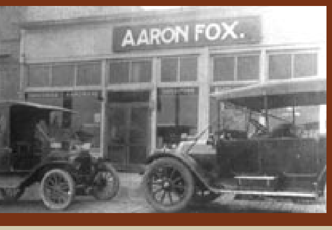
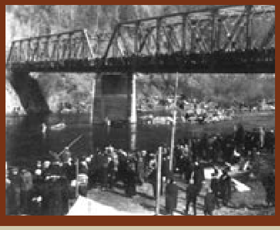
NORTH TROUTDALE

Storm Drainage Master Plan - Final

February 2007





Submitted to:
City of Troutdale
Public Works Department
342 SW 4th Street
Troutdale, Oregon 97060

otak

North Troutdale
Storm Drainage Master Plan

Final Plan

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OREGON
MAR 12, 2002
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4-4-07

EXPIRATION DATE: 06/30/2007

February 2007

June 2007 Errata

North Troutdale Storm Drainage Master Plan – Final February 2007

This errata was prepared to provide an update to the plan to reflect revised cost estimates and background on new developments that have affected plan implementation.

Since the production and adoption of the final master plan, the City has proceeded with implementation. In May of 2007, the City began exploring options for design and construction of CIP #1 – Salmon Creek Weir Improvement and CIP #2 – Arata Creek Culvert Improvements.

As part of this process, the City sought estimates for design and bid administration services for these two projects. During this time, additional research was conducted and new information that has affected the City's plans for implementation was obtained. First, the Sandy Drainage Improvement Company and the Port of Portland have plans for a wetland mitigation project that conflicts with the proposed weir improvement (CIP#1). Second, culvert sizing was incorrectly reflected in the XPSWMM model for the Arata Creek culvert improvement (CIP #2). When the model was corrected to reflect the actual culvert size, it revealed that the existing culvert passes the 25-year storm flows and does not need to be replaced. Consequently, CIP #1 is no longer feasible and CIP #2 is not necessary.

Due to the City's concerns about the rising costs of construction, the City asked Otak to review the plan cost estimates and clarify construction cost contingencies. The costs for all six CIPs were carefully reviewed and refined. The new costs are reflected in amended pages included in the Executive Summary, Section 7.0 and Appendix E. The new total estimated cost of the six CIPs is $2,249,000.

North Troutdale
Storm Drainage Master Plan

Final Plan

Submitted to:
City of Troutdale
Public Works Department
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February 2007

Preface and Acknowledgements

Development of the North Troutdale Drainage Basin Master Plan was a team effort between the City of Troutdale and consultant services. The individuals listed below contributed their time, expertise, and support to make the project a success.

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Geographically, Troutdale is bordered by the Sandy and Columbia Rivers to the east and north, Gresham to the south, and Gresham, Wood Village, and Fairview to the west. Portions of unincorporated Multnomah County are within Troutdale's urban growth boundary, including a strip of land between Troutdale and the Columbia River. The former aluminum plant site is located in this area and is ripe for redevelopment. Troutdale is close to build out and expects to reach that threshold within the next 15 years. Recent residential development accelerated in 2005 and is expected to continue.

As the Gateway to the Columbia River Gorge, Troutdale occupies a unique niche in the regional landscape, which sets it apart from its neighbors. Riverfront renewal, transportation and parks improvements are all on the horizon as Troutdale moves towards its centennial celebration in October 2007. Consistent with these very visible signs of progress, and to support this growth and economic development, the City is addressing needed stormwater and drainage improvements through this current North Troutdale storm drainage master planning process.

The original 1990 North Troutdale Storm Drainage Master Plan (NTSDMP) is over 16 years old. Changes in the regulatory environment and physical characteristics of the basin have rendered the existing master plan out of date. Much of the plan remains unimplemented because of these changes and questions about original assumptions and funding constraints. Anecdotal evidence indicates that existing drainage systems and pumping installations appear to be mitigating many of the City's potential flooding problems.

This new and revised North Troutdale Storm Drainage Master Plan includes an updated drainage basin characterization in Section 2.0. Hydrologic and hydraulic modeling of the City's stormwater system under existing and future conditions for a variety of design storms was performed and is documented in Sections 3.0, 4.0, and 5.0. Results were used to evaluate system capacity and identify trouble spots where capital facilities are needed to reduce flooding as discussed in Section 6.0. Capital facilities development includes project investigation, alternatives evaluation, prioritization, and cost estimation. Development projections provided guidance as to the priority and phasing of capital facility construction. Findings documented in Section 7.0 indicate that proposed capital improvements will be needed within the short term and within the next ten years dependent upon how rapidly the drainage basin develops. Of the six Capital Improvement Projects (CIPs) proposed, phasing of two are identified as being needed earlier than the remaining four and will provide improvement without the construction of concurrent downstream improvements. Phasing of the remaining four CIPs will depend on the timing of development of the area north of Halsey Street and, of those, three will require that multiple improvements occur simultaneously to be effective. Total estimated cost of the six CIPs is approximately $2,249,000.

In addition to the need for drainage master planning, Troutdale is also faced with meeting National Pollutant Discharge Elimination System (NPDES) Phase II requirements for its municipal separate storm sewer system. In response to these upcoming requirements, Troutdale prepared its February 2004 Stormwater Management Plan (SWMP) outlining the Best Management Practices (BMPs) the City proposes to use. As part of this master plan update, the City requested a qualitative evaluation of its SWMP. The evaluation included a comparison with its peers, an assessment of BMP effectiveness, and recommendations for program enhancements that are covered in Section 8.0.

As part of the master planning process, stakeholder and agency coordination was conducted with the Sandy Drainage Improvement Company, the Oregon Department of Environmental Quality, the Oregon Department of Transportation, neighboring jurisdictions, and City residents. An open house to present the draft plan was hosted by the City on November 30, 2006. The open house and public feedback received on the draft plan is documented in Section 9.0.

Section 1.0 – Purpose and Scope

The primary purpose of the 2006 North Troutdale Storm Drainage Master Plan process is two-fold. It includes production of a new contemporary master plan for the orderly provision of storm drainage and flood protection services within the North Troutdale drainage basin, and a qualitative evaluation of the City's February 2004 Stormwater Management Plan (SWMP).

The scope of the master plan update focuses primarily on flood analysis, infrastructure assessment and CIP development, with a qualitative water quality Best Management Practice (BMP) evaluation component. Scenarios include existing land use conditions and conditions corresponding to full build-out. Tasks include:

- Review of the existing master plan.
- Coordination with City staff and the Sandy Drainage Improvement Company throughout the plan update.
- Existing basin characterization focusing on existing data collection and review, system inventory with field verification, mapping, and GIS.
- Hydrologic and hydraulic modeling of the relationships of rainfall to runoff and effects on the conveyance system. Modeling was used to predict future conditions, to size stormwater management facilities, and to reduce flooding.
- CIP development based on findings from the above tasks and including project investigation, alternatives evaluation, prioritization, and cost estimation.
- Conceptual project design recommendations with cost estimates.
- Qualitative water quality BMP analysis involving the review of the City's BMPs as proposed in their draft SWMP, comparing these BMPs with other municipalities' BMP usage, and evaluating BMP effectiveness.

The plan can be considered a technical resource document to be used by City staff in their efforts to make prudent stormwater management decisions in the North Troutdale drainage basin. The plan helps answer such questions as:

- What are the existing facilities?
- What facilities will be needed in the future?
- When will they be needed?
- How much will they cost?
- What BMPs are being used by peer jurisdictions in the Willamette Valley Region?
- What BMPs are most appropriate for the City given its needs, opportunities, and resources?

Section 2.0 – Drainage Basin Background and Overview

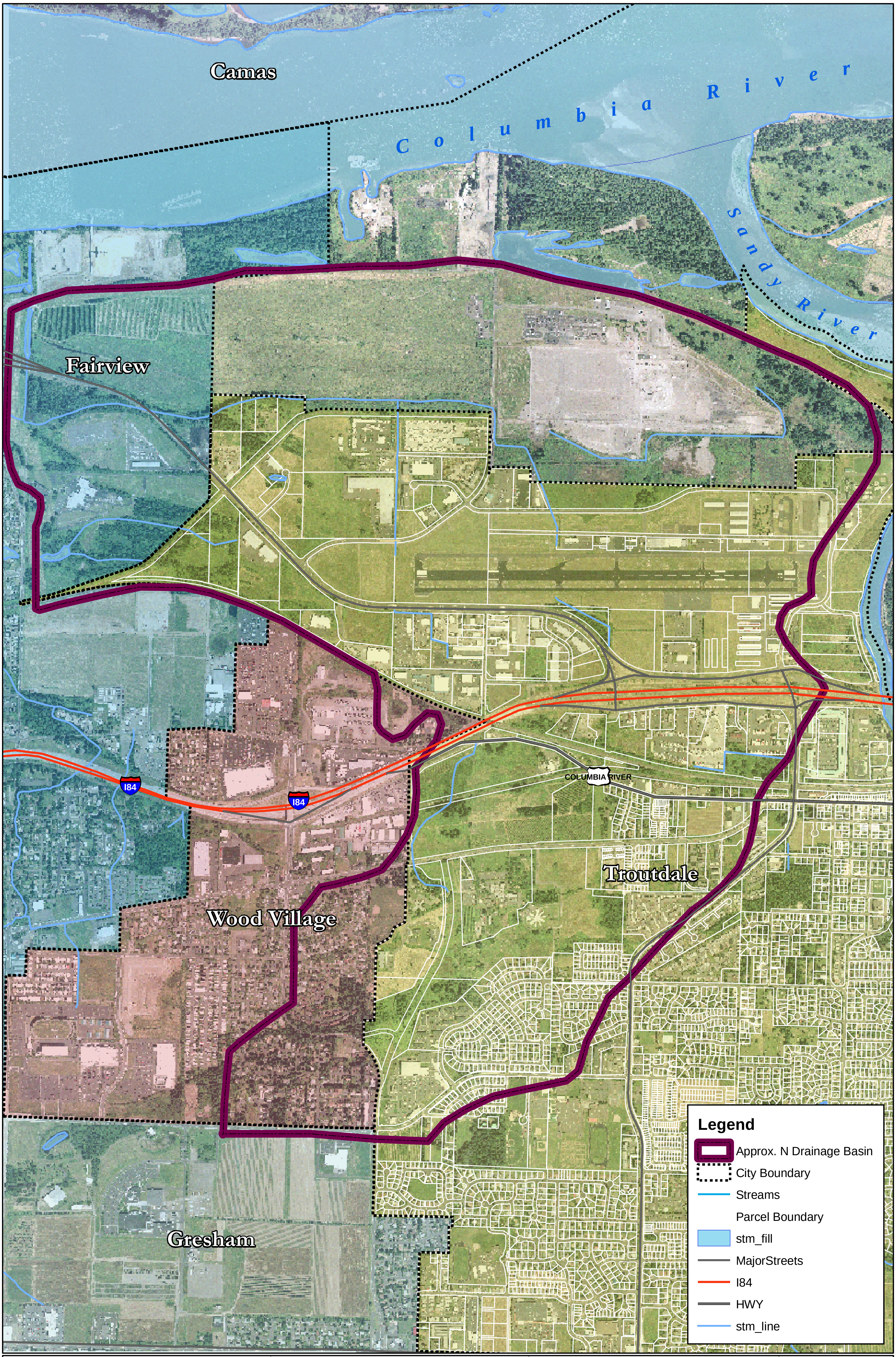
This section provides a brief overview of existing drainage facilities and describes characteristics of the 2,012 acre North Troutdale drainage basin, including location, climate, topography, soil conditions, and both existing and future land use conditions. Figure 2.1: Aerial Map, shows the limits of the drainage basin and study area. This information sets the basis for the modeling that will evaluate the performance of the existing drainage facilities and identify future drainage improvements.

2.1 Location

The North Troutdale drainage basin includes portions of the Cities of Troutdale, Wood Village and Fairview, and some areas of unincorporated Multnomah County lying along the Columbia River east of Blue Lake Road, west of the Sandy River, and north of the Troutdale Airport. The Sandy Drainage Improvement Company (SDIC) is situated within this drainage basin and is responsible for maintaining the floodplain water surface levels within the low-lying lands of the North Troutdale drainage basin. To accomplish this responsibility, the SDIC maintains the Columbia River levee and operates the storm runoff pumping station to which most runoff generated within this drainage basin is directed. Major developments and ownerships within this drainage basin include the Troutdale Airport, McMenamins, the Interstate 84 Troutdale Interchange, Travel Centers of America, and the former aluminum plant. The former aluminum plant site is served by its own pump station, which releases storm water indirectly to the Columbia River. Sale of the plant to the Port of Portland, and subsequent redevelopment, may result in future flows redirected to SDIC pumping facilities.

The drainage basin includes those parts of the City of Troutdale that lie to the north and west of Stella Way and 257th Avenue. In Wood Village, the drainage basin includes the area east of 236th Avenue from Glisan to Shannon Street, and east of 238th Avenue. Halsey Street marks the northern boundary of the drainage basin within the Wood Village city limits. Lands elsewhere in Troutdale discharge into the Sandy River. Areas draining to the Halsey and 257th Street storm lines discharge to the Sandy River.

Arata Creek drains parts of Wood Village and then flows generally northward into Salmon Creek. Salmon Creek flows east to west and conveys runoff to the pump station from upstream drainageways. The northwest corner of the drainage basin is within the City of Fairview. Figure 2.2: Jurisdictional Map, shows the jurisdictional limits within the drainage basin.



N. Troutdale Stormwater Management Plan

Multnomah County Oregon

Aerial Map

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Date
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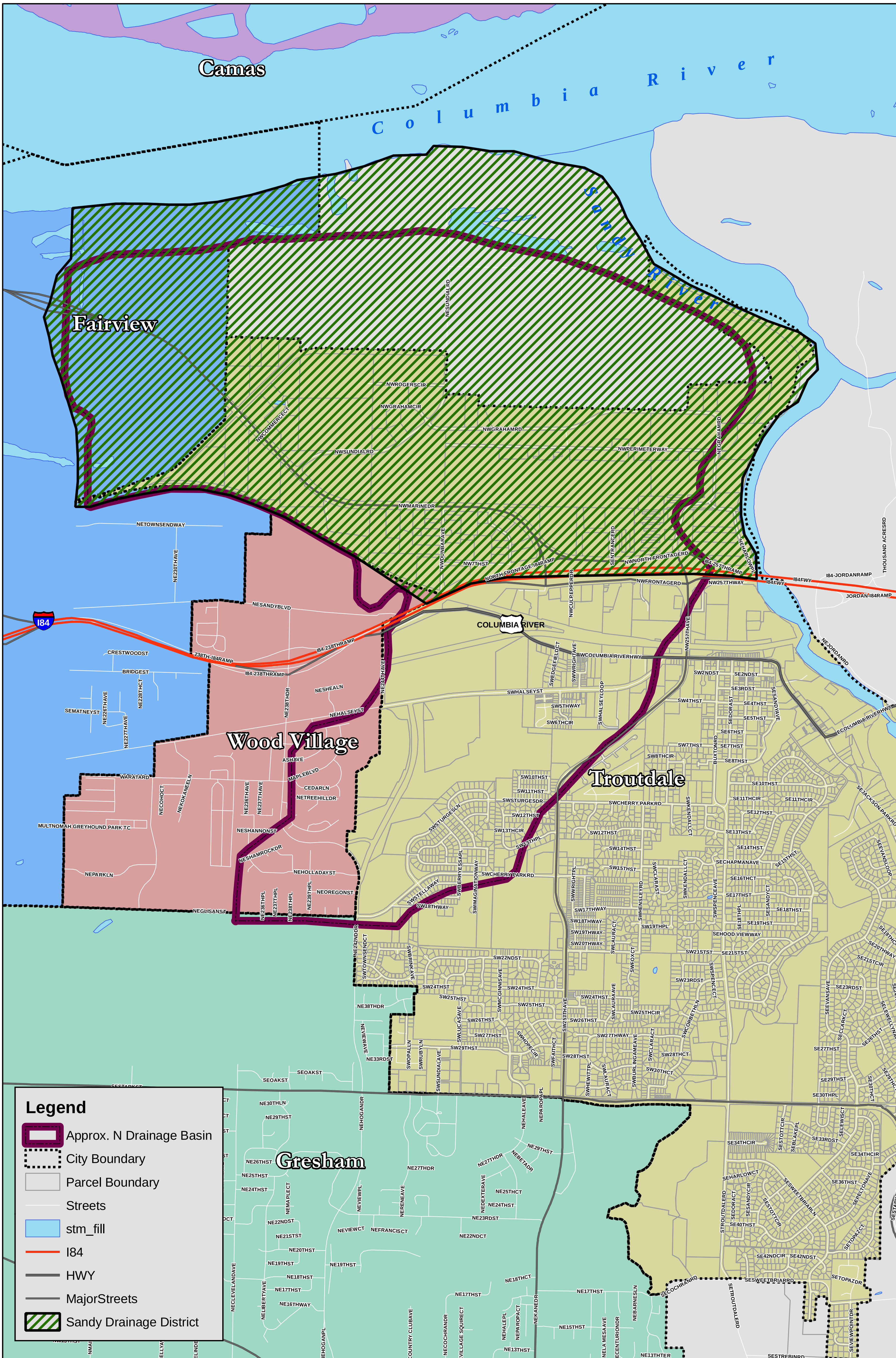
Figure 2.1



N. Troutdale Stormwater Management Plan

Multnomah County Oregon

Jurisdictional Map

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Date October 2006

Figure 2.2

The SDIC is bordered by the Sandy River to the east and Multnomah County Drainage District No. 1 to the west, at 223rd Avenue. The Union Pacific Railroad acts as the southern boundary to the District. SDIC is approximately 1,560 acres in size and its boundaries are shown on Figure 2.2. It contains the low-lying lands that are protected by a series of levees from flood waters of the Columbia and Sandy Rivers. The portion of the drainage basin lying south of the SDIC's boundaries is situated at much higher elevations and is unaffected by the floodplain levels of the lower lands. The drainage basin includes these higher elevation areas because they generate runoff that must be conveyed, stored, and pumped by downstream drainage facilities.

The SDIC pump station is located next to the Columbia River levee near the intersection of Blue Lake Road and Marine Drive. The levee protects the lands that would otherwise be flooded by the periodic flood stage waters of the Columbia River. The levee borders the drainage basin along its northern boundary. It extends from Blue Lake Road eastward along the Columbia River and then southward along the west bank of the Sandy River until it intersects higher ground at the Union Pacific Railroad embankment. The pump station discharges into a backwatered area that is approximately 3,400 feet in length which flows along the south side of the Multnomah County Boat Ramp facility and eventually drains to the Columbia River

Blue Lake also drains into the drainage basin through a control pipe which discharges through the cross levee. The cross levee connects the Marine Drive levee to the higher ground to the south and it parallels Blue Lake Road.

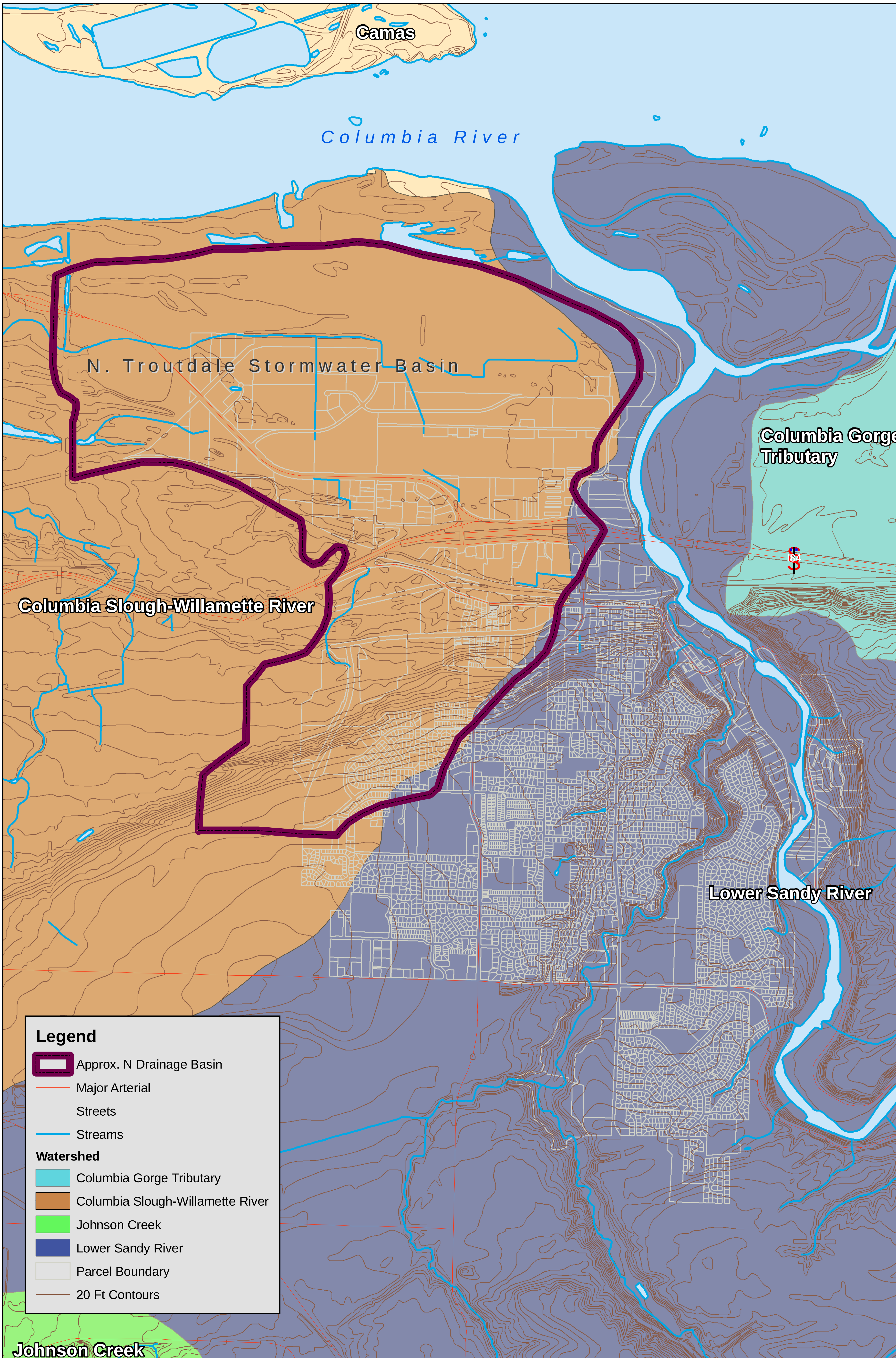
Figure 2.3: Topographical Map shows the boundaries of the North Troutdale drainage basin in relationship to the larger drainage basins of the Columbia River, of which it is a part.

2.2 Study Area

The study area for this master plan is the topographical limits of the North Troutdale drainage basin shown on Figure 2.3 with the following three exceptions:

A. The Blue Lake area, although it is directed into the drainage basin, is intended to be operationally detained during major storm events using existing structures and, therefore, will not be discussed further in this report.

B. The former aluminum plant site has been excluded in the existing conditions model because it is currently closed and has its own pump station. However, once purchased for redevelopment by the Port of Portland, flows may be redirected from the pump station to the SDIC facilities. The model contains a stub for future contributions from this area and the future conditions model will include flows from this area.



N. Troutdale Stormwater Management Plan

Multnomah County Oregon

Topographical Map

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Date October 2006

Figure 2.3

C. The storm drain in 257th Drive currently provides the southeast boundary of the drainage basin by preventing runoff from lands that would otherwise drain into the North Troutdale drainage basin. In the future, however, established drywells may be removed with runoff directed into the existing storm drainage system.

2.3 Climate

The climate of the North Troutdale drainage basin is similar to the other areas of the lower Willamette Valley. As a result of the moist maritime air masses moving inland from the Pacific Ocean, it is generally mild with long wet winters and short dry summers.

During the winter months, the temperature averages about 40 degrees F with an average daily minimum temperature of about 34 degrees. During the summer months, the average temperature is about 65 degrees with an average daily maximum temperature of around 76 degrees.

Average annual precipitation is approximately 40 inches.

2.4 Soils

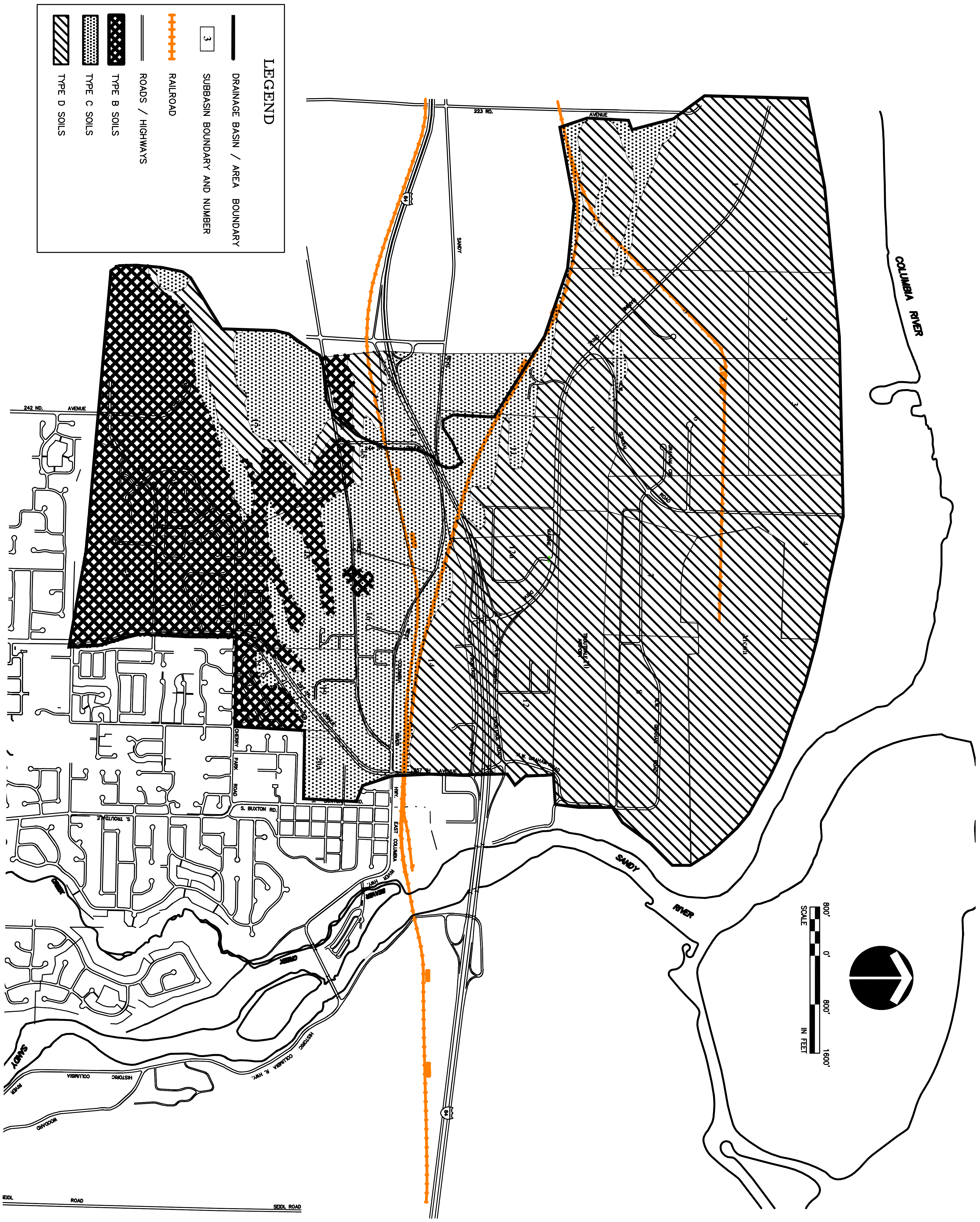
Knowledge of local soil conditions and their response to precipitation is essential for evaluating a drainage system. Many disposal paths are possible for precipitation. Precipitation may evaporate, collect in depressions, be intercepted and used by plants, or infiltrate into the soil. When precipitation exceeds the capacity of these paths, stormwater runoff results.

Impervious ground cover (pavement and rooftops, for example) increases runoff rates and total runoff volumes. Impervious areas are the predominant source of runoff and will generally dictate the scale of stormwater systems needed to convey, store and control stormwater runoff. The existing degree of soil saturation and the slope of the drainage basin also affect runoff rates. Runoff potential is based on the soil's capacity to absorb precipitation. Sandy soils have higher infiltration capacity and lower runoff potential, while impervious surfaces have limited infiltration capacity and very high runoff potential.

Soils within the North Troutdale drainage basin are listed in Table 2.1: Hydrological Classification of Soils. This information was compiled from the U.S. Soil Conservation Service's (now known as the Natural Resources Conservation Service) Soil Survey of Multnomah County, Oregon (1976). The soils found in the North Troutdale Drainage Basin are generally silt loams with low to moderate permeability. Each of the soil types are classified by runoff potential. Based on runoff potential, the soils are grouped into hydrologic soils groups (HSG) A, B, C, or D.

Soils in hydrological group A have good infiltration and low runoff potentials, while those in group D have poor infiltration and high runoff potentials. The location of these hydrologic soil groups within the study area are shown in Figure 2.4: Hydrologic Soil Group Map.

VAN: KELLYW 02/15/2007 10:17am --> R:\DWG\FIG 2.4.DWG



STORM DRAINAGE MASTER PLAN

FIGURE 2.4
HYDROLOGIC SOIL GROUPS

otak Incorporated

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FIG. 2.4 Drawing No.

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Design	Drawn	Checked	Date	Initial Issue Date:
	KW			DECEMBER 7, 2006

Within the study area, approximately 73 percent is Group D (high runoff potential) and located near the low-lying lands surrounding the pump station approximately 15 percent is Group C (moderate runoff potential) and 12 percent is considered to be Group B (moderately low runoff potential), with these lands concentrated at the most southerly reaches of the drainage basin.

Table 2.1: Hydrological Classification of Soils		
Soil Classification	Hydrological Group	Runoff Potential
Aloha Silt Loam 0 to 3% Slopes	C	Moderate
Faloma Silt Loam Protected	C	Moderate
Latourell Loam 0 to 30%	B	Low
Multnomah Silt Loam 3 to 15%	B	Low
Quafeno Loam 0 to 30%	C	Moderate
Quatama Loam 0 to 15%	C	Moderate
Quatama Urban Complex 0 to 3% Slopes	C	Moderate
Rafton Silt Loam Protected	D	High
Sauvie Silty Clay Loam Protected	C	Moderate

2.5 Topographical Features

There are two basic topographical features of the drainage basin: the higher situated, sloping lands lying generally to the south of the Union Pacific Railroad embankment, and the low-lying, generally flatter lands to the north. Much of the lower lands lie within the SDIC.

The higher lands are somewhat rolling with slopes generally in the 4 to 10 percent range, with some areas sloping up to 30 percent. This upper drainage basin area is drained by two primary drainageways. Arata Creek originates in Wood Village, flows through the City of Troutdale, continues northward across the Interstate, and is routed down through the Diebold Lumber property. It is a well-defined, established creek system that is mostly open channel except where it crosses streets and passes through Diebold Lumber property.

The other drainageway in the upper drainage basin has no clearly defined creek system and consists of ditches and culverts that flow generally northward in direction. This drainageway passes through the I-84 embankment and then flows through the Troutdale Airport.

Both of these upstream drainageways are collected by Salmon Creek, which flows from Sundial Road westward along the north side of the former aluminum plant site railroad spur. Salmon Creek crosses Marine Drive twice at the west end of the SDIC and terminates upstream of a manmade forebay that directs flows to the inlet bays prior to the pump station which delivers flows toward the Columbia River.

The low-lying lands north of the Union Pacific Railroad are quite flat with slopes generally varying between 1 percent and 4 percent. However, some steeper areas exist and are usually associated with rock out-croppings towards the northwest end of the study area. The drainageways within these lower lands are primarily manmade ditches dug to drain marshy areas for agriculture or to define and straighten indistinct surface drainage patterns.

Columbia River Highway, Interstate 84 and the Union Pacific Railroad tracks are built on fills. These east/west fills are barriers to runoff flowing northward unless adequate conveyance structures through those fills are provided, maintained and upgraded as necessary.

The 100-year floodplain within the study area has not been officially established as part of the Federal Emergency Management Agency Flood Insurance Study (FIS) program. In the past, the SDIC has considered 14 feet (USGS Datum) to be the floodplain based on their 1985 study entitled "Report on Drainage Hydrology and Pump Station Adequacy", by Cunningham and Associates. The SDIC has indicated that the base flood elevation is currently under study and review and will likely vary from earlier figures.

2.5 Existing Drainage Facilities

Storm water runoff within the North Troutdale drainage basin is generally transported by open channel systems except when culverted for road crossings. The primary exceptions are the mostly piped storm drainage facilities in the uppermost Arata Creek drainage basin within Wood Village and the partially piped systems serving the Troutdale Airport. Otherwise drainageways are free flowing in a combination of natural and man-made channels.

Much of the City's drainage south of I-84 is collected in catch basins and conveyed through drain lines to these open channels. An exception to this is the neighborhood north of Sturges Road and west of 257th Avenue. Under existing conditions these subbasins drain to dry wells, or otherwise infiltrate and are not collected by storm system structures or open channels. A channel, conveyance, and culvert inventory is included in Appendix C.

The lands situated below the floodplain provide flood storage during peak storm events. Large portions of the lands lying north of Salmon Creek and in the Fairview area of the drainage basin, have historically been used for flood storage.

There are no known combined sewers in the study area.

2.6 Land Use

Knowledge of local land use practices is essential for developing a successful drainage master plan. As a drainage basin urbanizes, impervious areas within the drainage basin typically increase. Increased impervious area dramatically increases the amount and rate of runoff within the drainage basin. Consequently, increased impervious area results in a shorter time between when the peak in precipitation occurs and when that peak reaches the discharge point.

To minimize the risk of flooding and protect property, a drainage system is typically designed to accommodate both existing flows and anticipated future flows for a selected design storm event that is commensurate with the potential for loss. Troutdale has selected several design storms for flood analysis as described in Section 3.0.

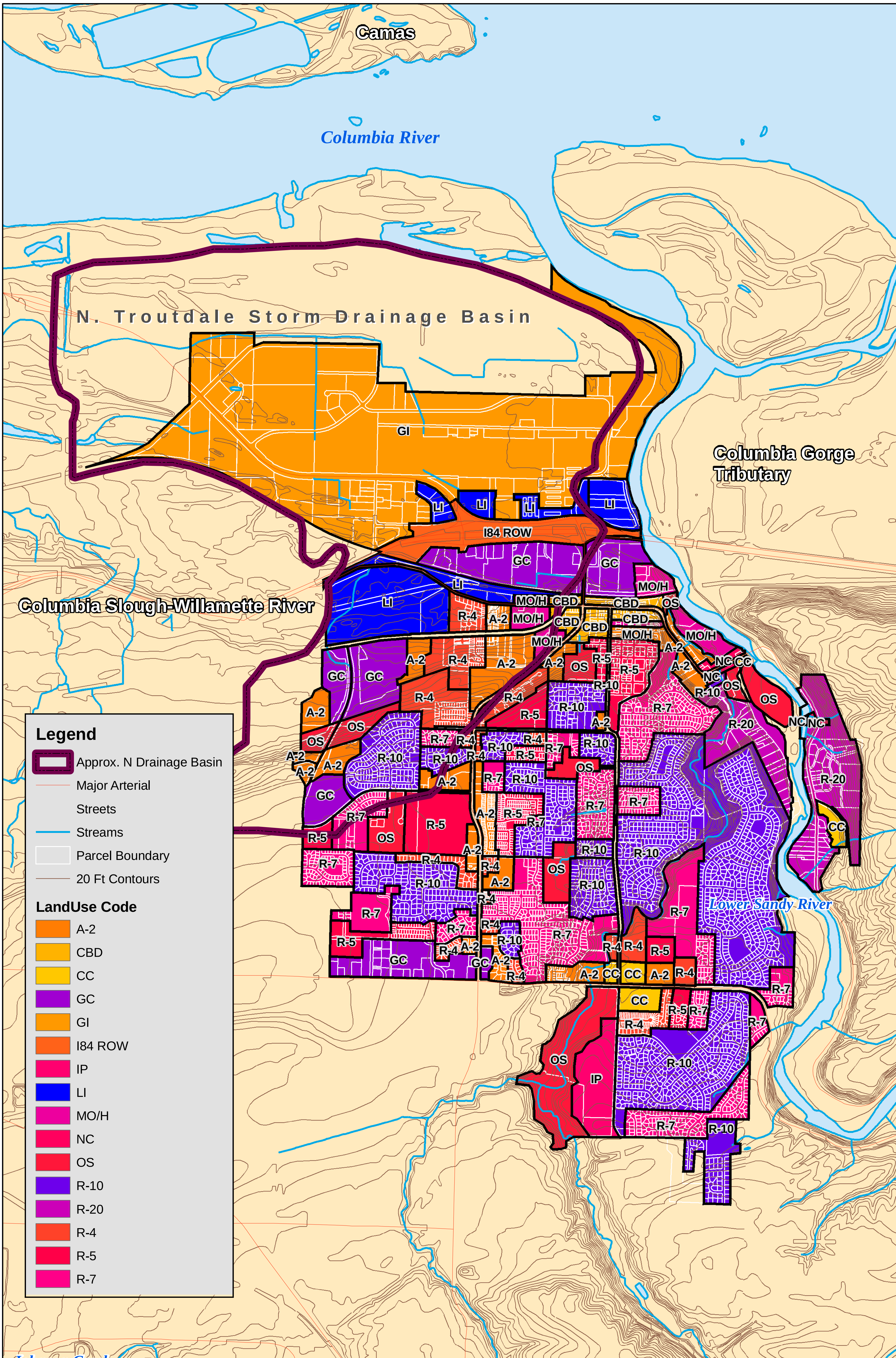
The present extent of land development in the drainage basin was based on City of Troutdale's 2005 aerial photography and known development that has taken place since the previous Drainage Master Plan. The land use designations were compiled from Comprehensive Plan information from the Cities of Troutdale, Wood Village, and Fairview and from Multnomah County. The results of this compilation of existing development information are shown on Figure 2.5: Land Use Designation and Existing Development Map.

Land use acreage estimates were made based on the current City and County Comprehensive Plans, information from the City of Troutdale's Planning Department, recent aerial photographs (2005), and on ground reconnaissance. Future land use conditions are shown on Figure 2.6: Future Land Use Map.

Approximately 81 percent of the drainage basin is currently within the incorporated limits of the Cities of Troutdale, Wood Village, and Fairview. The remaining area is unincorporated Multnomah County, lying north of Salmon Creek, and currently owned by Alcoa. The following paragraphs describe the current zoning and future zoning identified for ultimate development (full development within the urban growth boundary) for residential, commercial, and industrial land uses within the study area.

<u>Open Space</u>

Approximately 20 acres are designated for open space because of slope within the drainage basin. These are located east of NE 242nd Avenue and Cedar Lane, and at Columbia Park. Much of the former aluminum plant lands have been designated open space planning areas, as have parts of Fairview. Also, some "clear zone" requirements related to approach restrictions at the Troutdale Airport runway exist.



N. Troutdale Storm Drainage Master Plan

Multnomah County Oregon

Land Use Designation and Existing Development Map

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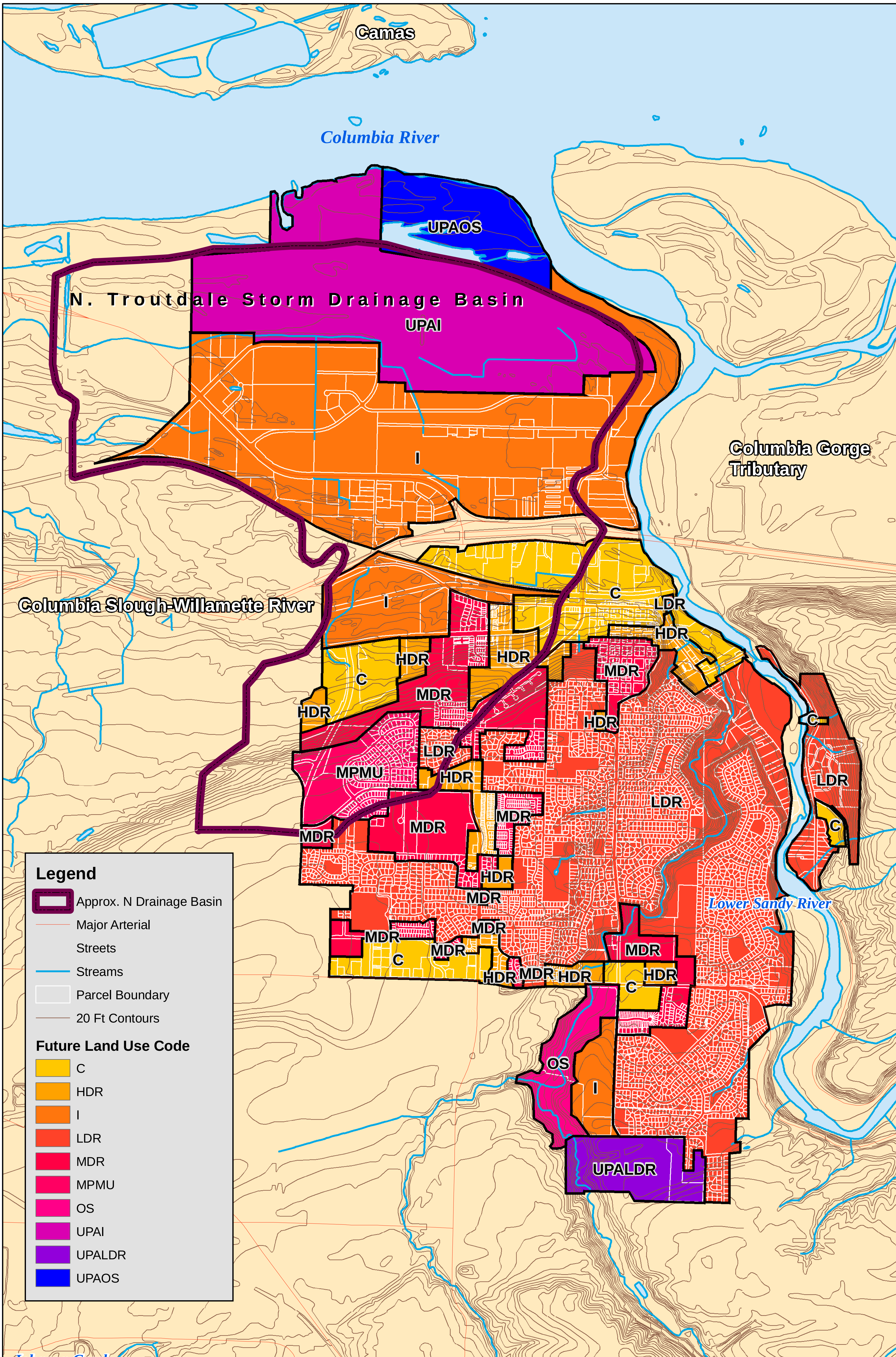
Figure 2.5



N. Troutdale Storm Drainage Master Plan

Multnomah County Oregon

Future Land Use Map

N W E S

0 0.25 0.5 Miles

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Date December 2006

Figure 2.6

Industrial

With the exception of part of the former aluminum plant site, all of the land lying north of both I-84 and the main Union Pacific Railroad line is zoned for industrial use. Part of the former aluminum plant site is zoned for open space. The unincorporated lands lying north of Salmon Creek and east of the Fairview city limits are designated as general industrial urban planning and lie within Troutdale's Urban Growth Boundary (UGB). Approximately 92 percent of the unincorporated areas is, or will be, zoned for industrial uses, although only 41 percent of those lands are currently developed. The industrial land area within the UGB is estimated at 1260 acres.

With the pending purchase of the former aluminum plant site by the Port of Portland, future development of industrial lands within the drainage basin may occur, particularly in the vicinity of Sundial Road and Marine Drive. The subsequent rate of impervious surface creation is expected to remain high over the next several years.

Commercial

Existing, zoned, and ultimate commercial development is concentrated in four areas: (1) Wood Village along Halsey Street, (2) Troutdale in the vicinity of Columbia River Highway and Halsey Streets, (3) the lands in the vicinity of the Travel Centers of America facility between the Union Pacific Railroad and I-84, (4) areas bordering NE Glisan Street. Of the 250 acres zoned for commercial development within the drainage basin, almost 71 percent is already developed.

Residential

There are approximately 233 acres within the drainage basin designated for low and high density residential development. This represents only 12 percent of the total drainage basin. Approximately 50 percent of these 233 acres are currently developed. These residential lands lie south of the Union Pacific Railroad tracks in the upper drainage basin. The residential lands within Wood Village are fully developed. It is estimated that there will be no increase in impervious surfaces within Wood Village over the study period of this plan. The residential lands within Troutdale are both high and low density.

Section 3.0 – Methodology

3.1 Basic Assumptions

The North Troutdale stormwater drainage basin consists of approximately 2,012 acres of mixed used land. The majority of land in this basin is industrial, with some open spaces. Flows in the basin tend to travel from the south toward the north via streams that consist of both open channel and culverted reaches. The upstream ends of the basins have steep slopes that transition to relatively flat downstream basins. Most basin flows are conveyed by the ditches and channels to a pump station located in the northwest corner of the North Troutdale drainage basin. That pump station lifts base flows in addition to flood waters and releases them to the Columbia River.

Some basin flows are collected by a piped storm system that serves Halsey and the north side of Halsey as well as 257th. Currently, Halsey and the area north of Halsey are not utilizing this system.

The North Troutdale Basin includes three major subbasins - the Arata Creek Basin draining to the north, the "B" Basin draining to the north and west and the Salmon Creek Basin draining to the west. The Arata Creek Basin and the "B" Basin are completely transected from east to west by the Union Pacific railroad, Interstate 84, and the Columbia River Highway. The three embankments formed by these roadways act to limit conveyance of flows from the south to the north through existing culverts. This results in reduced conveyance capacity for flows from the south to the north.

Both existing and future conditions for the North Troutdale Basin were modeled using the Version 10 XPSWMM hydrology/hydraulics program. Future conditions are defined as full build out of the basin expected by 2020 within the City's urban growth boundary based on Metro zoning maps. Maps of existing and future land use are included in Section 2, Figures 2.5 and 2.6. The models were used to calculate basin hydrology and to study the stormwater systems and operations under existing and future conditions. Both models consist of a runoff layer, which performs hydrologic calculations, and a hydraulic layer that performs open channel, culvert, pipe network, and other hydraulic structure calculations.

General model calibration was based on field observations and City Staff interviews. Staff identified two areas of observed flooding; including the railroad underpass of the Columbia River Highway, and the Sanitary pump station located along Marine drive south of the airport. City Staff described observed water surfaces at these locations during large storm events. These water surfaces as approximated by staff were taken into account to ensure reasonable model results for these locations.

The North Troutdale basin modeling effort was supported in part by a prior model developed by the SDIC, as further discussed in Section 3.3

3.2 Hydrologic Analysis

3.2.1 Soils and Land Use

Hydrologic Soil Groups (HSG) were determined from the 1976 Soil Conservation Service (SCS) Soils Report for Multnomah County, Oregon as described in Section 2 and summarized in Table 2.2. Curve numbers were selected from the Natural Resource Conservation Service (NRCS, formerly SCS) table of Runoff Coefficients for each subbasin based on HSG and existing and future land use. Existing land use was determined from site visits, aerial photography, and City-provided GIS data. Future land use was based on the City being at full build out as determined from Metro Zoning maps and descriptions.

3.2.2 Precipitation

Precipitation depths were obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas. Table 3.1: NOAA 24-Hour Precipitation Depths, lists the precipitation depths used in the model.

Table 3.1: NOAA 24-Hour Precipitation Depths	
Return Period (yrs)	Depth (inches)
2	2.7
5	3.3
10	3.8
25	4.1
100	4.9

3.2.3 Santa Barbara Urban Hydrograph Method

The North Troutdale Basin was divided into 27 subbasins for hydrologic analysis as shown in Figure 3.1: Drainage Areas and Subbasins. Peak flows for both the existing and proposed networks were calculated for the 2, 5, 10, 25, and 100-year, 24-hour storm events using the Santa Barbara Urban Hydrograph Method (SBUH) with a SCS Type 1A rainfall distribution.

The impervious and pervious areas of each subbasin were determined using aerial photography and City GIS data. Times of concentration calculations were performed in accordance with Technical Release 55 (TR-55). Peak flows were calculated in the runoff layer of the XPSWMM model for both impervious and pervious areas and were combined to determine the composite peak flow for each storm event. Appendix D contains model hydrology input data.

3.3 Hydraulic Analysis

The hydraulic layer consists of two separate networks. The first network consists of both Salmon and Arata Creeks as they flow to the pump station delivering flows to the Columbia River. The pump station was modeled with two pumps, one with a 15,000 gpm capacity and the other with a 20,000 gpm capacity. This network includes all the open channel reaches and culverts along Salmon and Arata creeks as well as some open channels that flow to these creeks. Two storage areas were modeled in the Salmon Creek area to account for the large amount of storage provided in this low relatively flat area. Table 4.2 lists the modeled storage volumes for these areas. Flows from the Troutdale Airport and from the former aluminum plant site property are also modeled in this network. The acceptance of drainage from the former aluminum plant property to the SDIC pumps for future conditions is a change from the 1990 master plan. The former aluminum plant property has historically been served by a private pump, and therefore, drainage from this property is not addressed in the existing conditions model.

To model existing conditions, a copy of an XPSWMM model completed by the SDIC was obtained and utilized with permission to model the first network. Existing open channel geometry, culvert geometry, and downstream boundary condition data were updated with City GIS data and used in the Salmon and Arata Creek networks.

The second network consists of the storm drain lines, catch basins and manholes in Halsey and 257^{th} Streets, from their upstream reaches to their junction at the Columbia River Highway. This network also contains the storm lines extending from this junction to Buxton Street and ultimately running north and east to the Sandy River.

For the second network, pipe network geometry and downstream boundary condition data were obtained from City as-built drawings and GIS data. Pipes and manholes were identified using the City's numbering conventions. The downstream boundary condition was modeled as a free outfall into the Sandy River, assuming normal depth in the pipe at the outfall.

Flows in the North Troutdale drainage basin appear to be independent of those in the South Troutdale drainage basin. As-builts from Multnomah County for the Historical Columbia Highway Station 491+ 75 to 512+66 project (11/12/93) seem to show a basin cross-connection at the junction of the Highway and Buxton Street but a field check by City crews shows that no connection exists.

This report includes two capital improvements constructed prior to this report but not included in the SDIC's model. These improvements were incorporated into hydraulics layers for both the existing and future conditions models. In fall 2006, a second culvert was installed across Marine Drive west of Dunbar Avenue. Also, a storm drain line has been installed along Halsey Street and extends to the Sandy River.

3.4 Analysis Approach

Both the existing and future condition models were set up as follows:

- Existing Condition: The City's existing storm system was used for both hydraulic networks, with hydrology based on the City's existing land use.
- Future Condition: Hydrology was based on the expected runoff for full build out conditions assuming Metro Zoning for land use and Developable Lands Maps.
- Future Condition with Capital Improvement Projects: Capital improvement projects were proposed and incorporated into both hydraulic networks.

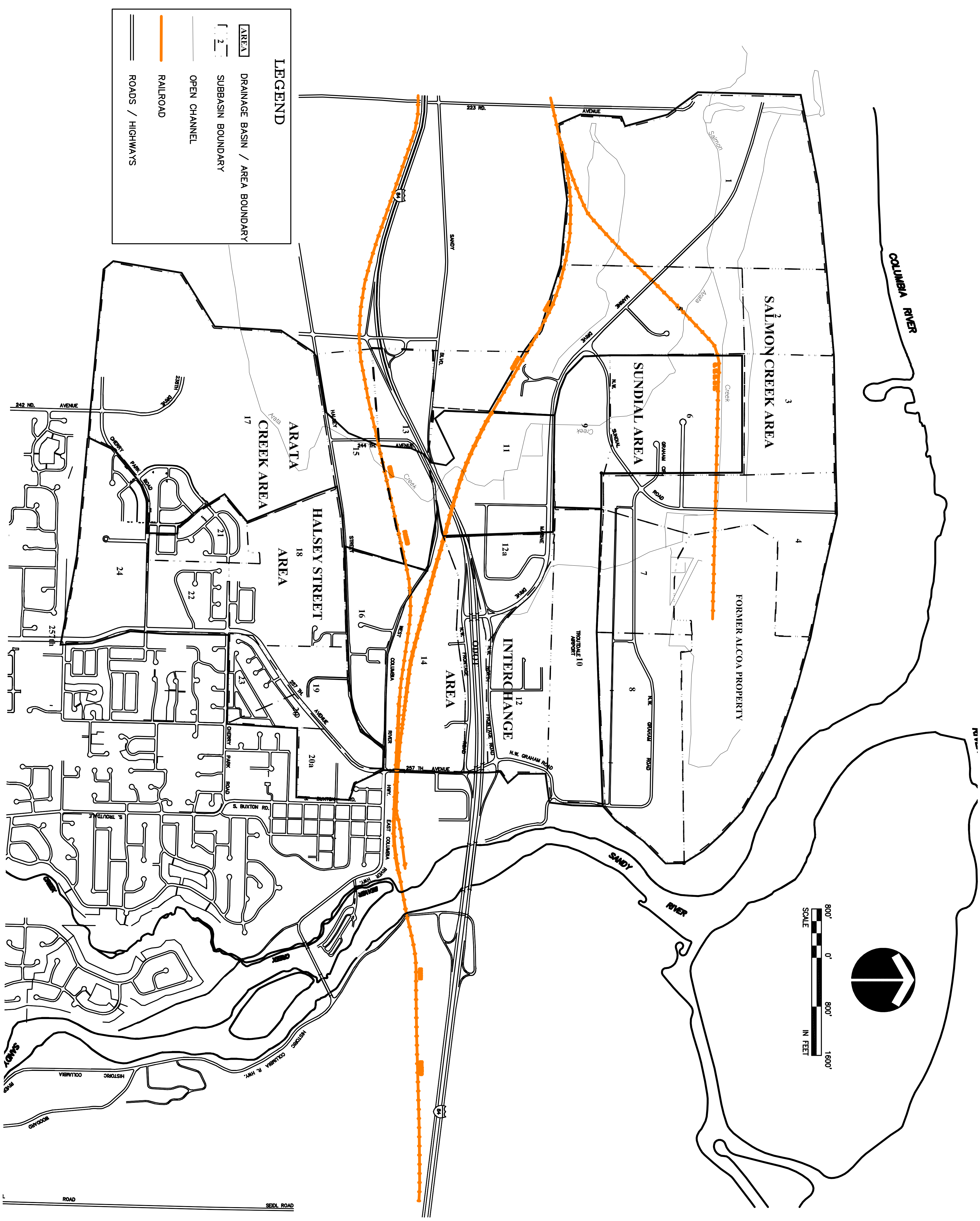
Models have been executed for the 2, 5, 10, 25, and 100-yr, 24-hour design storms. The North Troutdale Drainage Basin was divided into five areas to organize the results:

- Salmon Creek,
- Sundial Area,
- Arata Creek,
- Interchange Area, and
- Halsey Street Area.

Figure 3.1: Drainage Areas and Subbasins shows the five areas and the 27 subbasins that drain to them.

CIP evaluations and recommendations are discussed for each of the five areas in Sections 6.0 and 7.0.

VAN: KELLYW 02/15/2007 12:02am --> R:\DWG\FIG 3.1.DWG



STORM DRAINAGE MASTER PLAN

FIGURE 3.1
DRAINAGE AREAS AND SUBBASIN MAP

NO.	DATE	BY	REVISION COMMENTS

Design	Drawn	Checked	Date	Initial Issue Date:
	KW			NOVEMBER 29, 2006

otak Incorporated
17355 SW Boones Ferry Rd.
Lake Oswego, OR 97035-5217
Phone: (503) 635-3618
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Project No. 13840
Drawing No.
Exhibit No. FIG. 3.1

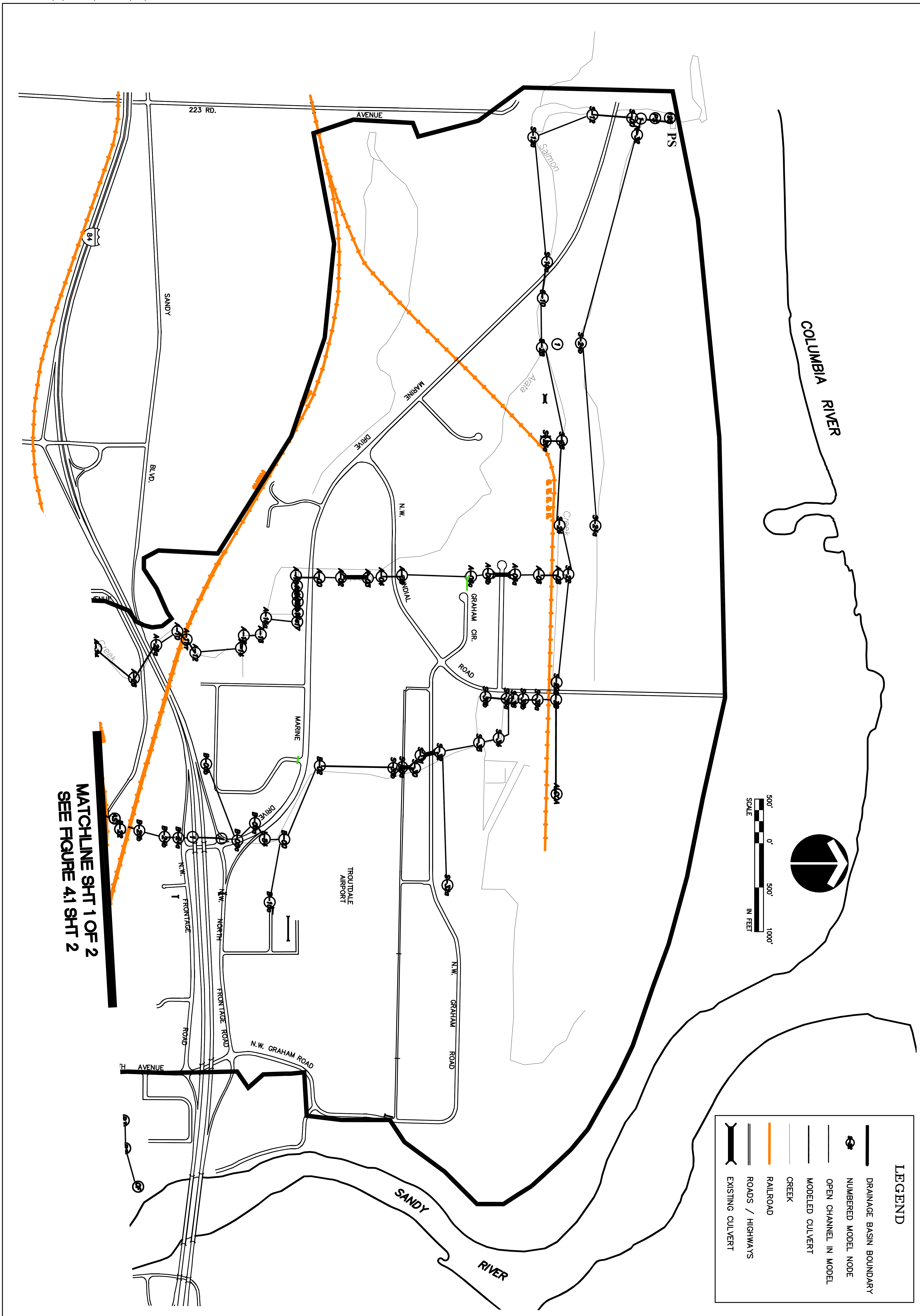
4.1 Introduction

Modeled hydrologic and hydraulic parameters of each of the five drainage areas were verified through site visits and meetings with City Staff. Consistent with Figure 3.1, Table 4.1: Drainage Areas, Subbasins and Input Nodes, lists the five areas and the hydrologic subbasins and corresponding input nodes that have been modeled to contribute flows within each area. Figure 4.1: Model Links and Node Map show the modeling layout. It provides a plan view of nodes including pumps, inlets, and manholes and links that represent the ditches and storm drain lines.

Table 4.1 Drainage Areas, Subbasins and Input Nodes

Areas	Subbasins		Input Nodes
	Existing	Future	
Salmon Creek	1	1	S10
	2	2	S24b
	3	3	S24a
	4	4	S38
	5	5	S26a
	5	5	S28
	7	7	S33
	8	8	S32a
	-	Alcoa	Alcoa
Sundial Area	6	6	A06
	9	9	A03
Arata Creek	11	11	A16A
	13	13	A26
	15	15	A30
	-	17	A60
	17	17	A70
Interchange Area	10	10	S30b
	12	12	B00
	12	12	B10c
	12a	12a	B00b
	14	14	B24b
	16	16	MHA71
Halsey Street Area	19	18	MHB218
	24	24	MHB47
	-	18	MHB258
	-	19	MHB16
	-	18	MHB221
	-	17	MHB224
	20	19	MHB18
	20a	20	MHB14
	23	20a	MHB8
	-	21	MHB43
	-	22	MHB43
	-	23	MHB23

VAN: KELLYW 02/15/2007 1:31pm --> R:\DWG\FIG 4.1.DWG



STORM DRAINAGE MASTER PLAN

FIGURE 4.1 SHEET 1
MODEL LINKS / NODE MAP

otak Incorporated
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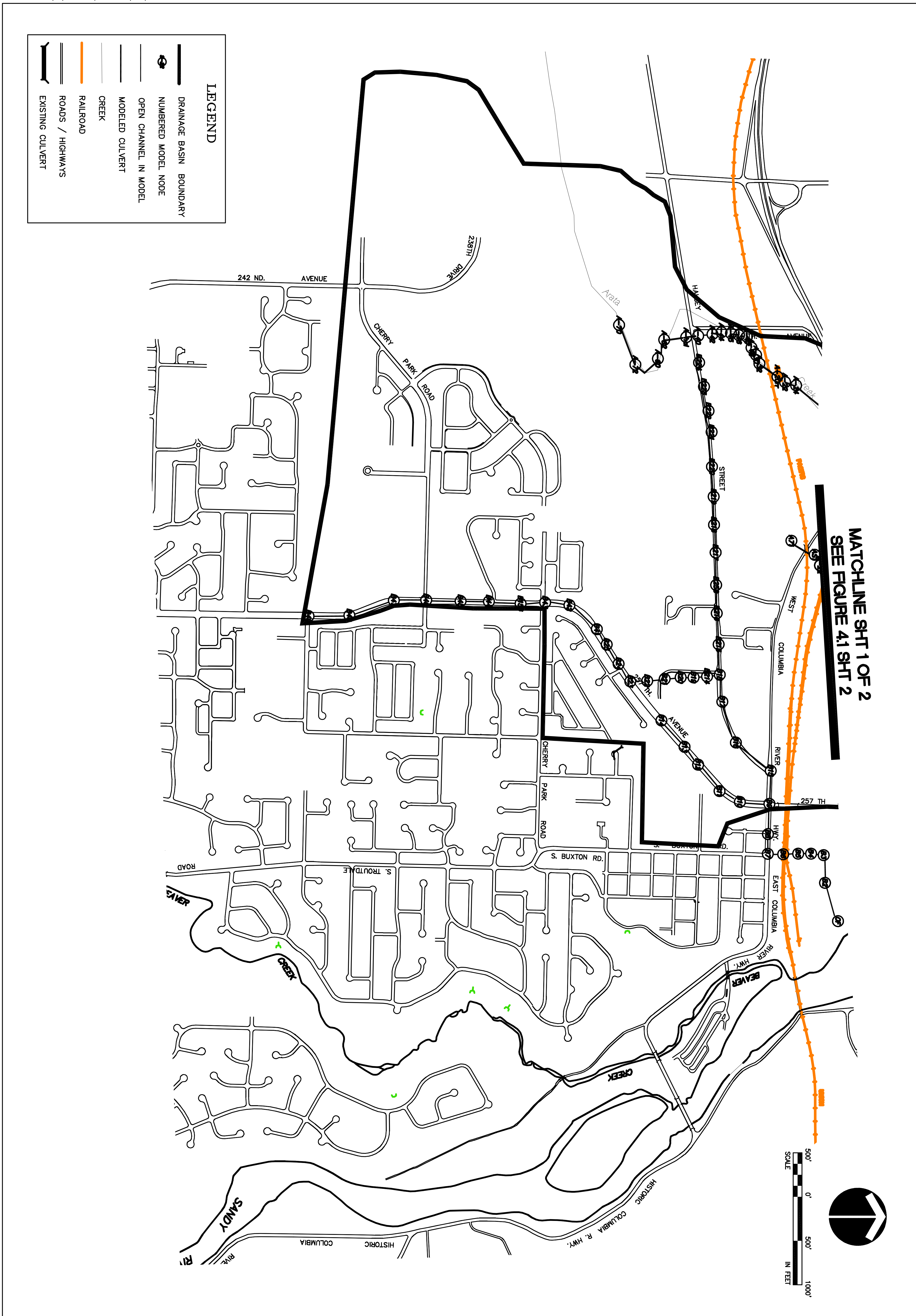
Project No. 13840
Drawing No.
Exhibit No. FIG. 4.1

NO.	DATE	BY	REVISION COMMENTS

Design	Drawn	Checked	Date	Initial Issue Date:
	KW			NOVEMBER 29, 2006

VAN: KELLYW 02/15/2007 1:35pm --> R:\DWG\FIG 4.1.DWG



STORM DRAINAGE MASTER PLAN

FIGURE 4.1 SHEET 2
MODEL LINKS / NODE MAP

NO.	DATE	BY	REVISION COMMENTS

Design	Drawn	Checked	Date	Initial Issue Date:
	KW			NOVEMBER 29, 2006

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Project No. 13840
Drawing No. FIG. 4.1
Exhibit No.

Significant existing and future hydrologic and hydraulic parameters were modeled using different features available in XPSWMM. Some of these modeled parameters were obtained from the SDIC model, and others were obtained from City data and field visits. Appendix C includes a channel, culvert, and conveyance inventory that identifies parameters used in the modeling.

4.2 Existing Conditions Modeling Parameters

4.2.1 Salmon Creek

The Salmon Creek area is part the Columbia River floodplain and is relatively flat. This area consists of mostly HSG group D soils with open and industrial land use. Flows from hydrologic subbasins 1 through 5 and 7 through 8 were modeled in this area.

The Salmon Creek area primarily consists of open channels and culverts with a large storage capacity. Open channels were modeled as having trapezoidal cross sections with geometry and roughness coefficients as determined from site visits. The storage capacity was modeled in the Salmon Creek area at Nodes S-12a and S-24b.

The storage volume modeled at node S-24b was estimated from City GIS contour areas between the elevations of 5 and 15 feet around the node. The storage volume at node S-12a was obtained from the SDIC model and was modeled to estimate the pond volumes upstream of the pump station. These ponds volumes were modeled by providing approximately 1 acre-foot of storage per foot of depth at the node. Table 4.2 lists total storage volumes modeled at each node.

Table 4.2: Node Storage Volumes

Node ID	Volume (acre-ft)
S-24b	389.0
S-12a	15.5

As discussed in Section 3.0, the Salmon Creek area contains the former aluminum plant property. Runoff from the former aluminum plant property was assumed to not enter the City system under existing conditions, and therefore was not modeled in the existing conditions model.

During periods of high runoff, flows are modeled to cross over a weir from the southern branch of Salmon Creek into the northern branch in this basin. This overflow was modeled as a weir and open channel connecting the two stream branches with a cross-section resembling the flow path between the two stream branches. There is a control gate located at the west end of the open channel that discharges upstream of the pump station forebay. The control gate consists of two culverts elevated above the low flow water surface elevation at the pump station. Due to limited pump capacity, water rises when the pump station is unable to pump enough water to keep up with inflows, and water begins to flow through the culverts to the storage areas listed above. As the water surface at the pump station begins to drop again, flows reverse and drain from the storage area to the pump station.

4.2.2 Sundial Area

The Sundial area receives flows from the Troutdale Airport, and consists of open channels and their connecting culverts. Many of the culverts are large with multiple barrels. Soils in this area consist mostly of HSG group D, and the majority of the land use is open space and industrial, with a small private residential area. Flows from Hydrologic subbasins 6 and 9 were modeled in this area.

4.2.3 Arata Creek

The Arata Creek area is modeled using open channels and culverts; there are no significant structures or characteristics in this area that required specific modeling. This subbasin consists of mostly HSG group C and group D soils with industrial land use. Flows from hydrologic subbasins 11, 13, 15, and 17 were modeled in this area.

4.2.4 Interchange Area

The Interchange Area includes the I-84 interchange in Troutdale. Runoff from I-84 and it's associated structures is collected and managed privately by the Oregon Department of Transportation (ODOT). Runoff managed by ODOT was assumed to not enter the Troutdale storm system and was not included in the models. This area consists of mostly HSG group D soils with industrial land use. Flows from hydrologic subbasins 10, 12, 12a, 14, and 16 were modeled in this area.

4.2.5 Halsey Street Area

This area contains the Halsey Street and 257th Avenue storm lines that drain to the Sandy River outfall. This area has some steeper slopes that meet Halsey Street. The basin contains open space, residential areas, and the former Multnomah County Farm area. The 257th Avenue line conveys some flows from the residential areas located east of 257th Avenue.

The Halsey Street line was constructed to intercept flows from future improvements to Halsey, and future development along the south side of Halsey. Soils in this subbasin consist mostly of HSG B, and runoff from hydrologic subbasins 19, 20, 20a, 23, and 24 were modeled in this area. Under existing conditions, flows from drainage areas south of Halsey Street appear to pool along the south side of the street. Some of the water passes through a culvert under Halsey and flows into an agricultural field where the water is assumed to infiltrate, evaporate, and be consumed by plant uptake. Remaining flows are assumed to infiltrate or evaporate along the south side of Halsey. For the existing case, no flows are modeled in upper reaches of the Halsey Street line.

Hydrologic subbasins 18, 21, and 22 are located in this area also, but under existing conditions these subbasins drain to dry wells, or otherwise infiltrate and are not collected by storm system structures or open channels. These hydrologic subbasins were not modeled in the existing conditions model.

4.3 Future Conditions Modeling Parameters

The existing conditions model was saved and the hydrology and hydraulic conditions were adjusted to model future conditions. The first adjustment included removing the existing conditions hydrology and replacing it with future conditions hydrology based on zoning at full build out expected by 2020 and developable lands maps provided by the City. Other adjustments are described in the following sections.

4.3.1 Salmon Creek

Under future conditions this basin was modeled to include flows from the former aluminum plant property. This property will likely be developed in the future and tied into the City's storm system.

Zoning for the Salmon Creek area is primarily open space and industrial. Industrial areas are characterized with large amounts of impervious areas and piped conveyance systems. Future conditions hydrology for this area utilizes larger runoff curve numbers and shorter times of concentration in the industrial zoned areas. Areas zoned for open space were modeled as they were in the existing conditions model. Other than adding a pipe and its geometry to model flows from the former aluminum plant property, no adjustments were needed to existing structures in this area.

4.3.2 Sundial Area

The future conditions model of the Sundial area was modeled with hydrographs representing full build out conditions based on zoning. The Sundial area is zoned for industrial and commercial land uses. A new culvert was constructed across Marine Drive near Dunbar Avenue in this area as the model was being developed. The new Marine Drive culvert was modeled under both existing and future conditions. No other adjustments in this area were needed.

4.3.3 Arata Creek

Hydrologic inputs were updated in the future conditions model for this area to represent full build out conditions of the zoned land use. The hydrograph area used as input to the modeled upstream end Arata Creek, node A70, was reduced. The hydrograph area reduced from node A70 was added to node A60 and the upstream node of the Halsey Line, MHB224.

Node A60 is an input node to Arata Creek downstream of node A70. This change was made to model future flows that will likely be collected and discharged to outfalls along Arata Creek. The flows reduced from A70 and added to MHB224 act to model future flows that will be intercepted before they reach Arata Creek and conveyed to the Halsey Line.

4.3.4 Interchange Area

Hydrologic inputs were updated for the future conditions model for this area to represent full build out conditions of the zoned land use. Zoning for this area is primarily industrial. No hydraulic adjustments were needed in this area.

4.3.5 Halsey Street Area

Hydrologic inputs were updated for the future conditions model for this area to represent full build out conditions of the zoned land use. This area is primarily zoned for residential land use.

Hydrologic subbasins 18 and 19 were routed to the Halsey line and subbasins 21 and 22 were routed to 257th. Under future conditions, the drywells are likely to be decommissioned and flows will be conveyed to the exiting 257th line. Development along the south side of Halsey will result in flows being collected and conveyed to the existing Halsey line.

5.1 XPSWMM Model Results

Existing and future conditions model results were reviewed and calibrated according to field visits and meetings with City Staff. Calibration consisted of adjusting basin areas and reviewing drainage paths to match observed water surfaces described by City staff at known problem areas in the existing system. Since modeling approaches in both existing and future conditions are consistent and utilize the same boundary conditions, the difference between existing and future condition model results should be adequate to help determine needed CIPs.

Existing and future model results were then compared for each area to evaluate areas for significantly increased flows under modeled conditions. For areas where significantly increased flows were identified, water surface profiles (Hydraulic Grade Lines) were used to help assess locations of surcharged pipes, flooded nodes, and overtopping channels where possible capital improvement projects may be needed. Flows to input nodes were tabulated for each of the subbasins. Tables 5.1 and 5.2 below list flows calculated by the XPSWMM model for both existing and future conditions for the respective storm events. Table 5.2 also lists the difference in existing and future condition flows for the 25-year event. The difference was calculated by subtracting the existing flow from the future flow so that a positive result indicates an increase in flow under future conditions.

Table 5.1: Flowrates at Input Nodes for Existing Conditions

Areas	Input Node	Predicted Runoff Rate [cfs]			
		2-Yr	5-Yr	10-Yr	25-Yr
Salmon Creek	S10	46	68	88	100
	S24b	6	10	13	16
	S24a	8	13	17	20
	S26a	5	8	11	12
	S38	23	32	40	45
	S28	35	49	61	69
	S33	14	19	23	26
	S32a	33	45	56	63
	Alcoa	0	0	0	0
Sundial Area	A06	29	39	47	52
	A03	10	14	17	20
Arata Creek	A16A	27	36	45	50
	A26	16	21	26	28
	A60	0	0	0	0
	A30	10	15	20	23
	A70	47	68	87	99
Interchange Area	S30b	31	40	49	54
	B10c	3	5	8	9
	B00	1	1	2	2
	B00b	13	18	22	24
	B24b	33	43	51	56
	MHA71	9	14	18	20
Halsey Street Area	MHB218	0	0	0	0
	MHB18	0	0	0	0
	MHB224	0	0	0	0
	MHB221	0	0	0	0
	MHB258	0	0	0	0
	MHB16	0	0	0	0
	MHB47	2	3	4	5
	MHB9	8	13	17	20
	MHB14	3	5	6	7
	MHB8	3	6	7	9
	MHB43	0	0	0	0
	MHB23	7	10	13	14

Table 5.2: Flowrates at Input Nodes for Future Conditions and 25-year Flow Differences							
Areas	Input Nodes	Predicted Runoff Rate [cfs]				Existing	Difference
		2-Yr	5-Yr	10-Yr	25-Yr	25-Yr	25-yr
Salmon Creek	S10	47	71	92	105	100	4
	S24b	18	24	29	31	16	16
	S24a	24	31	38	41	20	21
	S26a	5	8	11	12	12	0
	S38	46	64	79	89	45	44
	S28	72	97	118	131	69	62
	S33	28	39	47	53	26	27
	S32a	40	57	72	81	63	18
	Alcoa	80	108	132	146	0	146
Sundial Area	A06	41	53	63	69	52	18
	A03	14	21	27	30	20	11
Arata Creek	A16A	24	34	42	48	50	-2
	A26	33	44	54	59	28	31
	A60	35	48	58	64	0	64
	A30	23	34	44	50	23	27
	A70	55	79	99	112	99	12
Interchange Area	S30b	19	27	35	39	54	-15
	B10c	27	35	43	47	9	38
	Node99	15	20	24	27	N/A	27
	B00	1	2	3	3	2	1
	B00b	14	19	22	25	24	1
	B24b	43	58	71	78	56	22
	MHA71	11	14	17	19	20	-1
Halsey Street Area	MHB218	17	23	28	31	0	31
	MHB18	8	12	15	17	0	17
	MHB224	2	3	4	4	0	4
	MHB221	6	9	11	13	0	13
	MHB258	17	23	28	31	0	31
	MHB16	7	10	12	14	0	14
	MHB47	2	4	9	12	5	7
	MHB9	0	0	0	0	20	-20
	MHB14	3	4	5	6	7	-1
	MHB8	1	3	4	5	9	-4
	MHB43	12	20	26	30	0	30
	MHB23	5	8	10	12	14	-2

There are some node differences between the tables as a result of changing land use from existing to future conditions. Node 99 was added under proposed conditions to model input flows into the recommended bypass at the railroad crossing of the Columbia River Highway. Under existing conditions all the flows in this area are input into Node MH-A71. Under future conditions the flow input data to MH-A71 was divided between MH-A71 and Node99 to model the bypass, thus Node 99 was added to Table 5.2, but does not show up in Table 5.1.

Another difference between the tables is Node MH B9. Under existing conditions this node has the flow input for the local area around the node. Under proposed conditions, it is assumed the local area around MH B9 will be developed; therefore flows will be captured by a future conveyance system. To model this, the existing flow inputs into MH B9 were removed and future flow inputs were divided into nodes MH B16 and MH B18.

Some nodes show a decrease in flows under future conditions, this is a result of the model including programming to try and show how future basins may be redistributed as a result of development and changes to the existing storm system.

5.2 Changes in Flow Rates for Future Conditions

As Tables 5.1 and 5.2 demonstrate, the North Troutdale basin drainage system will see significant flow changes in the future. The most noteworthy flow changes include:

- Fifteen of the input nodes show an increase of at least 25 cfs for the peak 10-year flow.
- Drainage from the former aluminum plant site will be added to existing flow sources in Salmon Creek. The increases from that site represent approximately 146 cfs for the 25-year event.
- There are increased flows from the area south of Halsey Street both because of development and because of decommissioning of dry wells within the neighborhood north of Sturges Road and west of 257th Avenue. The total combined flow rate in the Halsey system is approximately 157 cfs for the 25-year event.

Further discussion of trouble spots and proposed improvements to address them are discussed in Section 6.0.

Section 6.0 –Trouble Spots And Proposed Improvements

A major objective of this study is to identify trouble spots based on historical records and modeling results and to then propose capital improvements to resolve identified drainage problems. The City of Troutdale and the SDIC have made major drainage improvements as the community developed and now seems to be relatively free of reported drainage problems. Interviews with City employees have identified only a few trouble spots.

Our analysis seeks to identify trouble spots based on the following criteria:
- Duration of flooding
- Depth of flooding
- Locations of traffic disruptions
- Potential flooding of businesses or homes
- Backwater effects from surface streams
- Conveyance limitations e.g., pipes are too small

6.1 Potential Trouble Spots

Trouble Spot No. 1 --- Salmon Creek Weir Improvement

The previous drainage plan indicated that water would not flow fast enough from the Salmon Creek to the storage area immediately upstream of the pump station. Our analysis indicates that the relief weir, which directs flows from Salmon Creek to the storage area north of Salmon Creek, is undersized and does not allow enough flow to reach the storage area. Model results show Salmon Creek overtopping its banks in this area for both existing and future conditions. Water that escapes the channel banks likely flows to the storage area to the north and could also be stored in overbank areas along the channel itself and likely goes unnoticed under existing conditions. The system appears to be adequate as modeled under existing conditions as the City has indicated that there have been few or no complaints of flooding problems in this area.

Under future conditions increased flows may contribute to increased channel overtopping and could become a nuisance to future development. Another problem associated with the undersized weir is the buildup of head in the Salmon Creek system. This causes the upstream systems to back up reducing the capacity of some pipes and channels in the flat areas directly south of Salmon Creek, including the Sundial area, and parts of Arata Creek.

The storage area north of Salmon Creek was modeled based on GIS contours with a 5-foot interval. This preliminary assessment of storage volume is not accurate enough for definitive modeling but indicates that the existing storage provided in this area is inadequate for effective flood control. If sufficient storage cannot be provided north of Salmon Creek or within the Salmon Creek overbank areas, then the pumping capacity for the existing SDIC drainage pumps may need to be increased.

A comprehensive solution to flood control in this area will require involvement of the SDIC, which is currently evaluating the function of district-owned facilities within its service area and considering options to address system deficiencies under existing and future conditions.

Further study should be completed of this area to determine the best combination of storage and pumping capacity to effectively control water surface elevations within the North Troutdale drainage basin.

In the interim, weir improvements could alleviate some flooding conditions and reduce backwater effects on the upstream system under existing conditions.

Trouble Spot No. 2 --- Arata Creek within the Dunbar Avenue Area

The Dunbar Avenue area is flat-lying and can be susceptible to flooding conditions related to the flows in Arata Creek. A new culvert crossing Marine Drive was installed this fall to alleviate flooding problems. That culvert appears to provide a distinct improvement for flows crossing Marine Drive. The slope of the Energy Grade Line is flatter than the culvert slope thereby indicating that the pair of culverts will not be a limiting factor in the conveyance system.

Under future conditions, there appears to be an undersized culvert located to the east along Marine Drive. This 4-ft culvert conveys flows under the driveway east of the new Marine Drive culvert crossing. Both the upstream 6-foot diameter culvert and the downstream pair of culverts crossing Marine Drive have much higher conveyance capacities. To maintain the highest possible conveyance capacity, the 4-ft culvert could be upsized.

Trouble Spot No. 3 --- North Arata Creek from Marine Drive to Salmon Creek

Modeling showed that drainage to the north from the Interchange Area is generally constrained by one drain line running north across the airport runways and by another drain line running north to the west of the runways. Meetings with City staff did not identify any existing flooding problems along this alignment. Development of the area north of Halsey Street will send more water to the north and should be routed through one of these two drain lines. Major improvements along the first alignment would require reconstruction of runways. Upgrading of the drainage system along the second alignment was therefore evaluated.

Trouble Spot No. 4 --- South Arata Creek Culvert Improvements

The Arata Creek system has conveyance limitations throughout its length. The portion of the creek crossing the Union Pacific Railroad north of Interstate-84 is no exception. The culvert appears to have adequate capacity for existing conditions but will not be able to convey fully developed flows in the future. Meetings with City staff did not identify any existing flooding problems along the South Arata Creek alignment. Modeling indicates that localized flooding will occur upstream of the culvert crossing the Union Pacific Railroad. Some culvert and piping improvements will be needed whenever the land north of Halsey Street is developed.

Trouble Spot No. 5 --- Columbia River Highway Bypass

Examination of the upstream flow conditions along Arata Creek revealed that the culvert crossing the railroad south of I-84 is undersized for existing and future 25-year flows. Providing an additional culvert in this area is recommended.

Minor flooding in the Columbia River Highway railroad underpass was discussed in the 1990 Master Plan and appears to occur periodically. The existing XPSWMM modeling predicts that the existing 24-inch drain line surcharges but water does not rise to the level of the roadway during a 25-year event. This indicates that periodic highwater in the underpass is caused by localized flooding, that may be reduced when the area south of Halsey Street is developed and localized flows are intercepted by the Halsey Street system.

Under future conditions, modeling shows the underpass and the channel downstream of the underpass to be susceptible to flooding. To alleviate flooding in these areas, constructing a bypass flow route to the east of the underpass, and providing an additional 3-ft culvert adjacent to the existing culvert under the railroad and downstream of the underpass is recommended. The Bypass should cross both the Columbia River Highway and the railroad and convey flows to the upstream end of the culvert that conveys flows under I-84.

Trouble Spot No. 6 --- Marine Drive Curve South of Airport

The Marine Drive curve south of the Airport and northeast of the I-84 Corporate Center presents some complex flow problems. The wooded area north of the curve provides a buffer for an open channel which receives water from a culvert under Marine Drive (Node B-00a). A sanitary pump station is located in this area near Node B-02 and reports of flood waters rising to its loading pad have been reported.

Under existing conditions, culverts and pipelines are generally able to convey drainage water while meeting conveyance criteria. For future conditions, the 4-foot culvert across Marine Drive (B-00) restricts the flow and the hydraulic grade line rises above the crowns thereby increasing the flooding potential in the Interchange Area.

The installation of an additional 3-foot culvert under Marine Drive east of the Corporate Center without proposing any other changes was considered. The additional conveyance capacity would relieve the surcharging of upstream pipes but the double culvert would release higher flowrates and would cause elevated water levels in the vicinity of the sanitary pump station and would raise the hydraulic grade line for the drain line crossing the airport runways. Since construction of an additional drain line across the runway could be difficult in terms of permitting and disruption of air traffic, this alternative was discarded and another evaluated.

Two scenarios were compared. First, a drain line from the curve to Arata Creek along the south side of Marine Drive was evaluated. This alternative did not provide significant drops in the predicted water levels for both the Dunbar area and the area surrounding the sanitary pump station area north of Marine Drive.

This second alternative evaluated the potential for providing a drain line extending along the north side of Marine Drive from the north end of the curve to Arata Creek as shown on Figure 7.6. At the east end, the drain line would receive flows from an open channel in the vicinity of the sanitary pump station and the ditch inlet for the drain line crossing the runways. The proposed drain line would be constructed to serve as a high flow bypass for the existing drain line. This alternative provided better drainage for both the Dunbar area and the pumping plant. It also provided a mechanism for transferring water to either the Arata Creek system or to the eastern system depending on the timing of inflow hydrographs.

When implemented, this alternative will reduce the flows in the drainage system crossing the airport runway and subsequently to the Salmon Creek system at the crossing of Sundial Road. The bypass will increase the flows to the Arata Creek system.

The additional flow to Arata Creek will require a drainage improvement for the conveyance problems described above as Trouble Spot No. 3. Additional culverts and drain lines will need to be added to the system to improve conveyance.

For these identified trouble spots, priorities and phasing of possible capital improvements are discussed in Section 7.0.

Section 7.0 – Capital Improvement Costs, Priorities and Phasing

7.1 Plans for Full Buildout

Full buildout for undeveloped lands within the SDIC is expected within the next ten years, and the additional drainage generated by development will become the SDIC's responsibility. Consequently, the SDIC's anticipated timetable helps establish the priority and phasing of capital improvements.

The SDIC anticipates full buildout of the area within the City of Troutdale's jurisdiction within 4 to 7 years. With the exception of some wetland and open space areas, the land is zoned General Industrial (GI). The City of Troutdale indicated that industrial zoning permits 85-90 percent of the buildable lands to become impervious area. Open space allows a maximum of 30 percent impervious area to be constructed. The City's Development Code controls the amount of impervious area permitted.

The SDIC also anticipates that the area within the City of Fairview's jurisdiction will reach full buildout within 7 to 10 years, three years after the area under the City of Troutdale's jurisdiction reaches full buildout. The pending purchase of the former aluminum plant site by the Port of Portland is expected to encourage rapid development. This area also is classified primarily as General Industrial (GI), with some area zoned for Open Space and River Oriented. Fairview Municipal Code permits a maximum of 85 percent of industrial land to become impervious area. River Oriented zoning permits General Industrial uses or residential multifamily buildings. Multifamily buildings may be subject to more limits on the amount of impervious area permitted than is allowed for buildings in a GI zoning.

According to the City of Wood Village, the area within the North Troutdale Drainage Basin already has reached buildout. No further development is anticipated. This area will not contribute additional drainage to the drainage basin in the future.

The schedule for the development of the area within the City of Troutdale lying north of Halsey and south of Columbia River Highway is unknown at this time. That development is critical in terms of storm drainage planning. This area contributes to both Arata Creek and to the drainage way crossing the Interchange Area. Several of the Capital Improvement Projects (CIP) proposed below will be triggered by the development of this area.

7.2 Proposed Capital Improvement Projects

Trouble spots have been identified in Section 6.0. The following Table 7.1 indicates the priorities and the phasing of possible capital improvements to help the drainage conditions in each of the hot spots. Several of the capital improvements need to occur simultaneously if they are to be effective.

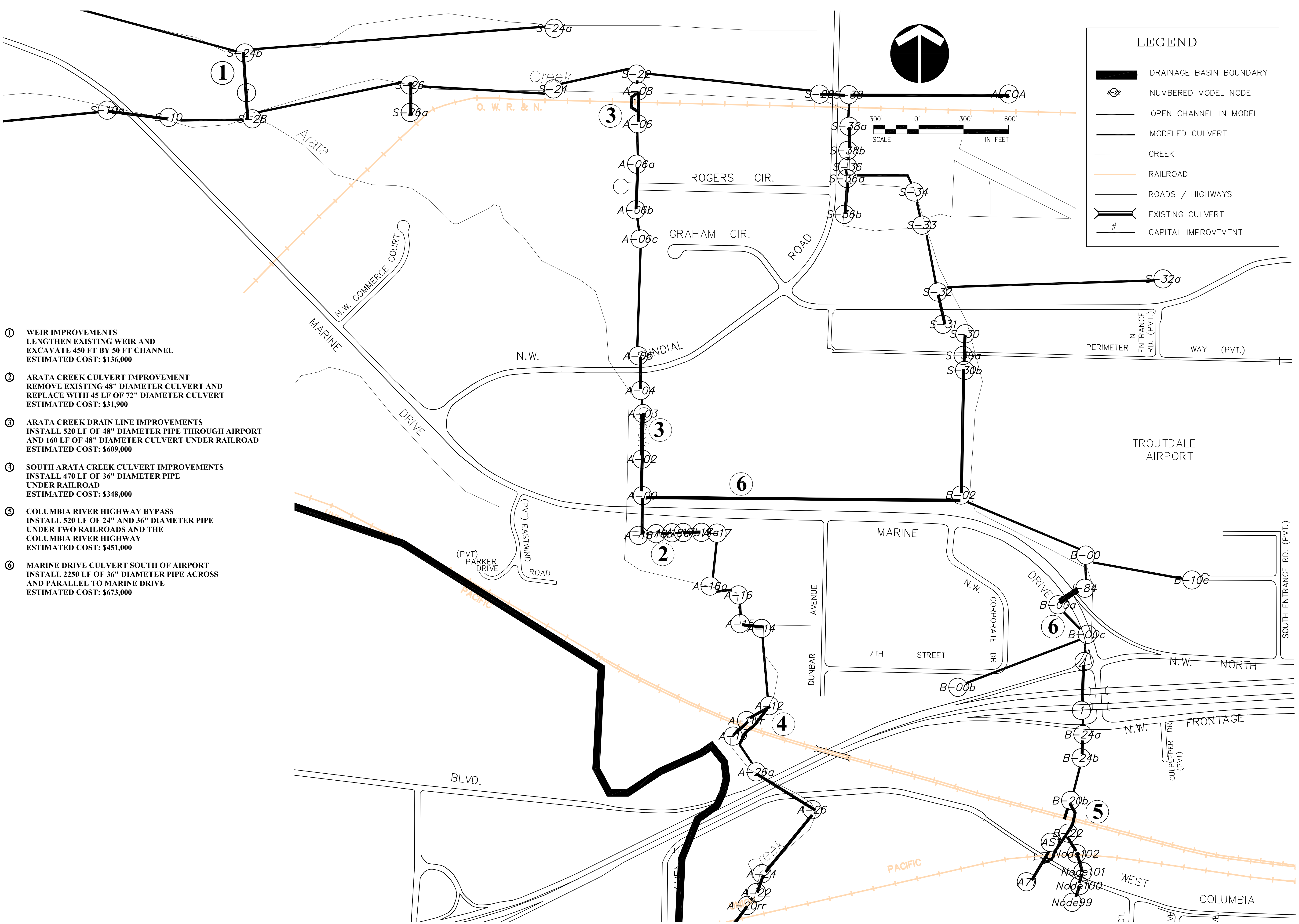
Table 7.1: Proposed Capital Improvement Projects			
Capital Improvement Number	Capital Improvement	Phasing	Necessary Concurrent Improvements
1	Salmon Creek Weir Improvement	Short term	None
2	Arata Creek Culvert Improvement within the Dunbar Avenue Area	Short term	None
3	Arata Creek Drain Line Improvements from Marine Drive to Salmon Creek	Before development of any of the land north of Halsey	4 or 5 and 6
4	South Arata Creek Culvert Improvements	Before development of land north of Halsey and draining to Arata Creek	3
5	Columbia River Highway Bypass	Before development of land north of Halsey and draining to Columbia River Highway Bypass	3 and 6
6	Marine Drive Curve Bypass South of Airport	Before development of land north of Halsey and draining to Columbia River Highway Bypass	3 and 5

Note that references to Arata Creek in this report include the open channels, culverts and drain lines where the flow alignments have been straightened. Some portions of the historical Arata Creek continue to provide localized drainage in the northwest part of the North Troutdale drainage basin. These segments have not been included as part of the XPSWMM hydraulics layer.

Costs for each of the Capital Improvement Projects have been determined and are tabulated in Appendix E. The estimates are based upon the best available information from manufacturers and current projects. The descriptions of each of the Capital Improvement Projects are included in the following subsections. All estimates include a 35 percent contingency for design, some permitting, and escalation of costs with time. A CIP location map with cost, materials and sizes is included as Figure 7.0. A flow chart that guides phasing of CIPs is provided as Figure 7.7 at the end of this section.

A timetable for implementing specific CIPs will depend upon the size and location of developed areas. As examples:

- The proposed weir improvement, CIP No. 1, should not be implemented until the ongoing XPSWMM modeling analysis has been completed by the SDIC.
- The railroad underpass at the Columbia River Highway, CIP No. 5, is problematic under existing conditions and does not have additional conveyance capacity available for buildout.
- Beyond that one specific location, however, our analysis shows that the development of drainage areas contributing to the Arata Creek culvert system within the Dunbar Avenue area will trigger flooding conditions earlier than areas contributing to other drain lines. For any future projects proposing a multi-lot buildout within this area, the City can conduct a downstream analysis using the XPSWMM model and evaluate the need for proposed CIPs or other measures such as requiring interim detention until such CIPs are constructed.



① WEIR IMPROVEMENTS
LENGTHEN EXISTING WEIR AND
EXCAVATE 450 FT BY 50 FT CHANNEL
ESTIMATED COST: $136,000

② ARATA CREEK CULVERT IMPROVEMENT
REMOVE EXISTING 48" DIAMETER CULVERT AND
REPLACE WITH 45 LF OF 72" DIAMETER CULVERT
ESTIMATED COST: $31,900

③ ARATA CREEK DRAIN LINE IMPROVEMENTS
INSTALL 520 LF OF 48" DIAMETER PIPE THROUGH AIRPORT
AND 160 LF OF 48" DIAMETER CULVERT UNDER RAILROAD
ESTIMATED COST: $609,000

④ SOUTH ARATA CREEK CULVERT IMPROVEMENTS
INSTALL 470 LF OF 36" DIAMETER PIPE
UNDER RAILROAD
ESTIMATED COST: $348,000

⑤ COLUMBIA RIVER HIGHWAY BYPASS
INSTALL 520 LF OF 24" AND 36" DIAMETER PIPE
UNDER TWO RAILROADS AND THE
COLUMBIA RIVER HIGHWAY
ESTIMATED COST: $451,000

⑥ MARINE DRIVE CULVERT SOUTH OF AIRPORT
INSTALL 2250 LF OF 36" DIAMETER PIPE ACROSS
AND PARALLEL TO MARINE DRIVE
ESTIMATED COST: $673,000

NO.	DATE	BY	REVISION COMMENTS

Design	Drawn	Checked	Date	Initial Issue Date:
	KW			NOVEMBER 29, 2006

STORM DRAINAGE MASTER PLAN

CAPITAL IMPROVEMENT PROJECT OVERVIEW
25 YEAR STORM

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13840
Project No. Drawing No.
FIG. 7.0
Exhibit No.

7.2.1 Capital Improvement No. 1 --- Salmon Creek Weir Improvement

Description:

Increase the crest length of the existing relief weir located along Salmon Creek and the width of the channel which receives water from the weir. The suggested weir length and the channel width are 50 feet.

Purpose:

Model results show that this improvement reduces the water surface elevation in Salmon Creek and consequently reduces the tailwater elevation for both Arata Creek and for the Salmon Creek crossing at Sundial Road. Expanding the existing 10-foot weir crest length to approximately 50-feet and widening the channel extending north 450 feet from the relief weir to approximately 50 feet maintains the water level in Salmon Creek.

Phasing:

This CIP will improve the function of all upstream drainage elements and can be implemented when funds become available. The final design for this CIP should include additional input from the SDIC which has been considering various pumping and storage alternatives. Note that the 50-foot weir represents an alternative which improves the flow characteristics but may not optimize the system which includes pumps, storage and conveyance elements in this part of the basin.

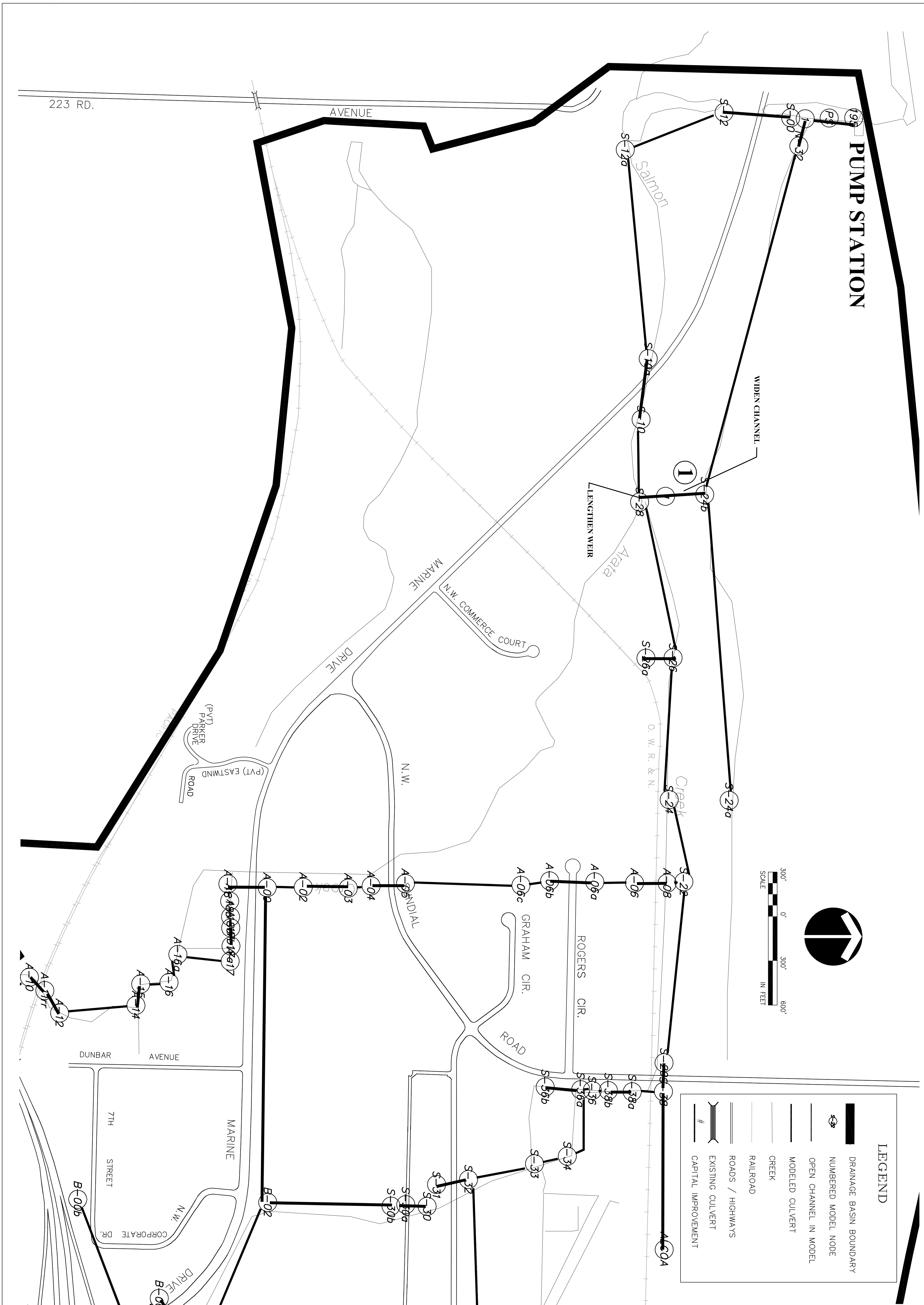
Cost:

Construction Costs, Design Contingency and Mobilization = $136,000

Plan View:

See Figure 7.1.

VAN: KELLYW 02/26/2007 11:46am --> R:\DWG\FIG 7.1.DWG



NO.	DATE	BY	REVISION COMMENTS

Design	Drawn	Checked	Date	Initial Issue Date:
	KW			NOVEMBER 29, 2006

STORM DRAINAGE MASTER PLAN

CAPITAL IMPROVEMENT PROJECT #1
SALMON CREEK WEIR IMPROVEMENTS

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13840
Project No. Drawing No.
FIG. 7.1
Exhibit No.

7.2.2 Capital Improvement No. 2 --- Arata Creek Culvert Improvement within the Dunbar Avenue Area

Description:

Replace existing 45 feet of 4-ft diameter culvert with a single 6-ft culvert or with two smaller barrels providing equivalent hydraulic capacity.

Purpose:

An existing 4-foot diameter culvert conveys flows under the driveway east of the new Marine Drive culvert crossing and west of Dunbar Avenue. We recommend upsizing the culvert to a 6-ft diameter culvert to match conveyance of adjacent upstream and downstream culverts.

Phasing:

Implementation of this CIP will improve the conveyance capacity of the Dunbar area and should be implemented as funds become available.

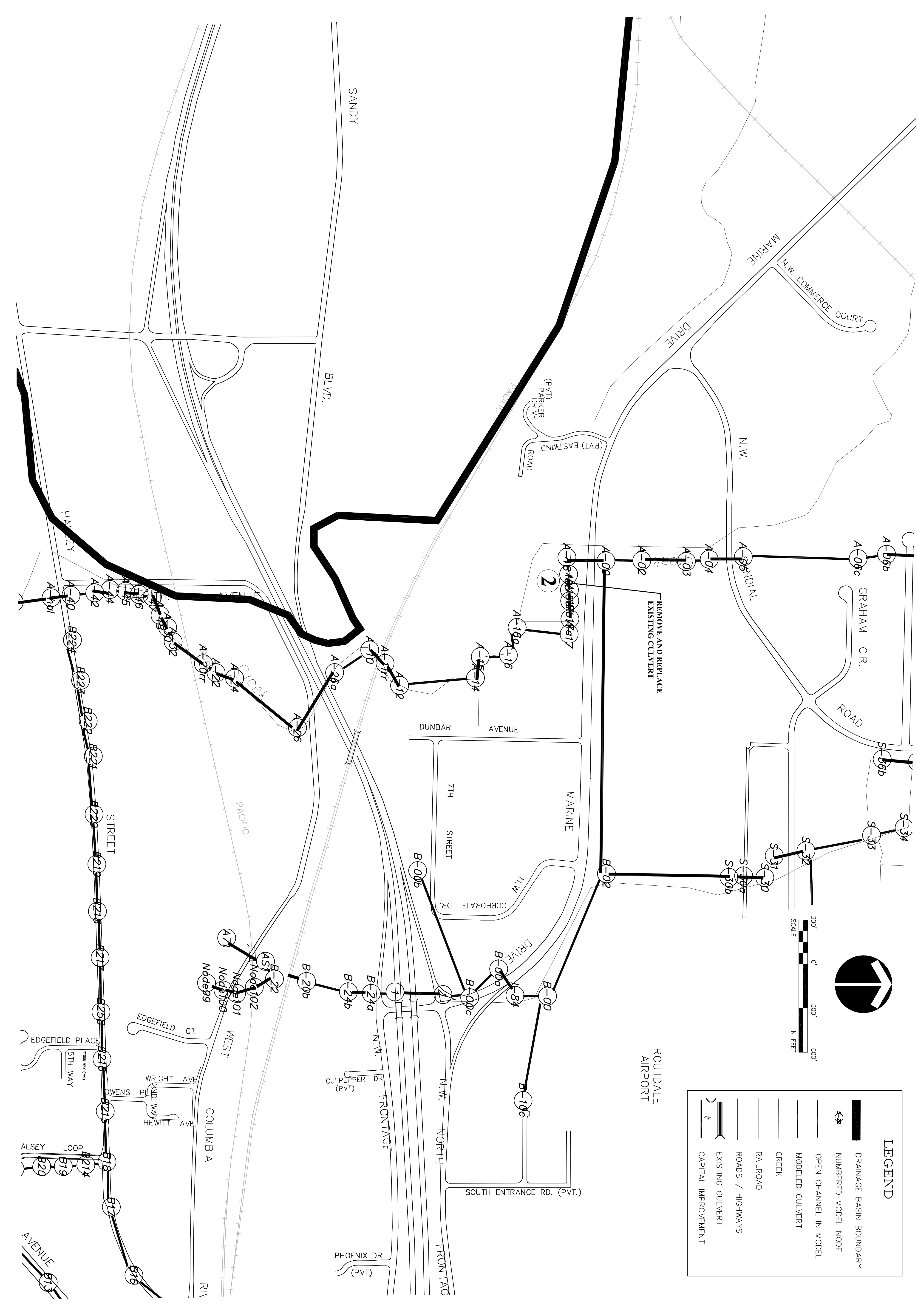
Cost:

Construction Costs, Design Contingency and Mobilization = $31,900.

Plan View:

See Figure 7.2.

VAN: KELLYW 02/26/2007 11:47am --> R:\DWG\FIG 7.1.DWG



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13840
Project No. Drawing No.
FIG. 7.2
Exhibit No.

STORM DRAINAGE MASTER PLAN

CAPITAL IMPROVEMENT PROJECT #2
ARATA CREEK CULVERT IMPROVEMENTS

NO.	DATE	BY	REVISION COMMENTS

Design	Drawn	Checked	Date	Initial Issue Date:
	KW			NOVEMBER 29, 2006

7.2.3 Capital Improvement No. 3 --- Arata Creek Drain Line Improvements from Marine Drive to Salmon Creek

Description:

Two improvements are proposed for this CIP. Install 160 feet of 48-inch CMP culvert under the railroad immediately upstream of the outlet to Salmon Creek and 520 feet of 48-inch PVC drain line directly west of the airport runway and parallel to the existing drain lines. The culvert through the railroad embankment will need to be bored.

Purpose:

The additional culverts reduce the water surface elevations for Arata Creek locations south of Marine Drive.

Phasing

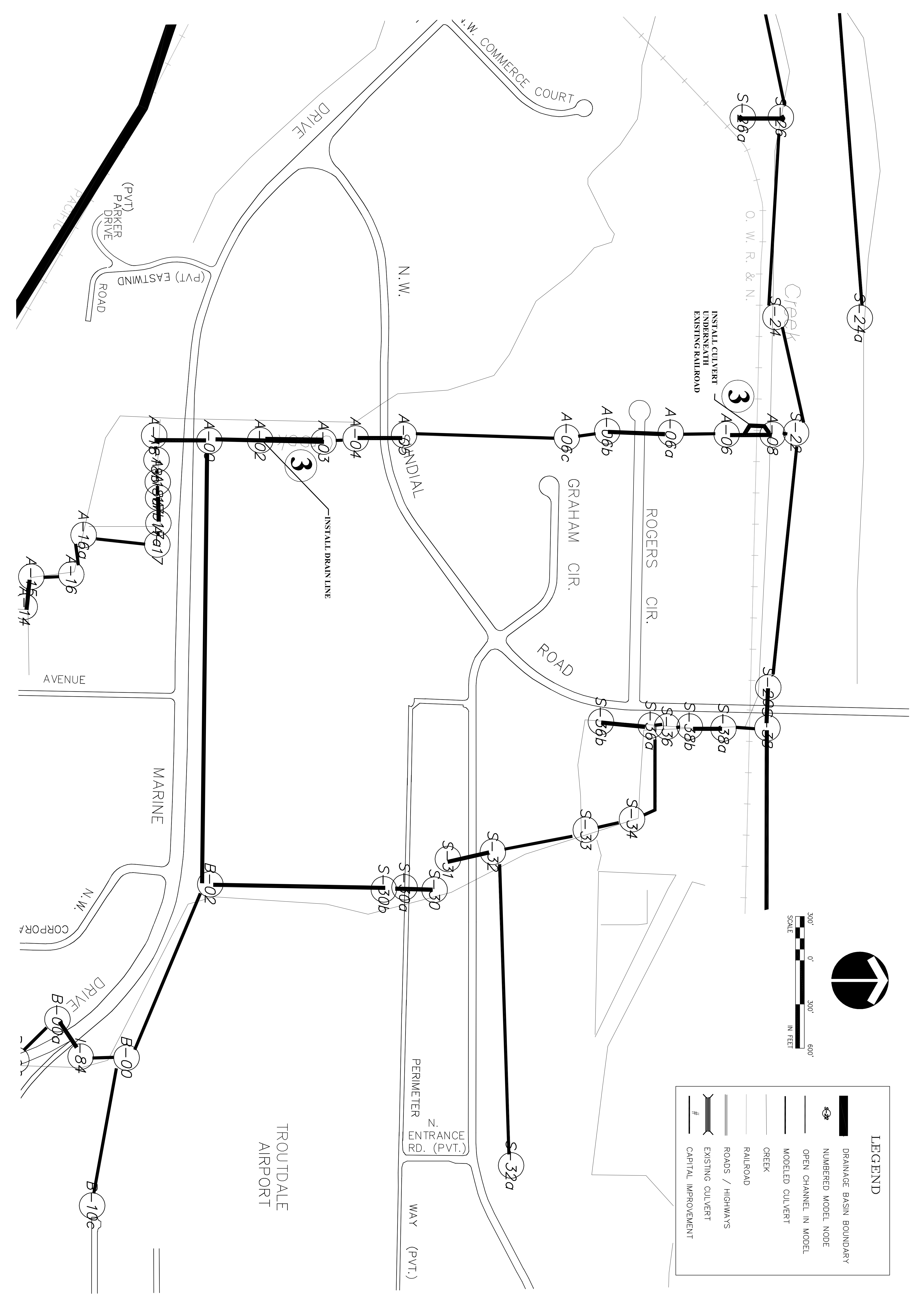
These improvements should be implemented prior to the development of the land areas north of Halsey Street. Refer to Figure 7.7: Flow Chart for Phasing of Capital Improvement Projects.

Cost:

Construction Costs, Design Contingency and Mobilization = $609,000.

Plan View:

See Figure 7.3.



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13840
Project No. Drawing No.
FIG. 7.3
Exhibit No.

STORM DRAINAGE MASTER PLAN

CAPITAL IMPROVEMENT PROJECT #3
ARATA CREEK DRAIN LINE IMPROVEMENTS

NO.	DATE	BY	REVISION COMMENTS

Design	Drawn	Checked	Date	Initial Issue Date:
	KW			NOVEMBER 29, 2006

7.2.4 Capital Improvement No. 4--- South Arata Creek Culvert Improvements

Description:

Install an additional 470 feet of 36-inch culvert where Arata Creek crosses the railroad embankment north of Interstate 84 and additional piping under the paved area directly north of the embankment. The culvert will need to be bored through the railroad embankment.

Purpose:

Any development of the area north of Halsey will increase the flows to the Arata Creek system. The existing railroad culvert needs to be augmented with an additional culvert to prevent localized flooding in the area immediately upstream of the railroad embankment.

Phasing:

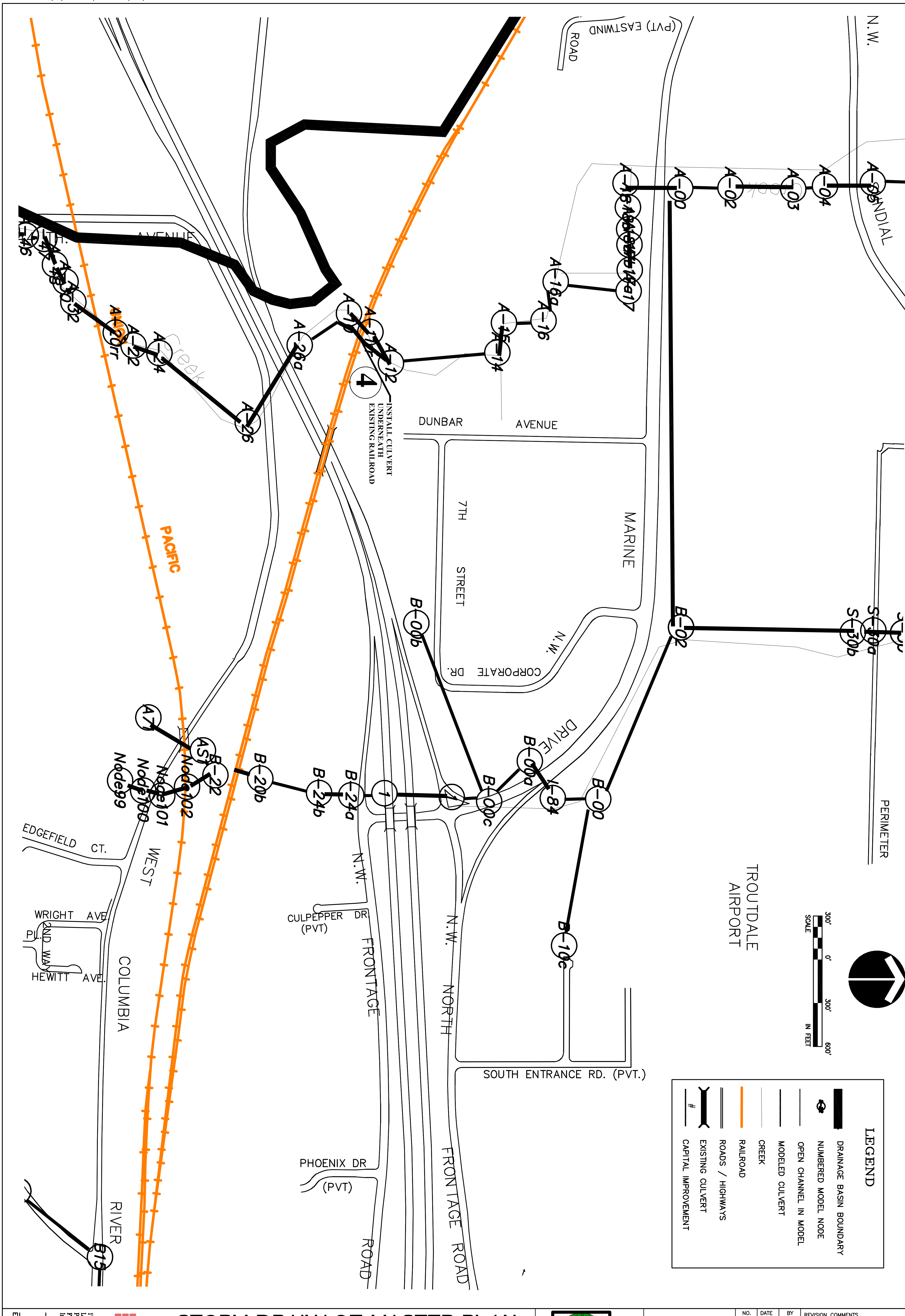
This CIP should be implemented before the flows to Arata Creek begin to increase due to future development on the north side of Halsey. Refer to Figure 7.7: Flow Chart for Phasing of Capital Improvement Projects.

Cost:

Construction Costs, Design Contingency and Mobilization = $348,000.

Plan View:

See Figure 7.4.



STORM DRAINAGE MASTER PLAN

CAPITAL IMPROVEMENT PROJECT #4
SOUTH ARATA CREEK CULVERT IMPROVEMENTS

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Project No. 13840
Drawing No.
Exhibit No. FIG. 7.4

NO.	DATE	BY	REVISION COMMENTS

Design	Drawn	Checked	Date	Initial Issue Date:
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7.2.5 Capital Improvement No. 5--- Columbia River Highway Bypass

Description:
Install a bypass where future flows leave the drainage area north of Halsey and cross Columbia River Highway. The bypass will consist of five elements: 50 feet of 24-inch trenched culvert under Columbia River Highway, 160 feet of 24-inch drain line, 40 feet of 24-inch culvert under a railroad embankment, another 40 feet of 36-inch drain line, and 80 feet of 36-inch culvert under a second railroad embankment. The culverts will need to be bored through the railroad embankment.

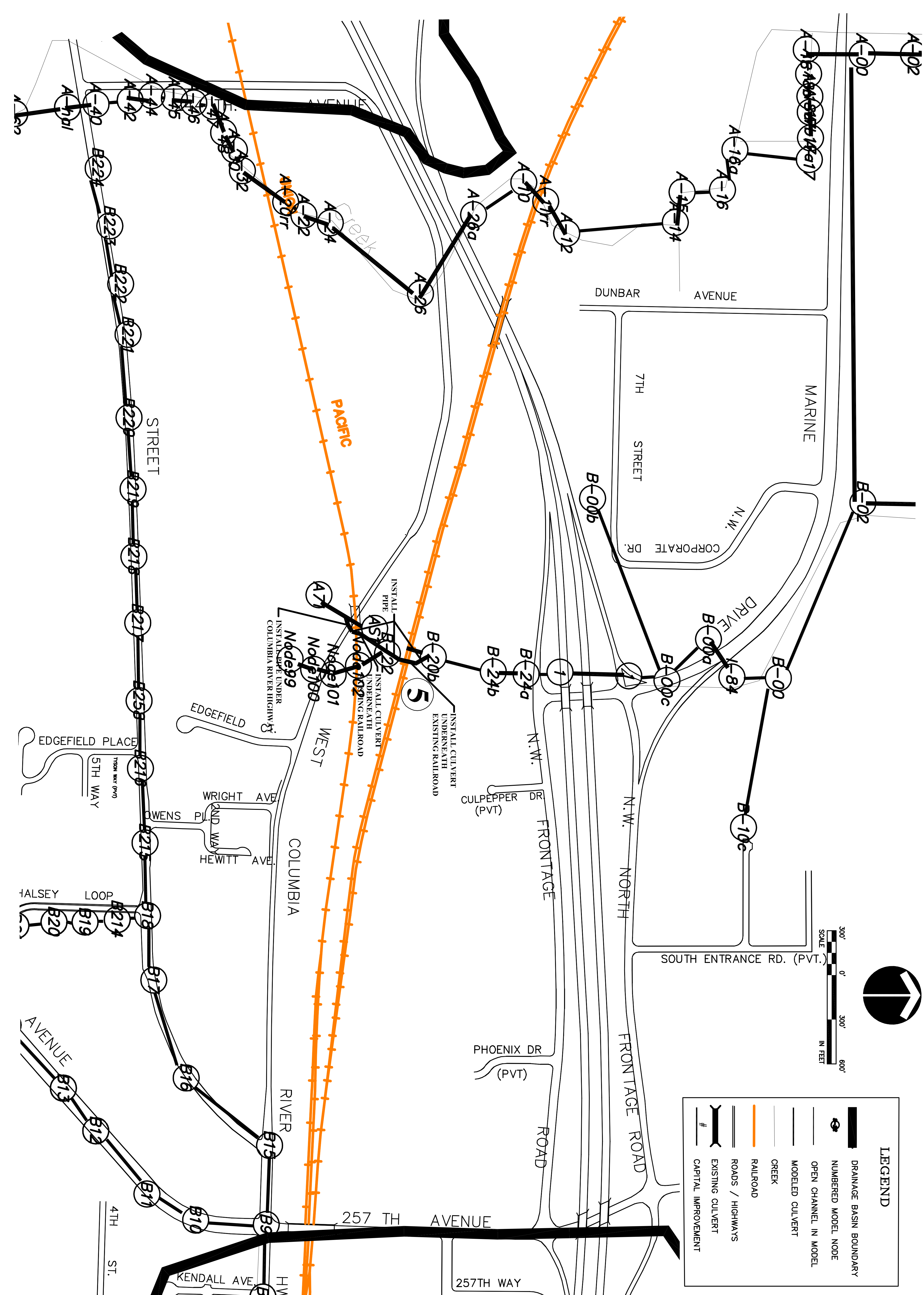
Purpose:
The proposed CIP will provide a drainage outlet for runoff from part of the land area lying north of Halsey and south of Columbia River Highway. The existing 24-inch drain line located in the Columbia River Highway's railroad underpass does not provide sufficient conveyance capacity for future flows.

Phasing:
This CIP should be implemented before additional flows are generated from the area north of Halsey. Its development should be concurrent with other downstream improvements associated with CIP Nos. 3 and 6. Refer to Figure 7.7: Flow Chart for Phasing of Capital Improvement Projects.

Cost:
Construction Costs, Design Contingency and Mobilization = $451,000.
Note that boring and installation of culvert under the railroad does not include costs for permitting and geotechnical investigation.

Plan View:
Please see Figure 7.5.

VAN: KELLYW 02/15/2007 2:46pm --> R:\DWG\FIG 7.1.DWG



STORM DRAINAGE MASTER PLAN

CAPITAL IMPROVEMENT PROJECT #5
COLUMBIA RIVER HIGHWAY BYPASS

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Project No. 13840
Drawing No.
Exhibit No. FIG. 7.5

NO.	DATE	BY	REVISION COMMENTS

Design	Drawn	Checked	Date	Initial Issue Date:
	KW			NOVEMBER 29, 2006

7.2.6 Capital Improvement No. 6--- Marine Drive Curve Bypass South of Airport

Description:

This CIP consists of two components: 2100 feet of 36-inch drain line north of and parallel to Marine Drive and an additional 150 feet of 36-inch culvert crossing Marine Drive east of the Corporate Center. For ease of permitting, we selected a buried drain line rather than proposing an open channel.

Purpose:

The drain line parallel to Marine Drive will provide a cross connection between the two south-to-north drainage systems and will help to balance flows. Localized flooding northeast of the Marine Drive curve will be reduced.

The additional Marine Drive culvert will supplement the conveyance capacity of the existing culvert. These two culverts will provide enough conveyance capacity to convey additional flows from the area north of the Columbia River Highway. Otherwise localized flooding is predicted upstream of these culverts.

Phasing:

This CIP should be implemented before upstream development is implemented. Development should be concurrent with CIP No. 3. Refer to Figure 7.7: Flow Chart for Phasing of Capital Improvement Projects.

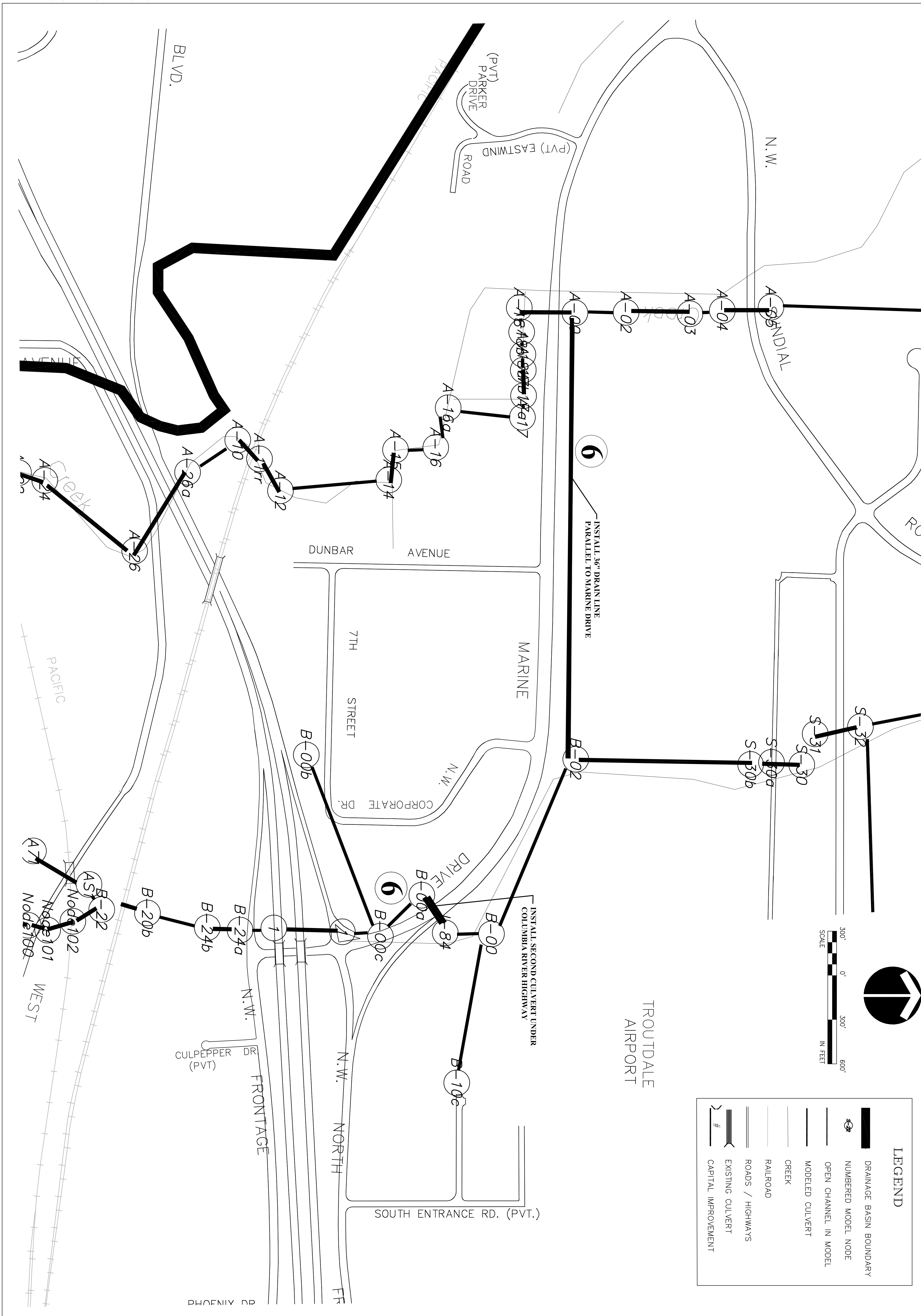
Cost:

Construction Costs, Design Contingency and Mobilization = $673,000.

Plan View:

See Figure 7.6.

VAN: KELLYW 02/22/2007 2:04pm --> R:\DWG\FIG 7.1.DWG



STORM DRAINAGE MASTER PLAN

CAPITAL IMPROVEMENT PROJECT #6
MARINE DRIVE CULVERT SOUTH OF AIRPORT

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Project No. 13840
Drawing No. FIG. 7.6
Exhibit No.

NO.	DATE	BY	REVISION COMMENTS

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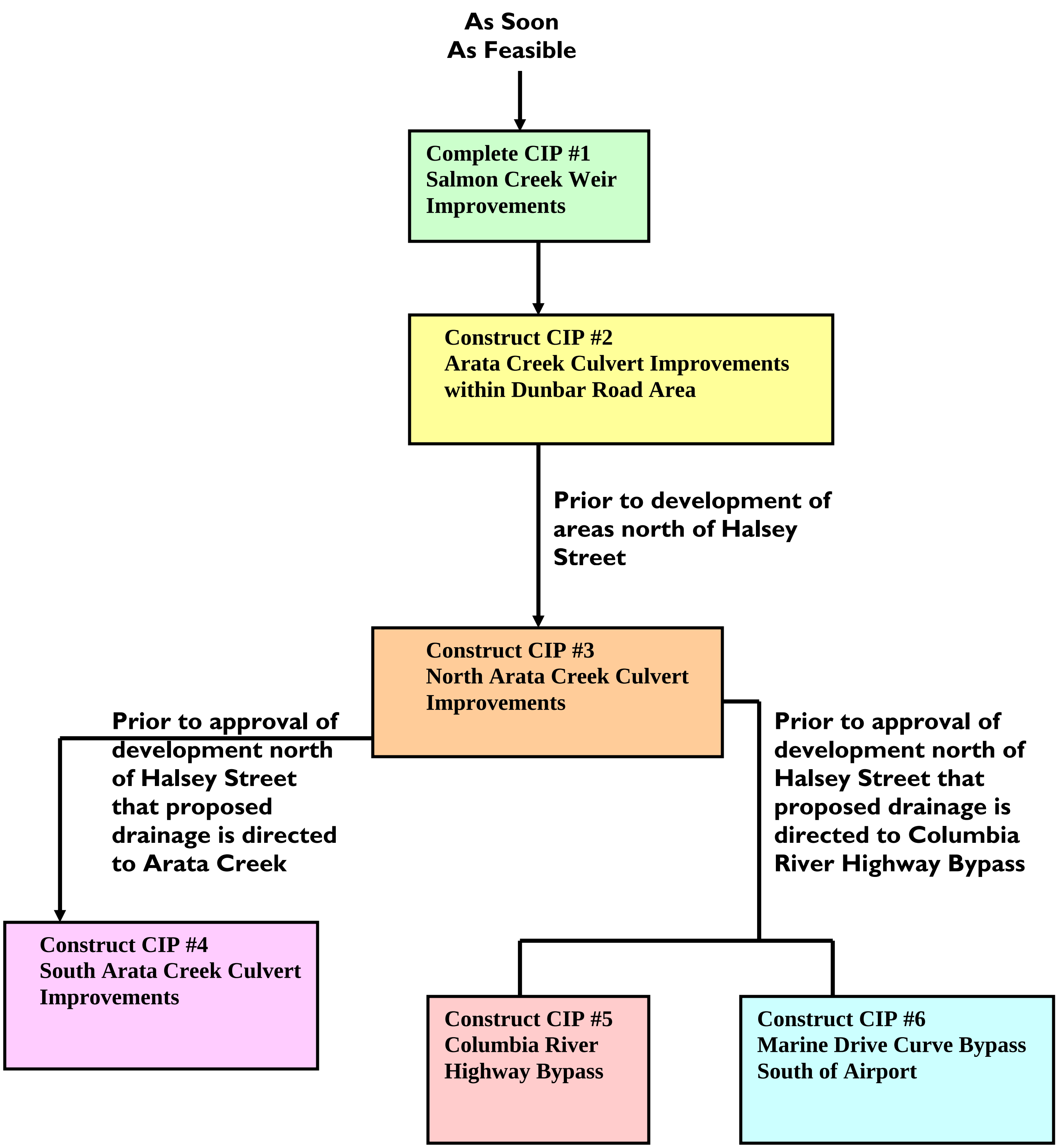
	KW			NOVEMBER 29, 2006

Figure 7.7: Flow Chart for Phasing Capital Improvement Projects



8.1 Introduction

As part of the master planning process for the North Troutdale Drainage Basin, the City included a qualitative review and evaluation of its 2004 Stormwater Management Plan (SWMP). When the SWMP was first developed, the primary driver was regulatory compliance with upcoming National Pollutant Discharge Elimination System (NPDES) Phase II permit requirements. While the City's initial planning efforts focused on addressing regulatory compliance, the City is now most interested in qualitatively comparing its approach to that of its peer jurisdictions, assessing effectiveness of its selected Best Management Practices (BMPs) in protecting water quality, and ensuring the greatest return on investment of resources. The SWMP review was limited to these specific objectives and did not include review of legal authority, staffing, funding, or implementation. This section provides background information on the NPDES program, and describes the SWMP review and evaluation methodology, findings, conclusions, and recommendations.

8.2 Background

The Federal Water Pollution Control Act (also known as the Clean Water Act) regulates the protection of the Nation's surface waters. The 1972 amendments to this Federal law provide the basis for the National Pollutant Discharge Elimination System (NPDES) permit program and the basic structure for regulating the discharge of pollutants. The law also assigns enforcement responsibility to the Environmental Protection Agency (EPA), which may delegate some of its responsibilities to the states. In Oregon, those responsibilities have been delegated to the Department of Environmental Quality (DEQ).

In 1999, EPA published rules that require certain regulated small municipal separate storm sewer systems, including Troutdale, to obtain NPDES permit coverage. This is often referred to as Phase II of the NPDES Storm Water Program. Phase I, which applied to larger municipalities, was covered by rules published in 1990.

Under these Federal rules, Troutdale submitted an application for an NPDES permit to DEQ in the March of 2003. The next requirement was to develop a Storm Water Management Plan (SWMP) by March of 2004 that formally addressed the following six minimum control measures required under NPDES Phase II requirements:

1. Public education and outreach on stormwater impacts
2. Public involvement/participation
3. Illicit discharge detection and elimination
4. Construction site stormwater runoff control
5. Post-construction stormwater management in new development and redevelopment
6. Pollution prevention/good housekeeping for municipal operations

City staff organized a Task Force within the Public Works Department to develop this SWMP. The City submitted the SWMP to DEQ in February 2004 for review. Due to threatened litigation involving the issuance of Phase I NPDES permits, DEQ delayed review of the City's SWMP plan and issuance of a NPDES permit to the City. DEQ has restarted the permit process, and issued a comment letter to the City dated August 15, 2006 (Appendix F). DEQ had two comments; the SWMP must list persons responsible for implementation, and include a timeline for developing an employee training program. DEQ expects to issue a Phase II NPDES permit to the City by April 2007, following a formal public comment period.

8.3 Selection of Peer Jurisdictions

Originally, the City wanted their SWMP compared with SWMPs from six other similar Phase II municipalities in terms of size, climate and soils. According to DEQ, seventeen municipalities in Oregon have submitted Phase II applications. Of the applicants, four were counties and thirteen were cities. With the exception of Wood Village, none of the applicants met Troutdale's criteria. For this reason, Phase I permittees within the geographic region fitting the City's criteria were considered for the comparison.

While there are differences between Phase I and Phase II requirements, the structure of the permits is similar enough to facilitate comparisons between them. Phase II requirements basically are a subset of the more rigorous Phase I requirements and are organized slightly differently. The primary differences between the phases are the Phase I requirements for outfall discharge and ambient water quality monitoring, and industrial facility monitoring and pollutant control.

The City suggested that the nine Oregon municipalities used for its annual comparison of systems development charges be considered for the SWMP comparison. These municipalities are within the same Willamette Valley region, meeting the climate and soils criteria, and range in population from a low of approximately 3,000 (Wood Village) to a high of approximately 96,000 (Gresham). The remaining cities include Cornelius, Fairview, Forest Grove, Gladstone, Milwaukie, Sherwood, and Wilsonville, with populations ranging from roughly 65 percent to 139 percent of Troutdale's population, making them the closest candidates in terms of residents. Population data was obtained from postings on the League of Oregon City's website as of September 2006.

Since Cornelius, Forest Grove, and Sherwood are covered under a regional drainage basin-based NDPES Phase I permit issued to Clean Water Services, these cities have not developed their own SWMPs. Rather, they all are co-implementers of Clean Water Services' regional SWMP. This regional approach sets these three cities apart from Troutdale and the other six mentioned. For this reason, the focus of the comparison is on the remaining six municipalities which are peer cities to Troutdale and have each developed, and are separately implementing, their own SWMPs.

Wood Village and Gresham anchor the two ends of the population range and provide reference points for how much smaller and much larger cities are responding, or plan to respond, to permit requirements. Fairview, Gladstone, Milwaukie and Wilsonville more closely bracket Troutdale's population and area coverage and would be expected to have similar programs. With the exception of Troutdale and Gresham, consultants were used to develop the cities' SWMPs. Overall, these six municipal SWMPs provide insight into the general level of effort being expended or proposed by each in the areas of the six minimum control measures and a relative sense of where Troutdale fits along that spectrum. Area coverage is also provided as a second measure of size. Consistent with the population data, Wood Village and Gresham mark the low and high ends of the area range. The remaining cities' area coverage is 59 percent to 145 percent of Troutdale's, similar to population range. Area coverage was obtained from City sources. Table 8.1 summarizes municipal population and area coverage statistics.

Table 8.1 Municipal Populations and Area Coverage

Peer Jurisdiction	Wood Village	Fairview	Gladstone	Troutdale	Wilsonville	Milwaukie	Gresham
Population	2,880	9,425	12,710	14,880	16,510	20,655	95,900
Area (mi^2)	1.0	3.8	3.0	5.1	7.4	5.0	22.0

8.4 Data Sources

Data used for the SWMP comparisons is the most recent information available. Phase I permittees were required to update their SWMPs and submit them to DEQ by May 2006. Phase II permittees were required to submit their SWMPs to DEQ within one year of their permit application deadline or March 2004. Troutdale's SWMP (February 2004) was obtained from the City's website. All other SWMPs were obtained from DEQ in September 2006 and are dated as follows:

- Wood Village (September 2001)
- Fairview (April 2006)
- Gladstone (May 2006)
- Wilsonville (April 2006)
- Milwaukie (May 2006)
- Gresham (May 2006)

With the exception of Wood Village, most of the data is very current. One reason for the early date of the Wood Village SWMP may be that they had considered applying for coverage under Phase I, but elected to wait for Phase II. Fortunately, the bulk of the data is current enough to support a timely and thorough comparison to Troutdale's SWMP.

8.5 SWMP Comparison and Findings

The SWMPs for each City were reviewed and the associated Best Management Practices

(BMPs) tabulated. To facilitate the comparison of Phase I permittees to Troutdale, only those BMPs relating to the six minimum control measures of the Phase II permit were included. Many of the BMPs selected by each City fulfill multiple measures; however, for simplicity, each BMP is shown only once in the tabulation under the measure with the strongest correlation. The BMP tabulation by City is shown in Table 8.2.

In order to give the greatest insight possible into the level of effort being expended by each City, the table also indicates which BMPs are provided by contractors and whether the City is implementing the BMP directly, providing support to other programs, or planning to develop/update programs during their permit term. Both Phase I and II permit terms are five years. Phase I permits were reissued in 2005. Phase II permits have yet to be issued although DEQ intends to issue all permits by June 2007.

Information used in the comparisons comes directly from the seven individual city SWMPs. In some cases, cities may not have specifically identified activities they are performing that could be credited toward permit compliance. The comparison provided here is based solely on activities described by each city as *explicitly* specified in their SWMPs.

In a few cases, Troutdale's broader BMPs can be broken down into multiple BMPs to facilitate comparison with more specific citations of some of the other cities. For example, under Illicit Discharges, Code Enforcement can be broken down into Municipal Code Prohibitions *and* Legal Authority for Enforcement. Similarly, Dry Weather Flow Observations can be broken down into Dry Weather Field Screening *and* Illicit Discharge Inspection/Investigation. Consequently, there are instances in the comparison where Troutdale is credited with more BMPs in a particular area than their explicit SWMP BMP titles reflect.

BMPs under each of the six minimum control measures and city utilization are summarized in the following paragraphs. The numbers of cities utilizing the BMPs are indicated in parentheses.

Minimum Control Measure #1: Public Education and Outreach

Under this measure, the Phase II permit requirements specify that Troutdale "must implement a program to distribute educational materials to the community or conduct equivalent outreach activities about the impacts of stormwater discharges on water bodies and the steps that the public can take to reduce pollutants in stormwater runoff."

For this minimum control measure, a range of eighteen BMPs was identified. Out of this range, five were cited as being performed by the majority of the cities:

- City Newsletters (6)
- Catch Basin Labeling or Stenciling (5)
- Billing Inserts (4)
- Pamphlets/Brochures/Posters (4)
- Hazardous Waste Disposal Events (4)

TABLE 8.2: SWMP COMPARISON

NPDES Phase II Minimum Control Measure and Associated BMPs		# of Cities Using BMP	Troutdale	Wood Village	Fairview	Gladstone	Wilsonville	Milwaukie	Gresham
		Population	14,880	2,880	9,425	12,170	16,510	20,655	95,900
		Area (mi²)	5.1	1.0	3.8	3.0	7.4	5.0	22.0
Public Education and Outreach on Stormwater Impacts									
1	City Newsletter	6	x	x		x	x	x	x
2	Catchbasin labeling	5	x	x		x	x	x	
3	Billing Inserts	4	x	x		x		x	x
4	Pamphlets/Brochures/Posters	4	x	Gresham		x			x
5	Hazardous Waste Disposal Event	4	x	x	Support				x
6	Local Newspaper Articles	3				x	x		x
7	School-based Education	3	x		Support		x		
8	Solid Waste/Recycling Programs	3		Gresham	Support				x
9	Regional Coalition for Clean Rivers and Streams	3				x	x	x	
10	Intergovernmental Coordination	3				x	x	x	
11	Spring Clean Up of Yard Debris	2	x		Support				
12	Information Kiosk at Events/City Hall	2		x	x				
13	Business Assistance - Private Catchbasin Cleaning	1			Support				
14	Pet Waste/Litter Receptacles	1			x				
15	Public Service Announcements	1							x
16	Television and Videos	1							x
17	Signs/Advertisements	1							x
18	Stakeholder Training of regulatory updates	1							x
Public Involvement and Participation									
1	Public Notice for SWMP Review and Comment	5			x	x	x	x	x
2	Website Stormwater Information	4	x		x		x	x	x
3	Volunteer Opportunities	3		x	x		x		
4	Stormwater Open House Events	2	x						x
5	Public Meetings	2	x						x
6	Presentations to Technical/Citizen Advisory Committees	2			x				x
7	Earth Day Event	1	x						
Illicit Discharge Detection & Elimination									
1	Dry Weather Field Screening	7	x	x	x	x	x	x	x
2	Municipal Code prohibitions of illicit discharges	6	x	x	x		x	x	x
3	Illicit Discharge/Dumping Inspection/Investigations	6	x	x	x	x	x	x	
4	Legal Authority for Enforcement Actions	5	x	x	x		x		x
5	Stormwater System Mapping	5	x	Update 2002			x	x	x
6	Inflow and Infiltration (I & I) Investigations	3		Develop		x		x	
7	Public Reporting Program	2			Develop		x		
8	Dechlorinate Water Line Flushing	2			x			x	x
9	Control Releases from Fire Training Activities	1							x
10	New Stormwater Pipe Television Inspections	1							x
Construction Site Stormwater Runoff Control									
1	Municipal Code requirements for Erosion Control	7	x	x	x	x	x	x	x
2	Inspection of Construction Sites	7	x	x	x	CCSD#1	x	x	x
3	Legal Authority for Enforcement Actions	7	x	x	x	x	x	x	x
4	NPDES 1200-C Permitting Authority	1	x						
5	Erosion Control Program Training for Contractors	1			Handbook	Manual	Precons	x	
Post Construction Runoff Control									
1	Development Review of New/Redevelopment	7	x	x	x	x	x	x	x
2	Water Quality Design Requirements	6	x	x	x		x	Update	x
3	Municipal Code Water Quality Provisions	6	x		x	x	x	x	x
4	Water Quantity Design Requirements	5	x	x	x		x	Update	
5	O and M requirements for private stormwater facilities	3	x	x					x
6	Maintenance Inspections of private stormwater facilities	2		x		x			
7	Enforce DEQ UIC Rules for UICs	1	x						
8	Promote Low Impact Development Practices	1							x
Pollution Prevention In Municipal Operations									
1	Street Sweeping	7	Multnomah	Multnomah	Multnomah	x	Contractor	x	x
2	Catchbasin Cleaning	7	x	Multnomah	x	x	x	x	x
3	Spill Response	7	Gresham	Gresham	Gresham	x	TVFR	CCFD#1	x
4	Conveyance System Cleaning and Maintenance	6		x	x	x	x	x	x
5	Sand Collection after Deicing	6		Multnomah	Multnomah	x	x	x	x
6	Water Quality Facility Maintenance	6	x		x	x	x	x	x
7	Stormwater Master Plan/CIP	5		1996	Update		x	x	x
8	Routine Road Maintenance	5			Multnomah	x	x	x	x
9	Landscape Maintenance/Chemical Applicator Licensing	5	x		x	x	x	x	
10	Spill Response Staff Training	4		x			x	x	x
11	Spill Prevention through Public Education	3		x			x		
12	Pollution/Spill Prevention Staff Training	3		x	x				x
13	Vehicle Maintenance	3	x		x				x
14	Integrated Pest Management	3			x	Evaluate	x		x
15	Policies to Encourage Native Vegetation	3			x		x	x	
16	Existing System Retrofits for Water Quality	2		Evaluate	x				x
17	Spill Response Plan	2		Future		x			x
18	Drywell Cleaning	1	x						
19	Enhance Riparian Areas	1							x
20	Spill Prevention through Wellhead Protection	1			x				
21	Stockpile Management	1	x						
22	Debris Disposal	1	x						
23	Hazardous Material Storage	1	x						
24	On-call Sanitary Sewer Response	1	x						
25	Weekly Curbside Collection of Yard Debris	1				x			
26	Stormwater Maintenance Plan and Procedures	1		Develop	Develop				x

Troutdale has included the first four BMPs with the exception of Billing Inserts and has included two additional BMPs shown below, for a total of six public education and outreach BMPs:

- School-based Education
- Spring Clean Up of Yard Debris

Minimum Control Measure #2: Public Involvement and Participation

Under this measure, the Phase II permit requirements specify that Troutdale "adopt a public participation process as part of their on-going stormwater management program. The public participation process must provide opportunities for members of the public to participate in program development and implementation."

In contrast, Phase I permit requirements specify that permittees conduct public involvement processes only for permit renewal submittals which includes an updated SWMP, and for on-going adaptive management. Most of the Phase I permittees efforts for public involvement is limited to making their SWMPs, as well as any proposed changes resulting from adaptive management, available for public review and comment and making presentations to technical or advisory groups.

For this minimum control measure, a range of seven BMPs was identified. Out of this range, two were cited as being performed by the majority of the cities:

- Public Notice for SWMP Review and Comment (5)
- Website Stormwater Information (4)

Troutdale has included the Website BMP and three additional BMPs shown below for a total of four public education and outreach BMPs:

- Stormwater Open House Event
- Earth Day Event
- Public Meetings

Minimum Control Measure #3: Illicit Discharge Detection and Elimination

Under this measure, the Phase II permit requirements specify that Troutdale must "develop, implement, and enforce a program to detect and eliminate illicit discharges" to their stormwater system, including mapping, ordinances, a detection and elimination plan, public information, and complaint response.

For this minimum control measure, a range of ten BMPs was identified. Out of this range, five were cited as being performed by the majority of the cities:

- Dry Weather Field Screening (7)
- Municipal Code Prohibitions of Illicit Discharges (6)
- Illicit Discharge/Illegal Dumping Inspection/Investigation (6)
- Legal Authority for Enforcement Actions (5)
- Stormwater System Mapping (5)

Troutdale has included all the above BMPs for a total of five Illicit Discharge Detection and Elimination BMPs.

Minimum Control Measure #4: Construction Site Stormwater Runoff Control

Under this measure, the Phase II permit requirements specify that Troutdale must "develop, implement, and enforce a program to reduce pollutants in any stormwater runoff" to their stormwater system from construction activities that result in a land disturbing activity of one acre or greater. Minimum requirements include an ordinance, use of erosion control BMPs, waste prevention and control, development review, inspection and enforcement, and a system for public reporting.

For this minimum control measure, a range of five BMPs was identified. Out of this range, three were cited as being performed by the majority of the cities:

- Municipal Code requirements for Erosion Control (7)
- Inspection of Construction Sites (7)
- Legal Authority for Enforcement Actions (7)

Troutdale has included all the above BMPs and one additional BMP as shown below for a total of four Construction Site Stormwater Runoff Control BMPs:

- NPDES 1200-C Permitting Authority

Minimum Control Measure #5: Post Construction Runoff Control

Under this measure, the Phase II permit requirements specify that Troutdale must "develop, implement, and enforce a program to address pollutants in stormwater runoff" to their stormwater system from new development and redevelopment projects that disturb one acre or greater. Minimum requirements include strategies combining structural and non-structural BMPs, an ordinance, and provision for long-term operations and maintenance of BMPs.

For this minimum control measure, a range of eight BMPs was identified. Out of this range, four were cited as being performed by the majority of the cities:

- Development Review of New and Redevelopment (7)
- Water Quality Design Requirements (6)
- Municipal Code Water Quality Provisions (6)
- Water Quantity Design Requirements (5)

Troutdale has included all the above BMPs and included the two additional BMPs shown below for a total of six Post Construction Runoff Control BMPs:

- Operations and Maintenance Requirements for Private Stormwater Facilities
- Enforce DEQ Underground Injection Control (UIC) Rule

Minimum Control Measure #6: Pollution Prevention in Municipal Operations

Under this measure, the Phase II permit requirements specify that Troutdale must "develop and implement an operations and maintenance program that includes an employee training component.

For this minimum control measure, a range of twenty-six BMPs was identified. Out of this range, ten were cited as being performed by the majority of the cities:

- Street Sweeping (7)
- Catch Basin Cleaning (7)
- Spill Response (7)
- Conveyance System Cleaning and Maintenance (6)
- Sand Collection after Deicing (6)
- Water Quality Facility Maintenance (6)
- Stormwater Master Plan/CIP (5)
- Routine Road Maintenance (5)
- Landscape Maintenance/Chemical Applicator Licensing (5)
- Spill Response Staff Training (4)

Troutdale has included five of the above BMPs. The City has included an additional six BMPs, shown below for a total of eleven Pollution Prevention in Municipal Operations BMPs:

- Drywell Cleaning
- Stockpile Management
- Debris Disposal
- Vehicle Maintenance
- Hazardous Material Storage
- On-call Sanitary Sewer Response

Table 8.3 shows Troutdale's BMPs along with all the prevalent BMPs (used by four or more of the peer cities). From this table it is easy to see that Troutdale is implementing 22 of the 29 most prevalent stormwater BMPs, and has added 14 additional BMPs specific to its program needs or opportunities, for a total of 36 BMPs.

Table 8.4 provides a tabular summary of the number of BMPs used by each City, categorized by control measure; a total of all BMPs utilized, by City; and a relative City ranking, based on the number of BMPs utilized.

TABLE 8.3: Troutdale SWMP BMPS and Utilization of Prevalent BMPS			
NPDES Phase II Minimum Control Measures		# of Cities Using BMP	Troutdale SWMP BMPs
Public Education and Outreach on Stormwater Impacts			
1	City Newsletter	6	x
2	Catchbasin labeling	5	x
3	Pamphlets/Brochures/Posters	4	x
4	Billing Inserts	4	
5	Hazardous Waste Disposal Event	4	x
6	School-based Education	3	x
7	Spring Clean Up of Yard Debris	2	x
Public Involvement and Participation			
1	Public Notice for SWMP Review and Comment	5	
2	Website Stormwater Page	4	x
3	Stormwater Open House Events	2	x
4	Public Meetings	2	x
5	Earth Day Event	1	x
Illicit Discharge Detection & Elimination			
1	Dry Weather Field Screening	7	x
2	Municipal Code prohibitions of illicit discharges	6	x
3	Illicit Discharge/Dumping Inspection/Investigations	6	x
4	Stormwater System Mapping	5	x
5	Legal Authority for Enforcement Actions	5	x
Construction Site Stormwater Runoff Control			
1	Municipal Code requirements for Erosion Control	7	x
2	Inspection of Construction Sites	7	x
3	Legal Authority for Enforcement Actions	7	x
4	NPDES 1200-C Permitting Authority	1	x
Post Construction Runoff Control			
1	Development Review of New/Redevelopment	7	x
2	Water Quality Design Requirements	6	x
3	Municipal Code Water Quality Provisions	6	x
4	Water Quantity Design Requirements	5	x
5	O and M requirements for private stormwater facilities	3	x
6	Enforce DEQ UIC Rules for UICs	1	x
Pollution Prevention In Municipal Operations			
1	Street Sweeping	7	Multnomah
2	Catchbasin Cleaning	7	x
3	Spill Response	7	Gresham
4	Sand Collection after Deicing	6	
5	Conveyance System Cleaning and Maintenance	6	
6	Water Quality Facility Maintenance	6	x
7	Stormwater Master Plan/CIP	5	
8	Routine Road Maintenance	5	
9	Landscape Maintenance/Chemical Applicator Licensing	5	x
10	Spill Response Staff Training	4	
11	Vehicle Maintenance	3	x
12	Drywell Cleaning	1	x
13	Stockpile Management	1	x
14	Debris Disposal	1	x
15	Hazardous Material Storage	1	x
16	On-call Sanitary Sewer Response	1	x

Table 8.4: Number Of BMPS Utilized By City By Measure							
NPDES Phase II Minimum Control Measures	Troutdale	Wood Village	Fairview	Gladstone	Wilsonville	Milwaukie	Gresham
Population	14,880	2,880	9,425	12,170	16,510	20,655	95,900
Area (mi²)	5.1	1.0	3.8	3.0	7.4	5.0	22.0
Public Education and Outreach on Stormwater Impacts	6	7	7	7	6	5	10
Public Involvement and Participation	4	1	4	1	3	2	5
Illicit Discharge Detection & Elimination	5	6	6	3	6	6	7
Construction Site Stormwater Runoff Control	4	3	4	4	4	4	3
Post Construction Runoff Control	6	5	4	3	4	4	5
Pollution Prevention In Municipal Operations	11	9	15	10	13	11	16
Total	36	31	40	28	36	32	46
Ranking	3	5	2	6	3	4	1

Recommendations for enhancements to Troutdale's SWMP based on this peer review are combined with those identified through the BMP evaluation and addressed later in this section under SWMP Recommendations.

8.6 BMP Effectiveness Evaluation and Findings

A primary goal of the Troutdale SWMP review is to qualitatively evaluate its associated BMPs in terms of improving water quality and providing a cost-effective return on investment of limited resources. Criteria to measure these qualities were developed with staff for use in the evaluation and include:

- Addresses known impacts to water quality
- Provides multiple benefits
- Reduces stormwater system maintenance costs
- Provides opportunities for partnering
- Meets public acceptance
- Meets Prevalent BMP category
- Requires no additional resources to implement

Each of these criterion and the BMPs that satisfy them are discussed in more detail in the following paragraphs and summarized in Table 8.5.

Addresses Known Impacts to Water Quality

Troutdale does not currently monitor water quality in its surface waters or stormwater outfall discharges. Without monitoring information, it is difficult to accurately assess water quality impacts. Phase I of NPDES does require outfall and ambient water quality monitoring. Similar monitoring requirements will likely be required in future permit cycles for Phase II jurisdictions.

Alternatively, as part of its responsibility for protecting Oregon's surface waters, DEQ has developed water quality standards and identifies waters that do not meet the standards through its 303d List. In cases where standards are not being met, DEQ also develops total maximum daily loads (TMDLs) or water clean-up plans designed to achieve standards. DEQ has identified temperature and bacteria as known impacts to the Sandy River and has proposed TMDLs. As specified in the Phase II draft permit, DEQ will require the City to implement adopted TMDLs and reduce these particular pollutant loads to the Sandy River in future permit cycles.

In addition to known impacts, the City can also reasonably assume water quality impacts from practices or pollution sources known to adversely affect water quality such as eroded sediment from construction sites, contaminated runoff from roads or yards, or potential sources such as spills, illicit connections, or illegal dumping. For the purposes of this qualitative evaluation, BMPs that address reasonably assumed water quality impacts will be treated as satisfying this criterion.

All the BMPs included in the City's SWMP satisfy this criterion. The intent of the Public Education and Outreach BMPs is to raise awareness of known or potential stormwater impacts and provide alternatives to avoid those impacts. Likewise, the Involvement and Participation BMPs have a similar aim and encourage a more active role of the community in stormwater management. All the remaining BMPs are focused on providing the tools or practices the City needs to address or avoid known or potential impacts from illicit discharges, development, and municipal housekeeping or maintenance operations.

Provides Multiple Benefits

BMPs that provide multiple benefits are also likely to be the most cost effective in meeting the City's overall needs. For example, street sweeping used as a pollutant source control mechanism removes pollutants from the roadway system before they are introduced into the stormwater system and affect water quality. This BMP can also be used to improve road safety, and increase aesthetic quality of the City.

TABLE 8.5: EVALUATION CRITERIA AND RATING

	NPDES Phase II Minimum Control Measures	Addresses Impacts	Provides Multiple Benefits	Reduces Maintenance Costs	Provides Partnering Opportunities	Meets Public Acceptance	Meets Prevalent BMP Definition	Requires No Additional Resources	Total Criterion Satisfied
Public Education and Outreach on Stormwater Impacts									
1	Pamphlets/Brochures/Posters	X	X	X	X	X	X		6
2	Catchbasin labeling	X	X	X		X	X		5
3	City Newsletter	X	X	X		X	X		5
4	School-based Education	X	X	X	X	X			5
5	Spring Clean Up of Yard Debris	X	X	X		X		X	5
6	Hazardous Waste Disposal Event	X	X	X	X	X	X	X	7
Public Involvement and Participation									
1	Stormwater Open House Events	X	X	X		X			4
2	Earth Day Event	X	X	X		X		X	5
3	Public Meetings	X	X	X		X			4
4	Website Stormwater Page	X	X	X		X	X		5
Illicit Discharge Detection & Elimination									
1	Stormwater System Mapping	X	X	X	X	X	X	X	7
2	Municipal Code prohibitions of illicit discharges	X		X		X	X	X	5
3	Legal Authority for Enforcement Actions	X		X		X	X	X	5
4	Dry Weather Field Screening	X		X		X	X		4
5	Illicit Discharge/Dumping Inspection/Investigations	X		X		X	X		4
Construction Site Stormwater Runoff Control									
1	NPDES 1200-C Permitting Authority	X			X	X	X	X	5
2	Municipal Code requirements for Erosion Control	X	X	X		X	X	X	6
3	Inspection of Construction Sites	X	X	X		X	X	X	6
4	Legal Authority for Enforcement Actions	X	X	X		X		X	5
Post Construction Runoff Control									
1	Water Quality Design Requirements	X		X		X	X	X	5
2	Water Quantity Design Requirements	X		X		X	X	X	5
3	Development Review of New/Redevelopment	X				X	X	X	4
4	Municipal Code Water Quality Provisions	X				X		X	3
5	Enforce DEQ UIC Rules for UICs	X		X		X			3
6	O and M requirements for private stormwater facilities	X		X		X		X	4
Pollution Prevention In Municipal Operations									
1	Street Sweeping	X	X	X	X	X	X	X	7
2	Catchbasin Cleaning	X			X	X	X	X	5
3	Drywell Cleaning	X				X		X	3
4	Water Quality Facility Maintenance	X				X	X	X	4
5	Spill Response	X			X	X	X		4
6	Stockpile Management	X				X		X	3
7	Debris Disposal	X				X			2
8	Vehicle Maintenance	X	X			X		X	4
9	Hazardous Material Storage	X				X		X	3
10	On-call Sanitary Sewer Response	X				X		X	3
11	Landscape Maintenance/Chemical Applicator Licensing	X				X	X	X	4

All the Education and Outreach BMPs provide multiple benefits by their potential to influence behaviors that can affect not only water quality but also the use of resources and demand on the stormwater system. By reducing illegal dumping and improper disposal of yard debris, the City can benefit from reduced need for maintenance. Many of the outreach and involvement efforts also provide relationship-building opportunities between the community and City staff as well as between the City and partnering agencies. Spring clean up of yard debris and hazardous waste disposal events also help the City meet its solid waste and recycling objectives and contribute to community aesthetics.

Stormwater system mapping is needed not only for development of an illicit discharge detection and elimination plan, but is also crucial to effective master planning, and planning for inspection, cleaning and maintenance. Erosion control requirements coupled with inspection and enforcement can translate into effective protection of surface water quality and stormwater system function by preventing impacts from sediment loading and reducing the need for maintenance. In addition to the multiple benefits mentioned earlier, street sweeping also offers the benefit of reducing costs through partnering. Vehicle maintenance not only improves source control of pollutants, but also provides for efficient, safe delivery of other City services and prolonged life of City assets.

Reduces Stormwater System Maintenance Costs

BMPs that focus on preventative maintenance, such as inspections and cleaning; and system longevity, such as design standards - requirements for Low Impact Development, and stormwater master planning; all have potential to contribute to reducing long-term maintenance costs. Public education and outreach BMPs also have the potential to contribute toward reducing maintenance costs by raising awareness and educating residential, commercial, and industrial system users about things they can do to reduce system impacts. For purposes of this evaluation, BMPs that reduce or have the potential to reduce maintenance costs will be treated as satisfying this criterion.

Provides Opportunities for Partnering

Partnering allows for cost savings through the pooling of resources and equipment or through greater program efficiency. Public involvement and outreach on stormwater impacts is one example of an area that lends itself well to partnering or regional approaches. This is also true for some maintenance practices that require specialized training and/or equipment. It is often most cost effective for smaller jurisdictions to contract with larger municipalities that possess vactoring or street sweeping equipment and the staff to operate it, rather than making that substantial investment for its own periodic needs. Troutdale currently partners with various agencies for use of existing educational resources and with Metro for their hazardous waste disposal event. The City also partners with Multnomah County for street sweeping and Gresham for spill response assistance. In cases where partnerships already exist, these BMPs are considered to satisfy this criterion.

Meets Public Acceptance

For most municipalities, public acceptance is a critical component of building credibility with its citizens and gaining the support of its programs. Public acceptance can be difficult to assess except in the most extreme of cases where the public is clearly in favor or clearly opposed to a proposed action, such as can be determined through the elections process. In many cases, public acceptance of stormwater management BMPs is assumed unless sufficient controversy is raised to bring the issue into question. Normally, public acceptance of stormwater management plans and associated BMPs is tested through the public review process where feedback can be used to tailor plans to meet the public's expectations. Because the City received no opposition to its 2004 SWMP through the public review process, this evaluation assumes that the associated BMPs meet with public acceptance. Since all of the City's BMPs are assumed to meet with public acceptance, one could argue that it is not necessary to include this criterion as part of the evaluation. However, the use of this criterion acknowledges that the City's selected BMPs passed the public acceptance test and that this important step was not overlooked.

Meets Prevalent BMP Category

As identified in the SWMP Comparison, several of the same BMPs are being used by a majority (four or more) of the peer jurisdictions. Five of the six peer jurisdictions are Phase I permittees who have been covered by NPDES stormwater permits since the mid-1990's. Selection of BMPs by Phase I permittees in Oregon has historically been based on guidance provided by EPA, DEQ, published research, and industry standards in the field of stormwater management. Many Phase II permittees are following this same approach in selecting BMPs for their SWMPs. While BMP technology continues to grow and evolve over time, it is a slow process. Scientific studies have been conducted and are underway to assess the effectiveness of structural and non-structural BMPs. So far, these studies have produced mixed results. Different studies show conflicting data as to the effectiveness of BMPs in reducing pollutant concentrations. For some BMPs and constituents, no studies have been published on the effectiveness of BMPs to reduce contamination. For purposes of this evaluation, BMPs identified as prevalent will be rated as more beneficial than others.

Requires No Additional Resources to Implement

This criterion addresses resources required to implement the SWMP. By making use of existing practices or readily available resources, or gaining efficiencies, the City is able to implement some BMPs without investment of additional resources. Feedback from the City for this criterion is based on the availability of resources at the time the BMPs were proposed for inclusion in the SWMP. For example, the City has had a street sweeping program for several years that was initially intended to address safety and aesthetics concerns. Because this program was already in place and provides the additional benefit of pollution reduction, this BMP satisfies this criterion.

Table 8.5 summarizes the findings from the BMP evaluation and Table 8.6 shows the number of BMPs satisfying the greatest number of criterion from highest to lowest.

Table 8.6: Number of Criteria Satisfied by Number of BMPs

# Criteria Satisfied	7	6	5	4	3	2	Total # of BMPs
# BMPs	3	3	13	10	6	1	36

8.7 Conclusions

SWMP Comparison

The results of the peer review reveal that Troutdale is implementing 22 of the 29 most prevalent BMPs and has included an additional 14, bringing its total to 36. Table 8.4 shows that of the seven jurisdictions reviewed, Troutdale ties for third in terms of the number of BMPs included in its SWMP. For comparison, Gladstone ranked lowest with 28 and Gresham ranked highest with 46. The remaining cities ranged between 31 and 40 BMPs, respectively. In relation to its peers, Troutdale is essentially in the middle of the range, which is consistent with expectations given the population and area statistics.

BMP Evaluation

Seven criteria were chosen by which to qualitatively evaluate the City's BMPs. All criteria reflected positive attributes aimed at providing a sense of the effectiveness and return on investment of each BMP. Twenty-nine BMPs satisfied more than four of the criterion, which confirms that these BMPs are worthwhile to conduct and many are required by the draft NPDES Phase II permit. The remaining seven BMPs satisfied between two and three criterion. These lower scoring BMPs are associated with two minimum control measures: Post Construction Site Runoff Control and Pollution Prevention. In both areas, these lower scoring BMPs are needed to meet permit requirements, protect property or resources, or may be required by other regulations such as wellhead protection and underground injection control.

Regulatory Compliance

The focus of this SWMP review is on comparing Troutdale's program with several of its peer jurisdictions and evaluating the effectiveness of the City's chosen BMPs. While these goals have been addressed through the evaluation process, additional insight can be gained by including a brief review of compliance of the City's SWMP BMPs with established draft permit requirements.

The City SWMP and its BMPs appear to meet the majority of the NPDES Phase II permit requirements for each of the six minimum control measures. In some areas, such as public education and outreach, the City has flexibility to choose BMPs they feel will adequately address stormwater impacts. This is also the case for public involvement and participation

BMPs. For illicit discharges, the City must implement specific requirements such as stormwater mapping, prohibitions of non-stormwater discharges, etc., and they have included BMPs that address some, but not all, of these requirements. The City has included the needed BMPs to satisfy the specific construction site runoff control and post-construction stormwater management permit requirements. For pollution prevention in municipal operations, the City has included most of the BMPs needed to address specific requirements although there is one area needing enhancement. For this component, the City is required to include training in their operations and maintenance program that addresses prevention and reduction of stormwater pollution from a host of sources. This training program was not identified in their SWMP and they have received feedback from DEQ that this requirement will need to be met either through a SWMP revision or through compliance schedule stipulations issued with their Phase II permit.

As part of the six minimum measures, the City is required to include structural and non-structural BMPs along with measurable goals, persons responsible for implementation, and a schedule that identifies frequency and interim milestones. Rationale for the choice of BMPs and the measurable goals must also be included in the SWMP. Troutdale's SWMP does not include a schedule or identify the persons responsible for implementation. DEQ also provided this feedback to the City in its August 2006, comment letter, indicating that these requirements can be addressed through SWMP revision or compliance schedule stipulations.

In addition to the six minimum control measures, Troutdale will also be responsible for complying with the draft permit stormwater management program requirements that include management practices, control techniques, system design and engineering requirements, and provision for the control of pollutants. The City's SWMP appears to meet these program requirements.

The draft Phase II permit requirements also include an adaptive management process, program effectiveness monitoring, and annual reporting. The SWMP does not provide information on how the City will meet these remaining permit requirements.

8.8 SWMP Recommendations

The results of the SWMP comparison and evaluation reveal that Troutdale has taken substantial steps to address the City's stormwater management needs and upcoming NPDES Phase II permit requirements. In summary, the City's SWMP:

- Includes 22 of the 29 most prevalent BMPs employed by its regional peer jurisdictions
- Includes 14 additional BMPs specific to its needs and opportunities
- Generally satisfies the six minimum control measures required by the draft NDPES Phase II permit
- Positions Troutdale in the middle of the spectrum in terms of its peer jurisdictions based on population and area

- Includes BMPs that are effective, produce worthwhile return on investment or must be included to satisfy draft NPDES Phase II permit or other regulatory requirements

While the results are positive, the evaluation has also identified several areas where there are opportunities for enhancement. The opportunities for enhancement fall into four general categories:

- Credit for existing BMPs not identified in the SWMP
- BMPs to target TMDL pollutant reduction
- Regulatory compliance gaps
- Enhancements to consider

Otak has produced recommendations in each category that are discussed in greater detail in the following paragraphs and summarized in Table 8.7. Lastly, observations on the adequacy of proposed frequencies for both street sweeping and catch basin cleaning have been included.

Credit for Existing BMPs

As part of the SWMP comparison, it became clear that Troutdale is conducting several activities that are not included in its SWMP that demonstrate compliance with permit requirements. For example, Troutdale has conducted stormwater master planning for both the North and South Troutdale drainage basins and could include this in their SWMP. Another example is conveyance system cleaning that the City conducts as part of its operations and maintenance program to maintain system capacity and reduce pollutant loading to receiving waters. Routine road maintenance practices may be another area where the City could receive credit toward regulatory compliance. By adding these existing BMPs to their SWMP, the City can better protect itself against legal challenges by regulators, the public, or special interest groups. This greater protection, however, comes at the cost of increased annual reporting to cover these additional activities.

BMPs to Target TMDL Pollutant Reduction

As mentioned earlier, the only known impacts to water quality are those identified by DEQ as part of its 303(d) listings of impaired water bodies. TMDLs are developed for 303(d) listed waters when conditions fail to meet certain water quality standards. The Sandy River Basin TMDL approved by the EPA on April 14, 2005, calls for load and waste load allocations for temperature and bacteria for contributing point and non-point sources.

The City has an existing NPDES permit for its sewage treatment plant. The City's NPDES permit renewal will include the waste load allocation identified in the TMDL. For stormwater sources, Schedule D of the draft Phase II permit is the enforcement mechanism for compliance with TMDLs. The City's NPDES Phase II permit for its municipal stormwater system will require the City to reduce bacteria discharges to Beaver Creek. For the first term of the permit, the draft permit language states that reducing bacteria discharges to the maximum extent practicable will be deemed adequate progress toward achieving the waste load allocation. The bacteria waste load allocation has been established at 86 percent reduction. The draft permit language goes on to specify that progress towards reducing TMDL pollutant loads will be evaluated, in subsequent permit terms, using performance measures and pollutant load reduction benchmarks developed and listed in (subsequent) SWMPs.

Since TMDL compliance is specifically required in the NPDES Phase II stormwater permit, Troutdale can better position itself for future compliance by including the BMPs best suited for reducing bacteria sources and pollutant loading in its SWMP now. The Sandy River TMDL cites urban runoff as a significant source of instream bacteria. Ultimate sources of urban bacteria cited include pet, wildlife, and animal waste; illegal dumping of sanitary waste; failing septic systems; and sanitary sewer overflows. In terms of stormwater BMPs that should be included in the City's SWMP today, those that focus on proper pet waste disposal and detection and elimination of illegal dumping of sanitary waste will provide the greatest benefit.

Proper pet waste disposal should be specifically included in the City's SWMP under the public education and outreach component and the topic included in existing BMPs such as pamphlets, the City newsletter and school based education. Placing signage, mitts, and bag dispensers at City park areas also encourages and facilitates proper pet waste disposal.

The City's SWMP currently identifies several BMPs under the illicit Discharge Detection and Elimination component. These may be sufficient to address illegal bacterial discharges associated with the stormwater system. However, the City would benefit from documenting their detection and elimination strategy as discussed next under Regulatory Compliance Gaps.

Regulatory Compliance Gaps

As part of the SWMP review, several compliance gaps were identified in relation to the NPDES Phase II permit requirements. In terms of the six minimum control measures, suggested enhancements are noted in the following areas:

Illicit Discharge – The City has specifically identified two of the required BMPs (mapping and ordinance) and included dry weather flow observations as a third. Beyond these steps, the draft permit requires that:

- a plan be developed to detect and address non-storm discharges and illegal dumping
- wide-spread education be conducted on hazards of illegal discharges and improper waste disposal, and
- a process be developed to respond to and document complaints

As identified in the preceding discussion of BMPs best suited for TMDL compliance, development of a plan that includes these remaining requirements and details mapping, field assessment, characterization and source tracking procedures, education mechanisms, and complaint response protocols, including activity schedules, would help close this gap and fully address permit requirements. The Center for Watershed Protection through funding from EPA has developed a comprehensive manual that outlines practical, low cost, and effective techniques for use by local governments. The Illicit Discharge Detection and Elimination Guidance Manual provides valuable guidance to NPDES Phase II communities and can be downloaded free of charge at www.cwp.org/idde_verify.htm.

Pollution Prevention – Consistent with DEQ's comment letter, the City needs to add an employee training program as one of it's BMPs for this component to fully address permit requirements. The City has identified spill response training as their initial training focus. Gresham has an established spill response protocol and has identified ongoing staff training for both spill response and spill prevention as part of their SWMP BMPs. Wilsonville identified OSHA First Responder training for staff under their Spill Prevention and Response BMP. Milwaukie identified staff training in spill response for non-hazardous spills as an Education and Outreach BMP. Fairview also identified staff training on stormwater requirements as one of their BMPs. Gresham, Wilsonville, Milwaukie and Fairview may be willing to serve as resources to Troutdale as the City develops its spill response training program.

Other Permit Requirements - DEQ's comment letter also identified the need for an overall SWMP BMP implementation schedule and designation of persons responsible for implementation to fully address permit requirements. The draft permit requires adaptive management, effectiveness monitoring, and annual reporting. The City may want to consider expanding their existing SWMP to address the steps and procedures needed to meet these remaining permit conditions. Developing a more comprehensive plan that describes the City's stormwater management strategy and implementation schedule will help staff plan more effectively and allow the most efficient use of resources.

Enhancements to Consider

Road Maintenance – Troutdale's SWMP does not specifically address road maintenance activities. Several of the peer jurisdictions noted in their SWMPs that they follow maintenance programs substantially similar to or more protective than the 1999 ODOT Routine Road Maintenance Water Quality and Habitat Guide procedures. NOAA Fisheries has approved these procedures under the ESA 4d rule, which when followed reduces municipal liability for salmon kill or habitat damage associated with road maintenance activities. Gresham, in partnership with Multnomah County and the Cities of Fairview and Wood Village, is currently developing and implementing a similar set of standard operating procedures for maintenance designed to minimize impacts to water quality and habitat. Troutdale might benefit from collaboration with this effort if they are not already following the ODOT guidance.

Landscape Maintenance – Troutdale's SWMP did not specifically address landscape maintenance other than to include a BMP to require Chemical Applicator Licensing for herbicide application. Several of the peer jurisdictions are following Integrated Pest Management practices consistent with or modeled after the City of Portland's Pest Management Program. Like the ODOT Regional Road Maintenance Guide, this program has also been approved by NMFS under the ESA 4d rule. Troutdale can further limit its liability for salmon kill and habitat damage by adopting this program.

Table 8.7: Summary of Recommendations	
Credit for Existing BMPs	
1.	Add Stormwater Master Planning
2.	Add Conveyance System Cleaning
3.	Add Routine Road Maintenance Practices
BMPs to Target TMDL Pollutant Reduction	
1.	Focus on Pet Waste in Public Education and Outreach component
2.	Focus on Illegal Dumping in Illicit Discharge Detection and Elimination component
Regulatory Compliance Gaps	
1.	Document Illicit Detection and Elimination Plan including procedures, education, and complaint response
2.	Add Employee Training Program to Pollution Prevention component
3.	Add implementation schedule and designation of responsible persons
4.	Consider expanding SWMP to address adaptive management, effectiveness monitoring, and annual reporting
Enhancements to Consider	
1.	Adopt Regional Road Maintenance Guidelines to limit liability for takings under ESA and add to Pollution Prevention component
2.	Adopt Integrated Pest Management program to limit liability for takings under ESA and add to Pollution Prevention component

Observations

Sweeping Frequency – Across the peer jurisdictions, sweeping frequency generally varied from three to four times a year up to monthly, with Milwaukie sweeping curbed streets weekly during the summer months. Gresham has reviewed national data related to the effects of street sweeping on water quality. To date, findings are inconclusive or contradictory regarding the optimal frequency and type of machinery to use. Their current program commitment is 8-10 sweeps per year based on available resources. Troutdale's frequency at six sweeps per year is about average when compared against the peer jurisdictions. The City should re-evaluate and adjust sweeping frequency when information that is more conclusive becomes available.

Catch Basin Cleaning Frequency – All peer jurisdictions reported cleaning frequency of once every year or two with the exception of Fairview, which did not specify. Requirements for NPDES Phase II communities in Washington State is to inspect catch basins at least once during the five-year permit term and clean as needed based on inspection. Based on these requirements, Troutdale's annual cleaning frequency should be adequate.

As part of the master planning process, stakeholders and agencies were asked for input and feedback regarding plan development. Agency coordination included contacts with the Sandy Drainage Improvement Company, the Oregon Department of Environmental Quality, the Oregon Department of Transportation, and the municipalities of Wood Village, Fairview, and Multnomah County.

Open House

On November 30, 2006, from 6 – 8 p.m., the City hosted an Open House to present the draft plan to the public and interested parties. The City developed and distributed a press release announcing the event, and a flyer was developed for attendees that provided an overview of the planning process and identified key staff from the City and Otak involved in the project (Appendix F). The draft plan was also made available by the City for review in electronic format two days prior to the meeting.

The Open House was structured to be somewhat informal and allow attendees to drop in, review the plan, view displays, see a demonstration of the stormwater system model, and ask questions of staff and consultants. Displays included the base map developed for the project, a map of the links and nodes of the model showing how drainage is collected and routed through the stormwater system, and a map of the five major drainage areas modeled and their subbasins.

Two persons attended the Open House as reflected on the sign in sheet (Appendix G). The first attendee was a consultant who had developed the Sandy Drainage Improvement Company model. Modeling information from this model was used as the starting point for development of the North Troutdale basin model. The second attendee was a representative of the Sedona Park neighborhood who brought forward concerns regarding drainage issues. The City shared their plans to improve conditions by decommissioning dry wells in the neighborhood.

The Draft Plan

The draft plan was finalized following the Open House and was distributed on January 12, 2007, to the following agencies for review and comment by January 31, 2007.

- Bob Cochran – City of Fairview
- Bill Carley – City of Wood Village
- Greg Kirby – Multnomah County
- Dave Hendricks – Sandy Drainage Improvement Company
- David Crawford – Crawford Engineering Associates

Comments were received from Crawford Engineering Associates, the Sandy Drainage Improvement Company and Multnomah County. Significant comments received from these agencies and City staff is documented in Appendix I.

Appendices

Appendix A — Acronyms

Acronyms

BMPs – Best Management Practices
DEQ – Department of Environmental Quality
EPA – Environmental Protection Agency
HSG – Hydraulic Soil Group
NPDES – National Pollutant Discharge Elimination System
NRCS – National Resource Conservation Service
SCS – Soil Conservation Service (now known as NRCS)
SDIC – Sandy Drainage Improvement Company
SWMP – Stormwater Management Plan
TMDLs – Total Maximum Daily Loads
UPRR – Union Pacific Railroad

Appendix B— References

References

1. ***City of Wilsonville Interim Evaluation Report and Updated Stormwater Management Plan***, URS Corporation, April 2006.
2. ***City of Milwaukie Interim Evaluation Report to Comply with MS4 NPDES Permit Requirements***, URS Corporation, May 1, 2006.
3. ***City of Wood Village Stormwater Management Plan NPDES Phase II Permit Application,*** HDR Engineering, Inc., September 2001.
4. ***City of Gresham, Oregon, Section 2.0 Stormwater Management Plan and Associated Documents***, May 2006.
5. ***City of Fairview Stormwater Management Plan and Supporting Documents***, Brown and Caldwell, April 2006.
6. ***City of Gladstone Interim Evaluation Report to Comply with MS4 NPDES Permit Requirements***, May 1, 2006, URS Corporation.
7. ***Oregon League of Cities, City Directory***, http://old.orcities.org/cityinfo/CitybooksView.cfm
8. ***Department of Environmental Quality, 8/1/06 Draft Template***, NPDES Stormwater Discharge Permit (for Phase II permittees).
9. ***City of Troutdale Draft Stormwater Management Plan***, February 2004.
10. ***North Troutdale Storm Drainage Master Pla***n, David J. Newton and Associates, March 1990
11. ***Sandy River Basin Total Maximum Daily Load(TMDL)***, March 2005, Oregon Department of Environmental Quality.
12. ***Sandy Drainage Improvement Company***, Dave Hendricks (name of model).

Appendix C— Channel, Culvert, and Conveyance Inventory

Link Name	Diameter (Height) ft	Length ft	Shape	Roughness	Upstream Invert Elevation ft	Downstream Invert Elevation ft	Conduit Slope %
B20b	7	400	Trapezoidal	0.02	44	25.16	4.7
L17	3	50	Circular	0.014	25.16	24.5	1.3
L14	4.5	730	Circular	0.014	16.83	16.1	0.1
S30	5	250	Trapezoidal	0.02	13.09	14.57	-0.6
L11	7	600	Trapezoidal	0.02	12.32	11.62	0.1
graham1	7	70	Trapezoidal	0.02	12.32	13.13	-1.2
grahm2	3	76	Circular	0.014	15.5	14.3	1.6
graham3	3	76	Circular	0.014	15.5	14.3	1.6
CheckDam	7	70	Trapezoidal	0.02	12.32	13.13	-1.2
S34	8	660	Trapezoidal	0.02	13.3	11.1	0.3
sundial-n	4	80	Circular	0.014	11.72	10.74	1.2
sundial-s	4	80	Circular	0.014	10.05	13.12	-3.8
r1	4	47	Circular	0.014	11.7	11.1	1.3
r2	4	47	Circular	0.014	11.7	11.1	1.3
S22	5	750	Trapezoidal	0.02	12.8	9.58	0.4
S24	5	820	Trapezoidal	0.02	9.58	9.2	0.0
S26	6	1100	Trapezoidal	0.02	9.2	6.49	0.2
S28	7.5	850	Trapezoidal	0.02	6.49	6.11	0.0
L2	5	48.5	Circular	0.014	6.11	5.5	1.3
mdwest	6	330	Circular	0.014	2.9	3.3	-0.1
mdeast	5	330	Circular	0.014	2.86	3.3	-0.1
L1	14	260	Trapezoidal	0.02	3.3	3	0.1
Sandy	0.05	10	Circular	0.014	0.05	0	0.5
SandyP2	0.05	10	Circular	0.014	0.05	0	0.5
Ahal	3	85	Circular	0.014	108.9	104.4	5.3
A40	2.5	580	Trapezoidal	0.035	104.4	89.9	2.5
A42	3	50	Circular	0.014	89.9	88.6	2.6
A44	2.5	64	Trapezoidal	0.035	88.6	85	5.6
A62	4	240	Circular	0.014	111.8	108.9	1.2
A60	3	2000	Trapezoidal	0.03	142	111.8	1.5
A46	2.5	56	Trapezoidal	0.035	83.9	82.5	2.5
A48	3.5	215	Circular	0.014	78	73.7	2.0
A30	2.5	633	Trapezoidal	0.035	73.7	66.1	1.2
A72	2.5	300	Circular	0.014	143.5	142	0.5
A70	2	900	Circular	0.014	148	143.5	0.5
A32	4	50	Rectangular	0.014	66.1	66.1	0.0
A20	2.5	785	Trapezoidal	0.035	66.1	55.1	1.4
A22	4	110	Circular	0.014	55.1	54.8	0.3
A10	4	120	Circular	0.024	42.94	43.3	-0.3

Link Name	Diameter (Height) ft	Length ft	Shape	Roughness	Upstream Invert Elevation ft	Downstream Invert Elevation ft	Conduit Slope %
A11	4	250	Circular	0.014	43.3	42.7	0.2
A12	2.5	490	Trapezoidal	0.02	42.7	31.7	2.2
A14	4	200	Circular	0.014	31.7	22.06	4.8
A15	3	190	Trapezoidal	0.02	22.06	20.87	0.6
A16	6	240	Trapezoidal	0.02	20.87	20.31	0.2
A!7	3	133	Trapezoidal	0.025	19.6	19.23	0.3
Marine1	4	130	Circular	0.014	18.82	18.82	0.0
Marine2	4.5	130	Circular	0.013	18.68	18.32	0.3
A00	7	150	Trapezoidal	0.02	18.82	16.9	1.3
airport-e	4	520	Circular	0.014	16.9	16.31	0.1
airport-w	4	520	Circular	0.014	17.86	16.32	0.3
A03	7	200	Trapezoidal	0.02	16.31	16.5	-0.1
sundial-e	4	100	Circular	0.014	16.16	15.48	0.7
sundial-w	4	100	Circular	0.014	16.06	15.15	0.9
L6	6	780	Trapezoidal	0.02	15.15	13.99	0.1
rrspur-1	3.5	50	Special	0.024	12.32	11.99	0.7
rrspur-2	3.5	55	Special	0.024	12.44	12.06	0.7
A08	5	160	Trapezoidal	0.027	12.8	12.8	0.0
A45	3	30	Circular	0.014	85	83.9	3.7
A47	3	215	Circular	0.014	82.5	78	2.1
A24	3	50	Circular	0.014	45	45	0.0
A26	4	390	Circular	0.014	45	42.54	0.6
B22	2	170	Circular	0.024	46	44	1.2
B00	5	800	Trapezoidal	0.02	16.88	16.83	0.0
graham-e	3	90	Circular	0.014	14.92	14.01	1.0
graham-mid	3	90	Circular	0.014	14.7	13.38	1.5
graham-w	3	90	Circular	0.014	14.8	13.77	1.1
S32	3	100	Trapezoidal	0.025	15.3	15.2	0.1
L9	8	370	Trapezoidal	0.02	11.1	10.61	0.1
S20	5	1700	Trapezoidal	0.02	12.1	12.8	0.0
rel_out	7	2580	Trapezoidal	0.02	7.61	9	-0.1
B10	8	270	Trapezoidal	0.02	20.82	16.88	1.5
S10	8	1500	Trapezoidal	0.02	5.5	4.43	0.1
L3	13	710	Trapezoidal	0.02	4.43	2.86	0.2
S00	14	350	Trapezoidal	0.02	3	2.8	0.1
L5	5	1900	Trapezoidal	0.02	10.77	7.78	0.2
L4	2.5	60	Circular	0.014	11	10.85	0.3
A05	6	500	Trapezoidal	0.02	11.26	10.38	0.2
rogerse	5	80	Circular	0.014	12.24	11.62	0.8
rogersw	5	80	Circular	0.014	12.21	11.62	0.7
L20	6	50	Circular	0.014	19.23	19.37	-0.3

Link Name	Diameter (Height) ft	Length ft	Shape	Roughness	Upstream Invert Elevation ft	Downstream Invert Elevation ft	Conduit Slope %
L21	6	164	Trapezoidal	0.02	19.37	19.29	0.0
L22	4	45	Circular	0.014	19.29	19.17	0.3
L23	6	85	Trapezoidal	0.02	19.17	18.68	0.6
L19	6	370	Trapezoidal	0.02	20.31	19.6	0.2
L18	6	300	Trapezoidal	0.02	42.54	42.94	-0.1
Link110	3	20	Trapezoidal	0.035	24.5	24.32	0.9
L26	4	150	Circular	0.024	21.36	20.82	0.4
L24	8	650	Trapezoidal	0.02	24.77	23	0.3
L16	4	580	Trapezoidal	0.014	20.83	18.93	0.3
L27	5	1310	Trapezoidal	0.02	17.16	13.23	0.3
perim-e	3	60	Circular	0.014	15.31	15.19	0.2
perimr-m	3	60	Circular	0.014	15.19	14.97	0.4
perimr-w	3	60	Circular	0.014	15.17	15.2	0.0
L15	5	130	Trapezoidal	0.02	16.1	16.061	0.0
sun@r-e	4	70	Circular	0.014	12.77	12.39	0.5
sun@r-w	4	70	Circular	0.014	12.66	12.08	0.8
L13	6	160	Trapezoidal	0.02	11.77	11.1	0.4
alcoa-rd-e	4	50	Circular	0.014	11.84	10.82	2.0
alcoa-rd-w	4	50	Circular	0.014	11.57	11	1.1
S36	8	130	Trapezoidal	0.02	10.63	10.05	0.4
L7	6	360	Trapezoidal	0.02	13.99	11.73	0.6
L25	10	420	Trapezoidal	0.014	23	20.15	0.7
swalegateN	3	40	Circular	0.014	8.5	8.38	0.3
swalegateS	3	40	Circular	0.014	11.48	11.36	0.3
B 54	1	453	Circular	0.013	306.89	304.63	0.5
B26	2.25	287	Circular	0.013	192.72	170.33	7.8
B25	2.5	215	Circular	0.013	170.33	156.47	6.4
B15	1.25	400	Circular	0.012	158.5	144.5	3.5
B10A	4.5	320	Circular	0.012	70.75	68.22	0.8
B6	4	108	Circular	0.012	45	41.99	2.8
Link109	0.05	10	Circular	0.014	0.05	0	0.5
B16	4	375	Circular	0.012	79.3	71.25	2.1
B17	4.5	385	Circular	0.013	82.85	79.6	0.8
B188	3	375	Circular	0.012	114.92	111.17	1.0
A136	2	246	Circular	0.012	48.75	46.96	0.7
B 187	3	375	Circular	0.012	110.97	107.15	1.0
B 186	3	375	Circular	0.012	106.95	104	0.8
B 185	3	375	Circular	0.012	104	101.19	0.7
B 184	3	375	Circular	0.012	100.99	98.95	0.5
B183	3	375	Circular	0.012	98.75	96.99	0.5
B182	3	375	Circular	0.012	96.79	95.03	0.5

Link Name	Diameter (Height) ft	Length ft	Shape	Roughness	Upstream Invert Elevation ft	Downstream Invert Elevation ft	Conduit Slope %
B181	3.5	237	Circular	0.012	95.03	92	1.3
B216	3.5	138	Circular	0.012	92	91	0.7
B180	3.5	375	Circular	0.012	91	90.25	0.2
B179	3.5	375	Circular	0.012	90.25	89	0.3
B19	4.5	385	Circular	0.013	87.85	85.35	0.6
B18	4.5	33	Circular	0.013	85.35	82.85	7.6
B20 N Half	4	55	Circular	0.013	89	88.35	1.2
B20 S HALF	4	27.5	Circular	0.013	89.07	89	0.3
B24A	2.5	112	Circular	0.013	156.47	148.8	6.8
B23	2.5	362	Circular	0.013	148.8	124	6.9
B 22	2.5	310	Circular	0.013	124	94.24	9.6
B9	4.5	280	Circular	0.012	68.22	66	0.8
B7	3	135	Circular	0.012	65.8	45.38	15.1
B5	3.5	96	Circular	0.012	41.9	36.4	5.7
B4	4.5	435	Circular	0.012	35.4	29.83	1.3
B3	5	336	Circular	0.012	29.33	27.37	0.6
B2A	5	537	Circular	0.012	27.17	23.95	0.6
B11	2	253	Circular	0.012	77.54	72.5	2.0
B12	1.5	260	Circular	0.012	94.5	78.04	6.3
B13	1.5	493	Circular	0.012	124.5	94.5	6.1
B14	1.25	500	Circular	0.012	144.5	124.75	4.0
B27	2.25	390	Circular	0.013	231.96	192.72	10.1
B47	2.25	491	Circular	0.013	261	231.69	6.0
B48	2.25	96	Circular	0.013	265.75	261	4.9
B49	2.25	291	Circular	0.013	280.38	265.75	5.0
B135	2.25	273	Circular	0.013	290.45	280.38	3.7
B50	2.5	358	Circular	0.013	295	290.82	1.2
B51	2.5	394	Circular	0.013	299.61	295	1.2
B52	1.5	404	Circular	0.013	301.32	299.3	0.5
AS Ditch	5	50	Trapezoidal	0.05	46.96	46	1.9
B 21	2.5	41	Circular	0.013	94.24	90.48	9.2
B 53	1.25	542	Circular	0.013	304.33	301.62	0.5
Link111	3	33	Circular	0.014	24.32	23.2	3.4
Link112	4	60	Circular	0.014	23.2	23	0.3

Appendix D—Model Hydrologic Inputs

Model Hydrology Input Data

Input Node ID	Basin ID	Area (acre)	CN	TC
S10	1	240.5	86	30.3
S24b	2	47.3	80	27.0
S24a	3	66.9	80	32.2
S38	4	108.1	90	7.3
S28	5	157.2	93	9.0
A06	6	96.1	91	5.6
S33	7	56.4	93	5.0
S32a	8	105.9	93	6.9
A03	9	46.6	93	7.5
S30b	10	91.9	93	39.9
A16a	11	88.0	93	27.0
B00a	12	57.5	93	13.0
B00b	12a	25.7	93	18.9
A26	13	63.9	94	6.1
B24b	14	86.5	95	7.4
A30	15	66.1	91	4.8
MHA71	16	52.9	91	5.0
A70	17	279.3	89	19.3
MHB218	18	93.4	91	5.2
MHB18	19	40.0	91	5.0
MHB14	20	10.0	85	5.4
MHB8	20a	23.0	71	23.3
MHB43	21	28.6	85	7.6
MHB43	22	35.4	85	21.6
MHB23	23	22.8	85	17.6
MHB49	24	78.9	81	11.8
Alcoa	Alcoa	179.7	93	5.0

NOAA 24-hour Precip. Depths

Return Period (years)	Depth (in)
2	2.7
5	3.3
10	3.8
25	4.1
100	4.9

Appendix E—CIP Costs and Details

North Troutdale Drainage Master Plan
Summary of CIP Plan Cost Estimates

1 Weir Improvements

Construction Costs Subtotal:		100,795
Construction Contingency	35%	35,278
	TOTAL	**$136,000**

2 Arata Creek Culvert Improvement

Construction Costs Subtotal:		23,600
Construction Contingency	35%	8,260
	TOTAL	**$31,900**

3 Arata Creek Drain Line Improvements

Construction Costs Subtotal:		451,415
Construction Contingency	35%	157,995
	TOTAL	**$609,000**

4 South Arata Creek Culvert Improvements

Construction Costs Subtotal:		257,615
Construction Contingency	35%	90,165
	TOTAL	**$348,000**

5 Columbia River Highway Bypass

Construction Costs Subtotal:		334,430
Construction Contingency	35%	117,051
	TOTAL	**$451,000**

6 Marine Drive Culvert South of Airport

Construction Costs Subtotal:		498,869
Construction Contingency	35%	174,604
	TOTAL	**$673,000**

COST ESTIMATE

City of Troutdale Capital Improvement Projects

CIP #		ITEM	QUAN	UNITS	UNIT PRICE	Total Price	Comments
1		***Weir Improvements***					
	1	Mobilization	1	LS	$9,170.00	$9,170.00	10% Construction Costs
	2	Install Sediment Fence	600	LF	$1.00	$600.00	Entire 450' length plus 20%
	3	Misc. Erosion Control Measures	1	LS	$5,000.00	$5,000.00	Dewatering, temporary barrier for graded area
	4	Clearing and Grubbing	22,500	SF	$0.30	$6,750.00	50' width by 450' length + 10%
	5	Grading	45	CY	$15.00	$675.00	40' x 6' x 4' dimensions for earth berm
	6	Channel Excavation	5,000	CY	$15.00	$75,000.00	6' x 50' x 450' dimensions, exc. & disposal
	7	Hand Placed Rip Rap	60	TN	$60.00	$3,600.00	(1' x 40' x 6') / 27 x 2.2 TN/ +10%, initial 6' channel
				TOTAL		**$100,795.00**	

COST ESTIMATE

City of Troutdale Capital Improvement Projects

CIP #		ITEM	QUAN	UNITS	UNIT PRICE	Total Price	Comments
2		***Arata Creek Culvert Improvements***					
	1	Mobilization	1	LS	$2,150.00	$2,150.00	10% Construction Costs
	2	Install Sediment Fence	55	LF	$1.00	$55.00	Assume 50' outside pavement+20%
	3	Misc. Erosion Control Measures	1	LS	$2,000.00	$2,000.00	Bypass pumping
	4	Pavement Removal	50	SY	$10.00	$500.00	8' trench + 1' either side = 10' wide
	5	SawCut AC/PC Pavement	90	FT	$1.50	$135.00	2x Trench Repair length
	6	Exc./Bedding/Backfill/Installation 72-inch-Class B	45	LF	$120.00	$5,400.00	$20/CY exc., $45/CY bedding, 8' wide x 6' deep
	7	Dewatering	1	LS	$5,000.00	$5,000.00	Assumed cost
	8	Foundation Geotextile Fabric	15	LF	$5.00	$75.00	30% of open trench
	9	Foundation Stabilization (Crushed Rock)	3	CY	$45.00	$135.00	6-inch depth 30% of open trench (8-ft wide)
	10	Remove Existing 48" Diameter Culvert	1	LS	$5,000.00	$5,000.00	Assumes RCP
	11	72-Inch CMP	45	LF	$70.00	$3,150.00	Contech verbal quote on pipe only
	12	Asphalt Trench Repair	450	SF	$5.00	$2,250.00	45 LF, 10' width driveway strip, 4" thick AC
				TOTAL		**$23,600.00**	

COST ESTIMATE

City of Troutdale Capital Improvement Projects

CIP #		ITEM	QUAN	UNITS	UNIT PRICE	Total Price	Comments
3		***Arata Creek Drain Line Improvements***					
		Culvert Upstream of Outlet to Salmon Creek					
	1	Mobilization	1	LS	$27,500.00	$27,500.00	10% Construction Costs
	2	Bore Setup	1	LS	$20,000.00	$20,000.00	Gonzales Boring Verbal Estimate
	3	Bore 70-Inch Carrier Pipe	50	LF	$4,000.00	$200,000.00	Incl. 70" Steel Casing, 0.562 thick
	4	Install Sediment Fence	180	LF	$1.00	$180.00	Assume 50' outside pavement+20%
	5	Misc. Erosion Control Measures	1	LS	$4,000.00	$4,000.00	Bypass pumping
	6	Dewatering	1	LS	$11,000.00	$11,000.00	Assume $10 per every foot outside boring
	7	6' Exc./Bedding/Backfill/Installation 48-inch-Class A	110	LF	$85.00	$9,350.00	$20/CY exc., $45/CY bedding, 7' wide x6' deep
	8	84-inch, Concrete, 6-10' Feet Deep New Manhole	2	EA	$11,000.00	$22,000.00	3 x $3800, Cascade Supply estimate
	9	Remove and Replace Topsoil	30	LF	$15.00	$450.00	Assume 30 LF for bore pits
	10	Foundation Geotextile Fabric	35	LF	$5.00	$175.00	30% of open trench
	11	Foundation Stabilization (Crushed Rock)	15	CY	$45.00	$675.00	6-inch depth 30% of open trench (6-ft wide)
	12	48-Inch CMP	160	LF	$45.00	$7,200.00	Estimate from Contech on pipe only
				TOTAL		**$302,530.00**	

		Drain Line West of Airport Runway					
	1	Mobilization	1	LS	$13,550.00	$13,550.00	10% Construction Costs
	2	Install Sediment Fence	1,200	LF	$1.00	$1,200.00	Assume both sides of trench+20%
	3	Misc. Erosion Control Measures	1	LS	$1,500.00	$1,500.00	Gravel Construction Entrances
	4	Dewatering	1	LS	$5,000.00	$5,000.00	Assume $10 per every foot
	5	8' Exc./Bedding/Backfill/Installation 48-inch-Class A	520	LF	$110.00	$57,200.00	$20/CY exc., $45/CY bedding, 6' wide x8' deep
	6	84-inch, Concrete, 8' Feet Deep New Manhole	2	EA	$11,000.00	$22,000.00	3 x $3800, Cascade Supply estimate
	7	Remove and Replace Topsoil	520	LF	$15.00	$7,800.00	Assume 8 foot wide trench
	8	Foundation Geotextile Fabric	160	LF	$5.00	$800.00	30% of open trench
	9	Foundation Stabilization (Crushed Rock)	7	CY	$45.00	$315.00	6-inch depth 30% of open trench (5-ft wide)
	10	48-Inch PE	520	LF	$76.00	$39,520.00	Consolidated Supply estimate, pipe only
				TOTAL		**$148,885.00**	

COST ESTIMATE

City of Troutdale Capital Improvement Projects

CIP #		ITEM	QUAN	UNITS	UNIT PRICE	Total Price	Comments
4		***South Arata Creek Culvert Improvements***					
	1	Mobilization	1	LS	$23,420.00	$23,420.00	10% Construction Costs
	2	Bore Setup	1	LS	$38,000.00	$38,000.00	Gonzales Boring Verbal Estimate
	3	Bore 48-Inch Carrier Pipe	80	LF	$850.00	$68,000.00	48" Steel Casing, 0.562 thick
	4	Install Sediment Fence	265	LF	$1.00	$265.00	Length outside 80' RR ROW plus 20%
	5	Misc. Erosion Control Measures	1	LS	$10,000.00	$10,000.00	Sediment pond, stream protection, biobags
	6	Utility Relocate	4	EA	$1,500.00	$6,000.00	Assume electrical conduit, building utilities.
	7	SawCut AC/PC Pavement	550	FT	$1.50	$825.00	2x Trench Repair length plus 10%
	8	Pavement Removal	140	SY	$7.00	$980.00	250' length by 5' width
	9	Dewatering	1	LS	$5,000.00	$5,000.00	Assume $10 per every foot outside boring
	10	6' Exc./Bedding/Backfill/Installation 36-inch-Class A	470	LF	$65.00	$30,550.00	$20/CY exc., $45/CY bedding, 5' wide x6' deep
	11	60-inch, Concrete, 6-10' Feet Deep New Manhole	6	EA	$10,000.00	$60,000.00	3 x list price, Hanson products estimate
	12	Remove and Replace Topsoil	250	LF	$10.00	$2,500.00	bore pits
	13	Foundation Geotextile Fabric	160	LF	$5.00	$800.00	30% of open trench
	14	Foundation Stabilization (Crushed Rock)	15	CY	$45.00	$675.00	6-inch depth 30% of open trench (5-ft wide)
	15	Asphalt Trench Repair	1750	SF	$4.00	$7,000.00	250 LF, 7-FT WIDE TRENCH
	16	36-Inch Class V Reinforced Concrete Pipe	80	LF	$45.00	$3,600.00	Estimate from Contech, for pipe only
	17	36-Inch CMP	470	LF	$30.00	$14,100.00	Estimate from Contech, for pipe only
				TOTAL		**$257,615.00**	

COST ESTIMATE

City of Troutdale Capital Improvement Projects

CIP #		ITEM	QUAN	UNITS	UNIT PRICE	Total Price	Comments
5		***Columbia River Highway Bypass***					
		UPRR Crossing					
	1	Mobilization	1	LS	$18,550.00	$18,550.00	10% Construction Costs
	2	Bore Setup	1	LS	$24,000.00	$24,000.00	Gonzales Boring Verbal Estimate
	3	Bore 48-Inch Carrier Pipe	80	LF	$850.00	$68,000.00	48" Steel Casing, 0.562 thick
	4	Install Sediment Fence	270	LF	$1.00	$270.00	Length outside 80' RR ROW plus 20%
	5	Misc. Erosion Control Measures	1	LS	$10,000.00	$10,000.00	Sediment control pond, stream protection
	6	Utility Relocate	2	EA	$1,500.00	$3,000.00	Assume electrical conduit only.
	7	Dewatering	1	LS	$5,000.00	$5,000.00	Assumed cost
	8	6' Exc./Bedding/Backfill/Installation 36-inch-Class A	240	LF	$65.00	$15,600.00	$20/CY exc., $45/CY bedding, 5' wide x6' deep
	9	60-inch, Concrete, 6-10' Feet Deep New Manhole	5	EA	$10,000.00	$50,000.00	3 x list price, Hanson products estimate
	10	Catch Basin	1	EA	$1,500.00	$1,500.00	Cascade Supply x 3
	11	Remove and Replace Topsoil	260	LF	$10.00	$2,600.00	bore pits
	12	Foundation Geotextile Fabric	80	LF	$5.00	$400.00	30% of open trench
	13	Foundation Stabilization (Crushed Rock)	8	CY	$45.00	$360.00	6-inch depth 30% of open trench (5-ft wide)
	14	12-Inch CMP	20	LF	$60.00	$1,200.00	Connect to new catch basin
	15	36-Inch Class V Reinforced Concrete Pipe	80	LF	$45.00	$3,600.00	Estimate from Hanson Pipe, for pipe only
	16	36-Inch CMP	240	LF	$30.00	$7,200.00	Estimate from Contech, for pipe only
				TOTAL		**$204,080.00**	

		Columbia River Highway Crossing					
	1	Mobilization	1	LS	3,720.00	$3,720.00	10% Construction Costs
	2	Traffic Control	4	Dy	2,500.00	$10,000.00	150'/dy,2-flagmen+signs
	3	Install Sediment Fence	110	LF	$1.00	$110.00	Assume 90' outside pavement+20%
	4	Misc. Erosion Control Measures	1	LS	$3,000.00	$3,000.00	Biobags, inlet protection, bypass pumping
	5	Utility Relocate	4	EA	$1,500.00	$6,000.00	Assume 1 each major utilities
	6	SawCut AC/PC Pavement	90	FT	$1.50	$135.00	2x Trench Repair length plus 10%
	7	Pavement Removal	20	SY	$7.00	$140.00	4' wide trench
	8	Dewatering	1	LS	$500.00	$500.00	Assume $10 per every foot
	9	6-10' Exc./Bedding/Backfill/Installation 36-inch-Class B	60	LF	$100.00	$6,000.00	$20/CY exc, $45/CY bedding, 4' wide x10' deep
	10	48-inch Concrete Manhole, 6-10' Deep	2	EA	$3,500.00	$7,000.00	Place over existing culvert to divert flow
	11	Remove Existing Concrete Pipe	1	LS	$2,000.00	$2,000.00	2 x list price, Hanson products estimate
	12	Foundation Geotextile Fabric	15	LF	$5.00	$75.00	30% of open trench
	13	Foundation Stabilization (Crushed Rock)	4	CY	$45.00	$180.00	6-inch depth 30% of open trench (5-ft wide)
	14	24-Inch CMP	40	LF	$20.00	$800.00	Estimate from Hanson Pipe, for pipe only
	15	Asphalt Trench Repair	240	SF	$5.00	$1,200.00	40 LF, 6' wide trenchH
				TOTAL		**$40,860.00**	

		Railroad Crossing					
	1	Mobilization	1	LS	$8,460.00	$8,460.00	10% Construction Costs
	2	Bore Setup	1	LS	$12,000.00	$12,000.00	Gonzales Boring Verbal Estimate
	3	Bore 36-Inch Carrier Pipe	40	LF	$700.00	$28,000.00	48" Steel Casing, 0.562 thick
	4	Install Sediment Fence	175	LF	$1.00	$175.00	Length around bore pits plus 20%
	5	Misc. Erosion Control Measures	1	LS	$5,000.00	$6,000.00	Bypass pumping, inlet protection
	6	Utility Relocate	2	EA	$1,500.00	$3,000.00	Assume electrical conduit only.

COST ESTIMATE

City of Troutdale Capital Improvement Projects

CIP #		ITEM	QUAN	UNITS	UNIT PRICE	Total Price	Comments
	7	Dewatering	1	LS	$5,000.00	$5,000.00	Assumed cost.
	8	6-10' Exc./Bedding/Backfill/Installation 36-inch-Class A	160	LF	$70.00	$11,200.00	$20/CY exc, $45/CY bedding, 5' wide x10' deep
	9	48-inch, Concrete, 6-10' Feet Deep New Manhole	4	EA	$3,000.00	$12,000.00	3 x list price, Hanson products estimate
	10	Foundation Geotextile Fabric	55	LF	$5.00	$275.00	30% of open trench
	11	Foundation Stabilization (Crushed Rock)	4	CY	$45.00	$180.00	6-inch depth 30% of open trench (4-ft wide)
	12	24-Inch CMP	160	LF	$20.00	$3,200.00	Estimate from Contech, for pipe only
	13	24-Inch Class V Reinforced Concrete Pipe	40	LF	$30.00	$1,200.00	Estimate from Hanson Pipe, for pipe only
				TOTAL		**$89,490.00**	

COST ESTIMATE

City of Troutdale Capital Improvement Projects

CIP #		ITEM	QUAN	UNITS	UNIT PRICE	Total Price	Comments
6		***Marine Drive Culvert South of Airport***					
		Marine Drive Crossing					
	1	Mobilization	1	LS	$8,600.00	$8,600.00	10% Construction Costs
	2	Traffic Control	5	Dy	$2,500.00	$12,500.00	150'/dy,2-flagmen+signs
	3	Install Sediment Fence	110	LF	$1.00	$110.00	Assume 90' outside pavement+20%
	4	Misc. Erosion Control Measures	1	LS	$3,000.00	$3,000.00	Biobags, inlet protection
	5	Utility Relocate	6	EA	$1,500.00	$9,000.00	Assume 1 each major utilities
	6	Dewatering	1	LS	$1,500.00	$1,500.00	Assume $10 per every foot
	7	8' Exc./Bedding/Backfill/Installation 36-inch-Class A	90	LF	$65.00	$5,850.00	$20/CY exc., $45/CY bedding, 5' wide x8' deep
	8	8' Exc./Bedding/Backfill/Installation 36-inch-Class B	60	LF	$100.00	$6,000.00	$20/CY exc., $45/CY bedding, 5' wide x8' deep
	9	60-inch, Concrete, 6-10' Feet Deep New Manhole	4	EA	$10,000.00	$40,000.00	3 x list price, Hanson products estimate
	10	Remove and Replace Topsoil	90	LF	$10.00	$900.00	Assume every foot outside paved street
	11	Foundation Geotextile Fabric	50	LF	$5.00	$250.00	30% of open trench
	12	Foundation Stabilization (Crushed Rock)	4	CY	$45.00	$180.00	6-inch depth 30% of open trench (5-ft wide)
	13	36-Inch CMP	150	LF	$30.00	$4,500.00	Estimate from Hanson Pipe, for pipe only
	14	Asphalt Trench Repair	420	SF	$4.00	$1,680.00	60 LF, 7' width trench
	15	Pavement Removal	47	SY	$7.00	$329.00	7' wide trench
	16	SawCut AC/PC Pavement	130	FT	$1.50	$195.00	2x Trench Repair length plus 10%
				TOTAL		**$94,594.00**	

		Culverts Paralleling Marine Drive					
	1	Mobilization	1	LS	$36,750.00	$36,750.00	10% Construction Costs
	2	Misc. Erosion Control Measures	1	LS	$5,000.00	$5,000.00	Bypass pumping
	3	Install Sediment Fence	2,100	LF	$1.00	$2,100.00	Assume 90' outside pavement+20%
	4	60-inch, Concrete, 6-10' Feet Deep New Manhole	6	EA	$10,000.00	$60,000.00	3 x list price, Hanson products estimate
	5	6' Exc./Bedding/Backfill/Installation 24-inch-Class A	2100	LF	$70.00	$147,000.00	$20/CY exc., $45/CY bedding, 4' wide x6' deep
	6	Dewatering	1	LS	$21,000.00	$21,000.00	Assume $10 per foot
	7	Foundation Geotextile Fabric	700	LF	$5.00	$3,500.00	30% of open trench
	8	Foundation Stabilization (Crushed Rock)	65	CY	$45.00	$2,925.00	6-inch depth 30% of open trench (5-ft wide)
	9	36-Inch PVC	2100	LF	$50.00	$105,000.00	Estimate from Contech, for pipe only
	10	Remove and Replace Topsoil	2,100	LF	$10.00	$21,000.00	Assume every foot
				TOTAL		**$404,275.00**	

Appendix F— DEQ Comment Letter of August 15, 2006

Oregon
Theodore R. Kulongoski, Governor

Department of Environmental Quality
811 SW Sixth Avenue
Portland, OR 97204-1390
503-229-5696
TTY 503-229-6993

August 15, 2006

Amy Pepper
City of Troutdale
104 SE Kibling St.
Troutdale, OR 97060

RE: Review of Stormwater Management Plans

Dear Ms. Pepper:

As discussed at the Phase II stormwater meeting in Springfield on August 3rd, the Department has completed a review of the Stormwater Management Plan submitted by your jurisdiction as part of your permit application. The Department regrets the delay in sharing the results of our review.

The Department found that the plan submitted by your jurisdiction contains the six (6) required minimum control measures, but does not list responsible persons for activities described in the plan or contain the required employee training program under the "Pollution Prevention in Municipal Operations" minimum control measure. Listing responsible persons and developing an employee training program are both requirements under the Phase II stormwater regulations. However, it may not be necessary for you to provide this information to the Department prior to permit issuance. Rather, the Department can include a these requirements in the compliance schedule (Schedule C) of your individual NPDES permit. The compliance schedule would also contain a requirement to provide a timeline in your Stormwater Management Plan in order to accurately reflect when implementation milestones are scheduled to be achieved.

Please review your Stormwater Management Plan in light of this review and contact me to discuss how best to move forward with this process.

As a reminder, the Department is taking informal comments on the draft Phase II stormwater permit that was distributed to Phase II communities via email on August 4th. This comment period will end on September 15th and the Department will begin the permit issuance process shortly thereafter. Please submit your comments to me via email or letter.

Thank you and please call me at (503) 229-6991 with any questions.

Sincerely,

Greg Geist
DEQ Stormwater Permit Specialist
Oregon Department of Environmental Quality
811 SW Sixth Avenue
Portland, OR 97204-1390

Appendix G—Open House Flyer

otak

Open House

Thursday, November 30, 2006
6 pm - 8 pm

Draft North Troutdale Stormwater Master Plan

City of Troutdale Conference Building, 223 S. Buxton Road

The City of Troutdale Public Works Department is currently developing an updated storm drainage system master plan for the North Troutdale Basin. The basin covers the City's incorporated area north of I-84 and the area north of Cherry Park Road and west of 257th Avenue (basin boundaries are identified in red on the accompanying map). The consulting firm of Otak, Inc. has been hired to assist the City in this effort.

The original 1990 North Troutdale Storm Drainage Master Plan is over 16 years old. Changes in the regulatory environment and physical characteristics of the basin have rendered the existing master plan out of date. Much of the plan remains unimplemented because of these changes and due to questions about original assumptions and funding constraints. Anecdotal evidence indicates that existing drainage systems and pumping installations appear to be mitigating many of the City's potential flooding problems.

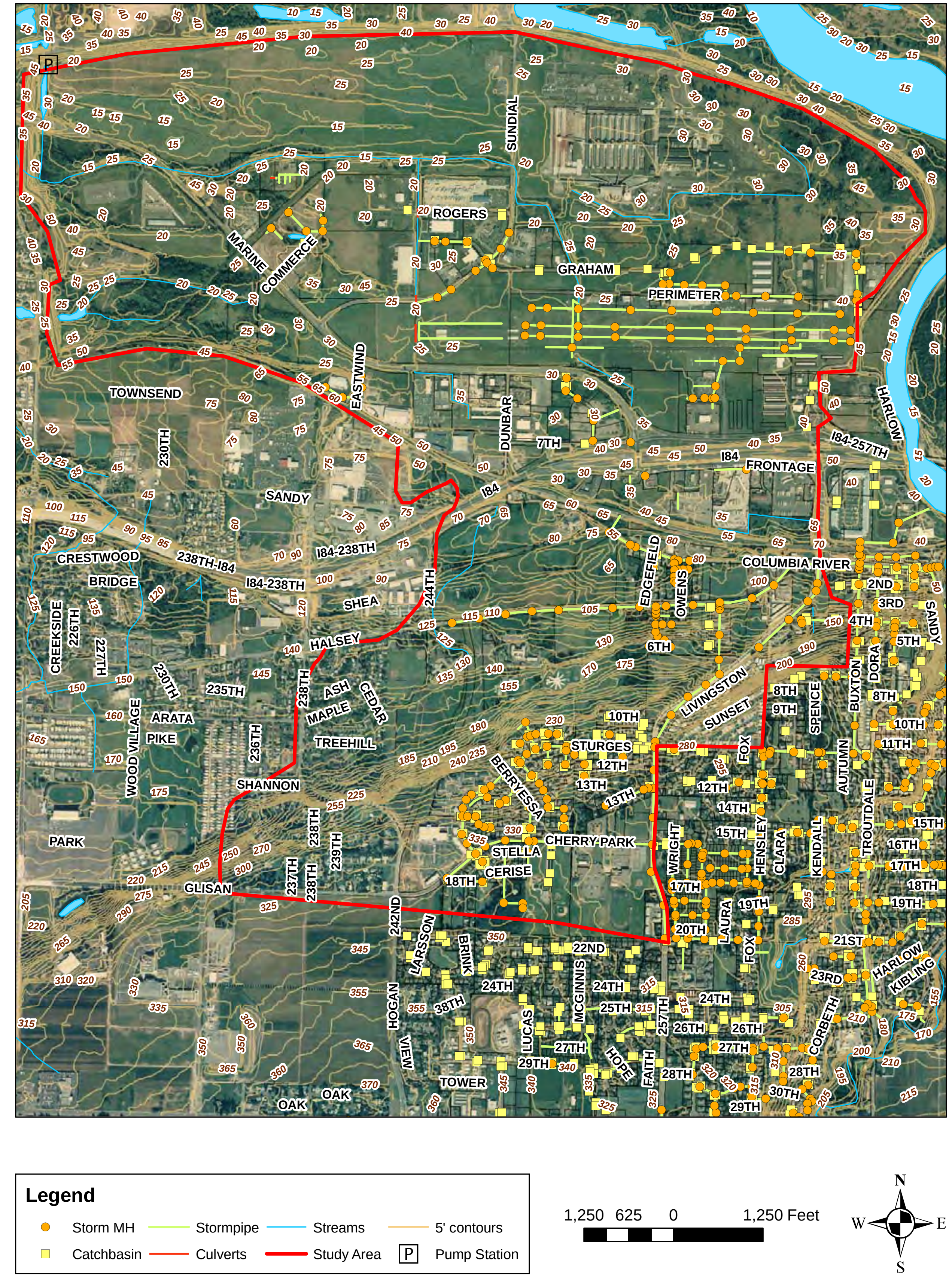
This new and revised North Troutdale Storm Drainage Master Plan includes an updated watershed characterization in Chapter 2 and stormwater system facility inventory in Appendix C. Hydrologic and hydraulic modeling of the City's stormwater system under existing and future conditions for a variety of design storms was performed and is documented in Chapters 3, 4, and 5. Results were used to evaluate system capacity and identify trouble spots where capital facilities are needed to reduce flooding as discussed in Chapter 6.

The planning effort is currently engaged in capital facilities development, which will include project investigation, cost estimation, evaluation, and ranking. Future development projections will provide guidance as to the priority and phasing of capital facility construction.

In addition to the need for drainage master planning, Troutdale is also faced with meeting National Pollutant Discharge Elimination System (NPDES) Phase II requirements for its municipal separate storm sewer system. In response to these upcoming requirements, Troutdale prepared its February 2004 Stormwater Management Plan (SWMP), outlining the Best Management Practices (BMPs) the City proposes to use. As part of this master plan update, the City requested a qualitative evaluation of its SWMP. The evaluation included a comparison with its peers, an assessment of BMP effectiveness, and recommendations for program enhancements that are covered in Chapter 8.

This Open House provides an opportunity for the public to learn more about the planning effort, review the draft plan, ask questions, and give feedback. Thank you for participating.

City of Troutdale Stormwater System



Troutdale Public Works Staff

Jim Galloway, Director
Travis Hultin, Chief Engineer
Amy Pepper, Environmental Specialist
Olaf Sweetman, Civil Engineer
Mike Sorensen, Water Pollution Control Facility Supt.
Wei Han, GIS Specialist

Otak, Inc. Staff

Tim Kraft, PE, Project Manager
Maureen Knutson, PE, Assistant Project Manager
Robert Schottman, Senior Technical Lead
Kelly Wood, PE, Civil Engineer
Scott Ferre, EIT, Civil Engineer

For more or updated information, contact Travis Hultin at 503/674-7265 or thultin@ci.troutdale.or.us.

Appendix H—Open House Sign-In Sheet

Open House

Thursday, November 30, 2006

6 pm – 8 pm

Draft North Troutdale Stormwater Master Plan

City of Troutdale Conference Building, 223 S. Buxton Road

Name	Address	E-Mail Address
DAVID CRAWFORD	3120 NE US GRANT PL. PDX	davidcea@comcast.net
Chad TiPPin	1270 S.W. 11th St Troutdale	

Appendix I—Summary of Significant Comments

The majority of the comments received on the January 2007 Draft North Troutdale Storm Drainage Master Plan was editorial in nature and addressed the need for clarifications, correction of typographical errors, and requested changes to format and wording that were incorporated in the final plan. Significant comments on the draft plan and how they were addressed in the final plan are documented here.

Sandy Drainage Improvement Company/Crawford Engineering Associates

- Pump station capacity
- Utilization of storage in the model
- Control gate
- Use of field visits to calibrate model
- Node changes in specific subbasins
- Channel improvements
- Qualification of cost estimates

Per request of the SDIC and Crawford Engineering, new discussion or more detail was added to the plan for each of these issues.

Multnomah County

- CIP #5 Columbia River Highway Bypass
- CIP #6 Consideration of open channel

The County is in agreement that CIP #5 is needed and has suggested that two culverts be added rather than one. They have also done some preliminary groundwork and obtained one of the easements needed. The City will want to continue coordination with the County in pursuit of this improvement. The County also questioned the use of a piped system for CIP #6 and suggested an open channel would be a better alternative. See City comments in the next section.

City of Troutdale

- CIP #6 Consideration of open channel
- Phasing of CIPs

Discussion with the City regarding the consideration of an open channel for CIP#6 acknowledged that this alternative would be easier to maintain, and would provide for some infiltration and treatment. However, the City also has concerns that open channels attract waterfowl that could create an air safety hazard due to the proximity of this CIP to the airport. Ultimately, the decision was made to stay with the original recommendation for a piped system. The City also wanted more detail on phasing of recommended CIPs. Additional language was added to Section 7 to address the use of the model to predict when CIPs would be needed and how the model could be used as a decision-making tool to help the City determine when detention was an appropriate interim solution.