improvements. We are recommending that each project be evaluated individually and that costs are developed based on the recommended unit costs for construction activities and materials provided in Table 1. In addition, if each open waterway improvement project is evaluated individually there is no longer a need for two different types of improvements. Therefore, we recommend that these improvements be combined into one category.

APPENDIX H

EUGENE DEVELOPMENT STANDARDS DRAFT DEVELOPMENT STANDARDS FACT SHEETS FOR WATER QUALITY STANDARDS #1 AND #3, AND FLOOD CONTROL STANDARDS #1 AND #2

EUGENE DEVELOPMENT STANDARDS
Draft Development Standards Fact Sheets for
Water Quality Standards #1 and #3,
and Flood Control Standards #1 and #2
March 1999

1.0 INTRODUCTION

This section of the binder includes draft development standard fact sheets for the following development standard options as described in Memo #3 (Selection of Potential Development Standards for Further Evaluation, 12/98):

Water Quality Standard #1 - Treat 80% of the Site Runoff Volume,
Water Quality Standard #3 – Specific BMPs are Required for Specific Land Uses
Flood Control Standard #1 - Maintain Pre-development Peak Flow Rates
Flood Control Standard #2 – Peak Flows Not to Exceed Conveyance System Capacity

The fact sheets were originally prepared based on 1994 land use data. However, LCOG recently provided updated information regarding vacant lands (1998 data). Rather than reconducting the evaluations (i.e., loads modeling) necessary to prepare the fact sheets, the information in the fact sheets was adjusted using a simpler method to account for the updated vacant lands information. In other words, the estimate of effectiveness in terms of TSS load reductions was adjusted based on the percentage change in vacant area from 1994 to 1998.

For the most part, the information in the fact sheets is comprehensive. However, in order to keep the fact sheets as brief as possible, a description of the detailed methods used to complete some of the technical analyses were not included in the fact sheets themselves. The following sections (Sections 2.0 and 3.0) provide the detailed information regarding the methods that were used for calculating technical information in the fact sheets for Water Quality Standard #1 and Flood Control Standards #1 and #2. Section 4.0 provides a summary of the evaluation results for all of the standards listed above.

2.0 METHODS FOR PREPARING A FACT SHEET FOR WATER QUALITY DEVELOPMENT STANDARD #1

Water Quality Development Standard #1 would required developers to treat 80% of their site runoff volume. A Water Quality Development Standard #1 fact sheet was prepared for the Amazon, Bethel-Danebo, Glenwood, Willakenzie, Willamette River, and Willow Creek basins. The purpose of the fact sheet is to show if this water quality standard is applied to the remaining vacant areas, what the effectiveness and cost of implementation will be. The standard was applied to areas within the urban growth boundary (UGB) for the Amazon, Bethel-Danebo, Glenwood, Willakenzie, and Willamette River basins and to the total basin

area which includes the UGB and the urban reserve boundary for the Willow Creek basin. Table 1 in the fact sheet for Water Quality Standard #1 shows estimated results if the standard is applied to vacant areas based on 1998 land use data. The standards were not applied to vacant residential parcels less than ½ acre if they were recently approved for development or to vacant areas where stormwater systems were recently extended.

The method for compiling the fact sheet and the sources of information are provided below.

Step 1- Estimate Future Stormwater Quality Conditions in Eugene's Drainage Basins if Water Quality Standards are Not Implemented:
The first step in developing the fact sheet for Water Quality Standard #1 was to estimate stormwater quality conditions under future land use conditions if standards are not implemented. Although several pollutants of concern have been identified in Eugene's stormwater runoff, many of these pollutants are associated with sediments. To simplify the description of stormwater quality conditions in Eugene, sediments (in the form of total suspended sediments or TSS) were used to represent pollutants of concern. Future stormwater quality conditions without the development standard in place, are represented by future TSS loads in stormwater. In the fact sheet, Table 1, these TSS loads were obtained from Stormwater Standards Memo #1 (City of Eugene 1998) and are provided for each basin (see column 5 of Tables 1 and 2). For the Willow Creek basin, the future TSS load estimate is based on development of the urban reserves.

Step 2- Identify Vacant Areas in Each Basin Where Water Quality Standard #1 Could Potentially be Applied:
For Table 1, the basins' vacant areas were extracted from updated 1998 land use information provided by LCOG and included in column 3. These refined vacant areas represent the 1998 vacant lands with the exception of vacant residential parcels less than ½ acre and vacant areas where stormwater systems were recently extended.

Step 3- Estimate the Expected Effectiveness of Water Quality Standard #1:
For each basin, the portion of the total future TSS load expected as a result of future development was extracted from Stormwater Standards Memo #1 (City of Eugene 1998). To calculate the expected TSS removal due to the application of the standard, this future portion of the TSS load was multiplied by 0.48 to account for the standard treating 80% of the runoff from future development using best management practices that are approximately 60% efficient. For the Willow Creek basin, the portion of TSS load expected from future development is based on development of the urban reserves. For Table 1, these 1994 numbers were reduced by the same percentage that the vacant land areas were reduced from 1994 to 1998 and are provided in column 6.

Step 4- Estimate the Expected Cost Per Acre of Implementing Water Quality Standard #1:
To estimate the capital and maintenance costs of implementing this standard, three example sites from the City of Gresham were used (commercial development, residential

development, and a Planned Unit Development (PUD)). Each site was designed using a traditional piped storm drainage system without on-site water quality facilities and then re-designed based on implementation of this water quality standard. The difference in cost between the two methods was then determined. For the commercial development, there was a savings in implementing the water quality standard due to the fact that vegetated swales were used in place of pipes. For the other two example sites, implementation of this standard resulted in an increase in development costs. These numbers are provided in columns 8 and 9 of Table 1. These estimated costs do not include costs associated with land consumption or costs incurred by the City to administer the program.

3.0 METHODS FOR PREPARING FLOOD CONTROL FACT SHEETS

Storage volume requirements in both of the flood control fact sheets are based on SWMM model results of the storm drainage system for each basin. During the calibration and verification phase of developing the SWMM models, our goal was to produce models that are well calibrated to peak flows as well as runoff volumes. Although every effort was made during the calibrations to match the shapes of the measured hydrographs with the modeled hydrographs, the models were not explicitly calibrated to only volumes. Therefore, the storage volumes provided in the fact sheets represent planning level estimates which should only be used to compare Flood Control Development Standard #1 with Flood Control Development Standard #2 and to compare both flood control standards with the capital project alternatives.

3.1 Flood Control Development Standard #1

This development standard would require developers to ensure that post-development peak flow rates do not exceed pre-development peak flow rates through the use of flood control measures. Typical flood control measures include; detention ponds, underground vaults, infiltration trenches/basins, drywells, reduced impervious areas, and/or disconnected impervious areas upstream of the problem.

This evaluation was conducted in order to estimate the required storage volumes and cost implications of applying this standard in the City of Eugene. The methods used for conducting this evaluation were as follows:

Step 1-Determine the Areas of Application:
This standard was only applied to vacant land upstream of flooding problems that are expected to occur only as a result of future development. In order to estimate the extent of these vacant acres, the 1994 GIS information for the sub-basins was used. The 1994 GIS data provided the total acreage as well as the existing and future imperviousness for each sub-basin but did not provide a quantification of vacant and developed areas. Therefore, in order to estimate the vacant acres of a sub-basin, it was assumed future development would have the same impervious characteristics as the existing development in the sub-basin. Based on this assumption, the vacant land in a sub-basin was estimated using the following formula:

$$\left[1 - \frac{\text{Existing Impervious \%}}{\text{Future Impervious \%}}\right] \times \text{Total Acres} = \text{Vacant Acres}$$

For each basin, the vacant areas upstream of future flooding problems were totaled. These estimated vacant areas are provided in column 6 of the fact sheet for Flood Control Standard #1.

Step 2-Determine the Peak Flows Under Existing Conditions for Areas Upstream of Future Flooding Problems:
For the sub-basins upstream of future flooding problems, the hydrology component (the RUNOFF block)of the SWMM model was run using just the vacant acres calculated in Step 1. Impervious percentages were set to zero and a hydrograph was generated for the design storm under which the future problems were identified. From these hydrographs, the existing peak runoff rate from vacant areas was estimated.

Step 3-Determine the Peak Flows Under Future Conditions for Areas Upstream of Future Flooding Problems:
The hydrology component (the RUNOFF block) of the SWMM model with just the vacant areas was re-run using the future impervious percentages assigned to each sub-basin. A hydrograph was generated for the vacant areas for each sub-basin under future impervious conditions.

Step 4-Estimate Storage Volumes Required to Ensure Post-Development Peak Flows do not Exceed Pre-Development Peak Flows:
The total volume of runoff generated by future flows greater than the existing peak flow was calculated. This calculation was made by determining the area under the curve of the future hydrograph that was above the existing peak flow rate. Figure 1 shows an example hydrograph for the 25-yr storm for the Willow Creek Basin. The circled area indicates the storage volume required for this sub-basin using this method. The storage volumes calculated for all of the sub-basins upstream of future problems were then summed to estimate the total storage volume required for the basin. This total storage volume was divided by the number of vacant acres to determine the storage required per acre. Column 7 of the table in the Fact Sheet for Flood Control Standard #1 provides the storage volume per acre for each of the basins. The surface area required for this storage volume was also calculated based on the assumption that all storage facilities would be an average of 3 feet deep. These surface areas per acre are provided in Column 8 of the table in the Fact Sheet for Flood Control Standard #1.

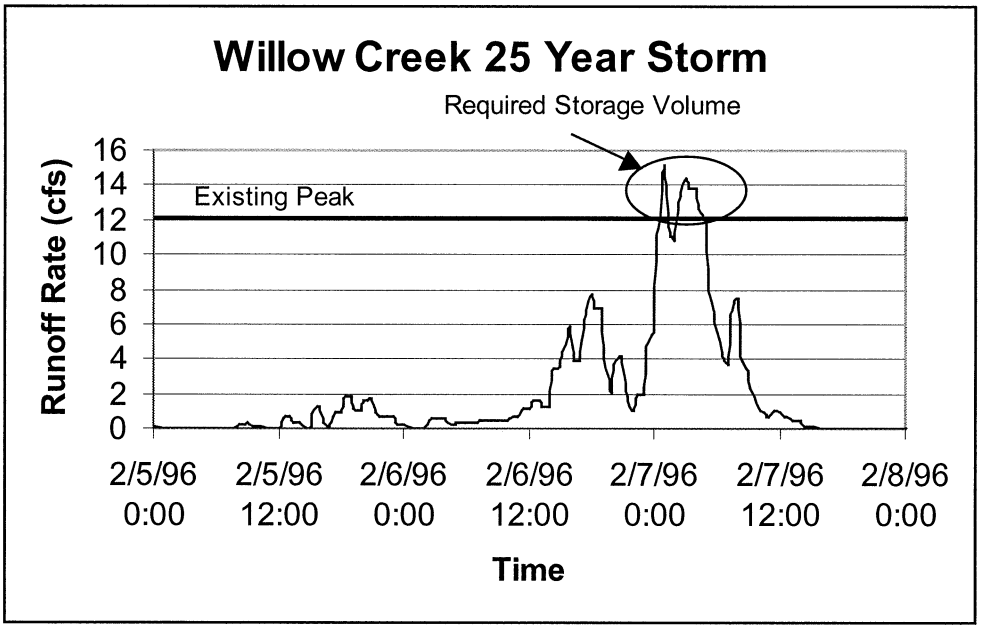
Step 5-Estimate the Costs of Implementing the Development Standard:
The costs of implementing the development standard were calculated based on the costs of constructing and maintaining detention basins of sufficient capacity to store the volume of

runoff that was required for each of the basins. The total required storage volume (in acre-ft) was multiplied by a unit cost (per acre-ft) for storage volume and for maintenance. These costs were obtained from the Capital Project Unit Cost Tables dated 1/29/99. The following unit costs were used for estimating the costs of the required storage facilities:

- Construction Costs $51,930 per Acre-ft
- Maintenance Costs $ 5,640 per Acre-ft

Once the total costs were estimated they were divided by the number of vacant acres to determine an estimated capital and maintenance cost per acre. These costs are provided in columns 10 and 11 of the summary table in the Fact Sheet for Flood Control Standard #1. These costs do not include land acquisition costs or costs incurred by the City to administer the program.

Figure 1: Example



3.2 Flood Control Development Standard #2

This development standard would require developers to ensure that post-development peak flow rates do not exceed the design capacity of the stormwater conveyance system through the use of flood control measures in any new development. Typical flood control measures include; detention ponds, underground vaults, infiltration trenches/basins, drywells, reduced impervious areas, and/or disconnected impervious areas upstream of the problem.

This evaluation was conducted in order to estimate the required storage volumes and cost implications of applying this standard in the City of Eugene. The methods used for conducting this evaluation were as follows:

Step 1-Determine Future Flow Volumes in Excess of System:
The hydraulic component of SWMM (the EXTRAN block) was set up so that any runoff in excess of the capacity of the system that was a result of future development was diverted out of the main conveyance system. This was done in order to be able to quantify the storage volume needed to store these flows. In order to accomplish this using the SWMM model, a diversion conduit was placed at the upstream, down stream, or both end(s) of the future problem segment. The invert of the diversion was placed just above the obvert of the problem conduit. Therefore, flows in excess of the system capacity would discharge through the diversion conduits. These excess flows were then totaled for each basin.

Step 2-Determine the Volume of Runoff that Existing Problems Contribute to Future Problems:
Flooding problems were defined when runoff got out of the conveyance system and into the roadway. Surcharging was not defined as a flooding problem. In conducting this evaluation as described in Step 1, in addition to future excess flows, runoff volumes associated with surcharging under existing conditions would be discharged through the diversion channels. To ensure that existing flows were not counted as part of the future required storage volumes, Step 1 was also conducted for existing conditions. This allowed for the quantification of the portion of the excess flows that was associated with existing as opposed to future conditions.

Step 3-Calculate the Volume of Runoff in Excess of System Capacity Contributed by Future Development:
The volume of runoff in excess of the system capacity that was wholly a result of future development was calculated as the difference between the volumes estimated in Steps 1 and 2. These volumes were then divided by the vacant areas (column 6 in Table 1 of the Fact Sheet) to estimate the storage volume required per acre. The storage volume required per acre is provided in column 7 of Table 1 in the Fact Sheet for Flood Control Standard #2. The surface area required for this storage volume was also calculated based on the assumption that all storage facilities would be an average of 3 feet deep. These surface areas per acre are provided in Column 8 of the table in the Fact Sheet for Flood Control Standard #1.

Step 4-Estimate the Costs of Implementing the Development Standard:
The costs of implementing the development standard were calculated based on the costs of constructing and maintaining detention basins of sufficient capacity to store the volume of runoff that was required for each of the basins. The total required storage volume (in acre-ft) was multiplied by a unit cost (per acre-ft) for storage volume and for maintenance. These costs were obtained from the Capital Project Unit Cost Tables dated 1/29/99. The following multipliers were used for estimating the costs of the required storage facilities:

- Construction Costs $51,930 per Acre-ft
- Maintenance Costs $ 5,640 per Acre-ft

Once the total costs were estimated they were divided by the number of vacant acres to determine an estimated capital and maintenance cost per acre. These costs are provided in columns 10 and 11 of the summary table in the Fact Sheet for Flood Control Standard #2. These costs do not include land acquisition costs or costs incurred by the City to administer the program.

4.0 SUMMARY

4.1 Water Quality Standard #1

The percentage of the 1998 total basin TSS load that is expected to be removed from stormwater discharges as a result of the Water Quality Standard #1 ranged from 3% in the Willamette River Basin to 14% in the Willow Creek basin. On a city-wide basis, approximately 6% of the 1998 total basin TSS load is expected to be removed as a result of the Water Quality Standard #1. The effect on capital costs associated with the on-site stormwater drainage system will vary depending upon site-specific conditions. Our range in costs estimated for the implementation of this standard is based on three example sites from the City of Gresham. Using these three sites, the cost of constructing a traditional piped storm drainage system without on-site water quality facilities was compared to the cost of constructing a drainage system necessary to implement this standard. In some cases, savings of capital costs may be realized if, for example, vegetated swales can be used for conveyance as well as water quality treatment instead of traditional storm drainage pipes. In other cases, where space is limited, capital costs to include on-site water quality BMPs will likely be higher than a traditional piped storm drainage system. The cost differences ranged from a savings of $8,700 per acre to an increased cost of $12,300 per acre.

4.2 Water Quality Standard #3

In December, 1998, the City of Eugene reviewed and selected development standard options for further evaluation (see Development Standards Memorandum #3). For each of the development standard options one of the following three determinations was made: 1) carry the standard forward for further evaluation, 2) drop the standard from the menu of options, or 3) conduct a reduced evaluation of the standard in order to carry the standard forward for potential further evaluation in the future. For Water Quality Standard #3 (Specific BMPs Are Required for Specific Site Uses), the decision was made to summarize the standard in more detail for potential future consideration. Therefore, a brief description of this standard is summarized in the fact sheet for Water Quality Standard #3. The fact sheet describes the types of site uses that could potentially warrant the application of additional BMPs. It also describes the types of BMPs that would be warranted such as maintenance activities, housekeeping practices, and structural controls. The fact sheet also describes options for administering the implementation

of this standard. Information on estimated effectiveness or costs of implementing the standard are not provided but should be evaluated in further detail when or if the City decides to consider the implementation of this standard.

4.3 Flood Control Standards #1 and #2

Both Flood Control Standards #1 and #2 would be expected to eliminate all of the flooding problems that are expected to occur as a result of future development. City-wide, the cost of implementing Flood Control Standard #1 (maintain pre-development peak flow rates) was approximately $1,600 per acre, and Flood Control Standard #2 (peak flows not to exceed conveyance system capacity) was approximately half that at $800 per acre. The maintenance cost was estimated to be approximately $170 per acre for Flood Control Standard #1 and $90 per acre for Flood Control Standard #2. Although the cost of implementing Flood Control Standard #2 is less than for Flood Control Standard #1, it would likely be more expensive for the City to administer this standard since the allowable peak discharge rate per acre would have to be determined for several unique drainage areas throughout the City.

As part of the basin planning portion of this project, existing flooding problems have been identified. As mentioned in the fact sheets, we have assumed that these existing flooding problems are anticipated to occur regardless of future development and would be eliminated by constructing capital projects (e.g., increasing pipe sizes). However, future development will increase the severity of these flooding problems. If either flood control standard were also applied in vacant areas upstream of existing problems, the costs of capital projects to eliminate the existing flooding problems may be reduced since the projects will not have to also accommodate an increase in peak flows due to future development.

DRAFT FACT SHEET 03/10/99
Flood Control Development Standard #1
"Maintain Pre-Development Peak Flow Rates"

CITY-WIDE
(Does not include the Santa Clara/River Road basin)

Purpose: The purpose of this standard is to prevent, through "on-site" requirements for runoff control, the storm system capacity problems that are predicted to occur solely as a result of future development.

Description of Standard: This standard is applied in areas upstream of drainage segments that are expected to have capacity problems as a result of future development only. The standard requires developers in these areas to limit their post-development peak rate of runoff to pre-development levels for the design storm of concern (e.g., the 10-year or 25-year storm). For example, if a pipe segment in the downstream portion of a basin is expected to flood under future development conditions for a 25-year storm, developers upstream of this segment would be required to limit their post-development peak runoff rate for the 25-year storm to the pre-development peak runoff rate

Statement of Basin Conditions: Approximately 22% of the identified flooding problems in the City are expected solely as a result of future development (i.e., 33 of the 152 identified deficient segments are expected to occur solely as a result of future development conditions). These 33 deficient segments represent approximately 10,165 lineal feet of pipe and 4,938 lineal feet of open waterway.

Potential Implementing Best Management Practices (BMPs): In order to limit the post-development peak runoff rates, BMPs that include storage or infiltration of stormwater runoff are required. These could include one or more of the following: detention ponds, underground vaults, infiltration trenches/basins, drywells, reduced impervious areas, and/or disconnected impervious areas.

How the Standard was Applied for Analysis: This standard was analyzed by applying it to all vacant land upstream of expected future only flooding problems based on 1994 land use data. As shown in Table 1, the standard was therefore applied to a total of 3,228 vacant acres. Although existing flooding problems are anticipated to occur regardless of future development, future development will also exacerbate these problems. For this evaluation, the flood control standard was not applied to vacant areas solely for the purpose of preventing the worsening of existing capacity problems. This was based on the following assumptions: the City would construct flood control capital projects (CPs) to address the existing problems, the CPs would be designed based on future development conditions, and SDCs would be charged to developers for their portion of the CP. As shown in Table 1, the amount of vacant area that was not included in the evaluation, but where standards could be applied to prevent the worsening of existing capacity problems is approximately 975 acres.

DRAFT FACT SHEET 03/10/99
Flood Control Development Standard #1
"Maintain Pre-Development Peak Flow Rates"
CITY-WIDE

Measure of Effectiveness: Based on the 1994 data, the identified future flooding problems in 33 segments would be expected to be eliminated (i.e., 22% of all identified flooding problems) as a result of the implementation of this standard. As stated above, these segments represent approximately 10,165 lineal feet of pipe system and 4,938 lineal feet of open waterway system. However, based on a 1998 update of land use data, 32% of the vacant area City-wide has been developed since 1994 (see column 4 of Table 1). Therefore, the effectiveness of the flood control standard as described in this fact sheet may be reduced as it would only be applied to approximately 2,066 out of the 3,228 vacant acres evaluated City-wide.

Cost to Implement: The estimated cost for developers to implement this standard City-wide is $5,100,000; the estimated average cost per acre is $1,600. However, in some cases developers could reduce this cost by using site planning techniques that would reduce their need for storage volume and piping.

Maintenance Cost to Implement: The estimated cost for developers to maintain BMPs that are implemented to comply with the standard City-wide is $554,000; the estimated average annual maintenance cost per acre is $170.

Interpretation of Results: The average storage volume required per acre ranged from 480 ft^3 for the Willow Creek basin to 5,520 ft^3 for the Willakenzie basin. It appears that these differences are likely due to soil infiltration rates in the basins. For example, the Willow Creek basin has some of the lowest soil infiltration rates in the City. Therefore, the difference in runoff rates between pre-development conditions (i.e., relatively impervious soils) and post-development conditions (i.e., impervious surfaces) will be relatively low. Willakenzie has some of the highest soil infiltration rates in the City. Therefore, the difference in runoff rates between pre-development conditions (i.e., very pervious soils) and post-development conditions (i.e., impervious surfaces) will be relatively high. However, if the developers could take advantage of the higher soil infiltration rates, storage volume costs would be reduced.

Other Considerations:

- As the storage volume requirements are based on model estimates, and assumptions regarding site conditions, many jurisdictions apply a factor of safety when implementing this type of standard. In addition, most consider that with a number of on-site facilities in place, some portion of the facilities may not be functioning properly at any given time. Therefore, some jurisdictions require developers to add up to +20% to their storage volume calculations. A factor of safety was not included in this evaluation. However, it would result in increased storage volume requirements and costs to the developer.

- This evaluation considers the development of vacant lands and does not take into account the effects of re-development. Re-development to greater densities could also add to existing and future capacity problems.

DRAFT FACT SHEET 03/10/99
Flood Control Development Standard #1
"Maintain Pre-Development Peak Flow Rates"
CITY-WIDE

Table 1
Summary of Evaluation:

Flood Control Standard Method #1	Total Basin Area	1994 Total Vacant Area (% of Total)	1998 Total Vacant Area (% of Total)	Vacant Area Not Addressed in the Evaluation where standards could potentially be applied to prevent further exacerbation of existing flooding problems.	Vacant Area Addressed in the Evaluation (i.e., vacant areas upstream of expected future flooding problems)	Average Storage Volume Required Per Acre (ft^3)	Average Surface Area Per Acre Required for Storage** (ft^2)	Total Lineal Feet of Expected Future Capacity Problems Eliminated (ft)	Estimated Const. Cost Per Acre***	Annual Maint. Cost/Acre
Glenwood	1,274 acres	607 acres (48%)	530 (42%)	178 acres	427 acres	4,160	1,390	1,757	$4,950	$540
Willakenzie	6,096 acres	1,526 acres (25%)	832 (14%)	50 acres	154 acres	5,520	1,840	1,540	$6,580	$720
Bethel Danebo	6,172 acres	1,688 acres (27%)	1,265 (20%)	293 acres	36 acres	730	240	1,873	$870	$90
Willow Creek*	2,567 acres	1,773 acres (69%)	1,108 (43%)	171 acres	1,588 acres	480	160	2,995	$570	$60
Amazon Creek (Tributaries Systems Only)	10,486 acres	2,724 acres (26%)	1,957 (19%)	283 acres	1,023 acres	850	280	6,938	$1,010	$110
Willamette River	3,794 acres	381 acres (10%)	242 (6%)	0 acres	0 acres	0	0	0	$0	$0
City-wide Total or Area Weighted Average:	**30,389 acres**	**8,699 acres (29%)**	**5,934 acres (20%)**	**975 acres**	**3,228 acres**	**1,300 ft^3**	**440 ft^2**	**15,103 ft**	**$1,600**	**$170**

* For this basin the urban reserve area has been included; all other basins reflect only the area within the urban growth boundary.

** This surface area is based on the assumption that all storage facilities would be an average of 3 feet deep.

*** This cost is an estimate of the cost to the developer to construct flood control BMPs necessary to implement the standard. The costs are based on unit costs from the capital project cost tables prepared for the City and dated 1/29/99. The costs do not include any land acquisition costs or costs to the City to administer the standard.

DRAFT FACT SHEET 03/10/99

Flood Control Development Standard #2

"Peak Flows Not To Exceed Conveyance System Capacity"

CITY-WIDE

(Does not include the Santa Clara/River Road basin)

Purpose: The purpose of this standard is to prevent, through "on-site" requirements for runoff control, the storm system capacity problems that are predicted to occur solely as a result of future development.

Description of Standard: This standard is applied in areas upstream of drainage segments that are expected to have capacity problems as a result of future development only. The standard requires developers in these areas to limit their post-development peak rate of runoff to the maximum capacity of the conveyance system for the design storm of concern (e.g., the 10-year or 25-year storm). For example, if a pipe segment in the downstream portion of a basin is expected to flood under future development conditions for a 25-year storm, developers upstream of this segment would be required to limit their post-development peak runoff rate for the 25-year storm to the maximum flow that the segment would allow without surcharging into the roadway.

Statement of Basin Conditions: Approximately 22% of the identified flooding problems in the City are expected solely as a result of future development (i.e., 33 of the 152 identified deficient segments are expected to occur solely as a result of future development conditions). These 33 deficient segments represent approximately 10,165 lineal feet of pipe and 4,938 lineal feet of open waterway.

Potential Implementing Best Management Practices (BMPs): In order to limit the post-development peak runoff rates, BMPs that include storage or infiltration of stormwater runoff are required. These could include one or more of the following: detention ponds, underground vaults, infiltration trenches/basins, drywells, reduced impervious areas, and/or disconnected impervious areas.

How the Standard was Applied for Analysis: This standard was analyzed by applying it to all vacant land upstream of expected future only flooding problems based on 1994 land use data. As shown in Table 1, the standard was therefore applied to a total of 3,228 vacant acres. Although existing flooding problems are anticipated to occur regardless of future development, future development will also exacerbate these problems. For this evaluation, the flood control standard was not applied to vacant areas solely for the purpose of preventing the worsening of existing capacity problems. This was based on the following assumptions: the City would construct flood control capital projects (CPs) to address the existing problems, the CPs would be designed based on future development conditions, and SDCs would be charged to developers for their portion of the CP. As shown in Table 1, the amount of vacant area that was not included in the evaluation, but where standards could be applied to prevent the worsening of existing capacity problems is approximately 975 acres.

DRAFT FACT SHEET 03/10/99
Flood Control Development Standard #2
"Peak Flows Not To Exceed Conveyance System Capacity"
CITY-WIDE

Measure of Effectiveness: Based on the 1994 data, the identified future flooding problems in 33 segments would be expected to be eliminated (i.e., 22% of all identified flooding problems) as a result of the implementation of this standard. As stated above, these segments represent approximately 10,165 lineal feet of pipe system and 4,938 lineal feet of open waterway system. However, based on a 1998 update of land use data, 32% of the vacant area City-wide has been developed since 1994 (see column 4 of Table 1). Therefore, the effectiveness of the flood control standard as described in this fact sheet may be reduced as it would only be applied to approximately 2,066 out of the 3,228 vacant acres evaluated City-wide.

Cost to Implement: The estimated cost for developers to implement this standard City-wide is $ 2,562,000; the estimated average cost per acre is $800. However, in some cases developers could reduce this cost by using site planning techniques that would reduce their need for storage volume and piping.

Maintenance Cost to Implement: The estimated cost for developers to maintain BMPs that are implemented to comply with the standard City-wide is $278,000; the estimated average annual maintenance cost per acre is $90.

Interpretation of Results: The average storage volume required per acre ranged from 480 ft^3 for the Willow Creek basin to 1,620 ft^3 for the Glenwood basin.

Other Considerations:
- As the storage volume requirements are based on model estimates, and assumptions regarding site conditions, many jurisdictions apply a factor of safety when implementing this type of standard. In addition, most consider that with a number of on-site facilities in place, some portion of the facilities may not be functioning properly at any given time. Therefore, some jurisdictions require developers to add up to +20% to their storage volume calculations. A factor of safety was not included in this evaluation. However, it would result in increased storage volume requirements and costs to the developer.

- This evaluation considers the development of vacant lands and does not take into account the effects of re-development. Re-development to greater densities could also add to existing and future capacity problems.

DRAFT FACT SHEET 03/10/99

Flood Control Development Standard #2

"Peak Flows Not To Exceed Conveyance System Capacity"

CITY-WIDE

Table 1

Summary of Evaluation:

Flood Control Standard Method #2	Total Basin Area	1994 Total Vacant Area (% of Total)	1998 Total Vacant Area (% of Total)	Vacant Area Not Addressed in the Evaluation where standards could potentially be applied to prevent further exacerbation of existing flooding problems.	Vacant Area Addressed in the Evaluation (i.e., vacant areas upstream of expected future flooding problems)	Average Storage Volume Required Per Acre (ft^3)	Average Surface Area Per Acre Required for Storage** (ft^2)	Total Lineal Feet of Expected Future Capacity Problems Eliminated (ft)	Estimated Const. Cost Per Acre***	Annual Maint. Cost/Acre
Glenwood	1,274 acres	607 acres (48%)	530 (42%)	178 acres	427 acres	1,620	540	1,757	$1,930	$210
Willakenzie	6,096 acres	1,526 acres (25%)	832 (14%)	50 acres	154 acres	710	240	1,540	$840	$90
Bethel Danebo	6,172 acres	1,688 acres (27%)	1,265 (20%)	293 acres	36 acres	730	240	1,873	$870	$90
Willow Creek*	2,567 acres	1,773 acres (69%)	1,108 (43%)	171 acres	1,588 acres	480	160	2,995	$570	$60
Amazon Creek (Tributaries Systems Only)	10,486 acres	2,724 acres (26%)	1,957 (19%)	283 acres	1,023 acres	550	180	6,938	$650	$70
Willamette River	3,794 acres	381 acres (10%)	242 (6%)	0 acres	0 acres	0	0	0	$0	$0
City-wide Total or Area Weighted Average:	**30,389 acres**	**8,699 acres (29%)**	**5,934 acres (20%)**	**975 acres**	**3,228 acres**	**670ft^3**	**220 ft^2**	**15,103 ft**	**$800**	**$90**

* For this basin the urban reserve area has been included; all other basins reflect only the area within the urban growth boundary.

** This surface area is based on the assumption that all storage facilities would be an average of 3 feet deep.

*** This cost is an estimate of the cost to the developer to construct flood control BMPs necessary to implement the standard. The costs are based on unit costs from the capital project cost tables prepared for the City and dated 1/29/99. The costs do not include any land acquisition costs or costs to the City to administer the standard.

DRAFT FACT SHEET – 3/11/99
Water Quality Development Standard #1
"Treat 80% of the Site Runoof Volume"
CITY-WIDE
(Does not include the Santa Clara/River Road Basin)

Description of the Standard: This development standard is typically applied to commercial, industrial, and multi-lot residential developments. It would require developers to implement best management practices designed to provide water quality treatment for 80% of the volume of annual stormwater runoff discharged from their site. The objective of the standard is to minimize the water quality impacts associated with new development. Although several pollutants of concern have been identified in urban stormwater runoff (i.e. sediments, nutrients, metals, bacteria, oil and grease), many of these pollutants are often associated with sediments. Therefore, to simplify the estimate of effectiveness for this standard, sediments (in the form of total suspended sediments or TSS) are used as an indicator of the pollutants of concern in stormwater. The effectiveness of the standard is based on the estimate of TSS removed from stormwater runoff.

Potential Implementing BMPs and Associated Maintenance Requirements:

Potential Implementing BMP	Associated Maintenance Requirements
Stormwater Filters: • Vegetated filters (vegetated swales and vegetated filter strips)	Inspect and clean inlet and outlet, remove debris, remove accumulated sediment, maintain vegetation
Stormwater Ponds: • Wet ponds • Dry extended detention ponds • Wet extended detention ponds	Inspect and clean inlet and outlet, maintain vegetation, inspect sediment loading, remove accumulated sediment, remove debris, inspect and repair separation berm
Stormwater Marshes: • Shallow marsh • Pond/marsh system • Extended detention marsh	Inspect and clean inlet and outlet, inspect and maintain vegetation, remove debris, remove accumulated sediment
Infiltration Facilities • Infiltration trenches • Infiltration basins • Concrete grid pavement systems	Inspect and clean inlet, remove large debris to prevent clogging, remove accumulated sediment, maintain vegetation where applicable
Structural Storm Sewer Devices: • Trapped catchbasins • Oil/water separators • Sedimentation vaults/tanks • Structural vaults with filter media (e.g., sand, compost, zeolite, etc.)	Inspect and clean inlet and outlet, inspect sediment loading, remove accumulated sediment, remove debris, remove oil, replace filter media as necessary where applicable
Disconnected roof drains and reduced impervious areas	None

DRAFT FACT SHEET – 3/11/99
Water Quality Development Standard #1
"Treat 80% of the Site Runoof Volume"
CITY-WIDE

Statement of Basin Conditions: Based on information provided in Stormwater Standards Memo #1 and updated land use information from Lane Council of Governments (LCOG), the estimated load of total suspended solids (TSS) based on 1998 land use data is 15,827,600 pounds per year. New development is expected to increase TSS loads by approximately 2,283,500 pounds (i.e. 14 percent). Based on instream water quality samples that have been collected during storm events at several locations in the City, instream water quality standards have been exceeded for copper, zinc, and bacteria. The State guidance level for phosphorus has also been exceeded. In addition, DEQ has designated the A-3 Channel, the Amazon Diversion Channel, Fern Ridge Reservoir, Long Tom River, and the Willamette River as water quality limited for a variety of parameters including bacteria, dissolved oxygen, turbidity, temperature, and toxics. The "water quality limited" designation is given to waters where the established water quality standards are not being met or where beneficial uses (i.e., fishing, swimming, etc.) are not protected.

Applicability of the Standard: This standard was applied to vacant land based on 1998 data. It was not applied to vacant residential parcels less than ½ acre or to vacant areas where stormwater systems were recently extended.

Effectiveness of the Standard: According to 1998 land use data, the city-wide reduction in TSS loads for areas where the water quality standard would apply is expected to be approximately 1,096,100 pounds per year or 6 percent of the total load (Table 1).

Cost per acre to implement the standard: To estimate the cost of this standard, three example sites from the City of Gresham were used (commercial development, residential development, and a Planned Unit Development (PUD)). Each site was designed using a traditional piped storm drainage system without on-site water quality BMPs and then re-designed based on implementation of this water quality standard. The difference in cost between the two methods was then determined. For the commercial development, there was a savings in implementing the water quality standard due to the fact that vegetated swales were used in place of pipes. For the other two example sites, implementation of this standard resulted in an increase in development costs. Based on costs to implement this water quality standard for the example sites in the City of Gresham, capital costs are estimated to range from a savings of $8,700/acre to an increase of $12,300/acre (Table 1).

Maintenance costs to implement the standard: Based on costs to implement this water quality standard for example sites in the City of Gresham, annual maintenance costs are estimated to range from $20/acre to $250/acre (Table 1).

DRAFT FACT SHEET - 3/10/99
Water Quality Development Standard #1
"Treat 80% of the Site Runoff Volume"
CITY-WIDE

Table 1
Summary of Evaluation for 1998 Data:

Basin Name	Total Basin*		1998 Vacant Land*					Costs	
	Area (acres)	Future TSS Load Without Standards (lbs/yr)	Area** (acres)	Percent of the Total Basin (%)	TSS Load from Future Development Only (lbs/yr)	Expected TSS Removal (lbs/yr)	Percent Reduction of the Total Basin Load (%)	Capital Savings/Costs to Implement the Standard*** ($/acre)	Annual Maintenance Cost to Implement the Standard ($/acre)
Amazon Basin	10,486	4,848,700	1,957	19%	583,400	280,000	6%	Ranges from a savings of $8,700 to a cost of $12,300	Ranges from $20 to $250
Bethel-Danebo Basin	6,172	3,910,000	1,265	20%	461,300	221,400	6%		
Glenwood Basin	1,274	693,000	530	42%	152,400	73,200	11%		
Willakenzie Basin	6,096	3,496,400	832	14%	391,500	187,900	5%		
Willamette River Basin	3,794	3,464,200	242	6%	183,600	88,100	3%		
Willow Creek Basin	2,567	1,698,800	1,108	43%	511,300	245,400	14%		
City-Wide Total	30,389	18,111,100	5,934	20%	2,283,500	1,096,000	6%		

*This information represents areas within the UGB, except for the Willow Creek basin which includes areas within the urban reserve.
**1998 vacant areas in Amazon, Bethel-Danebo, and Willow Creek were adjusted to account for wetlands acquisition efforts by BLM and TNC.
***This cost range is an estimate of the cost to the developer to implement the standard. It does not include land acquisition costs or costs to the City to administer the standard.

DRAFT FACT SHEET 3/3/99
Water Quality Development Standard #3
"Specific BMPs are Required for Specific Land Uses"

Purpose: The purpose of this standard is to address site specific industrial, commercial and transportation related operations and practices that are: 1) of concern locally due to the potential for generating pollutants that may be discharged to the City's stormwater system and 2) are not likely to be addressed through the implementation of Water Quality Standard #1 (treat 80% of the site runoff volume) or through any other State or City of Eugene NPDES BMP requirement.

Description of the Standard: This standard could be implemented using any of the following options:

1) The City could require specific BMPs to be implemented for specific site uses;
2) The City could set performance standards and provide guidance and the site operator may choose how to best meet the required objective;
3) A BMP program could be completely voluntary. For example, participants in the program might sign an agreement to implement a pollution prevention/control program and voluntarily conduct a system audit and submit an annual report. Successful participants could receive recognition through a Clean Water Partner Program;
4) The City could develop an incentives program to implement stormwater quality BMPs. See LCOG report "Incentives to Encourage the Protection of Stormwater-related Natural Resources" for an in-depth discussion of available incentive options.

Any combination of the above implementation strategies might also be appropriate.

Statement of Basin Conditions: Previous analyses of basin conditions (based on 1994 land use data) show that there are a total of 6,299 acres within the City's urban growth boundary that are designated under the Metro Plan for commercial and industrial uses. This represents about 17% of the City's area. Of this total area, approximately 34% of the existing commercial/industrial lands (or 6% of the City) are undeveloped (2,146 acres).

Potential Implementing Best Management Practices (BMPs): See Table 1.

TABLE 1
WATER QUALITY STANDARD #3
BMPs FOR INDUSTRIAL, COMMERCIAL AND TRANSPORTATION SPECIFIC SITE USE ACTIVITIES

RECOMMENDED BMPs: INDUSTRIAL COMMERCIAL & TRANSPORTATION SITE USE ACTIVITIES	Maintenance practices to include sweeping of paved surfaces and cleaning of the storm drainage system. Recommended frequencies are as follows: Sweep	Clean	Oil/water separator	Storm/ sanitary switch	Containment for supplies that have the potential to come into contact with stormwater runoff	Cover for supplies that have the potential to come into contact with stormwater runoff	Trash rack to remove trash from runoff prior to entering the public system	Other
Vehicle and equipment parking and storage	M	M or <50%	Y	n/a	Y	n/a	Y	
Vehicle repair and maintenance	M	M or <50%	Y	n/a	Y	Y	Y	
Truck/rail loading and unloading areas	M	M or <50%	Y	n/a	Y	Y	Y	
Vehicle washing/steam cleaning (including mobile operations)	M	M or <50%	Y	Y	Y	Y	n/a	
Solid waste management	M	M or <50%	n/a	n/a	Y	Y	Y	
Erodible materials &/or product storage	M	M or <50%	n/a	Y	Y	Y	n/a	
Fuel dispensing	M	M or <50%	Y	n/a	Y	Y	n/a	
Application and storage of landscape materials	n/a	M or <50%	n/a	n/a	Y	Y	n/a	
Draining pools and spas	n/a	As needed	n/a	n/a	n/a	n/a	n/a	dechlorinate
Discharge of process waste	n/a	M or <50%	n/a	n/a	Y			
Managing livestock/animal waste	W	W	n/a	N/a	Y	Y	n/a	

TABLE KEY: W = weekly
M = monthly
n/a = not applicable
Y = appropriate for site control
<50% = when less than 50% of the capacity is remaining

APPENDIX I

DEVELOPMENT STANDARDS MEMORANDUM #8 POTENTIAL MAINTENANCE IMPLICATIONS

DEVELOPMENT STANDARDS
MEMORANDUM #8
POTENTIAL MAINTENANCE IMPLICATIONS
DECEMBER 1999
(See also attached update dated 1/26/00)

1.0 Introduction

Currently, the City of Eugene's maintenance staff are responsible for maintaining the public storm drainage system and any public stormwater facilities within the City. The City does not currently provide maintenance for private stormwater facilities. If adopted, water quality stormwater standards will result in construction of additional stormwater facilities, and therefore the City could potentially incur significant additional maintenance responsibilities. The purpose of this memo is to estimate the maintenance implications associated with implementation of a stormwater quality development standard within the City of Eugene.

Section 2.0 of this memo provides the assumptions that were used as a basis for estimating maintenance implications. Section 3.0 provides an estimate of the cost and staffing implications with respect to public maintenance responsibilities and Section 4.0 discusses issues associated with private maintenance responsibilities. Section 5.0 provides additional discussion regarding some of the long term maintenance related activities.

2.0 Assumptions

The following assumptions were made in order to begin estimating the maintenance implications associated with the implementation of a stormwater quality development standard in Eugene.

1. Development standards will not apply to the development of a single low density residential parcel (i.e., parcels < 9000 square feet). A second scenario was also evaluated based on the assumption that subdivisions of < 4 lots (i.e., < ½ acre) would not be required to implement development standards.
2. The city will maintain approved residential facilities, which serve multiple parcels, but not apartment buildings, condominiums, commercial facilities, or industrial facilities.
3. The BMPs that the City will maintain include: swales, vegetated filter strips, ponds, constructed marshes/wetlands, dry wells, infiltration trenches, infiltration basins, structural devices for filtering, or structural devices for settling.
4. The BMPs that the City will not maintain include: pervious pavements, roof drain disconnects, eco roofs, landscape planters, xeriscaping/naturescaping, or any facility type that is implemented for treating parking lot runoff.
5. For the open waterway systems, detailed maintenance activities and resource implications are being developed and evaluated separately by public works maintenance.

The following sections are based on the assumptions listed above.

3.0 Public Maintenance Responsibilities (i.e., Multiple-Parcel Low Density Residential)

The purpose of this section is to estimate the increase in maintenance responsibilities that would be associated with the construction of stormwater facilities for multiple parcel low density residential land. Section 3.1 describes the maintenance activities and frequency of conducting those activities for the types of BMPs expected to be constructed. Section 3.2 describes the equipment and labor time that would be needed for maintaining the BMPs expected to be constructed. Section 3.3 uses the information in Sections 3.1 and 3.2 to estimate maintenance cost and labor hour implications based on the land that is currently available for development in Eugene. Section 3.4 discusses issues regarding the condition that stormwater facilities should be in prior to the city accepting responsibility for maintenance.

3.1 Maintenance Activities and Frequency

Table 3-1 provides a summary of the potential range of maintenance activities and the required frequency for conducting those activities based on the current draft list of BMPs allowed within the City of Eugene. The table is broken down according to the various maintenance tasks that may potentially be required for each type of BMP. The tasks in the table include:

- maintain vegetation (i.e., mow grass and remove invasive, overgrown or dead vegetation)

- remove debris and litter

- remove sediment (i.e., after reaching a specified depth, sediment should be removed from BMP facilities, as well as from any pretreatment devices, such as forebays or sedimentation catchbasins)

- regrade (i.e., swales and ponds will need to be regraded and vegetated after sediment removal is completed)

- inspect (i.e., inspect inlet/outlet, vegetation, sediment loading, and slopes)

- clean inlet/outlet (i.e., clean obstructed or blocked orifices)

- rototill/disk/aerate (i.e., following sediment removal the bottom of the vegetated area should be rototilled, disked or aerated)

- replace media (i.e., replace various media in cartridges from StormFilter structural storm sewer devices)

The frequencies of maintenance activities in Table 3-1 were obtained from Development Standards Memo #5, cost tables prepared for the Eugene capital projects, the Unified Sewerage Agency's Conveyance System Management Study, November 1998 *(USA, 1998)*, and the

Watershed Management Institute's Operation, Maintenance, & Management of Stormwater Management, August 1997 *(WMI, 1997)*.

Table 3-1 Maintenance Requirements for Public BMP Facilities

BMP	Maintenance Activity and Average Frequency/Year						
	Maintain Vegetation	Remove Debris/Litter	Remove Sediment	Regrade	Inspect	Clean Inlet/Outlet	Rototill/disk/ aerate
Vegetated Filters							
Swales	12	12	1	.2	3	3	
Filter Strips	12	12	1	.2	3		
Stormwater Ponds							
Wet Ponds	6	6	.2	.2	6	6	
Dry ED Ponds	6	6	.2	.2	6	6	
Wet ED Ponds	6	6	.2	.2	6	6	
Stormwater Marsh/Wetlands							
Stormwater Marsh/Wetland	1	6	.2		6	6	
Infiltration Facilities							
Dry Wells/Infiltration Vaults		12	1		12		
Infiltration Trench		12	1		12	2	
Infiltration/Retention Basin	6	6	.2	.2	6	6	1
Structural Storm Sewer Devices							
Structural Storm Sewer Devices		2	2		2		

Note: A frequency of 0.2 indicates that the activity is only necessary once every five years. Infiltration facilities may require replacement, however activities associated with replacement of infiltration facilities are not included in the table.

3.2 Equipment and Staff Time

Table 3-2 provides a summary of the equipment and staff needed to perform the required maintenance activities, and the estimated cost to complete the annual maintenance for each BMP. The costs are representative of average facilities maintained under typical conditions. Site conditions and BMP sizes will vary which may affect the maintenance costs. The costs associated with maintenance of the various BMPs were drawn from the cost tables prepared earlier for the Eugene capital projects. Since that time, those cost tables have been revised to reflect updated recommended maintenance frequencies and staff hours. Revised cost tables are provided at the end of this section (Tables 3-10 through 3-13). Revisions made since the earlier version are highlighted.

Table 3-2 Required Equipment and Staff Time to Conduct Maintenance of Public BMP Facilities

BMP	Equipment								Staff Time (hrs/yr)	Estimated Annual Cost ($/yr)
	Mower	Weedeater	Water truck	Dump truck	Hand tools	Tractor shovel	Vactor truck	Rototiller/aerator		
Vegetated Filters										
Swales	✓	✓		✓	✓	✓	✓		52	$4,100[1]
Filter Strips	✓	✓		✓	✓	✓			49	$3,500[1]
Stormwater Ponds										
Wet Ponds	✓	✓		✓	✓	✓	✓		64	$5,600[2]
Dry ED Ponds	✓	✓		✓	✓	✓	✓		76	$6,000[2]
Wet ED Ponds	✓	✓		✓	✓	✓	✓		64	$5,600[2]
Stormwater Marsh/Wetland										
Constructed Stormwater Marsh/Wetland	✓	✓		✓	✓	✓	✓		58	$4,700[3]
Infiltration Facilities										
Dry Wells/Infiltration Vaults					✓		✓			$2,400[4]
Infiltration Trench			✓		✓		✓		60	$3,400[5]
Infiltration/Retention Basin	✓	✓		✓	✓	✓	✓	✓	76	$6,000[6]
Structural Storm Sewer Devices										
Structural Storm Sewer Devices					✓		✓		24	$2,400[4]

[1] Cost estimate is based on maintenance of a vegetated filter approximately 500 feet in length and four feet wide.
[2] Cost estimate is based on maintenance of a 5 acre-foot pond.
[3] Cost estimate is based on maintenance of a 5 acre constructed stormwater marsh/wetland.
[4] Cost estimate is based on maintenance of a single device.
[5] Cost estimate is based on maintenance of a 500 foot long infiltration trench.
[6] Cost estimate is based on maintenance of a 5 acre-foot infiltration basin.

3.3 Estimated Costs and Labor Hours

This section includes cost and labor hour implications based on the maintenance activities and frequencies detailed in Section 3.1, the maintenance equipment and staff time detailed in Section 3.2, and on the GIS results regarding available vacant land from the Lane Council of Governments (LCOG). LCOG provided data regarding the number of vacant parcels grouped by parcel size for low density residential, medium/high density residential (HDR), commercial, industrial, and other land uses. They also provided data regarding the area of vacant parcels grouped by parcel size. For this analysis, only the parcels within the Urban Growth Boundary (UGB) were used and HDR, commercial and industrial land uses were grouped together assuming that each of these land uses would be responsible for their own maintenance, see Table 3-3. In addition, a separate analysis was conducted for parcels greater than 9000 square feet and parcels greater than ½ an acre. The minimum residential parcel size in the City is 4500 square feet, therefore any parcel less than 9000 square feet could not be subdivided and the first assumption was (see Section 2.0) that development standards would not apply to the development of a single residential parcel. The analyses conducted for parcels greater than ½ acre provides information with respect to the assumption that development standards would not apply to subdivisions of 4 parcels or less.

Table 3-3 Vacant Parcels within the UGB

Land Use	Number of Parcels ≥ 9000 ft^2	Total Area of Parcels ≥ 9000 ft^2 (acres)	Total Area of Parcels ≥ ½ acre (acres)
Low Density Residential	2259	4192	3647
HDR/Commercial/Industrial	1053	3220	-
Other	148	291	-

Cost and labor hour implications were estimated based on four different development scenarios. The first scenario assumes that all developers would construct the BMP that requires the most expensive maintenance (i.e., the most conservative option). Scenarios #2 and #3 assume developers would implement a mix of BMPs as described below. Scenario #4 was based on the assumption that in addition to maintaining facilities for residential parcels, public maintenance would be needed for a certain percentage of the HDR/commercial/industrial facilities that are not adequately maintained.

To estimate the number of potential developments for public maintenance, we assumed an average development size of five acres for both low density residential and HDR/commercial/industrial developments. That assumption resulted in approximately 840 and 730 future low density residential developments, based on parcel sizes greater than 9000 square feet and ½ acre, respectively, and 640 future HDR/commercial/industrial developments, based on parcel sizes greater than 9000 square feet. For each scenario, four situations were analyzed. The first situation was based on an assumption that the City would conduct all maintenance activities and that all activities would be conducted at ideal frequencies (Public/Ideal). The second situation was based on an assumption that the City would conduct all maintenance activities and that all activities would be conducted at reduced frequencies (Public/Reduced). The third situation was based on an assumption that the City would conduct all maintenance activities, with the exception of vegetation maintenance and debris/litter removal, which would be conducted by a private entity, and that all activities would be conducted at ideal frequencies (Private/Ideal). The fourth situation was based on an assumption that the City would conduct all maintenance activities, with the exception of vegetation maintenance and debris/litter removal, which would be conducted by a private entity, and that all activities would be conducted at reduced frequencies (Private/Reduced). Although the third and fourth situations would result in reduced FTE for maintenance, it should be noted that additional FTE would be needed for enforcement (see section 4.3.2 of this memo). The following sections describe the basis of the four scenarios and the assumptions that were made for evaluating each one.

Scenario #1

This scenario is based on the assumption that stormwater ponds would be implemented on each of the vacant residential developments. The annual maintenance cost to maintain stormwater ponds was reduced from the amount shown in Table 3-2 ($6,000) to account for the smaller sized ponds (approximately 0.3 acre-foot) that would be required for a five acre development. It was assumed that one stormwater pond would be constructed for each of the developments. The implementation of Scenario #1 resulted in estimated annual maintenance costs ranging from $1,749,600 to $3,696,000 and the need for 8 to 24 additional FTEs (see Table 3-4).

Table 3-4
Scenario #1-Residential Development

Parcel Size	≥ 9000 ft^2				≥ ½ acre			
Public[1]/Private[2]	Public	Public	Private	Private	Public	Public	Private	Private
Ideal[3]/Reduced[4]	Ideal	Reduced	Ideal	Reduced	Ideal	Reduced	Ideal	Reduced
# of Developments	840	840	840	840	730	730	730	730
Cost/Development to Implement Stormwater Ponds	$4,400	$3,100	$3,400	$2,400	$4,400	$3,100	$3,400	$2,400
Labor Hours/ Development	51	35	27	19	51	35	27	19
Total Estimated Annual Cost	**$3,696,000**	**$2,604,000**	**$2,856,000**	**$2,016,000**	**$3,212,000**	**$2,263,000**	**$2,478,600**	**$1,749,600**
Total Labor Hours	**42,840 (24 FTEs)**	**29,400 (16 FTEs)**	**22,680 (13 FTEs)**	**15,960 (9 FTEs)**	**37,230 (21 FTEs)**	**25,550 (14 FTEs)**	**19,710 (11 FTEs)**	**13,870 (8 FTEs)**

[1]All maintenance activities are conducted by the City.
[2]All maintenance activities, with the exception of vegetation maintenance and debris/litter removal, are conducted by the City.
[3]Maintenance costs are based on ideal frequencies for maintenance activities.
[4]Maintenance costs are based on reduced frequencies for maintenance activities.

Scenario #2

This scenario is based on the assumption that an equal ratio of stormwater ponds (1/3), structural storm sewer devices (1/3) and swales (1/3) would be implemented on the vacant residential developments. The annual maintenance cost to maintain stormwater ponds was reduced from the amount shown in Table 3-2 ($6,000) to account for the smaller sized ponds (approximately 0.3 acre-foot) that would be required for a 5 acre development. It was assumed that one stormwater pond would be constructed for 1/3 of the developments. It was assumed that one structural storm sewer device would be installed as an "end-of-pipe" water quality treatment facility for 1/3 of the developments; and it was assumed that a 200 lineal foot (LF) swale would be constructed as an "end-of-pipe" water quality treatment for the remaining 1/3 of the developments. Scenario #2 resulted in estimated annual maintenance costs ranging from $991,920 to $2,363,200 and the need for 4 to 15 additional FTEs (see Table 3-5).

Table 3-5
Scenario #2-Residential Development

Parcel Size	≥ 9000 ft^2				≥ ½ acre			
Public/Private	Public	Public	Private	Private	Public	Public	Private	Private
Ideal/Reduced	Ideal	Reduced	Ideal	Reduced	Ideal	Reduced	Ideal	Reduced
# of Developments	840	840	840	840	730	730	730	730
Cost/Development to Maintain Stormwater Ponds	$4,400	$3,100	$3,400	$2,400	$4,400	$3,100	$3,400	$2,400
Labor Hours/ Development to Maintain Stormwater Ponds	51	35	27	19	51	35	27	19
Cost/Development to Maintain Structural Storm Sewer Devices	$2,400	$1,300	$2,200	$1,200	$2,400	$1,300	$2,200	$1,200
Labor Hours/ Development to Maintain Structural Storm Sewer Devices	24	12	20	10	24	12	20	10
Cost/Development to Maintain Swales	$1,640	$680	$960	$480	$1,640	$680	$960	$480
Labor Hours/ Development to Maintain Swales	21	8	6	3	21	8	6	3
Total Estimated Annual Maintenance Cost:	**$2,363,200**	**$1,422,400**	**$1,836,800**	**$1,142,400**	**$2,052,560**	**$1,235,120**	**$1,595,040**	**$991,920**
Total Estimated Annual Labor Hours:	**26,880 (15 FTEs)**	**15,400 (9 FTEs)**	**14,840 (8 FTEs)**	**8,960 (5 FTEs)**	**23,350 (13 FTEs)**	**13,370 (7 FTEs)**	**12,890 (7 FTEs)**	**7,7780 (4 FTEs)**

Scenario #3

This scenario assumes that site planning controls would be implemented on ½ of all the residential sites to be developed. Site planning controls would reduce the amount of stormwater runoff from a development and would provide water quality treatment of the stormwater runoff from rooftops and driveways. Therefore, it was assumed that additional BMPs would not need to be implemented on development sites to provide water quality treatment of stormwater runoff from rooftops and driveways. BMPs would only be needed to provide treatment for the stormwater runoff from roads. It was assumed that one structural storm sewer device would be installed on each development as a water quality treatment device to treat roadway runoff for ½ of the developments implementing site planning controls. On each of the remaining development sites, it was assumed that 200 lineal foot (LF) swales would be constructed to provide stormwater runoff water quality treatment. Swales were chosen because they are commonly used facilities. The implementation of Scenario #3 resulted in estimated annual maintenance costs ranging from $613,200 to $1,696,800 and the need for 3 to 11 additional FTEs (see Table 3-6).

Table 3-6
Scenario #3-Residential Development

Parcel Size	≥ 9000 ft^2				≥ ½ acre			
Public/Private	Public	Public	Private	Private	Public	Public	Private	Private
Ideal/Reduced	Ideal	Reduced	Ideal	Reduced	Ideal	Reduced	Ideal	Reduced
# of Developments	840	840	840	840	730	730	730	730
Cost/Development to Maintain Structural Storm Sewer Devices	$2,400	$1,300	$2,200	$1,200	$2,400	$1,300	$2,200	$1,200
Labor Hours/ Development to Maintain Structural Storm Sewer Devices	24	12	20	10	24	12	20	10
Cost/Development to Maintain Swales	$1,640	$680	$960	$480	$1,640	$680	$960	$480
Labor Hours/ Development to Maintain Swales	21	8	6	3	21	8	6	3
Estimated Annual Maintenance Costs:	**$1,696,800**	**$831,600**	**$1,327,200**	**$705,600**	**$1,474,600**	**$722,700**	**$1,153,400**	**$613,200**
Estimated Annual Labor Hours:	**18,900 (11 FTEs)**	**8,400 (5 FTEs)**	**10,920 (6 FTEs)**	**5,460 (3 FTEs)**	**16,425 (9 FTEs)**	**7,300 (4 FTEs)**	**9,490 (5 FTEs)**	**4,745 (3 FTEs)**

Scenario #4

This scenario assumes that an equal ratio of stormwater ponds (1/3), structural storm sewer devices (1/3) and swales (1/3) would be implemented on the 640 vacant HDR/commercial/industrial developments. The annual maintenance cost to maintain stormwater ponds was reduced from the amount shown in Table 3-2 ($6,000) to account for the smaller sized ponds (approximately 0.3 acre-foot) that would be required for a 5 acre development. It was assumed that one stormwater pond would be constructed for each of 213 developments. It was assumed that one structural storm sewer device would be installed as an "end-of-pipe" water quality treatment for each of 213 developments; and it was assumed that a 200 lineal foot (LF) swale would be constructed as an "end-of-pipe" water quality treatment for each of the remaining 214 developments. In order to estimate the maintenance implications for privately owned facilities; it was assumed that approximately 15% of all private facilities would not be adequately maintained. Therefore, the City would incur annual maintenance costs of 15% of the total estimated annual maintenance costs for these facilities, approximately $269,900 (see Table 3-7).

Table 3-7
Scenario #4-HDR/Commercial/Industrial Development

BMPs	640 HDR/Commercial/Industrial Developments
Stormwater Ponds	213 developments x $4,400/development = $937,200
Structural Storm Sewer Devices	213 developments x $2,400/development = $511,200
Swales	214 developments x 200 LF/ development x $4,100/500 LF = $350,960
Estimated Annual Maintenance Costs:	$1,799,360
15% of Estimated Annual Maintenance Costs:	$269,904
Estimated Labor Hours/FTEs:	3,070 hours (2 FTEs)

Based on the assumption that additional maintenance would be required for some of the HDR/Commercial/Industrial facilities (i.e., Scenario #4), a range of total estimated annual maintenance costs for Scenarios #1, #2 and #3 are presented in Table 3-8 below. It should be noted that the additional costs associated with Scenario #4 could likely be recovered from the responsible part.

Table 3-8
Total Estimated Annual Maintenance Costs

	Scenario #1	**Scenario #2**	**Scenario #3**
Estimated Annual Maintenance Cost of Public Facilities	$1,749,600 to $3,696,000	$991,920 to $2,363,200	$613,200 to $1,696,800
Estimated Annual Maintenance Cost of Private Facilities	$269,900	$269,900	$269,900
Estimated Annual Maintenance Costs	**$2,019,500 to $3,965,900**	**$1,261,820 to $2,633,100**	**$883,100 to $1,966,700**
Estimated FTEs:	**10 to 26 FTEs**	**6 to 17 FTEs**	**5 to 13 FTEs**

3.4 City Assumption of BMP Maintenance

If water quality standards are implemented, it is expected that a BMP manual will also be developed. Both public and private BMP facilities would need to be designed in accordance with the manual. The manual would include design elements to ensure ease of maintenance. The manual would include:

- Design and construction standards (i.e., water quality facilities must be designed and constructed in accordance with a jurisdiction's design standards for sizing, locating, and landscaping. If the water quality facility being implemented is a proprietary structural storm sewer device then the facility must be designed in accordance with the manufacturer's requirements.)
- Requirements for providing maintenance access (e.g., the USA requires that water quality facilities have a permanent easement or dedication for facility access and maintenance access. The owner is required to provide USA with the documents necessary to grant such easements.)
- Access roads (e.g., the City of Portland's Bureau of Environmental Services (BES) requires an access road with a minimum width of 15 feet for all ponds and to all detention tanks and vaults not located in improved rights-of-way.)
- Requirements for plant establishment (e.g., the USA requires that 80 percent of each type of vegetation be established and healthy at the end of a two year period in order for the facility to be accepted by the agency.)
- Operation and Maintenance (O&M) Plans (e.g., the BES requires that a preliminary O&M plan be submitted prior to facility construction and that a final O&M plan detailing required maintenance activities and schedule be submitted within 30 days after project completion.)

A maintenance bond is a tool for ensuring that BMP facilities are functioning properly prior to the City taking responsibility for maintenance. Some jurisdictions require a maintenance bond be posted by the developer for stormwater facilities that are eventually to be maintained and operated by the jurisdiction. The applicant must post a maintenance bond for a certain period, typically a year or more, after which time the facility is then approved/accepted by the jurisdiction. This requirement allows the jurisdiction to defer maintenance responsibility for a facility until it is functioning properly and the vegetation has been established. The City of Eugene currently uses a one-year warranty bond for public projects.

3.5 Summary

In order to define the resources needed for public maintenance of residential BMP facilities, estimates of the maintenance implications were determined with respect to maintenance activities, equipment, and labor hours/FTEs. Four scenarios were evaluated so that an estimated range of annual maintenance implications could be provided to the City. Of the four scenarios, it is most likely that the City will experience a scenario that is a combination of Scenarios #2, #3, and #4 a distribution of stormwater ponds, structural storm sewer devices, swales, implementation of site planning controls, and assumption of maintenance for a percentage of the private facilities. Such a scenario would result in a range of estimated annual maintenance costs of approximately $0.9 million to $2.6 million, which includes 5 to 17 additional FTEs. However, any mix of the allowable BMPs may be implemented on the potential low density residential

development sites. In addition, some of the developments will be greater than 5 acres which would result in a smaller number of BMPs. Therefore, the estimated maintenance implications that are provided should only be used as planning level estimates to identify potential required maintenance activities, staffing, and equipment.

As a comparison to the estimates provided in this memo the USA's and the City of Bellevue's current maintenance programs were reviewed. The USA estimates that 46 FTEs are currently allocated to stormwater maintenance. USA assigns personnel to specific stormwater system maintenance operations (i.e., street sweeping, water quality facility maintenance, ditch cleaning, storm line cleaning, TV inspection, and system repair). USA's public stormwater system includes an estimated 26,500 catch basins (both sumped and flow through varieties); at least 42,000 LF of drainage ditch; 4,740,000 LF of stormwater pipe; and 348 detention basins/water quality facilities distributed over a 123 square mile service area (i.e., 2½ times the size of Eugene's service area). Of the 348 detention basins/water quality facilities, it's estimated that USA proactively maintains approximately 30% of the surface water facilities. However, it is likely that approximately 50% of the surface water facilities are maintained annually due to facility maintenance that is completed as a reaction to an emergency situation. The USA recently completed a Final Draft Conveyance System Management Study, November 1998. The study includes modifications to current maintenance practices and recommends a shift to a more proactive, preventative maintenance program, which would result in a need for additional staff.

The City of Bellevue has approximately 13 FTEs allocated to stormwater maintenance, however only 11 are allocated to fieldwork. The city's stormwater system includes approximately 12,000 catch basins, 3,000 manholes, 120 oil/water separators, 255 residential detention facilities and 11 regional detention facilities distributed over a service area of 31 square miles (slightly smaller than Eugene's service area of 47 square miles). Bellevue estimates that they routinely maintain all of their facilities (i.e., the detention facilities are inspected once a year, the inlets/outlets are brushed and cleaned, and the catch basins/manholes are cleaned once every 4 to 5 years). Currently the city operates two vactor trucks, which are in operation full-time. The city estimates that with a couple more FTEs they would be able to effectively meet their current operation and maintenance standards, however the State of Washington is implementing a new state standard which would require annual cleaning of catch basins/manholes. Therefore, the city may need to increase their stormwater maintenance staff significantly to meet the new standards.

Currently, the City of Eugene has approximately 8 to 10 FTEs allocated to stormwater maintenance. The city's stormwater system includes approximately 7,200 catchbasins, 2,000 inlet/outlet structures, and 180 miles of stormwater pipe. At this time, there is not an estimate of the number of detention/water facilities in place within the City. Currently the City of Eugene's service area is approximately 36 square miles, however the service area is expected to increase to approximately 47 square miles at full build-out. As stated in their NPDES Part 2 National Pollutant Discharge Elimination System Municipal Stormwater Permit Application the maintenance and operations crews are currently able to annually cover all the catchbasins, bubblers and manholes that require cleaning. Currently the city operates two sewer jet/vacuum machines, one with a full time crew of two FTEs to clean catch basin, manholes and connecting lines and the other 15% of the time for another combination machine and crew for the same task.

Table 3-9 presents a summary of the information provided in the text above with respect to the maintenance programs at the USA, the City of Bellevue and the City of Eugene.

Table 3-9
Comparison of Stormwater Maintenance Programs

	USA	City of Bellevue	City of Eugene	City of Eugene at Full Buildout
Service Area	123 mi^2	31 mi^2	36 mi^2	47 mi^2
Number of catch basins	26,500	12,000	7,200	NE
Number of detention/ water quality facilities	348	255	NE	additional 840
FTEs allocated to stormwater maintenance	46	13	8-10	additional 5 to 17

NE = Not Estimated

Table 3-10
STORMWATER FACILITIES
ESTIMATED ANNUAL MAINTENANCE COSTS
FOR PUBLIC/IDEAL SCENARIO

	Frequency	Effort/Time		Equip./Time			Comments
	Times/Year	Labor-Hour	$ @ $40/hr	Hours	$/hr Rate	$ Total	
Dry Extended Pond							
Inspection	6	2	$ 480.00	0	$ -	$ -	
Remove Debris/Garbage	6	2	$ 480.00	0	$ -	$ -	
Maintain Vegetation	6	2	$ 480.00	2	$ 10.00	$ 120.00	Mower, Weedeater, Etc.
Clean Inlet/Outlet	6	2	$ 480.00	2	$ 150.00	$ 1,800.00	Vactor Truck & Operator
Remove Sediment	0.2	8	$ 64.00	6	$ 300.00	$ 360.00	Tractor Shovel, 10 CY Dump & Operators
Disposal Costs	0.2		$ -	0	$ -	$ -	Assumes 10 CY Every Two Years
Inspect slopes	1	1	$ 40.00	0	$ -	$ -	
Repair Slopes (On Going Activity)			$ 100.00	0	$ -	$ -	Annual Misc. Cost
Subtotals		*51*	*$ 2,124.00*			*$ 2,280.00*	
Total Estimate Annual Maintenance				***$ 4,404.00***			
Vegetated Swale							
Inspection	3	1	$ 120.00	0	$ -	$ -	
Remove Debris/Garbage	12	1	$ 480.00	0	$ -	$ -	
Maintain Vegetation	12	2	$ 960.00	2	$ 10.00	$ 240.00	Mower, Weedeater, Etc.
Clean Inlet/Outlet	3	1	$ 120.00	1	$ 150.00	$ 450.00	Vactor Truck & Operator
Remove Sediment	1	8	$ 320.00	4	$ 300.00	$ 1,200.00	Tractor Shovel, 10 CY Dump & Operators
Disposal Costs	1		$ 80.00		$ -	$ -	Assumes 2 CY Per Year
Regrade	0.2	8	$ 80.00				
Subtotals		*52*	*$ 2,160.00*			*$ 1,890.00*	
Total Estimate Annual Maintenance				***$ 4,050.00***			
Water Quality Structures							
Remove Debris/Garbage	2	2	$ 160.00	0	$ -	$ -	
Inspect Sediment Loading	2	2	$ 160.00	0	$ -	$ -	
Remove Sediment	2	8	$ 640.00	4	$ 150.00	$ 1,200.00	Vactor Truck & Operator
Disposal Costs	2		$ 240.00		$ -	$ -	Assumes 3 CY a Year
Subtotals		*24*	*$ 1,200.00*			*$ 1,200.00*	
Total Estimate Annual Maintenance				***$ 2,400.00***			

Note: Labor rate of $40/hr is based information provided by the Unified Sewerage Agency of Washington County. Labor for maintenance activities is assumed to be City maintenance staff averaged for maintenance and supervisor effort. Effort shown includes travel time and office documentation time.

Table 3-11
STORMWATER FACILITIES
ESTIMATED ANNUAL MAINTENANCE COSTS
FOR PUBLIC/REDUCED SCENARIO

	Frequency Times/Year	Effort/Time Labor-Hour	Effort/Time $ @ $40/hr	Equip./Time Hours	Equip./Time $/hr Rate	Equip./Time $ Total	Comments
Dry Extended Pond							
Inspection	4	2	$ 320.00	0	$ -	$ -	
Remove Debris/Garbage	4	2	$ 320.00	0	$ -	$ -	
Maintain Vegetation	4	2	$ 320.00	2	$ 10.00	$ 80.00	Mower, Weedeater, Etc.
Clean Inlet/Outlet	4	2	$ 320.00	2	$ 150.00	$ 1,200.00	Vactor Truck & Operator
Remove Sediment	0.2	8	$ 64.00	6	$ 300.00	$ 360.00	Tractor Shovel, 10 CY Dump & Operators
Disposal Costs	0.2		$ -	0	$ -	$ -	Assumes 10 CY Every Two Years
Inspect slopes	1	1	$ 40.00	0	$ -	$ -	
Repair Slopes (On Going Activity)			$ 100.00	0	$ -	$ -	Annual Misc. Cost
Subtotals		*35*	*$ 1,484.00*			*$ 1,640.00*	
Total Estimate Annual Maintenance				***$ 3,124.00***			
Vegetated Swale							
Inspection	1	1	$ 40.00	0	$ -	$ -	
Remove Debris/Garbage	4	1	$ 160.00	0	$ -	$ -	
Maintain Vegetation	4	2	$ 320.00	2	$ 10.00	$ 80.00	Mower, Weedeater, Etc.
Clean Inlet/Outlet	1	1	$ 40.00	1	$ 150.00	$ 150.00	Vactor Truck & Operator
Remove Sediment	0.5	8	$ 160.00	4	$ 300.00	$ 600.00	Tractor Shovel, 10 CY Dump & Operators
Disposal Costs	0.5		$ 80.00		$ -	$ -	Assumes 2 CY Per Year
Regrade	0.2	8	$ 80.00				
Subtotals		*20*	*$ 880.00*			*$ 830.00*	
Total Estimate Annual Maintenance				***$ 1,710.00***			
Water Quality Structures							
Remove Debris/Garbage	1	2	$ 80.00	0	$ -	$ -	
Inspect Sediment Loading	1	2	$ 80.00	0	$ -	$ -	
Remove Sediment	1	8	$ 320.00	4	$ 150.00	$ 600.00	Vactor Truck & Operator
Disposal Costs	1		$ 240.00		$ -	$ -	Assumes 3 CY a Year
Subtotals		*12*	*$ 720.00*			*$ 600.00*	
Total Estimate Annual Maintenance				***$ 1,320.00***			

Note: Labor rate of $40/hr is based information provided by the Unified Sewerage Agency of Washington County. Labor for maintenance activities is assumed to be City maintenance staff averaged for maintenance and supervisor effort. Effort shown includes travel time and office documentation time.

Table 3-12
STORMWATER FACILITIES
ESTIMATED ANNUAL MAINTENANCE COSTS
FOR PRIVATE/IDEAL SCENARIO

	Frequency	Effort/Time		Equip./Time			
	Times/Year	Labor-Hour	$ @ $40/hr	Hours	$/hr Rate	$ Total	Comments
Dry Extended Pond							
Inspection	6	2	$ 480.00	0	$ -	$ -	
Remove Debris/Garbage	0	2	$ -	0	$ -	$ -	
Maintain Vegetation	0	2	$ -	2	$ 10.00	$ -	Mower, Weedeater, Etc.
Clean Inlet/Outlet	6	2	$ 480.00	2	$ 150.00	$ 1,800.00	Vactor Truck & Operator
Remove Sediment	0.2	8	$ 64.00	6	$ 300.00	$ 360.00	Tractor Shovel, 10 CY Dump & Operators
Disposal Costs	0.2		$ -	0	$ -	$ -	Assumes 10 CY Every Two Years
Inspect slopes	2	1	$ 80.00	0	$ -	$ -	
Repair Slopes (On Going Activity)			$ 100.00	0	$ -	$ -	Annual Misc. Cost
Subtotals		*27*	*$ 1,204.00*			*$ 2,160.00*	
Total Estimate Annual Maintenance				***$ 3,364.00***			
Vegetated Swale							
Inspection	3	1	$ 120.00	0	$ -	$ -	
Remove Debris/Garbage	0	1	$ -	0	$ -	$ -	
Maintain Vegetation	0	2	$ -	2	$ 10.00	$ -	Mower, Weedeater, Etc.
Clean Inlet/Outlet	3	1	$ 120.00	1	$ 150.00	$ 450.00	Vactor Truck & Operator
Remove Sediment	1	8	$ 320.00	4	$ 300.00	$ 1,200.00	Tractor Shovel, 10 CY Dump & Operators
Disposal Costs	1		$ 80.00		$ -	$ -	Assumes 2 CY Per Year
Regrade	0.2	8	$ 80.00				
Subtotals		*16*	*$ 720.00*			*$ 1,650.00*	
Total Estimate Annual Maintenance				***$ 2,370.00***			
Water Quality Structures							
Remove Debris/Garbage	0	2	$ -	0	$ -	$ -	
Inspect Sediment Loading	2	2	$ 160.00	0	$ -	$ -	
Remove Sediment	2	8	$ 640.00	4	$ 150.00	$ 1,200.00	Vactor Truck & Operator
Disposal Costs	2		$ 240.00		$ -	$ -	Assumes 3 CY a Year
Subtotals		*20*	*$ 1,040.00*			*$ 1,200.00*	
Total Estimate Annual Maintenance				***$ 2,240.00***			

Note: Labor rate of $40/hr is based information provided by the Unified Sewerage Agency of Washington County. Labor for maintenance activities is assumed to be City maintenance staff averaged for maintenance and supervisor effort. Effort shown includes travel time and office documentation time.

Table 3-13
STORMWATER FACILITIES
ESTIMATED ANNUAL MAINTENANCE COSTS
FOR PRIVATE/REDUCED SCENARIO

	Frequency	Effort/Time		Equip./Time			
	Times/Year	Labor-Hour	$ @ $40/hr	Hours	$/hr Rate	$ Total	Comments
Dry Extended Pond							
Inspection	4	2	$ 320.00	0	$ -	$ -	
Remove Debris/Garbage	0	2	$ -	0	$ -	$ -	
Maintain Vegetation	0	2	$ -	2	$ 10.00	$ -	Mower, Weedeater, Etc.
Clean Inlet/Outlet	4	2	$ 320.00	2	$ 150.00	$ 1,200.00	Vactor Truck & Operator
Remove Sediment	0.2	8	$ 64.00	6	$ 300.00	$ 360.00	Tractor Shovel, 10 CY Dump & Operators
Disposal Costs	0.2		$ -	0	$ -	$ -	Assumes 10 CY Every Two Years
Inspect slopes	1	1	$ 40.00	0	$ -	$ -	
Repair Slopes (On Going Activity)			$ 100.00	0	$ -	$ -	Annual Misc. Cost
Subtotals		*19*	*$ 844.00*			*$ 1,560.00*	
Total Estimate Annual Maintenance				***$ 2,404.00***			
Vegetated Swale							
Inspection	1	1	$ 40.00	0	$ -	$ -	
Remove Debris/Garbage	0	1	$ -	0	$ -	$ -	
Maintain Vegetation	0	2	$ -	2	$ 10.00	$ -	Mower, Weedeater, Etc.
Clean Inlet/Outlet	1	1	$ 40.00	1	$ 150.00	$ 150.00	Vactor Truck & Operator
Remove Sediment	0.5	8	$ 160.00	4	$ 300.00	$ 600.00	Tractor Shovel, 10 CY Dump & Operators
Disposal Costs	0.5		$ 80.00		$ -	$ -	Assumes 2 CY Per Year
Regrade	0.2	8	$ 80.00				
Subtotals		*8*	*$ 400.00*			*$ 750.00*	
Total Estimate Annual Maintenance				***$ 1,150.00***			
Water Quality Structures							
Remove Debris/Garbage	0	2	$ -	0	$ -	$ -	
Inspect Sediment Loading	1	2	$ 80.00	0	$ -	$ -	
Remove Sediment	1	8	$ 320.00	4	$ 150.00	$ 600.00	Vactor Truck & Operator
Disposal Costs	1		$ 240.00		$ -	$ -	Assumes 3 CY a Year
Subtotals		*10*	*$ 640.00*			*$ 600.00*	
Total Estimate Annual Maintenance				***$ 1,240.00***			

Note: Labor rate of $40/hr is based information provided by the Unified Sewerage Agency of Washington County. Labor for maintenance activities is assumed to be City maintenance staff averaged for maintenance and supervisor effort. Effort shown includes travel time and office documentation time.

4.0 Private Maintenance Responsibilities (i.e. apartment complexes, commercial facilities, industrial facilities)

The purpose of this section is to estimate and outline private maintenance responsibilities associated with the implementation of a storm water quality development standard. Section 4.1 outlines the types of maintenance agreements between the City and a developer. Section 4.2 describes maintenance criteria that should be included in agreements, and Section 4.3 discusses issues related to inspection and enforcement of maintenance agreements.

Many jurisdictions differ in the approach they take to require maintenance of private facilities. The following are some typical approaches to maintenance management by jurisdictions. Four approaches are described and evaluated, including their advantages and disadvantages.

4.1 Options for Formal Maintenance Agreements

This section includes text presented in the maintenance section of Memo #2 (Potential Stormwater Standards). Three of the five maintenance agreement options are provided here. The bonding option is provided in Section 3.4 of this memo as it relates to facilities that are turned over to the City for public maintenance. The option to use covenants to attach maintenance obligations to the property is not provided here as the City discussed this option and decided it is not sufficient enough to ensure proper maintenance.

Option 1- Site-specific Maintenance Agreements - This first approach is used by some jurisdictions to enforce maintenance requirements. Using this approach, a maintenance/ monitoring agreement is typically executed between the jurisdiction and the developer before work can begin on the site. The maintenance agreement is then recorded and kept on file with the auditor's office. Sample agreements can be found in the appendices.

The Cities of Olympia Washington and Alexandria Virginia have taken this approach. Both the jurisdictions implement agreements directly with the property owner indicating the party responsible for maintenance. These agreements have provisions allowing the City to perform the required maintenance and bill a non-responsive owner if necessary. Agreements are recorded with the auditor.

The City of Olympia's "Residential Agreement to Maintain Stormwater Management Facilities and to Implement a Pollution Prevention Plan," is notable in that it utilizes provisions that define owner maintenance responsibilities but also includes maintenance responsibilities for the city. Examples of owner maintenance include debris removal and maintaining access. However, the responsibility for sediment removal, managing vegetation in wet ponds, resetting orifice sizes and elevations on residential properties rests with the City (Watershed Management Institute, 1997). This agreement also incorporates:

- A pollution prevention plan that requires source control of pollutants;
- Identification of reimbursement activities if the City has to conduct maintenance activities that are the responsibility of the home owner;
- A requirement to submit an annual report by the owner; and
- An obligation by the city to annually inspect the facility.

This agreement is similar to the City of Gresham's "Residential Agreement to Maintain Stormwater Facilities and to Implement a Pollution Source Control Plan" (See appendices for a copy of the sample agreement).

For non-residential facilities, Olympia's "Commercial, Industrial Agreement to Maintain Urban Stormwater Management Facilities and to Implement a Pollution Prevention Plan" has a more widespread application. Maintenance responsibility rests completely with the owner. The agreement allows the city to revoke stormwater utility rate credits for stormwater treatment if required maintenance is not performed. Similar to the residential agreement, the commercial agreement allows reimbursement to the City for activities undertaken by the City that are the responsibility of the property owner. The commercial/industrial agreement also includes a pollution prevention plan, for source control of pollutants. In addition, it requires the city to perform an annual inspection, and requires the owner to prepare an annual report. (WMI, 1997).

A third example of a maintenance agreement addresses "unconventional" stormwater management facilities. The City of Alexandria, Virginia places emphasis on new technologies in areas where site specific BMPs are necessary and endeavors to support the evolution of stormwater facilities. Under their agreement, the landowner is obligated to pay the entire cost of a water quality monitoring program in order for the city to assess the performance of unconventional facilities where site specific constraints are an issue. It grants the City a monitoring fee for evaluating the performance of innovative stormwater BMPs such as eco-roofs and porous pavements, and grants permission to the City to enter the property for inspection purposes. Further, this agreement allows the City to perform needed maintenance and assess the landowner for the maintenance costs (WMI, 1997).

The advantages and disadvantages of site specific maintenance agreements are presented below.

Advantages:

1. These types of agreements require a developer to plan for maintenance prior to beginning work on the site.
2. Individual maintenance agreements allow flexibility for the unique site conditions.
3. Jurisdictions are able to test and emphasize progressive techniques and monitor the success of different types of BMPs.
4. Maintenance agreements establishing owner responsibilities create a better owner awareness and encourage involvement.

Disadvantages:

1. Individual site specific approaches require significant resources on the part of the City to administer and track.
2. As each maintenance agreement is individual to the site, some property owners may not feel they are treated equitably when compared to others.
3. When the property changes owners, the new property owner may not be familiar with the agreement made with the jurisdiction regarding maintenance.
4. City resources would be needed for monitoring and enforcement.

Option 2-Maintenance Requirements in the Jurisdictional Code - In some cases, maintenance requirements for stormwater facilities are specifically outlined in the jurisdiction's code or ordinances. Jurisdictions specify standard maintenance parameters and also identify the vehicle for maintenance guarantees.

King County, WA. code defines which facilities are accepted for maintenance, which facilities are *not* accepted for maintenance, and stipulates that maintenance shall be in compliance with King County's Surface Water Design Manual (Title 16). The code also contains language relating to Maintenance and Defect Guarantees. These are written agreements that guarantee the successful performance of a facility. Maintenance and Defect Guarantees apply to the developer warranting the successful operation and maintenance of improvements, guaranteeing the workmanship, materials, and compliance with King County Code (Title 9).

The City of Bellevue also specifies maintenance requirements and warranty periods for stormwater BMPs within chapter 24.08 of their city code.

The advantages and disadvantages of Jurisdictional Code Maintenance Requirements include:

Advantages:
1. Maintenance requirements are consistent city-wide and therefore, easier to administer and enforce than individual maintenance agreements.
2. City-wide maintenance requirements may be viewed as more equitable by developers.
3. Developers can anticipate what to expect in terms of maintenance requirements prior to beginning work on a site.
4. Incentives for user fee reductions could be included in the code.

Disadvantages:
1. Maintenance requirements may not be flexible enough to account for unique site conditions.
2. Since the requirements are in the jurisdiction's code and no specific negotiations are required, some developers may not note their obligation for stormwater facility maintenance.
3. City resources would be needed for monitoring and enforcement.

Option 3-Maintenance Permits are Issued by the Jurisdiction - Some jurisdictions establish maintenance requirements in the development permits issued to the owner or alternately they may issue individual permits that are specifically for maintenance. These are typically separate permits that must be approved by the jurisdiction prior to the beginning of any development.

The South Florida Water Management District requires a separate stormwater permit prior to land clearing. There are two types of permits issued for stormwater BMPs: General and Individual permits. General permits are issued for projects less than ten (10) acres with less than two acres of impervious surface. Individual permits are issued for projects over ten (10) acres. Both permits require erosion control plans; stormwater plans; operation and maintenance plans; engineering calculations and drawings of the proposed facility; and standards and specifications for the facility. General permits are issued by staff. Individual permits are reviewed and approved by the District's Governing Board (WMI, 1997).

Montgomery County Maryland also uses individual stormwater permits to monitor and control their stormwater facilities. Individual permits are required prior to approval of building, grading, or floodplain district permits (WMI, 1997).

The advantages and disadvantages of the stormwater permit process include:

Advantages:
1. Stormwater permits can be incorporated into permitting processes that already exist for developers.
2. A consistent permitting format may be developed to facilitate administration of the requirements.
3. Stormwater permits require the developer to think about and plan for maintenance prior to beginning work on the site.
4. Stormwater permits can provide a vehicle for the developers to become more aware of their ongoing operation and maintenance obligations.

Disadvantages:
1. May add time to already lengthy permitting processes for developers.
2. When a property changes hands new property owners may not be aware of existing permit requirements.
3. City resources would be needed for monitoring and enforcement.

4.2 Criteria That Need to Be Included in Formal Agreements

Some of the essential elements of a formal maintenance agreement and stormwater regulation that assure the successful operation and maintenance of BMPs are listed below.

- Operation and Maintenance Plans - An operation and maintenance plan and schedule should be provided to the owner or the maintenance entity. Maintenance requirements should be clearly defined to ensure proper short and long term maintenance. These requirements may be outlined in the agreement itself or the agreement may refer to maintenance requirements in the code or in a BMP design manual. Plans should stipulate what types of maintenance activities will be performed, a maintenance performance expectation, a schedule of maintenance to be performed and identification of the equipment and materials required to perform maintenance.

- Responsible Parties - The owner/permitee must assure that the facility will be properly maintained and operated at all times and managed according to the requirements of the agreement, permit, code and/or the BMP manual. When possible, one party should be identified who is responsible for facility maintenance. For larger developments, a property owners association may be responsible for stormwater system operation and maintenance. However, larger associations sometimes have difficulty providing regular maintenance due to lands being subdivided and sold. This can also be a problem with private residences which typically have multiple owners over time. Experienced urban runoff control programs around the country show that, even with the best intentions, maintenance of stormwater management facilities by large associations has generally not been adequate (WMI, 1997).

- Inspection - Inspections should be carried out by the identified responsible party or by the jurisdiction. Language should be included to provide for allowance of the jurisdiction to inspect the facility whenever they deem necessary. If the owner is other than the jurisdiction the appropriate public agency should have authority to inspect and ensure compliance with maintenance schedules and proper operation of the facility.

- Penalties - Failure to maintain facilities should be considered a permit violation and the owner/permitee should be subject to penalties established by the jurisdiction. Jurisdictions should reserve the right to perform needed maintenance and assess the owner for the cost of any fines as well as the cost of the maintenance performed.

- Potential Modifications - A clause regarding potential modifications should be included so that modifications require prior approval of the jurisdiction.

- Reporting - The frequency and type of inspections performed must be formally documented. Documentation can be provided in the form of a logbook kept by the owner or inspection reports provided by the jurisdiction. Reporting should occur as stipulated in agreements, code, or as stipulated in the BMP manual.

- Warranty Periods - Due to the variation in BMP types, soil types, facility size, sediment loading, and the contributing drainage area, entities may choose to require a waiting period prior to taking over maintenance of a facility. If posting a maintenance bond is required, the fee for the bond is typically a specified percentage of the total construction cost of the facility. A warranty period should be included if the jurisdiction is planning to take over some or all of the maintenance responsibilities (See Section 3.4).

4.3 Inspections, Enforcement and Incentives

The successful operation of stormwater facilities is highly dependent on regular maintenance. Because some owners are not aware of their maintenance responsibilities or may be negligent in performing routine maintenance, it is necessary to regularly inspect all facilities. Jurisdictions may also find the need for enforcement and, in an effort to get compliance, may offer incentives to facilitate the upkeep of BMPs as discussed below.

4.3.1 Inspections

Most jurisdictions perform inspections annually on private residential, commercial and public facilities or as defined within agreements, jurisdictional code, or permits. Agreements between an owner and a jurisdiction typically define inspection and maintenance responsibilities. Most facilities are inspected for overall proper functioning and may include a field checklist, inspection report and/or a logbook. Private owners may be required to maintain a maintenance logbook if there is a warranty period on the facility or if it is specified in the contract.

As an example, the City of Olympia enters into agreements with private and commercial residents, performs inspections annually on both types of facilities and requires that log-books be kept as part of the maintenance agreement (Blosser, 1999). Olympia inspects approximately 450 combined residential and commercial facilities within an 18.2 square mile area. The facilities

require approximately 0.4 FTE's (this is equivalent to two (2) days per week and based on approximately 1 hour/facility x 450 facilities x 1/1800 FTE/hour). Owners that are not in compliance receive letters detailing the maintenance problems and are given 30 days to comply.

The City of Bellevue Washington services approximately 31 square miles and performs inspections on private and commercial facilities. Inspections are made on approximately 1000 private detention and conveyance facilities on a biennial basis and require approximately 2 FTE's to perform inspections (Varner, 1999). Their inspectors check for proper functioning of the systems using checklists, noting any cleaning and repair requirements and will issue a "Notice to Comply" if maintenance requirements are not being met (Varner, 1999).

Within King County, approximately 1000 residential facilities and approximately 1500 commercial facilities are inspected per year. This area, including unincorporated King County, covers over 2,200 square miles and requires approximately 5 FTE'S to perform inspections (Hancock, 1999). The facilities are subject to a checklist that is specific to the type of facility. The inspectors make a determination based on the checklist whether or not proper maintenance is being performed at the sites. If the site is out of compliance, the inspector issues a "Notice to Comply" and will perform a follow-up inspection within 30 days (Hancock, 1999).

Based on the experience of the above jurisdictions, an estimate was made of the number of FTE that would be needed to conduct inspections in Eugene. The estimate is also based on the assumption that inspections would be conducted for a total of 640 stormwater facilities constructed in HDR, commercial, or industrial land uses (see Section 3.3, scenario #4). The estimated number of FTEs necessary to conduct inspections of stormwater facilities in single family residential land uses is not included here as it is accounted for in Section 3.0 of this memo. Based on these assumptions, it is estimated that approximately 1.3 FTE would be needed as shown in Table 4-1 below.

Table 4-1
Estimated FTE Needed to Conduct Inspections

Jurisdiction:	Olympia	Bellevue	King County	Eugene (estimate)
Approximate Service Area:	18.2 mi^2	31 mi^2	2,200 mi^2	47 mi^2
Estimated # of Facilities Inspected/Year:	450	1,000	2,500	640
FTE Needed Per Facility Per Year:	.001	.002	.002	.002
FTE Necessary to Conduct Inspections Per Year:	0.4	2.0	5.0	1.3

4.3.2 Enforcement

Most jurisdictions find that they rarely need to use enforcement procedures to obtain compliance. In the cases of King County and the City of Bellevue, sending a "Notice to Comply" citing specific issues that need to be addressed is usually adequate to get results (Hancock, 1999 and Varner, 1999). For both of these jurisdictions, a "Notice to Comply" is an initial letter detailing the specific nature of the infractions. In the case of the City of Bellevue, the owner is also provided with a list of contractors capable of performing the specific maintenance required (Varner, 1999). Thirty days after the initial letter, a subsequent inspection is performed by the

jurisdiction to determine if concerns have been addressed. If standards are not met the jurisdiction will typically resort to more stringent tactics (see appendices for sample, "Notice to Comply").

In the case of non-responsive owners, most jurisdictions provide language within their agreements, code, permits and/or their BMP manuals that specify the fines and the cost of repairs that may be levied against the owner. If maintenance has not been completed within thirty days, both the City of Bellevue and King County assess additional fines of up to $500 per day and in addition bill the owner for the cost of the maintenance performed (Hancock, 1999 and Varner 1999).

4.3.3 Incentives

For some facilities, bonding is required to ensure maintenance is performed. If the level of maintenance is not adequate the bond amount is forfeit and additional fines assessed. Bond amounts typically range from 10-30% of the total cost of construction. Cities that impose warranty periods on facilities, such as the City of Portland, King County and the City of Bellevue all rely on bonds posted to ensure maintenance is performed.

As an alternative incentive, King County offers a utility rate discount to private residential and commercial facilities if they perform and comply with operation and maintenance required on BMPs (Hancock, 1999). Since King County encourages detention as a BMP, owners can receive one rate level lower to their annual stormwater fee if Retention/Detention facilities are built to code and meet County maintenance standards. Also, if maintenance is completed by the time of the initial inspection owners will automatically receive a rate lower than their rate at the time of construction (see Table 4-2 below for schedule of fees).

King County annual rates are based on the amount of impervious surface and are based on the following service charge options:

Flat Rate (for Residential Facilities)
$85.02 per year for Category 1: Residential, and Category 2: Very Light Development parcels.
Sliding Rate (for Commercial Facilities)

With respect to the sliding rate, impervious surface percentages determine the rate category amount, which is multiplied by the total parcel acreage as follows:

Table 4-2: 1998 Surface Water and Land Resources Division Management Fee Rate Table		
Percent Impervious Surface	**Rate Category**	**Rate**
n/a	Category 1: Residential Development	$85.02 per acre
<10	Category 2: Very Light Development	$85.02 per acre
11-20	Category 3: Light Development	$198.40 per acre
21-45	Category 4: Moderate Development	$410.98 per acre
46-65	Category 5: Moderately Heavy Development	$793.60 per acre
66-85	Category 6: Heavy Development	$1,006.16 per acre
86-100	Category 7: Very Heavy Development	$1,317.94 per acre
	Minimum Rate	$85.02 per acre
	Light Discount	$85.02 per acre
	Residential/Very Light Discount	$42.51 per acre
King County 1999		

Many jurisdictions offer lower utility rates at the start of the project for developers who incorporate Retention/Detention. In these cases, generally no rate adjustments are made for performing maintenance after the facility is in operation. As an example, the City of Bellevue offers a lower utility rate if the developer incorporates Retention/Detention on their site (Varner, 1999), and the City of Olympia starts with a preferred rate based on impervious surface and makes no adjustments for performance of on-going maintenance (Blosser, 1999). These apply to both commercial and residential facilities. However, in all of these cases rates can be increased as an incentive to perform maintenance if compliance is not met.

5.0 Summary/Recommendations

To be completed.

References

Blosser, 1999. *Personal Communication with Mark Blosser*, City of Olympia Water Resources Division. October 1999.

Hancock, 1999. *Personal Communication with David Hancock*, King County Water and Land Resources Division. October 1999.

King County, 1998. *Surface Water Design Manual*, King County, Washington. September 1998.

Noble, 1999. *Personal Communication with Sun Noble*, City of Portland Permitting Department. October 1999.

Varner, 1999. *Personal Communication with Phyllis Varner*, City of Bellevue Water Resources Department. October 1999.

Washington State Department of Ecology. *Stormwater Management Manual for the Puget Sound Basin*. 1992.

Watershed Management Institute. *Operation, Maintenance and Management of Stormwater Systems*. 1997.

Watershed Management Institute. *Stormwater Management System Inspection Forms from: Operation, Maintenance and Management of Stormwater Systems*. 1997.

Appendices

City of Alexandria Virginia
"Standard Maintenance and Monitoring Agreement"
"BMP Facilities Maintenance/Monitoring Agreement"

City of Olympia Washington
"Commercial, Industrial Agreement to Maintain Stormwater Management Facilities and to Implement A Pollution Control Plan"

City of Olympia Washington
"Residential Agreement to Maintain Stormwater Management Facilities and to Implement A Pollution Control Plan"

State of Delaware
"Notice to Comply Inspection Report Form"

State of Delaware
"Construction Inspection Report Form"

King County Washington
"Maintenance and Defect Agreement"

City of Gresham Oregon
"Agreement to Maintain Stormwater Detention Facilities"

City of Gresham Oregon
Draft
"Residential Agreement to Maintain Stormwater Facilities and to Implement a Pollution Source Control Plan"

City of Alexandria Virginia
"Standard Maintenance and Monitoring Agreement"
"BMP Facilities Maintenance/Monitoring Agreement"

City of Alexandria, Virginia

Standard Maintenance and Monitoring Agreement
BMP Facilities Maintenance/Monitoring Agreement

THIS AGREEMENT, made and entered into this _____ day of _____, 19__, by and between _____, herein called the "Landowner" and the City of Alexandria, Virginia (the "City")

WITNESSETH

WHEREAS the Landowner is the owner of certain real property described _____ as acquired by deed in the land records of the City of Alexandria, Virginia, Deed Book _____ at Page _____, hereinafter called the "Property".

WHEREAS, the Landowner is proceeding to build on and develop the property; and

WHEREAS, Plan of Development/Site Plan/Subdivision Plan _____, hereinafter called the "Plan" which is expressly made a part hereof, as approved or to be approved by the City, provides for detention on-site treatment of stormwater runoff within the confines of the property; and

WHEREAS, the City and the Landowner, its successors and assigns agree that the health, safety, and welfare of the residents of the City of Alexandria, Virginia, require that on-site stormwater management facilities be constructed and maintained on the property; and

WHEREAS, the City requires that on-site stormwater management facilities as shown on the Plan be constructed and adequately maintained by the Landowner, its successors and assigns.

NOW, THEREFORE, in consideration of the foregoing premises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto agree as follows:

1. The on-site stormwater management facilities shall be constructed by the Landowner, its successors and assigns, in accordance with the plans and specifications identified in the plans.

2. The Landowner, its successors and assigns, shall maintain the stormwater management facilities in good working condition, acceptable to the City, so that they are performing their design functions.

3. The Landowner, its successors and assigns, hereby grants permission to the City, its authorized agents and employees, to enter upon the property, and to inspect the stormwater management facilities whenever the City deems necessary. The purpose of the inspection is to assure safe and proper functioning of the facilities. The inspection shall cover the entire facilities, berms, outlet structures, pond areas, access roads, etc.

When deficiencies are noted, the City shall give the Landowner, its successors and assigns, copies of the inspection report with findings and evaluations.

4. In the event the Landowner, its successors and assigns, fails to maintain the stormwater management facilities in good working condition acceptable to the City, the City may enter upon the Property and take whatever steps it deems necessary to maintain said stormwater management facilities and to charge the costs of the repairs to the Landowner, its successors and assigns. This provision shall not be construed to allow the City of Alexandria to erect any structure of a permanent nature on the land of the Landowner, outside of an easement belonging to the City. It is expressly understood and agreed that the City is under no obligation to maintain or repair said facilities, and in no event shall this Agreement be construed to impose any such obligation on the City.

5. The Landowner, its successors and assigns, will perform maintenance in accordance with the maintenance schedule for the stormwater management facilities including sediment removal as outlined on the approved plans and the following specific requirements:

   For extended dry detention facilities, wet ponds, or infiltration facilities, insert the following:

   Maintenance of the (Insert type of facility) shall conform to the maintenance requirements contained in the Northern Virginia BMP Handbook published by the Northern Virginia Planning District Commission.

   For unconventional BMPs for which design criteria is provided in the Design Manual, insert the following:

   Maintenance of the (insert type of facility) shall conform to the maintenance requirements contained in Chapter 2 of the Alexandria Supplement to the Northern Virginia BMP Handbook.

   For unconventional BMP's not detailed in Chapter 2 of this manual and for experimental BMP's, insert specific maintenance requirements as approved by the Director of Transportation and Environmental Services prior to release of the Final Site Plan.

6. In the event the City, pursuant to this Agreement, performs work of any nature, or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like on account of the Landowner's or its successors' and assigns, shall reimburse the City upon demand, within _____ days of receipt thereof for all costs incurred by the City hereunder. If not paid within such _____ day period, the City shall have a lien against the property in the amount of such costs, plus interest at the Judgment Rate, and may enforce same in the same manner as a lien for real property taxes may be enforced.

7. The Landowner, its successors and assigns, shall indemnify and hold harmless the City and its agents and employees for any and all damages, accidents, casualties, occurrences or claims which might arise or be asserted against the City for the construction, presence, existence or maintenance of the stormwater management facilities by the Landowner, its successors and assigns.

   In the event a claim is asserted against the City, its agents or employees, the City shall promptly notify the Landowners, their successors and assigns, and they shall defend, at their own expense, any suit based on such claim. If any judgment or claims against the City, its agents or employees shall be allowed, the Landowner, its successors and assigns shall pay all costs and expenses in connection therewith.

   The following additional paragraph shall be added for all agreements covering non-conventional or experimental BMP's.

8. The Landowner, its successors and assigns, hereby grants permission to the City, its authorized agents and employees, and to the Northern Virginia Planning District Commission, its authorized agents, employees and consultants, to enter upon the property, and to install, operate and maintain equipment to monitor the flow rate and pollutant content of the input flow, the effluent, and at intermediate points in the BMP. The Landowner further agrees to design and construct the facility to provide access for monitoring. The Landowner further agrees to a contribution of (as established during the Site Plan approval process _____ in the case of experimental BMP's) the entire cost of the monitoring program, payable prior to the release of the Final Site Plan, towards the cost of the monitoring program.

8. or 9. This Agreement shall be recorded among the land records of the City of Alexandria, Virginia, and shall constitute a covenant running with the land and/or equitable servitude, and shall be binding on the Landowner, its administrators, executors, assigns, heirs and any other successors in interests.

WITNESS the following signatures and seals:

_____

(Landowner) (Seal)

By: _____

_____

Type Name

_____

Type Name

ATTEST:

_____

STATE OF _____

CITY OF _____

I, _____, a Notary Public in and for the City and State aforesaid, whose commission expires on the _____ day of _____, 19___, do hereby certify that _____ whose name(s) is/are signed to the foregoing Agreement bearing date of the _____ day of _____, 19___, has acknowledged the same before me in my said City and State.

GIVEN UNDER MY HAND THIS _____ day of _____, 19___.

_____
NOTARY PUBLIC

WITNESS the following signatures and seals:

_____
Director, Department of T & ES (Seal)

By: _____

_____
Type Name

_____
Type Name

ATTEST:

_____

STATE OF _____

CITY OF _____

I, _____, a Notary Public in and for the City and State aforesaid, whose commission expires on the _____ day of _____, 19___, do hereby certify that _____ whose name(s) is/are signed to the foregoing Agreement bearing date of the _____ day of _____, 19___, has acknowledged the same before me in my said City and State.

GIVEN UNDER MY HAND THIS _____ day of _____, 19___.

_____
NOTARY PUBLIC

City of Olympia Washington
"Commercial, Industrial Agreement to Maintain Stormwater Management Facilities and to Implement A Pollution Control Plan"

Commercial, Industrial Agreement to Maintain Stormwater Management Facilities and to Implement A Pollution Prevention Plan

The upkeep and maintenance of stormwater management facilities and the implementation of pollution prevention plans is essential to the protection of aquatic resources. All property owners are expected to conduct business in a manner that promotes resource protection. This Agreement contains specific provisions with respect to maintenance of stormwater management facilities and use of pollution prevention practices.

LEGAL DESCRIPTION:

Whereas, Business Name, has constructed improvements, including but not limited to, buildings, pavement, and stormwater management facilities on the property described above. In order to further the goals of the Jurisdiction to ensure the protection and enhancement of Jurisdiction's aquatic resources, the Jurisdiction and Business Name hereby enter into this Agreement. The responsibilities of each party to this Agreement are identified below.

BUSINESS NAME SHALL:

1. Implement the stormwater management facility maintenance program included herein as Attachment "A". (maintenance checklist similar to that developed in Chapter 7)

2. Implement the pollution prevention plan included herein as Attachment "B". (parking lot maintenance, covering outdoor storage areas, etc.)

3. Maintain a record (in the form of a logbook) of steps taken to implement the programs referenced in (1) and (2) above. The logbook shall be available for inspection by Jurisdiction staff at _____ during normal business hours. The logbook shall catalog the action taken, who took it, when the action was done, how it was done, and any problems encountered or follow-on actions recommended. Maintenance items ("problems") listed in Attachment "A" shall be inspected on a monthly or more frequent basis as necessary. Business Name is encouraged to photocopy the individual checklists in Attachment "A" and use them to complete its monthly inspections. These completed checklists would then, in combination, comprise the monthly logbook.

4. Submit an annual report to the Jurisdiction regarding implementation of the programs referenced in (1) and (2) above. The report must be submitted on or before _____ of each calendar year and shall contain, at a minimum, the following items:

   A. Name, address, and telephone number of the business, the person, or the firm responsible for plan implementation, and the person completing the report.
   B. Time period covered by the report.
   C. A chronological summary of activities conducted to implement the program referenced in (1) and (2) above. A photocopy of the applicable sections of the logbook, with any

additional explanation needed, shall normally suffice. For any activities conducted by paid parties not affiliated with Business Name include a copy of the invoice for services.

D. An outline of planned activities for the next year.

THE JURISDICTION SHALL:

1. Provide technical assistance to Business Name in support of its operation and maintenance activities conducted pursuant to its maintenance and pollution prevention control programs. Said assistance shall be provided upon request, and as Jurisdiction time and resources permit, at no charge to Business Name.

2. Review the annual report and conduct a minimum of one (1) site visit per year to discuss performance and problems with Business Name.

3. Review this agreement with Business Name and modify it as necessary at least once every three (3) years.

REMEDIES

1. If the jurisdiction determines that maintenance or repair work is required to be done to the stormwater management facility existing on the Business Name property, the Jurisdiction shall give the owner of the property within which the facility is located, and the person or agent in control of said property, notice of the specific maintenance and/or repair required. The Jurisdiction shall set a reasonable time in which such work is to be completed by the persons who were given notice. If the above required maintenance and/or repair is not completed within the time set by the Jurisdiction, written notice will be sent to the persons who were given notice stating the Jurisdiction's intention to perform such maintenance and bill the owner for all incurred expenses. The Jurisdiction may also revoke stormwater runoff utility rate credits for the quality component or invoke surcharges to the quantity component of the Business Name bill if required maintenance is not performed.

2. If at any time the Jurisdiction determines that the existing facility creates any imminent threat to public health or welfare, the Jurisdiction may take immediate measures to remedy said threat. No notice to the persons, listed in (1) above, shall be required under such circumstances.

3. The owner grants unrestricted authority to the Jurisdiction for access to any and all stormwater management facility features for the purpose of performing maintenance or repair as may become necessary under Remedies (1) and (2).

4. The persons, listed in (1) above, shall assume all responsibility for the cost of any maintenance and for repairs to the stormwater management facility. Such responsibility shall include reimbursement to the Jurisdiction within 30 days of the receipt of the invoice for any such work performed. Overdue payments will require payment of interest at the current legal rate for liquidated judgments. If legal action ensues, any costs or fees incurred by the Jurisdiction will be borne by the parties responsible for said reimbursements.

5. The owner hereby grants to the Jurisdiction a lien against the above-described property in an amount equal to the cost incurred by the Jurisdiction to perform the maintenance or repair work described herein.

This Agreement is intended to protect the value and desirability of the real property described above and to benefit all the citizens of the Jurisdiction. It shall run with the land and be binding on all parties having or acquiring from Business Name or their successors any right, title, or interest in the property or any part thereof, as well as their title, or interest in the property or any part thereof, as well as their heirs, successors, and assigns. They shall inure to the benefit of each present or future successor in interest of said property or any part thereof, or interest therein, and to the benefit of all citizens of the Jurisdiction.

Agreed to and signed by:

_____

Owner Date

STATE OF WASHINGTON, COUNTY OF THURSTON

On this day and year, the above personally appeared before me and provided photo identification, and who executed the foregoing instrument and acknowledge that they signed the same as their free and voluntary act and deed for the uses and purposes therein mentioned.

Given under my hand and official seal this _____ day of _____, 199__

Notary Public in and for the State of
Washington, residing in _____
My commission expires _____

Dated in Olympia, Washington, this _____ day of _____, 199__

STATE OF WASHINGTON, COUNTY OF THURSTON

On this day and year, personally appearing before me, _____ and _____ , who executed the foregoing instrument and acknowledge the said instrument to be the free and voluntary act and deed of said Municipal Corporation for the uses and purposes therein mentioned and on oath states he is authorized to execute said instrument.

Given under my hand and official seal this _____ day of _____, 199__

Notary Public in and for the State of
Washington, residing in _____
My commission expires _____

Dated in Olympia, Washington, this _____ day of _____, 199__

City of Olympia Washington
"Residential Agreement to Maintain Stormwater Management Facilities and to Implement A Pollution Control Plan"

Residential Agreement to Maintain Stormwater Management Facilities and to Implement a Pollution Prevention Plan

The upkeep and maintenance of stormwater management facilities and the implementation of pollution prevention best management practices is essential to the protection of aquatic resources. All property owners are expected to conduct business in a manner that promotes resource protection. This Agreement contains specific provisions with respect to maintenance of stormwater management facilities and use of pollution prevention practices.

LEGAL DESCRIPTION

Whereas, the _____ have constructed improvements, including but not limited to buildings, pavement, and stormwater management facilities on the property described above. In order to further the goals of the Jurisdiction to ensure the protection and enhancement of aquatic resources, the Jurisdiction and the _____ hereby enter into this Agreement. The responsibilities of each party to this Agreement are identified below.

_____ SHALL

1. Implement the stormwater management facility maintenance program included herein as Attachment "A". (maintenance checklist similar to that developed in Chapter 7)

2. Implement the pollution prevention plan included herein as Attachment "B". (homeowner responsibilities such as disposal of household wastes, lawn care, etc.)

3. Maintain a record (in the form of a log book) of steps taken to implement the programs referenced in (1) and (2) above. The log book shall be available for inspection by appointment at _____. The log book shall catalog any action taken, who took the action, when it was taken, how it was done, and any problems encountered or follow-on actions recommended. Maintenance items ("problems") listed in Attachment "A" shall be inspected as specified in the attached instructions or more often if necessary. The _____ are encouraged to photocopy the individual checklists in Attachment "A" and use them to complete its inspections. These completed checklists would then, in combination, comprise the logbook.

4. Submit an annual report to the Jurisdiction regarding implementation of the programs referenced in (1) and (2) above. The report must be submitted on or before _____, 199_ and each calendar year and shall contain, at a minimum, the following items:

   A. Name, address, and telephone number of the businesses, the persons, or firms responsible for plan implementation, and the persons completing the report.
   B. Time period covered by the report.
   C. A chronological summary of activities conducted to implement the programs referenced in (1) and (2) above. A photocopy of the applicable sections of the logbook,

with any additional explanations needed, shall normally suffice. For any activities conducted by paid parties, include a copy of the invoice for services.

D. An outline of planned activities for the next year.

THE JURISDICTION SHALL:

1. Execute the following periodic major maintenance on the subdivision's stormwater management facilities: sediment removal from facilities, managing vegetation in wet ponds, resetting orifice sizes and elevations, and adding baffles.

2. Maintain all stormwater management facility elements in the public rights-of-way, such as catch basins, oil-water separators, and pipes.

3. Provide technical assistance to the _____ in support of its operation and maintenance activities conducted pursuant to its maintenance and source control programs. Said assistance shall be provided upon request and as Jurisdictions time and resources permit.

4. Review the annual report and conduct a minimum of one (1) site visit per year to discuss performance and problems with the _____.

5. Review the agreement with the _____ and modify it as necessary at least once every three (3) years.

REMEDIES

1. If the Jurisdiction determines that maintenance or repair work is required to be done to the stormwater management facilities located in the subdivision, the Jurisdiction shall give the _____ notice of the specific maintenance and/or repair required. The Jurisdiction shall set a reasonable time in which such work is to be completed by the persons who were given notice. If the above required maintenance and/or repair is not completed within the time set by the Jurisdiction, written notice will be sent to the _____ stating the Jurisdiction's intention to perform such maintenance and bill the _____ for all incurred expenses.

2. If, at any time, the Jurisdiction determines that the existing facility creates any imminent threat to public health or welfare, the Jurisdiction may take immediate measures to remedy said threat. No notice to the persons listed in Remedies (1), above, shall be required under such circumstances. All other _____ responsibilities shall remain in effect.

3. The _____ grant unrestricted authority to the Jurisdiction for access to any and all stormwater management facilities for the purpose of performing maintenance or repair as may become necessary under Remedies (1) and/or (2).

4. The _____ shall assume responsibility for the cost of maintenance and repairs to the stormwater management facilities, except for those maintenance actions

explicitly assumed by the Jurisdiction in the preceding section. Such responsibility shall include reimbursement to the Jurisdiction within 90 days of the receipt of the invoice for any such work performed. Overdue payments will require payment of interest at the current legal rate for liquidated judgements. If legal action ensues, any costs or fees incurred by the Jurisdiction will be borne by the parties responsible for said reimbursements.

This Agreement is intended to protect the value and desirability of the real property described above and to benefit all the citizens of the Jurisdiction. It shall run with the land and be binding on all parties having or acquiring any right, title, or interest, or any part thereof, of real property in the subdivision. They shall inure to the benefit of each present or future successor in interest of said property or any part thereof or interest therein, and to the benefit of all citizens of the Jurisdiction.

Agreed to and signed by:

_____

Owner Date

STATE OF WASHINGTON, COUNTY OF THURSTON

On this day and year, the above personally appeared before me and provided photo identification, and who executed the foregoing instrument and acknowledge that they signed the same as their free and voluntary act and deed for the uses and purposes therein mentioned.

Given under my hand and official seal this _____ day of _____, 199__

Notary Public in and for the State of
Washington, residing in _____
My commission expires _____

Dated in Olympia, Washington, this _____ day of _____, 199__

STATE OF WASHINGTON, COUNTY OF THURSTON

On this day and year, personally appearing before me,_____ and _____ , who executed the foregoing instrument and acknowledge the said instrument to be the free and voluntary act and deed of said Municipal Corporation for the uses and purposes therein mentioned and on oath states he is authorized to execute said instrument.

Given under my hand and official seal this _____ day of _____, 199__

Notary Public in and for the State of
Washington, residing in _____
My commission expires _____

Dated in Olympia, Washington, this _____ day of _____, 199__

State of Delaware
"Notice to Comply Inspection Report Form"

Notice to Comply Inspection Report Form

(adapted from State of Delaware Sediment and Stormwater Program)

Date _____

To: _____

Address: _____

_____

Project/Site/Contract Name _____

An inspection of the above referenced project on _____(Date) revealed that the site is not in compliance with the approved Sediment Control and Stormwater Management Plan, approved Plan amendments, Law, or Regulations, and the following violations exist:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Notice is hereby given that the above violations shall be corrected in accordance with the approved Sediment Control and Stormwater Management Plan, approved Plan amendments, Law, or Regulations on or before _____ (Date). The site will be reinspected at that time to determine if the site has been brought into compliance with the approved Plan, approved Plan amendments, Law, or Regulations.

Failure to comply with this notice will result in the initiation of legal action by the Department in order to bring the site into compliance with the approved Plan, approved Plan amendments, Law, or Regulations.

_____ _____

Received by Inspector

I hereby acknowledge receipt of this notice to comply. My signature does not imply agreement or disagreement with its content.

Questions or comments regarding this inspection report should be directed to the appropriate inspection agency at the appropriate address and phone number

white: developer/contractor yellow: file pink: legal/enforcement

State of Delaware
"Construction Inspection Report Form"

Construction Inspection Report Form

(adapted from State of Delaware Sediment and Stormwater Program)

Date _____ Time _____

Project _____

Location _____

Individual Contacted _____

Weather Conditions _____

Site Status _____ (active, inactive, completed)

Site Conditions:

acceptable _____
Unacceptable _____
In compliance with approved plan _____
Approved plan is adequate for the site _____

Written Comments:

_____
_____
_____
_____
_____
_____
_____

Action to be taken:

No action necessary. Continue routine inspections _____
Correct noted site deficiencies by _____
1st notice _____
2nd notice _____
Submit plan modifications as noted in written comments by _____
Notice to Comply issued _____
Final inspection, project completed _____
Other _____

_____ _____
Received by Inspector

I acknowledge receipt of this inspection report. My signature does not imply agreement or disagreement with its content

Questions or comments regarding this inspection report should be directed to the appropriate inspection agency the appropriate address and phone number.

white: developer/contractor yellow: file pink: legal/enforcement

King County Washington
"Maintenance and Defect Agreement"

MAINTENANCE AND DEFECT AGREEMENT (Two Years) For public roads and drainage facilities	Applicant's Name and Address
Agreement Number	Project Number and Name
Guarantee Amount	Site Location/Section

This AGREEMENT is made and entered into this _____ day of _____, 19___, between the King County Department of Transportation, Road Services Division, hereinafter called the COUNTY, and the above named APPLICANT, hereinafter called APPLICANT.

Basis for AGREEMENT:

WHEREAS the undersigned APPLICANT has constructed public roads and/or drainage facilities in connection with the above-referenced project; and

WHEREAS the APPLICANT has agreed to secure the successful maintenance and operation of said improvements for the referenced projects pursuant to King County Ordinance 12020 and King County Code Title 14 and 19;

NOW THEREFORE, the APPLICANT hereby agrees and binds itself and it's legal representatives, successors, and assigns as follows:

ms of the AGREEMENT:

1. The improvements constructed by the APPLICANT or his representative shall successfully operate and shall remain free of defects in design, workmanship, materials, and design for a period of two years from the date of satisfactory completion of the improvements or final plat approval, whichever is later. As used in this AGREEMENT, the term "defects" includes but is not limited to, damage resulting from construction activities and/or use during the two year period.
2. The APPLICANT is responsible for maintenance of the public road and drainage facilities, including the roadway surface for the two year period from the date of satisfactory construction approval or final plat approval, whichever is later.
3. In the event of any failure of the improvements to satisfactorily operate or in the event of a defect in design, workmanship or materials, the APPLICANT shall promptly and adequately repair and/or correct the failure or defect.
4. The COUNTY will perform maintenance inspections during the two year period.
5. During the two year period upon notification by the COUNTY, the APPLICANT shall correct and/or make repairs to the right-of-way improvements within the time period specified by the COUNTY when defects in the design, workmanship, or materials occur.
6. In the event the COUNTY determines that repairs must be performed immediately to prevent risk to person(s) and property, the COUNTY may make necessary repairs and the costs of those repairs shall be paid by the APPLICANT upon demand.
7. The APPLICANT shall pay all required fees in accordance with King County Code.
8. At the end of the two year period, the APPLICANT shall clean the drainage system prior to the COUNTY's final inspection.

City of Gresham Oregon
"Agreement to Maintain Stormwater Detention Facilities"

This Box For Multnomah County Recordin[illegible]Use Only

AFTER RECORDING, RETURN TO
UTILITY BILLING SECTION
RECORDING SERVICES
CITY OF GRESHAM
1333 NW EASTMAN PARKWAY
GRESHAM, OR 97030-3813

AGREEMENT TO MAINTAIN STORMWATER DETENTION FACILITIES

This agreement is made and entered into this _____ day of _____, 1997, by and between the City of Gresham, a municipal corporation of the State of Oregon (hereinafter known as CITY), and _____, (hereinafter known as OWNER).

RECITALS

1. OWNER has developed stormwater detention facilities located at **(Legal description of property, e.g., subdivision name and plat number, number of last recorded deed for total property, etc.)** to enable development of the property while mitigating the impacts of the additional surface water runoff that will be created by the addition of impervious surface area. The facilities consist of the following: **(Detailed description of system — feet of pipe and size, number of catch basins, size of detention pipe, etc.)**

2. OWNER has had stormwater detention facilities designed by a registered professional engineer to accommodate the anticipated volume of runoff and detain said runoff in a manner so as to release it at a volume no greater than would naturally occur on the undeveloped site during a 25-year/24-hour return storm event.

3. The construction of the stormwater detention facilities implies that maintenance will be necessary as long as the facilities shall exist for the purposes of detaining stormwater runoff.

4. CITY and OWNER agree that effective maintenance of said facilities may best be facilitated by regular inspections, not less than twice a year, those times being generally defined as once in the early spring and again in the fall prior to the onset of fall rains.

5. This agreement shall exist in perpetuity unless otherwise terminated by CITY and shall be binding on OWNER, OWNER's heirs, successors and assigns.

NOW, THEREFORE, the premises being in general as stated in the foregoing RECITALS, it is agreed by and between the parties hereto as follows:

I. INSPECTION

The OWNER shall inspect the facilities for maintenance items noted in Appendix A twice a year. One inspection shall occur prior to the onset of fall rains during the period of September 1 to October 15, and a second inspection shall occur in early spring during the period April 1 to May 31.

II. DEFICIENCIES

All deficiencies shall be noted as identified and consistent with Appendix A attached hereto and by reference incorporated herein.

III. CORRECTIONS

All deficiencies noted must be corrected within thirty (30) days at OWNER's expense.

IV. CITY INSPECTIONS

CITY reserves the right to inspect the stormwater detention facilities and to make determinations if maintenance is necessary or deficiencies need to be corrected. In any such case OWNER will be notified in writing through the US Mail of said noted deficiencies and requested to make corrections. If corrections are not completed within thirty (30) days of such notification, CITY reserves the right to have the work done and to bill OWNER accordingly. OWNER agrees to incur any costs associated with corrective action or maintenance activities performed by CITY following OWNER notification and failure to timely facilitate maintenance or repair of said stormwater detention facilities.

V. FORCE AND EFFECT

This Agreement has the same force and effect as any deed covenant running with the land and shall be binding on all owners, past, present and future, their heirs, successors and assigns.

VI. AMENDMENTS

The terms of this Agreement may be amended by mutual agreement of the parties. Any amendments shall be in writing and shall refer specifically to this Agreement and shall be valid only when executed by both parties to this Agreement and attached hereto.

VII. PREVAILING PARTY

In any action brought by either party to enforce the terms of this Agreement, the prevailing party shall be entitled to recover all costs, including reasonable attorney's fees as may be determined by the court having jurisdiction, including any appear therefrom.

VIII. SEVERABILITY

The invalidity of any section, clause, sentence, or provision of this Agreement shall not affect the validity of any other part of this Agreement which can be given effect without such invalid part or parts.

IN WITNESS WHEREOF, OWNER has set his hand and seal the day and year first above written, and CITY has caused these presents to be signed in its name by its City Manager, attested to the day and year first above written.

CITY OF GRESHAM OWNER

_____ _____

Bonnie R. Kraft, City Manager

APPROVED AS TO FORM:

_____

City Attorney

STATE OF OREGON)
) ss.
COUNTY OF MULTNOMAH)

On this _____ day of _____ , 1997, before me, a Notary Public in and for the State of Oregon, personally appeared Bonnie R. Kraft, known to me to be the person who executed the within instrument on behalf of the City of Gresham, and acknowledged to me that she executed the same for the purposes therein stated.

_____
Notary Public for Oregon
My commission expires:

STATE OF OREGON)
) ss.
COUNTY OF MULTNOMAH)

On this _____ day of _____ , 1997, before me, a Notary Public in and for the State of Oregon, personally appeared _____, known to me to be the person who executed the within instrument, and acknowledged to me that he/she executed the same for the purposes therein stated.

_____
Notary Public for Oregon
My commission expires:

City of Gresham Oregon
Draft
"Residential Agreement to Maintain Stormwater Facilities and to Implement a Pollution Source Control Plan"

DRAFT

RESIDENTIAL AGREEMENT TO MAINTAIN
STORMWATER FACILITIES AND TO IMPLEMENT A
POLLUTION SOURCE CONTROL PLAN
BY AND BETWEEN

THEIR HEIRS, SUCCESSORS, OR ASSIGNS
(HEREINAFTER "_____")

The upkeep and maintenance of stormwater facilities and the implementation of pollution source control best management practices (BMPs) are essential to the protection of water resources. All property owners are expected to conduct business in a manner that promotes environmental protection. This Agreement contains specific provisions with respect to maintenance of stormwater facilities and implementation of pollution source control BMPs.

LEGAL DESCRIPTION:

Whereas, the _____ have constructed improvements, including but not limited to, buildings, pavement, and stormwater facilities on the property described above. In order to further the goals of the City to ensure the protection and enhancement of water resources, the City and the _____ hereby enter into this Agreement. The responsibilities of each party to this Agreement are identified below.

_____SHALL:

(1) Implement the stormwater facility maintenance program included herein as Attachment "A".

(2) Implement the pollution source control program. Contact City for assistance.

(3) Maintain a record (in the form of a log book) of steps taken to implement the programs referenced in (1) and (2) above. The log book shall be available for inspection by appointment at _____. The logbook shall catalog the action taken, who took it, when it was done, how it was done, and any problems encountered or follow-up on actions recommended. Maintenance items ("problems") listed in Attachment "A" shall be inspected as specified in the attached instructions or more often if necessary. The _____ are encouraged to photocopy the individual checklists in Attachment "A" and use them to complete its inspections. These completed checklists would then, in combination, comprise the log book.

THE CITY SHALL:

(1) Execute the following periodic maintenance activities on the subdivision's stormwater facilities: sediment removal from ponds, managing vegetation in wet ponds, resetting orifice sizes and elevations, and adding baffles.

(2) Maintain all stormwater system elements in the public rights-of-way, such as catch basins, oil-water separators, and pipes.

(3) Provide technical assistance to the _____ in support of its operation and maintenance activities conducted pursuant to its maintenance and pollution source control programs. Said assistance shall be provided upon request and as City time and resources permit.

(4) Review this agreement with the _____ and modify it as necessary at least once every five (5) years.

REMEDIES:

(1) If the City determines that maintenance or repair work is required to the stormwater facilities located in the subdivision, the City shall give the _____ notice of the specific maintenance and/or repair required. The City shall set a reasonable time in which such work is to be completed by the persons who were given notice. If the above required maintenance and/or repair is not completed within the time set by the City, written notice will be sent to the _____ stating the City's intention to perform such maintenance and bill the _____ for all incurred expenses.

(2) If at any time the City determines that the existing system creates any imminent threat to public health or welfare, the City may take immediate measures to remedy said threat. No notice to the persons listed in Remedies (1), above, shall be required under such circumstances. All other _____responsibilities shall remain in effect.

DRAFT

(3) The _____ grant unrestricted authority to the City for access to any and all stormwater system features for the purpose of performing maintenance or repair as may become necessary under Remedies (1) and/or (2).

(4) The _____ shall assume responsibility for the cost of maintenance and repairs to the stormwater facilities, except for those maintenance actions explicitly assumed by the City in the preceding section. Such responsibility shall include reimbursement to the City within 90 days of the receipt of the invoice for any such work performed. Overdue payments will require payment of interest at the current legal rate for liquidated judgements. If legal action ensues, any costs or fees incurred by the City will be borne by the parties responsible for said reimbursements.

This Agreement is intended to protect the value and desirability of the real property described above and to benefit all the citizens of the City. It shall run with the land and be binding on all parties having or acquiring any right, title, or interest, or any part thereof, of real property in the subdivision. They shall inure to the benefit of each present or future successor in interest of said property or any part thereof, or interest therein, and to the benefit of all citizens of the City.

_____
Owner

_____
Owner

STATE OF OREGON) ss
COUNTY OF MULTNOMAH)

On this day and year above personally appeared before me, _____ and _____ known to be the individual (s) described, and who executed the foregoing instrument and acknowledge that they signed the same as their free and voluntary act and deed for the uses and purposes therein mentioned.

Given under my hand and official seal this _____day of _____, _____.

_____
Notary Public in and for the State of Oregon, residing in _____
My commission expires: _____
Dated at Gresham, Oregon, this _____ day of _____. _____.

STATE OF OREGON)
COUNTY OF MULTNOMAH)

On this day and year above personally appeared before me, _____ and _____ known to be the individual (s) described, and who executed the foregoing instrument and acknowledge that they signed the same as their free and voluntary act and deed for the uses and purposes therein mentioned.

Given under my hand and official seal this _____day of _____, _____.

_____
Notary Public in and for the State of Oregon, residing in _____
My commission expires: _____
APPROVED AS TO FORM:

_____

MEMORANDUM

TO: Eugene Stormwater Management DAC

FROM: Basin Planning Project Team

SUBJECT: **UPDATE - Maintenance Strategy and Implications**

DATE: January 26, 2000

On December 7, 1999, the DAC received a memorandum that described our recommendations with regards to maintenance responsibilities for water quality facilities constructed in response to the proposed water quality development standard. The memo included the following:

- a maintenance strategy for the proposed water quality development standard,
- estimated implications to City maintenance costs and staffing associated with public maintenance responsibilities, and
- public roles and staffing requirements to assure private maintenance is conducted.

At the time the memo was produced, a proposed water quality standard had been developed. However, a specific recommendation had not been made with respect to where the standard would apply. Therefore, the information presented in the original maintenance memo was based on an assumption that the standard would apply to all parcel sizes (regardless of land use) greater than or equal to 9,000ft^2.

A recommendation has now been made with respect to where the standards should apply. The purpose of this memo is to provide an update of maintenance implications based on the current recommendation. The current recommendation is not based strictly on parcel size. It is based on development size for residential developments, and it is based on square footage of impervious surface for high density residential (HDR), commercial, and industrial developments. For the purpose of updating the maintenance implications, the current recommendations for applying the standards have been converted to equivalent parcel sizes. For residential developments we have proposed that the standard will apply to developments that are larger than minor land divisions. A minor land division represents three lots. As the minimum lot size in Eugene is 4,500ft^2, the standard could therefore apply to parcel sizes >13,500ft^2 (i.e., 3 x 4,500ft^2). For HDR/Com/Indus developments we propose that the standard should apply to parcels with $\geq$3,000ft^2 of impervious surface. If HDR/Com/Indus developments are an average of 80% impervious, then this would convert to a parcel size of 3,750ft^2 (i.e., 80% x 3,750ft^2 = 3,000ft^2). These parcel sizes were used to determine whether there would be a significant change in the estimates of maintenance implications.

As shown in the original memo, the maintenance implication estimates based on $\geq 9{,}000 ft^2$ parcel sizes are as follows:

Land Use	Cost in Millions of Dollars	FTE Required
Residential	$1.2	6
HDR/Com./Indus.	$0.4	3
Total:	**$1.6**	**9**

Based on revised parcel size estimates, the changes in magnitude of maintenance implications are estimated to be as follows:

Land Use	Cost in Millions of Dollars	FTE Required
Residential	$1.2	6
HDR/Com./Indus.	$0.6	5
Total:	**$1.8**	**11**

With respect to residential land use, the estimated maintenance costs and FTEs went down by a small amount when applying the standard to $>13{,}500 ft^2$ instead of $\geq 9{,}000 ft^2$. And, once the numbers were rounded to the nearest $0.1 million and nearest 1 FTE, the difference was not apparent.

With respect to the HDR/Com/Indus land use, the estimated maintenance costs and required FTEs could potentially increase by up to $0.2 million and 2 FTE respectively. This change is in response to applying the standard to HDR/Com/Indus lots $\geq 3{,}750 ft^2$ instead of $\geq 9{,}000 ft^2$.

APPENDIX J

CAPITAL PROJECT PRIORITIZATION

URS Corporation

To: DevCore From: Water Resources Staff Group

Date: March 29, 2000 (with updates as noted from July 8, 2002)

Subject: **Status of the Capital Project Selection and Prioritization Process**

The following text provides a summary of the steps that were taken to: 1) develop a stormwater CP list, 2) screen the list, and 3) prioritize the list for implementation.

Step 1 - Problem Identification:
This step was completed by the basin-planning team. Stormwater related problems and opportunities were described and presented at the basin assessment meetings conducted for each basin. Summary information was compiled in the mail-out packets for these meetings and in the basin characterization reports.

Step 2 - Define Storm Drainage Master Planning Objectives:
Eugene's stormwater management program objectives are documented in the City's Comprehensive Stormwater Management Plan (CSWMP), which was formally adopted by the City. The basin assessment process helped to further refine the feasibility and applicability of CSWMP's generalized objectives for each basin.

Step 3 - Develop Multiple-Objective Solutions:
As a result of the recommendations from the basin assessment meetings, a total of approximately 154 preliminary single and multiple-objective CPs were proposed (see Attachment #1 for a complete list of proposed CPs). This included six federal priority projects.

Step 4 – Conduct a Subjective Screening of CPs:
An initial screening was conducted by DevCore and some of the CPs were removed from the list based on the fact that they weren't considered to be CPs or that they were maintenance rehabilitation projects, etc.

Step 5 - Develop and Apply an Evaluation Method for Screening CPs:
The following evaluation criteria were selected by the City for screening the list of preliminary single and multiple-objective CPs (based on a tech memo dated 8/12/98).

- Addresses an Identified Capacity Problem
- Provides Water Quality Benefits
- Provides Natural Resource Benefits
- Provides Maintenance Benefits
- Requires Acquisition
- Capital Costs

A scoring method was applied based on the above evaluation criteria (summarized in tech memo dated 8/12/98 and provided in Attachment #2). Single-objective CPs were isolated

from multiple-objective CPs in the scoring process to assure that high priority single-objective CPs were not screened from the list based on the fact that they were single-objective. The numerical scores were added to provide a total score for each CP. The value of the total scores ranged from 8 to 17. CPs were eliminated from the list based on a selected cutoff score. In addition, the list was reviewed from a subjective standpoint to assure high priority CPs had not been screened off the list. After the screening process, 82 CPs remained on the list (the screening process is summarized in tech memos dated 9/20/98 and 10/30/98).

Step 6 - Conduct Preliminary Evaluations of the Reduced CP List:
Each of the 82 CPs was further evaluated (for effectiveness and costs) and summarized in a fact sheet. During this step, several of the CPs were further screened from the list due to feasibility issues that were encountered during the evaluations. The resulting CP list that was presented to the DAC included 67 CPs including six federal priority projects.

Step 7 – Prioritize/Schedule CPs for Implementation:
Meetings were held with the water resources staff team on 2/22/2000, and 3/14/2000 to evaluate a proposed process for prioritizing the 67 CPs and to select the appropriate prioritization criteria. Suggested revisions were made to the proposed prioritization process and an initial prioritization was conducted. The purpose of this DevCore meeting (3/29/2000) is to review the results of the initial prioritization process for scheduling and implementing 67 CPs.

Prior to this step, the CPs were already scored and ranked based on the criteria in the bullets listed under Step 5. The criteria under Step 5 were used to evaluate the costs and benefits of the capital projects. The purpose of the scoring in Step 5 was to screen CPs from the list. The purpose of the scoring under this step is not intended to further screen CPs from the list but to prioritize them for implementation. Therefore, a different set of criteria will apply. The following draft criteria were used for the initial prioritization of CPs as follows:

1) Has the CP already been selected as a 2-Year CP?
2) What was the earlier score for this CP (i.e., how does this CP rank in terms of costs/benefits)?
3) Is the implementation of another CP dependent on the implementation of this CP?
4) Can this CP be designed/implemented in an integrated fashion with another CP?
5) Does the CP address an area where development is expected to be significant and imminent?

Staff reviewed the results of the initial prioritization based on the above criteria and determined that the outcome was not sufficiently reflective of goals. Therefore, some guiding principles were developed for refining the scoring process (see Attachment #3). As a result, the following changes were made to the scoring process:

- The earlier scores that reflect costs/benefits were revised so that a flood control project was only given a high score if the project addresses an observed flooding

problem. If the project addresses a flooding problem expected to occur under existing conditions (based on model results) it was given a medium score instead of the high score it was previously given.

- For the water quality scores, a high score (rather than a medium score) was given to projects if they address an observed water quality/downcutting problem.
- A base score of 2 was added to all water quality projects to elevate their final score.
- A base score of two was also added to flood control projects that address observed flooding problems.
- Bullet numbers three and four from above were also removed from the ranking process. It was determined that whether the implementation of another CP was dependent on a CP should not result in that CP being a higher priority. There should just be an assurance that one is implemented before the other. In addition, it was determined that whether the implementation of a CP could be grouped with the implementation of another CP should not result in that CP being a higher priority. There should just be an assurance that implementation of the projects are considered together.

The CPs were prioritized first based on the score received and second based on the imminence of development. A few of the capital projects were also moved up in the prioritization if it made sense to group their implementation with a higher priority CP. These are noted in the table (Attachment #4).

The results and total scores for each CP are provided in Attachment #4. This draft prioritization represents staff's first attempt at prioritizing CPs for review by DevCore. Input was obtained from DevCore to ensure the results of the prioritization process adequately reflected City objectives for implementation. An additional column was added to the table in Attachment #4 to assist in a subjective review. This column includes other CP benefits that may impact prioritization such as: the project is highly visible, the project has potential educational benefits, the project has potential recreational benefits, etc.

This prioritization process should be completed by the City every few years as priorities and circumstances will likely change over time.

July 8, 2002 Update:
Since the time this memo was prepared, several changes have been made to the capital project selection. The changes are as follows:

- Some of the capital projects were considered to be applicable to all of the basins and they were separated out into city-wide annual budget line items. These included: 1) water quality facilities in high source areas, 2) retrofits of tip-ups, 3) streambank stabilization, and 4) outfall stabilization (this change is reflected in the updated table in Attachment #1).

- The hydrologic/hydraulic models were rerun using an updated version of XP-SWMM (version 7.5) and incorporating some other recommended changes into the models. This rerun resulted in the elimination of five capital projects (these changes are reflected in the last column of the updated table in Attachment #1).

- One capital project was removed from the Willakenzie basin list of projects due to the fact that this was a University of Oregon project (this change is reflected in the last column of the updated table in Attachment #1).

As a result of the above changes, a total of 41 capital projects are proposed city-wide. This is consistent with the capital project list provided in Table 4-1 of this document. Four city-wide annual budget line items are also included in Table 4-1 along with four existing annual budget line items and two related Lane County projects.

ATTACHMENT #1
Comprehensive Summary of Proposed Capital Projects

Basin	Initial # of CPs		Number of CPs After Preliminary Evaluation		July 8, 2002 Updates	
	Total # of CPs	# of CPs Excluding Options	Total # of CPs	# of CPs Excluding Options	# of CPs Excluding Annual Budget Line Items	# of CPs Excluding CPs Removed as a Result of Model Updates
Amazon	72	50	32	25	21	*18
Bethel Danebo	24	23	12	12	8	**6
Laurel Hill	22	20	6	6	4	4
Willakenzie	33	31	12	12	8	***7
Willamette River	12	12	7	7	3	3
Willow Creek	20	18	5	5	3	3
Total:	**183**	**154**	**74**	**67**	**47**	****41

* CPs AM07, AM22, and AM26 were removed from the list.
** CPs BD14 and BD16 were removed from the list.
***CP WK21 was removed from the list. This project was not removed from the list as a result of a model update but due to the fact that it was a University of Oregon project.
****This is consistent with the number of CPs listed in Table 4-1 of this document.

AMAZON CREEK BASIN

	FC	WQ	NR	Maint.	Acquis	Cap $	**Total Score**
Federal Priority Projects – (Total # of CPs = 2)							
AM100 - Upper Amazon Enhancement Project							
AM101 - Central Amazon Enhancement Project							
Two Year CPs - (Total # of CPs = 3)							
AM07 – Martin Drive Pipe Improvements	5	1	1	3	3	3	**16**
AM09 – Frederick Court Pipe Daylight	3	2	3	2	1	2	**13**
AM11 – Hilyard Street Pipe Improvements (should include evaluation of Tugman Park channel enhancements).	5	1	1	3	3	2	**15**
Selected CPs – (Total # of CPs = 27 and Total # Excluding Flood Control Options = 20)							
AM02 – Water Quality Facilities in High Source Areas	1	5	1	1	3	3	**14**
AM03 – Outfall Stabilization	1	5	3	3	3	3	**18**
AM04 – Retrofit of Tip-ups	3	4	1	2	3	3	**16**
AM6 – Kinney Park Neighborhood Facility	2	5	3	1	3	1	**15**
AM8A – Mt. Cavalry Flood Control Facility	2	1	3	1	1	1	**9**
AM8B – Mt. Cavalry Pipe Improvements	2	1	1	3	3	1	**11**
AM8C – Mt. Cavalry Pipe Improvements & Flood Control Facility	2	1	3	2	2	1	**11**
AM8D – Mt. Cavalry Water Quality Facility	1	4	3	1	1	2	**12**
AM12 – Pine View Neighborhood Facility	1	5	3	2	1	2	**14**
AM13 – 43rd Ave. Pipe Improvements	2	1	1	3	3	1	**11**
AM14B – Morse Ranch Park Pipe Improvements	2	1	1	3	3	1	**11**
AM15A – Neighborhood Facilities in Laurelwood Golf Course	2	1	3	1	3	1	**11**
AM15B – Laurelwood Flood Control Facility and Pipe Improvements	2	1	2	2	3	1	**11**
AM15C – Laurelwood Golf Course Pipe Improvements	2	1	1	3	3	1	**11**
AM15D – North Laurelwood Golf Course Water Quality Facility	1	4	3	1	2	2	**13**
AM15E – South Laurelwood Golf Course Water Quality Facility	1	4	3	1	2	2	**13**
AM17 – Jackson Street Pipe Improvements	2	1	1	3	3	3	**13**
AM22A – Cleveland St. Flow Diversion	2	1	1	3	3	2	**12**
AM22B – Orr Lane and Cleveland St. Pipe Improvements	2	1	1	3	3	2	**12**
AM26A – Brittany Street Flow Diversion	2	1	1	3	3	2	**12**
AM26B – Brittany Street Pipe Improvements	2	1	1	3	3	2	**12**
AM27A – Flood Control Facility West of Hawkins Lane	2	1	2	1	1	1	**8**
AM27B – Windsor Circle Pipe Improvements	2	1	1	3	3	1	**11**
AM27C – Water Quality Facility West of Hawkins Lane	1	5	3	1	1	1	**12**
AM29 – Water Quality Facility at Sam R. Street	1	5	3	1	1	2	**13**
AM30 – Water Quality Facility at Interior Street	1	5	3	1	1	2	**13**
AM43 – Stream Stabilization at Multiple Locations	1	5	3	3	2	2	**16**

Previously Screened CPs - (Total # of CPs = 31 and Total Excluding Options = 25)		
	Reason for Screening	**Potential for Reconsideration**
AM01 – Protect/Enhance Open Waterways	Addressed under the Key Waterways element of this program.	
AM05 – Retrofit Existing Trash Racks	This was considered to be a maintenance rehab. project.	
AM10A – Tugman Park Piped Bypass	This was screened off due to the implementation of AM10B.	
AM10B – Tugman Park Open Channel Modification	This is being considered as part of AM11 which is in the 2-Year CP.	
AM14A – Morse Ranch Park Neighborhood Facility	Not likely to be feasible based on popularity of the existing dog park.	Look for other opportunities for potential enhancement of this site.
AM16A – Daylight 2-60" Pipes Draining into Amazon near 24th St.	Expensive and space consumptive. Could conflict with park use.	This site should be evaluated for potential opportunities in coordination with the Upper Amazon Enhancement Project.
AM16B – Replace 2-60" Pipes Draining into Amazon near 24th St.	Flooding due to backwater from the Amazon. Property damage is not a consequence of flooding at this location.	
AM18 – Implement Conceptual Design for Westmoreland Park	Expensive and space consumptive. Could conflict with park use.	Look for other less expensive and space consumptive opportunities at this site.
AM19 – Implement Conceptual Design for the Lane County Fairgrounds	Already being conducted by the Fairgrounds.	
AM20 – Enhance Amazon Creek in the Area of Ida Patterson School	Constraints due to bike path, use of school playground and depth of pipe outfall into Amazon Creek at this location.	Take another look at potential for opportunities at this site in coordination with the Central Amazon Enhancement project.
AM21 – Daylight the Outfall in Berkeley Park	Expensive and space consumptive. Could conflict with park use.	Look for other less expensive and space consumptive opportunities at this site.
AM23 – Increase Pipe Sizes Along Cleveland St.	This CP was kept but renumbered to be AM22B.	
AM24A – Neighborhood Facility to eliminate flooding in the Bailey Hill pipe system.	Due to a model update, this is no longer expected to be a problem.	
AM24B – Reroute the Bailey Hill pipe system.	Due to a model update, this is no longer expected to be a problem.	
AM24C – Retrofit the Bailey Hill pipe system.	Due to a model update, this is no longer expected to be a problem.	
AM25 – Retrofit pipes that runoff from 25th and Brittany to Westleigh St.	Combined with CP AM27B which is listed above under selected CPs.	

	Reason for Screening	Potential for Reconsideration
AM28 – Retrofit the Pipe Inlet at Wilshire Dr.	This was considered to be a maintenance rehab. project.	
AM31 – Construct a Neighborhood Facility just East of Dead Cow Creek	This was screened off by the City due to the fact that the wetland in this area is listed in the WEWP for development. In addition, there was a potential alignment conflict with one of the West Eugene Parkway alternatives.	
AM32 – Daylight the Pipe from Danebo to Atlantic	This was screened off by the City due to potential impacts to wetlands and the Amazon Parkway alignment.	
AM33 – Main Stem: Martin Dr. to 24th Channel Modifications	These projects on the main stem of Amazon Creek may still be planned but were taken off of the CP list and are now on a list of Federal Priority Projects. Exceptions include any CPs proposed for the concrete lined portion of the channel from 24th to the Fairgrounds.	
AM34 – Main Stem: Amazon Park Neighborhood Facility		
AM35 – Main Stem: 24th to 19th Channel Enhancements		
AM36A – Main Stem: Establish a shade tree corridor along the concrete lined portion.		
AM36B – Main Stem: Construct a low flow pipe system under the concrete lined portion.		
AM36C – Cap the creek in the concrete lined portion of the channel.		
AM37 – Main Stem: Fairgrounds to Bailey Hill obtain Easements for Maintenance		
AM38 – Main Stem: Fairgrounds to Bailey Hill Channel Enhancements		
AM39 – Main Stem: Grant St. to Arthur St. Channel Enhancements		
AM40 – Main Stem: City View to Oak Patch Wetland Enhancement and Acquisition		
AM41 – Main Stem: 24th to Fairgrounds Channel Modifications		
AM42 – Main Stem: Fairgrounds to Bailey Hill Channel Modifications		
Capital Projects that were Screened based on Earlier Discussions (these CP numbers were then reused for other projects)		
	Reason for Screening	**Potential for Reconsideration**
AM3 – Complete the natural resources field survey work for this basin.	This was not considered to be a capital project	
AM4 – Develop an education program for streamside property owners.	This was not considered to be a capital project.	
AM5 – Implement measures to stabilize Braeburn Creek.	Included under AM43.	

	Reason for Screening	Potential for Reconsideration
AM11 – Establish pedestrian trails for the tributaries in the Amazon headwaters tributaries.	This was not considered to be a CP and was noted for consideration under AM1.	
AM16 – Address observed flooding problems on 18th and 19th Aves.	These flooding problems are due to backwater from the Amazon. CPs were evaluated and determined to be infeasible due to costs.	
AM20 – Establish pedestrian trails for the tributaries in the upper Amazon subbasin.	This was not considered to be a CP and was noted for consideration under AM1.	
AM24 – Address flooding problems on Buck St.	Flooding due to tip-up. This CP was moved to AM04.	Since this is an observed problem, this CP should be high on the tip-up retrofit list.
AM24 – Establish pedestrian trails for the tributaries upstream of Laurelwood Golf Course.	This was not considered to be a CP and was noted for consideration under AM1.	
AM38 – Place additional emphasis on the implementation of the WEWP.	This was not considered to be a capital project.	

The term channel enhancement is for natural resources and water quality, the term channel modification is for flood control.

BETHEL DANEBO BASIN

	FC	WQ	NR	Maint.	Acquis	Capital Cost	**Total Score**
Federal Priority Projects – (Total # of CPs = 1)							
BD100 – Royal Node Stormwater Infrastructure							
Selected CPs - (Total # of CPs = 11)							
BD2 – Install Water Quality Facilities in High Source Areas	1	5	1	1	3	3	**14**
BD3 – Retrofit of Tip-ups	3	4	1	2	3	3	**16**
BD6 – Increase Pipe Sizes Along Bell Ave.	2	1	1	3	3	1	**11**
BD8 – Retrofit Empire Park Pond	1	5	3	1	3	1	**14**
BD11A – Greenhill Tributary Culvert Replacement	2	1	1	3	3	1	**11**
BD11C – Greenhill Tributary Water Quality Facility	1	5	3	1	1	1	**12**
BD14 – Increase Pipe Sizes Along Garfield St.	2	1	1	3	3	1	**11**
BD15 – Culvert Replacement in the Roosevelt Channel	5	1	1	3	3	2	**15**
BD16 – Wallis St. Culvert Replacement	2	1	1	3	3	1	**11**
*BD19 – Stream Stabilization at Selected Locations							
*BD20 – Outfall Stabilization							

Previously Screened CPs - (Total # of CPs = 12 Total # Excluding Options = 11)		
	Reason for Screening	**Potential for Reconsideration**
BD01 – Protect/Enhance Open Waterways	Addressed under the Key Waterways element of this program.	
BD04 – Clearing Debris from Culverts and Adjacent Open Waterways	This was considered to be a maintenance rehab. project.	
BD05 – Clearing Debris from Culverts	This was considered to be a maintenance rehab. project.	
BD07 – Protect and Enhance the functions of Golden Gardens Pond	Enhancement was considered to be too expensive and acquisition was determined to be unnecessary.	Revisit this site to look for potential lower cost enhancement opportunities.
BD09 – Acquire the area outside of the UGB at the downstream end of the A2 Channel.	This was screened off the list due to the fact that it is outside the UGB and does not address an identified problem.	
BD10 – Remove large construction debris from the open channel adjacent to Willamette High School.	This was considered to be a maintenance rehab. project.	
BD11B – Greenhill Tributary Flood Control Facility.	CP option BD11A was selected over this option due to expense and space issues.	
BD12A – Candlelight Park Flood Control Facility. BD12B – Candlelight Park Channel Modifications	Implementation of BD11A resolved the flooding problem at this location.	
BD13 – Neighborhood Facility in the Vicinity of the Royal Ave. nodal development.	This deficiency was caused by sediment build-up. Sediment removal (maintenance) is needed, not a CP.	

	Reason for Screening	Potential for Reconsideration
BD17 – Protect/Enhance Danebo Pond.	Screened off as it is already listed as protected in the WEWP.	Revisit this site to look for potential enhancement opportunities.
BD18 – Acquire wetland just west of the Roosevelt Channel and on the east side of Bertelsen Rd. Route low flows through this wetland.	This area was being reconfigured as part of an ODOT road project and an attempt was made to discuss this CP option with ODOT.	

*No scores are provided here as these were later added to this basin as they will be City-wide annual budget line items.

LAUREL HILL BASIN

	FC	WQ	NR	Maint.	Acquis	Capital Cost	**Total Score**
Two Year CPs - (Total # of CPs = 1)							
LH06C – Riverview/Augusta bypass and system improvements.	5	1	3	3	3	1	**16**
Selected CPs – (Total # of CPs = 5)							
LH7 – Minor system between Riverview and Augusta	5	1	1	3	2	3	**15**
LH8 – Riverview/Augusta Minor Storm Drainage System Plan	2	2	2	3	2	3	**14**
LH9 – Construct a Water Quality Facility at I-5 and Augusta	1	5	3	1	1	1	**12**
LH16 – Streambank Stabilization at Multiple Locations	1	5	3	3	2	2	**16**
*LH17 – Outfall Stabilization							

Previously Screened CPs – (Total # of CPs = 14 and Total # Excluding Options = 12)		
	Reason for Screening	**Potential for Reconsideration**
GL01 – Protect/Enhance Open Waterways	Addressed under the Key Waterways element of this program.	
GL02 – Clear debris from culverts and adjacent open waterways.	This was considered to be a maintenance rehab. project.	
GL03 – Clear debris from culverts.	This was considered to be a maintenance rehab. project.	
GL04 – Acquire easements for maintenance.	This was considered to be a maintenance rehab. project.	
GL05A – West Floral Hill Neighborhood Facility	This capacity problem is addressed through CP LH06C. The water quality issue is addressed through CP LH09 and development standards.	
GL05B – West Floral Hill High Flow Bypass	This capacity problem is addressed through CP LH06C.	
GL06A – East Floral Hill Neighborhood Facility	This capacity problem is addressed through CP LH06C. The water quality issue is addressed through CP LH09 and development standards.	
GL06B – East Floral Hill Pipe Size Increases	This capacity problem is addressed through CP LH06C.	

	Reason for Screening	Potential for Reconsideration
GL10 – Remove the concrete lined channel at the outfall to the Willamette River and enhance the channel.	This was considered to be expensive with respect to the benefits it would provide and with respect to the limited visibility of this location.	
GL11 – Retrofit pipes along Glenwood Blvd.	This area was transferred to Springfield.	
GL12 – Acquire/Protect/Enhance existing pond/wetlands on Pape Brothers site.	This area was transferred to Springfield.	
GL13 – Construct water quality facilities at three I-5 culvert locations.	This was screened off due to the implementation of development standards.	
GL14 – Remove debris from high flow channel to the Willamette River.	This was considered to be a maintenance rehab. project.	
GL15 – Acquire space to protect property from flooding associated with the Beaver Dam.	This area was transferred to Springfield.	
Capital Projects that were Screened based on Earlier Discussions (these CP numbers were then reused for other projects)		
	Reason for Screening	**Potential for Reconsideration**
GL2 – Complete the natural resources field survey work in this basin.	This was not considered to be a capital project.	
GL10 – Work with the youth corps to construct trails along the riparian corridor in Laurel Hill Park.	This was not considered to be a capital project.	

*No scores are provided here as this CP was later added to this basin as it will be a City-wide annual budget line item.

WILLAKENZIE BASIN

	FC	WQ	NR	Maint.	Acquis	Capital Cost	**Total Score**
Federal Priority Projects – (Total # of CPs = 1)							
WK100 - Delta Ponds Enhancement							
Two Year CP – (Total # of CPs = 2)							
WK07 – River Point Pond Outlet Channel	5	2	2	1	1	1	**12**
WK21 – Implement a Water Quality Pilot Project in Association with the Autzen Stadium Parking Lot Expansion.	1	5	1	1	3	3	**14**
Selected CPs – (Total # of CPs = 9)							
WK02 – Water Quality Facilities in High Source Areas	1	5	1	1	3	3	**14**
WK03 – Retrofit of Tip-ups	3	4	1	2	3	3	**16**
WK8A – Gilham Road System Culvert Replacement	2	1	1	2	3	3	**12**
WK8B – Gilham Road System Water Quality Facility	1	5	2	1	3	1	**13**
WK11A - Acquire Coburg/County Farm Road Wetland.	1	2	3	2	1	2	**11**
WK13 – Ayers Pond Outfall Retrofit	1	5	1	3	3	1	**14**
WK16A – Modify Ascot Park Open Waterway	2	2	3	2	3	1	**13**
*WK23 – Streambank Stabilization at Selected Locations							
*WK24 – Outfall Stabilization							

Previously Screened CPs – (Total # of CPs = 17 Total # Excluding Options = 15)		
	Reason for Screening	**Potential for Reconsideration**
WK01 – Protect/Enhance Open Waterways	Addressed under the Key Waterways element of this program.	
WK04 – Clear Open Waterways of Garbage and Debris	This was considered to be a maintenance rehab. project.	
WK05 – Clear Debris from Culverts	This was considered to be a maintenance rehab. project.	
WK06 – Clear Debris from Culverts and Adjacent Open Waterways	This was considered to be a maintenance rehab. project.	
WK09A – Enhance Open Waterway Adjacent to Gilham Elementary School.	**Eugene comment here was "mostly completed".**	
WK09B – Realign and Enhance Open Waterway Adjacent to Gilham Elementary School.	**Eugene comment here was "mostly completed".**	
WK10 – Address Future Flows from Subdivision Upstream of Wildish	This project has already been completed.	
WK12 – Coordinate with Ayers Rd. Team to Incorporate Water Quality Benefits to the Pond.		Check in to the status of this project and potential opportunities for coordination.
WK14 – Enhance Open Waterway Adjacent to Cal Young Middle School	A recommendation was made to have "seed" money available for projects associated with schools/churches, etc. when an interest is expressed.	Take another look at providing "seed" money for these types of activities.

	Reason for Screening	Potential for Reconsideration
WK15 – Beltline Interchange Water Quality Facility	The Beltline Interchange is currently on ODOT's replacement list. It would make the most sense to coordinate this project with the interchange replacement.	Track the timing of the Beltline Interchange replacement to ensure that this opportunity is not lost.
WK16B – Construct a Neighborhood Facility in Ascot Park.	Space conflicts with existing park use.	
WK17A – Enhance the Open Waterway Adjacent to Sheldon High School.	Conflict with school's desired use of the area for a football field.	See follow up action for WK14.
WK17B – Construct a Neighborhood Water Quality Facility Adjacent to Sheldon High School.	Conflict with school's desired use of the area for a football field.	
WK18 – Implement Recommendations in the Delta Ponds Enhancement Study.	Addressed through the Federal Priority Projects.	
WK19 – Retrofit Stabilization Measures adjacent to Abbie Lane on the east side of Delta Highway.	This was considered to be a maintenance rehab. project.	
WK20 – Retrofit Golf Course Culverts and Ponds.	Conflicts associated with private use. Consequences of flooding in this area do not include property damage. Add to business partners program.	
WK22 – Enhance the Riparian Area Along the Canoe Canal.	This was not considered to be a CP but more of a maintenance rehab. project.	Conduct a site visit to evaluate the potential for opportunities. Check to see if this site is listed in the NR study.
Capital Projects that were Screened based on Earlier Discussions (these CP numbers were then reused for other projects)		
	Reason for Screening	**Potential for Reconsideration**
WK3 – Look for opportunities to protect a high quality natural resources area east of WalMart	This was a suggestion from Ed Alverson. Needed more specifics on location.	
WK20 – Remove debris from open channels between Roan Dr. and Oakway Terrace	Considered to be a maintenance rehab. project.	
WK3 – Set aside "seed" money for groups that are interested in enhancement projects associated with schools, churches, etc.	Not considered to be a capital project.	
Unnumbered – Enhance the open channel in the back of the church on the east side of Coburg Rd.	This suggested opportunity is what lead to the idea for CP WK3 in the row directly above.	

*No scores are provided here as these were later added to this basin as they will be City-wide annual budget line items.

WILLAMETTE RIVER BASIN

	FC	WQ	NR	Maint.	Acquis.	Capital Cost	**Total Score**
Federal Priority Projects – (Total # of CPs = 2)							
WR100 - Willamette River Bank Restoration							
WR101 - Mill Race Enhancement							
Two Year CP – (Total # of CPs = 1)							
WR06 – Polk Street Water Quality Facilities	1	5	1	1	3	2	**13**
Selected CPs – (Total # of CPs = 4)							
WR02 – Outfall Stabilization	1	5	3	3	3	3	**18**
WR03 – Retrofit of Tip-ups	3	4	1	2	3	3	**16**
WR04 – Water Quality Facilities in High Source Areas	1	5	1	1	3	3	**14**
*WR10 – Streambank Stabilization at Selected Locations							

Previously Screened CPs – (Total # of CPs = 3)		
	Reason for Screening	**Potential for Reconsideration**
WR01 – Bank Stabilization and Enhancements Along the Willamette River		A suggestion was made to keep this on the list of selected CPs.
WR05 – Retrofit Heritage Ave./River Rd. Pipe System	Due to backwater from the Willamette River. Capacity enhancements to store water would not be cost effective.	
WR07 – Work with U of O to Address Water Quality problems in the Mill Race and to Address Riparian Zone Restoration Adjacent to the River Front Research Center.	This is addressed under a federal priority project.	

Capital Projects that were Screened based on Earlier Discussions (these CP numbers were then reused for other projects)		
	Reason for Screening	**Potential for Reconsideration**
WR2 – Develop a vision document for the Willamette River Greenway	Not considered to be a capital project.	
WR9 – Acquire/enhance the wetland north of Lane Community College.	Outside of the UGB	

*No scores are provided here as this CP was later added to this basin as it will be a City-wide annual budget line item.

WILLOW CREEK BASIN

	FC	WQ	NR	Maint.	Acquis	Capital Cost	**Total Score**
Selected CPs – (Total # of CPs = 5)							
WC3C3 – West Branch Culvert/Channel Retrofits	5	1	1	2	3	3	**15**
WC3C4 – East Branch Culvert/Channel Retrofits	5	1	1	2	1	3	**13**
WC06 – Streambank Stabilization at Multiple Locations	1	5	3	3	2	2	**16**
WC08 – Realign/restore the Main Stem of Willow Creek	2	2	3	1	2	1	**11**
*WC11 – Retrofit of Tip-ups							

Previously Screened CPs – (Total # of CPs = 11 Total # Excluding Options = 9)		
	Reason for Screening	**Potential for Reconsideration**
WC01 – Protect/Enhance Open Waterways	Addressed under the Key Waterways element of this program.	
WC02 – Conduct a FEMA Study of the Drainage Basin	Not considered to be a CP.	
WC3A – Acquire/protect floodplains.	Still uncertain as to whether the urban reserves in this basin will ever be developed. Therefore, development standards in combination with WC3C3 and WC3C4 were selected. Some of these sites were also identified for acquisition in the parks study.	
WC3B – Acquire/protect floodplains outside of City limits.		
WC3C – Construct piped bypass systems along Willow Creek and Bailey Hill Rds.		
WC3D – Construct three water quality/flood control facilities.		
WC3E – Modify the existing creek channel for increased capacity.		
WC04 – Continue with Implementation of the Willow Creek Monitoring Program.	Not considered to be a CP.	
WC05 – Develop Low-Impact Maintenance Practices for Open Channels.	Not considered to be a CP.	
WC07 – Eliminate Garbage/Dumping Problem at Bend in Willow Creek Rd.	Considered to be a maintenance rehab. project.	
WC09 – Repair/Replace Culvert at Private Rd. Crossing along Willow Creek Rd.	Considered to be a maintenance rehab. project.	

Capital Projects that were Screened based on Earlier Discussions (these CP numbers were then reused for other projects)		
	Reason for Screening	**Potential for Reconsideration**
WC3 – Replace the culvert under W. 18th.	Project already underway.	
WC8 – Develop a handbook for streamside property owners.	Not considered to be a capital project.	
WC9 – Remove non-native vegetation from the riparian corridor.	Not considered to be a capital project.	
WC10 – Provide native plants to streamside property owners.	Not considered to be a capital project.	

*No scores are provided here as this CP was later added to this basin as it will be a City-wide annual budget line item.

ATTACHMENT #2
Original CP Scoring Method for Screening (dated 8/12/98)

1. **Addresses an Identified Capacity Problem**
   H = Addresses a flooding problem predicted under existing conditions and/or a problem which has been observed.
   M = Addresses a flooding problem only predicted to occur under future build-out conditions.
   L = May provide some flood control benefits but it does not address an identified flooding problem.

2. **Provides Water Quality Benefits**
   H = - The CIP is a proposed water quality facility that is located in an industrial/commercial/transportation land use area; or
   - The CIP is a proposed water quality facility with an upstream drainage area of >200 acres.
   M = -The CIP is an open waterway enhancement (i.e., revegetation, buffer, shading); or
   -The CIP is a proposed water quality facility with an upstream drainage area of < 200 acres.
   L = The CIP does not provide water quality benefits.

3. **Provides Natural Resource Benefits**
   H = The CIP protects and/or enhances an existing natural resource.
   M = The CIP creates new natural resources.
   L = The CIP does not provide natural resource benefits.

4. **Proivdes Maintenance Benefits**
   H = The CIP will reduce existing maintenance requirements and/or provide increased capacity.
   M = The CIP will facilitate existing maintenance activities (i.e., provide access).
   L = The CIP will add to the existing maintenance work load or it will not affect maintenance.

5. **Requires Acquisition**
   H = The CIP is located on public property or an acquisition is not required.
   M = The CIP is located both on public and private property.
   L = The CIP is located on private property.

6. **Capital Costs**
   H = (i.e., low cost) less than $100,000
   - trash rack retrofits
   - tip-up retrofits
   - outfall protection
   - structural water quality facilities (compost filter...)

   M = between $100,000 and $500,000

   L = greater than $500,000

Attachment 3
Guiding Principles

The guiding principles by which the projects have been ordered for implementation are:

In general

For those capital projects that apply to most or all basins, and represent several locations, we recommend creating four new line items in the stormwater budget and provide funding each year ($50,000 each) for:

- water quality retrofits in high source areas;
- channel stabilization;
- outfall stabilization; and
- tip-up retrofits.

All of the four categories above rated relatively high with respect to benefits/costs.

Those projects other than the four types mentioned above have been ordered for implementation based upon their **benefits & costs**. Further refinements to the ordering are reflected in the following guiding principles for: Two-year CPs (00 & 01), the early years (1-5 years out, through FY 2006), middle years (6-10 years out, through FY2011) and later years (11-20 years out, through 2021).

Early years (1-5, through FY 2006)

- Because flood control problems are few, focus these years primarily on water quality/natural resources projects initially through:
  - system retrofits;
  - water quality facilities on properties in public ownership; and
  - federal/city cost share environmental restoration projects.
- Focus the few needed flood control projects in areas where:
  - there has been an observed problem rather than only model predictions where there is no confirmation of a problem, and
  - upstream development is imminent and there has been an observed or modeled problem.
- Pursue acquisition for sites on which the City will construct water quality facilities in the future.
- Design projects to incorporate multiple objectives wherever feasible, including water quality, natural resources, flood control.
- Coordinate with other City projects/goals to incorporate recreation, education to the extent possible.

Middle Years (6-10, through FY 2011)

- Continue to focus on water quality/natural resources, including constructing water quality facilities where acquisition needs have been met.
- Continue to assess the need for projects where the model identified flooding under existing conditions but where field observations do not confirm. Re-prioritize accordingly.
- Design projects to incorporate multiple objectives wherever feasible, including water quality, natural resources, flood control.
- Coordinate with other City projects/goals to incorporate recreation, education to the extent possible.

Later Years (11-20, through FY 2021)

- Balance out funding through each program area (water quality, natural resources, flood control).
- Design projects to incorporate multiple objectives wherever feasible, including water quality, natural resources, flood control.
- Coordinate with other City projects/goals to incorporate recreation, education to the extent possible.

ATTACHMENT #4
Prioritization of Eugene's Proposed Stormwater Related Capital Projects
(July 8 updates not made to this table)

Rank #1	Rank #2	Total	Cumulative Cost	CP ID	Application or Location	Stormwater Benefits				Cost (including acquis.)	Acquis. Cost	Total Annual Maint. Cost	Potential Funding Source (approximate %)		Selected as a 2-Yr CP	Earlier Score #1	This CP Addresses an Area Where Development is Imminent #2	Moved up in the Prioritization Due to Benefits of Grouping w/Another CP	Other Benefits and Comments
						FC	WQ	NR	MN				SDC	User Fee					
				FPWK	Delta Ponds Enhancement							$800,000							
				WK07	River Point Pond Outlet Channel	●		●		$1,635,800	$13,200	$29,700	41%	59%	Y	12	A		Addresses flooding complaints received from Wildish.
				LH06C	Riverview/Augusta Bypass and System Improvements	●			●	$774,900		$5,000	82%	18%	Y	16	A		
				AM07	Martin Drive Pipe Improvements	●			●	$92,400		$0****	72%	28%	Y	16	A		
				AM11	Hilyard Street Pipe Improvements	●			●	$290,200		$0	23%	77%	Y	15	B		
				WR06	Polk Street Water Quality Facilities		●	●		$357,000		$15,500	0%	100%	Y	13	C		Visible and addresses many complaints that have been received regarding discharges from this outfall.
				AM09	Frederick Court Pipe Daylight	●	●	●		$134,400	$16,000	$3,300	46%	54%	Y	13	B		
6	2	8	$8,000	AM03	Outfall Stabilization		●	●	●	$8,000		$900	0%	100%		18	B		
6	1	7	$16,000	WR02	Outfall Stabilization		●	●	●	$8,000		$900	0%	100%		18	C		
4	3	7	$416,000	LH16	Channel Stabilization at Multiple Locations		●	●	●	$400,000		$200	25%	75%		16	A		Highly visible with associated educational opportunities.
4	3	7	$916,000	AM43	Channel Stabilization at Multiple Locations		●	●	●	$500,000		TBD	25%	75%		16	A		Highly visible with associated educational opportunities
4	1	5	$1,400,800	WC06	Channel Stabilization at Multiple Locations		●	●	●	$484,800		$200	25%	75%		16	C		Highly visible with associated educational opportunities
4	2	6	$1,427,200	WK03	Retrofit of Tip-ups	●	●	●	●	$26,400		$1,000	0%	100%		16	B		
4	2	6	$1,453,600	BD03	Retrofit of Tip-ups	●	●	●	●	$26,400		$1,000	0%	100%		16	B		
4	2	6	$1,480,000	AM04	Retrofit of Tip-ups	●	●	●	●	$26,400		$1,000	0%	100%		16	B		
4	1	5	$1,506,400	WR03	Retrofit of Tip-ups	●	●	●	●	$26,400		$1,000	0%	100%		16	C		
2	2	4	$1,733,200	WK02	Install Four Structural Water Quality Facilities in Commercial/Industrial High Source Areas		●	●		$226,800		$8,500	0%	100%		14	B		
2	2	4	$2,648,200	BD02	Install Five Structural Water Quality Facilities in High Source Areas Upstream of the Bertelsen Slough and Five in High Source Areas Upstream of the Roosevelt Channel		●	●		$915,000		$34,000	18%	83%		14	B		
2	1	3	$3,784,000	AM02	Install Water Quality Facilities in High Source Areas		●	●		$1,135,800		$46,300	0%	100%		14	C		
2	1	3	$4,141,000	WR04	Install Water Quality Facilities in High Source Areas		●	●		$357,000		$15,500	0%	100%		14	C		
			$5,341,000	FPAM	Upper Amazon Enhancement Project					$1,200,000									
			$5,691,000	FPWR	Willamette River Bank Restoration					$350,000									
5	3	8	$6,356,100	AM06A	Kinney Park Neighborhood Facility	●	●	●	●	$665,100		$11,200	74%	26%		15	A		
5	2	7	$6,547,600	BD15	Culvert Replacement in the Roosevelt Channel	●			●	$191,500		$3,300	32%	68%		15	B		Highly visible with associated educational opportunities.
5	1	6	$6,607,000	LH07	Minor system between Riverview and Augusta	●			●	$59,400		$0	0%	100%		15	C		
5	1	6	$6,642,800	WC3C3	West Branch Culvert/Channel Retrofits	●		●	●	$35,800		$0	0%	100%		15	C		Potential educational/recreational benefits and/or space conflicts associated with the proposed park use.
4	3	7	$6,951,900	AM12	Pine View Neighborhood Facility		●	●		$309,100	$50,000	$5,600	0%	100%		14	A		
4	2	6	$6,999,900	LH08	Riverview/Augusta Minor Storm Drainage System Plan	●	●	●	●	$48,000		$0	0%	100%		14	B		
4	1	5	$7,773,900	WK13	Ayers Pond Outfall Retrofit		●		●	$774,000		$1,000	0%	100%		14	C		
4	1	5	$8,344,800	BD08	Retrofit Empire Park Pond	❍	●	●		$570,900		$9,000	20%	80%		14	C		
			$9,544,800	FPAM	Central Amazon Enhancement Project					$1,200,000									
			$10,419,800	FPWR	Mill Race Enhancement					$875,000									
3	3	5.5	$11,073,700	WK08B	Gilham Road System Water Quality Facility		●	●		$653,900		$11,800	10%	90%		13	A		Potential educational/recreational benefits and/or space conflicts associated with the adjacent park.
2	3	5.5	$11,106,100	WK08A	Gilham Road System Culvert Replacement	●			●	$32,400		$3,300	100%	0%		12	A	X	Potential educational benefits associated with the adjacent park.
3	2	5	$11,183,500	AM17	Jackson Street Pipe Improvements	●			●	$77,400		$0	25%	75%		13	B		
3	2	4.5	$11,629,100	AM15D	North Laurelwood Water Quality Facility		●	●		$445,600	$60,000	$6,700	0%	100%		13	B		Fairly visible with the potential to provide a public amenity and associated educational opportunities.
3	2	4.5	$12,000,500	AM15E	South Laurelwood Water Quality Facility		●	●		$371,400	$50,000	$5,600	0%	100%		13	B		
1	2	4.5	$13,809,500	AM15	An average cost for three options is provided for this CP. The three options are A - Laurelwood Golf Course Flood Control Facilities, B - Laurelwood Gol Course Pipe Improvements and Flood Control Facility, and C - Laurelwood Golf Course Pipe Improvement	●			●	$1,809,000	$86,700	$7,800	22%	78%		11	B	X	
3	2	5	$14,296,000	AM29	Water Quality Facility at Sam R. Street		●	●		$486,500	$120,000	$6,200	0%	100%		13	B		Provides educational opportunities associated with adjacent trail.

ATTACHMENT #4
Prioritization of Eugene's Proposed Stormwater Related Capital Projects
(July 8 updates not made to this table)

Rank #1	Rank #2	Total	Cumulative Cost	CP ID	Application or Location	Stormwater Benefits				Cost (including acquis.)	Acquis. Cost	Total Annual Maint. Cost	Potential Funding Source (approximate %)		Selected as a 2-Yr CP	Earlier Score #1	This CP Addresses an Area Where Development is Imminent #2	Moved up in the Prioritization Due to Benefits of Grouping w/Another CP	Other Benefits and Comments
						FC	WQ	NR	MN				SDC	User Fee					
3	2	5	$14,624,200	AM30	Water Quality Facility at Interior Street		●	●		$328,200	$40,000	$5,600	0%	100%		13	B		Potential conflict with golf course use.
3	1	4	$15,286,600	WK16A	Modify Ascot Park Open Waterway	●	❍	❍	●	$662,400		$12,100	66%	34%		13	C		Potential to provide educational/recreational benefits and/or space conflicts associated with the golf course use.
3	1	4	$16,266,800	WC3C4	East Branch Culvert/Channel/Retrofits	●		●	●	$980,200		$17,100	0%	100%		13	C		Potential to provide educational/recreational benefits and/or space conflicts associated with the golf course use.
2	3	5	$16,637,650	AM22	An average cost for two options is provided for this CP. The two options are A - Cleveland St. Flow Diversion, and B - Orr Lane and Cleveland St. Pipe Improvements	●			●	$370,850		$0	56%	44%		12	A		
2	3	5	$16,923,550	AM26	An average cost of two options is provided for this CP. The two options are A - Brittany Street Flow Diversion, and B - Brittany Street Pipe Improvements	●			●	$285,900		$0	24%	76%		12	A		
2	3	5	$17,672,350	BD11C	Greenhill Tributary Water Quality Facility		●	●		$748,800	$105,000	$11,200	30%	70%		12	A		Potential conflict with cemetery use.
1	3	5	$18,612,950	BD11A	Greenhill Tributary Culvert Replacement	●			●	$940,600		$0	34%	66%		11	A	X	
2	3	5	$19,238,250	AM27C	Water Quality Facility West of Hawkins Lane		●	●		$625,300	$80,000	$9,500	0%	19%		12	A		
0	3	5	$20,081,500	AM27	An average cost for two options is provided for this CP. The two options are A - Flood Control Facility West of Hawkins Lane, B - Windsor Circle Pipe Improvements	●			●	$843,250	$40,000	$4,150	73%	27%		10	A	X	
2	3	5	$21,327,100	LH09	Construct a Water Quality Facility at I-5 and Augusta		●	●		$1,245,600		$20,900	60%	40%		12	A		
2	2	3.5	$21,796,700	AM08D	Mt. Cavalry Water Quality Facility		●	●		$469,600	$80,000	$6,700	0%	100%		12	B		
0	2	3.5	$22,647,300	AM08	An average cost for three options is provided for this CP. The three options are A - Mt. Cavalry Flood Control Facility, B - Mt. Cavalry Pipe Improvements, and C - Mt. Cavalry Flood Control Facility and Pipe Improvements	●			●	$850,600	$73,300	$4,100	39%	61%		10	B	X	
1	2	3	$23,307,300	BD16	Replace Wallis St. Culvert (Bertlesen Slough)	●			●	$660,000		$3,300	31%	69%		11	B		This could be a highly visible CP and recreational/educational benefits could be achieved.
1	2	3	$24,102,000	BD06	Increase Pipe Sizes Along Bell Ave.	●			●	$794,700		$0	46%	54%		11	B		This CP could be designed to include an aesthetic water feature (e.g., a cascading waterfall as an energy dissipator).
1	2	3	$26,257,500	AM13	43rd Ave. Pipe Improvements	●			●	$2,155,500		$0	32%	68%		11	B		The pond could be developed into a public amenity that offers educational/recreational opportunities.
1	2	3	$27,261,700	AM14B	Morse Ranch Park Pipe Improvements	●			●	$1,004,200		$0	11%	89%		11	B		Highly visible with the potential to provide a public amenity with associated educational opportunities.
1	2	3	$28,413,700	WK11A	Wetland Protection - Coburg & County Farm Rds.	❍	❍	❍		$1,152,000	$960,000	$0	28%	72%		11	B		Highly visible with associated educational opportunities
1	2	3	$31,102,900	WC08	Realign/restore the Main Stem of Willow Creek	●	❍	●		$2,689,200		$31,500	0%	100%		11	B		
1	1	2	$32,722,900	BD14	Increase Pipe Sizes Along Garfield St.	●			●	$1,620,000		$0	37%	63%		11	C		

FC = Flood Control Project
WQ = Water Quality Project
NR = Natural Resources Enhancement Project
MN = Project provides maintenance related benefits (i.e., reduces need for maintenance or facilitates maintenance access).
❍ = Existing Benefit to be Protected
● = Primary Benefit of Capital Project

APPENDIX K

WATER QUALITY DESIGN STORM DEVELOPMENT

CITY OF EUGENE
DEVELOPMENT STANDARDS MEMORANDUM #4
WATER QUALITY DESIGN STORM SELECTION

INTRODUCTION

In Development Standards Memorandum #2, the following four approaches for implementing stormwater quality requirements were considered:

1. Stormwater quality facilities are required to reduce pollutants in the stormwater runoff resulting from a specified amount of rainfall, or "water quality design storm"
2. Stormwater quality facilities are required to meet a specified performance threshold (e.g., 80% removal of TSS)
3. Specific stormwater quality facilities are required for specific land uses
4. In-lieu-of fees are allowed

Based on the advantages and disadvantages described for each of the four approaches, we decided to further evaluate Approach #1 – Stormwater quality facilities are required to reduce pollutants in the stormwater runoff resulting from a specified water quality design storm.

Structural stormwater quality facilities (i.e., not site planning) can generally be divided into two groups based on different design requirements: detention facilities and flow-through facilities. Detention type facilities include dry ponds, wet ponds, and stormwater marshes. These facilities are designed to allow for the settling of particulates and other pollutants in stormwater by storing the stormwater runoff for a certain period. Therefore, the total rainfall (depth in inches) of the water quality design storm needs to be specified to determine the appropriate size of a detention type facility.

Flow-through facilities include vegetated swales and/or structural facilities with filter media such as sand or compost. These facilities remove particulates and other pollutants by mechanical means (e.g., baffles) or by passing the stormwater through a filtration media (e.g., vegetation, sand or compost). Since flow-through type facilities operate with little or no detention, these types of facilities are designed to treat a maximum flow rate rather than a total runoff volume. Therefore, the rainfall intensity (inches/hour) of the water quality design storm needs to be specified to determine the appropriate size of a flow-through based facility.

The purpose of this memorandum is to describe the methods used to select the water quality design storm parameters for detention type and flow-through type stormwater quality facilities. This memo contains the following information:

- Description of measured rainfall data sources
- Description of the rainfall analysis procedures
- A discussion of the conceptual design procedure for the preliminary capital projects
- Summary of the results of the water quality design storm analysis

- Comparison to other jurisdictions
- Recommendation for further evaluation

LONG-TERM RAINFALL DATA SOURCES

The parameters of the water quality design storm (i.e., total rainfall and rainfall intensity) are based on a statistical analysis of local long-term rainfall data. Hourly rainfall measurements are needed to determine the total rainfall volume for designing detention type facilities. For Eugene, long-term hourly precipitation data are available from a rain gage operated by the National Weather Service (NWS) at the Eugene Airport. Hourly precipitation data is available for this gauge location from 1948 to the present.

Shorter increment rainfall measurements (i.e., 5 to 15 minutes) are more appropriate for determining the rainfall intensity for designing flow-through type facilities. The City has operated several rain gauges within Eugene for the past six years that measure rainfall at 15-minute increments. The rainfall data collected at City gauge I1 (located in west Eugene on the Bertlesen Slough) and City gauge M2 (located in Amazon Park) were used in this analysis.

RAINFALL ANALYSIS PROCEDURES

The statistical analyses of the long-term hourly rainfall measurements collected by the NWS at the Eugene Airport were completed using the Synoptic Rainfall Data Analysis Program (SYNOP). SYNOP provides a summary and statistical analysis of storm event parameters (e.g., rainfall depths, storm intensity, storm duration) and of annual and monthly rainfall totals. The two key input variables in SYNOP are the inter-event time and minimum storm depth. The inter-event time represents the minimum length of dry period, in hours, beyond which additional rainfall measurements are considered to be separate storm events. It is used to separate a long-term continuous rainfall record into discrete, independent storm events. The minimum storm depth is applied to eliminate small storm events from the long-term record that are unlikely to produce measurable stormwater runoff. Storm events with a depth of 0.01 inches or less were eliminated from the long-term record as they are unlikely to produce measurable stormwater runoff. Additional analyses of the results from SYNOP were completed using Microsoft Excel.

CONCEPTUAL DESIGN OF PRELIMINARY CAPITAL PROJECTS

In order to develop conceptual designs for the preliminary capital projects identified during the basin planning process, a preliminary water quality design storm was needed. A SYNOP analysis was completed on the long-term hourly precipitation data from the NWS gage at the Eugene airport using an inter-event time of 6 hours and a minimum storm depth of 0.01 inches. The results of the SYNOP and spreadsheet analyses are presented in Figure 1.

The plot in Figure 1 presents the average annual percentage of storm events (y axis) that are equal to or less than a specific design storm rainfall depth (x axis). For example,

approximately 80% of the storm events have a rainfall depth of 1.4 inches or less. Therefore, if a detention type stormwater quality facility were designed to capture and treat the stormwater runoff from a site resulting from a 1.4 inch storm event, approximately 80% of the annual stormwater runoff from the site would be treated. This storm depth, 1.4 inches, was selected as the preliminary water quality design storm for completing the conceptual designs for the detention type stormwater quality capital projects.

WATER QUALITY DESIGN STORM ANALYSIS

Based on recent Department Advisory Committee meetings, it seems apparent that development standards for stormwater quality are recommended for portions of Eugene. Therefore, we completed a more detailed analysis of the NWS and City rainfall records to develop the specific parameters of the water quality design storm for implementing development standards. The total rainfall and rainfall distribution is required to design detention type stormwater quality facilities. The rainfall intensity is required to design flow-through type facilities (both off-line and on-line). The procedures used to obtain these water quality design storm parameters are described below.

Detention Type Water Quality Facilities

Long-term hourly precipitation data at the Eugene airport were analyzed to select the water quality design storm parameters for designing detention type stormwater quality facilities. The SYNOP analysis was conducted using an inter-event time of 6 hours and a minimum storm depth of 0.01 inches. Based on the results presented in Figure 1, a design storm rainfall depth of 1.4 inches is required to capture approximately 80% of the average annual runoff from a site. A design storm rainfall depth of 0.95 inches is required to capture approximately 70% of the average annual runoff from a site. A design storm rainfall depth of 2.4 inches is required to capture 90% of the average annual runoff from a site.

The rainfall distribution describes the temporal distribution for the total rainfall. The U.S. Soil Conservation Service (SCS) developed a rainfall distribution for western Oregon and Washington referred to as SCS Type 1A. The duration of the SCS Type 1A storm event is typically specified as 24 hours. Based on our SYNOP analysis, the average storm durations for a 6-hr, 12-hr, and 24-hr inter-event time were 16 hours, 26 hours, and 46 hours, respectively. Therefore, a 24-hour rainfall distribution appears to be appropriate.

Flow-through Type Water Quality Facilities

Flow-through type facilities can be installed as off-line or on-line structures. With off-line facilities, an inlet control structure (e.g., flow control manhole) is installed to limit the maximum allowable flow rate that can be treated by the stormwater quality facility. Stormwater flows that exceed the maximum allowable flow rate are bypassed around the facility. The off-line configuration minimizes the possibility that particulates and other

pollutants previously trapped by the facility will be resuspended and transported downstream during higher flows.

For on-line facilities, the high flows are not bypassed around the stormwater quality facility. A typical example of this type of facility is a vegetated swale. Most vegetated swales are designed to treat the peak flow rate resulting from the water quality design storm but also convey the peak flow rate resulting from the flood control design storm. During high flows, the treatment effectiveness of an on-line facility is eliminated or greatly reduced. Furthermore, there is a risk that a portion of the particulates and other pollutants that were previously trapped by the on-line facility could be resuspended and transported downstream. Due to these concerns, for an equivalent drainage area, an on-line facility typically must be significantly larger than an off-line facility to provide an equivalent degree of water quality treatment. Therefore, two rainfall intensities need to be specified for designing these facilities: one for the design of on-line facilities and one for the design of off-line facilities.

QA/QC for the 15-Minute Rainfall Data Collected at City Gauges I1 and M2

The 15-minute rainfall data collected at City gauges I1 and M2 were used to determine the rainfall intensity for designing flow-through type facilities. The rainfall data were available from I1 and M2 from January 1995 to December 1999. A comparison of the rainfall data from the two gauges indicated that significant differences exist in the two data sets for some periods of record. Therefore, the 15-minute rainfall data collected at I1 and M2 were studied and analyzed for quality assurance and control purposes. The daily precipitation data collected from the NWS Rain Gauge at the Eugene Airport were also used in the data QA/QC process. The steps involved in data QA/QC are summarized below.

First we calculated daily precipitation at I1 and M2 from 1995 to 1999 by summing all the 15-minute rainfall data collected on each individual day. The daily precipitation at I1 and M2 were then compared with the daily precipitation data collected from the National Weather Service Rain Gauge at the Eugene Airport. One rainfall data file was developed from the two city data sets (i.e., the I1 and M2 rain gages) based on the following criteria:

- If the daily precipitation data for specific dates at one city gauge were significantly different from the daily rainfall data from the NWS gauge and the other city gauge, the data collected at this city gauge were excluded for those dates;
- If the daily precipitation data collected at the two city gauges were similar for a storm event but were quite different from the data collected from NWS, the city gauge that had the closer daily rainfall values to the NWS data were included in the combined data set;
- For certain days in a month that the daily rainfall data were different at all three rain gauges, data from the city gauge that was excluded the least frequently in that month was included in the combined data set.

The following periods of precipitation data were excluded altogether from the records due to the malfunctioning of both the I1 and M2 rain gages:

1. March 6, 1995 through March 31, 1995
2. September 1, 1999 through December 31, 1999.

The QA/QC results can be found in the spreadsheet files titled 1995.xls, 1996.xls, 1997.xls, 1998.xls and 1999.xls. The shaded areas in the spreadsheet represent the periods of record that were excluded. A new set of 15-minute rainfall data was developed by combining the 15-minute rainfall data collected at I1 and M2 from 1995 to 1999 as described above. A spreadsheet analysis was then performed on the combined data set to develop a frequency distribution of rainfall intensities for on-line and off-line flow-through water quality facilities. Descriptions of the spreadsheet analysis for both off-line and on-line flow-through facilities are provided in the following sections.

Off-line Flow-through Type Facilities

A spreadsheet analysis of the combined 15-minute rainfall data collected at City gauges I1 and M2 was completed to summarize the occurrence of rainfall intensities for off-line facilities. The results are presented in Figure 2. The results are based on the assumption that all stormwater runoff would be treated if the measured rainfall intensity was equal to or less than the design storm intensity. If the measured rainfall intensity exceeded the design storm intensity, then the percentage of the storm that could be treated was set equal to the ratio of the design storm intensity to the actual storm intensity. For example, if the facility is designed to treat storm events with a maximum intensity of 0.2 in/hr, then all the runoff from storm events with intensities less than or equal to 0.2 in/hr can be treated. However, if the rainfall intensity is 0.3 in/hr, then only 2/3 (or 66%) of the runoff generated this storm event would get treated.

Based on these assumptions, 80% of the average annual runoff volume would be treated if the off-line facility is designed using a rainfall intensity of 0.13 in/hr. Approximately 70% of the average annual runoff volume would be treated using a rainfall intensity of 0.08 in/hr, and 90% would be treated using a rainfall intensity of 0.19 in/hr.

On-line Flow-through Type Facilities

A spreadsheet analysis of the combined 15-minute rainfall data collected at City gauges I1 and M2 was also completed to summarize the occurrence of rainfall intensities for on-line facilities. The results are presented in Figure 2. The results for on-line facilities are based on a different set of assumptions than for off-line facilities. Similar to off-line facilities, if the measured rainfall intensity was less than or equal to the design storm intensity, then all of the stormwater runoff would be treated. However, if the measured rainfall intensity exceeded the design storm intensity, the results are based on the assumption that all of the stormwater runoff from that event would not receive treatment.

Based on these assumptions, 80% of the average annual runoff volume would be treated if the off-line facility is designed using a rainfall intensity of 0.22 in/hr. Approximately 70% of the average annual runoff volume would be treated using a rainfall intensity of 0.17 in/hr, and 90% would be treated using a rainfall intensity of 0.34 in/hr.

COMPARISON WITH OTHER JURISDICTIONS

Several other regional jurisdictions have recently adopted development standards for water quality. The following table presents the water quality requirements for Portland, Gresham, and the Unified Sewerage Agency with proposed requirements in Eugene.

Jurisdiction	Average Annual Rainfall (in)	Water Quality Design Storm			
		Detention Type Facilities		Flow-through Type Facilities	
		Total Rainfall (in)	Storm Duration	Off-Line Facilities	On-Line Facilities
Portland	34	0.83	24-hr duration	Not Specified	Not Specified
Gresham	34	1.2	12-hr duration	0.11 in/hr	0.20 in/hr
USA	40	0.36	4-hr duration	Not Specified	Not Specified
Eugene	45	1.4	24-hr duration	0.13 in/hr	0.22 in/hr

RECOMMENDATION

Based on the above analysis, we recommend that preliminary capital project designs and example site designs (for the DAC) incorporate the use of the following design storm specifications:

- For detention type facilities: required storage volume is equal to the stormwater runoff resulting from a 1.4 inch, 24-hour duration design storm
- For off-line flow-through type facilities: treat the peak flow rate resulting from a design storm with a rainfall intensity of 0.13 in/hr
- For on-line flow-through type facilities: treat the peak flow rate resulting from a design storm with a rainfall intensity of 0.22 in/hr

For the development of design tools (Task 400B1) and development of the BMP manual (Task 400B3), we recommend further analysis of the proposed design storms. Specifically, we recommend designing some example facilities to meet these requirements and running the long-term rainfall record through the facilities to ensure 80% capture of runoff.

Figure 1

Occurrence of Storm Events Based on an Analysis of the 50-year NWS Rainfall Record from the Eugene Airport (inter-event time = 6 hrs, minimum storm volume = 0.01 in)

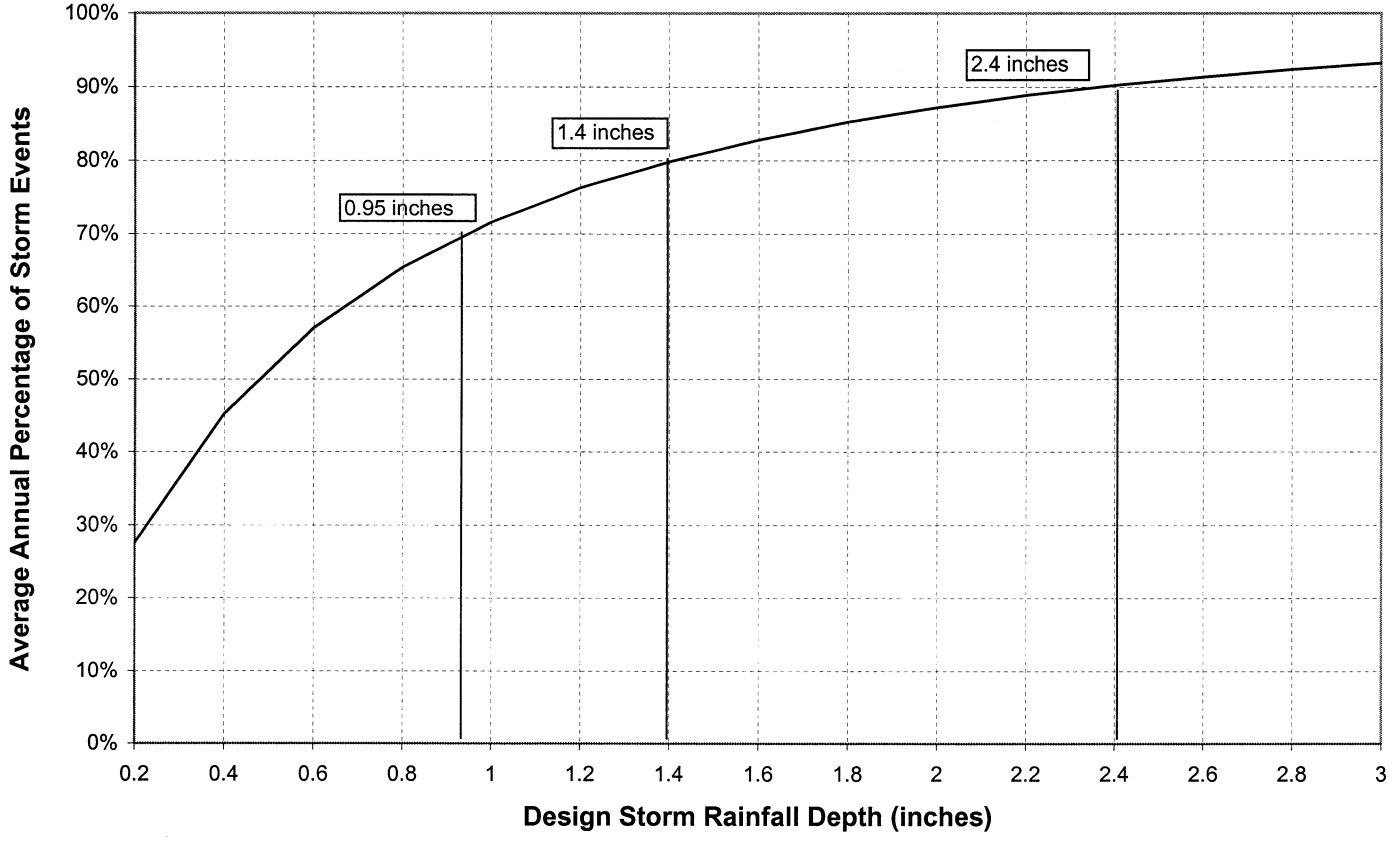
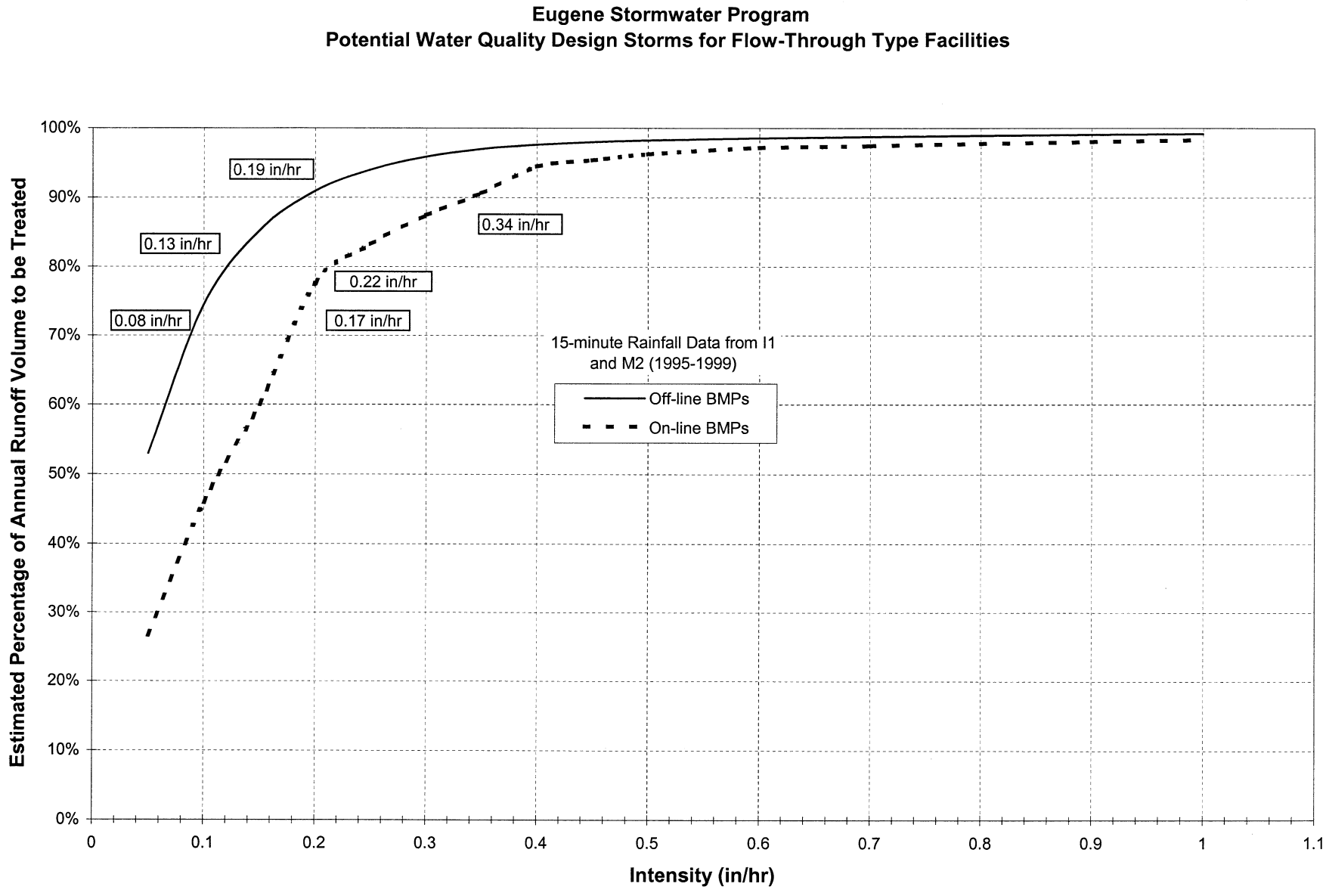


Figure 2



i:\945042\task300\precip\wqdesign\int-plot.xls

FIGURE 1