South Park Drainage Study

Seattle Public Utilities

December 2002

SOUTH PARK DRAINAGE STUDY

CERTIFICATE OF ENGINEER

The engineering material and data contained in this study were prepared by the undersigned, whose seals as registered professional engineers are affixed below.

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SEATTLE PUBLIC UTILITIES
SOUTH PARK DRAINAGE STUDY

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Certificate of Engineer
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This report has been prepared for the use of the client for the specific purposes identified in the report. The conclusions, observations and recommendations contained herein attributed to R. W. Beck, Inc. (R. W. Beck) constitute the opinions of R. W. Beck. To the extent that statements, information and opinions provided by the client or others have been used in the preparation of this report, R. W. Beck has relied upon the same to be accurate, and for which no assurances are intended and no representations or warranties are made. R. W. Beck makes no certification and gives no assurances except as explicitly set forth in this report.

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EXECUTIVE SUMMARY

The South Park basin was indicated in the City of Seattle's 1995 Comprehensive Drainage Plan as one of several drainage basins having significant drainage problems resulting from poor roadway grading, inadequate capacity of existing storm drain systems, lack of storm drainage pipes, and topographic constraints such as low elevation and tidal influence. The South Park basin plan included in the City's Comprehensive Drainage Plan identified specific drainage problems and potential solutions. The South Park Drainage Study was prepared in order to address drainage problems identified in the basin plan and to plan for future drainage infrastructure.

The South Park Drainage Study area covers approximately 587 acres extending from the City of Seattle's southern border with King County to the Duwamish River, roughly between State Route 509 to the west and 17th Avenue South to the east (Figure 1-1). Drainage infrastructure within this study area includes regions with combined stormwater and sanitary sewer service, regions with separate stormwater service, and regions that currently have no formal drainage or sewer systems where stormwater collects in low spots. The study area was divided into seven subbasins because each subbasin functions independently from the other subbasins. The three main subbasins, in order of size, are the combined sewer subbasin, the 7th Avenue subbasin and the 2nd Avenue subbasin. The 7th Avenue subbasin and the 2nd Avenue subbasins were studied in the greatest detail because of severe historical flooding.

The purpose of this study was to identify and analyze existing and potential flooding problems in the South Park area and to evaluate and recommend alternative solutions to these problems in a way that integrates both current and future infrastructure needs.

Recommendations made in this study are consistent with City planning goals and policies. These goals and policies are presented in the South Park Neighborhood Plan, the Greater Duwamish Manufacturing and Industrial Center Neighborhood Plan, the Comprehensive Plan, and the 1995 Comprehensive Drainage Plan Update.

Flooding and drainage system deficiencies were identified through public input as well as review of South Park Neighborhood Plans, existing City drainage complaints, field visits, computer modeling, and maintenance records. Topographic mapping and historical tide data were also reviewed to evaluate the possibility of direct tidal flooding. Field reconnaissance verified 48 reported problem issues and locations. A portion of the problems are the responsibility of the City of Seattle and a portion involving on-site management of stormwater is the responsibility of individual property owners.

Insufficient system capacity and poor routing of stormwater to a conveyance system result in flooding throughout the study area. Tidal influence in the Duwamish River also causes gravity storm drain systems to backup and flood low-lying areas.

Stormwater flooding on the roadways is also a result of poor street grading and potholes.

Alternative solutions for the stormwater and drainage problems were identified and evaluated for which the City has responsibility. In some cases, small or isolated modifications to the existing system would solve flooding problems. These small modifications are referred to as local solutions. Solutions were developed for the most significant of these problems, most of which are in the combined sewer subbasin.

In other cases, flooding caused by lack of a collection system or an inadequate collection system can only be solved by major drainage system modifications or installation of major new systems. Solutions to these problems are referred to as 7th Avenue basin solutions. Potential basin wide solutions were developed and analyzed, including constructing new drainage collection and conveyance pipes; providing stormwater detention and stormwater pumping; diverting flow; providing a flood protection berm; and regrading roadways and private property.

The 7th Avenue subbasin solutions are designed to solve flooding problems identified in Section 3 and provide protection for a 25-year design event throughout the study area. These alternatives were created to solve a large number of flooding problems.

The recommended basin wide solution includes a pump station and a new 22,600 lf stormwater collection system to address flooding problems. The new collection system would be installed in the lower and middle 7th Avenue subbasins to convey flow to the existing trunk along 7th Avenue South. This new collection system includes a portion of the 2nd Avenue subbasin which would divert runoff to the 7th Avenue system. Storm drainage would also be separated from sanitary sewage and added to the 7th Avenue system via a new collection system in areas adjacent to the 7th Avenue subbasins where the combined sewer system provides an inadequate level of drainage service. This would reduce flows to the combined sewer system.

The total cost project cost for the recommended solution is $12.9 million.

The annual operation and maintenance cost is expected to be $0.3 million. Because the pump is only needed when rainfall occurs during high tide, the pump would operate approximately 1 percent of the time.

Section 1
INTRODUCTION

1.1 Authorization

The South Park basin was indicated in the City of Seattle's 1995 Comprehensive Drainage Plan as one of several drainage basins having significant drainage problems resulting from lack of surface storage, poor roadway grading, inadequate capacity of existing storm drain systems, ditches, and culverts, and topographic constraints such as low elevation, tidal influence and other significant problems. The South Park basin plan included in the City's Comprehensive Drainage Plan identified specific drainage problems and potential solutions. Based on the results of this plan, it was determined that further study of the area was necessary in order to plan for future drainage infrastructure.

Acting in response to the adopted neighborhood plans and the need for further analysis of the South Park basin, Seattle Public Utilities (SPU) authorized the preparation of this drainage study in an engineering agreement with R. W. Beck dated December 5, 2000. The work is authorized under contract number CD99087, work assignment 11. As subconsultants to R. W. Beck, Symonds Consulting Engineers, Inc. provided survey services and Northwest Hydraulic Consultants, Inc. (NHC) provided assistance with hydrologic analysis.

1.2 Study Area

The South Park Drainage Study area covers approximately 587 acres extending from the City of Seattle's southern border with King County to the Duwamish River, roughly between State Route 509 to the west and 14th Avenue South to the east (Figure 1-1). The northern portion of the study area is part of the Greater Duwamish Manufacturing and Industrial Center Neighborhood. A large part of the study area is also included in the South Park Neighborhood. The southern portion of the study area consists of land draining to the stormwater pipe network which runs along 5th and 7th Avenue South to the Duwamish River. Drainage infrastructure within this study area includes regions with combined stormwater and sanitary sewer service, regions with separate stormwater service, and regions that currently have no formal drainage systems where stormwater collects in low spots. These areas are described in detail in Section 2. Photos 1 and 2 show the northern portion of the study area.

1.3 Purpose

The purpose of this study is to identify and analyze existing and potential flooding problems in the South Park area and to evaluate and recommend alternative solutions to these problems in a way that integrates both current and future infrastructure needs.

Specific objectives of the study are to:

- Conduct a public involvement process.
- Update comprehensive GIS maps of the City's drainage system.
- Define flooding problems and problem solutions using hydrologic and hydraulic computer models.
- Identify observed and reported basinwide and localized flooding problems.
- Identify solutions to localized flooding problems[1](footnote: SPU is continuing analysis and will be included in addendum)
- Analyze special flooding problems associated with low-lying areas next to the tidally influenced Duwamish River.
- Propose a formal drainage system to correct existing flooding problems and avoid future problems within the 7th Avenue system of the study area.
- Present a breakdown of the basinwide solution into capital improvement projects (CIPs).
- Help SPU respond to adopted neighborhood plans

1.4 Relevant Planning Documents

Recommendations made in this report are consistent with City planning goals and policies. These goals and policies are presented in the following planning documents.

1.4.1 Adopted Neighborhood Plans

The South Park Neighborhood Plan and the Greater Duwamish Manufacturing and Industrial Center Neighborhood Plan were reviewed as part of this study. These plans address economic, land use, transportation, utilities, environmental and public safety issues. Relevant policies identified by these plans are included in Table 1-1.

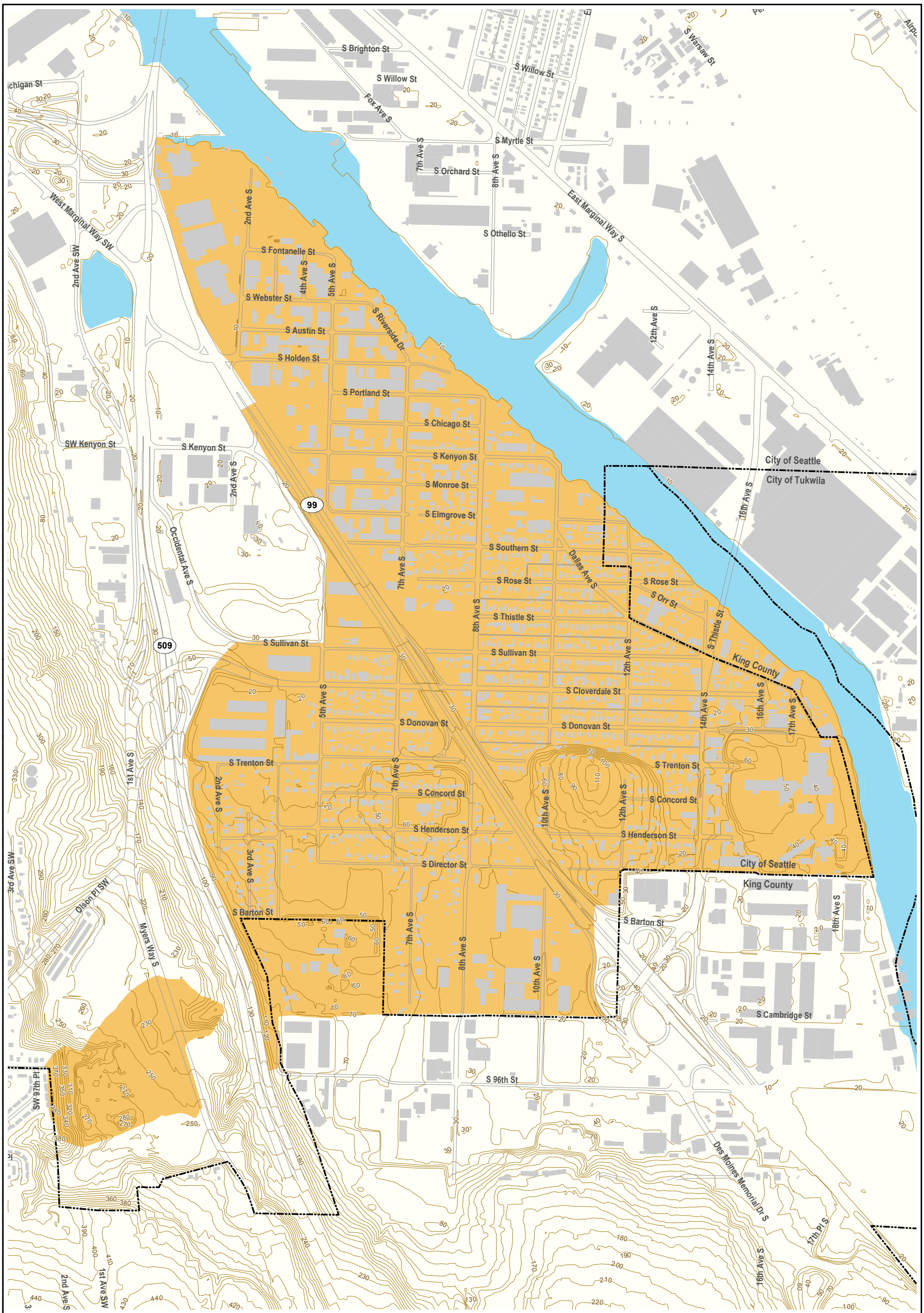

Figure 1-1
Drainage Study Area
South Park Drainage Study

Legend

- Study Area
- Buildings
- Pavement Edge
- 10 ft Contours
- Seattle City Limits

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Feet

1 inch equals 800 feet

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Table 1-1
Summary of Relevant Stormwater Program Goals and Policies

Policy	Description
SP-P12[1]	Continue seeking grass-roots involvement in siting utility facilities for South Park.
SP-P13[1]	Seek to provide timely and effective notification to other interested utilities of planned road and right-of-way trenching, maintenance, and upgrading activities in order to minimize the cost and public inconvenience of road and right-of-way trenching activities.
SP-P14[1]	Seek to coordinate utility capital expenditure planning with capital investment planning by King County departments, where appropriate.
Pol. UT 1.4[2]	Provide adequate stormwater facilities in areas where deficiencies currently exist.
Pol. UT 1.5[2]	Increase roadway and pavement durability and longevity with drainage facilities and improved maintenance.
Act. UT-3[2]	Provide drainage facilities.
Act. UT-4[2]	Conduct an in-depth community outreach process for SPU's South Park storm drainage study that takes direct input from property owners and operating businesses in order to effectively consider additional needs of the area not identified in Act. UT-3.
Act. UT-5[2]	Coordinate upcoming storm drainage and public utility study between Seattle Public Utilities and King County to facilitate growth and development of the South Park/King County Manufacturing and Industrial Area.

[1] Source: South Park Neighborhood Plan.
SP-P refers to South Park Policies from South Park Neighborhood Plan.
[2] Source: Greater Duwamish Manufacturing and Industrial Center Neighborhood Plan.
Pol. UT refers to Utilities Goals and Policies.
Act. UT refers to Recommended Actions and Strategies.

1.4.2 City of Seattle Comprehensive Plan

The Comprehensive Plan, Toward a Sustainable Seattle, is a 20-year policy plan (1994-2014) designed to guide growth and development in Seattle. Such a plan is required by the state's 1990 Growth Management Act. The Comprehensive Plan makes basic policy choices and provides a framework for adapting to real conditions over time. Table 1-2 summarizes relevant stormwater policies identified in the plan. These and other drainage policies are supported in the 1995 Comprehensive Drainage Plan Update described below.

Table 1-2
Summary of Relevant Stormwater Program Goals and Policies in the City of Seattle Comprehensive Plan

Policy	Category	Description
LG10	Preferred Development Pattern – Urban Village Strategy, Goals	Maximize the benefit of public investment in infrastructure and services.
EG1	Environmental Element, City Government Operations Goals	Comply with regulations that govern protection of the environment.
E1	Environmental Element, Policies	In managing City government operations, take reasonable steps to reduce impacts to the environment and ecosystems upon which we depend.
EG10	Environmental Element, Water Quality Goals	Strive to reduce the number and extent of combined sewer overflow events occurring annually in the City.
UG1	Utilities Element, Goals	Provide reliable service at lowest cost consistent with the City's aims of environmental stewardship, social equity, economic development, and the protection of public health.
UG2	Utilities Element, Goals	Maintain the service and reliability of the City's utility infrastructure.
UG4	Utilities Element, Goals	Minimize the cost and public inconvenience of road and right-of-way trenching activities.
U4	Utilities Element, Utility Policies, Utility Infrastructure Goals	Continue to provide for critical maintenance and remedying of existing deficiencies in City utility capital facilities.
U16	Utility Element, Utility Policies, Utility Relationships	Provide timely and effective notification to other interested utilities of planned road and right-of-way trenching, maintenance, and upgrade activities.

1.4.3 1995 Comprehensive Drainage Plan Update

The 1995 Comprehensive Drainage Plan Update contains drainage policies, programs for public involvement, a capital improvements plan, and funding methodology. The Plan addresses drainage problems citywide and focuses on ten areas (including South Park) that have the most critical needs. The plan includes planning level analysis for these ten basins where individual projects cannot be implemented without examining

the entire system. Comprehensive drainage policies presented in the plan provide guidance to the SPU in managing water resources. Policies emphasize environmental considerations and the protection of public and private property from damage caused by excess stormwater. The Comprehensive Drainage Plan was amended by the Drainage Policy Study adopted in May 2000. An updated Comprehensive Drainage Plan is currently being drafted and is scheduled for issue by December 2003.

1.5 Study Description

The initial task of this study involved the collection of information about the study area through site visits and review of development plans and existing reports and documents. Aerial photogrammetry and surveying were completed to identify drainage structures and produce topographic mapping for the lower portion of the Study area. A detailed description of the drainage study area and its existing drainage system is presented in Section 2. Information on the study area was used to perform hydrologic and hydraulic modeling, which involved the development and application of computer models using the Expert Stormwater Management Model (XP-SWMM). The development and application of these models is described and detailed in Volume II of this report.

Flooding problems throughout the study area were identified through neighborhood plan input, city-wide complaint database information, operation and maintenance records, known problem locations, field observation, analysis of the hydrologic and hydraulic modeling results, research of existing documents, and public input obtained through a mail-in survey of local residents and businesses. The identified problems and the problem identification methodology are described in Section 3. Section 4 presents several basin wide and local solutions developed to solve the flooding problems identified throughout the study area. This section also includes analysis and evaluation of these alternatives.

Evaluation of alternative solutions led to the recommended plan of subbasin wide and local solutions. Section 5 describes these solutions and the layout and analysis performed toward their development. The section provides a breakdown of the recommended plan into smaller capital improvement projects and provides a cost analysis of these projects.

Section 2
STUDY AREA DESCRIPTION

2.1 General

The South Park Drainage Study area covers approximately 587 acres, including 543 acres within the City of Seattle and 44 acres within King County. Current land uses within the study area include industrial, commercial, residential and undeveloped land. Separated stormwater trunk systems in the area convey runoff north to outfalls along the Duwamish River. Runoff is conveyed to the trunk system via natural drainage ways, ditches, and enclosed pipe systems. Stormwater in some areas is conveyed via a combined sewer system to a sanitary sewage treatment plant operated by King County.

2.2 Duwamish River and Tidal Impacts

The study area lies adjacent to the Duwamish River. At this location, the river is tidally influenced. During high tide the water level in the river, at times has a major impact on the flow of stormwater from the lower lying areas of the study area. For example, the 7th Avenue South and 2nd Avenue South system outfalls are located on the bank of the Duwamish River. Tide valves have been installed that regulates flow from the basins. When the water surface on the land side of the valve is greater than the river level, flow discharges into the river. When the river level is higher than the water level in the pipe system, no outflow occurs. In this condition, runoff from the basin will be stored in the pipe system or above the ground (creating surface flooding) until the tide recedes.

2.3 Study Area Subbasins and Drainage Systems

The South Park Study area (Figure 2-1) has been divided into the following subbasins, each functioning independently of the other subbasins:

- The area that drains to an existing storm drainage trunk system along 7th Avenue South (referred to as the 7th Avenue subbasin)
- The area that drains to an existing storm drainage trunk system along 2nd Avenue South (referred to as the 2nd Avenue subbasin)
- The area that drains to the pipes that collect both stormwater and sanitary sewage in combined sewers (referred to as the combined sewer area subbasin)

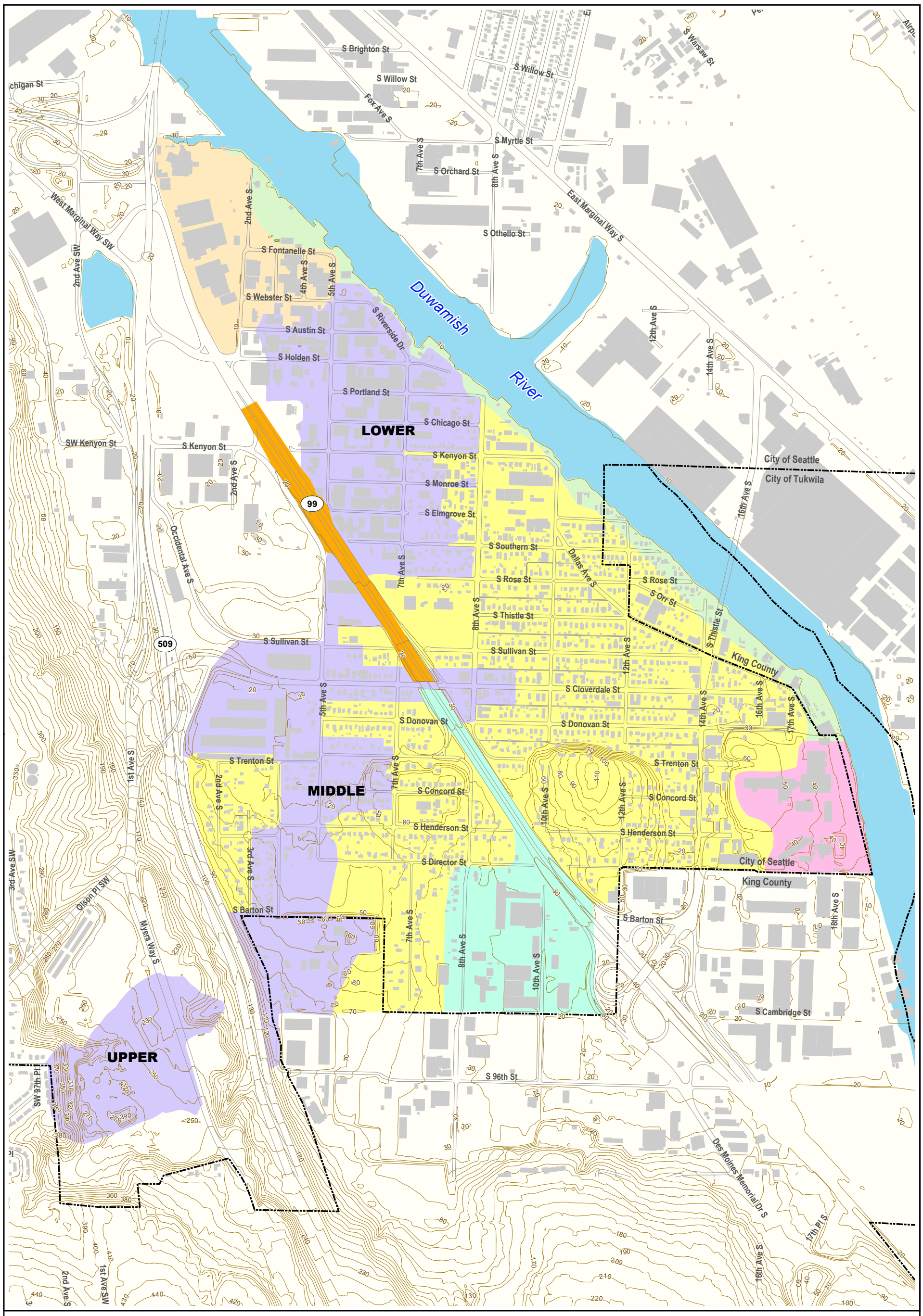

Figure 2-1
Study Area Subbasins
South Park Drainage Study

Legend

- 7th Ave Subbasin
- 2nd Ave Subbasin
- Hamm Creek Subbasin
- North 99 Subbasin
- Riverside Subbasin
- 17th Ave Subbasin
- Combined Sewer Subbasin
- Buildings
- Pavement Edge
- 10 ft Contours
- Seattle City Limits

N W E S

0 400 800 Feet

1 inch equals 800 feet

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- The area near 17th Avenue South and drains to a private drainage system (referred to as the 17th Avenue South Subbasin)
- The area lying along the banks of the Duwamish River (referred to as the Riverbank Subbasin)
- The area north of South Donovan Street that drains to a storm drainage trunk along SR 99 (referred to as the SR-99 North Subbasin).
- The area that drains to a storm drainage trunk along SR 99 and south of South Donovan Street and along SR 99 as well as other areas draining south to Hamm Creek (referred to as the Hamm Creek Subbasin)

These subbasins are described in greater detail in the following subsections. The remaining portion of the study area, which drains to combined sanitary and stormwater sewer systems (referred to as the combined sewer area), most of which is located east of the 7th Avenue subbasin

2.3.1 7th Avenue Subbasin

The 7th Avenue subbasin boundaries are shown on Figure 2-1. The subbasin encompasses an area that is currently or (based on existing topography) potentially could drain to an existing stormwater trunk system that drains north along 7th Avenue South. The existing drainage systems in the 7th Avenue subbasin are shown in Figure 2-2 and described below. Stormwater drainage service in the 7th Avenue Basin consists of natural drainage ways, ditches, and storm pipe systems. These systems route runoff to a trunk storm drain running north along 7th Avenue South to the Duwamish River. The drainage basin boundaries were drawn after the topography and existing storm drainage facilities were taken into account so the boundaries are irregular in some areas. For the purposes of this study the 7th Avenue subbasin was further subdivided into three smaller areas. This study refers to these areas as the upper, middle, and lower 7th Avenue subbasins (Figure 2-1). The three 7th Avenue subbasins are distinguished by topography and serve for reference purposes only.

2.3.1.1 Lower 7th Avenue Subbasin

Land Use and Characterization

The largely industrially-developed lower 7th Avenue subbasin includes 70 acres and is bordered by South Rose Street on the south, the Duwamish River to the north, State Route 99 to the west, and 8th Avenue South to the east. All runoff in the lower 7th Avenue subbasin is routed to and then conveyed through a pipe system (Figure 2-2). Flows from the upper and middle 7th Avenue subbasins enter the lower 7th Avenue subbasin east of SR 99 near South Southern Street, west of 7th Avenue South. Pipes convey flow east along South Southern Street to the 72-inch-diameter trunk that runs north on 7th Avenue South to its outfall into the Duwamish River. The main trunk picks up drainage from several branch collection systems. Runoff from a subbasin including the area bound by South Chicago Street, South Portland Street, 5th Avenue South and 7th Avenue South enters the 7th Avenue trunk at the intersection of South Portland Street and 7th Avenue South. An additional collection system draining to the

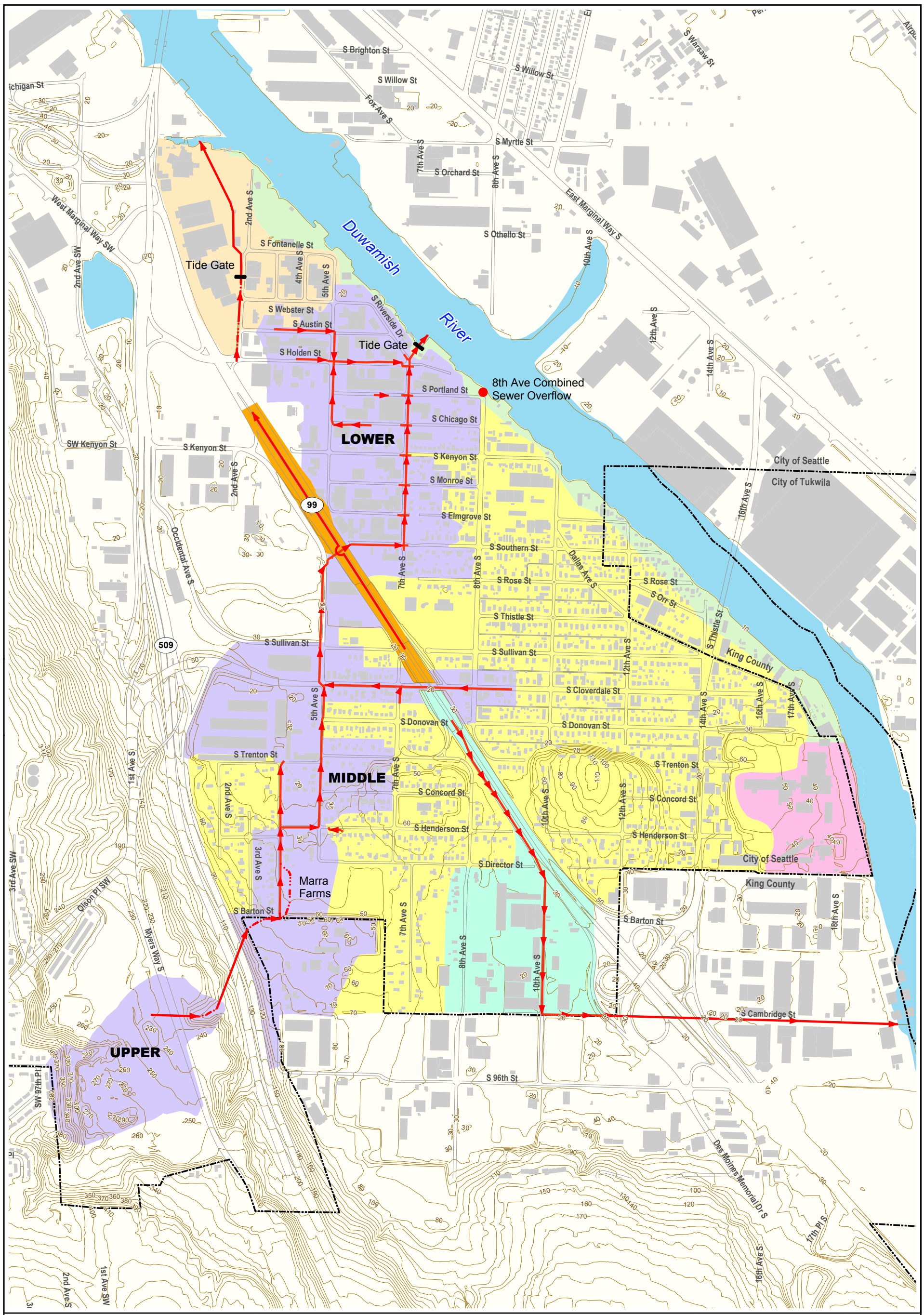

Figure 2-2
Existing Stormwater Conveyance System
South Park Drainage Study

Legend

- Drainage Pipe System
- Open Channel
- 7th Ave Subbasin
- 2nd Ave Subbasin
- Hamm Creek Subbasin
- North 99 Subbasin
- Riverside Subbasin
- 17th Ave Subbasin
- Combined Sewer Subbasin
- Buildings
- Pavement Edge
- 10 ft Contours
- Seattle City Limits

N W E S

0 400 800 Feet

1 inch equals 800 feet

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7th Avenue trunk also exists on South Austin Street between 3rd Avenue South and 5th Avenue South and on South Holden Street between 3rd Avenue South and 7th Avenue South. The area that drains to this system is referred to as the "Holden low area" in this study.

The lower basin is primarily industrial with residential properties east of 7th Avenue South and south of South Kenyon Street. The street and roadways in the lower basin are typically poorly graded and are characterized by poor pavement conditions and potholes. Storm water collects and ponds in potholes and low spots throughout this area and either infiltrates or evaporates. The potholes and low spots are filled with water throughout the winter months. Photos 3 and 4 of the lower basin are presented in the end of this section.

Existing land cover including impervious area in the lower 7th Avenue subbasin is presented in Table 2-1. The subbasin was characterized based on current land use information in the City of Seattle's GIS database. Characterizations were confirmed during field visits. To evaluate the impacts of development on the production of runoff, future land cover was estimated using City of Seattle zoning data. Data obtained from the City's GIS database was evaluated, and impervious area was calculated assuming maximum development within density and lot coverage regulations specified in the City of Seattle Land Use Code. Future land use and impervious area, and percent increase in impervious area are also presented in Table 2-1.

Table 2-1
Land Use in the 7th Avenue Subbasin

			Existing Land Use		Future Land Use		
7th Avenue Subbasin	Zoning Designation	Total Area (acres)	Percent Impervious[1]	Impervious Area (acres)	Percent Impervious[2]	Impervious Area (acres)	Increase in Impervious Area From Existing Conditions
Lower	Industrial Buffer	7.1	86%	6.1	90%	6.3	5%
Lower	Industrial General 1	12.0	90%	10.8	95%	11.4	6%
Lower	Industrial General 2	47.2	90%	42.5	95%	44.9	6%
Lower	Single Family Residential - 1du/5000sf	4.2	36%	1.5	53%	2.2	47%
Middle	Commercial 2-65	3.4	90%	3.1	95%	3.2	6%
Middle	Industrial General 2	31.7	80%	25.3	95%	30.1	19%
Middle	Industrial Buffer	10.3	86%	8.8	90%	9.2	5%
Middle	Single Family Residential - 1du/5000sf	27.4	36%	9.9	53%	14.5	47%
Middle	Multifamily Residential - Lowrise	8.6	40%	3.4	75%	6.4	88%
Middle	Neighborhood Commercial 2-40	4.3	76%	3.3	80%	3.4	5%
Upper	Commerical 2-65	31.7	20%	6.3	95%	30.1	375%
Total		**187.8**		**121.0**		**161.9**	**34%**

1. Percent impervious calculated based on current land use data obtained from SPU GIS information and field verified.
2. Percent impervious reflects maximum buildout under City of Seattle Land Use Code.

Surficial Geology

Figure 2-3 shows surficial geology in the study area. The lower 7th Avenue Subbasin of the study area has been mapped primarily as modified land or fill. This material was probably placed in many episodes over time and has a variety of characteristics. Groundwater levels in this material are typically within 10 feet of the surface.

Topography

Topography and slope influence runoff and peak flow rates within a drainage basin. The topography is generally flat throughout the lower 7th Avenue subbasin. The elevation of the upstream end of the subbasin is approximately 20 feet (NAVD 88) and the basin slopes at a shallow gradient toward an elevation of approximately 12 feet (NAVD 88) at the Duwamish River. The elevation of the bank along the river varies between 11 feet to 14 feet (NAVD88). Grades along South Austin Street, South Holden Street and South Portland Street, west of 7th Avenue South, are lower than the remainder of the basin. This report refers to this area as the "Holden Low Area". As discussed in Section 3, Problem Identification, the low elevations and lack of grade in the lower basin contribute to the inefficiency of the existing stormwater collection system and present challenges in designing an effective collection and conveyance system.

Flow Characteristics

The flow in the storm drain system in the lower 7th Avenue Subbasin is directly affected by the tide level in the Duwamish River. When the tide level in the river is higher than the water level in the storm drain, stormwater accumulates and is stored in the 72-inch storm drain. As the tide recedes, water is released from the storm drain. The flow rate at the outfall is then related to the amount of water stored in the pipe system and not directly related to rainfall. The 72-inch trunk, therefore, provides not only conveyance but also storage. Detailed flow characteristics for the lower 7th Avenue South basin are discussed in Section 3.3

2.3.1.2 Middle 7th Avenue Subbasin

Land Use and Characterization

The middle 7th Avenue subbasin is primarily residential with some industrial areas north of South Trenton Street and west of 5th Avenue South. Residential properties vary from undeveloped areas and single family homes to apartment units.

The middle 7th Avenue subbasin is bound by State Route 509 to the west, South 96th Street to the south, 7th Avenue South and State Route 99 to the east, and South Sullivan Street to the north. The middle 7th Avenue subbasin drains approximately 85.5 acres. An open channel conveying flows from the upper 7th Avenue subbasin enters the middle 7th Avenue subbasin on the east side of SR 509 (Figure 2-2). The channel conveys flows to the main trunk pipe system beginning near the intersection of South Barton Street and 4th Avenue South. Flow is conveyed north along 4th

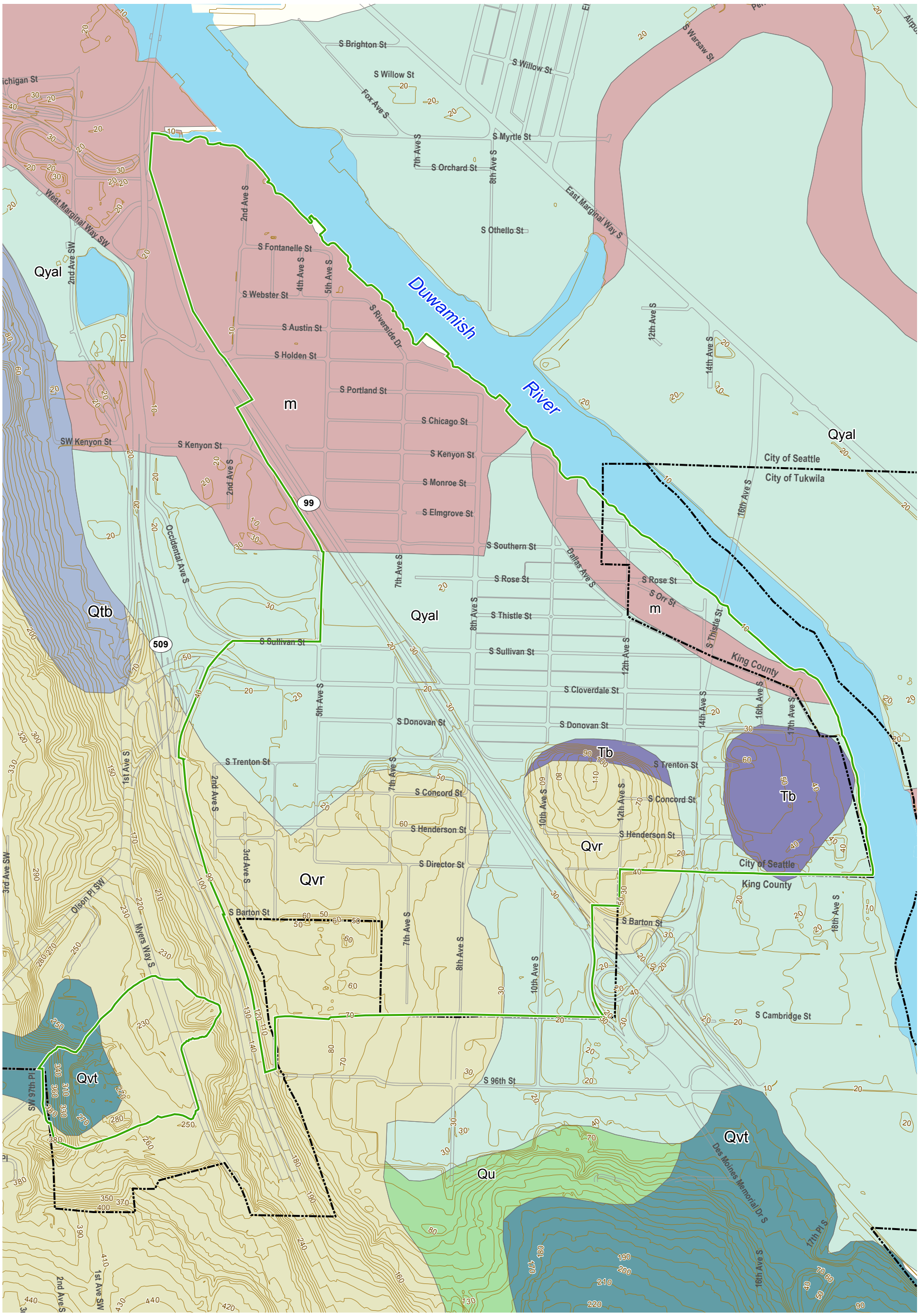

Figure 2-3
Surficial Geology
South Park Drainage Study

Legend

- Study Area
- Water Bodies
- Pavement Edge
- 10 ft Contours
- Seattle City Limits

Surficial Geology Units

- Transitional beds (Qtb)
- Undivided surficial deposits (QU)
- Recessional outwash (Qvr)
- Till (Qvt)
- Younger alluvium (Qyal)
- Sandstone/conglomerate (Tb)
- Modified land (m)

N W E S

0 400 800 Feet

1 inch equals 800 feet

R·W·BECK

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Avenue South past the Marra Farm property. Low flows from the upper and a portion of the middle 7th Avenue subbasins bypass the pipe system on 4th Avenue South north of South Barton Street and enter a constructed channel along the Marra Farms property. This open channel provides aquatic habitat and an educational resource for local elementary schools. Flows reenter the pipe system near the intersection of 4th Avenue South and South Director Street and continues north to South Henderson Street. The pipe system continues east on South Henderson Street to 5th Avenue South where it turns north. A tributary system collecting runoff between 8th Avenue South and 5th Avenue south along South Cloverdale Street enters the main system, which then continues north under SR 99 to the upstream end of the lower 7th Avenue subbasin. Photos 5 and 6 of the subbasin are presented in the end of this section

Existing and future land cover including impervious area in the middle 7th Avenue subbasin is presented in Table 2-1.

Surficial Geology

Figure 2-3 shows surficial geology in the study area. The middle 7th Avenue subbasin has been mapped as Younger alluvium consisting of fine sand and silt in the northern half and recessional outwash in the southern half. Recessional outwash is comprised of sand and gravel. Groundwater levels in this material are typically within 10 feet of the surface.

Topography

The average slope of the subbasin between South 96th Street and South Trenton Street is approximately 4 percent. The remaining northern portion of the subbasin is generally flat. The southwest border of the middle 7th Avenue subbasin extends along State Route 509. Here, the ground slopes away from the freeway at a 45 percent slope for 100 feet.

Flow Characteristics

The flow in the storm drain system in the middle 7th Avenue Subbasin is directly affected by the tidal level in the Duwamish River for the portion of the storm drain system north of South Trenton Street. South of South Trenton Street, the flow in the storm drain system is not tidally influenced. Springs have been noted west of 5th Avenue South and north of South Henderson Street, however no further investigation was completed as part of this project. Detailed characteristics for the middle basin are presented in Section 3.3

2.3.1.3 Upper 7th Avenue Subbasin

Land Use and Characterization

The upper 7th Avenue subbasin covers 32 acres west of SR 509 and south of Olsen Place SW. This area is currently undeveloped and consists of an abandoned, regraded gravel pit with mostly exposed soils with and some vegetation and brush west of Meyers Way South. The area east of Myers Way South and west of SR 509 is

forested. Runoff in the upper 7th Avenue subbasin is routed via surface and subsurface flow to a storm drainage pipe conveying flow east underneath Meyers Way South (Figure 2-2). After crossing below Meyers Way South, flow is daylighted to a natural channel. The channel conveys runoff northeast to a long culvert crossing under SR 509. The open channel east of SR 509 flows to the upstream end of the middle 7th Avenue basin. Photos 7 and 8 show the upper 7th Avenue subbassin and are presented in the end of this section.

Existing land cover including impervious area in upper 7th Avenue subbasins is presented in Table 2-1. The subbasin was characterized based on current land use information in the City of Seattle's GIS database. Future land use and impervious area, and percent increase in impervious area are also presented in Table 2-1. The most significant increase in impervious area in the 7th Avenue basin is predicted to occur in the upper 7th Avenue subbasin.

Surficial Geology

Figure 2-3 shows surficial geology in the study area. The subbasin is underlain by recessional outwash material, comprised of sand and gravel. In fact, much of the study area west of Myers Way was used as a source of sand, although the pit is now closed and it has been regraded. As shown on Figure 2-3, the uppermost portion of the subbasin has been mapped as glacial till although most of this material appears to have been removed as overburden for the sand pit.

Topography

The topography of study area west of Myers Way is representative of a gravel pit that has been regraded. The study area east of Myers Way and west of State Route 509 is undeveloped with dense vegetation in areas with steep slopes.

Flow Characteristics

The flow in the storm drain system in the upper 7th Avenue Subbasin is directly related to rainfall. The tides in the Duwamish River do not have any impact on the flow characteristics. Runoff is now relatively low and is expected to increase with development since the area is zoned for commercial development. Detailed flow values are discussed in Section 3.3.

2.3.1.4 7th Avenue Subbasin Design Event

Typically, drainage infrastructure within the City of Seattle is designed and analyzed using a standard 25-year rainfall event consisting of 3.12 inches of rainfall occurring over a 24-hour period. The single event model is based on a unit hydrograph that describes surface flow over a drainage basin over a specified period of time. Unit hydrographs assume that surface flow is generated uniformly at a constant rate and that basin conditions remain constant throughout the duration of the event. In the 7th Avenue subbasin, conditions vary significantly with the tidally influenced stage of the Duwamish River. The storage in the storm drain system regulated by the tide gate varies with the tide and the rainfall over the basin.

This condition makes using only a single rainfall event inappropriate for simulating the basin's response to rainfall. Instead, return periods (2-year, 10-year, 25-year, and 100-year) were assigned to combined tide/rainfall events based on a study performed by Northwest Hydraulic Consultants. These return periods were determined based on continuous simulation modeling and frequency analysis of historical SeaTac rainfall data and observed tidal data corresponding to data recorded by NOAA at the Seattle tide gage for water years 1949 through 1996. The results show that the critical design events consisted of periods of very high tides and relatively modest rainfall. This conclusion is verified by observed historical flooding patterns. Details of the analysis are presented in the Modeling Manual. The following design events were used for hydrologic modeling in this study:

Table 2-2
Design Events Used for the Hydrologic Modeling

Date	Design Event	Peak Tide (ft, NAVD 88)	24-Hour Rainfall (in)
December 15, 1977	100-year event	12.15	1.1
January 14, 1974	25-year event	11.74	1.3
January 30, 1952	10-year event	11.02	1.5
November 27, 1984	2-year event	10.09	1.0

For comparison, the Mean High Water elevation (long-term, average high tide) is 7.5 feet (NAVD 88) and the Mean Low Water elevation (long-term, average low tide) is -0.2 feet (NAVD 88). To ensure that the proposed pipe systems would have adequate conveyance capacity for a high intensity event, the model was also run using SPU's standard 25-year rainfall event with no tidal influence.

2.3.2 2nd Avenue Subbasin

Land Use and Characterization

Land use in the subbasin is nearly all industrial with a few isolated homes. Streets are in fair to poor condition. Because of the industrial and storage uses there are no curbs or sidewalks. The character of the subbasin is shown in photos 9 and 10.

Surficial Geology

The surface materials in the subbasin have been mapped as modified land (fill).

Topography

The land surface in the subbasin is flat with the ground varying about eight feet in elevation.

Flow Characteristics

The 2nd Avenue system, shown on Figure 2-2, consists of a series of open channels and culverts between South Holden Street and South Webster Street. Between South Webster and South Fontanelle Streets, flows enter a pipe system. At South Fontanelle Street, the existing storm drain turns northwest across private property and discharges into the Duwamish River. A tide gate was installed at the upstream end of this pipe system. This tide gate prevents tidewater from backing into the open channel. However, capacity within the system is significantly reduced when high tides occur. When even modest rainfall occurs during high tides the water surface in the open channel can rise to the base of 2nd Avenue South.

2.3.3 Combined Sewer Subbasin

Land Use and Characterization

The Combined Sewer Subbasin encompasses a large portion of the study area and some areas where overland flow eventually drain to the combined sewer pipe system (Figure 2-1). The combined system consists of pipelines that convey both sanitary sewage and storm water. This pipe network discharges into a King County pipeline that eventually flows to West Point Treatment Plant. When high runoff events occur, the hydraulic capacity of the combined system may be exceeded. During these occurrences, flow is discharged directly to the Duwamish River via combined sewer over flow at the north end of 8th Avenue South (Figure 2-2).

The subbasin is predominately residential in zoning with smaller portions that are light commercial and industrial. East of Highway 99, the basin is characterized by very flat grades. There is a business corridor along 14th Avenue South as well as South Cloverdale Street. Otherwise, this subbasin is dominated by single family residential use. The pipe network is extensive and provides at least some drainage service to most of the subbasin with the exception of some areas, such as 7th Avenue South and south of South Director Street.

West of Highway 99, the subbasin is dominated by single family residential homes. Along South Trenton Street and 2nd Avenue South there are new housing apartments under construction. This subbasin also has a high water table with springs scattered throughout. A wetland is located in the vicinity of 3rd Avenue South and South Henderson Street Representative views of the subbasin are shown in photos 11 and 12.

Surficial Geology

The surficial geology includes Younger alluvium, modified land (fill) in the low-lying areas. The hill near 12th Avenue South and South Henderson Street is composed of glacial recessional outwash (sand and gravel) and pre glacial bedrock (sandstone, conglomerate and siltstone) (Figure 2-3).

Topography

The north half of the subbasin has very flat grades. South of South Donovan Street the ground begins to rise. A 100-foot high hill creates a high point at South Concord Street and 10th Avenue South. A second, smaller hill exists at South Concord Street and 7th Avenue South with a school located at the top.

2.3.4 17th Avenue Subbasin

The 17th Avenue subbasin is bounded by the Duwamish River, S. Director Street (city limits), South Donovan Street and 14th Avenue South. This subbasin is a topographic high point 20 to 40 feet in elevation created by the underlying bedrock of sandstone and conglomerate (Figure 2-3). Land use consists of two commercial companies. Drainage from this subbasin is collected in a private pipe network and discharged directly into the Duwamish River. There are no public streets in this subbasin. No detailed investigation was completed for this subbasin.

2.3.5 Riverbank Subbasin

The riverbank subbasin lies on the bank of the Duwamish River all along the study area. Figure 2-1 shows that the basin consists of a sliver immediately along the river bank. Runoff from this subbasin flows directly into the river either by surface flow or in relatively short pipe systems. Most of the drainage features lie on private property and are privately owned and maintained. The investigation of this subbasin was limited.

Figure 2-1 also shows that a portion of this subbasin, along with a portion of the Combined Sewer Subbasin, lie in unincorporated King County. This area could potentially be annexed by the City of Seattle.

The topography is flat and the land use consists primarily of water oriented industrial and commercial uses. There are also areas of residential use. The condition of the streets vary considerably with the more residential areas between 14th Avenue South. and 8th Avenue South being in relatively good condition although most lack curbs and sidewalks. Other areas are in fair to poor condition. Potholes are evident in many of the industrial streets.

Surficial geology consists of younger alluvium (sand and gravel) and modified land (fill) (Figure 2-3). The riverbank has both designed and informal armoring for erosion protection

2.3.6 SR 99N Subbasin

The SR 99N subbasin includes areas that drain north through the WSDOT drainage system along SR 99. These areas do not drain to the storm drainage systems studied in this report and, therefore, no further investigation was completed.

2.3.7 Hamm Creek Subbasin

The Hamm Creek subbasin is shown in Figure 2-1 and includes SR 99 south of South Donovan Street to the City boundary, and the area east of 10th Avenue South and north of South Cambridge Street. This subbasin drains to the storm drain system along South 96th Street, flows under SR 99 and discharges directly to the Duwamish River. This pipe system is a portion of the drainage network in the Hamm Creek Subbasin. Drainage along this corridor is mostly in King County and under King County jurisdiction. A majority of the contributing area of the Hamm Creek basin lies in King County. The lower end of the drainage system is part of the WSDOT drainage system. No further investigation was completed for this subbasin.

Historically, the downstream end of Hamm Creek meandered through an intertidal marsh and flowed into the Duwamish River. Hamm Creek was diverted to a ditch and routed into a culvert with an outfall into the Duwamish River accessible to fish only at higher tides. As part of a recent restoration project sponsored by the United States Army Corps of Engineers and King County, 1,900 feet of new productive riparian streambed and channel for Hamm Creek was created. The restored area was enhanced to provide improved wildlife habitat and a fish passable connection to the Duwamish River.

Photo 1: Typical street ponding

Photo 2: Typical street ponding

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Seattle Public Utilities
South Park Drainage Study

Lower 7th Avenue Subbasin Photos

Photo 3: Typical street ponding

Photo 4: Typical street ponding, near inlet

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South Park Drainage Study

Lower 7th Avenue Subbasin Photos

Photo 5: Sidewalk flooding near 5th Avenue South and South Concord Street

Photo 6: Driveway flooding near 4th Avenue South and South Trenton Street

Photo 7: Abandoned gravel pit

Photo 8: South of abandoned gravel pit

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Seattle Public Utilities
South Park Drainage Study

Upper 7th Avenue Subbasin Photos

Photo 9: South Webster Street

Photo 10: 2nd Avenue and South Webster Street

Photo 11: Near 12th Avenue South and South Concord Street

Photo 12: 5th Avenue South and South Henderson Street

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Seattle Public Utilities
South Park Drainage Study

Combined Sewer Subbasin Photos

Section 3
PROBLEM IDENTIFICATION

3.1 General

This section describes the stormwater flooding problems identified within the project study area. Flooding and drainage system deficiencies were identified through public input as well as review of South Park Neighborhood Plans and other reports, existing City drainage complaints, and maintenance records. A comprehensive evaluation of drainage complaint data, maintenance records, field observation, and surface water and drainage systems within the basin using a hydrologic and hydraulic model, was also used to identify flooding problems. Topographic mapping and historical tide data were also reviewed to evaluate the potential of direct tidal flooding. Field reconnaissance conducted by the Consultant and SPU staff verified reported problem issues and locations.

Insufficient system capacity and poor routing of stormwater to a conveyance system results in flooding throughout the study area. Tidal influence in the Duwamish River causes gravity storm drain systems that discharge to the river to backup and flood low-lying areas. Drainage system capacity in the South Park basin is reduced because of flat topography and low elevation relative to the Duwamish River. Stormwater flooding on the roadways is also a result of poor street grading. Much of the study area also has a high percentage of impervious area, which results in high peak runoff rates during storm events. These high peak flow rates exceed the capacity of the drainage system in some areas, which causes flooding of developed areas.

3.2 Problem Identification Methodology

Several methods were used to identify flooding problems, which are compiled in Table 3-1.

3.2.1 Public Involvement

An important method for identifying flooding problems was to survey residents and businesses. This element of data collection for the South Park Drainage Study consisted of the distribution of mail-in surveys, participation in meetings with the South Park Business Association, and a Public Community Meeting.

3.2.1.1 Mail-In Survey

A mail-in survey with a letter describing this study and was delivered to all of the residents and businesses in the study area in November 2001. A Spanish version of the

letter and questionnaire was also distributed to residents in the area. The questionnaire was designed to identify and help categorize specific flooding and drainage problems and give the public an opportunity to inform the City of problems that may have been observed. The letter and questionnaire (in English and Spanish) are included in Appendix A.

Responses from the mail-in surveys distributed for public involvement were collected. Complaint mailer numbers were assigned based on the order in which they were received. Follow-up calls made to the residents and business owners who identified problems provided further clarification and description of the problems. Multiple complaints from different residents regarding the same flooding problem were compiled into one problem location and given a problem identification number.

The Consultant and SPU Staff conducted field reconnaissance visits in January 2002 to review all of the problems identified on the compiled list. Field notes, sketches of the problems, and suggestions for possible solutions were documented. Mailers that noted "no problems" or were not drainage related, were removed from the list. The remaining problems, are included in Table 3-1.

3.2.1.2 South Park Business Association Meetings

Members of the project team met on three occasions with the South Park Business Association (SPBA). On September 25, 2001, team members described the scope and schedule for the study and obtained input from the attendees regarding flooding problems and concerns. The flooding problems voiced by members of the SPBA echoed complaints received in response to the mail-in surveys. No new problems were raised during the meeting.

The team also met with the SPBA on June 18, 2002. During this meeting, the team members described the problem identification methodology, the alternatives analyzed, and the preferred alternative to solve flooding in the lower 7th Avenue basin. Street restoration and funding were also discussed. A third meeting was held on September 17, 2002 with SPU and the SPBA and a summary of the study, including the recommended alternative were presented.

3.2.2 Existing SPU Database

SPU has a database of drainage problem locations. This database has hundreds of complaints throughout the City and was reviewed as part of this project.

3.2.3 Observation and Historical Knowledge

Field visits and information gathered during those visits were used to identify new problems and clarify known problems. Some visits to the lower 7th Avenue subbasin and 2nd Avenue subbasin were scheduled to coincide with extreme high tides to observe the effects of the tides. Flooding in these subbasins was confirmed and the operation of the tide valve at 7th Avenue South outfall was verified. Visits to other locations in the study area and conversation with businesses and private property owners were also used to assess problem areas.

3.2.4 South Park Neighborhood Plan

The South Park Neighborhood Plan presents policies and short- and long-term activities for improving the quality of life in the area. Among the planned activities is improvement of infrastructure. Table 3-2 identifies key activities identified in the adopted matrix associated with improvement of drainage infrastructure in the study area. These activities were called for in response to public flooding problems identified in the plan. The problems identified in the plan were echoed in the mail-in survey responses and are included in Table 3-1 as Problem Nos. C1, C3, and C6.

Table 3-2
Key Activities for Improving Infrastructure

Key Activity	Description
KA 3.02	Design, engineer and rebuild the streets per current City of Seattle street improvement standards in the 4th Avenue South right of way between South Trenton Street and South Henderson Street.
KA 3.05	Install street drainage systems in the area east of 4th Avenue South to 8th Avenue South and south of South Director Street to South Cambridge Street.
KA 3.06	Improve street drainage along South Director Street, including the stormwater flooding at 565 South Director Street.
KA 3.07	Install street drainage systems on 7th Avenue South, 8th Avenue South, and South Henderson Street, around Concord School
KA 3.08	Study the feasibility of connecting the drainage systems described in activity numbers: Key Activity 3.05, Key Activity 3.06, Key Activity 3.07 above, to the proposed bioswale on the Fibers and Marra Farm properties along South Director Street (parcel nos. 3224049021, 3224049035, and 3224049044. The Bioswale will be constructed in 1999 as part of Phases I and II of the 4th Avenue S / S, Barton Street flood control / Hamm Creek daylighting project.
KA 3.12	Conduct a comprehensive inventory of infrastructure needs in South Park to identify the severity and extent of drainage and other problems. Prioritize need and provide alternate solutions and funding strategies to address these problems

Source: South Park Neighborhood Plan. KA = Key Activity

3.2.5 Greater Duwamish Manufacturing and Industrial Center Neighborhood Plan

The Greater Duwamish Manufacturing and Industrial Center Neighborhood Plan, recommends specific goals and policies to maintain and enhance the viability of the industrial area and protect its vital employment database. Stormwater program goals and policies from the plan were summarized in Table 1-2, but no specific activities were identified.

3.2.6 Topographic Mapping

A topographic map of the lower 7th Avenue subbasin was generated from survey data and aerial photography collected for this study. The map shows contours at a 1-foot interval as well as key spot elevations. The mapping was done to accurately determine locations and elevations of the drainage and sanitary sewer systems as well as surface

Table 3.1
Identified Flooding Problems within the Study Area

Problem Identification Number	Problem Location	Source of Identification/Information				Approx Number and Type of Locations Affected	Flooding and Cause Description	Cause				
		Complaint Mailers	Neighborhood Plan[1]	SPU Files, Phone Contact and Field Visit	Hydraulic & Hydrologic Modeling			Lack of Existing Stormwater Collection System	Inadequate Existing Stormwater Collection System	Direct Tidal Flooding	Inadequate Private Stormwater System	Lack of Maintenance
	Lower 7th Avenue Subbasin											
L1	S. Elmgrove St between 5th Ave S & 7th Ave S	17, 53		X		5 businesses	Roadway flooding, business and parking area flooding, insufficient road grade for drainage	X				
L2	S. Monroe St between 3rd and 5th Ave S	3		X		6 businesses	Loading ramp, interior business and parking area flooding	X				
L3	Alley bordered by S Monroe St, Kenyon St., 7th and 8th Ave S	43, 56		X		15 homes	Flooding from the Duwamish River. Flooding in the poorly graded alley, roof drain from business drains to alley, potholes in alley, basement flooding. Combined sewer backup.	X				
L4	7th Ave S. between S. Kenyon and Monroe St.	61		X	X	1 businesses	Inlet is too far from curb to pick up drainage, causing flooding in parking lot downstream		X			
L5	S Chicago between 5th Ave S & 7th Ave S	36		X	X	4 businesses	Flooding inlet, pipe has reverse grade.		X			
L6	5th Ave S between S Holden St & S Austin St	20, 40		X	X	4 businesses	System exists, however no inlets into the system		X			
L7	S Holden St between 2nd Ave S & 3rd Ave S	66		X		9 businesses	Flooding of parking and yard area. Both are below road elevation	X				
L8	5th Ave S between S. Kenyon St & S. Monroe St	18		X		1 business	Ponding in parking lot/loading dock	X				
L9	North half of Lower 7th Ave subbasin	43		X		Approx 10 homes and 60 businesses	Areas along the Duwamish River banks are lower than the maximum observed tide, overtopping is possible causing interior flooding			X		
	Middle 7th Avenue Subbasin											
M1	S Cloverdale St at 7th Ave S	47		X		1 home	Basement flooding, possible surcharging drainline.		X			
M2	8th Ave S and S Cloverdale St	38		X		2 homes	Flooding near inlet on 8th. Road not graded to drain.		X			
M3	5th Ave S and S Concord St	25, 73		X		5 homes	Large scale sidewalk, street and yard flooding, low spot with no inlet	X				
M4	5th Ave S and S Trenton St	52		X		4 homes	Street and yard ponding	X				
M5	Alley bordered by Cloverdale, Donovan, 7th and 5th Ave S.	1,7,27		X		12 homes	Flooding of apartments and marginally improved alley which lacks drainage system	X				
M6	Cloverdale St. between 5th and 6th Ave S.	49		X		1 home	Parking lot flooding	X				
M7	S. Henderson St and 4th Ave S.	2		X		1 home	Ditch blocked by neighbor					X
	Upper 7th Avenue Subbasin											
	No identified problems											
	2nd Avenue Subbasin											
S1	S Webster St between 2nd and 3rd Ave s.	45		X		6 businesses	Pipe system and insufficient pipe storage causes flooding with rainfall and high tides		X			
S2	S Webster St between 3rd and 4th Ave S	13,63		X		2 businesses	Roadway and parking area flooding	X				
	Combined Sewer Subbasin											
C1	5th Avenue S and S Henderson St	75	KA#3.06	X		10 homes	Ditch on south side of S Director Street is overgrown and lacks sufficient capacity, causing flooding on S Henderson St	X				
C2	3rd Ave S between S Henderson and Trenton St	14		X		1 home	Illegal fill causes flooding due to flow direction changes	X				
C3	7th Ave S south of Director St.	12, 16, 68	KA#3.07	X		16 homes	Roadway, driveway and private yard flooding	X				
C4	S Trenton St. between 3rd Ave S and 4th Ave S	58, 60		X		3 homes	Flooding caused by runoff from street and business parking lot.	X				

Problem Identification Number	Problem Location	Source of Identification/Information				Approx Number and Type of Locations Affected	Flooding and Cause Description	Cause				
		Complaint Mailers	Neighborhood Plan[1]	SPU Files, Phone Contact and Field Visit	Hydraulic & Hydrologic Modeling			Lack of Existing Stormwater Collection System	Inadequate Existing Stormwater Collection System	Direct Tidal Flooding	Inadequate Private Stormwater System	Lack of Maintenance
C5	S Trenton St between 7th and 8th Ave S.	34, 65		X		7 homes	Sidewalk, basement, street and driveway flooding		X			
C6	S Director and Henderson between 8th and 7th Ave. S.	21, 24	KA#3.05	X		9 homes, 2 businesses	Roadway, driveway and parking area flooding. No drainage system.	X				
C7	Area bounded by S Cloverdale St, S Donovan St, 15th Ave S and 17th Ave S.	4, 5, 35, 69		X		3 homes, 2 businesses	Roadway, driveway, basement and yard flooding.	X				
C8	S Rose St and 10th Ave S.	59		X		4 homes	Driveway flooding, no inlets.	X				
C9	4th Ave S & S Trenton St	51,74		X		6 homes	Ponding in the yard and parking area from street runoff. No inlet to existing system.		X			
C10	7th Ave S and S Trenton St	50, 67, 77		X		3 homes	Home, alley, parking lot and yard ponding below hill		X			
C11	S Henderson St and 8th Ave S.	65		X		4 homes	Basement and yard flooding. An inlet is present but runoff cannot enter.		X			
C12	S Concord St and 14th Ave S.	76		X		3 homes, 1 businesses	Low area that collects water and has no inlet. Surrounding area is higher so flow by gravity to existing storm drain system is not currently possible.		X			
C13	S Thistle St and 8th Ave S.	55		X		3 homes	Driveway and basement flooding possibly from street drainage.					
C14	S. Donovan St. and 7th Ave S.	19, 57		X		3 homes	Minor street ponding due to improper		X			
C15	S. Southern St. and 10th Ave S.	32		X		2 homes	Minor street ponding at low point in street		X			
C16	S. Sullivan St and 8th Ave S	10, 46		X		2 homes	Basement and yard flooding				X	
C17	12th Ave S and Trenton Ave S.	6		X		1 home	Basement and yard flooding				X	
C18	S. Donovan St. and 10th Ave S.	37		X		1 home	Basement and yard flooding				X	
C19	S Cloverdale St. and 12th Ave S.	15		X		1 home	Basement flooding				X	
C20	S. Donovan St. and 12th Ave S.	26		X		1 home	Basement bathroom flooding				X	
C21	S. Sullivan St and 10th Ave S	39		X		1 home	Basement flooding				X	
C22	S. Donovan St. and 5th Ave S.	42, 54		X		2 homes	Basement and yard flooding				X	
C23	S. Cloverdale St and 8th Ave S.	48		X		1 home	Basement and yard flooding				X	
C24	S. Rose St. and 7th Ave. S.	70		X		1 home	Combined sewer backup in basement		X			
C25	S. Southern St. and 8th Ave S.	64		X		1 home	Water Quality concern. No flooding					
C26	S. Thistle St. and 8th Ave S.	23		X		5 homes	Leaves clog inlets					X
C27	S. Monroe/S. Elmgrove St and 7th Ave S.	22, 31		X		2 homes	Combined sewer backup in basement					X
	17th Avenue Subbasin											
	No identified problems											
	Riverbank subbasin											
R1	S. Elmgrove St. and 12th Ave S.	28,29		X		2 homes	Street, yard and crawl space flooding because of lack of inlets	X				
R2	S. Southern St and 12th Ave S.	41		X		1 home	Minor flooding of driveway and erosion of riverbank	X				
	Hamm Creek Subbasin											
H1	8th Ave S. between S. Cambridge and Director St.	33		X		3 homes 1 business	Street and driveway flooding	X				

Notes

[1]Neighborhood Plan= South Park Neighborhood Plan, Plan Infrastructure, Key Activities Element

features. Topographic mapping and historical tide data were reviewed to determine the likelihood of direct tidal flooding caused by riverbank overtopping.

3.3 Modeling

A detailed hydrologic and hydraulic model was developed for the 7th Avenue Subbasin to quantify existing and future surface water conditions and to identify problem areas.

Hydrologic models are used to assess physical characteristics of a watershed and determine the rate and amount of stormwater runoff that will be generated during a storm. Runoff data generated by a hydrologic model can then be used as input to a hydraulic model. Hydraulic models simulate the routing of these flows through stormwater conveyance systems. In the 7th Avenue basin, conveyance systems consist of stream channels, culverts and enclosed pipe systems.

Methodology, assumptions, as well as input and output data for the model comprise considerable detail. This section describes the main features of the modeling. Details of the modeling are presented in Volume II, Modeling Manual.

3.3.1 Model Selection

Hydrologic and hydraulic analysis for the 7th Avenue basin was performed with the RUNOFF and EXTRAN modules of Expert Storm Water Management Model (XP-SWMM) 2000 Version 8.05 computer program. This model was selected because it can model the runoff characteristics of the basin to determine the rate and amount of stormwater runoff that will be produced in response to rainfall events that can be used to simulate the hydraulics of drainage systems, which consist mostly of enclosed pipes. This model considers the flood storage occurring in the system and corresponding flow attenuation. The EXTRAN portion of the SWMM program is one of the most accurate programs for simulating the hydraulics of drainage networks and includes modeling of backwater effects, flow reversal, surcharging, pressure flow, and tidal outfalls and interconnected ponds. EXTRAN also contains a wide variety of options, including the simulation of pipe systems, open channels, detention ponds, and pump stations.

3.3.2 Model Development

The objective of using the XP-SWMM RUNOFF computer program is to model the runoff characteristics of the subbasins to determine the rate and amount of stormwater runoff that will be produced in response to rainfall events. This runoff data can then be subjected to statistical analysis to determine flood-frequency. Delineation of subbasins coincided with drainage divides determined from topographic mapping, surveyed drainage inventory data, as-built plans of developments within the basin, and field observations. Delineation of these subbasins is shown in the modeling manual.

The objective of hydraulic modeling is to determine the capacity of the existing or proposed system to convey runoff during the design event. The hydraulic model routes

these flows through a network that simulates the existing or any proposed new conveyance system and compute water surface elevations throughout the conveyance system. This modeled conveyance system consists of enclosed conveyance pipes, open channel segments, weirs, orifices, and tide valves. When the model shows that the water surface elevation at any specific location is higher than the ground surface, the system is surcharging at that location under the modeled flow conditions and flooding occurs.

The model was run for a range of historical rainfall/tidal events identified by the Northwest Hydraulic Consultants analysis. This analysis was described briefly in Section 2.3.1 and in detail in Volume II of this report.

3.3.2.1 Data Collection

Precipitation, tide level, and subbasin characteristics such as subbasin areas, land cover, length, width, and slope were collected for input into the hydrologic model. Historical precipitation and tide data were collected and compiled to develop the design event. Existing and future land use and topographic information required for the hydrologic model was obtained from City of Seattle GIS data. Existing land use information was verified during field reconnaissance. Surface geology information was from *Duwamish Industrial Area Hydrogeologic Pathways*, (SPU, 1998).

To ensure the model accurately predicted the basin's response to various rainfall events, the model was calibrated using precipitation and streamflow data. Precipitation data was obtained from a rain gage located near the basin. Stream gages installed at key locations throughout the basin provided water level and flow rate data. Additional gage information is included in the Modeling Manual, Volume II of this report.

Data required for assessing drainage in the 7th Avenue subbasin was obtained using as-built plans for developments, City of Seattle GIS information, and information obtained from survey conducted for this study. Because the system has low ground elevations near the Duwamish River and because GIS elevations had proven to be unreliable, surveying and mapping was performed in the lower basin. Collected survey data for the enclosed pipe systems included pipe inverts, shape, diameter and material, and rim elevations. This inventoried data was used to update the City of Seattle's GIS database.

The vertical datum used for this project is the North American Vertical Datum 1988 (NAVD88). The collected survey data and the City's GIS database data are on the NAVD88 datum. Much of the City's data is based on the old City of Seattle Datum established in 1962. The conversion from the old City of Seattle Datum to NAVD88 for this project is +9.33 feet, based on surveyed monuments in the area.

3.3.2.2 Hydrologic Model Input

The calculation of runoff rates in a watershed is affected by basin characteristics including land cover, topography, and soil type. Detailed analyses of the 7th Avenue subbasin characteristics are included in the Modeling Manual, Volume II of this report. The following subsections provide general descriptions of factors influencing the development of runoff in the basin.

3.3.2.3 Hydraulic Model Setup

A computer model was constructed using XP-SWMM 2000 to simulate existing and future land use water surface profiles for the middle and lower 7th Avenue subbasins under existing conveyance conditions. A hydraulic model of the upper 7th Avenue subbasin was not performed because there are no identified existing flooding problems in the area. Although no hydraulic modeling was performed for the upper 7th Avenue subbasin, hydrologic modeling was performed for this area as discussed previously and the flows from the upper 7th Avenue subbasin were fed into the hydraulic model that begins in the middle basin.

The upstream end of the hydraulic model developed for existing conveyance begins in the middle 7th Avenue subbasin at the intersection of 4th Avenue South and South Barton Street, with a closed pipe trunk system that conveys flow north along 4th Avenue South to South Henderson Street. At South Henderson Street, the trunk turns east and flows north on 5th Avenue South to SR99. The trunk system conveys flow under SR99 to 7th Avenue South in the lower 7th Avenue subbasin. The system continues north along 7th Avenue South, picking up flow from tributary areas in the lower 7th Avenue subbasin between 2nd Avenue South and 8th Avenue South. At the north end of 7th Avenue South, the main trunk outfall to the Duwamish River is regulated with a 72-inch tide valve. When the river level is above the outfall, the trunk does not discharge and runoff is stored in the pipe system.

The conveyance system was modeled assuming that all flow from each subbasin was routed to the system.

3.3.3 Model Results

Table 3-3 lists peak flows at selected locations in the 7th Avenue subbasin for existing and future land use conditions estimated from the hydrologic analysis for the 2-, 10-, 25-, and 100-year recurrence intervals. The flow results appear unusual, compared to typical drainage basins. This is because the peak flow values in the lower 7th Avenue pipe system occur when the tide drops and stored water in the trunk drains. These values do not reflect peak runoff from the ground surface. Peak flow values at 4th Avenue South and South Barton Street display a more typical relationship with values increasing for events with greater recurrence intervals. A complete list of computed flows is provided in Volume II of this report.

Table 3-3
Hydrologic Modeling Results for the 7th Avenue Subbasin
Existing Storm Drain System

Location	Existing Land Use Flow (cfs)				Future Land Use Flow (cfs)			
	2-year	10-year	25-year	100-year	2-year	10-year	25-year	100-year
7th Ave South and South Riverside Drive [1]	44	46	24	22	18	47	23	33
South Southern Street and SR 99 [2]	10	14	16	17	11	35	19	25
4th Ave South and South Barton Street [3]	1.2	1.3	1.5	2.2	3.2	3.7	4.8	7.4

1. Strong tidal influence at this location. Values represent draining of pipe system as tide drops, not peak runoff.
2. Tidal influence at this location.
3. No tidal influence at this location.

The hydraulic model generated water surface profiles for the conveyance system in the lower and middle basins of the 7th Avenue system. The results are shown on Table-3-4. These results show that flooding caused by capacity limitations in the 7th Avenue trunk occurs with a 10-year event under existing land use. This flooding occurs in the lower basin. The frequency of flooding increases with more intensive land use in the future. As stated previously, other significant flooding occurs with greater frequency in many locations which have no collection system.

Table 3-4
Hydraulic Modeling Results for the 7th Avenue Subbasin
Maximum Water Surface Elevation (feet)

Location	Existing Land Use				Future Land Use			
	2-year	10-year	25-year	100-year	2-year	10-year	25-year	100-year
7th Ave South and South Riverside Drive	9.6	11.1	11.5	11.5	10.6	11.3	11.6	11.8
SR 99 and South Southern Street	9.6	11.2	11.5	11.5	10.7	11.3	11.6	11.9
5th Ave South and South Trenton	9.7	11.3	11.5	11.5	10.7	11.3	11.6	12.2

Modeling results were used to identify problems in these basins. The results and identified problems are discussed in Section 3.5 of this report. The model of the 7th Avenue subbasin, the 2nd Avenue subbasin, and portions of the area served by

combined sewer was also used to develop and evaluate proposed solutions to the identified flooding problems. Section 4 provides discussion of problem solutions.

3.4 Problem Descriptions

Based on input from the complaint mailers, neighborhood plans, hydraulic modeling and review of topographic mapping and historical tide data, Table 3-1 presents a list of problems identified for further study. Table 3-1 groups problems by study area basins and provides problem location, problem identification number, source of identification, the number and type of locations affected and a brief description of the problem and its general cause. Locations of these problems are shown in Figure 3-1. Flooding problems throughout the study area are generally caused by an inadequate trunk system, inadequate collection system, and direct tidal flooding. The following subsections provide a description, by subbasin, of the problems considered as part of this study.

The identified problems were categorized using several factors to develop a level of severity. The factors considered include type of street flooding, type of property flooding, approximate number of homes and businesses affected and frequency of flooding. Table 3-2 shows how each problem was categorized with respect to these factors. In addition Table 3-5 provides the suggested approach to solving each problem. These approaches are discussed in Section 4.

3.4.1 Lower 7th Avenue Subbasin

A number of flooding problems in the lower 7th Avenue subbasin are identified in Table 3-1. The three primary causes for flooding in the lower 7th Avenue subbasin include inadequate trunk system, inadequate collection system, and direct tidal flooding. In addition to those primary causes of flooding, poorly graded roadways and pot holes filled with stormwater runoff also contributes to flooding.

3.4.1.1 Trunk System

The existing 72-inch trunk in the lower subbasin has considerable conveyance capacity and was built to provide flood storage during high tides when flow has minimal or no ability to enter the Duwamish River. These high tides cause the tide gate on the trunk outfall to close and no outflow leaves the trunk. Although there is volume in the trunk to store some of the runoff during high tides, it is insufficient to store all of the runoff during the 25-year event.

Problem Nos. L5–L6 in Table 3-1 are examples of flooding caused by the trunk's inability to drain during high tides. Stored water backs up into the collection system causing surface flooding.

3.4.1.2 Collection System

General Problem #1 – Lack of Formal Stormwater Collection System

Most side streets in the lower basin lack a collection system to convey the runoff to the main trunk running north along 7th Avenue South. Flooding caused by lack of a formal stormwater collection system affects many businesses and homes in the lower basins (See Problem Numbers L1–L3 in Table 3-1 and on Figure 3-1).

General Problem #2 – Inadequate Existing Stormwater Collection System

Some streets within the lower basin have collection pipes. Roadway and property flooding in these areas is often caused by inadequate pipe capacity. Some pipes in these systems have been improperly installed with reverse gradient, creating a system with inadequate conveyance capacity. Other streets have adequate conveyance pipe systems, but poor street conditions, inadequate gutter gradients, or lack of inlets preventing runoff from entering the system. This condition causes the flooding of several homes on South Chicago Street between 5th Avenue South and 7th Avenue South (Problem No. L5) and 4 businesses on South Monroe Street (Problem No. L3). Gradients along the ditch or gutter line are irregular so runoff does not uniformly flow to an inlet or catch basin. This creates widespread, shallow ponding that can persist for days. An example of such flooding is Problem No. L4, where a business is flooded because the nearby inlet is located in the street at a higher elevation than the gutter.

3.4.2 Direct Tidal Flooding

In addition to these internally-produced runoff flooding problems, direct tidal flooding may also occur in the lower basin. Topographic mapping and historical tide data were reviewed to determine the likelihood of direct tidal flooding caused by riverbank overtopping. According to topographic survey conducted for this study, the ground elevation of the bank along the Duwamish River within the study area varies from 12 to 14 feet (NAVD88). Elevations within the basin are as low as 9.6 feet (NAVD88). Tidal records show a maximum observed tide of 12.15 feet (NAVD88) on December 15, 1997 and tides exceeding 12.0 feet (NAVD88) are expected to occur about every 25 years. The recurrence period of high tides was determined by a frequency analysis of the maximum observed tide for each year for the period 1949-1996. Additional information about this analysis is presented in the Modeling Manual, Volume II of this report.

Overtopping of the riverbank will occur during a high tide with a recurrence interval of 25 years along two low saddles, each about 30 feet wide. The locations of these two saddles are the intersection of 2nd Avenue South and South Webster Street and the intersection of 2nd Avenue South and South Fontanelle Street. Water overtopping the bank is expected to flood 20 acres of industrial property when a tide of elevation 12.0 feet is exceeded. This area is shown in Figure 3-1. This area of inundation is based on new topographic mapping with 1-foot contours developed for this project A 50-year resident also reported that over bank flooding occurred 2 times since 1951.

The 1994 FEMA Flood Insurance Study shows the flood level at the study area for the 100-year return period is 11.8 feet (NAVD88), suggesting a potential for flooding. This extent of this area is shown in Figure 3-1 and was based on earlier topographic mapping.

3.4.3 Middle 7th Avenue Subbasin

A number of flooding problems identified in Table 3-1 occur in the middle 7th Avenue subbasin. The primary causes for flooding in the middle 7th Avenue subbasin include inadequate collection system and lack of a collection system.

3.4.3.1 Trunk System

The middle 7th Avenue subbasin trunk runs along 5th Avenue South and connects to the lower 7th Avenue subbasin trunk. Hydraulic modeling shows that the trunk in the middle 7th Avenue subbasin has adequate conveyance and storage capacity. Modeling results indicate that the trunk is surcharged during the 25-year event. However, ground elevations in the middle 7th Avenue subbasin are high enough above the hydraulic grade line to prevent surface flooding. It is possible that isolated low areas that weren't modeled experience flooding resulting from surcharging of the trunk.

3.4.3.2 Collection System

General Problem #1 – Lack of Formal Stormwater Collection System

Several side streets in the middle basin lack a collection system to convey the runoff to the main trunk running north along 5th Avenue South. An example is Problem No. M3 which is caused by lack of a formal stormwater collection system. This type of problem affects many homes in the subbasin.

General Problem #2 – Inadequate Existing Stormwater Collection System

Inadequate collection systems include a lack of capacity, lack of inlets and poor grading. Some streets have collection pipes but street and property flooding in these areas is caused by inadequate pipe capacity. Other streets have adequate conveyance pipe systems, but poor street conditions, inadequate gutter gradients, or lack of inlets preventing runoff from entering the system. This condition causes Problem Nos. M1–M2 affecting several homes.

3.4.4 Upper 7th Avenue Subbasin

No flooding-related problems were identified in the upper 7th Avenue subbasin.

3.4.5 2nd Avenue Basin

The primary drainage system in the 2nd Avenue subbasin consists of roadside ditches and culverts, a tide valve and a pipe system that has an outfall to the Duwamish River. As mentioned previously, the Duwamish River is tidally influenced in this area. A tide gate installed near 2nd Avenue South and South Webster Street, upstream of the

outfall, reduces tidal flooding, but because there is insufficient volume in the trunk system to store runoff of certain storms, ponding reportedly persists along 2nd Avenue South. The pipe system outfalling to the Duwamish River is located on private industrial properties. SPU has no easements for the segment so the maintenance program of the pipeline is unknown.

3.4.5.1 Trunk System

The size and slope of the trunk system on private property is unknown although no flooding has been reported downstream of the tide gate. Low elevations in the basin extending only a few feet above the tide level result in limited storage capacity and also contribute to flooding. Flooding occurs when a high tide and significant storm event occur simultaneously. The high tide causes the tide gate to close preventing stormwater runoff from draining from the area. When runoff volumes exceed the storage capacity of the trunk system, roadway flooding occurs. Flooding results as reported for Problem No. S1. The surface ponding in this location has created difficult conditions for several local industries.

3.4.5.2 Collection System

General Problem #1 – Lack of Formal Stormwater Collection System

Other than the main system along 2nd Avenue South, few drainage features exist in the basin. Irregular ditch/gutter gradients contribute to flooding problems in the basin. These inadequacies cause flooding Problem No. S2 in the 4th Avenue South and South Webster Street vicinity. This flooding affects several businesses.

3.4.6 Combined Sewer Subbasin

Many flooding problems identified in Table 3-1 are located in areas served by combined sewers. These problems are primarily caused by an inadequate level of drainage service caused by lack or inadequacy of the existing system.

The combined sewer system conveys sanitary sewage and stormwater to the Westpoint Wastewater Treatment Plant. When flows exceed the conveyance capacity of the combined sewer system in the study area, overflows occur at 8th Avenue South into the Duwamish River. According to King County's 1999/2000 Annual Combined Sewer Overflow Report Resubmittal (January 2001), six overflows per year were recorded during the baseline period of 1981–1983. No overflows occurred during the period of June 1999 to May 2000. This reduction was due to low rainfall during the period and possibly system improvements.

3.4.6.1 Collection System

General Problem #1 – Lack of Formal Stormwater Collection System

Several streets in the combined sewer subbasin area are served by combined sewers lack stormwater collection and conveyance systems. Following are several examples of larger problems:

Table 3.5 Problem Severity

		Type of Street Flooding *(choose only one)*						Type of Property Flooding *(more than one can be chosen)*					Approx Number of Properties Flooded				Flooding Occurrence (Existing or Future) *(choose only one)*			Suggested Approach for Solving Problem			
Problem Identification Number	**Problem Location**	Alley	Non Arterial	Collector arterial	Minor arterial	Principal arterial	Freeway or expressway	Landscaped area or yard	Private driveway or parking area	garage or crawl space of residence	Basement	Living / work area of a residence or building	1 property	2-4 properties	5-9 properties	> 10 properties	Less than 1 occurrence in 25 years	1 occurrence in 2-25 years	1 or more occurrence in 2 years	Recommended Solution	Local Solution	Private Action	Maintainence
	Lower 7th Avenue Subbasin																						
L1	S Elmgrove St between 5th Ave S and 7th Ave S		X						X			X			X				X	X			
L2	S Monroe St between 3rd and 5th Ave S			X					X			X			X				X	X			
L3	Alley bordered by S Monroe St, S Kenyon St, 7th and 8th Ave S	X						X	X	X	X	X				X			X			X	
L4	7th Ave S between S Kenyon and Monroe St			X					X			X			X				X	X			
L5	S Chicago between 5th Ave S and 7th Ave S		X						X					X					X	X			
L6	5th Ave S between S Holden St and S Austin St		X						X			X		X					X	X			
L7	S Holden St between 2nd Ave S and 3rd Ave S			X					X			X			X				X	X			
L8	5th Ave S between S Kenyon St and S Monroe St								X				X						X	X			
L9	North half of Lower 7th Ave subbasin			X					X	X		X				X	X				X		
	Middle 7th Avenue Subbasin																						
M1	S Cloverdale St at 7th Ave S									X	X		X						X			X	
M2	8th Ave S and S Cloverdale St		X						X				X						X			X	
M3	5th Ave S and S Concord St		X					X	X	X				X					X	X			
M4	5th Ave S and S Trenton St		X					X	X	X				X					X	X			
M5	Alley bordered by Cloverdale, Donovan, 7th and 5th Ave S	X						X	X	X		X				X			X			X	
M6	S Cloverdale St between 5th and 6th Ave S								X				X						X			X	
M7	S Henderson St and 4th Ave S							X					X						X			X	
	Upper 7th Avenue Subbasin																						
	No identified problems																						
	2nd Avenue Subbasin																						
S1	S Webster St between 2nd and 3rd Ave S		X						X			X			X				X	X			
S2	S Webster St between 3rd and 4th Ave S		X						X					X					X	X			
	Combined Sewer Subbasin																						
C1	5th Avenue S and S Henderson St		X					X	X	X		X				X			X	X			
C2	3rd Ave S between S Henderson and Trenton St		X					X	X		X		X						X	X			
C3	7th Ave S south of S Director St		X					X	X	X	X					X			X	X			

		Type of Street Flooding *(choose only one)*						Type of Property Flooding *(more than one can be chosen)*					Approx Number of Properties Flooded				Flooding Occurrence (Existing or Future) *(choose only one)*			Suggested Approach for Solving Problem			
Problem Identification Number	**Problem Location**	Alley	Non Arterial	Collector arterial	Minor arterial	Principal arterial	Freeway or expressway	Landscaped area or yard	Private driveway or parking area	garage or crawl space of residence	Basement	Living / work area of a residence or building	1 property	2-4 properties	5-9 properties	> 10 properties	Less than 1 occurrence in 25 years	1 occurrence in 2-25 years	1 or more occurrence in 2 years	Recommended Solution	Local Solution	Private Action	Maintainence
C4	S Trenton St between 3rd Ave S and 4th Ave S		X					X	X	X				X					X	X			
C5	S Trenton St between 7th and 8th Ave S			X					X		X				X				X		X		
C6	S Director St and S Henderson St between 8th and 7th Ave S			X					X							X			X	X			
C7	Area bordered by S. Cloverdale St, S Donovan St, 15th Ave S and 17th Ave S		X					X	X		X	X			X				X		X		
C8	S Rose St and 10th Ave S		X					X	X					X					X		X		
C9	4th Ave S and S Trenton St		X					X	X						X				X	X			
C10	7th Ave S and S Trenton St	X						X	X		X	X		X					X			X	
C11	S Henderson St and 8th Ave S		X					X	X			X		X					X			X	
C12	S Concord St and 14 Ave S		X						X			X		X					X		X		
C13	S Thistle St and 8th Ave S		X							X				X					X			X	
C14	S Donovan St and 7th Ave S		X										X						X		X		
C15	S Southern St and 10th Ave S		X										X						X		X		
C16	S Sullivan St and 8th Ave S							X			X		X						X			X	
C17	12th Ave S and Trenton Ave S										X		X						X			X	
C18	S Donovan St and 10th Ave S							X			X		X						X			X	
C19	S Cloverdale St and 12th Ave S										X		X						X			X	
C20	S Donovan St and 12th Ave S										X		X						X			X	
C21	S Sullivan St and 10th Ave S										X		X						X			X	
C22	S. Donovan St and 5th Ave S							X			X		X						X			X	
C23	S Cloverdale St and 8th Ave S							X			X		X						X			X	
C24	S Rose St and 7th Ave S										X		X					X				X	
C25	S Southern St and 8th Ave S												X										
C26	S. Thistle St. and 8th Ave S.		X										X						X				X
C27	S Monroe/S Elmgrove St and 7th Ave S		X											X					X				X
	17th Avenue Subbasin																						
	No identified problems																						
	Riverbank subbasin																						
R1	S Elmgrove St. and 12th Ave S		X					X		X				X					X		X		
R2	S Southern St and 12th Ave S								X				X						X			X	
	Hamm Creek Subbasin																						
H1	8th Ave S between S Cambridge and S Director St		X						X					X					X		X		

Notes:
The categorizations were completed by interpreting available information.

7th Avenue S. South of Director Street (Problem C3)

Flooding occurs along 7th Avenue S. south of S. Director Street. 7th Avenue S. is a dead end residential street with no drainage facilities and receives runoff from higher areas to the southwest. A ditch west of and parallel to 7th Avenue S. provides partial drainage collection for the area. Many homes are affected and the lack of drainage facilities will effect more homes because this street is experiencing home building.

S. Director and Henderson Streets between 7th and 8th Avenue S. (Problem C6)

Roadway, driveway and parking areas are being flooded along S. Henderson Street and S. Director Streets east of 7th Avenue S. Neither of these streets has drainage facilities.

16th Avenue South and South Dallas Street (Problem C7)

Flooding occurs primarily at the intersection of Dallas Avenue South and 16th Avenue South, where the entire lane width is commonly blocked. Ponding also occurs along 16th Ave. South and can inundate planting strips, parking lots and the yards of some residences.

17th Avenue South and Dallas Avenue South (Problem C7)

Flooding occurs at the intersection of 17th Avenue South and Dallas Avenue South. There are no drainage facilities on the block, there is insufficient grade for the runoff to leave the intersection and the street is severely pot-holed. The block is a mix of industrial and residential and borders King County.

South Rose Street and 10th Avenue South (Problem C8)

Along South Rose Street ponding extends into the street lane width, the planting strip, and the front yards of residences. The street is flat has and no drainage facilities.

General Problem #2 – Inadequate Existing Stormwater Collection System

Several locations in the area served by combined sewer are inadequately served by the existing system. The following are several examples:

South Trenton Street, east of 7th Avenue South (Problem C5)

Ponding is clustered at the base of a hill along South Trenton Street. Water continually saturates the yards and planting strips of several houses and when combined with rainfall, the water can completely block a lane width on South Trenton Street. There is currently an inlet located near the flooded area, however there is not sufficient grade to drain all of the water toward the inlet. Because of the geographic location and year-round persistence of the flooding, groundwater influence is suspected. In addition, SPU did not find any evidence of a leaking or broken waterline that would cause this problem.

South Concord Street and 14th Avenue South (Problem C12)

Flooding occurs at a low spot on South Concord approximately 140’ from the intersection with 14th Avenue South. At an elevation of close to 14’(NAVD 88), this location is one of the lowest in the combined sewer subbasin. There is a catch basin at the low spot, but because of the low elevation a flap gate is installed to prevent sewage

from overflowing. As capacity in the combined line shrinks, the flap gate closes. This prevents runoff from draining, creating massive flooding. Once the capacity in the sewer increases, the flap gate opens and the runoff is allowed to drain.

South Donovan Street, east of 7th Avenue South (Problem C14)

South Donovan Street is very flat and ponding occurs periodically as water slowly flows toward the existing inlets. A combined sewer line serves the street, with inlets at the intersection of 7th Avenue South and at the dead-end of South Donovan Street to the east.

South Southern Street and Dallas Avenue South (Problem C15)

Ponding occurs along the pavement edge of South Southern Street. The street is flat and runoff is not conveyed to the existing drainage inlets at the intersection.

General Problem #3 – Inadequate Private Stormwater Collection Systems

Many private property have inadequate systems to collect and discharge stormwater into the public network.

On some streets within this area, including Donovan and Trenton Streets, the road elevation in front and back of the residences is higher than the elevation surrounding the residences. In these cases, runoff cannot flow away from those properties. In addition, some residential drainage problems result from unconnected roof leaders and lack of basement foundation drains and sump pumps. This type of flooding is prevalent where houses are lower than the street. Examples of these types of problems are C16-C24.

3.4.7 17th Avenue Subbasin

The drainage facilities consist of a private network that discharges directly into the Duwamish River. No problems were reported in the 17th Avenue Subbasin.

3.4.8 Riverbank Subbasin

This subbasin has limited stormwater facilities. Two problems were reported in this subbasin, both in unincorporated King County. The problems (R1 and R2) related to flooding caused by a lack of a collection system. These problems may be addressed in the future if this area is annexed by the City of Seattle.

3.4.9 SR 99 North

No investigation of flooding problems was conducted in this subbasin as part of this study.

3.4.10 Hamm Creek Subbasin

8th Avenue South between South Director Street and South Cambridge Street (Problem H1)

The drainage system in this subbasin consists of a drain line along SR99 and 10th Avenue South where it enters the King County system.

Street and private property flooding occurs on 8th Avenue South between South Director Street and South 96th Street. This block is a mix of industrial and residential properties and is near the King County border. There are few formal stormwater collection systems in this area. However there are inlets in the street right of way and on private property that drain through a private system that discharges to the storm drain pipe along 10th Avenue South.

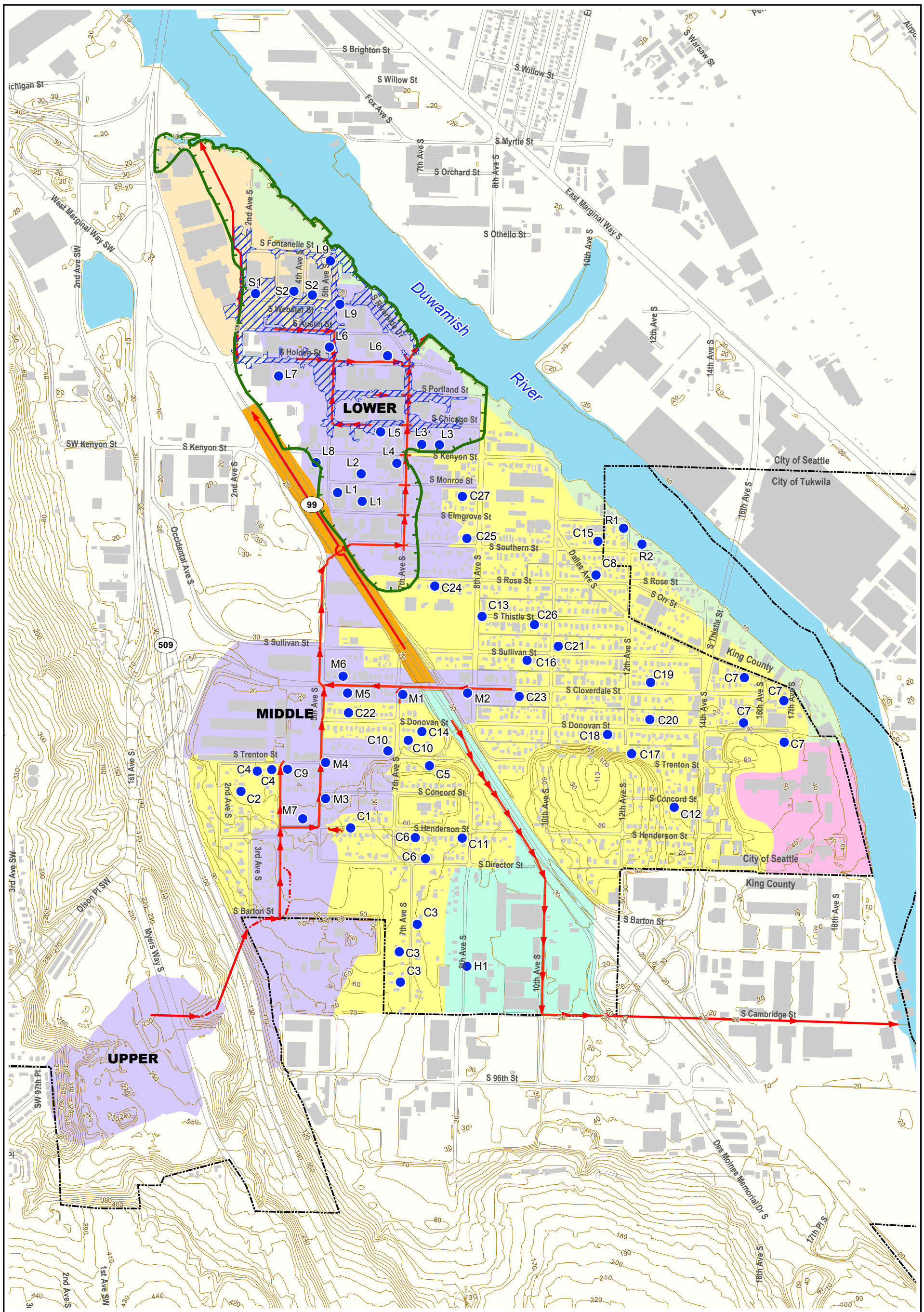

Figure 3-1
Problem Locations
South Park Drainage Study

Legend

- Study Problem and Problem ID
- Areas Flooded by EL 12' Tide
- FEMA Floodplain
- Current System
- Open Channel
- 7th Ave Subbasin
- 2nd Ave Subbasin
- Hamm Creek Subbasin
- North 99 Subbasin
- 17th Ave Subbasin
- Riverside Subbasin
- Combined Sewer Subbasin
- Buildings
- Pavement Edge
- 10 ft Contours
- Seattle City Limits

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1 inch equals 800 feet

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Section 4
ALTERNATIVE SOLUTIONS

4.1 General

This section describes the identification and analysis of alternative solutions to the stormwater and drainage problems identified in Section 3. As discussed in Section 3, flooding problems throughout the study area are often caused by a lack of collection systems, inadequate collection systems and tidal influence.

The flooding problems in the study area were identified and evaluated. Solutions were developed to solve these problems.

In some cases, small modifications to the existing system would solve flooding problems. These small modifications are referred to as local solutions. These solutions are generally isolated, require limited engineering analysis, and have relatively low implementation costs. The implementation costs are low because an adequate, existing system can be improved or modified to solve flooding problems.

In other cases, flooding caused by lack of a collection system or an inadequate collection system can only be solved by major drainage system modifications or installation of major new systems. Solutions to these problems are referred to as basin solutions and require in-depth engineering analysis. The following sections describe 7th Avenue basin alternatives and local solutions developed for the flooding problems.

Detailed description and analysis of those alternatives follows.

4.2 7th Avenue Basin Alternatives

The 7th Avenue basin solutions were developed to solve flooding problems identified in Section 3 and provide protection for a 25-year design event. These alternatives were created to solve a large number of flooding problems.

Based on the physical characteristics of the study area and discussions with SPU staff, it was determined that solutions would address problems in the 7th Avenue subbasin, the southern half of the 2nd Avenue subbasin, and a portion of the area now served by combined sewer where the drainage level of service is inadequate. The portion of the 2nd Avenue subbasin served by all alternatives covers the 3rd, 4th, and 5th Avenue South blocks north of South Webster Street. Only this portion of the 2nd Avenue subbasin is diverted to the 7th Avenue system because the remaining area slopes to the north, consists primarily of private property and is currently served by a private pipe system.

To address problems in the area served by combined sewer system, it was determined that sewage in some areas adjacent to the 7th Avenue subbasin would be partially separated and storm systems would be installed to include these areas in the 7th Avenue system. Partial separation refers to the separation of street drainage from sanitary sewage. Private drainage systems such as roof drains would remain connected to the combined system. The areas to receive partial separation are distinguished on the figures showing the alternatives. As a result of adding this collection area to the 7th Avenue system, combined sewer overflows will be reduced. Evaluating the specific benefits of this reduction was beyond this scope of work.

4.2.1 Criteria

All basin wide alternatives provide a 25-year level of service to the 7th Avenue subbasin, a portion of the 2nd Avenue subbasin, and the identified adjacent areas served by combined sewer systems where the drainage level of service is inadequate. Each alternative consists of partial sewer separation in adjacent areas served by combined sewers.

Due to the flat topography, low elevation and proximity of the basin to the Duwamish River, certain preliminary design criterion was proposed for this project. These criterion may be revisited during project design. In addition to SPU standard design requirements, the following criterion were discussed by the project team and approved for use in this analysis:

- The water surface elevation (or hydraulic grade line) during the design event would be at least one foot below the lowest point in the study area (elevation 9.6 feet in a storage yard off 2nd Avenue South between South Webster Street and South Austin Street).
- For the pipe system layout, a minimum cover of two foot above the crown of pipe, a minimum velocity of 2.5 feet per second in the pipe and a maximum catch basin spacing of 240 feet were used.

The following evaluation criteria were used to compare alternatives:

- ***Solves Flooding***. This evaluation was based on hydrologic and hydraulic modeling and consideration of physical constraints of the area. Fatal flaws in design or assumptions were identified in this evaluation. Alternatives that did not solve flooding were not evaluated for other criteria.

  Table 4-1 summarizes the water surface elevation in the lower 7th Avenue subbasin during the 25-year design event. These results from hydraulic modeling determine if the alternative meets the design criteria of a maximum water surface elevation being one foot below the lowest point in the basin at 2nd Avenue South and South Webster Street. Peak flows are not listed in the table because unlike most systems, the peak flows in the 7th Avenue system are not a direct result of peak runoff flows. In the 7th Avenue system, peak flows occur when the pipe system drains accumulated storage after the tide level falls. The 7th Avenue trunk has the capacity to convey flows much larger than peak design event flows if there were no tidal effects.

Table 4-1
7th Avenue Basin Modeling Results

Basinwide Alternative	Description	Maximum Water Surface Elevations in Lower Basin (25-year event)	
		Elevation (feet)	Meets Water Surface Elevation Criteria?[1]
1	New storm drain conveyance system	Above 9.6	No
2	Storage in oversized pipes	Above 9.6	No
3	Storage in a 7.9 acre-foot regional detention pond	8.6	Yes
4	18 cfs Stormwater pump station and new stormwater conveyance system	8.1	Yes
5	15 cfs Pump station with storage in oversized collection pipe	7.8	Yes
6	Oversized collection pipes and a 6.3 acre-foot regional detention pond	8.6	Yes

Notes:
[1] Water surface elevation stays one foot below lowest point in basin (at elevation 9.6)

Figure 4-1 presents a schematic profile of the lower basin. The profile shows the existing drainage system and the water surface elevations computed for the alternatives. For clarity, the features of the proposed alternatives are not shown. Modeling showed that the water surface elevation is virtually flat in the lower basin.

- ***Cost***. Cost estimates for total project cost as well as operation and maintenance were prepared for technically feasible alternatives. Total project cost was estimated using SPU winter 2001 unit bid prices with additive indirect costs for contingency, location, incidental construction costs, construction inspection, and preconstruction cost. Preconstruction costs include design, surveying, permitting, and administration. Construction costs for projects located outside the public right-of-way also included estimated costs of property acquisition. Typical parcel sizes in the study area and an average assessor's value per acre were used to estimate the cost of property acquisition. The costs include full width pavement replacement in the lower subbasin on streets where pipes are installed and trench patching in other subbasins. The cost estimates did not include costs related to the clean up of contaminated soils.

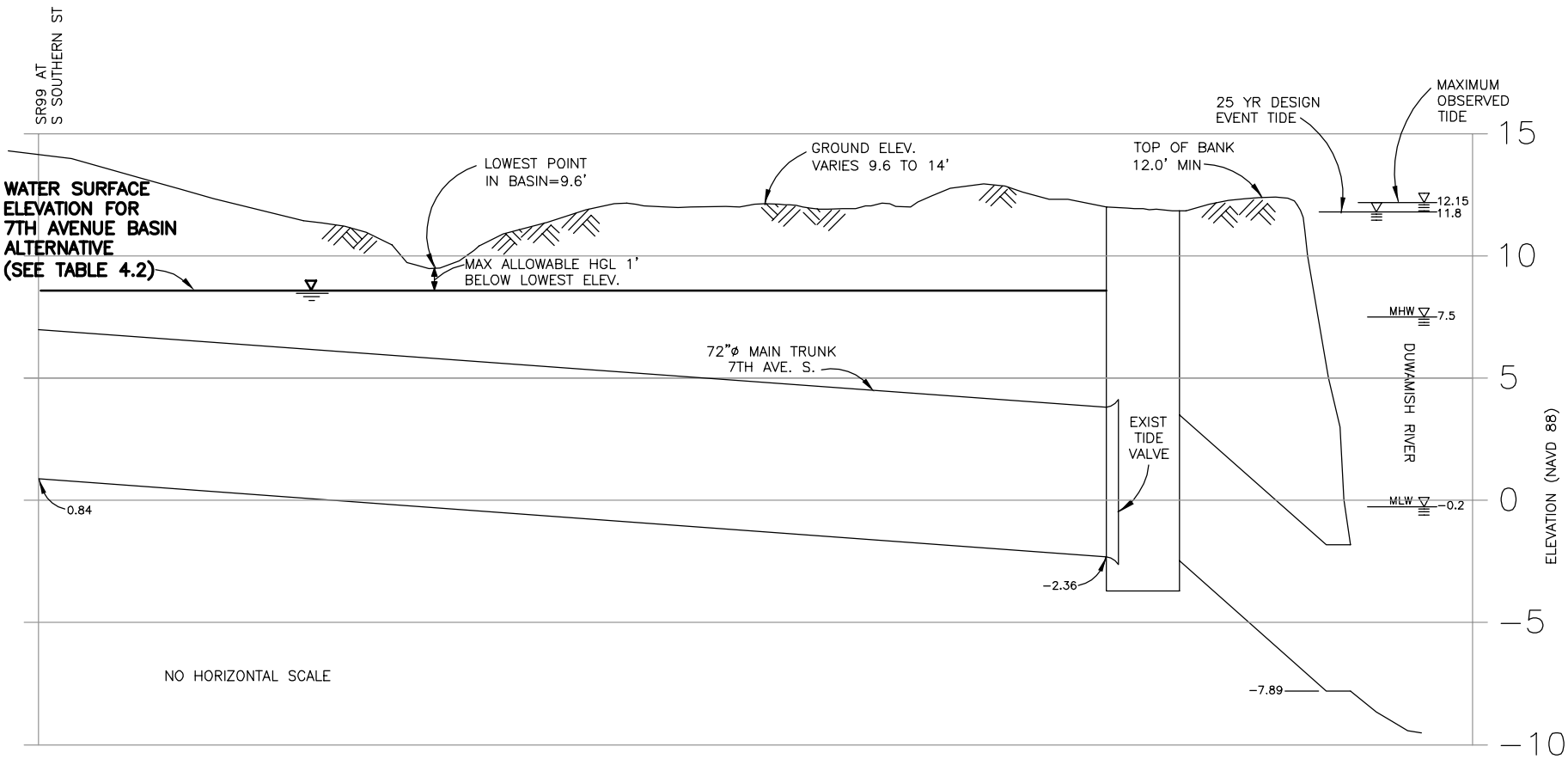

Fig 4-1
Schematic Profile
7th Avenue Basin Alternatives
South Park Drainage Study

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Operations and maintenance costs were based on labor, material and equipment required to complete normal maintenance and operation. The costs were first computed for one year, then the 20-year present worth was determined. Note that the operations and maintenance costs were found to not vary greatly from alternative to alternative because much of the cost is for cleaning catch basins, manholes, and pipes. All of the alternatives would have nearly the same number of catch basins and manholes and linear feet of pipe. Additional cost assumptions are discussed in Appendix B.

- ***Advantages and Disadvantages***. Alternatives were evaluated based on general long- and short-term advantages and disadvantages.

Each 7th Avenue basin alternative would solve 15 of the problems identified. Table 4-2 presents the flooding problems solved in each subbasin.

Table 4-2
Problems Solved by 7th Avenue Basin Alternatives

Subbasin	
Lower 7th Ave	L1, L2, L4, L5, L6, L7, L8
Middle 7th Ave	M3, M4
2nd Ave	S1, S2
Combined	C1, C2, C3, C4, C6, C9

4.2.2 Description and Evaluation

The alternatives are described in the following text and summarized in Table 4-3.

4.2.2.1 Alternative #1 – Install New Storm Drain Conveyance System

Description

Alternative #1 consists of the installation of a new stormwater collection system for streets in the expanded 7th Avenue subbasin to convey the runoff from side streets to the 7th Avenue system. This alternative also separates storm drainage from sanitary sewage in areas served by combined systems. Because of the importance of regrading roadways to stormwater inlets, full-width roadway pavement replacement for all streets where new pipes are installed is included.

In the lower 7th Avenue subbasin, new stormwater collection systems including catch basins, manholes and pipes, would be installed on streets from South Southern Street north to South Webster Street between 4th Avenue South and 8th Avenue South. The system on South Monroe Street would extend east to the Combined Service Area located between 8th Avenue South and 10th Avenue South.

New systems in the middle 7th Avenue subbasin would serve South Concord and South Trenton Streets between 4th Avenue South and 7th Avenue South. The South Trenton system would extend east to 2nd Avenue South to provide service to 2nd Avenue South and 3rd Avenue South in a Combined Service Area would be separated.

Table 4-3
7th Avenue Basin
Alternatives Evaluation

7th Avenue Basin	Description	Solves Flooding	Advantages	Disadvantages	Total Project Construction Cost ($million)	O & M Cost-20-year Present Worth ($million)	Conclusion
Alternative #1	New storm drain conveyance system	No - Hydraulic modeling shows that conveyance improvements alone do not solve flooding. Additional storage capacity or pumping is required.	N/A	N/A	NC	NC	No further consideration given to this alternative.
Alternative #2	Storage in oversized pipes	No - Cover requirements limits the length of large diameter pipes that can be installed in the lower basin. Hydraulic modeling showed that flooding would be reduced but not solved.	N/A	N/A	NC	NC	No further consideration given to this alternative.
Alternative #3	Storage in a 7.9 acre-foot regional detention pond	Yes	Not affected by mechanical equipment failure.	Construction of a 1.33-acre detention pond would likely require the acquisition of multiple parcels and the relocation of multiple businesses. There is a risk of encountering contaminated soil when excavating pond.	18.5	0.3	Because of high construction and land acquisition costs, impacts to industries and the risk of encountering contaminated ground, this alternative is not recommended.
Alternative #4	18 cfs Stormwater pump station and new stormwater conveyance system	Yes	A pump station could be constructed within the City's right-of-way. The system's capacity could be increased to accommodate development or new collection areas. Would only run 1% of time.	Some risk of mechanical equipment failure	12.9	0.3	Recommend this alternative as the proposed solution to regional flooding problems.
Alternative #5	15 cfs Pump station with storage in oversized collection pipe	Yes	Required pump would be slightly smaller than Alternative #4, and would operate less frequently.	Has all disadvantages of Alternatives #3 and #4.	NC	NC	Advantages outweight disadvantages, compared to Alternatives #3 and #4. No further consideration given to this alternative.
Alternative #6	Oversized collection pipes and a 6.3 acre-foot regional detention pond	Yes	Not affected by mechanical equipment failure.	Construction of this 1.05-acre detention pond would likely require the acquisition of multiple parcels and the relocation of multiple businesses. There is risk of encountering contaminated soil when excavating pond	22.7	0.3	Because of high construction and land acquisition costs, impacts to industries and the risk of encountering contaminated ground, this alternative is not recommended.

NC=Not computed.

New systems would also be installed on South Donovan Street, South Director Street, and 7th Avenue South (south of South Director Street) to separate sewerage. The new system boundaries were based on topography and the existing drainage system.

Evaluation

Hydraulic analysis was performed on the proposed conveyance system. Modeling results show that the proposed system could not adequately convey flows during the design event without flooding. This alternative did not meet the design requirement of the maximum water surface profile in the lower 7th Avenue subbasin being at least 1 foot below the lowest point in the basin and was eliminated from further consideration. However, the pipe network proposed in this alternative is included in all of the other alternatives.

4.2.2.2 Alternative #2 – Provide Storage in Oversized Pipes

Description

During high tides, the tide gate at the 7th Avenue trunk outfall closes and prevents the system from draining. One possible solution for eliminating flooding is to provide storage for runoff collected during high tides. Alternative #2 proposes the storage of runoff in oversized pipes.

This alternative consists of the same pipe system layout as that of Alternative #1, however collection pipes in the lower 7th Avenue subbasin would have larger diameters than that required to convey the flow. These oversized pipes, when connected to the 7th Avenue system, would create additional flood storage so more stormwater could be stored in pipes instead of overflowing onto streets during rainfall events that coincide with high tides

Evaluation

As described in subsection 4.2.1.1, Alternative #2 calls for the provision of stormwater storage in oversized pipes with the same layout as the conveyance system. Hydraulic modeling showed that the amount of storage required could not be provided in oversized pipes alone. The low elevations of the lower 7th Avenue subbasin relative to the Duwamish River make it impossible to install oversized diameter pipes while meeting pipe cover and slope requirements. Hydraulic modeling of this system showed that the maximum water surface profile in the lower 7th Avenue subbasin during the design event was elevation 11.2 feet, 2.6 feet higher than the design requirement of 8.6 feet. No further evaluation was performed on this alternative.

4.2.2.3 Alternative #3 – Provide Storage in a Detention Pond

Description

Alternative #3 provides stormwater storage serving the 7th Avenue system, a portion of the 2nd Avenue system, and areas inadequately served by combined sewers. This alternative consists of a new storm drain conveyance system as described in subsection 4.2.2.1 (Alternative #1) and a large stormwater detention pond with 7.9 acre feet of storage located in the lower 7th Avenue Subbasin (Figure 4-2). The pond

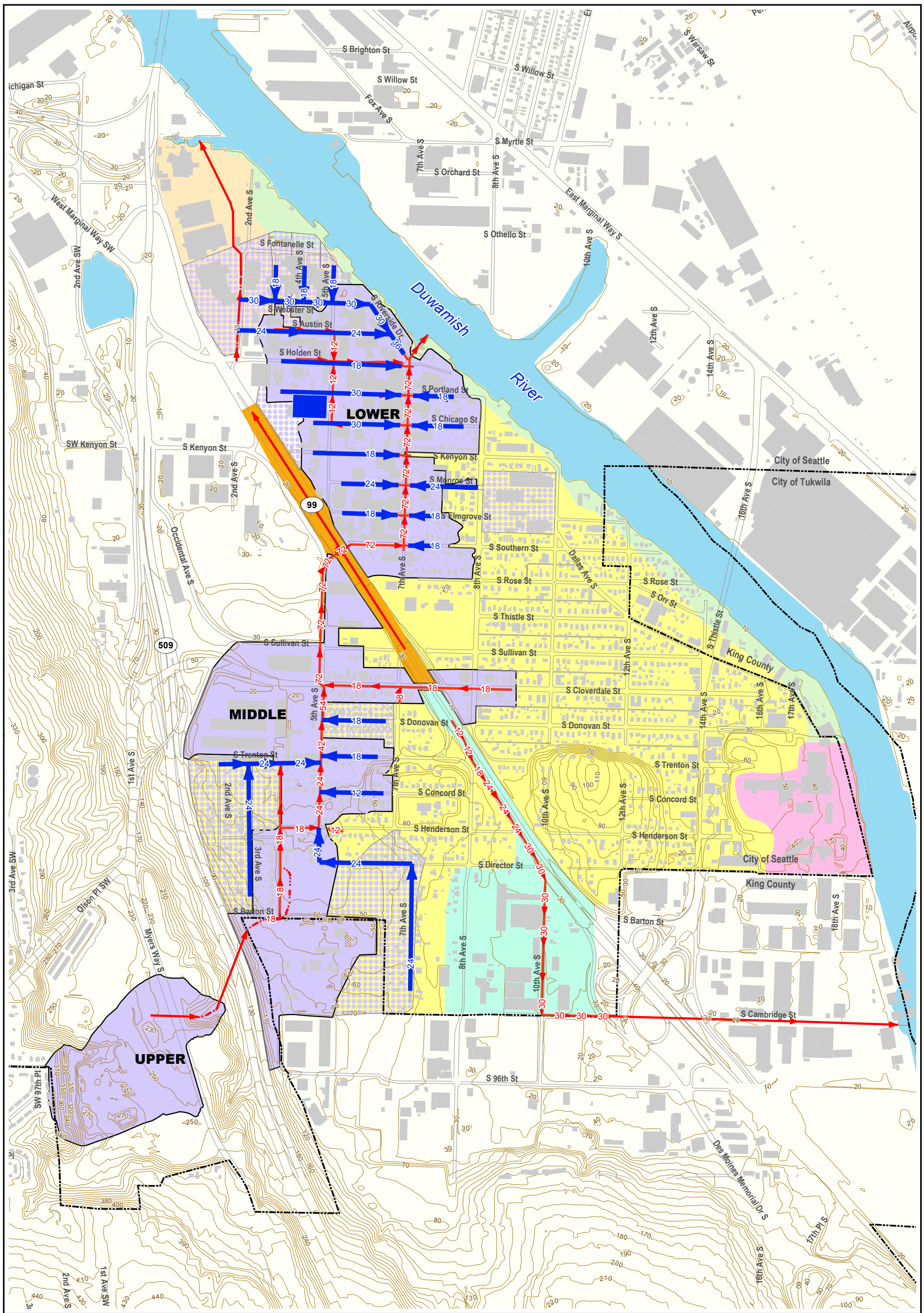

Figure 4-2
7th Ave Basin Alternative #3
South Park Drainage Study

Legend

- Proposed Collection System
- Large Detention Pond (No Proposed Location)
- 7th Ave Subbasin Delineations
- Areas added to 7th Ave Trunk for Solution
- 2nd Ave Subbasin
- Hamm Creek Subbasin
- North 99 Subbasin
- Riverside Subbasin
- 17th Ave Subbasin
- Combined Sewer Subbasin
- Current System
- Open Channel
- Buildings
- 10 ft Contours
- Pavement Edge
- Seattle City Limits

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would be 1.33 acres in area, 7 feet deep and vertical sides. The regional detention pond was sized to provide flood storage during rainfall events that coincide with high tides. When the water level in the Duwamish River is high and the tide valve is closed, stormwater will be diverted by gravity to a large detention pond for storage until the tide subsides.

Evaluation

To evaluate Alternative #3, the collection and conveyance system described in Section 4.2.2.1 was modeled with a regional detention pond. The required storage volume was determined using hydrologic and hydraulic modeling. Preliminary examination of aerial photos showed no sites of sufficient size in a suitable location that are vacant or are providing low utilization. Consequently, the pond would probably require the relocation of an industrial business in the lower 7th Avenue subbasin. This alternative was determined to be technically feasible and therefore

further evaluated for cost. The total project cost was estimated assuming that soil at the detention pond site would not be contaminated. If present, the excavation and disposal of contaminated soil would result in additional cost. High groundwater may be a problem as well. The advantage of storing runoff in a detention pond is that it would function under all conditions and would not be affected by equipment failure or power losses. It would also not consume electricity. Operations and maintenance costs for this alternative including all pipes and catch basins would be $0.3 million (20-year present worth).

Alternative #3 has several disadvantages. It would require that a business be relocated, possibly creating impacts to the implementation schedule and it would permanently eliminate land that could be used for industry.

Total project cost: $18.5 million.

4.2.2.4 Alternative #4 – Install a Stormwater Pump Station and Install New Stormwater Conveyance System

Description

Alternative #4 consists of installation of a new stormwater conveyance system as described in Section 4.2.2.1 and a pump station located just upstream of the 7th Avenue system outfall (Figure 4-3). Rather than detaining floodwaters during coincident rainfall and high tide events, this alternative proposes the pumping of excess volumes of stormwater to the Duwamish River when the tide valve is closed. A pump would turn on and pump the water from the pipe to the Duwamish River when the water level in the pipe rises to a predetermined elevation.

Evaluation

Alternative #4 was modeled to determine technical feasibility. It was determined that an 18 cfs pump could provide the desired level of service while meeting design requirements. The pump would operate about 80-100 hours during an average year, about 1 percent of the time.

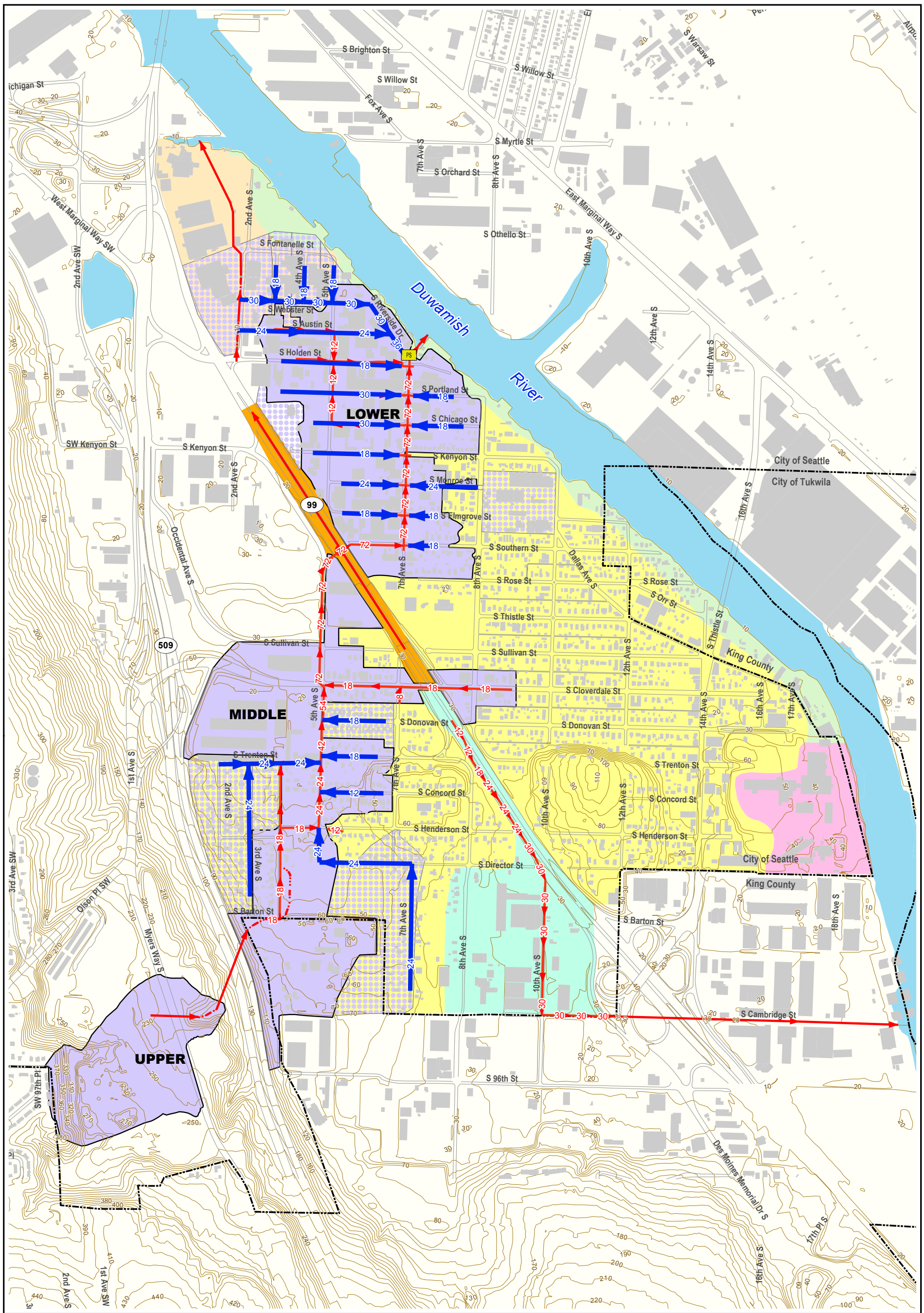

Figure 4-3
7th Ave Basin Alternative #4
South Park Drainage Study

Legend

- Proposed Collection System
- Pump Station
- 7th Ave Subbasin Delineations
- Areas added to 7th Ave Trunk for Solution
- 2nd Ave Subbasin
- Hamm Creek Subbasin
- North 99 Subbasin
- Riverside Subbasin
- 17th Ave Subbasin
- Combined Sewer Subbasin
- Current System
- Open Channel
- Buildings
- 10 ft Contours
- Pavement Edge
- Seattle City Limits

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The total project cost for this alternative would be $12.9 million, including an emergency generator. The operations and maintenance costs would be about $0.3 million over a 20 year period. This low operation and maintenance cost reflects the modest size of the pump and the limited number of hours it would operate. The pump replacement cost is also modest because the pump would last for 20-25 years.

Operation of a pump station on the 7th Avenue system has several advantages. The facility could be constructed in an existing City right-of-way, eliminating property acquisition and business relocation costs. Further, the capacity of a stormwater system operating with a pump could be increased to accommodate an increase in service area. If, as part of the Combined Sewer Overflow Reduction Plan, SPU implemented sewer separation projects, stormwater flows could be diverted to the 7th Avenue trunk system.

One disadvantage to the operation of a pump station is its reliance on mechanical equipment that would be subject to failure.

Total project cost: $12.9 million.

4.2.2.5 Alternative #5 – Combine Pump Station with Storage in Oversized Collection Pipe

Description

Alternative #5 consists of a pump station installed upstream of the 7th Avenue system outfall in combination with an oversized stormwater collection system. This flooding solution was considered as an alternative to Alternative #4 with the aim of decreasing the size and operation of the pump station. This would be achieved by creating additional storage volume in new oversized-diameter pipes to store runoff during storm events. The new collection system would be installed as suggested in Section 4.2.2.1 and only some pipes in the lower 7th Avenue subbasin would be sized with diameters larger than required for conveyance. When the storage capacity of the pipe system reaches a certain level, the pump would turn on and pump the stormwater out of the main trunk and into the Duwamish River.

Evaluation

Hydrologic and hydraulic modeling determined that this alternative is technically feasible. This flooding solution was considered as an alternative to Alternative #4 with the aim of decreasing the size and operation of the pump station. This would be achieved by creating additional storage volume in oversized-diameter pipes to store runoff during storm events. About 8,900 linear feet of oversized diameter pipe and a 15 cfs pump would be required to provide the desired level of service. By examination it became clear that the cost of oversized pipe would exceed the cost savings of a smaller pump and a shorter pump run time. There are no identified advantages to having both a pump station and additional flood storage, so this alternative received no further evaluation.

4.2.2.6 Alternative #6 – Provide Storage in Oversized Collection Pipes and a Regional Detention Pond

Description

This solution was considered as an alternative to the large detention pond proposed in Alternative #3. This alternative would consist of an oversized collection system in the lower 7th Avenue subbasin and a detention pond (Figure 4-4). Providing storage capacity in oversized pipes would reduce the needed volume of the detention pond to 6.3 acre-feet, thereby reducing the land required and business impacts.

Evaluation

This alternative would consist of an oversized collection system and a detention pond. Based on hydraulic modeling of the system, this alternative would require 8,900 feet of oversized pipe and a 1.05-acre detention pond.

The total project cost of this alternative would be $22.7 million. The present worth of the 20 year operations and maintenance cost would be $0.3 million.

The advantage of this alternative over Alternative #3 is that the detention pond is smaller and would require acquisition of a smaller property. Parcels of about one acre which currently have low utilization were identified as potential sites for the pond. Consequently, it may be possible to implement this alternative with minimal impacts to the industrial businesses in the lower 7th avenue subbasin. However, although the impacts are reduced, the cost is still considered high relative to other feasible alternatives. Furthermore, the alternative has the disadvantage of requiring maintenance and operation of both oversized pipes and a detention pond. High ground water may be a problem to the detention pond as well.

Total project cost: $22.7 million.

4.2.3 7th and 2nd Avenue Potential Solutions Considered and Eliminated

4.2.3.1 Install a New Storm Drain Conveyance System

Installation of a new storm drain conveyance system was evaluated in Section 4.2.2.1 and could not adequately convey flows during the design event described in Section 2. This alone is not a viable solution, however in combination with Alternatives #2 through #6 this could be a solution to flooding problems.

4.2.3.2 Storage in Oversized Pipe

Use of storage in oversized pipes in the 7th Avenue subbasin was evaluated in Section 4.2.2. This evaluation found that this would not solve flooding and is not a viable solution.

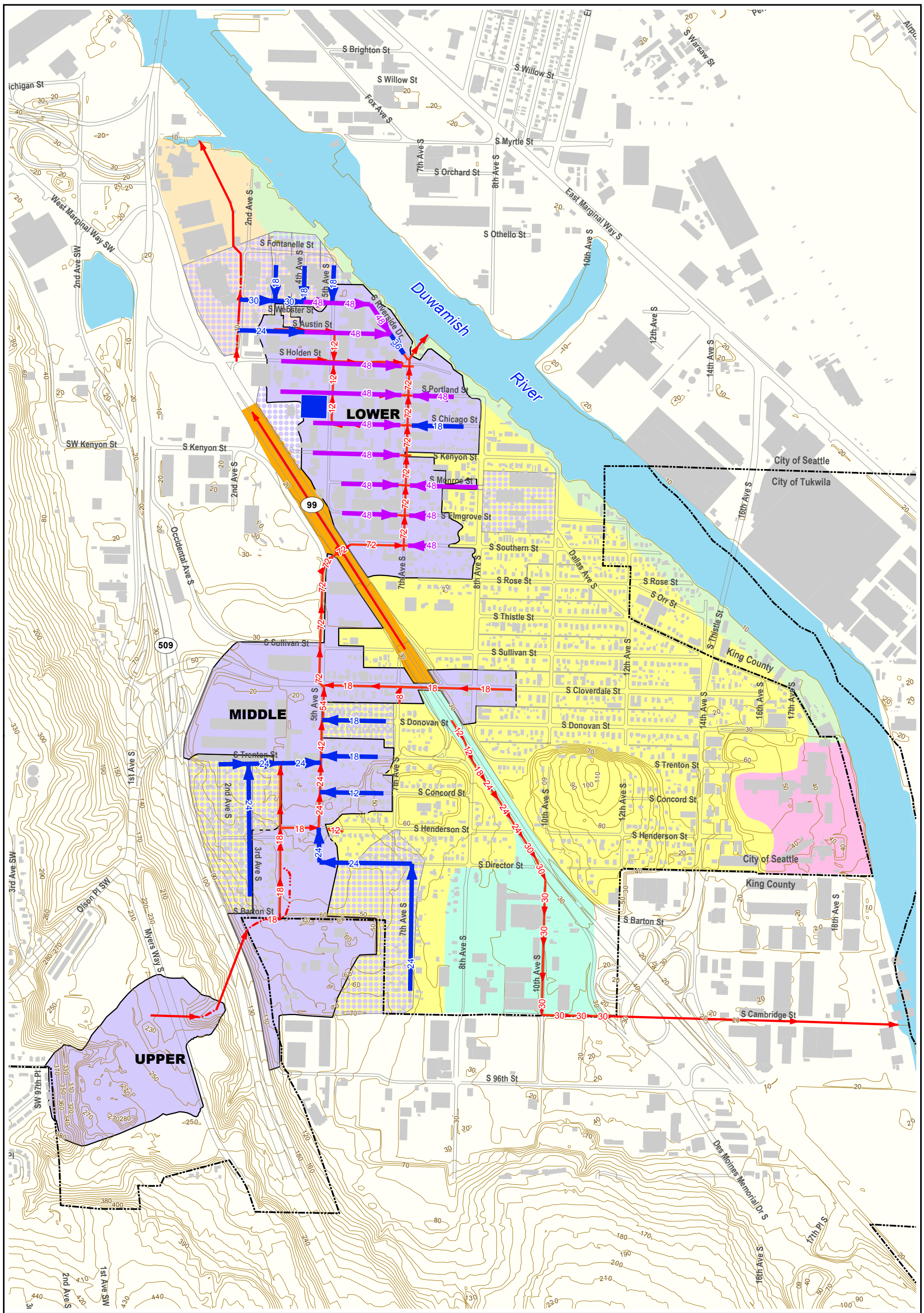

Figure 4-4
7th Ave Basin Alternative #6
South Park Drainage Study

Legend

- Collection Pipe Oversized for Detention
- Proposed Collection System
- Small Detention Pond (No Proposed Location)
- 7th Ave Subbasin Delineations
- Areas added to 7th Ave Trunk for Solution
- 2nd Ave Subbasin
- Hamm Creek Subbasin
- North 99 Subbasin
- Riverside Subbasin
- 17th Ave Subbasin
- Combined Sewer Subbasin
- Current System
- Open Channel
- Buildings
- 10 ft Contours
- Pavement Edge
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N W E S

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1 inch equals 800 feet

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4.2.3.3 Combine Pump Station with Storage in Oversized Collection System

This alternative was eliminated in Section 4.2.5 and is not considered viable.

4.2.3.4 Divert Upper 7th Avenue Subbasin Flows to Hamm Creek

Description

This involves the diversion of a portion of the Upper 7th Avenue subbasin flows from the 5th Avenue pipe system to a new system consisting of open channels and pipes which would drain south to Hamm Creek. This was considered to determine if reducing flows in the middle and lower 7th Avenue subbasins would reduce flooding in those areas. Low and moderate flows would be diverted and enter a new open channel beginning at the Marra Farm property near the intersection of 4th Avenue South and South Barton Street. The open channel would convey flows approximately 500 feet east along the south border of the property. The channel would continue flowing east, then north along the border of a vacant lot owned by King County. Flow would continue east through private property then cross 7th Avenue South in a new culvert and continue south along 7th Avenue South for approximately 160 feet. The stream would turn east through private property before flowing to an existing wetland on City-owned property west of 8th Avenue South. A new pipe system would convey the flow through an active industrial parcel to an upsized system conveying flow south along 10th Avenue South. An existing system of open channels and pipes then conveys flow along South Cambridge Street under SR99 and to the Duwamish River.

Evaluation

A preliminary layout and evaluation of topography determined that it is feasible to divert flow from the upper 7th Avenue subbasin to Hamm Creek through a system of pipes and open channels. However modeling results show that even diversion of all the flow from the upper 7th Avenue subbasin does not significantly alleviate flooding in the middle and lower subbasins. For the purposes of solving flooding problems in the study area, this potential solution did not receive further evaluation. However, the diversion of upper 7th Avenue subbasin to an open channel draining to Hamm Creek could have advantages unrelated to solving flooding problems.

Advantages of the diversion include:

- The creation of approximately 1,820 lineal feet of stream channel and aquatic habitat.
- The increase of flows to an existing wetland could have positive impacts.

Disadvantages of the diversion include:

- Creating a channel along the proposed alignment would require considerable excavation; the top of the channel would be approximately 50 feet wide at the deepest section. One residence would need to be demolished. The proposed channel would not look like the nearby Marra Farms channel.
- The Seattle Municipal Code classifies riparian corridors as Class A and Class B. Class A riparian corridors flow year-round and/or support salmonids. To create a

Class A Riparian Corridor, the code requires a 50-foot buffer. To provide a buffer for the proposed channel, easements would have to be purchased from four property owners.

- Diverting flows at the proposed location would dry up the existing 400 lf of stream on the Marra property, decreasing the net gain of open channel to 1,420 lf.
- Upstream migration of returning adult salmonids would require that they swim up 1300 linear feet of pipe. Although individual fish are known to be able to accomplish this, the 1,300-linear foot pipe segment creates undesirable conditions for fish passage.
- According to King County staff, diversion of additional flows may create flooding downstream at the existing pipe under SR 99.

4.2.3.5 Raise the grade of low-lying private properties and streets.

This would require redevelopment of many parcels. For this potential solution to be effective, redevelopment would have to occur simultaneously. Redevelopment of one parcel could exacerbate flooding on a neighboring parcel that was not redeveloped. Because it is not likely that all impacted parcels and rights-of-way could be redeveloped simultaneously, this was rejected with the approval of SPU staff.

Although this was eliminated from this analysis, it may be included as part of a future design alternative and the possibility of that should not be eliminated.

4.2.3.6 Ditch and culvert improvements in the Lower 7th Avenue subbasin.

This would consist of regrading roadways to include asphalt swales conveying runoff to inlets. It was determined that this solution action alone would not effectively reduce flooding because it wouldn't solve problems caused by undersized pipes.

Although this was eliminated from this analysis, it may be included as part of a future design alternative and the possibility of that should not be eliminated.

4.3 7th Avenue Local Solutions

4.3.1 Construct a Flood Control Berm

Description

Flooding problem L9, discussed in Section 3, identified the possibility of flooding caused by overtopping of riverbanks in the lower 7th Avenue and 2nd Avenue subbasins. For this problem, a storm drain system cannot prevent flooding. In order to keep flow from overtopping the bank, this solution proposes a low, 1,900-foot long flood control berm built to elevation 12.6 feet, 0.5 feet above the maximum observed tide of 12.1 feet. This low berm would have a maximum height of 1.6 feet and an average height of about 0.6 feet above the existing ground. The berm would follow the existing streets and would actually consist of slightly elevated streets. The route lies

almost entirely on existing rights-of-way. The locations where a berm will be necessary are shown in Figure 4-5.

Evaluation

Based on review of existing site conditions and topography, construction of a flood protection berm is feasible. This berm would protect low-lying areas near the Duwamish River from flooding caused by river overtopping of banks. If alternative #4 were built, this berm would reduce the risk of overbank flow from the river overwhelming the pump station. It would not affect flooding caused by internally produced runoff.

Total project cost: $249,000

4.4 Combined Sewer Subbasin

The pipe network in the combined sewer subbasin is typically at or near capacity and overflow frequency is reduced by allowing pipes to surcharge. In addition, much of the subbasin is flat. The combination of these two factors adds increased complexity to potential solutions. A full hydraulic analysis of this subbasin was beyond the scope of this study. Below is a discussion of alternatives to solve of several local problems within the combined sewer subbasin.

4.4.1 South Concord Street and 14th Avenue South (Problem C12)

Three alternatives for solving this problem were evaluated. The capacity of the combined sewer pipeline is the primary constraint.

Alternative #1 includes construction of a new storm drain that would connect to an existing storm line that terminates on South Cloverdale Street, just west of 10th Avenue South. This new pipeline would be over 1,500' long and set at a slope of nearly 1%. This option is cost prohibitive for a local problem, but packaged together as a new pipe network, it may be an effective option.

Alternative #2 would include building a new storm drainage network that is combined with the construction of a new South Park Bridge (at 14th Avenue South). This project may yield the opportunity to build a new outfall, and the new network could solve many of the local problems in the combined sewer subbasin.

The final option, Alternative #3 is to wait for future development along this block and establish a new grade. The planned grade of the future street has been set much higher (up to 8' in some places in the block) than the current elevation. Filling to the new grade would not solve the flooding for the existing residents and business' but would provide a framework for a long-term solution.

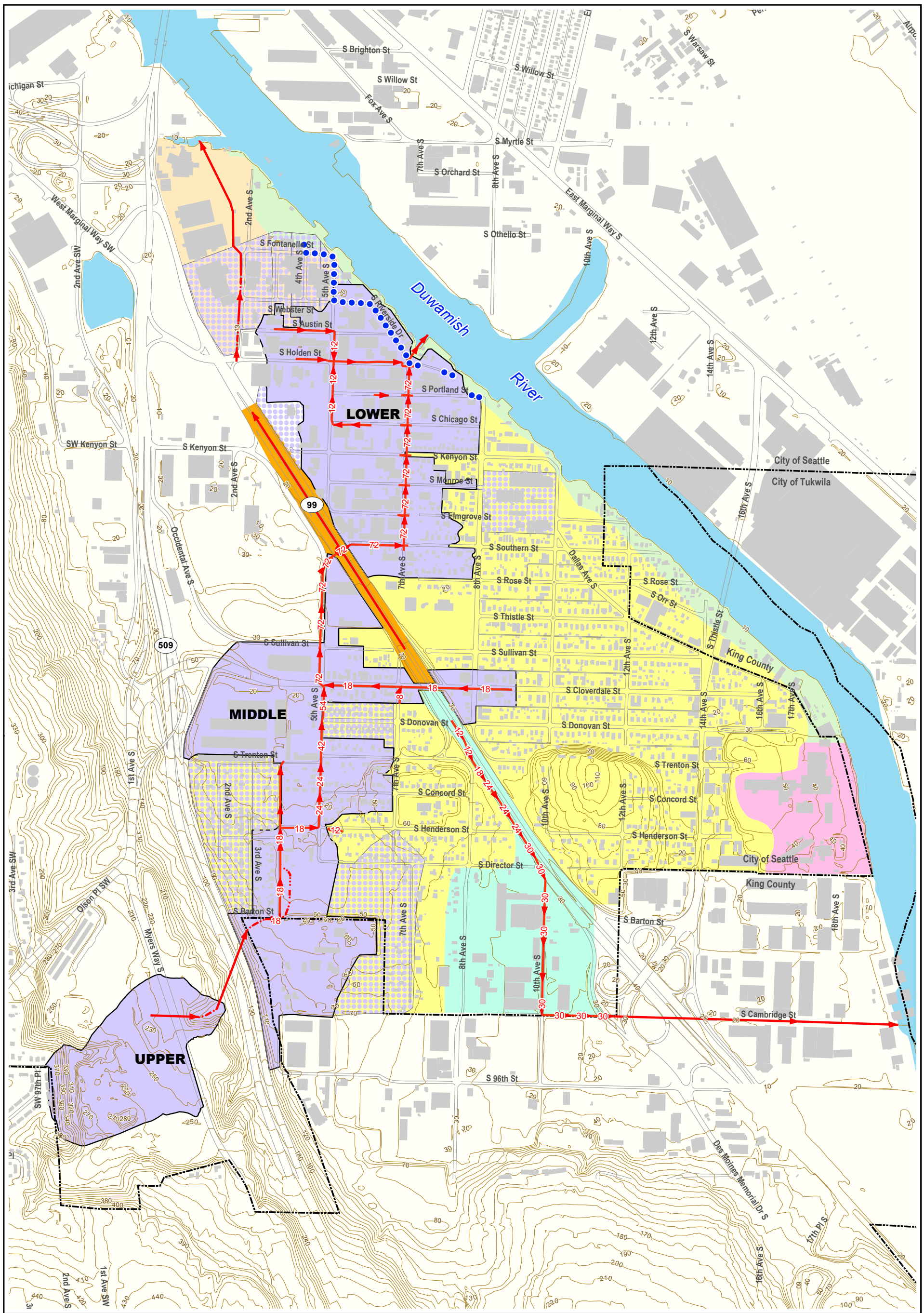

Figure 4-5
Flood Control Berm
South Park Drainage Study

Legend

- Flood Control Berm
- 7th Ave Subbasin Delineations
- Areas added to 7th Ave Trunk for Solution
- 2nd Ave Subbasin
- Hamm Creek Subbasin
- North 99 Subbasin
- Riverside Subbasin
- 17th Ave Subbasin
- Combined Sewer Subbasin
- Current System
- Open Channel
- Buildings
- 10 ft Contours
- Pavement Edge
- Seattle City Limits

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1 inch equals 800 feet

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4.4.2 South Trenton Street east of 7th Avenue S (Problem C5)

Two alternatives were analyzed for this problem.

Alternative #1 would consist of installation of a new inlet to the existing combined sewer line that runs along S Trenton Street, alleviating some of the ponding.

Alternative #2 would involve regrading the street adjacent to the existing inlet, creating a localized low spot. This would help convey runoff toward the existing inlet.

4.4.3 16th Avenue South and Dallas Avenue South (Problem C7)

There are two alternatives that were considered to solve this problem.

Alternative #1 would consist of installing inlets and catch basins at the intersection of Dallas Avenue South and 16th Avenue South. A pipeline is also needed to connect the inlets to the combined sewer pipe that terminates at Cloverdale Avenue. The approximate cost of this solution would be $110,000.

Alternative #2 would include providing drainage directly to the Duwamish River, as part of either the Riverside subbasin redevelopment or the South Park Bridge Project. SPU will evaluate this option further during discussions of the previously-mentioned annexation and bridge project.

4.4.4 South Rose Street and Dallas Avenue South (Problem C8)

The majority of the ponding is situated at the pavement edge of South Rose Street, approximately 65 feet from Dallas Avenue South. South Rose Street is an asphalt street and is nearly flat (<1% slope). There is a depression line along the pavement edge on the northern section of the street. Stormwater ponds here, where it eventually percolates or evaporates. There are drainage inlets at the intersection of Dallas Avenue South, but because of the factors stated above, much of the runoff is unable to reach the intersection. A combined sewer lateral runs along South Rose Street and then connects to the trunk that runs along Dallas Avenue South. The entire length of the street experiences varying degrees of ponding. The street is too flat to convey runoff to the existing inlets at the intersection. Therefore, to solve the majority of the ponding along the street, additional drainage inlets will be needed.

4.4.5 South Southern Street and Dallas Avenue South (Problem C15)

This problem is similar to the problem at South Rose Street and Dallas Avenue South. This type of flooding, ponding at the pavement edge, is common throughout the northern section of the combined sewer subbasin.

South Southern Street is an asphalt street and is nearly flat (<1% slope). There is a depression line along the pavement edge of the street. Stormwater ponds here, where

it eventually percolates or evaporates. There are drainage inlets at the intersection of Dallas Avenue South, but much of the runoff is unable to reach the intersection. A combined sewer lateral runs along South Southern Street and then connects to the trunk that runs along Dallas Avenue South. The entire length of the street experiences varying degrees of ponding. The street is too flat to convey runoff to the existing inlets at the intersection. Therefore, to solve the majority of the ponding along the street, additional drainage inlets will be needed.

4.4.6 South Donovan Street and 7th Avenue South (Problem C4)

Adding a drainage inlet at the ponding location (mid-block of South Donovan Street, east of 7th Avenue South) would alleviate some of the flooding. The inlet would connect to the existing combined sewer line that runs along South Donovan Street.

4.4.7 8th Avenue South between South Director and Cambridge Streets (Problem H-1)

The flooding problem on 8th Avenue South is described in Section 3.5.10. The recommended solution for solving the flooding in this area is construction of a new storm drain system to convey flow south on 8th Avenue South and then east along a portion of private property to the South Cambridge Street right of way, connecting to the existing drainage channel on South Cambridge Street, east of 10th Avenue South.

A preliminary layout and evaluation of topography determined that the storm drainage system is feasible. This would require the minimal amount of private property easements. The remainder of the storm drain system will be within the City right of way. This solution would require construction of a new 1,200 linear feet storm drain system, of which 200 linear feet would be on private property.

4.4.8 17th Avenue South and South Dallas Street (Problem C7)

Alternative #1 includes a new pipe system to connect to the existing combined sewer line on Cloverdale Avenue. SPU is still evaluating the feasibility of this solution as it would require an easement through at least one private property.

Alternative #2 would provide drainage directly to the Duwamish River, as part of either the riverside subbasin redevelopment or the South Park Bridge Project. SPU will evaluate this option further during discussions of the previously mentioned ‘sliver-by-the-river’ annexation and bridge project.

Section 5
RECOMMENDED PLAN

5.1 Introduction

Evaluation of the alternatives in Section 4 resulted in the recommendation of implementing Alternative #4 as well as a flood control berm. These are combined and referred to as the Recommended Solution. The Recommended Solution consists of construction of a new stormwater collection system, a pump station, and a flood protection berm, and implementation of a public involvement element. The Recommended Solution was broken down into smaller capital improvement projects that can be integrated with SPU's Capital Improvement Program (CIP). This section describes the elements of the Recommended Solution and presents a drainage capital improvement program for the study area.

5.2 Collection System and Pump Station

The Recommended Solution provides a pump station and a new stormwater collection system throughout the study area to address flooding problems L1, L2, L4, L5, L6, L7, L8, M3, M4, S1, S2, C1-C4, C6 and C9 (see Section 3, Problem Identification). New collection systems would be installed in the lower and middle 7th Avenue subbasins to convey flow to the existing trunk along 7th Avenue South. A new collection system in a portion of the 2nd Avenue subbasin would divert street runoff to the 7th Avenue system. Storm drainage would be separated from sanitary sewage and added to the 7th Avenue system via a new collection system in areas adjacent to the 7th Avenue subbasins where the combined sewer system provides an inadequate level of drainage service. The proposed collection system and areas served are shown in Figure 5-1.

A preliminary collection system layout is shown in Figure 5-1. Hydraulic modeling of the proposed system determined the diameter of pipes required to meet the design level of service. A schematic profile of the proposed pump station is presented in Figure 5-2. As shown in this figure, the proposed system meets the design requirement of a maximum water surface elevation during the 25-year design event being one foot below the lowest elevation in the basin. However, the pump size and configuration can be optimized in preliminary engineering and the design requirements can be modified.

The proposed system also includes catch basins and inlets. Catch basins are provided at a maximum separation distance of 240 feet and not more than 120 feet from the collection area limit. This is closer than SPU criteria but this spacing will be needed because of the flat gradient of the streets. Approximately one inlet for every catch basin is also provided to ensure adequate collection along flat grades. Manholes are

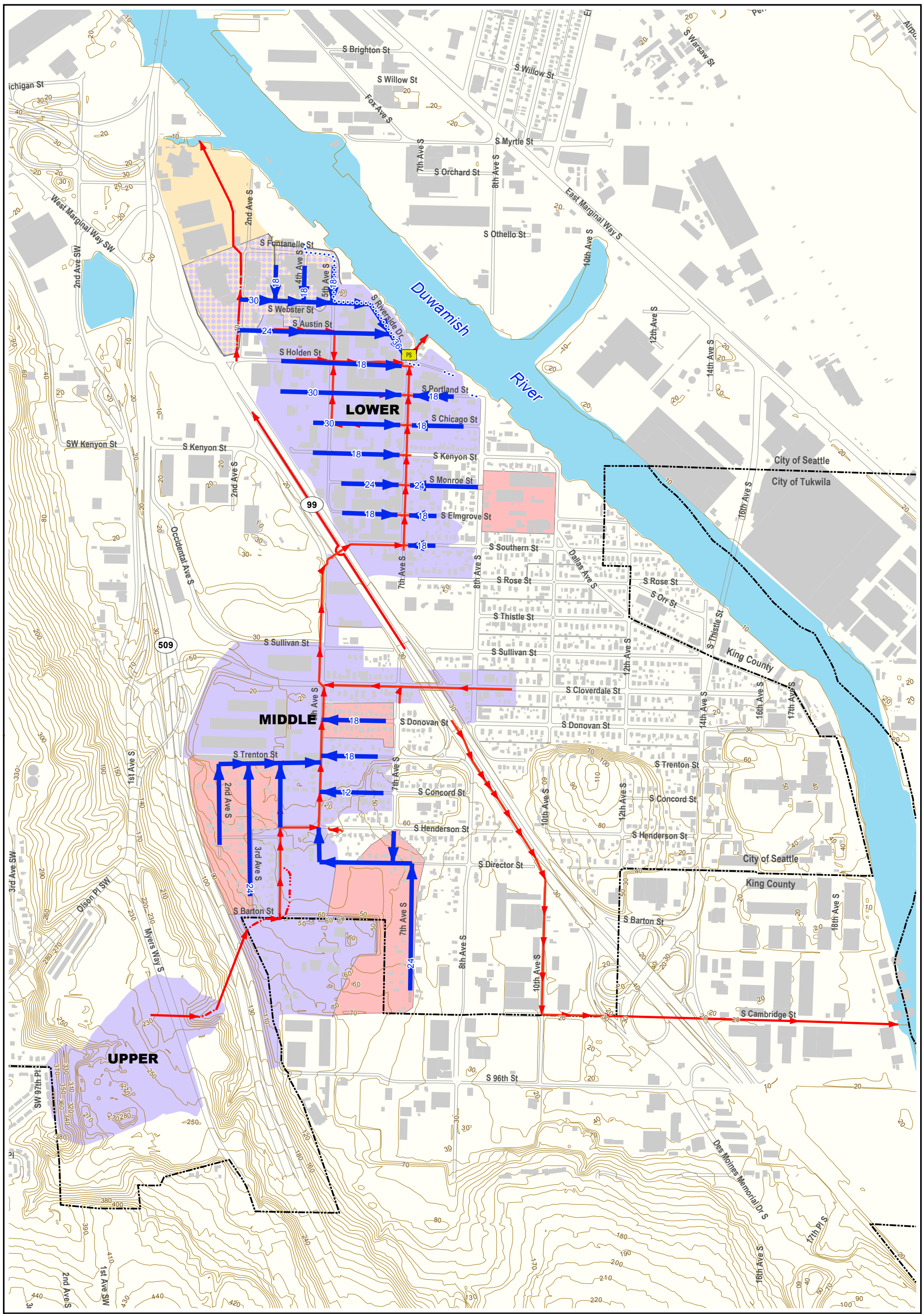

Figure 5-1
Recommended Solution
South Park Drainage Study

Legend

- 7th Ave Subbasin
- 2nd Ave Subbasin
- Split 2nd Ave SB to 7th Ave Trunk
- Sewer Separation Areas to 7th Ave Trunk
- Pump Station
- Flood Control Berm
- Proposed System
- Current System
- Open Channel
- Buildings
- Pavement Edge
- 10 ft Contours
- Seattle City Limits

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provided at a separation distance of not greater than 300 feet to provide access for system maintenance.

Pipes in the proposed collection system have a minimum of 2 feet of cover above the crown of the pipe. This is less than the standard SPU requirement of 6 feet but necessary to achieve minimum slope requirements. The minimum slope is that slope which yields a flow velocity of 2.5 feet per second.

As part of the installation of a new collection system, the proposed solution includes full width, full block pavement replacement on streets where new pipes are installed. This was included because many of the roads in the study area are in poor condition and the heavy equipment required to install new pipes could cause further damage to these streets. Further, because slopes are minimal in several areas throughout the basin, it is essential that roads be properly graded to drain. This recommendation calls for pavement replacement of approximately 22,600 linear feet of road.

The collection system provides adequate conveyance for a typical gravity flow condition, but certain tidal conditions prevent outflow to the Duwamish River. A pump station installed near the outfall of the 7th Avenue system would operate during high tides, about 80–100 hours during an average year. Assumptions used in this estimate are presented in Appendix B. The proposed pump station would have a footprint of approximately 15 feet by 10 feet and would house two submersible 9 cfs pumps.

As shown on Figure 5-2, the pumps would start when the water surface elevation in the 7th Avenue trunk reaches 7.0, after most of the storage capacity in the trunk has been filled. The pumps would operate until the water surface was lowered to elevation 3.0 feet, when they would shut off. An emergency generator will be located nearby and would be dedicated to the pump station in the event of an electrical power outage.

The recommended solution also includes construction of a flood control berm. The berm would reduce the risk of overbank flooding from the Duwamish River at a relatively low cost. If river levels produced overbank flow, approximately 20 acres of industrial area and streets would be inundated. The berm would average 0.6 feet in height and would have a maximum height of 1.6 feet. The existing street surfacing would be removed to provide a good base for the berm. The new berm would act as a raised road. Additional grading would be needed to create a workable transition to nearby industries. The berm would be located along existing streets in existing City rights-of-way; the location is shown on Figure 5-1.

5.3 Public Comment

SPU recognizes public involvement efforts as a key element of the City's drainage program. The Consultant and SPU hosted a community meeting held on November 14, 2002 in the South Park neighborhood to discuss the Recommended Solution. This meeting took place between the draft and final report of this Drainage Study. The meeting minutes and the slide presentation materials used in the meeting are included in Appendix A.

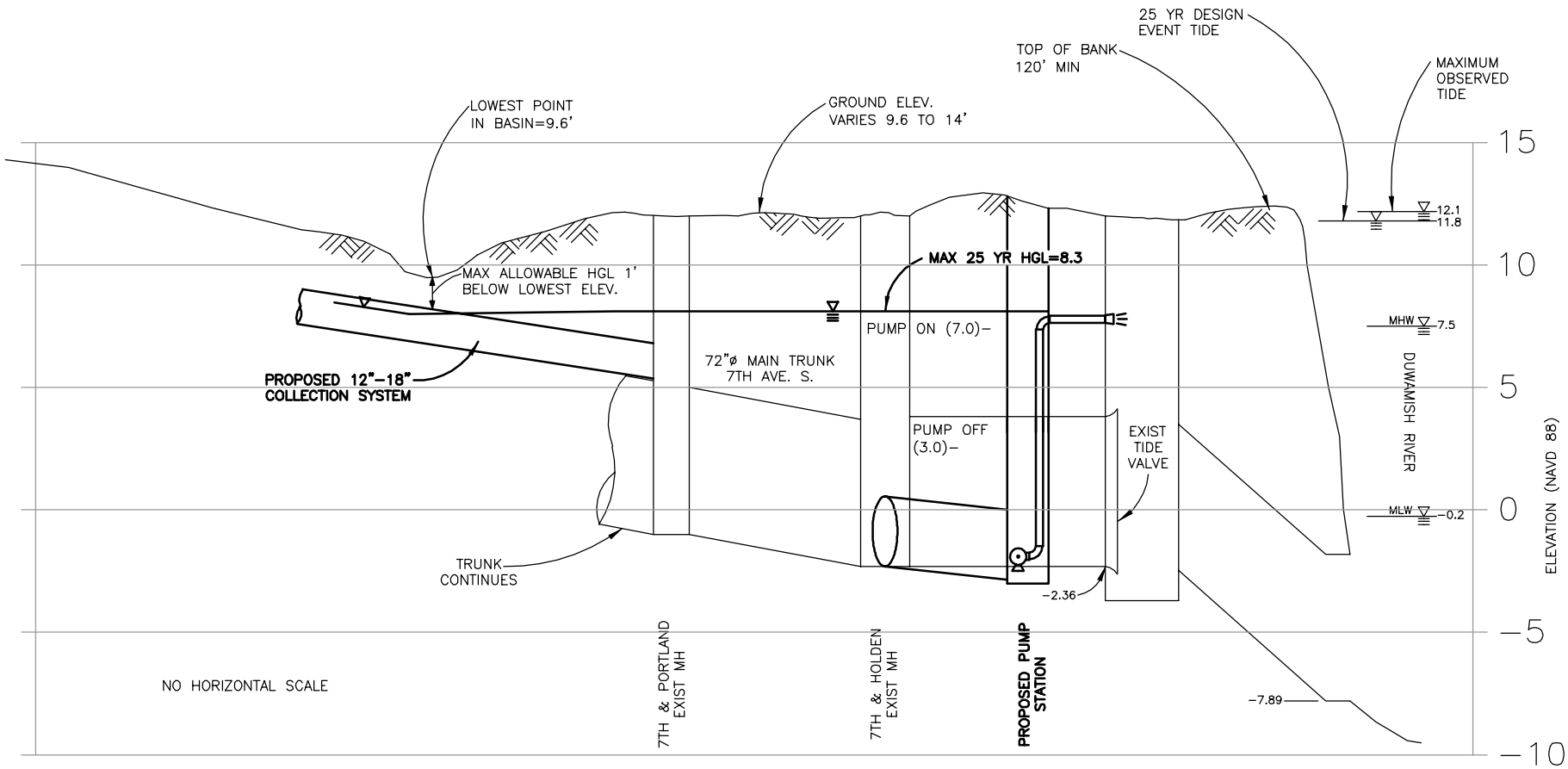

Fig 5-2
Schematic Profile
Recommended Solution
South Park Drainage Study

R:\11-00599 SPU Drainage design Serv\Densmoresouth\CAD\DENSMOREDSCH_8.dwg

5.4 Proposed Capital Improvement Program

The City of Seattle's Drainage Capital Improvement Program identifies a series of projects to be implemented over a 15-year period. Projects from several study basins within the City are combined to assist in the prioritization of City-wide improvements.

Project Implementation

Implementation of the overall Recommended Solution consists of constructing a number of individual capital projects. The order of these capital improvement projects is generally based on the severity of problems the project solves. This proposed order also considers the implementation of projects in an order that would not create additional flooding problems downstream. Table 5-1 lists the capital improvement projects derived from the Recommended Solution in the proposed order of implementation. The table describes the project location, flooding problems solved, and total project cost. The total project cost includes construction costs, and indirect cost for design, implementation, and contingency. The flooding problems listed in this table reflect those identified in Section 3, Problem Identification. These problems generally also serve as an indicator of other unidentified problems. Detailed cost estimates for each project are included in Appendix B. Figure 5-3 shows the proposed collection systems and the areas served by each capital improvement project.

Table 5-1
Capital Improvement Program

Capital Improvement Project ID	Project Location[1]	Identified Flooding Problem Solved[2]	Total Project Cost	Required Project Predecessor
A	Pump Station	L4, L6	$ 587,000	None
B	S Elmgrove St, S Monroe St, S Kenyon St between 5th Ave S and 7th Ave S	L1, L2, L8	$ 1,213,000	A
C	S Trenton St, from 2nd Ave S to 5th Ave S	C4, C9	$ 820,000	A
D	S Director St, east of 5th Ave S and 7th Ave S, south of S Directo	C1, C3, C6	$ 1,166,000	A,C
E	S Portland and S Chicago St, west of 7th Ave S	L5, L6, L7	$ 2,622,000	A
F	S Austin St, S Webster St between 2nd Ave S and 7th Ave S and S Riverside Dr between S Austin St and S Webster St	S1	$ 2,029,000	A
G	3rd, 4th, 5th Ave S between S Fontanelle St and S Webster St	S2	$ 764,000	A,F
H	S Monroe St, east of 7th Ave S	(none identified)	$ 348,000	A
I	2nd, 3rd, 4th Ave S from S Barton St to S Trenton St	C2	$ 1,038,000	A,C
J	Flood control berm	L9	$ 249,000	None
K	S Donovan St and S Trenton St from 5th Ave S to 7th Ave S	C10	$ 569,000	A
L	S Concord St from 5th Ave S to 7th Ave S	M3	$ 268,000	A
M	S Holden St, S Portland St, S Chicago St, west of 7th Ave S	L3	$ 602,000	A
N	S Elmgrove St, S Southern St, east of 7th Ave S	(none identified)	$ 626,000	A
		Total:	**$ 12,901,000**	

[1] See Figure 5-3
[2] See Section 3, Problem Identification

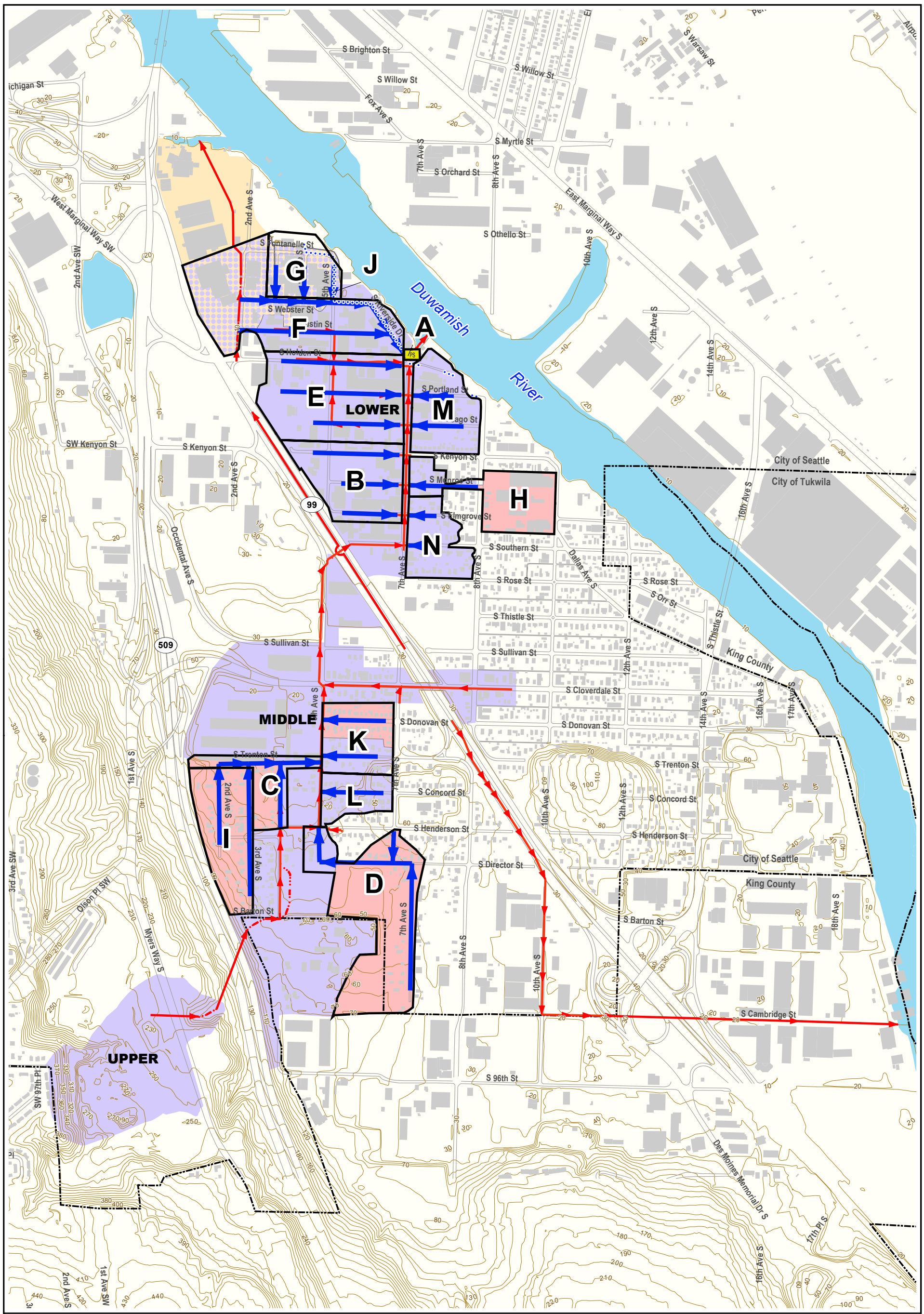

Figure 5-3
Recommended Capital Improvement Projects
South Park Drainage Study

Legend

- Capital Improvement Project Service Areas, with CIP ID
- 7th Ave Subbasin
- 2nd Ave Subbasin
- Split 2nd Ave SB to 7th Ave Trunk
- Sewer Separation Areas to 7th Ave Trunk
- Pump Station
- Flood Control Berm
- Proposed System
- Current System
- Open Channel
- Buildings
- Pavement Edge
- 10 ft Contours
- Seattle City Limits

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Before additional flow can be added to the 7th Avenue system, the pump station must be installed (Project A). This would solve problems L4 and L6. Following installation of the pump station, new stormwater collection systems can be installed to convey drainage to the 7th Avenue trunk. The second recommended capital improvement project (Project B) includes a new collection system in the lower 7th Avenue subbasin on South Elmgrove Street, South Monroe Street, and South Kenyon Street between 5th Avenue South and 7th Avenue South. Installation of this collection system would solve two major identified flooding problems, (L1 and L2). Project C solves two flooding problems by installing a collection system along South Trenton Street from 2nd Avenue South to 5th Avenue South. This project must be implemented prior to construction of the Project D collection system. This collection system along South Director Street and 7th Avenue South would solve three major identified problems in the middle 7th Avenue subbasin.

Three problems in the lower 7th Avenue subbasin would be solved with the implementation of Project E. Project F consists of installation of a stormwater collection system in the lower 7th Avenue subbasin on South Austin Street and South Webster Street between 2nd Avenue South and 7th Avenue South. Although this project would only solve one identified major problem (S1), it is a required predecessor of project G, which would solve one problem in the 2nd Avenue Subbasin (S2).

Implementation of Project H would not solve any identified flooding problems, but is likely to alleviate unidentified flooding throughout the area. Construction of a collection system along 2nd Avenue South and 3rd Avenue South of South Trenton Street (Project I) would solve one identified moderate flooding problem in the middle 7th Avenue subbasin.

Construction of the flood control berm (Project J) is not dependent upon installation of the pump station or any of the collection systems and could be implemented at any time. It would reduce the risk of infrequent but highly damaging overbank flooding. The remaining identified capital improvement projects (K-M) would solve four problems and could be implemented in any order.

This capital improvement program presents a series of projects prioritized by technical value and downstream impacts. Other considerations that could affect order of implementation include funding and coordination with other city or private improvements.

5.5 Proposed Local Solutions

The following local solutions are recommended. Other local flood problems would be solved by the 7th Avenue basin projects.

5.5.1 South Concord Street and 14th Avenue South (Problem C12)

Alternative #3 is the preferred solution and consists of waiting for future development and requiring that a new grade to be established.

5.5.2 South Trenton Street and 7th Avenue South (Problem C5)

Alternative #1, installing drainage inlets to the existing combined sewer is the preferred solution. The approximate cost of the new drainage inlets and pavement restoration is $10,000.

5.5.3 16th Avenue South and Dallas Avenue South (Problem C7)

The recommendation is to wait for the annexation and bridge issues to be resolved before developing a solution.

5.5.4 South Rose Street and Dallas Avenue South (Problem C8)

The recommendation is to add drainage inlets at the ponding location and connect them to the existing combined sewer along South Rose Street. The approximate cost of adding an inlet and catch basin and restoring the street is $10,000.

5.5.5 South Southern Street and Dallas Avenue South (Problem C15)

The recommendation is to add drainage inlets at the ponding location and connect them to the existing combined sewer along South Southern Street. The approximate cost of adding an inlet and catch basin and restoring the street is $10,000.

5.5.6 South Donovan Street and 7th Avenue South (Problem C4)

The recommendation is to install a drainage inlet mid-block of South Donovan Street. The approximate cost of the solution is $10,000.

5.5.7 17th Avenue South and Dallas Avenue South (Problem C7)

The recommendation is to wait for the annexation and bridge issues to be resolved before developing a solution.

Appendix A

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MAIL-IN-SURVEY

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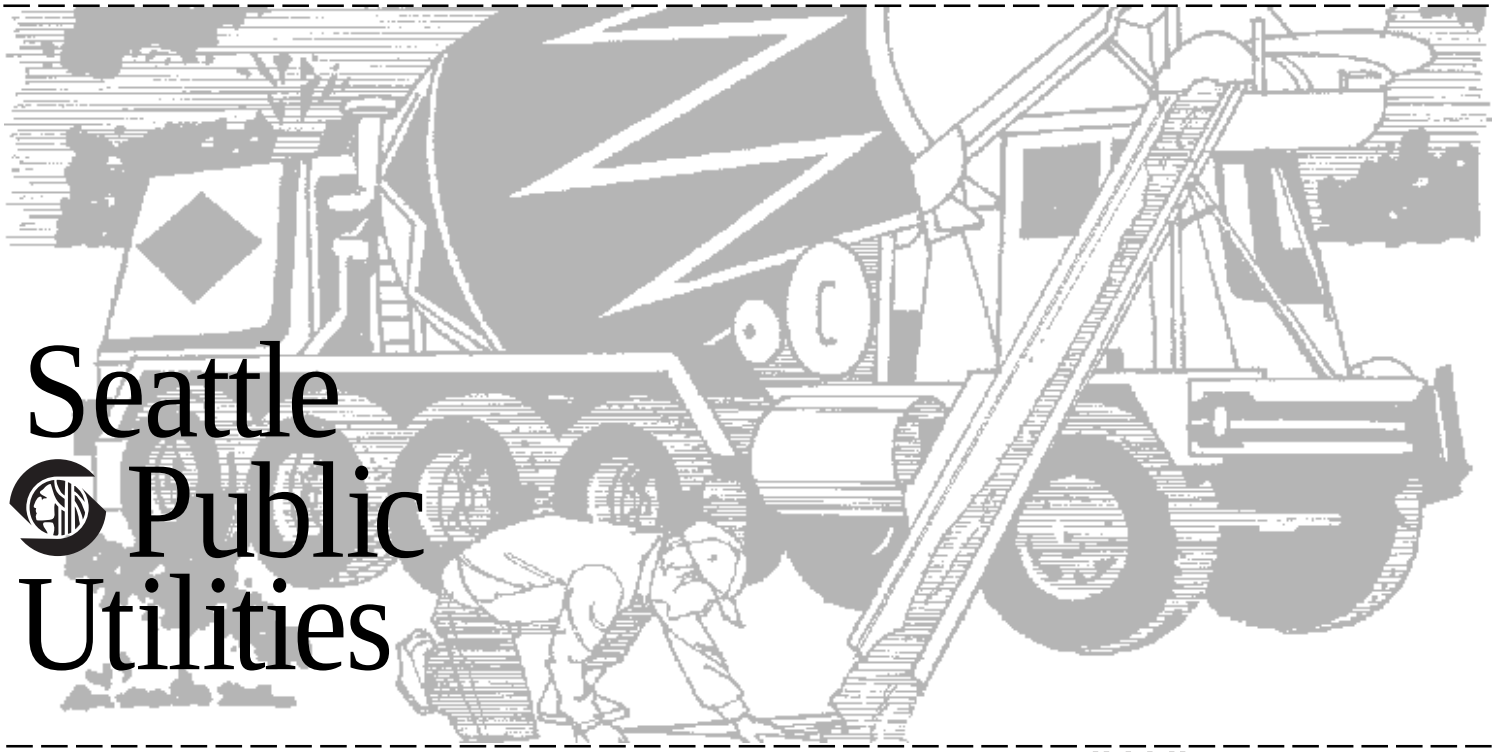
Seattle Public Utilities



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South Park - 7th Ave. S. Drainage Basin Questionaire

Thank you for you interest. We appreciate your input. If you know of a specific drainage problem in this area, we would like to know more about it. Please complete this form, fold it as instructed on the back of this sheet and mail it to Seattle Public Utilities by **November 30, 2001**. No postage is necessary. Please focus your comments on drainage issues. You may attach additional sheets describing the problem. Thank you.

Name: _____

Address: _____

How long at this address? _____ ❑ **Residence** ❑ **Business**

Daytime phone: _____ **E-Mail:** _____

Problem location: _____

_____

_____

Problem type (check all that apply):

❑ Flooding of Finished Floor/Living Area Floor
❑ Flooding of Basement
❑ Flooding Under Residence/Crawl Space
❑ Flooding Street/Driveway
❑ Flooding Yard/Landscaped Area
❑ Flooding Outside Storage/Parking Areas
❑ Flooding Commercial/Retail Buildings
❑ Flooding Warehouse/Industrial Buildings
❑ Flooding Office Finished Floor
❑ Erosion
❑ Sedimentation
❑ High Maintenance Requirement
❑ Water Quality
❑ Clogging of Culvert
❑ Clogging of Ditch
❑ Clogging of Drainage Grate
❑ Other

Specific problem description and approximate date(s) of occurrence (or how many times a year): _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Please include photographs of the flooded areas if available.

Seattle Public Utilities

If you have any questions or comments about the drainage basin plan, please contact Karen Goto at (206) 615-0867, or by email at Karen.Goto@ci.seattle.wa.us.

City of Seattle
Paul Schell, Mayor
Seattle Public Utilities
Diana Gale, Director

November 15, 2001

South Park Drainage Basin
Residents and Businesses: We need your help!

Seattle Public Utilities (SPU) is conducting a study of the South Park Drainage Basin to evaluate alternatives for minimizing flooding problems. The study's recommendations will be used to guide future actions for handling storm water runoff within the basin, including helping to select and prioritize potential City projects.

The study team has identified some flooding problems, but needs your input in order to determine improvements that best address the specific flooding conditions faced by your neighborhood. We would like you to please share any flooding experiences you have in your neighborhood with SPU by filling out the attached questionnaire and mailing it back to us by November 30, 2001. Please complete this questionnaire even if you have previously reported problems to SPU.

We are also planning to conduct two community meetings and encourage your attendance and participation. The first meeting will provide an overview of the study and discuss potential alternatives for minimizing flooding problems. A later meeting will be held to discuss recommendations for future drainage improvements. Both meetings will be held twice, once during the day and once in the evening so that business owners and residents have the opportunity to attend. You will receive further notification about specific dates and times for the community meetings.

For more information about this study, please contact **Karen Goto, SPU Project Manager, at (206) 615-0867, or by e-mail at Karen.Goto@ci.seattle.wa.us.**

In addition to providing more than 1.3 million customers in the Seattle metropolitan area with a reliable water supply, SPU provides essential sewer, drainage, solid waste and engineering services that safeguard public health, maintains the City's infrastructure, and protects, conserves and enhances the region's environmental resources.

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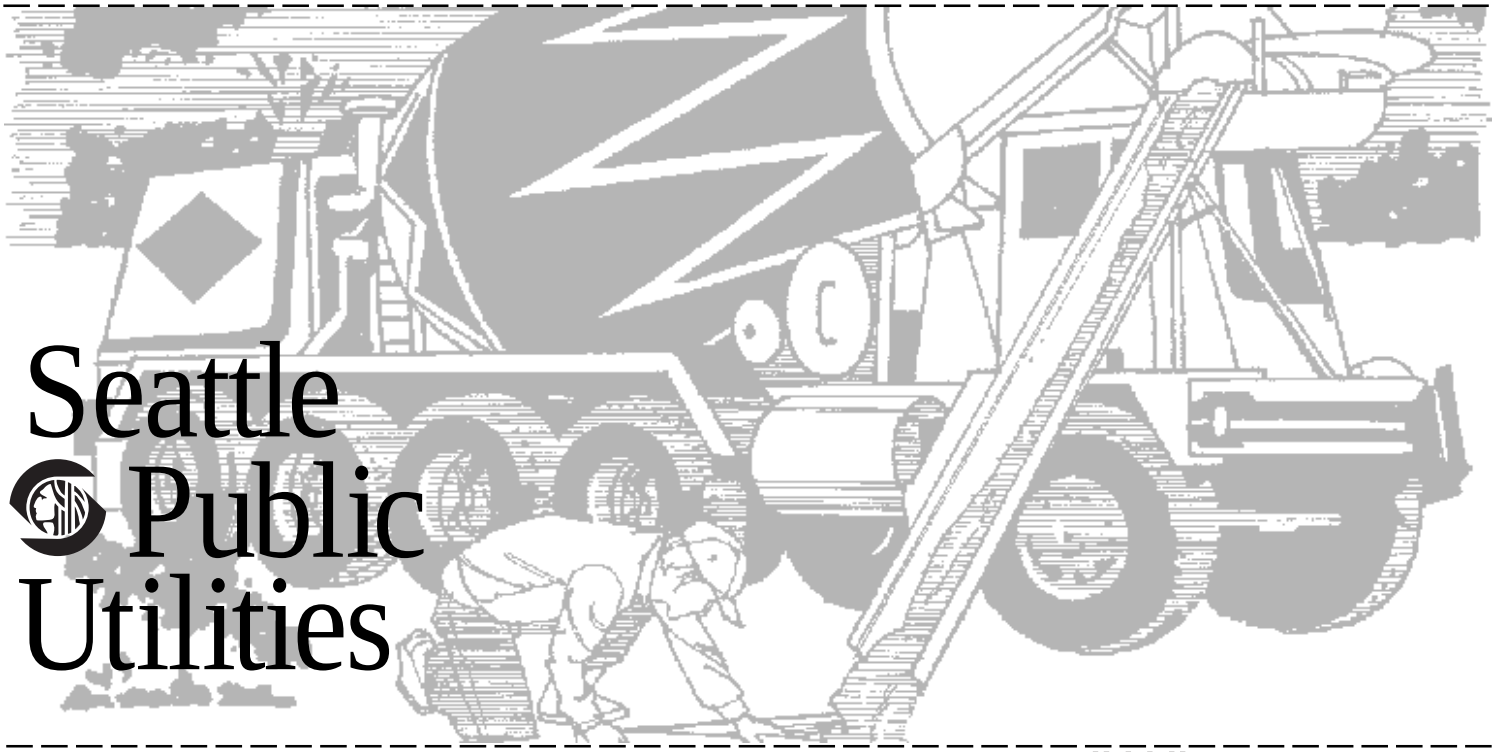
Utilities



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- Doble en tres sobre las líneas.
- Asegure que esta parte se pueda ver una vez doblado el papel.
- Selle la carta con cinta adhesiva o goma de pegar (no use corchetes).
- Envíelo por correo.
- No necesita estampilla postal.

Cuestionario Para Evaluar Alternativas Proyecto: South Park - 7th Ave. S.

Estamos muy interesados en saber si existe algún problema de drenaje en su comunidad. Por favor complete este cuestionario, dóblelo como está indicado en el reverso, y envíelo a "Seattle Public Utilities" antes del **30 de noviembre del 2001**. No necesita estampilla postal. Por favor denos solamente sus comentarios relacionados a problemas de drenaje, ya que este cuestionario va a ser dirigido al departamento de aguas servidas y drenaje. Si no tiene suficiente espacio en esta hoja para la descripción de su problema, incluya otra hoja más. Gracias por su interés y apreciamos su colaboración.

Nombre: _____

Direccion: _____

¿Hace cuanto que vive en esta direccion? _____ ❑ **Hogar** ❑ **Negocio**

Telefono de dia: _____ **E-Mail:** _____

Lugar donde el problema existe: _____

_____

_____

Tipo de problema (marque todos los cuadrados que necesite):

❑ Inundación en el primer piso / sala principal o Living.
❑ Inundación en el subterráneo
❑ Inundación debajo de la casa/(Crawl Space)
❑ Inundación en la acera o vereda
❑ Inundación en el jardín o patio

❑ Inundación en el garage o estacionamiento
❑ Inundación de edificios comerciales
❑ Inundación de edificios industriales/bodegas
❑ Inundación en oficinas

❑ Erosión de tierra
❑ Sedimentación
❑ Necesidad de alta mantención
❑ Calidad de agua potable
❑ Estancamiento de agua en alcantarillas

❑ Estancamiento de agua en zanjas
❑ Obstrucción en la rejilla de drenaje
❑ Otros

Describa el problema y aproximadamente el dia(s) en que ocurrio o cuantas veces al año: _____

_____

_____

_____

_____

_____

_____

_____

_____

Seattle Public Utilities

Si desea, incluya copias de fotografías (no envíe originales).

Si desea hablar personalmente con uno de nuestros empleados o si todavía tiene preguntas sobre este cuestionario, por favor llame a Patricia Cortez al (206) 615-1632, o envíe un e-mail a Patricia.Cortez-Quinones@ci.seattle.wa.us.

City of Seattle
Paul Schell, Mayor
Seattle Public Utilities
Diana Gale, Director

15 de noviembre 2001

Sistema de Drenaje en South Park
Residentes y comerciales: necesitamos su ayuda!

Seattle Public Utilities (SPU) esta haciendo un estudio del sistema de drenaje en South Park. El estudio tiene como fin evaluar alternativas para minimizar el problema de inundaciones en este sector. Este estudio ha encontrado que su sector tiene problemas con el drenaje de agua fluvial, pero necesitamos su ayuda para determinar cuál es la mejor solución para su vecindad. Queremos que comparta con nosotros (Seattle Public Utilities) todos los problemas que usted ha tenido o visto al respecto, incluso si ya ha contactado SPU por problemas de drenaje anteriormente. Para esto, adjunto a esta carta, le estamos enviando un cuestionario para que usted nos lo devuelva con sus respuestas y comentarios. Para su conveniencia el cuestionario ya tiene estampilla. Por favor envíe su cuestionario de vuelta antes del 30 de Noviembre de 2001. Sus comentarios y respuestas al cuestionario ayudará a que se preparen diferentes recomendaciones para el drenaje de agua fluvial y también para ayudar a seleccionar cuáles proyectos deben tener prioridad en el futuro en su comunidad.

SPU también esta planeando realizar dos reuniones con los vecinos de este sector y queremos animarlos a que atiendan y participen. La primera reunión será para explicar y hablar de los resultados de este estudio, además de las diferentes alternativas que se han encontrado para solucionar el problema del drenaje. La segunda reunión será para discutir diferentes recomendaciones para futuros proyectos relacionados con drenaje en el sector. Las reuniones serán realizadas dos veces al día, una en la mañana y otra por la tarde, para que los dueños de negocios u oficinas y residentes puedan asistir. Enviaremos más información al respecto cuando se establezca el día y las horas en que las reuniones se llevarán a efecto.

Para más información al respecto por favor llame a Patricia Cortez, SPU, al (206) 615-1632, o envíe un e-mail a Patricia.Cortez-Quinones@ci.seattle.wa.us.

Seattle Public Utilities: Aparte de proveer a más de 1.3 millones de clientes con agua potable en la ciudad de Seattle, SPU también provee de drenaje para aguas servidas y fluviales, ingeniería, servicios de salud pública y mantenimiento de la infraestructura de la ciudad. Además protege, conserva y mejora el medio ambiente y sus recursos.

Dexter Horton Building, 10th Floor, 710 Second Avenue, Seattle WA 98104
Tel: (206) 684-5851, TTY/TDD (206) 233-7241, FAX: (206) 684-4631
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COMMUNITY MEETING

R·W·BECK

MEMORANDUM

To: Sahba Mohandessi

From: Jack Bjork

Subject: **South Park Community Meeting**

Date: November 15, 2002

A community meeting was held last night to discuss the South Park Drainage Study. The agenda for the meeting is attached. The attendees include members of the community shown on the attached sign-in sheet as well as the following City staff:
Karen Goto
Sahba Mohandessi
Reed Blanchard
Martha Burke
Mara Rogers
Patty Quinones
Judith Noble

Staff from R.W.Beck included:
Willie Moneda
Mike Giseburt
Jack Bjork

The presentation followed the agenda and included the attached Powerpoint slides. After the presentation the citizens asked questions and the project team answered the questions:

1. What is the location and height of the flood control berm? The berm would be located as shown on the 3rd map. The average height would be 7" and the maximum height would be 1 1/2 '. The berm is actually small unlike a large levee. It consist of raising the street. Preliminary engineering will begin in January to develop the design and address additional issues such as the impact on people on the river side of the berm.
2. How long will it take to implement the early action project? Preliminary engineering planned (but not promised) to be done in 2003-2004 and construction in 2004-2005.
3. Is funding in place to do the early action projects?Yes. Funding for other capital projects is more costly due to the needed street work and will be evaluated with other drainage projects in the city.
4. Is the pump station exempt from permitting? Permitting will be addressed in preliminary engineering. At this time, we think a shoreline permit will be required but not a Corps of Engineers permit since there is no "in water" work.
5. Are there any provisions to pick up street contamination? Water quality treatment is not planned and is not required.

1001 Fourth Avenue, Suite 2500 Seattle, WA 98154-1004 Phone (206) 695-4700, Fax (206) 695-4701

6. Were catch basin filters or a filtration system for the pump station considered? The city is evaluating the effectiveness of catch basin filters in other locations. They are costly and require a high level of maintenance.
7. Citizen comment: it be a good idea to plan for a filtration system for the pump station due to its proximity to the river. Grants may be available due to the presence of salmon in the river.
8. Was the pipe in 96th street part of the investigation? No, it is out of the study area and under the jurisdiction of King County. We did determine the general flow pattern in this portion of Hamm Creek.
9. Will the proposed project handle the flooding at 4th and Trenton. Yes.
10. Patty Quinones discussed the SEA street approach to stormwater management and its application to South Park.
11. Did you consider the local problem along Dallas? Yes, the city is evaluating this local problem although there are issues to consider like pipe capacity.
12. Citizen comment: they live in the King County portion of the study area and would like to be annexed to the city.
13. Can I get a copy of the maps for community meetings? Yes, Sahba will e-mail them to you.

South Park Community Meeting

14-Nov-02

List of Attendees

Name	Address	Zip	Phone	Email
Nigel Day	1210 S. Trenton Street	98108	763-8380	nigelday@attbi.com
Tim McNeil	8112 Dallas South	98108	763-5735	
Deborah McNeil	8112 Dallas South	98108	763-5735	debtimmc@aol.com
Gloria Jaiquemat	847 S. Thistle Street	98108	762-2475	
Bob Cronn	1046 S. Elmgrove	98108		cronn@aokland.edu
Joseph E. Pasquarella-Smith	1210 S. Trenton Street	98108		seph@scu.org

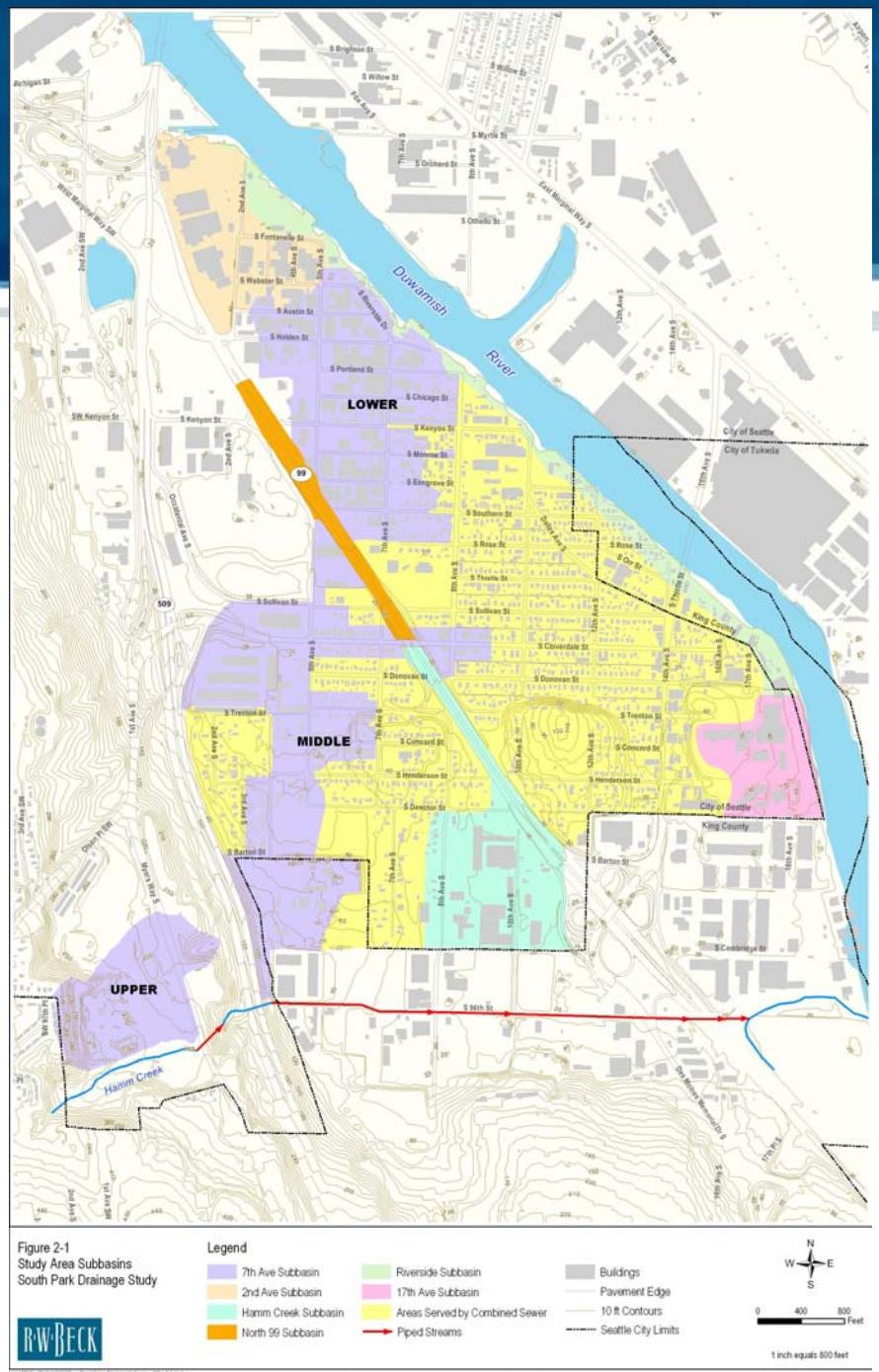
South Park Community Meeting

Seattle Public Utilities

November 14, 2002

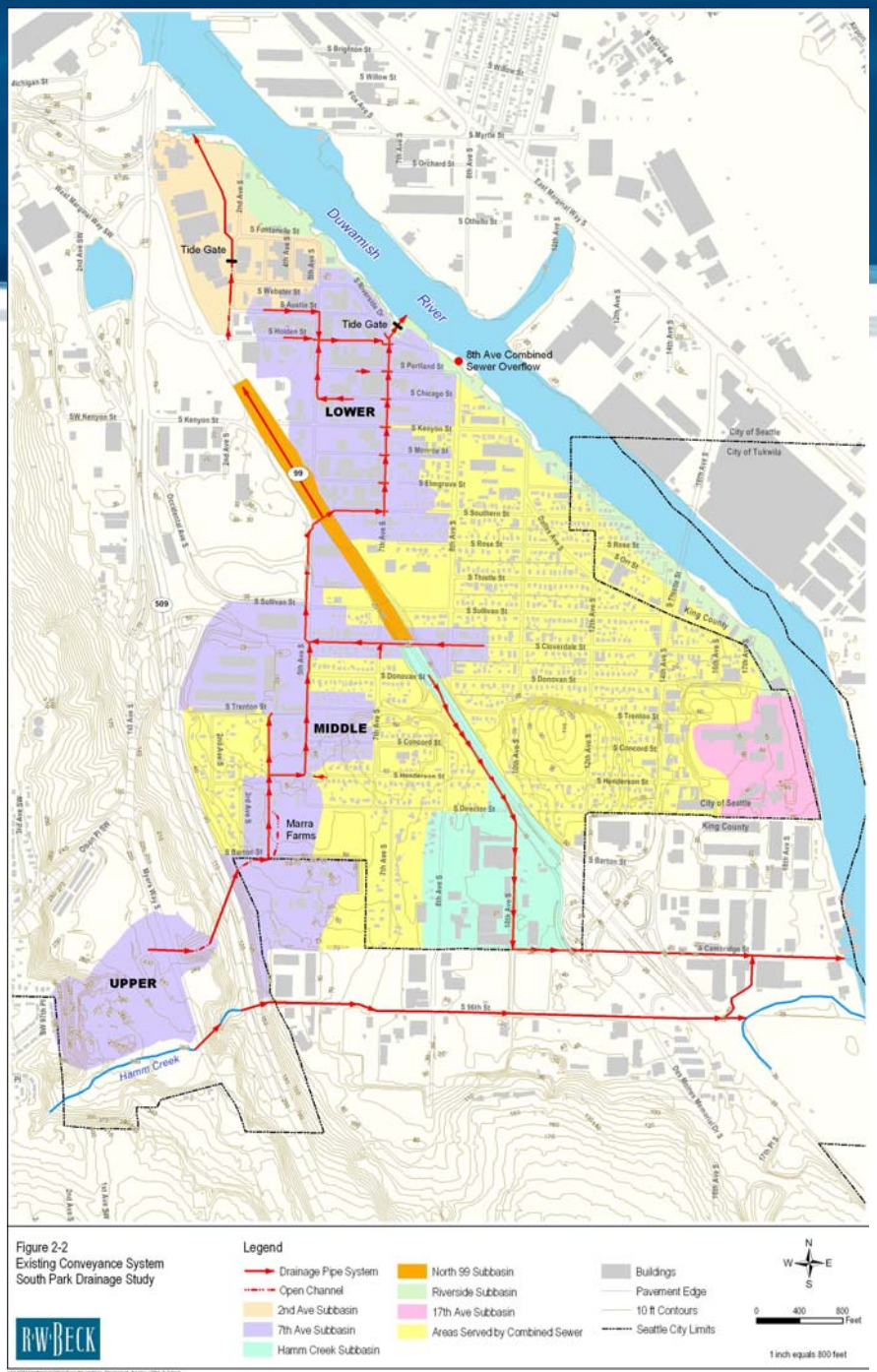
8201 Tenth Avenue South
(SPARC Building)

Study Area Map



R·W·BECK

Existing Drainage System Map



R·W·BECK

Upper Basin

R·W·BECK

Middle Basin

R·W·BECK

Lower Basin

R·W·BECK

Problem Identification Map

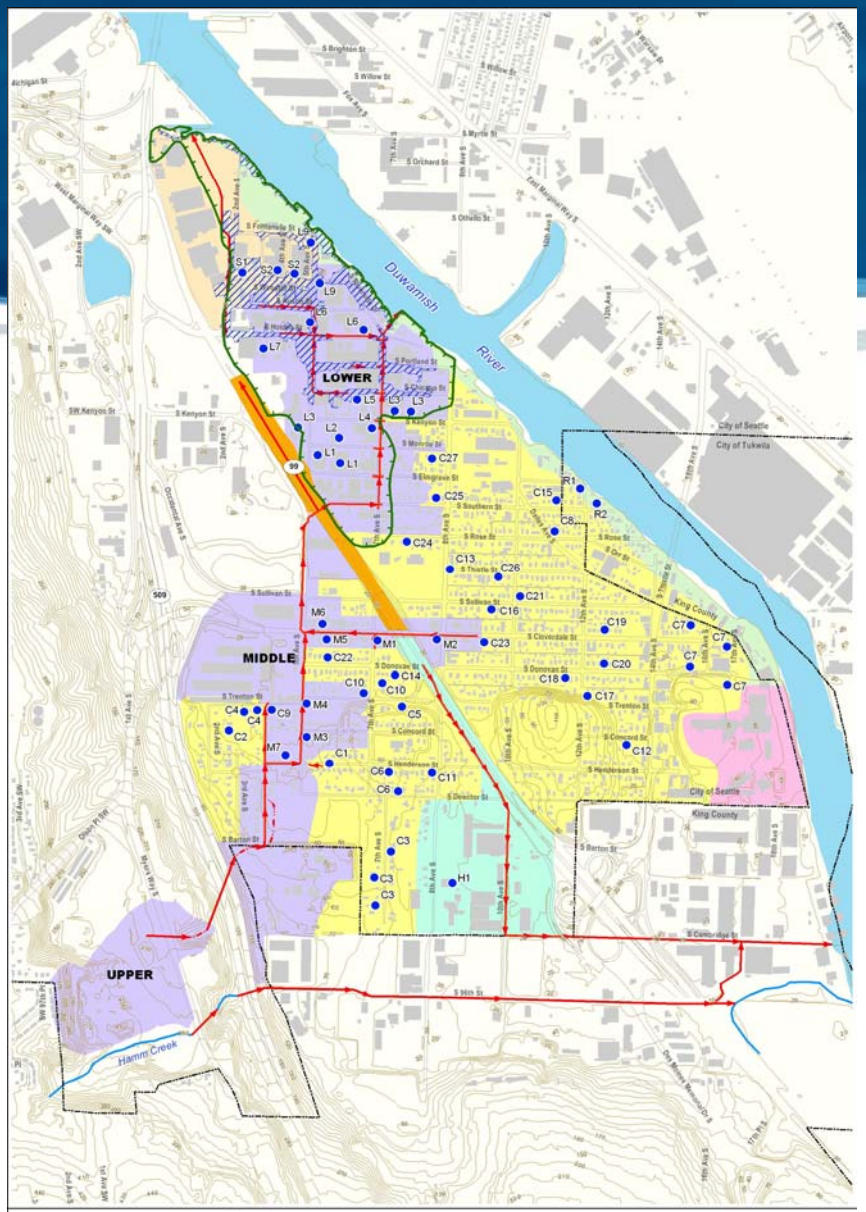


Figure 3-1
Problem Locations
South Park Drainage Study

Solutions to Local Flooding Problems

- S Trenton St east of 7th Ave S
- 16th Ave S and S Dallas St
- S Rose Street and Dallas Ave S
- S Southern St and Dallas Ave S
- S Donovan St and 7th Ave S
- 8th Ave S between S Director and S Cambridge St

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7th Ave and 2nd Ave Basin Alternatives

- Raising the grade of the lower basin
- Adding a new stormwater collection system
- Detention pond for stormwater storage
- Diversion of the upper basin to Hamm Creek
- Installing a new pump station

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Recommended 7th Ave Basin Solution

- Installing a new pump station
- Adding a new stormwater collection system
- Upgrading the streets in the lower basin also included in cost
- Flood control berm
- Total Cost is $12.9M

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Recommended 7th Ave Basin Solution

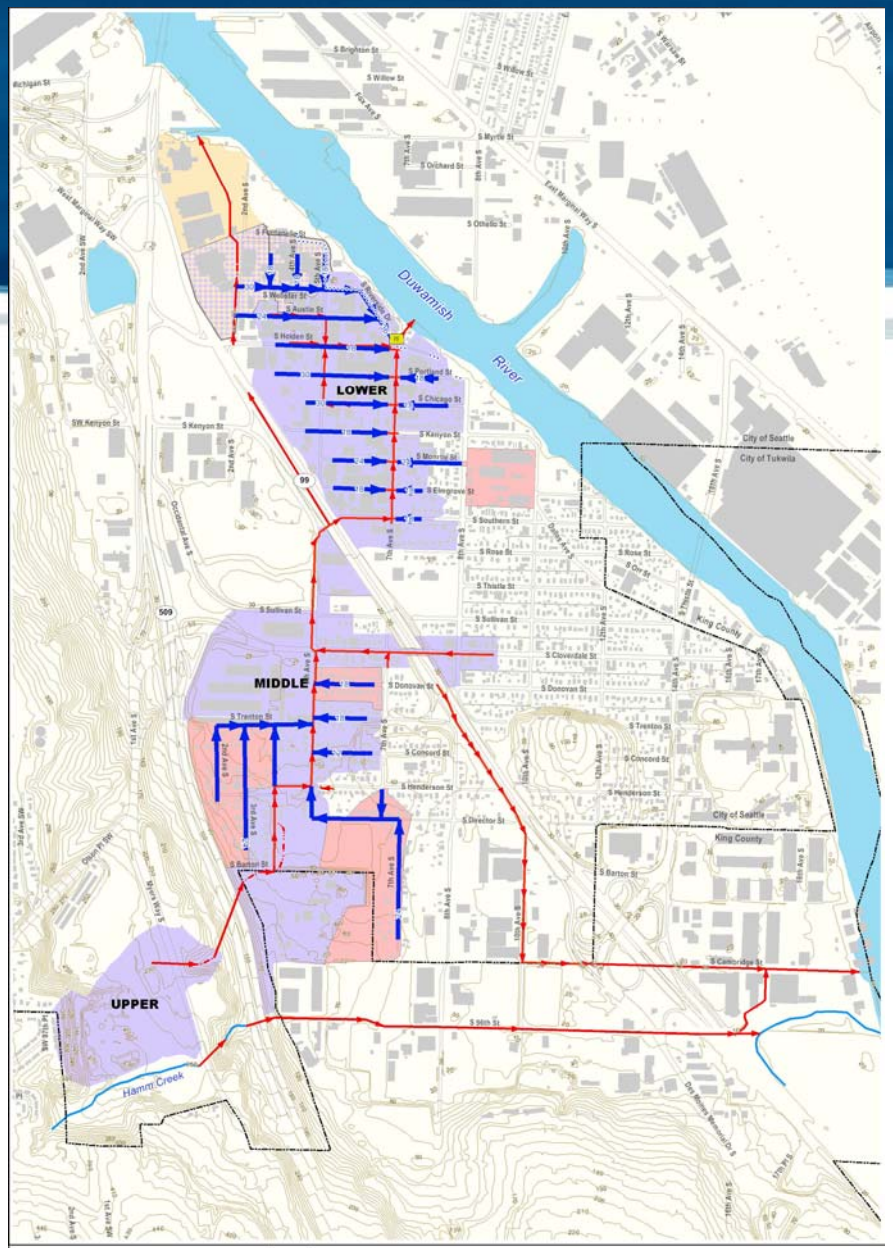

Figure 5-1
Recommended Solution
South Park Drainage Study

R·W·BECK

SOUTH PARK BUSINESS ASSOCIATION MEETING

R·W·BECK

Appendix B

R·W·BECK

Cost Estimating Assumptions

Costs

- Unit prices based on SPU Winter 2001 bid costs
- Pipe costs include excavation, bedding, backfill, trench safety, average cover of 2.5 feet.
- Construction contingency of 35%
- Mobilization costs of 10% of construction costs
- Preconstruction costs include design, surveying, permitting and administration
- Property acquisition costs for project work located outside public right of way determined based on average assessed property values in the project area.
- Potential costs related to excavation and cleanup of contaminated soils not included

Quantities

- Road replacement to end of block in lower and middle 7th Avenue subbasins (this resulted in an addition of approximately 4100 ft of road replacement)
- Full width road replacement in lower 7th Avenue subbasin (assumed width of 25 feet)
- 10' width road replacement in middle 7th Avenue subbasin
- Traffic control labor: 2 laborers/day at 100 lf pipe per day for pipe placement and 2 laborers at 1 block/week for pavement replacement
- An additional 15% of required CBs in lower basin added because of shallow slopes.
- One inlet per catch basin in lower and middle 7th Avenue subbasins.

7TH AVENUE BASIN ALTERNATIVE COSTS

R·W·BECK

SOUTH PARK DRAINAGE STUDY **DATE:** **11-Nov-02**
11-00599-00011 **ESTIMATOR:** **LMM**
DESCRIPTION: Flood Protection Berm

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$11,024.40	$11,024
TRAFFIC CONTROL LABOR	1	LS	$5,000.00	$5,000
TRAFFIC CONTROL DEVICES	1	LS	$10,000.00	$10,000
REMOVE PAVEMENT	70	SY	$10.00	$700
BERM KEY EXCAVATION (COMMON/STRUCTURE)	156	CY	$30.00	$4,680
GRAVEL BORROW	156	CY	$19.00	$2,964
BERM PAVEMENT, ASPHALT CONCRETE, CL A (NOT PATCH)	700	CY	$105.00	$73,500
MINERAL AGGREGATE, CRUSHED ROCK	40	CY	$30.00	$1,200
ADJUST EXISTING MH, CB, OR VC, INLET	20	EA	$360.00	$7,200
EROSION CONTROL	1	LS	$5,000.00	$5,000
CURB, EXTRUDED ASPHALT CONCRETE		LF	$6.50	$0

SUBTOTAL		$121,268
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)	0%	
SUBTOTAL	.	$121,268
CONSTRUCTION CONTINGENCY (2) CONTINGENCY = 35%		$42,444
ENGINEERS ESTIMATE (PLANNING LEVEL)		**$163,712**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)		$16,371
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)		**$180,084**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)		$27,013
CONSTRUCTION PHASE COST		**$207,096**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)		$40,928
LAND ACQUISITION		$0
TOTAL PROJECT COST		**$248,024**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.
2) CONSTRUCTION CONTINGENCY TO BE BETWEEN 25% TO 50% DEPENDING UPON PROJECT COMPLEXITY

7TH AVENUE BASIN CIP COSTS

SOUTH PARK DRAINAGE STUDY **DATE: 11-Nov-02**
11-00599-00011 **ESTIMATOR: LMM**
CAPITAL IMPROVEMENT PROJECT ID: A

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$26,050	$26,050
TEMPORARY EROSION AND SEDIMENTATION CONTROL	1	LS	$3,000	$3,000
EXCAVATION (COMMON/STRUCTURE)	200	CY	$30	$6,000
FOUNDATION	1	LS	$5,000	$5,000
BACKFILL	150	CY	$30	$4,500
DEWATER/SHORING	1	LS	$45,000	$45,000
GRAVEL RESTORATION	1	LS	$500	$500
WET WELL VAULT	1	LS	$30,000	$30,000
VAULT FOR VALVES	1	LS	$6,000	$6,000
PIPE SUPPORTS	1	LS	$500	$500
THRUST BLOCKS	6	CY	$500	$3,000
MISC METALS	1	LS	$11,000	$11,000
GRAVEL SURFACING	2600	SF	$3	$7,800
PIPE, DI, 12 IN	30	LF	$60	$1,800
PIPE, DI, 18 IN	50	LF	$90	$4,500
12 IN FITTINGS	4	EA	$1,000	$4,000
18 IN FITTINGS	1	EA	$3,000	$3,000
MISC RESTRAINTS, SUPPORTS, VALVE BOXES	1	LS	$4,000	$4,000
12-IN CHECK VALVE	2	EA	$4,200	$8,400
12-IN GATE VALVE	2	EA	$1,100	$2,200
SUBMERSIBLE PUMP, 25 HP	2	EA	$15,000	$30,000
SUMP PUMP	1	EA	$300	$300
ELECTRICAL SERVICE ENTRANCE WITH MTS	1	LS	$13,500	$13,500
MOTOR CONTROL CENTER	1	LS	$20,000	$20,000
ELECTRICAL GROUNDING	1	LS	$1,000	$1,000
LIGHTING AND SMALL POWER	1	LS	$2,000	$2,000
ELECTRICAL DUCT	1	LS	$3,000	$3,000
GENERATOR, TRANSFER SWITCH, BATTERY, CHARGER, DAY TANK	1	LS	$35,000	$35,000
CABLE	1	LS	$2,500	$2,500
TESTING AND STARTUP	1	LS	$3,000	$3,000
SUBTOTAL				$286,550
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)			$ -	
SUBTOTAL			.	$286,550
CONSTRUCTION CONTINGENCY (1) CONTINGENCY =	35%			$100,293
ENGINEERS ESTIMATE (PLANNING LEVEL)				**$386,843**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)				$38,684
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)				**$425,527**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)				$63,829
CONSTRUCTION PHASE COST				**$489,356**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)				$96,711
LAND ACQUISITION				$0
TOTAL PROJECT COST				**$586,066**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.

SOUTH PARK DRAINAGE STUDY **DATE:** **11-Nov-02**
11-00599-00011 **ESTIMATOR:** **LMM**
CAPITAL IMPROVEMENT PROJECT ID: B

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$53,897	$53,897
TRAFFIC CONTROL LABOR	548	HR	$36	$19,717
TRAFFIC CONTROL DEVICES	1	LS	$2,000	$2,000
REMOVE PAVEMENT	6222	SY	$10	$62,222
DEMOLISH/ABANDON EXISTING SYSTEM	1	LS	$0	$0
TEMPORARY EROSION AND SEDIMENTATION CONTROL	1	LS	$3,000	$3,000
MINERAL AGGREGATE, CRUSHED ROCK	1037	CY	$30	$31,111
PAVEMENT, ASPHALT CONCRETE, CL A (NOT PATCH)	1390	CY	$105	$145,911
PAVEMENT MARKINGS	1	LS	$4,000	$4,000
MANHOLE, TYPE 200 (48" DIA) (MAX PIPE = 24" CONC)(TO 10' DEPTH)	6	EA	$2,800	$16,800
CATCH BASIN, TYPE 240 (48" DIA) (NOT AT CURB)	18	EA	$1,700.00	$30,600
SUPPLEMENTAL CATCH BASIN, TYPE 240 (48" DIA) (LOW SPOTS)	3	EA	$1,700.00	$5,100
INLET, TYPE 250/252	18	EA	$950	$17,100
PIPE, PSD, CONC REINF, 18 IN (3)	1210	LF	$96	$116,160
PIPE, PSD, CONC REINF, 24 IN (3)	490	LF	$141	$69,090
ADJUST EXISTING MH, CB, OR VC, INLET	6	EA	$360	$2,160
UTILITY RELOCATION	4	EA	$3,000	$12,000
TEMPORARY STORMWATER BYPASS	1	LS	$2,000	$2,000
SUBTOTAL				$592,869
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)			$ -	
SUBTOTAL			.	$592,869
CONSTRUCTION CONTINGENCY (2) CONTINGENCY = 35%				$207,504
ENGINEERS ESTIMATE (PLANNING LEVEL)				**$800,372**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)				$80,037
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)				**$880,410**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)				$132,061
CONSTRUCTION PHASE COST				**$1,012,471**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)				$200,093
LAND ACQUISITION				$0
TOTAL PROJECT COST				**$1,212,564**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.
2) CONSTRUCTION CONTINGENCY TO BE BETWEEN 25% TO 50% DEPENDING UPON PROJECT COMPLEXITY
3) INCLUDES BEDDING, BACKFILL WITH 50% MINERAL AGGREGATE TYPE 17, AVERAGE TRENCH DEPTH 7 FEET. ASSUMES TEES AND CONNECTIONS INCIDENTAL.

SOUTH PARK DRAINAGE STUDY **DATE: 11-Nov-02**
11-00599-00011 **ESTIMATOR: LMM**
CAPITAL IMPROVEMENT PROJECT ID: C

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$36,425	$36,425
TRAFFIC CONTROL LABOR	403	HR	$36	$14,511
TRAFFIC CONTROL DEVICES	1	LS	$2,000	$2,000
REMOVE PAVEMENT	1689	SY	$10	$16,889
DEMOLISH/ABANDON EXISTING SYSTEM	1	LS	$0	$0
TEMPORARY EROSION AND SEDIMENTATION CONTROL	1	LS	$2,000	$2,000
MINERAL AGGREGATE, CRUSHED ROCK	281	CY	$30	$8,444
PAVEMENT, CEM CONC CL 6.5 (1-1/2), 6 IN	1689	SY	$40	$67,556
PAVEMENT MARKINGS	1	LS	$2,700	$2,700
MANHOLE, TYPE 200 (48" DIA) (MAX PIPE = 24" CONC)(TO 10' DEPTH)	5	EA	$2,800	$14,000
CATCH BASIN, TYPE 240 (48" DIA) (NOT AT CURB)	12	EA	$1,700	$20,400
INLET, TYPE 250/252	12	EA	$950	$11,400
PIPE, PSD, CONC REINF, 24 IN (3)	1350	LF	$141	$190,350
PIPE, PSD, CONC REINF C76 CL III, 36 IN (3)	0	LF	$128	$0
UTILITY RELOCATION	4	EA	$3,000	$12,000
TEMPORARY STORMWATER BYPASS	1	LS	$2,000	$2,000
SUBTOTAL				$400,675
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)			$ -	
SUBTOTAL			.	$400,675
CONSTRUCTION CONTINGENCY (2) CONTINGENCY =	35%			$140,236
ENGINEERS ESTIMATE (PLANNING LEVEL)				**$540,911**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)				$54,091
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)				**$595,002**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)				$89,250
CONSTRUCTION PHASE COST				**$684,252**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)				$135,228
LAND ACQUISITION				$0
TOTAL PROJECT COST				**$819,480**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.
2) CONSTRUCTION CONTINGENCY TO BE BETWEEN 25% TO 50% DEPENDING UPON PROJECT COMPLEXITY
3) INCLUDES BEDDING, BACKFILL WITH 50% MINERAL AGGREGATE TYPE 17, AVERAGE TRENCH DEPTH 7 FEET. ASSUMES TEES AND CONNECTIONS INCIDENTAL.

SOUTH PARK DRAINAGE STUDY **DATE: 11-Nov-02**
11-00599-00011 **ESTIMATOR: LMM**
CAPITAL IMPROVEMENT PROJECT ID: D

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$51,799	$51,799
TRAFFIC CONTROL LABOR	706	HR	$36	$25,410
TRAFFIC CONTROL DEVICES	1	LS	$1,500	$1,500
REMOVE PAVEMENT	2833	SY	$10	$28,333
DEMOLISH/ABANDON EXISTING SYSTEM	1	LS	$0	$0
TEMPORARY EROSION AND SEDIMENTATION CONTROL	1	LS	$3,400	$3,400
MINERAL AGGREGATE, CRUSHED ROCK	472	CY	$30	$14,167
PAVEMENT, CEM CONC CL 6.5 (1-1/2), 6 IN	2833	SY	$40	$113,333
PAVEMENT MARKINGS	1	LS	$4,600	$4,600
MANHOLE, TYPE 200 (48" DIA) (MAX PIPE = 24" CONC)(TO 10' DEPTH)	8	EA	$2,800	$22,400
CATCH BASIN, TYPE 240 (48" DIA) (NOT AT CURB)	21	EA	$1,700	$35,700
INLET, TYPE 250/252	21	EA	$950	$19,950
PIPE, PSD, CONC REINF, 18 IN (3)	2450	LF	$96	$235,200
UTILITY RELOCATION	4	EA	$3,000	$12,000
TEMPORARY STORMWATER BYPASS	1	LS	$2,000	$2,000
SUBTOTAL				$569,793
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)			$ -	
SUBTOTAL			.	$569,793
CONSTRUCTION CONTINGENCY (2) CONTINGENCY =	35%			$199,428
ENGINEERS ESTIMATE (PLANNING LEVEL)				**$769,221**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)				$76,922
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)				**$846,143**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)				$126,921
CONSTRUCTION PHASE COST				**$973,064**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)				$192,305
LAND ACQUISITION				$0
TOTAL PROJECT COST				**$1,165,369**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.
2) CONSTRUCTION CONTINGENCY TO BE BETWEEN 25% TO 50% DEPENDING UPON PROJECT COMPLEXITY
3) INCLUDES BEDDING, BACKFILL WITH 50% MINERAL AGGREGATE TYPE 17, AVERAGE TRENCH DEPTH 7 FEET. ASSUMES TEES AND CONNECTIONS INCIDENTAL.

SOUTH PARK DRAINAGE STUDY **DATE:** **11-Nov-02**
11-00599-00011 **ESTIMATOR:** **LMM**
CAPITAL IMPROVEMENT PROJECT ID: E

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$116,514	$116,514
TRAFFIC CONTROL LABOR	1114	HR	$36	$40,110
TRAFFIC CONTROL DEVICES	1	LS	$2,000	$2,000
REMOVE PAVEMENT	12597	SY	$10	$125,972
DEMOLISH/ABANDON EXISTING SYSTEM	1	LS	$0	$0
TEMPORARY EROSION AND SEDIMENTATION CONTROL	1	LS	$6,100	$6,100
MINERAL AGGREGATE, CRUSHED ROCK	2100	CY	$30	$62,986
PAVEMENT, ASPHALT CONCRETE, CL A (NOT PATCH)	2813	CY	$105	$295,405
PAVEMENT MARKINGS	1	LS	$8,200	$8,200
MANHOLE, TYPE 200 (48" DIA) (MAX PIPE = 24" CONC)(TO 10' DEPTH)	4	EA	$2,800	$11,200
MANHOLE, TYPE 201 (54" DIA) (MAX PIPE = 30" CONC)(TO 10' DEPTH)	8	EA	$3,300	$26,400
CATCH BASIN, TYPE 240 (48" DIA) (NOT AT CURB)	24	EA	$1,700.00	$40,800
SUPPLEMENTAL CATCH BASIN, TYPE 240 (48" DIA) (LOW SPOTS)	4	EA	$1,700.00	$6,800
INLET, TYPE 250/252	24	EA	$950	$22,800
PIPE, PSD, CONC REINF, 18 IN (3)	1050	LF	$96	$100,800
PIPE, PSD, CONC REINF C76 CL III, 30 IN (3)	2425	LF	$165	$400,125
ADJUST EXISTING MH, CB, OR VC, INLET	4	EA	$360	$1,440
UTILITY RELOCATION	4	EA	$3,000	$12,000
TEMPORARY STORMWATER BYPASS	1	LS	$2,000	$2,000
SUBTOTAL				$1,281,652
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)			$ -	
SUBTOTAL			.	$1,281,652
CONSTRUCTION CONTINGENCY (2) CONTINGENCY = 35%				$448,578
ENGINEERS ESTIMATE (PLANNING LEVEL)				**$1,730,230**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)				$173,023
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)				**$1,903,252**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)				$285,488
CONSTRUCTION PHASE COST				**$2,188,740**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)				$432,557
LAND ACQUISITION				$0
TOTAL PROJECT COST				**$2,621,298**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.
2) CONSTRUCTION CONTINGENCY TO BE BETWEEN 25% TO 50% DEPENDING UPON PROJECT COMPLEXITY
3) INCLUDES BEDDING, BACKFILL WITH 50% MINERAL AGGREGATE TYPE 17, AVERAGE TRENCH DEPTH 7 FEET. ASSUMES TEES AND CONNECTIONS INCIDENTAL.

SOUTH PARK DRAINAGE STUDY **DATE:** **11-Nov-02**
11-00599-00011 **ESTIMATOR:** **LMM**
CAPITAL IMPROVEMENT PROJECT ID: F

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$90,164	$90,164
TRAFFIC CONTROL LABOR	787	HR	$36	$28,330
TRAFFIC CONTROL DEVICES	1	LS	$2,000	$2,000
REMOVE PAVEMENT	7722	SY	$10	$77,222
DEMOLISH/ABANDON EXISTING SYSTEM	1	LS	$20,000	$20,000
TEMPORARY EROSION AND SEDIMENTATION CONTROL	1	LS	$3,700	$3,700
MINERAL AGGREGATE, CRUSHED ROCK	1287	CY	$30	$38,611
PAVEMENT, ASPHALT CONCRETE, CL A (NOT PATCH)	1725	CY	$105	$181,086
PAVEMENT MARKINGS	1	LS	$5,000	$5,000
MANHOLE, TYPE 200 (48" DIA) (MAX PIPE = 24" CONC)(TO 10' DEPTH)	4	EA	$2,800	$11,200
MANHOLE, TYPE 201 (54" DIA) (MAX PIPE = 30" CONC)(TO 10' DEPTH)	5	EA	$3,300	$16,500
CATCH BASIN, TYPE 240 (48" DIA) (NOT AT CURB)	23	EA	$1,700.00	$39,100
SUPPLEMENTAL CATCH BASIN, TYPE 240 (48" DIA) (LOW SPOTS)	3	EA	$1,700.00	$5,100
INLET, TYPE 250/252	23	EA	$950	$21,850
PIPE, PSD, CONC REINF, 24 IN (3)	1190	LF	$141	$167,790
PIPE, PSD, CONC REINF C76 CL III, 30 IN (3)	1330	LF	$165	$219,450
PIPE, PSD, CONC REINF C76 CL III, 36 IN (3)	260	LF	$195	$50,700
UTILITY RELOCATION	4	EA	$3,000	$12,000
TEMPORARY STORMWATER BYPASS	1	LS	$2,000	$2,000
SUBTOTAL				$991,804
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)			$ -	
SUBTOTAL			.	$991,804
CONSTRUCTION CONTINGENCY (2) CONTINGENCY = 35%				$347,131
ENGINEERS ESTIMATE (PLANNING LEVEL)				**$1,338,935**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)				$133,894
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)				**$1,472,829**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)				$220,924
CONSTRUCTION PHASE COST				**$1,693,753**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)				$334,734
LAND ACQUISITION				$0
TOTAL PROJECT COST				**$2,028,487**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.
2) CONSTRUCTION CONTINGENCY TO BE BETWEEN 25% TO 50% DEPENDING UPON PROJECT COMPLEXITY
3) INCLUDES BEDDING, BACKFILL WITH 50% MINERAL AGGREGATE TYPE 17, AVERAGE TRENCH DEPTH 7 FEET. ASSUMES TEES AND CONNECTIONS INCIDENTAL.

SOUTH PARK DRAINAGE STUDY **DATE: 11-Nov-02**
11-00599-00011 **ESTIMATOR: LMM**
CAPITAL IMPROVEMENT PROJECT ID: G

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$33,915	$33,915
TRAFFIC CONTROL LABOR	356	HR	$36	$12,814
TRAFFIC CONTROL DEVICES	1	LS	$1,500	$1,500
REMOVE PAVEMENT	3917	SY	$10	$39,167
DEMOLISH/ABANDON EXISTING SYSTEM	1	LS	$0	$0
TEMPORARY EROSION AND SEDIMENTATION CONTROL	1	LS	$1,900	$1,900
MINERAL AGGREGATE, CRUSHED ROCK	653	CY	$30	$19,583
PAVEMENT, ASPHALT CONCRETE, CL A (NOT PATCH)	875	CY	$105	$91,846
PAVEMENT, CEM CONC CL 6.5 (1-1/2), 6 IN	0	SY	$40	$0
PAVEMENT MARKINGS	1	LS	$2,500	$2,500
MANHOLE, TYPE 200 (48" DIA) (MAX PIPE = 24" CONC)(TO 10' DEPTH)	4	EA	$2,800	$11,200
CATCH BASIN, TYPE 240 (48" DIA) (NOT AT CURB)	12	EA	$1,700.00	$20,400
SUPPLEMENTAL CATCH BASIN, TYPE 240 (48" DIA) (LOW SPOTS)	2	EA	$1,700.00	$3,400
INLET, TYPE 250/252	12	EA	$950	$11,400
PIPE, PSD, CONC REINF, 18 IN (3)	1140	LF	$96	$109,440
UTILITY RELOCATION	4	EA	$3,000	$12,000
TEMPORARY STORMWATER BYPASS	1	LS	$2,000	$2,000
SUBTOTAL				$373,065
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)			$ -	
SUBTOTAL			.	$373,065
CONSTRUCTION CONTINGENCY (2) CONTINGENCY =	35%			$130,573
ENGINEERS ESTIMATE (PLANNING LEVEL)				**$503,637**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)				$50,364
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)				**$554,001**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)				$83,100
CONSTRUCTION PHASE COST				**$637,101**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)				$125,909
LAND ACQUISITION				$0
TOTAL PROJECT COST				**$763,010**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.
2) CONSTRUCTION CONTINGENCY TO BE BETWEEN 25% TO 50% DEPENDING UPON PROJECT COMPLEXITY
3) INCLUDES BEDDING, BACKFILL WITH 50% MINERAL AGGREGATE TYPE 17, AVERAGE TRENCH DEPTH 7 FEET. ASSUMES TEES AND CONNECTIONS INCIDENTAL.

SOUTH PARK DRAINAGE STUDY **DATE: 11-Nov-02**
11-00599-00011 **ESTIMATOR: LMM**
CAPITAL IMPROVEMENT PROJECT ID: H

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$15,437	$15,437
TRAFFIC CONTROL LABOR	133	HR	$36	$4,799
TRAFFIC CONTROL DEVICES	1	LS	$1,500	$1,500
REMOVE PAVEMENT	1528	SY	$10	$15,278
DEMOLISH/ABANDON EXISTING SYSTEM	1	LS	$0	$0
TEMPORARY EROSION AND SEDIMENTATION CONTROL	1	LS	$700	$700
MINERAL AGGREGATE, CRUSHED ROCK	255	CY	$30	$7,639
PAVEMENT, ASPHALT CONCRETE, CL A (NOT PATCH)	341	CY	$105	$35,826
PAVEMENT MARKINGS	1	LS	$1,000	$1,000
MANHOLE, TYPE 200 (48" DIA) (MAX PIPE = 24" CONC)(TO 10' DEPTH)	1	EA	$2,800	$2,800
CATCH BASIN, TYPE 240 (48" DIA) (NOT AT CURB)	4	EA	$1,700.00	$6,800
SUPPLEMENTAL CATCH BASIN, TYPE 240 (48" DIA) (LOW SPOTS)	1	EA	$1,700.00	$1,700
INLET, TYPE 250/252	4	EA	$950	$3,800
PIPE, PSD, CONC REINF, 24 IN (3)	410	LF	$141	$57,810
ADJUST EXISTING MH, CB, OR VC, INLET	2	EA	$360	$720
UTILITY RELOCATION	4	EA	$3,000	$12,000
TEMPORARY STORMWATER BYPASS	1	LS	$2,000	$2,000
SUBTOTAL				$169,809
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)			$ -	
SUBTOTAL			.	$169,809
CONSTRUCTION CONTINGENCY (2) CONTINGENCY =	35%			$59,433
ENGINEERS ESTIMATE (PLANNING LEVEL)				**$229,242**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)				$22,924
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)				**$252,166**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)				$37,825
CONSTRUCTION PHASE COST				**$289,991**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)				$57,310
LAND ACQUISITION				$0
TOTAL PROJECT COST				**$347,301**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.
2) CONSTRUCTION CONTINGENCY TO BE BETWEEN 25% TO 50% DEPENDING UPON PROJECT COMPLEXITY
3) INCLUDES BEDDING, BACKFILL WITH 50% MINERAL AGGREGATE TYPE 17, AVERAGE TRENCH DEPTH 7 FEET. ASSUMES TEES AND CONNECTIONS INCIDENTAL.

SOUTH PARK DRAINAGE STUDY **DATE: 11-Nov-02**
11-00599-00011 **ESTIMATOR: LMM**
CAPITAL IMPROVEMENT PROJECT ID: I

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$46,130	$46,130
TRAFFIC CONTROL LABOR	556	HR	$36	$20,005
TRAFFIC CONTROL DEVICES	1	LS	$2,000	$2,000
REMOVE PAVEMENT	2344	SY	$10	$23,444
DEMOLISH/ABANDON EXISTING SYSTEM	1	LS	$0	$0
TEMPORARY EROSION AND SEDIMENTATION CONTROL	1	LS	$2,800	$2,800
MINERAL AGGREGATE, CRUSHED ROCK	391	CY	$30	$11,722
PAVEMENT, CEM CONC CL 6.5 (1-1/2), 6 IN	2344	SY	$40	$93,778
PAVEMENT MARKINGS	1	LS	$3,800	$3,800
MANHOLE, TYPE 200 (48" DIA) (MAX PIPE = 24" CONC)(TO 10' DEPTH)	8	EA	$2,800	$22,400
CATCH BASIN, TYPE 240 (48" DIA) (NOT AT CURB)	22	EA	$1,700.00	$37,400
INLET, TYPE 250/252	22	EA	$950	$20,900
PIPE, PSD, CONC REINF, 12 IN (3)	700	LF	$67	$46,900
PIPE, PSD, CONC REINF, 24 IN (3)	1150	LF	$141	$162,150
UTILITY RELOCATION	4	EA	$3,000	$12,000
TEMPORARY STORMWATER BYPASS	1	LS	$2,000	$2,000
SUBTOTAL				$507,429
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)			$ -	
SUBTOTAL			.	$507,429
CONSTRUCTION CONTINGENCY (2) CONTINGENCY =	35%			$177,600
ENGINEERS ESTIMATE (PLANNING LEVEL)				**$685,030**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)				$68,503
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)				**$753,533**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)				$113,030
CONSTRUCTION PHASE COST				**$866,562**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)				$171,257
LAND ACQUISITION				$0
TOTAL PROJECT COST				**$1,037,820**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.
2) CONSTRUCTION CONTINGENCY TO BE BETWEEN 25% TO 50% DEPENDING UPON PROJECT COMPLEXITY
3) INCLUDES BEDDING, BACKFILL WITH 50% MINERAL AGGREGATE TYPE 17, AVERAGE TRENCH DEPTH 7 FEET. ASSUMES TEES AND CONNECTIONS INCIDENTAL.

SOUTH PARK DRAINAGE STUDY **DATE: 11-Nov-02**
11-00599-00011 **ESTIMATOR: LMM**
CAPITAL IMPROVEMENT PROJECT ID: J

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$11,024	$11,024
TRAFFIC CONTROL LABOR	1	LS	$5,000	$5,000
TRAFFIC CONTROL DEVICES	1	LS	$10,000	$10,000
REMOVE PAVEMENT	70	SY	$10	$700
BERM KEY EXCAVATION (COMMON/STRUCTURE)	156	CY	$30	$4,680
GRAVEL BORROW	156	CY	$19	$2,964
BERM PAVEMENT, ASPHALT CONCRETE, CL A (NOT PATCH)	700	CY	$105	$73,500
ROCK FACING		SF	$16	$0
MINERAL AGGREGATE, CRUSHED ROCK	40	CY	$30	$1,200
ADJUST EXISTING MH, CB, OR VC, INLET	20	EA	$360	$7,200
EROSION CONTROL	1	LS	$5,000	$5,000
CURB, EXTRUDED ASPHALT CONCRETE		LF	$7	$0
SUBTOTAL				$121,268
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)			$ -	
SUBTOTAL			.	$121,268
CONSTRUCTION CONTINGENCY (2) CONTINGENCY = 35%				$42,444
ENGINEERS ESTIMATE (PLANNING LEVEL)				**$163,712**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)				$16,371
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)				**$180,084**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)				$27,013
CONSTRUCTION PHASE COST				**$207,096**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)				$40,928
LAND ACQUISITION				$0
TOTAL PROJECT COST				**$248,024**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.
2) CONSTRUCTION CONTINGENCY TO BE BETWEEN 25% TO 50% DEPENDING UPON PROJECT COMPLEXITY

SOUTH PARK DRAINAGE STUDY **DATE: 11-Nov-02**
11-00599-00011 **ESTIMATOR: LMM**
CAPITAL IMPROVEMENT PROJECT ID: K

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$25,290	$25,290
TRAFFIC CONTROL LABOR	320	HR	$36	$11,516
TRAFFIC CONTROL DEVICES	1	LS	$2,000	$2,000
REMOVE PAVEMENT	1400	SY	$10	$14,000
DEMOLISH/ABANDON EXISTING SYSTEM	1	LS	$0	$0
TEMPORARY EROSION AND SEDIMENTATION CONTROL	1	LS	$1,700	$1,700
MINERAL AGGREGATE, CRUSHED ROCK	233	CY	$30	$7,000
PAVEMENT, CEM CONC CL 6.5 (1-1/2), 6 IN	1400	SY	$40	$56,000
PAVEMENT MARKINGS	1	LS	$2,300	$2,300
MANHOLE, TYPE 200 (48" DIA) (MAX PIPE = 24" CONC)(TO 10' DEPTH)	3	EA	$2,800	$8,400
CATCH BASIN, TYPE 240 (48" DIA) (NOT AT CURB)	14	EA	$1,700.00	$23,800
INLET, TYPE 250/252	14	EA	$950	$13,300
PIPE, PSD, CONC REINF, 18 IN (3)	1030	LF	$96	$98,880
UTILITY RELOCATION	4	EA	$3,000	$12,000
TEMPORARY STORMWATER BYPASS	1	LS	$ 2,000	$2,000
SUBTOTAL				$278,185
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)			$ -	
SUBTOTAL			.	$278,185
CONSTRUCTION CONTINGENCY (2) CONTINGENCY = 35%				$97,365
ENGINEERS ESTIMATE (PLANNING LEVEL)				**$375,550**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)				$37,555
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)				**$413,105**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)				$61,966
CONSTRUCTION PHASE COST				**$475,071**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)				$93,887
LAND ACQUISITION				$0
TOTAL PROJECT COST				**$568,958**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.
2) CONSTRUCTION CONTINGENCY TO BE BETWEEN 25% TO 50% DEPENDING UPON PROJECT COMPLEXITY
3) INCLUDES BEDDING, BACKFILL WITH 50% MINERAL AGGREGATE TYPE 17, AVERAGE TRENCH DEPTH 7 FEET. ASSUMES TEES AND CONNECTIONS INCIDENTAL.

SOUTH PARK DRAINAGE STUDY **DATE: 11-Nov-02**
11-00599-00011 **ESTIMATOR: LMM**
CAPITAL IMPROVEMENT PROJECT ID: L

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$11,899	$11,899
TRAFFIC CONTROL LABOR	151	HR	$36	$5,450
TRAFFIC CONTROL DEVICES	1	LS	$2,000	$2,000
REMOVE PAVEMENT	644	SY	$10	$6,444
DEMOLISH/ABANDON EXISTING SYSTEM	1	LS	$0	$0
TEMPORARY EROSION AND SEDIMENTATION CONTROL	1	LS	$800	$800
MINERAL AGGREGATE, CRUSHED ROCK	107	CY	$30	$3,222
PAVEMENT, ASPHALT CONCRETE, CL A (NOT PATCH)	0	CY	$105	$0
PAVEMENT, CEM CONC CL 6.5 (1-1/2), 6 IN	644	SY	$40	$25,778
PAVEMENT MARKINGS	1	LS	$1,000	$1,000
MANHOLE, TYPE 200 (48" DIA) (MAX PIPE = 24" CONC)(TO 10' DEPTH)	2	EA	$2,800	$5,600
CATCH BASIN, TYPE 240 (48" DIA) (NOT AT CURB)	8	EA	$1,700.00	$13,600
INLET, TYPE 250/252	8	EA	$950	$7,600
PIPE, PSD, CONC REINF, 12 IN (3)	500	LF	$67	$33,500
UTILITY RELOCATION	4	EA	$3,000	$12,000
TEMPORARY STORMWATER BYPASS	1	LS	$2,000	$2,000
SUBTOTAL				$130,894
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)			$ -	
SUBTOTAL			.	$130,894
CONSTRUCTION CONTINGENCY (2) CONTINGENCY = 35%				$45,813
ENGINEERS ESTIMATE (PLANNING LEVEL)				**$176,707**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)				$17,671
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)				**$194,377**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)				$29,157
CONSTRUCTION PHASE COST				**$223,534**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)				$44,177
LAND ACQUISITION				$0
TOTAL PROJECT COST				**$267,710**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.
2) CONSTRUCTION CONTINGENCY TO BE BETWEEN 25% TO 50% DEPENDING UPON PROJECT COMPLEXITY
3) INCLUDES BEDDING, BACKFILL WITH 50% MINERAL AGGREGATE TYPE 17, AVERAGE TRENCH DEPTH 7 FEET. ASSUMES TEES AND CONNECTIONS INCIDENTAL.

SOUTH PARK DRAINAGE STUDY **DATE: 11-Nov-02**
11-00599-00011 **ESTIMATOR: LMM**
CAPITAL IMPROVEMENT PROJECT ID: M

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$26,732	$26,732
TRAFFIC CONTROL LABOR	275	HR	$36	$9,885
TRAFFIC CONTROL DEVICES	1	LS	$1,500	$1,500
REMOVE PAVEMENT	3417	SY	$10	$34,167
DEMOLISH/ABANDON EXISTING SYSTEM	1	LS	$0	$0
TEMPORARY EROSION AND SEDIMENTATION CONTROL	1	LS	$1,700	$1,700
MINERAL AGGREGATE, CRUSHED ROCK	569	CY	$30	$17,083
PAVEMENT, ASPHALT CONCRETE, CL A (NOT PATCH)	763	CY	$105	$80,121
PAVEMENT MARKINGS	1	LS	$2,200	$2,200
MANHOLE, TYPE 200 (48" DIA) (MAX PIPE = 24" CONC)(TO 10' DEPTH)	3	EA	$2,800	$8,400
CATCH BASIN, TYPE 240 (48" DIA) (NOT AT CURB)	8	EA	$1,700.00	$13,600
SUPPLEMENTAL CATCH BASIN, TYPE 240 (48" DIA) (LOW SPOTS)	1	EA	$1,700.00	$1,700
INLET, TYPE 250/252	8	EA	$950	$7,600
PIPE, PSD, CONC REINF, 18 IN (3)	770	LF	$96	$73,920
ADJUST EXISTING MH, CB, OR VC, INLET	4	EA	$360	$1,440
UTILITY RELOCATION	4	EA	$3,000	$12,000
TEMPORARY STORMWATER BYPASS	1	LS	$2,000	$2,000
SUBTOTAL				$294,047
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)			$ -	
SUBTOTAL			.	$294,047
CONSTRUCTION CONTINGENCY (2) CONTINGENCY =	35%			$102,917
ENGINEERS ESTIMATE (PLANNING LEVEL)				**$396,964**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)				$39,696
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)				**$436,660**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)				$65,499
CONSTRUCTION PHASE COST				**$502,160**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)				$99,241
LAND ACQUISITION				$0
TOTAL PROJECT COST				**$601,401**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.
2) CONSTRUCTION CONTINGENCY TO BE BETWEEN 25% TO 50% DEPENDING UPON PROJECT COMPLEXITY
3) INCLUDES BEDDING, BACKFILL WITH 50% MINERAL AGGREGATE TYPE 17, AVERAGE TRENCH DEPTH 7 FEET. ASSUMES TEES AND CONNECTIONS INCIDENTAL.

SOUTH PARK DRAINAGE STUDY **DATE:** **11-Nov-02**
11-00599-00011 **ESTIMATOR:** **LMM**
CAPITAL IMPROVEMENT PROJECT ID: N

BID ITEM DESCRIPTION	*QUANTITY*	*UNIT*	*UNIT PRICE* (1)	*COST*
MOBILIZATION (10% of subtotal)	1	LS	$27,803	$27,803
TRAFFIC CONTROL LABOR	297	HR	$36	$10,691
TRAFFIC CONTROL DEVICES	1	LS	$2,000	$2,000
REMOVE PAVEMENT	4139	SY	$10	$41,389
DEMOLISH/ABANDON EXISTING SYSTEM	1	LS	$0	$0
TEMPORARY EROSION AND SEDIMENTATION CONTROL	1	LS	$2,000	$2,000
MINERAL AGGREGATE, CRUSHED ROCK	690	CY	$30	$20,694
PAVEMENT, ASPHALT CONCRETE, CL A (NOT PATCH)	924	CY	$105	$97,057
PAVEMENT MARKINGS	1	LS	$2,700	$2,700
MANHOLE, TYPE 200 (48" DIA) (MAX PIPE = 24" CONC)(TO 10' DEPTH)	2	EA	$2,800	$5,600
CATCH BASIN, TYPE 240 (48" DIA) (NOT AT CURB)	4	EA	$1,700.00	$6,800
SUPPLEMENTAL CATCH BASIN, TYPE 240 (48" DIA) (LOW SPOTS)	1	EA	$1,700.00	$1,700
INLET, TYPE 250/252	4	EA	$950	$3,800
PIPE, PSD, CONC REINF, 18 IN (3)	710	LF	$96	$68,160
ADJUST EXISTING MH, CB, OR VC, INLET	4	EA	$360	$1,440
UTILITY RELOCATION	4	EA	$3,000	$12,000
TEMPORARY STORMWATER BYPASS	1	LS	$ 2,000	$2,000
SUBTOTAL				$305,835
LOCATION CONTINGENCY(100% FOR DOWNTOWN, 25% DENSE RESIDENTIAL, OR 0%)			$ -	
SUBTOTAL			.	$305,835
CONSTRUCTION CONTINGENCY (2) CONTINGENCY =	35%			$107,042
ENGINEERS ESTIMATE (PLANNING LEVEL)				**$412,877**
CONSTRUCTION INCIDENTALS (10% OF ENG. ESTIMATE)				$41,288
CONSTRUCTION CONTRACT AMOUNT (PLANNING LEVEL)				**$454,165**
CONSTRUCTION CONTROL - INSPECTION (15% OF CONST. CONTRACT AMOUNT)				$68,125
CONSTRUCTION PHASE COST				**$522,290**
PRECONSTRUCTION PHASE (25% OF ENGINEERS ESTIMATE)				$103,219
LAND ACQUISITION				$0
TOTAL PROJECT COST				**$625,509**

NOTES
1) UNIT PRICES ARE BASED UPON SPU WINTER 2001 BID PRICES, ADJUSTED WHERE APPROPRIATE FOR PLANNING LEVEL STUDY.
2) CONSTRUCTION CONTINGENCY TO BE BETWEEN 25% TO 50% DEPENDING UPON PROJECT COMPLEXITY
3) INCLUDES BEDDING, BACKFILL WITH 50% MINERAL AGGREGATE TYPE 17, AVERAGE TRENCH DEPTH 7 FEET. ASSUMES TEES AND CONNECTIONS INCIDENTAL.

7TH AVENUE BASIN OPERATIONS AND MAINTENANCE COSTS

R·W·BECK