City of Molalla

Stormwater Master Plan

December 2003

Tetra Tech/KCM, Inc.
7080 SW Fir Loop
Portland, Oregon 97223

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Stormwater Master Plan

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Prepared for:
City of Molalla
PO Box 248
Molalla, OR 97038

Prepared by:

Tetra Tech/KCM, Inc.
7080 SW Fir Loop
Portland, Oregon 97223-8022

Project #2140078

City of Molalla
Stormwater Master Plan

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CHAPTER 1.
INTRODUCTION

BACKGROUND

The City of Molalla is developing a stormwater master plan to inventory the City's existing drainage system and address existing and future potential problems in the system. The City contracted with Tetra Tech/KCM, Inc. to evaluate drainage conditions and future requirements within the City's urban growth boundary (UGB). The master plan identifies existing drainage problems and proposed solutions and recommends future actions by the City and private developers to enhance the City's creek corridors, improve water quality, and handle future storm flows.

Wetlands in the City are being inventoried by others concurrently with this study. Therefore, in this report wetlands and natural drainageways will only be discussed in terms of their ability to convey stormwater runoff. This report does not address protection of existing wetlands, creation of future wetlands, or the ability of wetlands to provide water quality treatment. Together with the wetland inventory, this report will form a comprehensive stormwater plan that addresses natural and man-made elements of the drainage system.

AUTHORIZATION

In June 2001, the City of Molalla contracted with Tetra Tech/KCM, Inc. to develop this stormwater and drainage master plan. The plan uses information from existing stormwater maps developed in 1984, as-built drawings, the Clackamas County geographic information system (GIS), and field reconnaissance.

PURPOSE AND SCOPE

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

- Review existing information, including previous designs, maps, drainage reports, and other data.
- Develop an inventory of existing drainage pipes using City as-built drawings and maps and input from City staff. Evaluate the pipes using hydrologic and hydraulic modeling for existing and future land-use conditions.
- Identify measures for improving the conveyance of the piped and natural drainage systems. Investigate alternatives and recommend improvements to reduce existing and predicted future capacity problems.
- Present improvement alternatives to the City.

- Develop a capital improvement program for recommended projects with cost estimates and priorities for each recommendation.
- Document the analysis and recommendations in a draft and final master plan report.

REPORT ORGANIZATION

The *City of Molalla Stormwater Master Plan* consists of the following chapters:

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

Appendices provide supporting information on project cost and hydrologic and hydraulic modeling.

CHAPTER 2.
STUDY AREA AND
EXISTING DRAINAGE SYSTEM DESCRIPTION

STUDY AREA DESCRIPTION

Location and Boundaries

The City of Molalla is in Clackamas County, approximately 30 miles south of Portland (see Figure 2-1). Highway 213 runs north-south through the west end of the City and Highway 211 runs east-west through the middle. The Molalla River is located just east of the City.

The study area is defined by the existing urban growth boundary (UGB), which is shown in Figure 2-2. Areas outside the UGB that discharge runoff to areas within the UGB are also included as part of the study area. The area within the UGB is approximately 1,763 acres.

The existing UGB is expected to reach buildout (the maximum amount of development allowed by zoning) within the 20-year planning period. Future conditions in this report are defined as the buildout conditions, or the condition expected in 20 years, including possible expansions of the UGB.

Topography

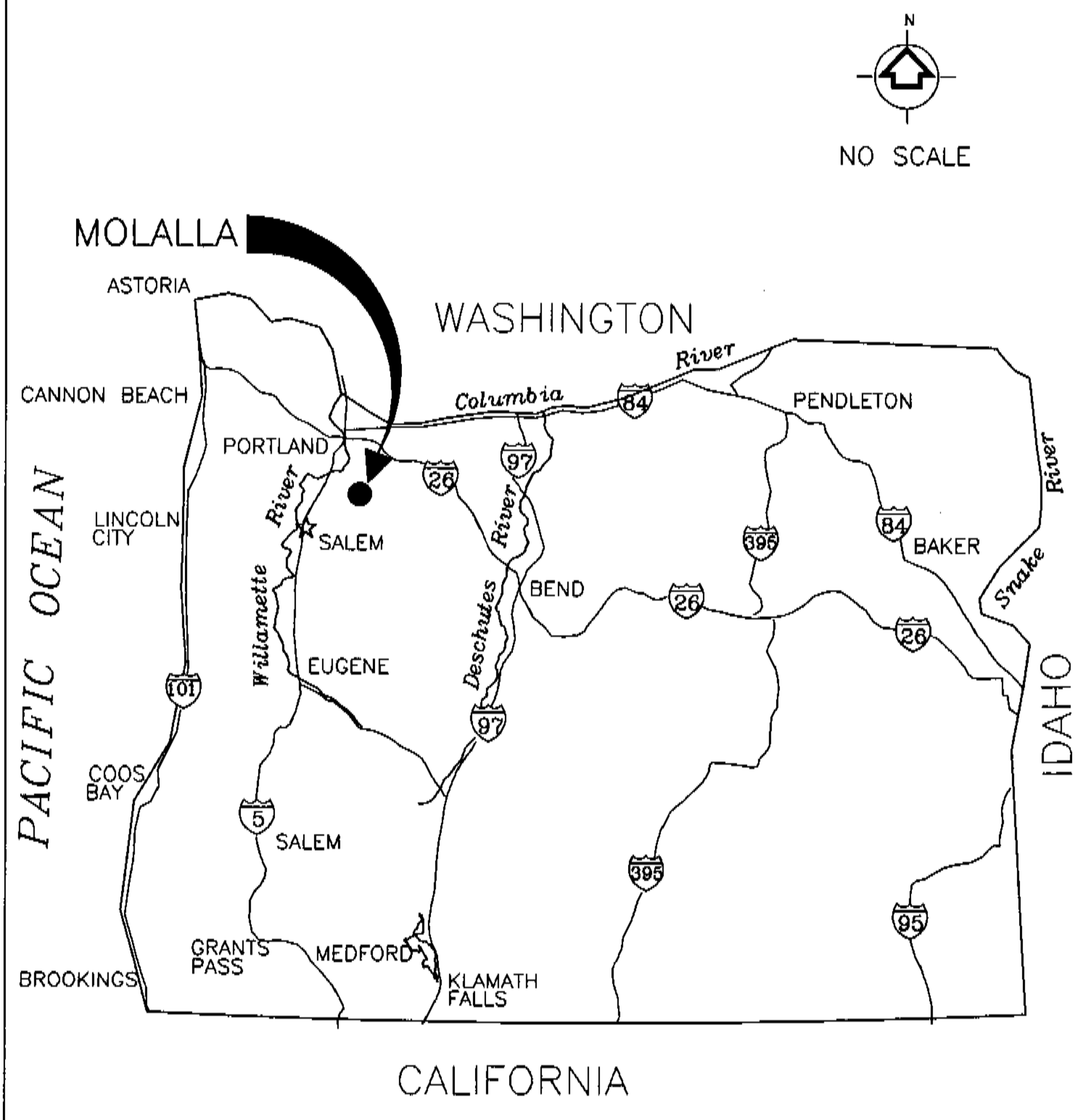
The study area consists of level to gently sloping land with the center of the City (the intersection of Highway 211 and Molalla Avenue) at an approximate elevation of 375 feet. Elevations within the City range from approximately 300 feet to 420 feet. Ground slopes range from nearly flat to approximately 10 percent.

Soils

Soils data for this study was obtained from the *Soil Survey of Clackamas County* developed by the U.S. Department of Agriculture. Predominant soils in the study area are alluvial silt deposits of the Concord-Clackamas-Amity and Briedwell associations. These soils have high seasonal water tables and a depth to hard rock of 20 to 40 inches or more. Although classified as silts, these soils contain areas of clay, gravel, or loam and are somewhat poorly drained. Septic tank limitations in the area are classified as moderate to severe. The soils, however, are classified as having fair stability for building sites with slight to moderate restrictions.

The soil survey divides soils into four hydrologic soil groups defined by how easily rainfall can infiltrate the soil:

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



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Tetra Tech/KCM, Inc.
7080 SW Fir Loop
Portland, Oregon 97223
503-684-9097 Fax: 503-598-0583

City of Molalla, Oregon	FIGURE 2-1
STORMWATER MASTER PLAN	LOCATION MAP

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City of Molalla, Oregon
STORMWATER MASTER PLAN

FIGURE 2-2
URBAN GROWTH BOUNDARY

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

Only Group C and D soils are found in the study area. The majority of area within the UGB is Saum silt loam, 3 to 8 percent slopes. This is a deep, well drained Group C soil found in uplands. West of Ridings Street, Dayton silt loam becomes the predominate soil found. This is a deep, poorly drained Group D soil.

Climate and Rainfall

The climate of the study area includes dry, moderately warm summers and mild, wet winters. The temperature ranges from an average high of 81°F in July to an average low of 33°F in January.

Molalla usually receives between 40 and 50 inches of rainfall annually, most of it between October and March. These are the months when most flooding events have occurred. Summer months generally have hot days with little rainfall. Table 2-1 shows the rainfall amounts obtained from the *Precipitation—Frequency Atlas of the Western United States, Volume X—Oregon* developed by the National Oceanic and Atmospheric Administration (NOAA).

Current and Future Land Use

Molalla's Comprehensive Plan was published in 1987 and is implemented by the City's zoning code and other plans and ordinances. Figure 2-3 shows the Molalla zoning map from the 1987 Comprehensive Plan.

The City is primarily zoned residential, with a downtown commercial center and an industrial area in the southwest. Wood-product mills are the largest industries in Molalla; however, significant industrial land exists within the UGB for diversified industrial growth in the future.

TABLE 2-1.
STUDY AREA RAINFALL DATA

Return	Rainfall Depth (in)

Tetra Tech/KCM, Inc.
7080 SW Fir Loop
Portland, Oregon 97223
503-684-9097 Fax: 503-588-0583

City of Molalla, Oregon STORMWATER MASTER PLAN	FIGURE 2-3 ZONING MAP

Frequency	6-Hour	24-Hour
2-Year	1.25	2.7
5-Year	1.5	3.5
10-Year	1.8	4.0
25-Year	2.0	4.2
50-Year	2.2	4.5
100-Year	2.4	5.0

There are no designated floodplains in Molalla, but Bear Creek lies within the UGB. Bear Creek's floodplain has never been defined, as it was outside the corporate limits when the U.S. Army Corps of Engineers last mapped floodplains in Oregon. A floodplain mapping project for Bear Creek should be conducted in the near future.

Lands surrounding Molalla are predominantly used for agricultural purposes. Significant stands of timber are located nearby to the east in the Cascade Range foothills.

Population

Historical population records and expected land development were used to project future populations through the 20-year study period.

Table 2-2 summarizes historical population and average annual growth rates for the City of Molalla. Population data are from Portland State University's (PSU) Population Research and Census Center.

PSU calculated a population density value from the 1980 census of 2.80 people per dwelling. For subsequent population estimates, PSU has assumed a slightly lower density. PSU assumed 2.73 people per dwelling for its 1998 population estimate.

Previous Population Projections

Population projections in the 1987 Molalla Comprehensive Plan assumed strong growth during the 1980s (7 percent annual average) and slower growth during the 1990s and early 2000s (2 to 3 percent annual average). The resulting population projection for 1998 was 7,317, which is 36 percent higher than the actual 1998 population of 5,395. The strong growth predicted in the 1980s, however, did occur during the mid-1990s.

A more recent population projection was performed for the Water System Master Plan (EAS, 1996), which assumed a steady 5 percent average annual growth rate over a 20-year planning period. Based on the 1995 population of 4,000, the population projection for 2016 was 11,144.

TABLE 2-2.
HISTORICAL POPULATION

		Annual Growth Rates			
Year	Population	1-year Average	5-year Average	10-year Average	20-year Average

1965	1,599	—	—	—	—
1970	2,005	—	4.6%	—	—
1975	2,760	—	6.6%	5.6%	—
1980	2,992	—	1.6%	4.1%	—
1985	3,100	—	0.7%	1.2%	3.4%
1990	3,637	—	3.2%	2.0%	3.0%
1991	3,650	0.4%	2.8%	1.6%	2.6%
1992	3,680	0.8%	2.7%	1.8%	2.4%
1993	3,820	3.8%	3.4%	2.4%	2.3%
1994	3,915	2.5%	3.9%	2.4%	2.0%
1995	4,045	3.3%	2.1%	2.7%	1.9%
1996	4,505	11.4%	4.3%	3.5%	2.4%
1997	4,920	9.2%	6.0%	4.3%	2.6%
1998	5,395	9.7%	7.1%	5.3%	3.2%

Metro, the planning agency for the Portland metropolitan area, has performed population projections throughout its four-county area (Clackamas County, Multnomah County, Washington County, and Columbia County). The Metro projections are based on 1995 population and are delineated by transportation analysis zone (TAZ). Molalla is included in a very large TAZ, TAZ 535, which is roughly bounded by the divide between the Molalla and Clackamas River basins on the east, the Clackamas County boundary on the southwest, and the Cities of Canby and Estacada on the north. The 1995 population estimate for this TAZ was 25,963, of which Molalla's population made up 15.4 percent. The Metro projections for this TAZ assume 1.8 percent average annual growth between 1995 and 2000 and somewhat declining growth rates through 2020, for an overall average annual growth rate between 1995 and 2020 of 0.9 percent. The resulting 2000 and 2020 projected populations for the TAZ are 28,345 and 32,593, respectively.

PSU has also made countywide population projections based on the estimated 1995 population (312,294 for Clackamas County, with Molalla contributing 1.3 percent). PSU estimates that the county population will grow at average annual rates of 1.7 percent through 2000, 1.6 percent from 2000 to 2005, and 1.5 percent from 2005 to 2010. The resulting 2000 and 2010 projected county populations are 339,451 and 395,138, respectively.

Table 2-3 summarizes the previous population projections. The annual rates shown represent the average annual growth rate between the corresponding population projection and the previous (five year earlier) population projection.

TABLE 2-3.
PREVIOUS POPULATION PROJECTIONS

	1985 Comp Plan – City of Molalla		1996 Water Plan – City of Molalla		Metro Projections - TAZ 535		PSU Projections - Clackamas County	
Year	Population	Annual Rate	Population	Annual Rate	Population	Annual Rate	Population	Annual Rate

1980	3,663	—	—	—	—	—	—	—
1985	5,136	7.0%	—	—	—	—	—	—
1990	5,952	3.0%	—	—	—	—	—	—
1995	6,897	3.0%	4,000	—	25,963	—	312,294	—
2000	7,645	2.1%	5,105	5.0%	28,345	1.8%	339,451	1.7%
2005	7,940	0.8%	6,516	5.0%	30,187	1.3%	367,332	1.6%
2010	—	—	8,316	5.0%	31,479	0.8%	395,138	1.5%
2015	—	—	10,613	5.0%	32,032	0.4%	—	—
2020	—	—	—	—	32,593	0.4%	—	—

The City of Molalla Wastewater Facilities Plan (April 2000, Tetra Tech/KCM) projects a population of 13,400 in 2019. All the population projections indicate that within the next 20 years the area within the Molalla UGB will experience urbanization and a higher level of impervious area. Therefore this report assumes the future or buildout condition will occur within the next 20 years.

EXISTING DRAINAGE SYSTEM DESCRIPTION

Creek Systems

Depending on the location within the City, stormwater runoff flows directly to one of three natural systems. The very northeast sections of the City drain directly to the Molalla River. The southwest and west sections of the City drain to Bear Creek and the remaining areas drain to Creamery Creek. The map in Appendix A shows the Creek systems and drainage divides for Molalla and the surrounding areas. The City is located at approximately river mile 20 of the Molalla River. Two branches of Creamery Creek flow through the north end of the City and run generally from the southeast to the northwest. These branches meet east of Highway 213, and Creamery Creek flows into the Molalla River several miles outside the UGB. Bear Creek, which runs generally parallel to and south of Creamery Creek in the vicinity of Molalla, eventually flows into the Pudding River. The Pudding River flows into the Molalla River at approximately river mile 1, just before the Molalla River enters the Willamette River.

Development in Molalla has altered the creeks to the extent that the stream's natural geomorphologic structure and processes cannot be fully restored; such impacts are typical of communities of similar size. Although this plan will not discuss the condition of the natural features, some natural functions can be attained with planning measures, capital projects, and community-based stream enhancement. Although not investigated in this study, such measures would help to achieve the overall objective of this master plan's goal of protecting property, improving water quality, and protecting and enhancing riparian habitat.

Storm Sewers

Computer modeling of the storm system performed for this master plan was limited to public systems and pipes greater than 8 inches in diameter. The analysis was for the main pipe system and did not include catch basins or the single pipes leading from them. The Creamery Creek Basin model incorporated the creek as part of the overall storm system model. The Bear Creek Basin model assumed the creek was the outfall and the storm system was broken into several smaller systems. The model assumes that Bear Creek does not cause backwater effects within the pipe system. To include the actual creek in the model, more topographic information would be required. The detailed layout of the storm sewer system is shown in the map in Appendix A.

Creamery Creek Basin

The headwaters of the Creamery Creek Basin is the field on the east side of Mathias Road and North of Feyrer Park Road. The creek passes below Mathias Road and travels through the heart of Molalla, crossing under Main Street at Cole Avenue and under Molalla Avenue at Heintz Street. The creek crosses under Toliver Road next to vacated railroad tracks, crosses under the tracks, and then flows out of the UGB. This main branch of Creamery Creek has a watershed that extends from 5th Street to the south and Frances Street to the North. The watershed extends from east of Mathias Road to the vacated railroad west of Kennel Avenue.

Creamery Creek has a western branch that drains an area west of the vacated railroad tracks, travels through the Big Meadows development and joins the main branch of Creamery Creek north of the Big Meadows development and outside the UGB.

Bear Creek Basin

The storm sewer system in the Bear Creek Basin is segmented, with reaches of open channel between pipe sections. Sewers in much of the upper reaches of the basin are smaller than 12 inches in diameter. Modeling of the system was also segmented, with large portions of the open channel not modeled.

Four major storm systems were modeled in the Bear Creek Basin. The first system extends east from Bear Creek down Main Street and consists of open ditch with driveway culverts and piped systems around Bi-Mart. The second system is the area around Industrial Way and the channel east and upstream of Industrial Way. The third system extends into the western section of the Big Meadows Development. The fourth system extends south on Highway 213 and incorporates the new Safeway development and the Highway 213 and Main Street intersection.

Areas that Discharge Directly to the Molalla River

The area that discharges directly into the Molalla River and is inside the UGB is very small and not developed. This area has no identifiable storm system and therefore no modeling was conducted in this area.

Culverts

Most of the City's road crossings of creeks and channels were analyzed to determine whether existing culverts can accommodate design storms (storms with a 25-year recurrence interval). Culverts in the Creamery Creek basin were modeled and are discussed as part of the Creamery Creek storm system. Culverts in the Bear Creek Basin within the UGB were analyzed separately using a culvert program. Table 2-4 summarizes the characteristics of the Bear Creek Basin culverts that were evaluated. These culverts are Bear Creek at Mathias Road, Molalla Road, Ona Way, Highway 211, the old North Forest Road (no longer in use) downstream of Highway 211, and Highway 213. Two other culverts were evaluated, the first is the 48" culvert below Highway 211 directly south of the new Safeway Store and the second is the 36" culvert below the North Forest Road south of Lowe Road.

The data was compiled through field study of each culvert. Some of the identified culverts were not accessible for measurement. Although these culverts' characteristics are not recorded, they have been identified for the hydrologic modeling described in Chapter 3.

TABLE 2-4.
BEAR CREEK BASIN CULVERTS EVALUATED FOR MASTER PLAN

Location	Size and Type	Tributary Drainage Area (acres)	Assumed Slope (%)
Mathias Road	(2) 36" CMP	1,060	0.9%
Molalla Road	72" x 44" CMPA 60" x 36" CMPA	1,611	0.2% 2.5%
Ona Way	64" x 42" CMPA (2) 72" x 44" CMPA	2,158	1.0% 1.0%
Highway 211	6' x 15' Bridge	2,204	No Slope
North Forest Road	(3) 6' x 6' Wooden Box	2,250	0.5%
Highway 213	(2) 48" RCP (1) 48" CMP	2,590	1.25% 1.1%
Highway 211	48" CMP	184	1.1%
Forest Road	36" CMP	408	0.9%

CMP = corrugated metal pipe; CMPA = corrugated metal arch pipe;
RCP = reinforced concrete pipe

Reported Flooding Problems

The City has identified areas that have been subject to flooding during past storms. The map in Appendix A shows these areas. The City has identified five culverts along Bear Creek that have flooded in recent history. The culvert under Ona Way has been upgraded since reports of flooding and is not expected to flood in the future. The other four culverts are below Highway 213, below Highway 211, below Molalla Avenue and below Mathias Road.

Other areas identified with recent flooding are near the Industrial Road and Toliver Road intersection, on Hoyt Street between Dixon and Ridings, the area along Heintz Street east of Ridings, Main Street at Kennel Avenue and at Molalla Avenue, Creamery Creek between Main Street and Stowers Avenue, on Stowers Avenue between 5th Street and 6th Street, and along 5th Street.

Water Quality

The Oregon Department of Environmental Quality (DEQ) has established total maximum daily load (TMDL) limitations on the Molalla River and the Pudding River. These limitations were established under guidelines developed by the Environmental Protection Agency (EPA) under section 303(d) of 40 CFR Part 130 of the Clean Water Act. Table 2-5 identifies the listed portions of these rivers.

For the foreseeable future, the City of Molalla will not be required to regulate stormwater quality. However, eventually the City will need to develop methods to reduce the amount of pollutants being discharged through the City's storm system. The City has begun regulating stormwater quality with the requirement of stormwater treatment in the City's Design Standards. The next step for the City to reduce pollutants is to develop an erosion control program. The movement of total suspended solids (TSS) impacts fish habitat downstream, and in urban areas a portion of the pollutants can be attributed to TSS.

The TMDLs should also be part of the review process when selecting CIP alternatives. For example, if detention ponds are reviewed as alternatives, they should not be permanent pool facilities, which are know to elevate water temperature.

TABLE 2-5.
303(D) LISTINGS FOR THE MOLALLA RIVER AND THE PUDDING RIVER

River	Water Body Boundaries	Parameter	Season
Molalla	Mouth to North Fork Molalla (R.M. 26)	Flow Modification	
		Bacteria	Fall, Winter, Spring
		Temperature	Summer
	North Fork Molalla (R.M. 26) to Headwaters	Temperature	Summer
Pudding	Mouth to Little Pudding River (R.M. 36)	Bacteria	Year-Round
		Temperature	Summer
		Toxics	

CHAPTER 3.
DRAINAGE SYSTEM EVALUATION

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

- Storm Sewers:
  - A hydrologic analysis of the storm sewer system was performed to estimate flows through each pipe reach for the 10- and 25-year storms under existing and future (full buildout) land use conditions. The 25-year storm is the design storm for storm sewers.
  - A hydraulic analysis of the storm sewer system was performed to determine the flow capacity of each pipe reach.
  - Computer modeling was performed for storm sewers with capacities less than the predicted design storm flows to determine the pipe size required to accommodate the flow.
- Culverts:
  - Culverts in the Creamery Creek Basin were analyzed as part of the storm sewer system evaluation. Culverts in the Bear Creek Basin were analyzed in a separate analysis.
  - A hydrologic analysis of Bear Creek Basin culverts was performed to estimate flows through each pipe reach for the 25-, 50-, and 100-year storms under future (full buildout) land use conditions.
  - A hydraulic analysis was performed to determine the flow capacity of each culvert.
  - Computer modeling was performed for culverts with capacities less than the predicted design storm flows to determine the pipe size required to pass the flow. The new culvert structures were sized for 100-year, 24-hour storm flows.
- Field reconnaissance was conducted to inventory the City's drainage system.

EVALUATION OF THE PIPED STORM SYSTEM

The hydrology and hydraulics of the City's piped storm system was evaluated using XP-SWMM 2000 developed by XP Software Ltd. And is based on the U.S. Environmental Protection Agency's SWMM computer model. The model uses the methodology described in Appendix B. The SWMM model combines hydrology and hydraulics into one model for piped systems. The model was used for the Creamery Creek basin portion of the study area, which has very little open channel. It was also used for the following urbanized sections of the Bear Creek basin:

- The closed system serving the area around the Highway 211 and Highway 213 intersection
- The ditch and piped section along Highway 211 east of the Bear Creek crossing
- The system North of the Highway 213 crossing of Bear Creek that includes Big Meadows and Toliver Road.

The rest of the Bear Creek basin within the study area is open channel with culverts, and a different modeling approach was used for that area. Appendix A includes a map of the modeled storm sewer systems.

A SWMM model simulates a series of manholes with connecting pipes. Hydrographs (estimates of expected flow for the duration of a storm) are developed for each manhole and the program checks the flow in each pipe, as well as the combined flow through the entire system. Catch basins were not modeled; it was assumed that runoff can flow from each catch basin to the downstream manhole. The manholes throughout the systems were numbered as shown in Appendix A. The downstream pipe from each manhole was assigned the same number as the manhole. Appendix C presents flow information in pipes for three modeling conditions: the 25-year storm with existing hydrology and existing pipe system; the 25-year storm with future hydrology and existing pipe system; and the 25-year storm with future hydrology and proposed pipe system (as described in Chapters 4 and 5).

The modeling predicts flooding in most of the Creamery Creek storm system for existing and future land use conditions. The main flooding problems predicted are as follows:

- The main stem of the Creamery Creek system enters the City below Mathias Road approximately 500 feet south of Highway 211. It travels in an open channel with culverts from Mathias Road to north of Highway 211, where it enters a piped storm system. The piped system appears to be a straight system traveling southeast to northwest and cutting across private property until it reaches Heintz Street. There, the pipe turns west and continues to Kennel Street, at which point it turns north, then northwest. The system crosses Toliver Road just east of the vacated railroad tracks. The modeling shows this system is undersized for almost its entire length.
- Five major pipe reaches drain the area south of the main pipeline. These reaches run along the streets of Fenton Avenue, Grange Avenue, Center Avenue, Molalla Avenue and Kennel Avenue. The modeling indicates that portions of each of these systems are undersized.
- When the main Creamery Creek Pipe system turns west at Heintz Street, it is joined by a large pipe system that comes down Heintz Street. This large system is undersized down a portion of Heintz Street and along Shirley Street that discharges into the system along Heintz Street. Both systems, as well as with the connection, need to be upsized.
- The western fork of the Creamery Creek system starts in the vicinity of Hoyt Street and Dixon Avenue and travels in pipes north along Ridings Avenue to Toliver Road. North of Toliver Road, it discharges into a channel that travels through the Big Meadows subdivision and joins the main

branch of Creamery Creek north of Big Meadows. The piped storm system along Ridings Avenue is undersized.

The City's storm system has not experienced all the flooding predicted by the modeling and there was no calibration information to refine the model. Without calibration, modeling typically predicts more flooding than is actually experienced. The following factors contribute to the differences between modeled flooding and actual past reported flooding:

- The City is not at buildout conditions and therefore does not generate the flows predicted by the modeling for future land use conditions. When a basin develops, peak flows increase due to more impervious surface area and greater connectivity of the storm system.
- Although the existing-conditions model uses impervious surface area estimates from aerial photography, the modeled storm system has a buildout connectivity. This means that it does not account for flow reductions due to water that ponds in vacant lots and front yards.
- The SCS Type I-A rainfall curve was used for the modeling on this project. This rainfall curve is an industry standard that was developed using rainfall information throughout the Northwest and Northern California. It is not area specific and it has been observed in other studies to over-predict rainfall intensities for the Portland area, leading to higher modeled flows in a storm system.

In developing storm system improvement projects, the highest priority is given to projects addressing problems that have actually been reported in the past. Lower priority is given to measures that address problems predicted by the computer modeling but not actually reported.

BEAR CREEK CULVERT EVALUATION

The Bear Creek basin culverts addressed in the culvert evaluation are described in Chapter 2 (see Table 2-4). For these culverts, the Santa Barbara Urban Hydrograph model was used to generate hydrographs. Information required to calculate hydrographs includes drainage area, soil permeability (as measured by curve number), time of concentration (T_c), and rainfall information. Table 3-1 summarizes this information for future conditions in each culvert's drainage basin. Only future conditions were modeled because Bear Creek is a large basin that lies mainly outside the urban growth boundary, so there little difference between existing and future hydrology.

Culvert hydraulics were evaluated using the program HY-8, developed for the Federal Highway Administration. The detailed model output is presented in Appendix D and summarized in Table 3-2. The overtopping flows listed represent the levels at which flow starts passing over the road. Culverts are defined as undersized when their overtopping capacity is less than predicted flows.

Some culverts, such as the Bear Creek culvert under Highway 211, were found to have adequate capacity for a 100-year storm. Others, such as the Bear Creek culvert under Mathias Road, have capacities inadequate to pass the 25-year storm. No culverts were found to fall between these extremes. For this study, all structures that cannot pass the 25 year storm flows are considered undersized, with the exception of the 36-inch culvert under Forest Road, which is further discussed in Chapter 4.

TABLE 3-1.
CULVERT DRAINAGE BASIN DATA USED FOR HYDROLOGIC EVALUATION

Culvert Location	Drainage (acres)	Area (acres)		Curve Number		T_c (min.)
		Pervious	Impervious	Pervious	Impervious	
Mathias Road	1,060	1,052	8	78.5	98	76
Molalla Road	1,611	1,589	22	78.4	98	97
Ona Way	2,158	2,086	72	78.3	98	130
Highway 211 (Bridge)	2,204	2,130	74	77.5	98	138
North Forest Rd.	2,250	2,174	76	77.5	98	138
Highway 213	2,590	2,446	144	77.5	98	149
Highway 211 (Culvert)	184	174	10	77.5	98	31
Forest Road	408	388	20	76	98	44

TABLE 3-2.
CULVERT HYDRAULIC ANALYSIS RESULTS

Location	Structure	Length (feet)	Peak Flow (cfs)			Overtopping Flows (cfs)
			25-Year	50-Year	100-Year	
Mathias Road	(2) 36" CMP	175	232	266	324	104
Molalla Road	72" x 44" CMPA 60" x 36" CMPA	27 24	311	355	432	203
Ona Way	64" x 42" CMPA (2) 72" x 44" CMPA	30 30	364	415	504	317
Highway 211	6' x 15' Bridge	30	364	415	504	600
North Forest Rd.	(3) 6' x 6' Wooden Box	22	364	415	504	950
Highway 213	(2) 48" RCP (1) 48" CMP	32 45	398	455	552	358
Highway 211	48" CMP	131	63	71	86	99
Forest Road	36" CMP	32	108	124	152	71

CMP = corrugated metal pipe; CMPA = corrugated metal arch pipe; RCP = reinforced concrete pipe

CHAPTER 4.
EVALUATION OF IMPROVEMENTS

Four types of improvements were developed to address identified problems in the City's stormwater system: storm sewer improvements, culvert improvements, creek improvements, and nonstructural improvements. Nonstructural improvements include maintenance programs, regulations, education programs, and other projects that do not address individual problem locations. Projects that fall under more than one category are described below in the section for which they are most important. Design elements and costs described in this chapter are intended to be used only for comparison of alternatives. Preliminary and final design will be required prior to construction.

Alternatives were developed and evaluated at a planning level of detail. Cost estimates are based on construction costs for similar projects. Attempts were made to develop all projects within public right-of-way. If a project requires land purchase or easements, this is noted in the project description but not included in the estimated cost. The estimates are budget level estimates only; actual project cost should be within the range of plus 35 percent to minus 20 percent of the estimate. The budget estimates contain the following elements:

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

A project-by-project breakdown of the budget level estimates are provided in Appendix E. A proposed capital improvement program (CIP) incorporating recommended projects is presented in Chapter 5.

STORM SEWER IMPROVEMENTS

All flow from the Creamery Creek system drains into one series of pipes through the middle of downtown. This pipeline is shallow, undersized and nearing the end of its design life, and sections of it are on private land. Replacing this line with adequately sized pipe at a proper depth would be difficult and expensive. Therefore, ways were investigated to divert flow from this pipeline to a single new pipe system or several smaller systems.

One opportunity exists in the railroad that is currently in the process of being removed. The old railway alignment is conveniently located to allow the construction of a new drainage channel that will relieve capacity problems on the Creamery Creek main system. Systems improvements throughout the basin, as well as existing storm systems south of Main Street, could discharge to this new drainage channel. If the railroad right of way is not available or is cost-prohibitive, then the Heintz Street outfall project described below will be required to convey flow from the corner of Heintz Street and Kennel Avenue.

All pipes within the proposed alternatives are smooth walled pipes (ADS, PVC, Concrete). Cost were based on using ADS or PVC pipe.

2nd Street Relief Project

The purpose of this project is to intercept flow along 2nd Street, relieve flow along Main Street, and provide a main system from this section of the City down to the lower reaches of Creamery Creek within the City limits. A new storm system along 2nd Street is proposed to relieve excess flows in the existing Grange Avenue, Center Avenue, Molalla Avenue and Kennel Avenue storm systems and to allow for increased future storm runoff. The new storm system along 2nd Street will eliminate several flooding points along Main Street and limit the work required in ODOT right of way. Two alternatives were developed for this project:

- Alternative 1—2nd Street/Railroad Alignment Storm System (see Figure 4-1). This alternative, which is recommended if the railroad alignment is available and is not cost-prohibitive, includes the following:
  - Replacing the storm pipe along 2nd Street between Eckerd Avenue and Berkeley Avenue
  - Installing a new storm pipe along 2nd Street from Berkeley Avenue to Molalla Avenue, continuing on through new rights of way to the old railroad alignment.
  - Constructing a new channel in the old railroad alignment to convey flow from the new piped systems to Creamery Creek at the point where it crosses the railroad alignment.
  - Replacement of some existing pipe sections along 2nd Street to maintain hydraulic connectivity
- Alternative 2—2nd Street/Kennel Avenue Storm System (see Figure 4-2). This alternative, which is recommended if the railroad alignment is not available or its use is cost-prohibitive, includes the following:
  - Replacing the storm pipe along 2nd Street between Eckerd Avenue and Berkeley Avenue (same as in Alternative 1)
  - Installing a new storm pipe along 2nd Street from Berkeley Avenue to Molalla Avenue, continuing on through new rights of way to Hart Avenue and then to Kennel Avenue
  - Installing a new pipe down Kennel Avenue to Heintz Street to convey flow to a new Creamery Creek system, as described in the Heintz Street Outfall project below.
  - Replacement of some existing pipe sections along 2nd Street to maintain hydraulic connectivity

Estimated Cost: $1,230,000 (Alternative 1); $1,400,000 (Alternative 2).

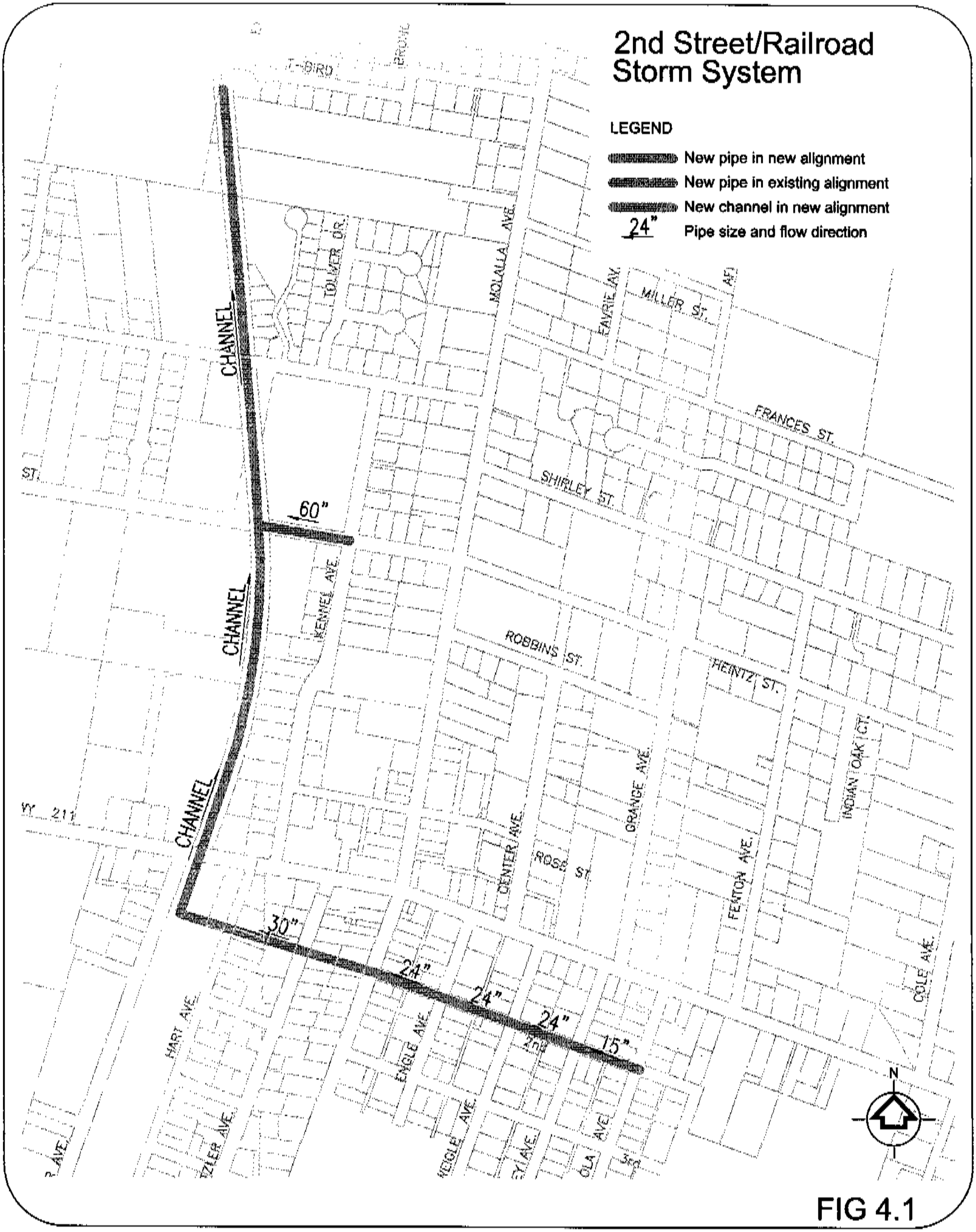
2nd Street/Railroad Storm System
LEGEND
New pipe in new alignment
New pipe in existing alignment
New channel in new alignment
24"
Pipe size and flow direction
CHANNEL
CHANNEL
CHANNEL
60"
30"
24"
24"
24"
15"
MOLALLA AVE.
TOLIVER DR.
KENNEL AVE.
FAIRE AV.
MILLER ST.
FRANCES ST.
SHIRLEY ST.
ROBBINS ST.
HEINTZ ST.
INDIAN OAK CT.
GRANGE AVE.
CENTER AVE.
ROSE ST.
FENTON AVE.
COLE AVE.
HART AVE.
ENGLE AVE
N

FIG 4.1

2nd Street/Kennel Ave Storm System

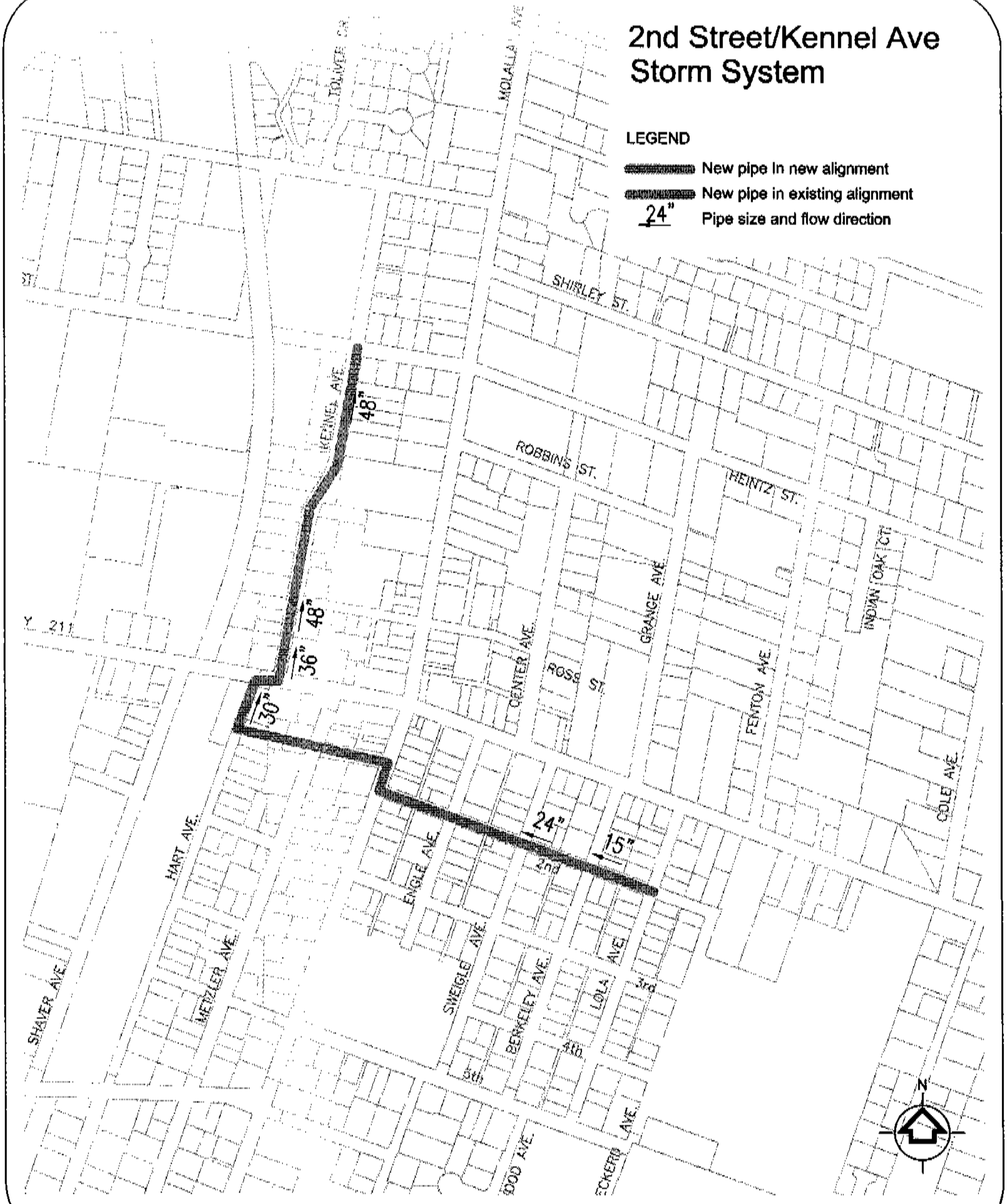

FIG 4.2

Industrial Way

Flooding has been reported near Industrial Way along Toliver Road. This is a result of undersized pipes and downstream conditions. Considerable improvements have been made as part of the Toliver Road project. We do not recommend any improvements at this time; however, if flooding persists, the existing 36-inch pipe would need to be upgraded to a 48-inch pipe, as shown on Figure 4-5. No alternative was identified for this improvement. Because flooding at this location does not pose a risk to any structures, monitoring of the area is proposed rather than the pipe upgrade. The upgrade should be implemented only if a persistent problem is noted in the monitoring.

Estimated Cost: $51,000.

Shirley Street Drainage Improvements

Figure 4-6 shows drainage improvements that would allow the drainage system on Shirley Street to discharge to the proposed Heintz Street system. Implementing these improvements would eliminate the need for one project included in the City's existing stormwater CIP.

Estimated Cost: $91,000

Dixon Avenue Improvements

Figure 4-7 shows potential drainage improvements along Dixon Avenue. Recent channel improvements along Hoyt Street may have solved reported flooding problems in this area. This area should be monitored to determine the need for further improvements. The system along Dixon Avenue could be developed as part of a long-term plan when this area is developed. Implementing these improvements would eliminate the need for one project included in the City's existing stormwater CIP.

Estimated Cost: $139,000

Effect of Proposed Projects on Existing Stormwater CIP Projects

The existing 10-year stormwater CIP summary is included in Appendix G of this report. Although current work and planned work will eliminate the need for some projects included in the existing CIP, other existing CIP projects should be incorporated into a proposed new CIP.

The following existing CIP projects can be eliminated because of the 5th Street improvement project (Schedules A through E) scheduled to start construction in the spring of 2002:

- May Street Drainage Improvements — Estimated Cost: $29,235
- Part of Sunrise Acres Drainage Imp.; Phase 1 — Estimated Cost: $62,277
- Sunrise Acres Drainage Imp. – Phase 2 — Estimated Cost: $16,804

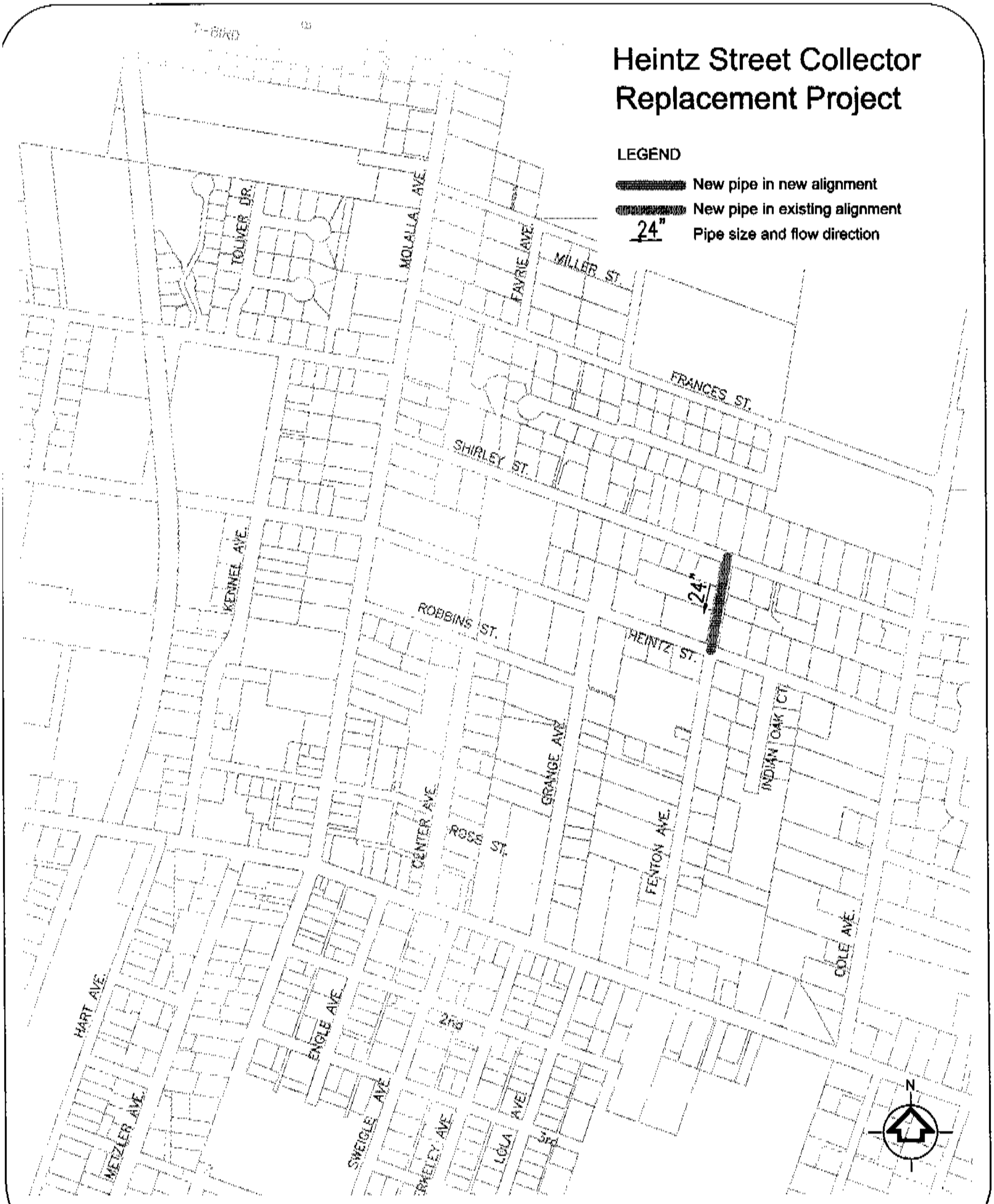
Heintz Street Collector Replacement Project
LEGEND
New pipe in new alignment
New pipe in existing alignment
24"
Pipe size and flow direction
TOLIVER DR.
MOLALLA AVE.
FAYRIE AVE.
MILLER ST.
FRANCES ST.
SHIRLEY ST.
KENNEL AVE.
ROBBINS ST.
HEINTZ ST.
24"
INDIAN OAK CT.
GRANGE AVE.
CENTER AVE.
ROSS ST.
FENTON AVE.
COLE AVE.
HART AVE.
ENGLE AVE.
2nd
SWEIGLE AVE.
METZLER AVE.
LOLA AVE.
N

FIG 4.3


Heintz Street
Outfall Project
LEGEND
New pipe in new alignment
New pipe in existing alignment
24"
Pipe size and flow direction
Twin 48"
Twin 48"
TOLIVER DR.
MOLALLA AVE.
SHIRLEY ST.
KENNEL AVE.
ROBBINS ST.
HEINTZ ST.
INDIAN OAK CT.
GRANGE AVE.
CENTER AVE.
ROSS ST.
FENTON AVE.
COLE AVE.
HART AVE.
ENGLE AVE.
2nd
SWEIGLE AVE.
LOLA AVE.
METZLER AVE.
SHAVER AVE.
BERKELEY AVE.
3rd
4th
5th
AVE.
N
211

FIG 4.4

Heintz Street Collector Replacement Project

This project is to replace the existing Creamery Creek pipe. The existing 60-inch CMP pipe is old and in places very shallow. In addition, the system capacity is inadequate for predicted future flows. At least two failures have been recorded in the last few years. Only one alternative has been identified for this project. The proposed improvement is to intercept Creamery Creek at the South end of Indian Oak Court and divert the creek down to Heintz Street. A new pipe would then be constructed down Heintz Street to the corner of Kennel Avenue and Heintz Street. The pipeline will consist of pipe between 18 and 60 inches in diameter. Figure 4-3 shows the elements of this project.

Estimated Cost: $1,200,000.

Heintz Street Outfall Project

In the event the old railway alignment is not obtainable, the storm systems downstream of Kennel Avenue and Heintz Street will need to be upgraded. This will require a new system from this intersection down to Toliver Road. Because of shallow depth, the structure would need to be twin 48-inch pipe or a box structure. For planning purposes, we have assumed twin 48-inch pipes. No alternative to this project was identified. Figure 4-4 shows the elements of this project.

Estimated Cost: $570,000.

Detention Pond at Mathias Avenue and Creamery Creek

A detention pond to store storm flows upstream of Mathias Avenue could reduce or eliminate flooding downstream along Creamery Creek. Without detailed survey information of the potential pond site, many assumptions were required to evaluate this project. The detention pond was modeled with a 12-inch concrete pipe for an outfall structure. Storage behind the pipe is defined in terms of depth and area. At 1-foot depth, it was assumed that 1.5 acres would flood; at 3 foot of depth, 10 acres of pasture would flood. There would be no permanent pond. The pooled water would be less than 3 feet deep at the pipe for the 25-year storm and the pool would dissipate within 24 hours following the storm.

Downstream benefits would be significant. At Creamery Creek and Stowers Avenue, the 25-year flow would drop from 31 cfs to 10 cfs. Where Creamery Creek crosses Heintz Street, the 25-year storm flows drop from 76.5 cfs to 58.5 cfs. A berm would have to be keyed into good ground and would require a concrete spillway. This berm would not be classified as a dam, but it would need to be engineered as a small dam because of the potential damage should it fail. Engineering, survey and permitting would be the largest expense of this project, estimated at $45,000. The project will increase periodic flooding on the land but will not produce a permanent pool. Cost of easements is not included in the cost estimate. This project could reduce the cost of the Heintz Street Outfall and Heintz Street Collector projects by allowing the use of smaller pipes for those projects.

Estimated Cost: $96,000.

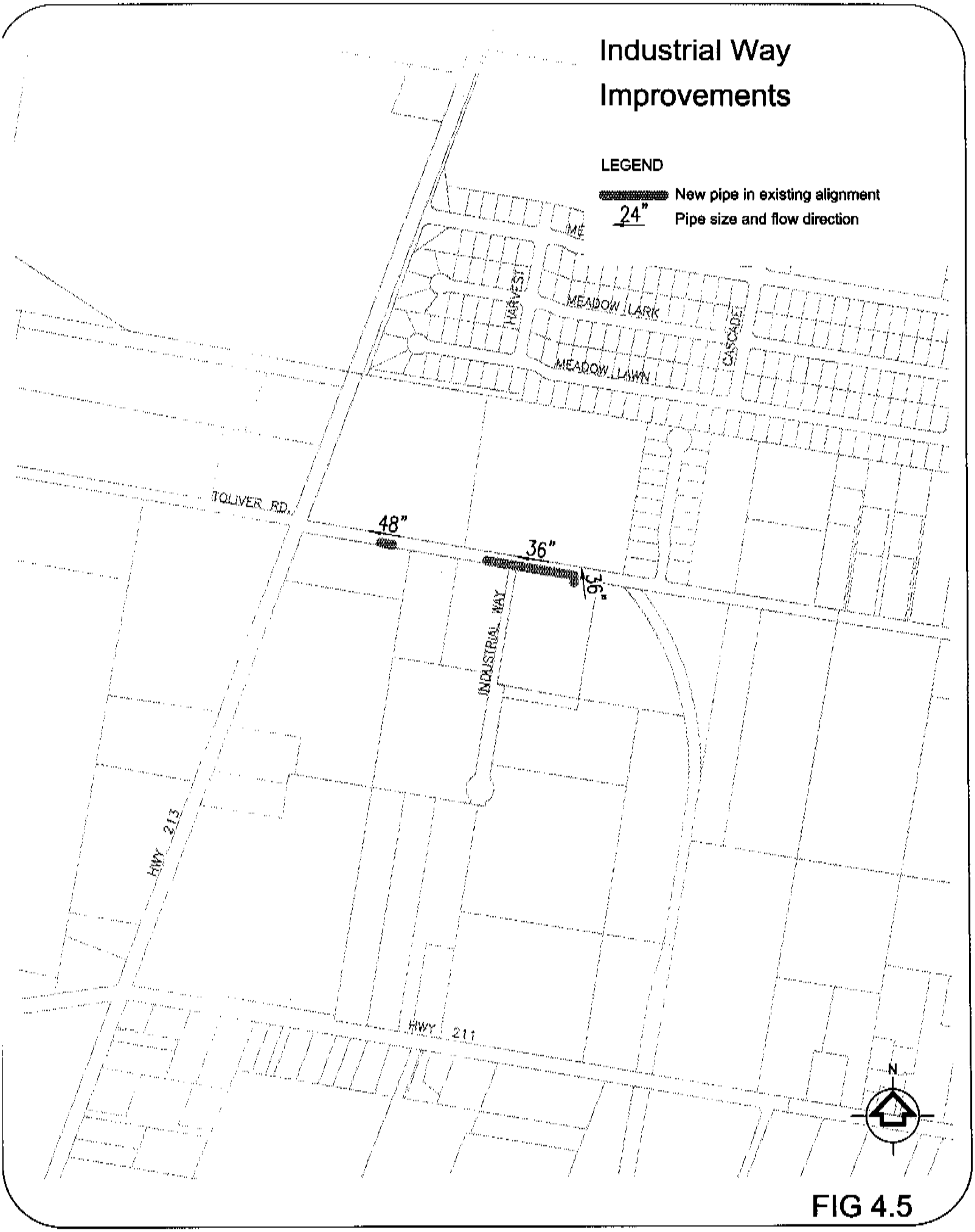
Industrial Way
Improvements
LEGEND
New pipe in existing alignment
24"
Pipe size and flow direction
MEADOW LARK
MEADOW LAWN
HARVEST
CASCADE
TOLIVER RD.
48"
36"
36"
INDUSTRIAL WAY
HWY 213
HWY 211
N

FIG 4.5

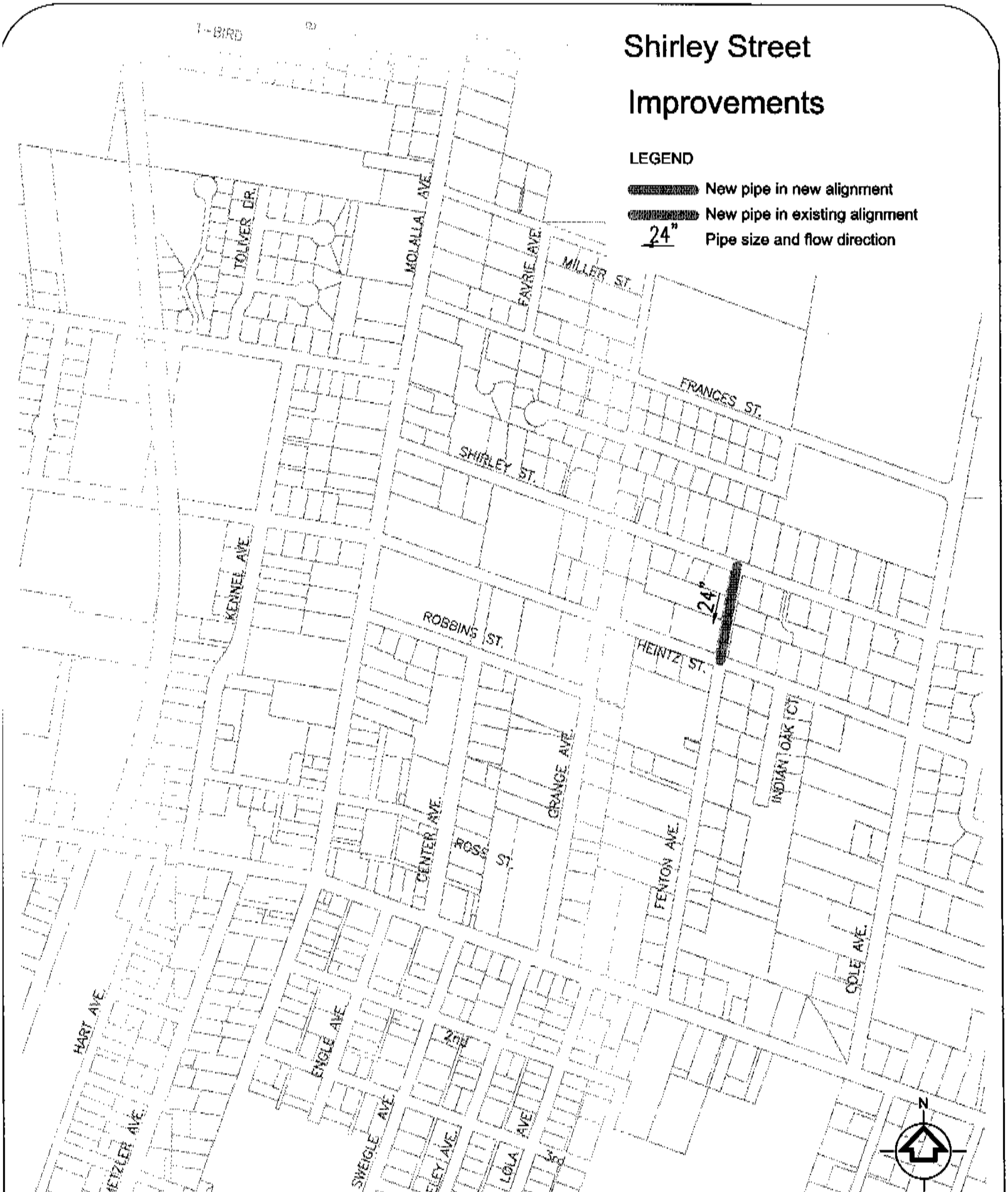
Shirley Street
Improvements
LEGEND
New pipe in new alignment
New pipe in existing alignment
24"
Pipe size and flow direction
MOLALLA AVE.
TOLIVER DR.
FAYRIE AVE.
MILLER ST.
FRANCES ST.
SHIRLEY ST.
KENNEL AVE.
ROBBINS ST.
HEINTZ ST.
24"
INDIAN OAK CT.
ORANGE AVE.
CENTER AVE.
ROSS ST.
FENTON AVE.
COLE AVE.
HART AVE.
ENGLE AVE.
2nd
METZLER AVE.
SWEIGLE AVE.
LOLA AVE.
N

FIG 4.6

Dixon Avenue Improvements

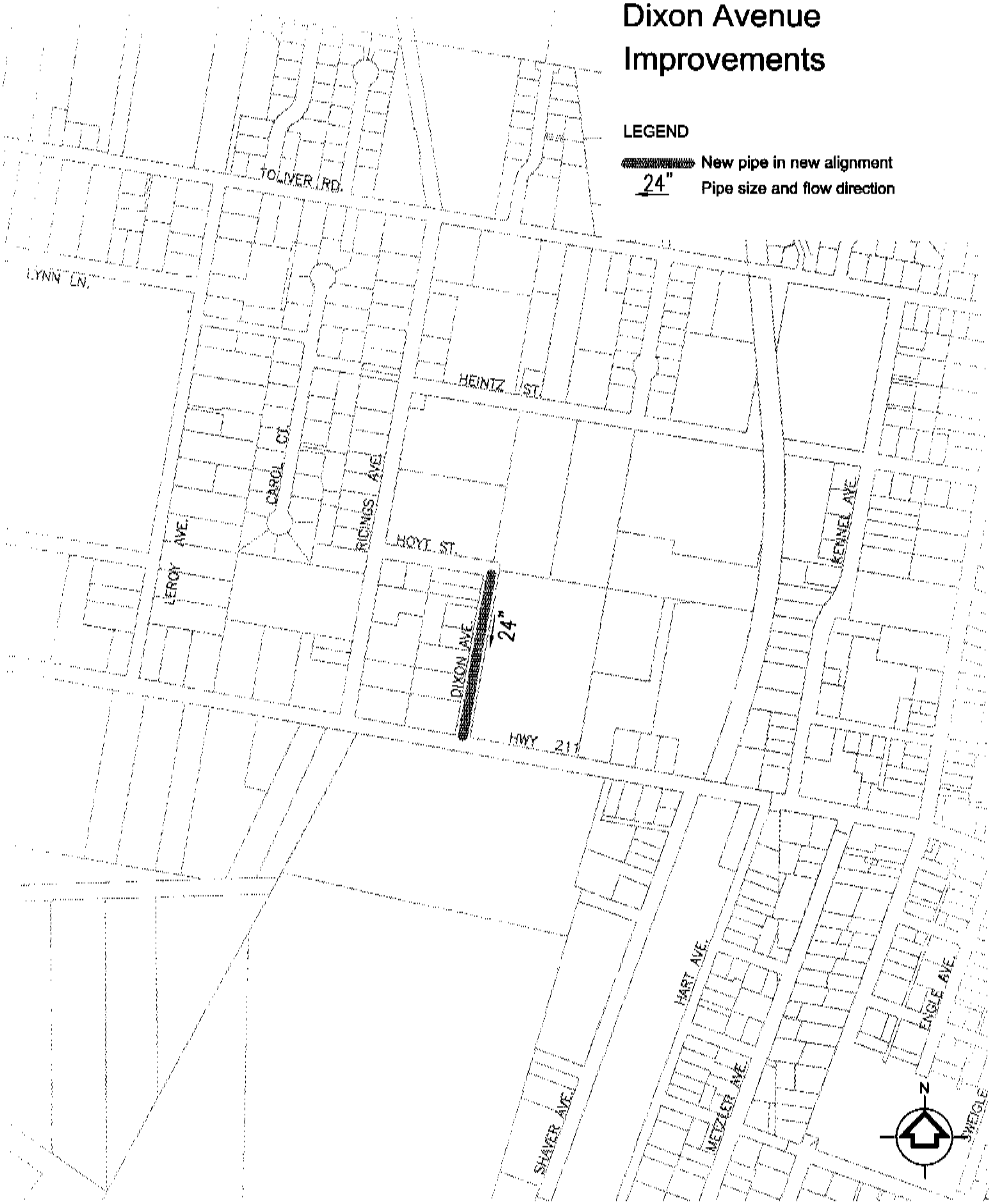

FIG 4.7

The following existing CIP projects would not be needed if projects described above are implemented:

- Kennel Avenue Drainage Improvements — Estimated Cost: $43,324
- Hart Avenue Drainage Improvements — Estimated Cost: $149,371
- Heintz Street Drainage Improvements — Estimated Cost: $251,047

The following existing CIP projects would be replaced by projects described above:

Dixon Avenue Drainage Improvements — Estimated Cost: $89,410

Shirley Street Drainage Improvements — Estimated Cost: $88,292
(Downstream improvements are required prior to this project)

The following existing CIP projects are still required with the improvements described above:

- Miller Street Drainage Improvements — Estimated Cost: $45,480
- Sunrise Acres Drainage Improvements — Estimated Cost: $41,740

Other Improvements

The SWMM modeling indicated that a significant amount of the existing storm pipe system is undersized for a 25-year storm under future conditions. The pipe size needed to accommodate the 25-year future-conditions flow has been determined for all pipes in the system, as shown in Appendix F. The table in Appendix F includes pipe sizes for existing, future and with the Railroad Alignment and Heintz Street Collector Projects Constructed.

These sizes should be used if any pipe not identified here as a capital improvement is replaced. This could occur when roads are being reconstructed, when land is being developed or redeveloped, or when the system has a failure or reaches its design life and is no longer functioning. No cost has been estimated for these improvements and they are not incorporated in the revised CIP program.

CULVERT IMPROVEMENTS

The culverts assessed for potential improvement were selected based on existing flooding problems or the potential for flooding in the future. Improvement cost estimates were based on culverts sized to pass flows from the 50-year design storm. The culverts also were checked for their ability to convey 100-year flows. Detailed information about the culverts is presented in Table 3-2.

Many culverts in the City have adequate flow capacity but could be improved for fish passage and habitat; these are not included in the list of improvements. When new culverts or culvert replacements are proposed along Bear Creek, the design review should include fish passage in accordance with Oregon Department of Fish and Wildlife guidelines.

The recommended sizes are based on general assumptions about site conditions. A survey of the site and creek conditions at each culvert is required to develop final design. The recommended size should not be used without a site survey and hydraulic design.

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

Bear Creek at Mathias Road

The existing culverts are two 36-inch corrugated metal pipes (CMPs). As shown in Table 3-2, the culverts cannot pass the 25-year storm flows. The recommendation is to replace the culverts with a bottomless culvert that can pass 100-year storm flows (324 cfs). The preliminary recommendation for the new culvert is a 12-foot span bridge or arch span with a natural creek bottom. Mathias Road is a County road and therefore this project will be presented in the City's storm CIP list in Chapter 5 however no cost will be presented in the list.

Estimated Cost: $280,000.

Bear Creek at Molalla Avenue

The existing culverts are two arch CMPs. As shown in Table 3-2, the culverts cannot pass the 25-year storm flows. The recommendation is to replace the culverts with a bottomless culvert that can pass 100-year storm flows (432 cfs). The preliminary recommendation for the new culvert is a 14-foot span bridge or arch span with a natural creek bottom. Molalla Avenue is a County road and therefore this project will be presented in the City's storm CIP list in Chapter 5 however no cost will be presented in the list.

Estimated Cost: $300,000.

Bear Creek at Ona Way

The existing culverts are two arch CMPs. As shown in Table 3-2, the culverts cannot pass the 25-year storm flows. The recommendation is to replace the culverts with a bottomless culvert that can pass 100-year storm flows (504 cfs). The preliminary recommendation for the new culvert is a 15-foot span bridge with a natural creek bottom. This is the same size as the bridge below Highway 211. Ona Way is a County road and therefore this project will be presented in the City's storm CIP list in Chapter 5 however no cost will be presented in the list.

Estimated Cost: $320,000.

Bear Creek at Highway 213

The existing culverts are two arch CMPs. As shown in Table 3-2, the culverts cannot pass the 25-year storm flows. The recommendation is to replace the culverts with a bottomless culvert that can pass 100-year storm flows (552 cfs). The preliminary recommendation for the new culvert is an 18-foot span bridge with a natural creek bottom. Highway 213 is a State road and therefore this project will be presented in the City's storm CIP list in Chapter 5 however no cost will be presented in the list.

Estimated Cost: $350,000.

Culvert Below Forest Road

The 36-inch CMP below Forest Road East of Ona Way is undersized for the flow expected from the upstream basin. We recommend leaving this culvert in place at this time. It appears that no habitat structures exist upstream and the area upstream provides temporary detention during large storm events.

CREEK IMPROVEMENTS

Although this study only investigated the condition of natural drainageways from a conveyance standpoint, several general recommendations for creek system improvements can be made. The City has a stream corridor protection ordinance for new development that protects the Bear and Creamery Creek corridors. The City should also look for opportunities to enhance creek corridors. Enhancement of these corridors has the effects of protecting property, protecting and enhancing water quality, and enhancing riparian habitat. Opportunities to look for include the following types of projects:

- Channel Stabilization—These projects stabilize streambeds and streambanks to protect property and infrastructure and alleviate sedimentation problems. They require on-site professional expertise to determine appropriate measures to stabilize the streambed or streambank. The City should fully evaluate bioengineering concepts as the first choice for these projects, as opposed to traditional riprap solutions.
- Riparian Corridor Restoration—These projects restore natural plant communities as much as practical to reduce stream temperature and sedimentation and to restore riparian wildlife habitat.
- Community-Based Enhancement—These projects provide water quality benefits and riparian habitat enhancements through local neighborhood improvements using volunteer involvement with some City resources. City contributions might include plant materials, site preparation, volunteer coordination, etc. The focus of these projects is to eliminate blackberry and other invasive exotic plants and to plant desirable native species that will reestablish the riparian forest canopy and wildlife habitat.
- Protection from future development—This strategy focuses on protecting existing riparian corridors and native vegetation by implementing stream buffer zone regulations in areas where future development might occur.

NONSTRUCTURAL MEASURES

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

Stormwater Codes

The City should periodically review stormwater standards in its published Design Standards. This allows improvement to the code based on recent experience with implementing it. The adoption of guidelines developed by other agencies is one way to better define City codes. For example, the City of Portland's *Stormwater Quality Facilities; A Design Guidance Manual* could be a standard that the City follows when reviewing stormwater quality features for new development. This would allow developers guidance when designing a project.

Operation and Maintenance

This study did not attempt to match existing City maintenance staff with the duties and requirements of maintaining the City's storm system. This should be left up to staff who have knowledge of crew sizes and the time required to accomplish each task. It is recommended that the City start a maintenance program with record keeping. With the new City-wide mapping, each segment of the system can be numbered and maintenance records can be kept. This would allow the City to maintain long-term records of maintenance problems.

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

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

Implementation of a plan should define scheduled maintenance for each facility and who is responsible, outline reports to be used for inspection documentation, and detail what can and cannot be removed.

CHAPTER 5.
CAPITAL IMPROVEMENT PROGRAM

RECOMMENDED IMPROVEMENT PROJECTS

Recommended improvement projects described in Chapter 4 make up the proposed new stormwater capital improvement program (CIP). In addition to the identification of the projects and their estimated cost, the CIP includes a priority for each project and a recommendation for project phasing based on priority. Five priority levels were identified:

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

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

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

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

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

Table 5-1 summarizes the capital projects in the CIP, along with their estimated costs and priorities.

TABLE 5-1.
CAPITAL IMPROVEMENT PROJECTS

Project	Estimated Cost	Priority
2nd Street/Railway Alignment Storm System	$1,230,000	High
Detention Pond at Mathias Avenue and Creamery Creek	$96,000	High
Heintz Street Collector Replacement Project	$1,200, 000	Medium
Shirley Street Drainage Improvements	$91,000	Medium
Miller Street Drainage Improvements	$45,480	Medium
Sunrise Acres Drainage Improvements	$41,740	Medium
Bear Creek at Molalla Avenue Culvert Replacement	County Road	Medium
Bear Creek at Highway 213 Culvert Replacement	State Road	Medium
Bear Creek at Mathias Culvert Replacement	County Road	Low
Bear Creek at Ona Way Culvert Replacement	County Road	Low
Industrial Way Stormwater Improvements		Monitor
Dixon Avenue Drainage Improvements		Monitor

For Creamery Creek, the two highest priority projects will route flows south of Main Street west and around the downtown area to eliminate flooding along Main Street and allow development of the area south of Main Street and west of Molalla Avenue:

- The railroad alignment allows for an opportunity to combine a stormwater project and a recreational project. A swale can be designed along this alignment that will allow trees and smaller brush to grow and provide water quality treatment to stormwater. The tree-lined swale would provide an attractive pedestrian trial through the downtown area.
- The Mathias detention pond will reduce flows in the main channel of Creamery Creek. This, along with the routing of stormwater along the railroad alignment, will reduce the flows in Creamery Creek and reduce, but not eliminate, the need for the Heintz Street Collector Replacement Project.

If these two projects are implemented, the major concerns of the Creamery Creek pipe system will be structural integrity and alignment of the pipe on private property. We recommend running a video camera through the main stem of the system to determine if the pipe is collapsing at any location. Depending on the results of the video survey, the Heintz Street Collector Replacement Project could become a high priority.

The Shirley Street Project should be constructed concurrently or following the completion of the Heintz Street Collector Replacement Project. The remaining projects are independent and can be moved in priority depending on flooding problems or opportunities to combine with other projects.

NONSTRUCTURAL PROJECTS

Drainage Design Standards

The City's drainage design standards (March 1997) should be periodically reviewed to ensure that their intent meets the City's needs.

Riparian Corridor Protection

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

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

NPDES Requirements

The NPDES Storm Water Phase II Program identifies six implementation requirements:

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

The capital improvement program addresses each of these items and therefore helps to prepare the City for NPDES requirements.

FUNDING ALTERNATIVES

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

General Obligation Bonds

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

Revenue Bonds

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

State/Federal Grants and Loans

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

System Development Charges

ORS 223.297 establishes the use of system development charges (SDCs) and provides a framework for establishing fees that recover from new development the City's costs in providing utility system capacity. It also establishes a basis for fee calculation, which the City must follow. However, the fundamental objective for the fee structure is the imposition on new development of a proportionate share of the costs associated with providing or expanding stormwater infrastructure to meet the capacity needs created by that specific development. SDCs cannot be applied retroactively and are a one-time charge at the time of development approval. Only infrastructure funded through stormwater charges or other City fees is eligible for inclusion in the SDC. If the existing system has any capacity remaining and available to new development, this available capacity becomes the basis for reimbursement of the SDC. Table 5-2 provides some SDC rates for communities in Oregon.

Stormwater Management Service Charges

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

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

City	Population	Stormwater Utility Rate (per month)	ERU (square feet)	SDC (charge per ERU)
Banks	625	$4.00	2,640	$500.00
Beaverton	66,225	$5.00	2,640	$901.00
Cannon Beach	1,425	$3.50	5,000	$701.00
Cottage Grove	8,005	$2.50		$928.96
Gresham	81,865	$3.53	2,500	$725.00
Medford	57,610	$2.95	3,000	$400.00
Molalla (2001)	6,000	$2.00	$2,640	$289.00
Roseburg	19,810	$2.85	3,000	$400.00
Sherwood	8,125	$4.00	2,640	
Tigard	36,680	$4.00	2,640	$500.00

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

City	Population	Stormwater Utility Rate (per month)	ERU (square feet)	SDC (charge per ERU)
Tualatin	20,405	$4.00	2,640	$500.00
West Linn	20,415	$3.75		$376.00
Wilsonville	10,940	$1.40	2,000	$81.00
Woodburn	16,150	n/a	n/a	$275.00

APPENDIX A.
STORM SYSTEM MAP

City of Molalla
Stormwater Master Plan
March 2002

APPENDIX B.
STORM SYSTEM EVALUATION METHODOLOGY

This appendix describes the methodology and assumptions used for modeling of the closed storm system in the Molalla study area.

STORM SEWER SYSTEM EVALUATION

Modeling Parameters

The model used for this analysis was XP-SWMM 2000 developed by *XP Software Pty. Ltd.* It is based on the U.S. Environmental Protection Agency's Storm Water Management Model (SWMM) and uses rainfall information and percent-impervious information, along with subcatchment-specific parameters, to determine the hydrology and hydraulics of a modeled drainage area. Each catchment is subdivided into subcatchments that are hydrologically similar. The model requires the following parameters for each subcatchment to define the flow:

- Subcatchment area
- Subcatchment slope
- Subcatchment width
- Percent impervious
- Pervious curve number
- Time of concentration

The study area is sufficiently small that the design rainfall is the same for the whole study area. The study area was divided into areas with similar infiltration characteristics. Infiltration for each subcatchment is calculated based on the following characteristics:

- Depression storage for impervious and pervious areas
- Roughness coefficients for impervious and pervious areas
- Infiltration rate information (maximum, minimum and decay rate).

The approach used for defining each modeling parameter is described below.

Subcatchment Area

Subcatchment area is the actual area of the subcatchment in acres.

Subcatchment Width

Subcatchment width is the width of overland flow. In an idealized rectangular subcatchment with a channel in the center, the width is twice the length of the main drainage channel. Where the drainage channel is on one side of the subcatchment, the width is equal to the length of the drainage channel. Where subcatchments are not uniformly shaped, the width is calculated as follows (DiGiano, et al., 1997):

$$W = (2 - S_k) * L_c$$

where

W = Subcatchment overland flow width (feet)
L_c = Length of main drainage channel (feet)
S_k = Skew factor, calculated as follows:

$$S_k = (A_2 - A_1)/A$$

where

A_1 = Area on one side of the channel
A_2 = Area on other side of the channel
A = Total Area

Subcatchment Slope

Subcatchment slope is defined as the average slope of the subcatchment in non-dimensional units (feet per foot). The subcatchment slope reflects the average slope along the pathway of overland flow to inlet locations. For simple geometry, such as in this study area, this is simply the elevation difference divided by the length of flow.

Impervious Areas

The percent-impervious value indicates the percentage of the drainage area that is covered with impervious surfaces that prevent infiltration of rainfall into the ground. Existing and future percent-impervious values were determined for each subcatchment based on existing zoning and land.

The impervious area used in the modeling was the *mapped impervious area* (MIA), which is the actual total impervious area. The modeling did not use *effective impervious area* (EIA), which is usually a percentage of the MIA and difficult to measure. Most newer developments in the study area are served by storm sewers, so existing MIA and EIA are essentially equal. Future development using biofiltration swales and other water quality facilities could result in an EIA that is significantly smaller than MIA; however, to be conservative in the modeling, MIA was used for future as well as existing conditions.

Each type of land use was assigned a percent-impervious value as shown in Table B-1. The value for each subcatchment was calculated as a weighted average by area of each land use in that subcatchment. Existing land use was determined from a 1993 aerial photograph.

Pervious Curve Numbers

Pervious curve numbers for each subcatchment were developed for pervious areas and used in conjunction with the percent-impervious values described above. For pervious areas, the curve numbers are related to soil type, land use, cover and hydrologic condition. Table B-2 shows the curve numbers by land use and soil type. Curve numbers were calculated for each subcatchment as a weighted average by area of land use.

TABLE B-1.
PERCENT IMPERVIOUS BY LAND USE

Land use zones		% Impervious
C1	Central Commercial	85
C2	General Commercial	85
EFU	Exclusive Farm Use	0
M1	Light Industrial	72
M2	Heavy Industrial	72
PSP	Public or Semi-public	25
R1	Single family residential	38
R2	Two family residential	65
R3	Multi family residential	65
RI	Rural Industrial	36
RRFF5	Rural Residential Farm/Forest	0

Source: *Urban Hydrology for Small Watersheds.* Soil Conservation Service Technical Release 55. June 1986

TABLE B-2.
PERVIOUS CURVE NUMBERS

		Curve Number	
Land use zones		Group C Soils	Group D Soils
C1	Central Commercial	94	95
C2	General Commercial	94	95
EFU	Exclusive Farm Use	74	80
M1	Light Industrial	91	93
M2	Heavy Industrial	91	93
PSP	Public or Semi-public	79	84
R1	Single family residential	83	87
R2	Two family residential	90	92
R3	Multi family residential	90	92
RI	Rural Industrial	80.5	85
RRFF5	Rural Residential Farm/Forest	77	82

Source: *Urban Hydrology for Small Watersheds.* Soil Conservation Service Technical Release 55. June 1986

Time of Concentration

The time of concentration for a drainage area is defined as the time it takes for storm runoff to travel to the storm inlet from the most hydraulically distant point in the drainage area. This was calculated for each subcatchment as the length of travel divided by the estimated travel speed. A velocity of 0.5 feet per second (fps) was assumed for overland flow and a velocity of 0.1 fps was assumed for channel flow.

Depression Storage

The volume of rainfall needed to fill small depressions before runoff occurs is called the depression storage. These depressions are low ponding areas where rainfall can only escape by evaporation or infiltration. The model requires values for both impervious and pervious areas, and gives the following equation for estimating storage in impervious areas:

$$d_p = 0.0303.S^{-0.49}$$

where

d_p is the depression storage in inches

S is the subcatchment slope in percent.

As the slopes of the subcatchments in the study area were similar, one value for depression storage was used for all subcatchments. Using an average slope of 1.2 percent, the depression storage was calculated as 0.0277 inches for impervious areas.

For pervious areas, the depression storage is related to soil type. The soils within the study area are all defined as silt loam soils except soil type 84, which is described as a silty clay loam. The SWMM manual suggests values of depression storage of 0.15 inches for pervious areas.

Roughness Coefficients

The roughness coefficient, called *Manning's n-factor*, is used to determine the roughness of the surfaces over which water will flow. SWMM requires values for both pervious and impervious areas, and recommends the following values:

- Impervious areas:
  - Asphalt or concrete surfaces: 0.011 to 0.013
  - Graveled surfaces: 0.012 to 0.030
- Pervious areas:
  - Dense grass: 0.350
  - Bluegrass sod: 0.390 to 0.630
  - Bermuda grass: 0.300 to 0.480

Since the impervious and pervious areas will likely be some combination of the above described conditions (as well as other conditions), the following values were used in modeling for this study:

- Impervious roughness coefficient: 0.012
- Pervious roughness coefficient: 0.300

Infiltration Rates

The SWMM program's Horton infiltration equation was used to estimate infiltration rates for this analysis. The following parameters are used for this equation:

- Maximum infiltration rate (f_o) in inches/hour (initial conditions)
- Minimum infiltration rate (f_c) in inches/hour (saturated conditions)
- Decay rate, coefficient (k) in 1/seconds

The study area includes soil types 1A, 3, 17, 29, 41, 79B and 84. As shown in Table B-3, all the soils in the study area except for soil type 84 have the same infiltration properties. The portion of the study area with soil type 84 is very small, so the rates for all other soils in the study area (f_c = 0.6 inches/hour and f_o = 2.0 inches/hour) were used for this analysis. The decay rate coefficient used was k = 0.00115/second.

TABLE B-3.
INFILTRATION RATES

Soil Type	Soil Description	f_c (in/hr)	f_o (in/hr)	Hydro Group
1A	Aloha silt loam, 0-3 percent slopes	0.6	2.0	C
3	Amity silt loam	0.6	2.0	D
17	Clackamas silt loam	0.6	2.0	D
29	Dayton silt loam	0.6	2.0	D
41	Huberly silt loam	0.6	2.0	D
79B	Sawtell silt loam, 0-8 percent slopes	0.6	2.0	C
84	Wapato silty clay loam	0.2	2.0	D

Source: *Soil Survey of Clackamas County Area, Oregon*. Soil Conservation Service. November 1985.

Hydrologic Analysis Approach

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

- **The equivalent impervious runoff area for the area draining to each storm inlet**—The equivalent impervious runoff area for each drainage area was calculated by multiplying its runoff coefficient by its total acreage.
- **Runoff discharge to each manhole along the length of each system**—The runoff discharge for a drainage area was calculated by multiplying the equivalent impervious runoff area by the rainfall intensity shown in Table B-4.

TABLE B-4. RAINFALL DURATION AND INTENSITY		
Storm Duration (minutes)	Rainfall Intensity (inches/hour)	
	10-Year Storm	25-Year Storm
5	2.50	2.90
10	1.95	2.25
15	1.65	1.92
20	1.42	1.68
25	1.28	1.59

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

Hydraulic Analysis Approach

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

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

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

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
EXISTING (25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
CREAMERY CREEK									
PC100	36	313.8	313.3	47	0.025	0.99	Trapezoidal	36	0
PC1002	12	373.8	367.0	331	0.013	2.08	Circular	6	30
PC1004	12	374.8	373.8	425	0.013	0.24	Circular	3	765
PC1006	12	376.3	374.8	600	0.013	0.25	Circular	2	1367
PC1008	10	378.0	376.3	681	0.013	0.25	Circular	2	1323
PC101	54	314.7	313.8	438	0.025	0.19	Trapezoidal	23	0
PC1010	10	385.2	378.0	420	0.013	1.71	Circular	3	748
PC1012	10	389.7	385.2	655	0.013	0.69	Circular	3	106
PC1014	10	390.7	389.7	922	0.013	0.11	Circular	1	132
PC102	36	315.0	314.7	60	0.022	0.53	Circular	23	0
PC103	8	316.4	315.0	714	0.025	0.19	Trapezoidal	23	0
PC104	36	332.0	316.4	1905	0.025	0.82	Trapezoidal	32	0
PC106	36	334.0	332.0	247	0.025	0.82	Trapezoidal	27	0
PC108	36	338.5	334.0	558	0.025	0.82	Trapezoidal	24	0
PC110	50	339.3	338.5	89	0.022	0.83	Circular	20	0
PC1100	60	364.7	364.1	52	0.022	1.06	Circular	19	0
PC1102	12	369.8	364.7	478	0.013	1.07	Circular	4	480
PC1104	12	373.6	369.8	398	0.013	0.95	Circular	4	870
PC1106	12	378.0	373.6	500	0.013	0.89	Circular	4	467
PC1108	12	386.0	378.0	300	0.013	2.66	Circular	6	102
PC1110	13	387.0	386.0	135	0.013	0.74	Circular	1	30
PC1110A	12	387.0	380.8	364	0.013	1.71	Circular	3	41
PC1116	12	376.7	373.6	313	0.013	1.00	Circular	4	459
PC1118	12	384.9	376.7	820	0.013	1.00	Circular	3	69
PC112	24	339.6	339.3	34	0.022	0.80	Circular	11	0
PC114	14	340.0	339.6	60	0.009	0.82	Circular	11	81
PC116	12	342.3	340.0	264	0.009	0.85	Circular	3	81
PC118	10	343.2	342.3	144	0.009	0.64	Circular	3	14
PC120	10	343.9	343.2	99	0.009	0.72	Circular	3	29
PC122	10	345.3	343.9	239	0.009	0.59	Circular	3	33
PC123	24	341.1	340.0	82	0.022	1.26	Circular	16	108
PC124	24	345.4	341.1	343	0.022	1.26	Circular	16	36
PC1250	24	368.0	364.7	341	0.022	0.97	Circular	15	76
PC1252	24	372.9	368.0	500	0.022	0.97	Circular	15	154
PC1254	21	375.1	372.9	231	0.013	0.98	Circular	15	148
PC1256	21	378.2	375.1	314	0.013	0.97	Circular	16	116
PC1258	21	380.8	378.2	270	0.013	0.97	Circular	20	81
PC126	24	348.5	345.4	308	0.022	1.00	Circular	16	34
PC1260	15	387.0	380.8	211	0.013	2.94	Circular	9	54
PC1262	15	387.6	387.0	36	0.013	1.71	Circular	9	36
PC1264	12	395.7	387.6	233	0.013	3.46	Circular	3	18
PC1270	15	385.9	380.8	510	0.013	1.00	Circular	5	51
PC128	24	351.8	348.5	329	0.022	1.00	Circular	5	25
PC1290	15	388.7	387.6	230	0.013	0.47	Circular	6	45
PC1292	15	390.8	388.7	88	0.013	2.42	Circular	8	27
PC1294	15	399.1	390.8	342	0.013	2.43	Circular	8	0

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
EXISTING (25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PC1296z	36	399.4	399.2	221	0.022	0.10	Circular	1	0
PC1296y	36	399.4	399.2	221	0.022	0.10	Circular	1	0
PC132	18	345.0	340.0	70	0.022	7.09	Circular	9	0
PC134	12	348.8	345.0	305	0.009	1.25	Circular	6	21
PC136	12	349.1	348.8	298	0.009	0.10	Circular	4	1128
PC138	12	350.5	349.1	136	0.009	1.00	Circular	6	1464
PC140	12	351.5	350.5	101	0.009	1.00	Circular	5	450
PC1402	12	372.4	368.3	402	0.013	1.03	Circular	4	531
PC1404	12	375.8	372.4	330	0.013	1.03	Circular	5	1041
PC1406	12	380.8	375.8	330	0.013	1.53	Circular	4	780
PC1408	12	381.1	380.8	80	0.013	0.30	Circular	4	643
PC1410	12	382.7	381.1	350	0.013	0.47	Circular	4	760
PC1412	12	386.8	382.7	335	0.013	1.23	Circular	3	506
PC1414	12	389.7	386.8	330	0.013	0.88	Circular	2	156
PC1416	10	386.0	382.7	265	0.013	1.26	Circular	2	630
PC1418	10	386.9	386.0	342	0.013	0.25	Circular	1	465
PC142	12	353.2	351.5	175	0.009	1.00	Circular	5	162
PC1420	10	389.7	386.9	350	0.013	0.80	Circular	1	306
PC1422	12	388.3	386.0	230	0.013	1.00	Circular	1	354
PC1424	10	391.6	388.3	326	0.013	1.00	Circular	2	111
PC144	12	355.7	353.2	249	0.009	1.00	Circular	5	121
PC146	12	356.2	355.7	47	0.009	1.01	Circular	5	94
PC148	12	360.2	356.2	398	0.009	1.00	Circular	2	43
PC1502	12	374.9	374.4	168	0.013	0.29	Circular	4	486
PC1504	12	385.5	374.9	415	0.013	2.54	Circular	5	486
PC1506	12	385.7	385.5	32	0.013	0.87	Circular	5	16
PC1508	12	387.1	385.7	148	0.013	0.91	Circular	4	31
PC1510	12	388.2	387.1	172	0.013	0.66	Circular	3	29
PC1512	12	388.9	388.2	124	0.013	0.56	Circular	2	21
PC1514	12	389.5	388.9	148	0.013	0.43	Circular	2	7
PC1600	36	377.9	376.0	8	0.022	23.68	Circular	1	0
PC1602	36	378.2	377.9	80	0.022	0.26	Circular	1	0
PC1604	36	378.5	378.2	126	0.022	0.27	Circular	1	0
PC1700	36	389.8	377.3	611	0.025	2.04	Trapezoidal	46	56
PC1702	18	394.0	389.8	76	0.013	5.61	Circular	2	0
PC1800	36	389.9	389.8	62	0.013	0.27	Circular	40	0
PC1802	12	393.0	389.9	161	0.013	1.90	Circular	6	118
PC1804	12	395.5	393.0	179	0.013	1.42	Circular	5	233
PC1806	12	399.9	395.5	237	0.013	1.84	Circular	5	221
PC1808	12	401.7	399.9	237	0.013	0.75	Circular	4	321
PC1810	12	405.2	401.7	297	0.013	1.18	Circular	3	310
PC1900	36	392.2	389.9	198	0.013	1.16	Circular	32	0
PC200	36	344.8	313.8	4348	0.025	0.71	Trapezoidal	13	1178
PC2000	36	397.6	392.2	465	0.025	1.16	Trapezoidal	32	0
PC2002	12	398.4	397.6	184	0.013	0.43	Circular	2	72
PC202	24	346.2	344.8	129	0.025	1.02	Trapezoidal	18	2385
PC204	24	347.4	346.2	116	0.009	1.07	Circular	18	1208

APPENDIX C
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SWMM ANALYSIS RESULTS
EXISTING (25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PC206	12	359.5	347.4	586	0.009	2.06	Circular	7	0
PC208	12	360.2	359.5	120	0.009	0.63	Circular	3	0
PC210	12	360.7	360.2	51	0.009	0.96	Circular	3	0
PC2100	36	402.0	397.6	740	0.025	0.59	Trapezoidal	31	0
PC212	12	364.6	360.7	384	0.009	1.00	Circular	3	0
PC214	24	347.1	347.4	218	0.009	-0.16	Circular	12	5
PC216	24	348.1	347.1	244	0.009	0.42	Circular	8	5
PC218	24	350.7	348.1	54	0.009	4.95	Circular	4	0
PC220	12	352.9	350.7	339	0.009	0.62	Circular	2	0
PC2200	36	402.3	402.0	30	0.022	1.00	Circular	31	0
PC222	12	354.6	352.9	253	0.009	0.70	Circular	1	0
PC224	12	348.5	348.1	212	0.009	0.20	Circular	4	21
PC226	12	351.1	348.5	466	0.009	0.55	Circular	2	21
PC230	10	355.7	347.1	394	0.009	2.20	Circular	1	5
PC250	36	345.5	344.8	95	0.025	0.71	Trapezoidal	54	1178
PC260	36	345.7	345.5	20	0.013	0.75	Trapezoidal	54	0
PC265	12	361.3	354.4	1639	0.009	0.00	Circular	3	112
PC300	30	346.2	345.7	75	0.025	0.71	Trapezoidal	54	0
PC302	48	347.0	346.2	77	0.025	1.00	Trapezoidal	5	0
PC304	12	347.4	347.0	82	0.009	0.52	Circular	5	0
PC306	60	347.7	347.4	72	0.025	0.48	Trapezoidal	6	0
PC308	24	348.0	347.7	171	0.009	0.16	Circular	7	0
PC310	15	348.3	348.0	114	0.009	0.26	Circular	7	9
PC312	15	354.1	348.3	226	0.009	2.55	Circular	7	9
PC314	15	355.2	354.1	170	0.009	0.68	Circular	7	0
PC316	15	356.5	355.2	157	0.009	0.79	Circular	4	0
PC318	12	358.7	356.5	187	0.009	1.20	Circular	2	0
PC320	12	359.4	358.7	105	0.009	0.61	Circular	2	0
PC350	30	351.9	346.2	802	0.025	0.71	Trapezoidal	50	0
PC400	30	352.3	351.9	70	0.022	0.59	Circular	50	490
PC401	36	353.4	352.3	29	0.025	3.89	Trapezoidal	2	1152
PC402	12	355.3	353.4	187	0.013	1.00	Circular	2	1345
PC404	12	355.1	355.3	32	0.013	-0.62	Circular	2	1394
PC406	12	357.3	355.1	310	0.013	0.71	Circular	2	801
PC500	36	353.5	353.5	4	0.025	0.28	Trapezoidal	22	661
PC502	36	354.8	353.5	328	0.022	0.39	Circular	22	1290
PC504	36	357.3	354.8	663	0.022	0.39	Circular	31	1127
PC506	36	357.4	357.3	41	0.022	0.17	Circular	31	998
PC508	36	358.8	357.4	418	0.022	0.33	Circular	19	868
PC510	36	360.9	358.8	212	0.022	1.00	Circular	19	372
PC550	30	358.6	357.9	500	0.009	0.14	Circular	17	877
PC552	30	359.4	358.6	195	0.009	0.39	Circular	14	602
PC554	12	360.4	359.4	60	0.013	1.64	Circular	2	595
PC556	12	361.3	360.4	335	0.013	0.29	Circular	2	610
PC556A	12	359.0	359.0	50	0.010	0.00	Circular	4	352
PC558	12	364.0	361.3	270	0.013	1.00	Circular	5	926
PC560	12	364.8	364.0	78	0.013	1.00	Circular	5	1376

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
EXISTING (25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PC562	12	367.5	364.8	266	0.013	1.00	Circular	4	833
PC570	30	359.6	359.4	12	0.009	1.83	Circular	13	361
PC572	30	360.9	359.6	359	0.009	0.37	Circular	21	136
PC574	21	364.0	360.9	304	0.009	1.02	Circular	16	0
PC606	15	366.1	363.4	38	0.009	7.19	Circular	10	0
PC608	15	369.1	366.1	327	0.009	0.91	Circular	7	0
PC610	12	375.0	369.1	597	0.009	0.99	Circular	2	0
PC612	12	393.5	375.0	640	0.009	2.89	Circular	3	0
PC700	60	353.5	352.3	198	0.025	0.59	Trapezoidal	104	490
PC702	60	356.8	353.5	571	0.022	0.58	Circular	91	0
PC704	60	357.6	356.8	208	0.022	0.39	Circular	84	0
PC706	60	358.0	357.6	70	0.022	0.53	Circular	84	0
PC708	60	360.2	358.0	413	0.022	0.53	Circular	80	0
PC710	60	361.2	360.2	194	0.022	0.53	Circular	64	0
PC710A	36	361.2	360.9	44	0.022	0.68	Circular	19	5
PC712	60	363.5	361.2	269	0.022	0.84	Circular	82	0
PC714	60	364.1	363.5	77	0.022	0.84	Circular	76	0
PC716	48	368.3	364.1	490	0.022	0.84	Circular	57	0
PC718	48	374.4	368.3	783	0.022	0.79	Circular	51	0
PC720	48	376.0	374.4	324	0.022	0.50	Circular	44	0
PC722	48	376.8	376.0	73	0.025	1.00	Trapezoidal	44	0
PC724	34	377.3	376.8	55	0.022	1.00	Special	43	56
PC802	15	365.6	360.2	75	0.013	7.27	Circular	7	0
PC804	15	365.8	365.6	298	0.013	0.06	Circular	3	33
PC806	15	366.2	365.8	702	0.013	0.06	Circular	1	33
PC806A	21	366.2	364.0	195	0.009	1.11	Circular	16	0
PC808	15	368.6	366.2	339	0.013	0.71	Circular	9	438
PC810	15	373.0	368.6	346	0.013	1.27	Circular	6	565
PC812	15	377.4	373.0	352	0.013	1.25	Circular	6	150
PC814	12	378.5	377.4	202	0.013	0.54	Circular	5	281
PC816	12	381.0	378.5	357	0.013	0.70	Circular	3	357
PC818	12	373.2	368.6	300	0.013	1.53	Circular	4	490
PC820	12	377.6	373.2	350	0.013	1.26	Circular	4	67
PC822	12	379.6	377.6	300	0.013	0.67	Circular	2	17

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
EXISTING (25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
BEAR CREEK									
PB100	72	294.5	293.6	86	0.040	1.01	Trapezoidal	81	0
PB1000	72	374.6	357.7	2268	0.040	0.74	Trapezoidal	15	0
PB1002	24	384.3	374.6	976	0.040	1.00	Trapezoidal	15	0
PB1004	24	389.8	384.3	547	0.040	1.00	Trapezoidal	8	0
PB1006	24	392.4	389.8	261	0.040	1.00	Trapezoidal	4	0
PB1008	12	392.7	392.4	105	0.013	0.31	Circular	4	67
PB1010	10	393.2	392.7	90	0.013	0.50	Circular	3	152
PB1012	10	395.4	393.2	439	0.013	0.50	Circular	1	131
PB102	36	299.3	294.5	184	0.022	2.61	Circular	2	0
PB104	30	299.8	299.3	64	0.013	0.75	Circular	2	0
PB1050	12	394.3	384.3	191	0.013	5.23	Circular	8	0
PB1052	12	397.1	394.3	412	0.013	0.68	Circular	4	44
PB106	30	300.3	299.8	49	0.013	1.17	Circular	2	0
PB108	30	304.8	300.3	427	0.013	1.04	Circular	2	0
PB110	24	306.3	304.8	127	0.013	1.16	Circular	2	0
PB1102	12	391.4	389.8	170	0.013	0.96	Circular	4	416
PB1104	12	391.8	391.4	35	0.013	0.94	Circular	4	833
PB1106	12	393.4	391.8	175	0.013	0.96	Circular	4	814
PB1108	12	395.1	393.4	175	0.013	0.95	Circular	5	782
PB1110	12	395.5	395.1	30	0.013	1.33	Circular	4	766
PB1112	12	397.1	395.5	265	0.013	0.60	Circular	2	746
PB1114	12	397.8	397.1	210	0.013	0.33	Circular	2	722
PB1116	12	397.9	397.8	270	0.013	0.04	Circular	-2	714
PB112	24	309.8	306.3	132	0.013	2.65	Circular	2	0
PB114	24	312.4	309.8	91	0.013	2.94	Circular	2	0
PB1150	12	396.4	395.5	182	0.013	0.50	Circular	1	736
PB1152	12	396.6	396.4	44	0.013	0.51	Circular	3	594
PB116	24	313.5	312.4	50	0.013	2.10	Circular	2	0
PB200z	48	296.2	294.5	59	0.022	2.91	Circular	5	0
PB200y	48	296.2	294.5	32	0.010	5.41	Rectangular	37	0
PB200x	48	296.2	294.5	32	0.010	5.41	Rectangular	37	0
PB2000	72	319.8	315.4	585	0.040	0.74	Trapezoidal	13	0
PB201	48	302.6	296.2	643	0.040	1.00	Trapezoidal	42	0
PB202	48	305.3	302.6	267	0.040	1.00	Trapezoidal	42	0
PB203	53	305.6	305.3	29	0.022	1.00	Trapezoidal	42	0
PB204	48	306.5	305.6	90	0.040	1.00	Trapezoidal	42	0
PB205	48	306.9	306.5	48	0.022	0.85	Circular	39	0
PB206	48	310.3	306.9	394	0.040	0.98	Trapezoidal	39	0
PB208	24	310.3	310.3	122	0.009	0.01	Circular	33	467
PB210	24	317.5	310.3	241	0.009	2.99	Circular	31	467
PB2100z	48	320.1	319.8	44	0.022	0.75	Circular	4	0
PB2100y	48	320.1	319.8	44	0.022	0.75	Circular	4	0
PB2100x	48	320.1	319.8	44	0.022	0.75	Circular	4	0
PB212	24	319.2	317.5	289	0.009	0.57	Circular	10	0
PB214	18	319.9	319.2	39	0.009	1.85	Circular	8	0
PB216	18	324.5	319.9	236	0.009	1.94	Circular	5	0

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
EXISTING (25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PB218	18	330.3	324.5	529	0.009	1.11	Circular	4	0
PB220	21	332.1	330.3	377	0.009	0.47	Circular	4	0
PB2200	72	357.4	320.1	5017	0.040	0.74	Trapezoidal	13	0
PB222	18	336.6	332.1	668	0.009	0.68	Circular	5	0
PB224	18	338.2	336.6	160	0.009	0.96	Circular	5	0
PB226	12	339.6	338.2	419	0.013	0.34	Circular	0	0
PB228	12	340.6	339.6	276	0.009	0.37	Circular	0	0
PB230	18	319.4	319.2	45	0.009	0.47	Circular	2	0
PB2300	48	357.7	357.4	45	0.022	0.73	Circular	14	0
PB232	18	319.8	319.4	70	0.009	0.60	Circular	2	0
PB234	12	326.4	319.8	217	0.009	3.07	Circular	2	0
PB234A	12	326.4	326.3	34	0.009	0.50	Circular	1	0
PB236	12	332.5	326.4	734	0.009	0.82	Circular	3	0
PB238	15	332.6	332.1	34	0.009	1.32	Circular	0	0
PB240	12	337.6	332.6	678	0.009	0.75	Circular	0	0
PB240A	12	337.4	336.6	35	0.009	2.14	Circular	0	0
PB242	15	338.9	338.2	185	0.009	0.40	Circular	5	0
PB244	12	341.4	338.9	576	0.013	0.44	Circular	2	0
PB246	15	306.7	306.5	395	0.013	0.53	Circular	4	1129
PB248	15	307.3	306.7	151	0.013	0.54	Circular	11	1629
PB250	12	311.3	308.5	544	0.013	0.50	Circular	4	877
PB252	18	317.6	317.5	19	0.009	0.73	Circular	20	0
PB254	72	318.7	317.6	137	0.040	0.74	Trapezoidal	20	0
PB256z	18	321.4	318.8	367	0.009	0.72	Circular	11	237
PB256y	24	321.4	318.7	367	0.022	0.73	Circular	10	237
PB258	18	321.9	321.4	75	0.009	0.74	Circular	28	363
PB260	48	324.5	321.9	353	0.040	0.74	Trapezoidal	24	126
PB262	24	325.5	324.5	300	0.013	0.33	Circular	23	51
PB264	48	326.5	325.5	341	0.040	0.29	Trapezoidal	24	51
PB266	31	327.5	326.5	180	0.022	0.56	Circular	26	0
PB268	48	328.5	327.5	403	0.040	0.25	Trapezoidal	26	0
PB270	18	329.5	328.5	22	0.009	4.61	Circular	24	0
PB272	48	330.5	329.5	305	0.040	0.33	Trapezoidal	25	0
PB274	48	330.9	330.5	315	0.040	0.12	Trapezoidal	25	0
PB276	48	331.5	330.9	491	0.040	0.12	Trapezoidal	16	0
PB278	12	331.5	331.5	43	0.013	0.12	Circular	7	1144
PB280	12	332.5	331.5	135	0.013	0.74	Circular	3	1516
PB282	12	333.5	332.5	309	0.013	0.32	Circular	3	729
PB284	12	334.5	333.5	106	0.014	0.94	Circular	3	583
PB286	12	335.5	334.5	65	0.014	1.53	Circular	4	338
PB288	12	336.5	335.5	81	0.014	1.23	Circular	4	208
PB290	24	325.0	321.9	629	0.040	0.50	Trapezoidal	7	126
PB292	12	326.2	325.0	243	0.013	0.49	Circular	4	588
PB293	24	329.7	326.2	709	0.040	0.50	Trapezoidal	15	588
PB294	24	337.1	329.7	1486	0.040	0.73	Trapezoidal	11	0
PB296	24	344.2	337.1	193	0.040	3.68	Trapezoidal	2	0
PB298	12	347.5	344.2	578	0.013	0.57	Circular	2	69

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
EXISTING (25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PB500	72	307.6	296.2	706	0.040	1.69	Trapezoidal	39	0
PB502	24	315.0	307.6	740	0.040	1.00	Trapezoidal	3	0
PB504	24	315.5	315.0	88	0.013	0.53	Circular	3	0
PB506	24	316.7	315.5	300	0.013	0.40	Circular	3	0
PB508	15	318.6	316.7	278	0.013	0.71	Circular	2	0
PB510	12	319.5	318.6	194	0.013	0.42	Circular	0	0
PB510A	24	319.5	313.5	180	0.013	3.30	Circular	2	0
PB600	72	308.3	307.6	639	0.025	0.10	Trapezoidal	31	0
PB602	24	310.5	308.3	224	0.040	1.00	Trapezoidal	4	0
PB604	24	312.3	310.5	335	0.009	0.54	Circular	4	0
PB606	24	313.3	312.3	96	0.009	0.97	Circular	4	0
PB608	24	313.9	313.3	132	0.009	0.45	Circular	4	0
PB610	18	315.2	313.9	299	0.009	0.45	Circular	4	0
PB612	18	316.0	315.2	297	0.009	0.28	Circular	4	0
PB614	15	317.0	316.0	240	0.009	0.40	Circular	4	0
PB700	48	315.4	315.1	45	0.022	0.73	Circular	24	0
PB702	24	327.8	315.4	2474	0.040	0.50	Trapezoidal	13	0
PB704	12	330.4	327.8	515	0.013	0.50	Circular	3	1194
PB706	15	331.6	330.4	238	0.013	0.50	Circular	5	2368
PB708	18	332.5	331.6	184	0.013	0.50	Circular	7	2311
PB710	18	333.8	332.5	266	0.013	0.50	Circular	7	1686
PB712	15	334.9	333.8	225	0.013	0.50	Circular	5	960
PB714	15	336.0	334.9	208	0.013	0.50	Circular	5	834
PB716	12	336.6	336.0	120	0.013	0.50	Circular	2	793
PB730	15	334.1	333.8	53	0.013	0.50	Circular	10	566
PB732	30	334.8	334.1	142	0.013	0.50	Circular	10	47
PB734	30	336.9	334.8	421	0.013	0.50	Circular	10	10
PB750	72	315.1	308.3	919	0.040	0.74	Trapezoidal	30	0
PB752	24	321.8	315.1	1338	0.040	0.50	Trapezoidal	9	0
PB754	24	326.2	321.8	874	0.040	0.50	Trapezoidal	5	0
PB756	12	326.9	326.2	157	0.013	0.50	Circular	3	0
PB758	24	331.7	326.9	951	0.040	0.50	Trapezoidal	1	0

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
FUTURE (25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
CREAMERY CREEK									
PC100	36	313.8	313.3	47	0.025	0.99	Trapezoidal	43	0
PC1002	12	373.8	367.0	331	0.013	2.08	Circular	6	30
PC1004	12	374.8	373.8	425	0.013	0.24	Circular	3	825
PC1006	12	376.3	374.8	600	0.013	0.25	Circular	2	1535
PC1008	10	378.0	376.3	681	0.013	0.25	Circular	1	1476
PC101	54	314.7	313.8	438	0.025	0.19	Trapezoidal	30	0
PC1010	10	385.2	378.0	420	0.013	1.71	Circular	3	795
PC1012	10	389.7	385.2	655	0.013	0.69	Circular	3	106
PC1014	10	390.7	389.7	922	0.013	0.11	Circular	1	132
PC102	36	315.0	314.7	60	0.022	0.53	Circular	30	0
PC103	96	316.4	315.0	714	0.025	0.19	Trapezoidal	33	0
PC104	36	332.0	316.4	1905	0.025	0.82	Trapezoidal	34	0
PC106	36	334.0	332.0	247	0.025	0.82	Trapezoidal	29	0
PC108	36	338.5	334.0	558	0.025	0.82	Trapezoidal	26	0
PC110	50	339.3	338.5	89	0.022	0.83	Circular	21	0
PC1100	60	364.7	364.1	52	0.022	1.06	Circular	19	0
PC1102	12	369.8	364.7	478	0.013	1.07	Circular	4	524
PC1104	12	373.6	369.8	398	0.013	0.95	Circular	4	1027
PC1106	12	378.0	373.6	500	0.013	0.89	Circular	4	608
PC1108	12	386.0	378.0	300	0.013	2.66	Circular	6	143
PC1110	13	387.0	386.0	135	0.013	0.74	Circular	1	61
PC1110A	12	387.0	380.8	364	0.013	1.71	Circular	4	74
PC1116	12	376.7	373.6	313	0.013	1.00	Circular	4	572
PC1118	12	384.9	376.7	820	0.013	1.00	Circular	3	70
PC112	24	339.6	339.3	34	0.022	0.80	Circular	11	0
PC114	14	340.0	339.6	60	0.009	0.82	Circular	11	142
PC116	12	342.3	340.0	264	0.009	0.85	Circular	3	142
PC118	10	343.2	342.3	144	0.009	0.64	Circular	3	18
PC120	10	343.9	343.2	99	0.009	0.72	Circular	3	36
PC122	10	345.3	343.9	239	0.009	0.59	Circular	3	39
PC123	24	341.1	340.0	82	0.022	1.26	Circular	16	208
PC124	24	345.4	341.1	343	0.022	1.26	Circular	16	119
PC1250	24	368.0	364.7	341	0.022	0.97	Circular	15	103
PC1252	24	372.9	368.0	500	0.022	0.97	Circular	15	205
PC1254	21	375.1	372.9	231	0.013	0.98	Circular	15	195
PC1256	21	378.2	375.1	314	0.013	0.97	Circular	16	160
PC1258	21	380.8	378.2	270	0.013	0.97	Circular	20	119
PC126	24	348.5	345.4	308	0.022	1.00	Circular	17	117
PC1260	15	387.0	380.8	211	0.013	2.94	Circular	9	79
PC1262	15	387.6	387.0	36	0.013	1.71	Circular	9	52
PC1264	12	395.7	387.6	233	0.013	3.46	Circular	3	25
PC1270	15	385.9	380.8	510	0.013	1.00	Circular	5	84
PC128	24	351.8	348.5	329	0.022	1.00	Circular	6	64
PC1290	15	388.7	387.6	230	0.013	0.47	Circular	6	60
PC1292	15	390.8	388.7	88	0.013	2.42	Circular	9	35
PC1294	15	399.1	390.8	342	0.013	2.43	Circular	9	0

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
FUTURE (25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PC1296z	36	399.4	399.2	221	0.022	0.10	Circular	1	0
PC1296y	36	399.4	399.2	221	0.022	0.10	Circular	1	0
PC132	18	345.0	340.0	70	0.022	7.09	Circular	10	0
PC134	12	348.8	345.0	305	0.009	1.25	Circular	6	19
PC136	12	349.1	348.8	298	0.009	0.10	Circular	4	1200
PC138	12	350.5	349.1	136	0.009	1.00	Circular	6	1605
PC140	12	351.5	350.5	101	0.009	1.00	Circular	5	554
PC1402	12	372.4	368.3	402	0.013	1.03	Circular	4	707
PC1404	12	375.8	372.4	330	0.013	1.03	Circular	5	1307
PC1406	12	380.8	375.8	330	0.013	1.53	Circular	4	1017
PC1408	12	381.1	380.8	80	0.013	0.30	Circular	3	842
PC1410	12	382.7	381.1	350	0.013	0.47	Circular	4	852
PC1412	12	386.8	382.7	335	0.013	1.23	Circular	3	581
PC1414	12	389.7	386.8	330	0.013	0.88	Circular	2	190
PC1416	10	386.0	382.7	265	0.013	1.26	Circular	2	726
PC1418	10	386.9	386.0	342	0.013	0.25	Circular	1	559
PC142	12	353.2	351.5	175	0.009	1.00	Circular	5	224
PC1420	10	389.7	386.9	350	0.013	0.80	Circular	1	348
PC1422	12	388.3	386.0	230	0.013	1.00	Circular	1	527
PC1424	10	391.6	388.3	326	0.013	1.00	Circular	2	239
PC144	12	355.7	353.2	249	0.009	1.00	Circular	5	171
PC146	12	356.2	355.7	47	0.009	1.01	Circular	5	138
PC148	12	360.2	356.2	398	0.009	1.00	Circular	2	61
PC1502	12	374.9	374.4	168	0.013	0.29	Circular	4	600
PC1504	12	385.5	374.9	415	0.013	2.54	Circular	6	623
PC1506	12	385.7	385.5	32	0.013	0.87	Circular	6	55
PC1508	12	387.1	385.7	148	0.013	0.91	Circular	4	66
PC1510	12	388.2	387.1	172	0.013	0.66	Circular	3	70
PC1512	12	388.9	388.2	124	0.013	0.56	Circular	3	70
PC1514	12	389.5	388.9	148	0.013	0.43	Circular	3	69
PC1600	36	377.9	376.0	8	0.022	23.68	Circular	1	0
PC1602	36	378.2	377.9	80	0.022	0.26	Circular	1	0
PC1604	36	378.5	378.2	126	0.022	0.27	Circular	1	0
PC1700	36	389.8	377.3	611	0.025	2.04	Trapezoidal	60	58
PC1702	18	394.0	389.8	76	0.013	5.61	Circular	2	0
PC1800	36	389.9	389.8	62	0.013	0.27	Circular	42	0
PC1802	12	393.0	389.9	161	0.013	1.90	Circular	6	230
PC1804	12	395.5	393.0	179	0.013	1.42	Circular	5	458
PC1806	12	399.9	395.5	237	0.013	1.84	Circular	5	365
PC1808	12	401.7	399.9	237	0.013	0.75	Circular	4	384
PC1810	12	405.2	401.7	297	0.013	1.18	Circular	3	362
PC1900	36	392.2	389.9	198	0.013	1.16	Circular	32	0
PC200	36	344.8	313.8	4348	0.025	0.71	Trapezoidal	13	1212
PC2000	36	397.6	392.2	465	0.025	1.16	Trapezoidal	32	0
PC2002	12	398.4	397.6	184	0.013	0.43	Circular	2	72
PC202	24	346.2	344.8	129	0.025	1.02	Trapezoidal	18	2448
PC204	24	347.4	346.2	116	0.009	1.07	Circular	18	1237

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
FUTURE (25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PC206	12	359.5	347.4	586	0.009	2.06	Circular	7	0
PC208	12	360.2	359.5	120	0.009	0.63	Circular	3	0
PC210	12	360.7	360.2	51	0.009	0.96	Circular	3	0
PC2100	36	402.0	397.6	740	0.025	0.59	Trapezoidal	31	0
PC212	12	364.6	360.7	384	0.009	1.00	Circular	3	0
PC214	24	347.1	347.4	218	0.009	-0.16	Circular	12	5
PC216	24	348.1	347.1	244	0.009	0.42	Circular	8	5
PC218	24	350.7	348.1	54	0.009	4.95	Circular	4	0
PC220	12	352.9	350.7	339	0.009	0.62	Circular	2	0
PC2200	36	402.3	402.0	30	0.022	1.00	Circular	31	0
PC222	12	354.6	352.9	253	0.009	0.70	Circular	1	0
PC224	12	348.5	348.1	212	0.009	0.20	Circular	4	21
PC226	12	351.1	348.5	466	0.009	0.55	Circular	2	21
PC230	10	355.7	347.1	394	0.009	2.20	Circular	1	5
PC250	36	345.5	344.8	95	0.025	0.71	Trapezoidal	54	1212
PC260	36	345.7	345.5	20	0.013	0.75	Trapezoidal	54	0
PC265	12	361.3	354.4	1639	0.009	0.42	Circular	3	142
PC300	30	346.2	345.7	75	0.025	0.71	Trapezoidal	54	0
PC302	48	347.0	346.2	77	0.025	1.00	Trapezoidal	5	0
PC304	12	347.4	347.0	82	0.009	0.52	Circular	5	0
PC306	60	347.7	347.4	72	0.025	0.48	Trapezoidal	6	0
PC308	24	348.0	347.7	171	0.009	0.16	Circular	7	0
PC310	15	348.3	348.0	114	0.009	0.26	Circular	7	9
PC312	15	354.1	348.3	226	0.009	2.55	Circular	7	9
PC314	15	355.2	354.1	170	0.009	0.68	Circular	7	0
PC316	15	356.5	355.2	157	0.009	0.79	Circular	4	0
PC318	12	358.7	356.5	187	0.009	1.20	Circular	2	0
PC320	12	359.4	358.7	105	0.009	0.61	Circular	2	0
PC350	30	351.9	346.2	802	0.025	0.71	Trapezoidal	50	0
PC400	30	352.3	351.9	70	0.022	0.59	Circular	50	539
PC401	36	353.4	352.3	29	0.025	3.89	Trapezoidal	2	1252
PC402	12	355.3	353.4	187	0.013	1.00	Circular	2	1454
PC404	12	355.1	355.3	32	0.013	-0.62	Circular	2	1859
PC406	12	357.3	355.1	310	0.013	0.71	Circular	2	1209
PC500	36	353.5	353.5	4	0.025	0.28	Trapezoidal	22	710
PC502	36	354.8	353.5	328	0.022	0.39	Circular	22	1384
PC504	36	357.3	354.8	663	0.022	0.39	Circular	31	1232
PC506	36	357.4	357.3	41	0.022	0.17	Circular	31	1121
PC508	36	358.8	357.4	418	0.022	0.33	Circular	19	967
PC510	36	360.9	358.8	212	0.022	1.00	Circular	19	418
PC550	30	358.6	357.9	500	0.009	0.14	Circular	17	996
PC552	30	359.4	358.6	195	0.009	0.39	Circular	14	683
PC554	12	360.4	359.4	60	0.013	1.64	Circular	2	664
PC556	12	361.3	360.4	335	0.013	0.29	Circular	2	690
PC556A	12	359.0	359.0	50	0.010	0.00	Circular	4	419
PC558	12	364.0	361.3	270	0.013	1.00	Circular	5	962
PC560	12	364.8	364.0	78	0.013	1.00	Circular	5	1375

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
FUTURE (25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PC562	12	367.5	364.8	266	0.013	1.00	Circular	4	833
PC570	30	359.6	359.4	12	0.009	1.83	Circular	13	478
PC572	30	360.9	359.6	359	0.009	0.37	Circular	21	228
PC574	21	364.0	360.9	304	0.009	1.02	Circular	16	0
PC606	15	366.1	363.4	38	0.009	7.19	Circular	10	0
PC608	15	369.1	366.1	327	0.009	0.91	Circular	7	0
PC610	12	375.0	369.1	597	0.009	0.99	Circular	3	0
PC612	12	393.5	375.0	640	0.009	2.89	Circular	3	0
PC700	60	353.5	352.3	198	0.025	0.59	Trapezoidal	108	539
PC702	60	356.8	353.5	571	0.022	0.58	Circular	94	0
PC704	60	357.6	356.8	208	0.022	0.39	Circular	88	0
PC706	60	358.0	357.6	70	0.022	0.53	Circular	88	0
PC708	60	360.2	358.0	413	0.022	0.53	Circular	83	0
PC710	60	361.2	360.2	194	0.022	0.53	Circular	65	0
PC710A	36	361.2	360.9	44	0.022	0.68	Circular	19	14
PC712	60	363.5	361.2	269	0.022	0.84	Circular	84	0
PC714	60	364.1	363.5	77	0.022	0.84	Circular	78	0
PC716	48	368.3	364.1	490	0.022	0.84	Circular	59	0
PC718	48	374.4	368.3	783	0.022	0.79	Circular	53	0
PC720	48	376.0	374.4	324	0.022	0.50	Circular	45	0
PC722	48	376.8	376.0	73	0.025	1.00	Trapezoidal	44	0
PC724	34	377.3	376.8	55	0.022	1.00	Special	45	58
PC802	15	365.6	360.2	75	0.013	7.27	Circular	7	0
PC804	15	365.8	365.6	298	0.013	0.06	Circular	3	33
PC806	15	366.2	365.8	702	0.013	0.06	Circular	1	33
PC806A	21	366.2	364.0	195	0.009	1.11	Circular	16	0
PC808	15	368.6	366.2	339	0.013	0.71	Circular	9	565
PC810	15	373.0	368.6	346	0.013	1.27	Circular	6	719
PC812	15	377.4	373.0	352	0.013	1.25	Circular	6	176
PC814	12	378.5	377.4	202	0.013	0.54	Circular	5	416
PC816	12	381.0	378.5	357	0.013	0.70	Circular	3	523
PC818	12	373.2	368.6	300	0.013	1.53	Circular	4	617
PC820	12	377.6	373.2	350	0.013	1.26	Circular	4	67
PC822	12	379.6	377.6	300	0.013	0.67	Circular	2	17

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
FUTURE (25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
BEAR CREEK									
PB100	72	294.5	293.6	86	0.040	1.01	Trapezoidal	86	0
PB1000	72	374.6	357.7	2268	0.040	0.74	Trapezoidal	15	0
PB1002	24	384.3	374.6	976	0.040	1.00	Trapezoidal	15	0
PB1004	24	389.8	384.3	547	0.040	1.00	Trapezoidal	8	0
PB1006	24	392.4	389.8	261	0.040	1.00	Trapezoidal	4	0
PB1008	12	392.7	392.4	105	0.013	0.31	Circular	4	70
PB1010	10	393.2	392.7	90	0.013	0.50	Circular	3	158
PB1012	10	395.4	393.2	439	0.013	0.50	Circular	1	135
PB102	36	299.3	294.5	184	0.022	2.61	Circular	2	0
PB104	30	299.8	299.3	64	0.013	0.75	Circular	2	0
PB1050	12	394.3	384.3	191	0.013	5.23	Circular	8	0
PB1052	12	397.1	394.3	412	0.013	0.68	Circular	4	46
PB106	30	300.3	299.8	49	0.013	1.17	Circular	2	0
PB108	30	304.8	300.3	427	0.013	1.04	Circular	2	0
PB110	24	306.3	304.8	127	0.013	1.16	Circular	2	0
PB1102	12	391.4	389.8	170	0.013	0.96	Circular	4	438
PB1104	12	391.8	391.4	35	0.013	0.94	Circular	4	878
PB1106	12	393.4	391.8	175	0.013	0.96	Circular	4	862
PB1108	12	395.1	393.4	175	0.013	0.95	Circular	5	831
PB1110	12	395.5	395.1	30	0.013	1.33	Circular	4	809
PB1112	12	397.1	395.5	265	0.013	0.60	Circular	2	772
PB1114	12	397.8	397.1	210	0.013	0.33	Circular	2	734
PB1116	12	397.9	397.8	270	0.013	0.04	Circular	-2	724
PB112	24	309.8	306.3	132	0.013	2.65	Circular	2	0
PB114	24	312.4	309.8	91	0.013	2.94	Circular	2	0
PB1150	12	396.4	395.5	182	0.013	0.50	Circular	1	762
PB1152	12	396.6	396.4	44	0.013	0.51	Circular	3	609
PB116	24	313.5	312.4	50	0.013	2.10	Circular	2	0
PB200z	48	296.2	294.5	59	0.022	2.91	Circular	6	0
PB200y	48	296.2	294.5	32	0.010	5.41	Rectangular	39	0
PB200x	48	296.2	294.5	32	0.010	5.41	Rectangular	39	0
PB2000	72	319.8	315.4	585	0.040	0.74	Trapezoidal	13	0
PB201	48	302.6	296.2	643	0.040	1.00	Trapezoidal	43	0
PB202	48	305.3	302.6	267	0.040	1.00	Trapezoidal	43	0
PB203	53	305.6	305.3	29	0.022	1.00	Trapezoidal	43	0
PB204	48	306.5	305.6	90	0.040	1.00	Trapezoidal	44	0
PB205	48	306.9	306.5	48	0.022	0.85	Circular	40	0
PB206	48	310.3	306.9	394	0.040	0.98	Trapezoidal	40	0
PB208	24	310.3	310.3	122	0.009	0.01	Circular	33	515
PB210	24	317.5	310.3	241	0.009	2.99	Circular	31	515
PB2100z	48	320.1	319.8	44	0.022	0.75	Circular	4	0
PB2100y	48	320.1	319.8	44	0.022	0.75	Circular	4	0
PB2100x	48	320.1	319.8	44	0.022	0.75	Circular	4	0
PB212	24	319.2	317.5	289	0.009	0.57	Circular	11	0
PB214	18	319.9	319.2	39	0.009	1.85	Circular	8	0
PB216	18	324.5	319.9	236	0.009	1.94	Circular	5	0

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
FUTURE (25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PB218	18	330.3	324.5	529	0.009	1.11	Circular	5	0
PB220	21	332.1	330.3	377	0.009	0.47	Circular	5	0
PB2200	72	357.4	320.1	5017	0.040	0.74	Trapezoidal	13	0
PB222	18	336.6	332.1	668	0.009	0.68	Circular	5	0
PB224	18	338.2	336.6	160	0.009	0.96	Circular	5	0
PB226	12	339.6	338.2	419	0.013	0.34	Circular	0	0
PB228	12	340.6	339.6	276	0.009	0.37	Circular	0	0
PB230	18	319.4	319.2	45	0.009	0.47	Circular	2	0
PB2300	48	357.7	357.4	45	0.022	0.73	Circular	14	0
PB232	18	319.8	319.4	70	0.009	0.60	Circular	2	0
PB234	12	326.4	319.8	217	0.009	3.07	Circular	2	0
PB234A	12	326.4	326.3	34	0.009	0.50	Circular	1	0
PB236	12	332.5	326.4	734	0.009	0.82	Circular	3	0
PB238	15	332.6	332.1	34	0.009	1.32	Circular	0	0
PB240	12	337.6	332.6	678	0.009	0.75	Circular	0	0
PB240A	12	337.4	336.6	35	0.009	2.14	Circular	0	0
PB242	15	338.9	338.2	185	0.009	0.40	Circular	5	0
PB244	12	341.4	338.9	576	0.013	0.44	Circular	2	0
PB246	15	306.7	306.5	395	0.013	0.53	Circular	4	1170
PB248	15	307.3	306.7	151	0.013	0.54	Circular	11	1766
PB250	12	311.3	308.5	544	0.013	0.50	Circular	5	1127
PB252	18	317.6	317.5	19	0.009	0.73	Circular	20	0
PB254	72	318.7	317.6	137	0.040	0.74	Trapezoidal	20	0
PB256z	18	321.4	318.8	367	0.009	0.72	Circular	11	281
PB256y	24	321.4	318.7	367	0.022	0.73	Circular	10	281
PB258	18	321.9	321.4	75	0.009	0.74	Circular	29	432
PB260	48	324.5	321.9	353	0.040	0.74	Trapezoidal	24	151
PB262	24	325.5	324.5	300	0.013	0.33	Circular	24	77
PB264	48	326.5	325.5	341	0.040	0.29	Trapezoidal	24	77
PB266	31	327.5	326.5	180	0.022	0.56	Circular	26	0
PB268	48	328.5	327.5	403	0.040	0.25	Trapezoidal	27	0
PB270	18	329.5	328.5	22	0.009	4.61	Circular	25	0
PB272	48	330.5	329.5	305	0.040	0.33	Trapezoidal	27	0
PB274	48	330.9	330.5	315	0.040	0.12	Trapezoidal	27	0
PB276	48	331.5	330.9	491	0.040	0.12	Trapezoidal	16	0
PB278	12	331.5	331.5	43	0.013	0.12	Circular	7	1152
PB280	12	332.5	331.5	135	0.013	0.74	Circular	3	1535
PB282	12	333.5	332.5	309	0.013	0.32	Circular	3	748
PB284	12	334.5	333.5	106	0.014	0.94	Circular	3	601
PB286	12	335.5	334.5	65	0.014	1.53	Circular	4	361
PB288	12	336.5	335.5	81	0.014	1.23	Circular	4	227
PB290	24	325.0	321.9	629	0.040	0.50	Trapezoidal	7	151
PB292	12	326.2	325.0	243	0.013	0.49	Circular	4	667
PB293	24	329.7	326.2	709	0.040	0.50	Trapezoidal	17	667
PB294	24	337.1	329.7	1486	0.040	0.73	Trapezoidal	12	0
PB296	24	344.2	337.1	193	0.040	3.68	Trapezoidal	2	0
PB298	12	347.5	344.2	578	0.013	0.57	Circular	2	89

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
FUTURE (25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PB500	72	307.6	296.2	706	0.040	1.69	Trapezoidal	43	0
PB502	24	315.0	307.6	740	0.040	1.00	Trapezoidal	3	0
PB504	24	315.5	315.0	88	0.013	0.53	Circular	3	0
PB506	24	316.7	315.5	300	0.013	0.40	Circular	3	0
PB508	15	318.6	316.7	278	0.013	0.71	Circular	2	0
PB510	12	319.5	318.6	194	0.013	0.42	Circular	0	0
PB510A	24	319.5	313.5	180	0.013	3.30	Circular	2	0
PB600	72	308.3	307.6	639	0.025	0.10	Trapezoidal	35	0
PB602	24	310.5	308.3	224	0.040	1.00	Trapezoidal	4	0
PB604	24	312.3	310.5	335	0.009	0.54	Circular	4	0
PB606	24	313.3	312.3	96	0.009	0.97	Circular	4	0
PB608	24	313.9	313.3	132	0.009	0.45	Circular	4	0
PB610	18	315.2	313.9	299	0.009	0.45	Circular	4	0
PB612	18	316.0	315.2	297	0.009	0.28	Circular	4	0
PB614	15	317.0	316.0	240	0.009	0.40	Circular	4	0
PB700	48	315.4	315.1	45	0.022	0.73	Circular	27	0
PB702	24	327.8	315.4	2474	0.040	0.50	Trapezoidal	17	0
PB704	12	330.4	327.8	515	0.013	0.50	Circular	3	1228
PB706	15	331.6	330.4	238	0.013	0.50	Circular	5	2439
PB708	18	332.5	331.6	184	0.013	0.50	Circular	7	2395
PB710	18	333.8	332.5	266	0.013	0.50	Circular	7	1763
PB712	15	334.9	333.8	225	0.013	0.50	Circular	5	1066
PB714	15	336.0	334.9	208	0.013	0.50	Circular	5	922
PB716	12	336.6	336.0	120	0.013	0.50	Circular	2	857
PB730	15	334.1	333.8	53	0.013	0.50	Circular	10	617
PB732	30	334.8	334.1	142	0.013	0.50	Circular	11	49
PB734	30	336.9	334.8	421	0.013	0.50	Circular	11	11
PB750	72	315.1	308.3	919	0.040	0.74	Trapezoidal	33	0
PB752	24	321.8	315.1	1338	0.040	0.50	Trapezoidal	9	0
PB754	24	326.2	321.8	874	0.040	0.50	Trapezoidal	5	0
PB756	12	326.9	326.2	157	0.013	0.50	Circular	3	0
PB758	24	331.7	326.9	951	0.040	0.50	Trapezoidal	1	0

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
PROPOSED (FUTURE 25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
CREAMERY CREEK									
PC0002	48	354.3	344.8	1864	0.040	0.51	Trapezoidal	234	4
PC0004	36	358.6	354.3	855	0.040	0.45	Trapezoidal	60	4
PC0006	24	364.2	358.6	797	0.010	0.91	Trapezoidal	54	0
PC100	36	313.8	313.3	47	0.025	0.99	Trapezoidal	279	0
PC1002	18	373.8	367.0	331	0.010	2.08	Circular	12	0
PC1004	18	374.8	373.8	425	0.010	0.24	Circular	7	12
PC1006	18	376.3	374.8	600	0.010	0.25	Circular	6	12
PC1008	15	378.0	376.3	681	0.010	0.25	Circular	2	0
PC101	54	314.7	313.8	438	0.025	0.19	Trapezoidal	41	0
PC1010	24	380.3	377.6	320	0.010	0.85	Circular	23	0
PC1012	15	389.7	385.2	655	0.010	0.69	Circular	4	0
PC1014	15	390.7	389.7	922	0.010	0.11	Circular	2	0
PC102	36	315.0	314.7	60	0.022	0.53	Circular	39	0
PC103	96	316.4	315.0	714	0.025	0.19	Trapezoidal	52	0
PC104	36	332.0	316.4	1905	0.040	0.82	Trapezoidal	60	0
PC106	36	334.0	332.0	247	0.040	0.82	Trapezoidal	58	0
PC108	36	338.5	334.0	558	0.040	0.82	Trapezoidal	55	0
PC110	50	339.3	338.5	89	0.022	0.83	Circular	50	0
PC1100	60	363.4	363.1	52	0.010	0.62	Circular	151	0
PC1102	15	368.8	363.7	478	0.018	1.07	Circular	4	0
PC1104	12	372.6	369.8	398	0.018	0.95	Circular	2	0
PC1105	18	371.6	370.7	90	0.010	1.00	Circular	8	0
PC1105A	24	370.7	368.7	391	0.010	0.52	Circular	15	18
PC1106	21	378.0	374.3	416	0.010	0.89	Circular	7	0
PC1108	15	386.0	378.0	300	0.018	2.66	Circular	7	31
PC1110	13	387.0	386.0	135	0.013	0.74	Circular	1	35
PC1110A	12	387.0	380.8	364	0.013	1.71	Circular	4	11
PC1116	18	376.7	373.6	313	0.018	1.00	Circular	8	0
PC1118	12	384.9	376.7	820	0.013	1.00	Circular	3	0
PC112	36	339.6	339.3	34	0.018	0.80	Circular	22	0
PC114	36	340.0	339.6	60	0.018	0.82	Circular	22	0
PC116	15	342.3	340.0	264	0.010	0.85	Circular	4	0
PC118	15	343.2	342.3	144	0.010	0.64	Circular	4	0
PC120	15	343.9	343.2	99	0.010	0.72	Circular	4	0
PC122	15	345.3	343.9	239	0.010	0.59	Circular	4	0
PC123	24	341.1	340.0	82	0.022	1.26	Circular	18	0
PC124	24	345.4	341.1	343	0.010	1.26	Circular	18	0
PC1250	48	365.5	363.4	341	0.010	0.63	Circular	146	0
PC1252	42	368.7	365.5	500	0.010	0.63	Circular	131	18
PC1254	42	370.1	368.7	231	0.010	0.63	Circular	97	18
PC1256	24	378.2	375.1	314	0.010	0.97	Circular	33	10
PC1258	24	380.8	378.2	270	0.010	0.97	Circular	30	16
PC126	27	348.5	345.4	308	0.018	1.00	Circular	18	0
PC1260	18	387.0	380.8	211	0.010	2.94	Circular	13	7
PC1262	18	387.6	387.0	36	0.010	1.71	Circular	13	0
PC1264	12	395.7	387.6	233	0.013	3.46	Circular	2	0

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
PROPOSED (FUTURE 25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PC1270	18	385.9	380.8	510	0.010	1.00	Circular	8	7
PC128	24	351.8	348.5	329	0.022	1.00	Circular	2	0
PC1290	18	388.7	387.6	230	0.010	0.47	Circular	9	0
PC1292	15	390.8	388.7	88	0.013	2.42	Circular	9	0
PC1294	15	399.1	390.8	342	0.013	2.43	Circular	9	0
PC1296z	36	399.4	399.2	221	0.022	0.10	Circular	1	0
PC1296y	36	399.4	399.2	221	0.022	0.10	Circular	1	0
PC132	24	345.0	340.0	70	0.010	7.11	Circular	28	0
PC134	24	348.1	345.0	305	0.010	1.00	Circular	24	0
PC136	21	351.0	348.1	298	0.010	1.00	Circular	21	0
PC138	21	352.4	351.0	136	0.010	1.00	Circular	18	0
PC140	18	353.4	352.4	101	0.010	1.00	Circular	15	0
PC1402	21	372.4	368.3	402	0.010	1.03	Circular	12	22
PC1404	15	375.8	372.4	330	0.010	1.03	Circular	9	5
PC1406	12	380.8	375.8	330	0.013	1.53	Circular	3	5
PC1408	12	381.1	380.8	80	0.013	0.30	Circular	0	0
PC1410	24	382.7	380.3	279	0.010	0.85	Circular	16	0
PC1412	12	386.8	382.7	335	0.013	1.23	Circular	5	11
PC1414	12	389.7	386.8	330	0.013	0.88	Circular	2	12
PC1416	15	386.0	382.7	265	0.010	1.26	Circular	8	0
PC1418	15	386.9	386.0	342	0.010	0.25	Circular	2	0
PC142	18	355.2	353.4	175	0.010	1.00	Circular	14	0
PC1420	10	389.7	386.9	350	0.013	0.80	Circular	1	0
PC1422	12	388.3	386.0	230	0.010	1.00	Circular	5	3
PC1424	10	391.6	388.3	326	0.013	1.00	Circular	2	3
PC144	18	357.6	355.2	249	0.010	1.00	Circular	12	0
PC146	15	358.1	357.6	47	0.010	1.01	Circular	6	0
PC148	12	362.1	358.1	398	0.009	1.00	Circular	2	0
PC1502	21	374.9	374.4	168	0.010	0.29	Circular	8	0
PC1504	15	385.5	374.9	415	0.010	2.54	Circular	7	0
PC1506	12	385.7	385.5	32	0.013	0.87	Circular	7	23
PC1508	15	387.1	385.7	148	0.010	0.91	Circular	5	23
PC1510	15	388.2	387.1	172	0.010	0.66	Circular	4	0
PC1512	15	388.9	388.2	124	0.010	0.56	Circular	3	0
PC1514	15	389.5	388.9	148	0.010	0.43	Circular	3	0
PC1600	36	377.9	376.0	8	0.022	23.68	Circular	1	0
PC1602	36	378.2	377.9	80	0.022	0.26	Circular	1	0
PC1604	36	378.5	378.2	126	0.022	0.27	Circular	1	0
PC1700	36	389.8	377.3	611	0.025	2.04	Trapezoidal	57	0
PC1702	18	394.0	389.8	76	0.013	5.61	Circular	2	0
PC1800	36	389.9	389.8	62	0.013	0.27	Circular	55	0
PC1802	24	393.0	389.9	161	0.018	1.90	Circular	19	0
PC1804	24	395.5	393.0	179	0.018	1.42	Circular	18	0
PC1806	24	399.9	395.5	237	0.018	1.84	Circular	16	0
PC1808	21	401.7	399.9	237	0.018	0.75	Circular	13	23
PC1810	21	405.2	401.7	297	0.018	1.18	Circular	7	23
PC1900	36	392.2	389.9	198	0.013	1.16	Circular	34	0

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
PROPOSED (FUTURE 25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PC200	60	344.8	313.8	4348	0.025	0.71	Trapezoidal	241	0
PC2000	36	397.6	392.2	465	0.150	1.16	Trapezoidal	1	0
PC2000-1	36	395.6	392.2	465	0.010	0.73	Circular	33	0
PC2000A	36	397.6	395.6	33	0.010	6.06	Circular	30	0
PC2002	15	398.4	395.6	184	0.018	1.52	Circular	3	0
PC202	24	346.2	344.8	129	0.025	1.02	Trapezoidal	18	538
PC204	24	347.4	346.2	116	0.009	1.07	Circular	18	538
PC206	12	359.5	347.4	586	0.009	2.06	Circular	7	0
PC208	12	360.2	359.5	120	0.009	0.63	Circular	3	0
PC210	12	360.7	360.2	51	0.009	0.96	Circular	3	0
PC2100	36	402.0	397.6	740	0.040	0.59	Trapezoidal	31	0
PC212	12	364.6	360.7	384	0.009	1.00	Circular	3	0
PC214	24	347.1	347.4	218	0.009	-0.16	Circular	12	6
PC216	24	348.1	347.1	244	0.009	0.42	Circular	8	6
PC218	24	350.7	348.1	54	0.009	4.95	Circular	4	0
PC220	12	352.9	350.7	339	0.009	0.62	Circular	2	0
PC2200	36	402.3	402.0	30	0.022	1.00	Circular	31	0
PC222	12	354.6	352.9	253	0.009	0.70	Circular	1	0
PC224	12	348.5	348.1	212	0.009	0.20	Circular	4	21
PC226	12	351.1	348.5	466	0.009	0.55	Circular	2	21
PC230	10	355.7	347.1	394	0.009	2.20	Circular	1	6
PC250	36	345.5	344.8	95	0.025	0.71	Trapezoidal	17	29
PC260	36	345.7	345.5	20	0.013	0.75	Trapezoidal	17	29
PC300	30	346.2	345.7	75	0.025	0.71	Trapezoidal	17	0
PC302	48	347.0	346.2	77	0.025	1.00	Trapezoidal	4	0
PC304	12	347.4	347.0	82	0.009	0.52	Circular	4	0
PC306	60	347.7	347.4	72	0.025	0.48	Trapezoidal	5	0
PC308	24	348.0	347.7	171	0.009	0.16	Circular	7	0
PC310	15	348.3	348.0	114	0.009	0.26	Circular	7	7
PC312	15	354.1	348.3	226	0.009	2.55	Circular	7	7
PC314	15	355.2	354.1	170	0.009	0.68	Circular	7	0
PC316	15	356.5	355.2	157	0.009	0.79	Circular	4	0
PC318	12	358.7	356.5	187	0.009	1.20	Circular	2	0
PC320	12	359.4	358.7	105	0.009	0.61	Circular	2	0
PC350	30	351.9	346.2	802	0.025	0.71	Trapezoidal	14	0
PC400	30	352.3	351.9	70	0.022	0.59	Circular	15	0
PC401	36	353.4	352.3	29	0.025	3.89	Trapezoidal	7	0
PC402	15	355.3	353.4	187	0.010	1.00	Circular	7	0
PC404	15	355.1	355.3	32	0.010	-0.62	Circular	7	17
PC406	15	357.3	355.1	310	0.010	0.71	Circular	3	17
PC500	36	353.5	353.5	4	0.025	0.28	Trapezoidal	0	0
PC502	36	354.8	353.5	328	0.022	0.39	Circular	0	0
PC504	60	356.4	354.3	349	0.010	0.63	Circular	220	4
PC506	60	356.7	356.4	41	0.010	0.63	Rectangular	220	0
PC550	30	358.6	357.9	500	0.009	0.14	Circular	34	17
PC552	30	359.4	358.6	195	0.009	0.39	Circular	28	20
PC554	12	360.4	359.4	60	0.013	1.64	Circular	2	21

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
PROPOSED (FUTURE 25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PC556	12	361.3	360.4	335	0.013	0.29	Circular	2	20
PC556A	12	359.0	359.0	50	0.010	0.06	Circular	3	2
PC558	12	364.0	361.3	270	0.010	1.00	Circular	5	2
PC560	12	364.8	364.0	78	0.010	1.00	Circular	4	0
PC562	12	367.5	364.8	266	0.010	1.00	Circular	4	0
PC565	12	361.3	358.6	324	0.010	0.27	Circular	3	0
PC570	30	359.6	359.4	12	0.009	1.83	Circular	24	2
PC572	30	360.9	359.6	359	0.009	0.37	Circular	20	0
PC574	21	364.0	360.9	304	0.009	1.02	Circular	15	0
PC606	15	366.1	363.4	38	0.009	7.19	Circular	10	0
PC608	15	369.1	366.1	327	0.009	0.91	Circular	7	0
PC610	12	375.0	369.1	597	0.009	0.99	Circular	3	0
PC612	12	393.5	375.0	640	0.009	2.89	Circular	3	0
PC700	60	353.5	352.3	198	0.025	0.59	Trapezoidal	8	0
PC702	60	356.8	353.5	571	0.022	0.58	Circular	8	0
PC706	60	357.1	356.7	65	0.010	0.63	Rectangular	187	0
PC708	60	359.7	357.1	413	0.010	0.63	Circular	183	0
PC710	60	360.9	359.7	194	0.010	0.62	Circular	165	0
PC712	60	362.6	360.9	268	0.010	0.63	Circular	165	0
PC714	60	363.1	362.6	78	0.010	0.62	Circular	152	0
PC716	18	368.3	365.5	288	0.010	0.94	Circular	15	22
PC718	21	374.4	368.7	753	0.010	0.76	Circular	12	18
PC720	36	376.0	370.1	943	0.010	0.63	Circular	61	0
PC722	48	376.8	376.0	73	0.025	1.00	Trapezoidal	60	0
PC724	30	377.3	376.8	55	0.010	1.00	Circular	60	0
PC802	15	365.6	360.2	75	0.013	7.27	Circular	7	0
PC804	15	365.8	365.6	298	0.013	0.06	Circular	2	20
PC806	15	366.2	365.8	702	0.013	0.06	Circular	1	20
PC806A	21	366.2	364.0	195	0.009	1.11	Circular	15	0
PC808	15	368.6	366.2	339	0.013	0.71	Circular	8	37
PC810	30	370.3	364.2	851	0.010	0.58	Circular	41	0
PC812	18	377.4	373.0	352	0.010	1.25	Circular	13	0
PC814	21	378.5	377.4	202	0.010	0.54	Circular	12	0
PC816	18	381.0	378.5	357	0.010	0.70	Circular	8	0
PC818	12	373.2	368.6	300	0.013	1.53	Circular	2	37
PC820	24	377.6	370.3	294	0.010	2.50	Circular	29	0
PC822	12	379.6	377.6	300	0.013	0.67	Circular	2	0

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
PROPOSED (FUTURE 25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
BEAR CREEK									
PB100	72	294.5	293.6	86	0.040	1.01	Trapezoidal	161	0
PB1000	72	374.6	357.7	2268	0.040	0.74	Trapezoidal	33	0
PB1002	24	384.3	374.6	976	0.040	1.00	Trapezoidal	35	0
PB1004	24	389.8	384.3	547	0.040	1.00	Trapezoidal	27	18
PB1006	24	392.4	389.8	261	0.040	1.00	Trapezoidal	10	18
PB1008	18	392.7	392.4	105	0.010	0.31	Circular	10	0
PB1010	15	393.2	392.7	90	0.010	0.50	Circular	9	16
PB1012	12	395.4	393.2	439	0.010	0.50	Circular	3	21
PB102	36	299.3	294.5	184	0.022	2.61	Circular	2	0
PB104	30	299.8	299.3	64	0.010	0.75	Circular	2	0
PB1050	15	394.3	384.3	191	0.010	5.23	Circular	9	0
PB1052	15	397.1	394.3	412	0.010	0.68	Circular	4	0
PB106	30	300.3	299.8	49	0.010	1.17	Circular	2	0
PB108	30	304.8	300.3	427	0.010	1.04	Circular	2	0
PB110	24	306.3	304.8	127	0.010	1.16	Circular	2	0
PB1102	24	391.4	389.8	170	0.010	0.96	Circular	19	18
PB1104	24	391.8	391.4	35	0.010	0.94	Circular	19	0
PB1106	24	393.4	391.8	175	0.010	0.96	Circular	16	0
PB1108	24	395.1	393.4	175	0.010	0.95	Circular	15	0
PB1110	24	395.5	395.1	30	0.010	1.33	Circular	14	0
PB1112	24	396.0	395.5	265	0.010	0.20	Circular	8	0
PB1112A	12	396.0	393.2	350	0.010	0.82	Circular	3	16
PB1114	18	396.5	396.0	210	0.010	0.20	Circular	8	5
PB1116	18	397.0	396.5	270	0.010	0.20	Circular	4	5
PB112	24	309.8	306.3	132	0.010	2.65	Circular	2	0
PB114	24	312.4	309.8	91	0.010	2.94	Circular	2	0
PB1150	12	396.4	395.5	182	0.010	0.50	Circular	3	0
PB1152	12	396.6	396.4	44	0.010	0.51	Circular	3	0
PB116	24	313.5	312.4	50	0.010	2.10	Circular	2	0
PB200z	48	296.2	294.5	59	0.022	2.91	Circular	31	0
PB200y	48	296.2	294.5	32	0.010	5.41	Rectangular	64	0
PB200x	48	296.2	294.5	32	0.010	5.41	Rectangular	64	0
PB2000	72	319.8	315.4	585	0.040	0.74	Trapezoidal	26	0
PB201	48	302.6	296.2	643	0.040	1.00	Trapezoidal	77	0
PB202	48	305.3	302.6	267	0.040	1.00	Trapezoidal	77	0
PB203	63	305.6	305.3	29	0.022	1.00	Trapezoidal	77	0
PB204	48	306.5	305.6	90	0.040	1.00	Trapezoidal	77	0
PB205	48	306.9	306.5	48	0.022	0.85	Circular	68	0
PB206	48	310.3	306.9	394	0.040	0.98	Trapezoidal	68	0
PB208	36	310.3	310.3	122	0.010	0.01	Circular	60	69
PB210	36	317.5	310.3	241	0.009	2.99	Circular	60	69
PB2100z	48	320.1	319.8	44	0.022	0.75	Circular	9	0
PB2100y	48	320.1	319.8	44	0.022	0.75	Circular	9	0
PB2100x	48	320.1	319.8	44	0.022	0.75	Circular	9	0
PB212	24	319.2	317.5	289	0.009	0.57	Circular	11	0
PB214	18	319.9	319.2	39	0.009	1.85	Circular	8	0

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
PROPOSED (FUTURE 25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PB216	18	324.5	319.9	236	0.009	1.94	Circular	5	0
PB218	18	330.3	324.5	529	0.009	1.11	Circular	5	0
PB220	21	332.1	330.3	377	0.009	0.47	Circular	5	0
PB2200	72	357.4	320.1	5017	0.040	0.74	Trapezoidal	28	0
PB222	18	336.6	332.1	668	0.009	0.68	Circular	5	0
PB224	18	338.2	336.6	160	0.009	0.96	Circular	5	0
PB226	12	339.6	338.2	419	0.010	0.34	Circular	0	0
PB228	12	340.6	339.6	276	0.009	0.37	Circular	0	0
PB230	18	319.4	319.2	45	0.009	0.47	Circular	2	0
PB2300	48	357.7	357.4	45	0.022	0.73	Circular	31	0
PB232	18	319.8	319.4	70	0.009	0.60	Circular	2	0
PB234	12	326.4	319.8	217	0.009	3.07	Circular	2	0
PB234A	12	326.4	326.3	34	0.009	0.50	Circular	1	0
PB236	12	332.5	326.4	734	0.009	0.82	Circular	3	0
PB238	15	332.6	332.1	34	0.009	1.32	Circular	0	0
PB240	12	337.6	332.6	678	0.009	0.75	Circular	0	0
PB240A	12	337.4	336.6	35	0.009	2.14	Circular	0	0
PB242	15	338.9	338.2	185	0.009	0.40	Circular	5	0
PB244	12	341.4	338.9	576	0.010	0.44	Circular	2	0
PB246	15	306.7	306.5	395	0.010	0.53	Circular	12	170
PB248	15	307.3	306.7	151	0.010	0.54	Circular	15	195
PB250	12	311.3	308.5	544	0.010	0.50	Circular	8	25
PB252	36	317.6	317.5	19	0.009	0.73	Circular	54	0
PB254	72	318.7	317.6	137	0.040	0.74	Trapezoidal	54	0
PB256z	18	321.4	318.8	367	0.009	0.72	Circular	10	0
PB256y	36	321.4	318.7	367	0.010	0.73	Circular	45	0
PB258	36	321.9	321.4	75	0.010	0.74	Circular	51	0
PB260	48	324.5	321.9	353	0.040	0.74	Trapezoidal	29	0
PB262	24	325.5	324.5	300	0.010	0.33	Circular	29	11
PB264	48	326.5	325.5	341	0.040	0.29	Trapezoidal	29	11
PB266	31	327.5	326.5	180	0.022	0.56	Circular	30	0
PB268	48	328.5	327.5	403	0.040	0.25	Trapezoidal	31	0
PB270	18	329.5	328.5	22	0.009	4.61	Circular	29	0
PB272	48	330.5	329.5	305	0.040	0.33	Trapezoidal	32	0
PB274	48	330.9	330.5	315	0.040	0.12	Trapezoidal	34	0
PB276	48	331.5	330.9	491	0.040	0.12	Trapezoidal	22	0
PB278	18	331.5	331.5	43	0.010	0.12	Circular	14	369
PB280	18	332.5	331.5	135	0.010	0.74	Circular	9	430
PB282	18	333.5	332.5	309	0.010	0.32	Circular	9	95
PB284	15	334.5	333.5	106	0.014	0.94	Circular	6	65
PB286	12	335.5	334.5	65	0.014	1.53	Circular	4	57
PB288	12	336.5	335.5	81	0.014	1.23	Circular	4	49
PB290	24	325.0	321.9	629	0.040	0.50	Trapezoidal	22	30
PB292	24	326.2	325.0	243	0.010	0.49	Circular	20	44
PB293	24	329.7	326.2	709	0.040	0.50	Trapezoidal	22	33
PB294	24	337.1	329.7	1486	0.040	0.73	Trapezoidal	15	19
PB296	24	344.2	337.1	193	0.040	3.68	Trapezoidal	5	0

APPENDIX C
MOLALLA - STORM WATER MASTER PLAN
SWMM ANALYSIS RESULTS
PROPOSED (FUTURE 25 Year)

MH Name	Diameter/ Depth	Upstream Invert Elevation	Downstream Invert Elevation	Length	Roughness (Manning's n)	Conduit Slope	Shape	Max Flow	Time Surcharged
	[in]	[ft]	[ft]	[ft]		[%]		[cfs]	[min]
PB298	15	347.5	344.2	578	0.010	0.57	Circular	5	0
PB500	72	307.6	296.2	706	0.040	1.69	Trapezoidal	84	0
PB502	24	315.0	307.6	740	0.040	1.00	Trapezoidal	3	0
PB504	24	315.5	315.0	88	0.010	0.53	Circular	4	0
PB506	24	316.7	315.5	300	0.010	0.40	Circular	4	0
PB508	15	318.6	316.7	278	0.010	0.71	Circular	2	0
PB510	12	319.5	318.6	194	0.010	0.42	Circular	0	0
PB510A	24	319.5	313.5	180	0.010	3.30	Circular	2	0
PB600	72	308.3	307.6	639	0.025	0.10	Trapezoidal	75	0
PB602	24	310.5	308.3	224	0.040	1.00	Trapezoidal	3	0
PB604	24	312.3	310.5	335	0.009	0.54	Circular	4	0
PB606	24	313.3	312.3	96	0.009	0.97	Circular	4	0
PB608	24	313.9	313.3	132	0.009	0.45	Circular	4	0
PB610	18	315.2	313.9	299	0.009	0.45	Circular	4	0
PB612	18	316.0	315.2	297	0.009	0.28	Circular	4	0
PB614	15	317.0	316.0	240	0.009	0.40	Circular	4	0
PB700	48	315.4	315.1	45	0.022	0.73	Circular	67	0
PB702	36	327.8	315.4	2474	0.010	0.50	Circular	56	0
PB704	36	329.4	327.8	515	0.010	0.31	Circular	42	0
PB706	30	330.6	329.4	238	0.010	0.50	Circular	42	0
PB708	30	331.5	330.6	184	0.010	0.50	Circular	42	0
PB710	27	333.8	331.5	266	0.010	0.50	Circular	31	0
PB712	24	334.9	333.8	225	0.010	0.50	Circular	21	0
PB714	24	336.0	334.9	208	0.010	0.50	Circular	21	0
PB716	15	336.6	336.0	120	0.010	0.50	Circular	5	13
PB730	15	334.1	333.8	53	0.010	0.50	Circular	10	0
PB732	30	334.8	334.1	142	0.010	0.50	Circular	10	0
PB734	30	336.9	334.8	421	0.010	0.50	Circular	11	0
PB750	72	315.1	308.3	919	0.040	0.74	Trapezoidal	75	0
PB752	24	321.8	315.1	1338	0.040	0.50	Trapezoidal	9	0
PB754	24	326.2	321.8	874	0.040	0.50	Trapezoidal	5	0
PB756	12	326.9	326.2	157	0.010	0.50	Circular	3	0
PB758	24	331.7	326.9	951	0.040	0.50	Trapezoidal	1	0

CURRENT DATE: 12-14-2001
CURRENT TIME: 10:20:56

FILE DATE: 12-14-2001
FILE NAME: MATHIAS

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.1

CULV	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	100.00	99.70	34.00	2 CSP	3.00	3.00	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS)   FILE: MATHIAS   DATE: 12-14-2001

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
102.10	0	0	0	0	0	0	0	0	1
102.43	32	32	0	0	0	0	0	0	1
103.24	65	65	0	0	0	0	0	0	1
104.71	97	97	0	0	0	0	0	0	1
105.26	130	110	0	0	0	0	0	19	5
105.46	162	114	0	0	0	0	0	48	4
105.63	194	117	0	0	0	0	0	76	3
105.78	227	120	0	0	0	0	0	105	3
105.93	259	123	0	0	0	0	0	136	3
105.95	266	123	0	0	0	0	0	141	2
106.19	324	126	0	0	0	0	0	196	3
105.00	104	104	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS   FILE: MATHIAS   DATE: 12-14-2001

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
102.10	0.00	0	0	0.00
102.43	0.00	32	0	0.00
103.24	0.00	65	0	0.00
104.71	0.00	97	0	0.00
105.26	-0.00	130	1	0.57
105.46	-0.01	162	1	0.31
105.63	-0.01	194	1	0.71
105.78	-0.00	227	1	0.51
105.93	-0.00	259	1	0.41
105.95	-0.01	266	2	0.82
106.19	-0.00	324	1	0.36

<1> TOLERANCE (FT) = 0.010   <2> TOLERANCE (%) = 1.000

CURRENT DATE: 12-14-2001 FILE DATE: 12-14-2001
CURRENT TIME: 10:20:56 FILE NAME: MATHIAS

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PERFORMANCE CURVE FOR CULVERT # 1 - 2 (3 BY 3) CSP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	102.10	0.00	2.10	0-NF	0.00	0.00	0.00	0.00	0.00	2.40
32	102.43	1.95	2.43	3-M1t	1.46	1.28	2.67	2.40	0.00	2.40
65	103.24	3.08	3.24	3-M1t	2.35	1.84	5.34	2.40	0.00	2.40
97	104.71	4.46	4.71	6-FFn	3.00	2.26	6.88	3.00	0.00	2.40
110	105.25	5.13	5.25	6-FFn	3.00	2.40	7.75	3.00	0.00	2.40
114	105.46	5.39	5.46	6-FFn	3.00	2.44	8.06	3.00	0.00	2.40
117	105.62	5.59	5.62	6-FFn	3.00	2.46	8.30	3.00	0.00	2.40
120	105.78	5.78	5.78	6-FFn	3.00	2.49	8.51	3.00	0.00	2.40
123	105.92	5.92	5.89	6-FFn	3.00	2.51	8.67	3.00	0.00	2.40
123	105.95	5.95	5.91	6-FFn	3.00	2.51	8.69	3.00	0.00	2.40
126	106.19	6.19	6.10	6-FFn	3.00	2.54	8.95	3.00	0.00	2.40

El. inlet face invert 100.00 ft El. outlet invert 99.70 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

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***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	1034.00
INLET ELEVATION (FT)	100.00
OUTLET STATION (FT)	1000.00
OUTLET ELEVATION (FT)	99.70
NUMBER OF BARRELS	2
SLOPE (V-FT/H-FT)	0.0088
CULVERT LENGTH ALONG SLOPE (FT)	34.00

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	3.00 FT
BARREL MATERIAL	CORRUGATED STEEL
BARREL MANNING'S N	0.024
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	THIN EDGE PROJECTING
INLET DEPRESSION	NONE

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CURRENT DATE: 12-14-2001 FILE DATE: 12-14-2001
CURRENT TIME: 10:20:56 FILE NAME: MATHIAS

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CONSTANT WATER SURFACE ELEVATION
102.10

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ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	20.00
CREST LENGTH (FT)	50.00
OVERTOPPING CREST ELEVATION (FT)	105.00

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CURRENT DATE: 12-12-2001
CURRENT TIME: 10:35:39

FILE DATE: 12-11-2001
FILE NAME: MOLALLA

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.1

C U L V	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	100.00	99.95	27.00	1 CMPA	6.00	3.67	.028	CONVENTIONAL
2	102.20	101.60	24.01	1 CMPA	4.82	2.96	.024	CONVENTIONAL
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: MOLALLA DATE: 12-11-2001

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
102.40	0	0	0	0	0	0	0	0	0
102.59	32	30	2	0	0	0	0	0	9
103.65	65	46	19	0	0	0	0	0	5
104.17	97	67	30	0	0	0	0	0	3
104.59	130	90	40	0	0	0	0	0	3
105.08	162	110	52	0	0	0	0	0	3
105.65	194	130	64	0	0	0	0	0	4
106.10	227	144	72	0	0	0	0	10	4
106.38	259	152	77	0	0	0	0	30	3
106.44	266	153	78	0	0	0	0	34	3
106.85	324	164	84	0	0	0	0	75	3
105.83	203	136	67	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: MOLALLA DATE: 12-11-2001

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
102.40	0.00	0	0	0.00
102.59	0.00	32	-0	-0.76
103.65	-0.01	65	0	0.72
104.17	-0.00	97	0	0.05
104.59	0.00	130	-0	-0.20
105.08	0.00	162	-0	-0.11
105.65	-0.00	194	0	0.10
106.10	-0.00	227	0	0.19
106.38	-0.00	259	1	0.25
106.44	-0.00	266	0	0.08
106.85	-0.00	324	0	0.02

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 12-12-2001 FILE DATE: 12-11-2001
CURRENT TIME: 10:35:39 FILE NAME: MOLALLA

PERFORMANCE CURVE FOR CULVERT # 1 - 1 (6 BY 3.666667) CMPA

DIS- CHARGE FLOW (cfs)	HEAD- WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	102.40	0.00	2.40	0-NF	0.00	0.00	0.00	0.00	0.00	2.45
30	102.59	1.80	2.59	3-M1t	2.14	1.15	2.35	2.45	0.00	2.45
46	103.87	2.32	3.87	6-FFn	3.48	1.44	2.65	3.67	0.00	2.45
67	104.16	2.97	4.16	6-FFn	3.67	1.78	3.90	3.67	0.00	2.45
90	104.59	3.64	4.59	6-FFn	3.67	2.10	5.21	3.67	0.00	2.45
110	105.08	4.33	5.08	6-FFn	3.67	2.35	6.40	3.67	0.00	2.45
130	105.65	5.12	5.65	6-FFn	3.67	2.58	7.54	3.67	0.00	2.45
144	106.10	5.75	6.10	6-FFn	3.67	2.71	8.34	3.67	0.00	2.45
152	106.38	6.15	6.38	6-FFn	3.67	2.79	8.80	3.67	0.00	2.45
153	106.44	6.24	6.44	6-FFn	3.67	2.80	8.89	3.67	0.00	2.45
164	106.85	6.83	6.85	6-FFn	3.67	2.91	9.52	3.67	0.00	2.45

El. inlet face invert 100.00 ft El. outlet invert 99.95 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	1027.00
INLET ELEVATION (FT)	100.00
OUTLET STATION (FT)	1000.00
OUTLET ELEVATION (FT)	99.95
NUMBER OF BARRELS	1
SLOPE (V-FT/H-FT)	0.0019
CULVERT LENGTH ALONG SLOPE (FT)	27.00

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	PIPE ARCH
BARREL SPAN	6.00 FT
BARREL RISE	3.67 FT
BARREL MATERIAL	STEEL OR ALUMINUM
BARREL MANNING'S N	0.028
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	PROJECTING
INLET DEPRESSION	NONE

CURRENT DATE: 12-12-2001 FILE DATE: 12-11-2001
CURRENT TIME: 10:35:39 FILE NAME: MOLALLA

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PERFORMANCE CURVE FOR CULVERT # 2 - 1 (4.816667 BY 2.958333) CMPA

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DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	102.40	0.00	0.20	0-NF	0.00	0.00	0.00	0.00	0.00	0.80
2	102.59	0.39	0.39	1-S2n	0.20	0.27	2.62	0.20	0.00	0.80
19	103.66	1.46	1.46	1-S2n	0.71	0.89	6.38	0.72	0.00	0.80
30	104.18	1.98	1.98	1-S2n	0.94	1.17	7.57	0.94	0.00	0.80
40	104.59	2.39	2.39	1-S2n	1.12	1.39	8.10	1.14	0.00	0.80
52	105.08	2.88	2.88	1-S2n	1.33	1.62	8.72	1.36	0.00	0.80
64	105.64	3.44	3.44	5-S2n	1.55	1.84	9.26	1.58	0.00	0.80
72	106.10	3.90	3.90	5-S2n	1.70	1.98	9.59	1.73	0.00	0.80
77	106.38	4.18	4.18	5-S2n	1.79	2.06	9.78	1.81	0.00	0.80
78	106.43	4.23	4.23	5-S2n	1.81	2.07	9.78	1.84	0.00	0.80
84	106.85	4.65	4.65	5-S2n	1.93	2.16	10.09	1.93	0.00	0.80

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El. inlet face invert 102.20 ft El. outlet invert 101.60 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

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***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	1024.00
INLET ELEVATION (FT)	102.20
OUTLET STATION (FT)	1000.00
OUTLET ELEVATION (FT)	101.60
NUMBER OF BARRELS	1
SLOPE (V-FT/H-FT)	0.0250
CULVERT LENGTH ALONG SLOPE (FT)	24.01

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	PIPE ARCH
BARREL SPAN	4.82 FT
BARREL RISE	2.96 FT
BARREL MATERIAL	STEEL OR ALUMINUM
BARREL MANNING'S N	0.024
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	PROJECTING
INLET DEPRESSION	NONE

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CURRENT DATE: 12-12-2001 FILE DATE: 12-11-2001
CURRENT TIME: 10:35:39 FILE NAME: MOLALLA

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CONSTANT WATER SURFACE ELEVATION
102.40

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ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	24.00
CREST LENGTH (FT)	24.00
OVERTOPPING CREST ELEVATION (FT)	105.83

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CURRENT DATE: 12-12-2001
CURRENT TIME: 11:01:01

FILE DATE: 12-12-2001
FILE NAME: ONAWAY

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CULV	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	100.00	99.70	30.00	1 CMPA	5.33	3.58	.024	CONVENTIONAL
2	100.00	99.70	30.00	1 CMPA	6.00	3.67	.028	CONVENTIONAL
3	100.00	99.70	30.00	1 CMPA	6.00	3.67	.028	CONVENTIONAL
4								
5								
6								

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SUMMARY OF CULVERT FLOWS (CFS) FILE: ONAWAY DATE: 12-12-2001

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
102.50	0	0	0	0	0	0	0	0	0
102.65	50	15	17	17	0	0	0	0	6
102.75	101	31	35	35	0	0	0	0	8
103.02	151	47	53	53	0	0	0	0	4
103.40	202	62	70	70	0	0	0	0	3
103.84	252	77	87	87	0	0	0	0	3
104.32	302	93	104	104	0	0	0	0	6
105.05	353	104	114	114	0	0	0	19	4
105.29	403	105	122	122	0	0	0	52	3
105.34	415	107	123	123	0	0	0	61	3
105.67	504	115	133	133	0	0	0	122	3
104.80	317	104	106	106	0	0	0	OVERTOPPING	

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SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: ONAWAY DATE: 12-12-2001

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
102.50	0.00	0	0	0.00
102.65	-0.00	50	0	0.28
102.75	0.00	101	-1	-0.79
103.02	0.00	151	-1	-0.34
103.40	0.00	202	-1	-0.32
103.84	0.00	252	-0	-0.11
104.32	-0.00	302	1	0.17
105.05	-0.01	353	2	0.46
105.29	-0.01	403	3	0.66
105.34	-0.00	415	1	0.20
105.67	-0.00	504	1	0.22

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<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

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CURRENT DATE: 12-12-2001 FILE DATE: 12-12-2001
CURRENT TIME: 11:01:01 FILE NAME: ONAWAY

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PERFORMANCE CURVE FOR CULVERT # 1 - 1 (5.333333 BY 3.583333) CMPA

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	102.50	0.00	2.50	0-NF	0.00	0.00	0.00	0.00	0.00	2.80
15	102.65	1.28	2.65	3-M1t	0.83	0.81	1.19	2.80	0.00	2.80
31	102.74	1.94	2.74	3-M1t	1.23	1.20	2.38	2.80	0.00	2.80
47	103.02	2.51	3.02	3-M1t	1.59	1.51	3.58	2.80	0.00	2.80
62	103.39	3.03	3.39	3-M1t	1.93	1.79	4.76	2.80	0.00	2.80
77	103.83	3.55	3.83	3-M1t	2.29	2.03	5.94	2.80	0.00	2.80
93	104.31	4.15	4.31	3-M1t	2.72	2.26	7.15	2.80	0.00	2.80
104	105.26	4.62	5.26	6-FFn	3.40	2.41	6.90	3.58	0.00	2.80
105	105.30	4.67	5.30	6-FFn	3.58	2.42	6.97	3.58	0.00	2.80
107	105.35	4.73	5.35	6-FFn	3.58	2.44	7.06	3.58	0.00	2.80
115	105.67	5.12	5.67	6-FFn	3.58	2.54	7.59	3.58	0.00	2.80

El. inlet face invert 100.00 ft El. outlet invert 99.70 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

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***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	1030.00
INLET ELEVATION (FT)	100.00
OUTLET STATION (FT)	1000.00
OUTLET ELEVATION (FT)	99.70
NUMBER OF BARRELS	1
SLOPE (V-FT/H-FT)	0.0100
CULVERT LENGTH ALONG SLOPE (FT)	30.00

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	PIPE ARCH
BARREL SPAN	5.33 FT
BARREL RISE	3.58 FT
BARREL MATERIAL	STEEL OR ALUMINUM
BARREL MANNING'S N	0.024
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	PROJECTING
INLET DEPRESSION	NONE

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CURRENT DATE: 12-12-2001 FILE DATE: 12-12-2001
CURRENT TIME: 11:01:01 FILE NAME: ONAWAY

PERFORMANCE CURVE FOR CULVERT # 2 - 1 (6 BY 3.666667) CMPA

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	102.50	0.00	2.50	0-NF	0.00	0.00	0.00	0.00	0.00	2.80
17	102.65	1.30	2.65	3-M1t	0.92	0.84	1.19	2.80	0.00	2.80
35	102.75	1.96	2.75	3-M1t	1.37	1.24	2.42	2.80	0.00	2.80
53	103.02	2.52	3.02	3-M1t	1.75	1.55	3.59	2.80	0.00	2.80
70	103.39	3.03	3.39	3-M1t	2.13	1.83	4.79	2.80	0.00	2.80
87	103.83	3.55	3.83	3-M1t	2.55	2.06	5.98	2.80	0.00	2.80
104	104.31	4.10	4.31	3-M2t	3.19	2.28	7.14	2.80	0.00	2.80
114	105.06	4.45	5.06	6-FFn	3.67	2.39	6.60	3.67	0.00	2.80
122	105.30	4.75	5.30	6-FFn	3.67	2.48	7.05	3.67	0.00	2.80
123	105.35	4.82	5.35	6-FFn	3.67	2.50	7.15	3.67	0.00	2.80
133	105.67	5.23	5.67	6-FFn	3.67	2.61	7.70	3.67	0.00	2.80

El. inlet face invert 100.00 ft El. outlet invert 99.70 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	1030.00
INLET ELEVATION (FT)	100.00
OUTLET STATION (FT)	1000.00
OUTLET ELEVATION (FT)	99.70
NUMBER OF BARRELS	1
SLOPE (V-FT/H-FT)	0.0100
CULVERT LENGTH ALONG SLOPE (FT)	30.00

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	PIPE ARCH
BARREL SPAN	6.00 FT
BARREL RISE	3.67 FT
BARREL MATERIAL	STEEL OR ALUMINUM
BARREL MANNING'S N	0.028
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	PROJECTING
INLET DEPRESSION	NONE

CURRENT DATE: 12-12-2001 FILE DATE: 12-12-2001
CURRENT TIME: 11:01:01 FILE NAME: ONAWAY

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PERFORMANCE CURVE FOR CULVERT # 3 - 1 (6 BY 3.666667) CMPA

DIS- CHARGE FLOW (cfs)	HEAD- WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	102.50	0.00	2.50	0-NF	0.00	0.00	0.00	0.00	0.00	2.80
17	102.65	1.30	2.65	3-M1t	0.92	0.84	1.19	2.80	0.00	2.80
35	102.75	1.96	2.75	3-M1t	1.37	1.24	2.42	2.80	0.00	2.80
53	103.02	2.52	3.02	3-M1t	1.75	1.55	3.59	2.80	0.00	2.80
70	103.39	3.03	3.39	3-M1t	2.13	1.83	4.79	2.80	0.00	2.80
87	103.83	3.55	3.83	3-M1t	2.55	2.06	5.98	2.80	0.00	2.80
104	104.31	4.10	4.31	3-M2t	3.19	2.28	7.14	2.80	0.00	2.80
114	105.06	4.45	5.06	6-FFn	3.67	2.39	6.60	3.67	0.00	2.80
122	105.30	4.75	5.30	6-FFn	3.67	2.48	7.05	3.67	0.00	2.80
123	105.35	4.82	5.35	6-FFn	3.67	2.50	7.15	3.67	0.00	2.80
133	105.67	5.23	5.67	6-FFn	3.67	2.61	7.70	3.67	0.00	2.80

El. inlet face invert 100.00 ft El. outlet invert 99.70 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

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***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	1030.00
INLET ELEVATION (FT)	100.00
OUTLET STATION (FT)	1000.00
OUTLET ELEVATION (FT)	99.70
NUMBER OF BARRELS	1
SLOPE (V-FT/H-FT)	0.0100
CULVERT LENGTH ALONG SLOPE (FT)	30.00

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	PIPE ARCH
BARREL SPAN	6.00 FT
BARREL RISE	3.67 FT
BARREL MATERIAL	STEEL OR ALUMINUM
BARREL MANNING'S N	0.028
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	PROJECTING
INLET DEPRESSION	NONE

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CURRENT DATE: 12-12-2001 FILE DATE: 12-12-2001
CURRENT TIME: 11:01:01 FILE NAME: ONAWAY

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CONSTANT WATER SURFACE ELEVATION
102.50

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ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	26.00
CREST LENGTH (FT)	50.00
OVERTOPPING CREST ELEVATION (FT)	104.80

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CURRENT DATE: 12-12-2001
CURRENT TIME: 11:18:50

FILE DATE: 12-12-2001
FILE NAME: N_FOREST

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.1

C U L V	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	100.00	99.80	22.00	3 RCB	6.00	6.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

Wood structures

SUMMARY OF CULVERT FLOWS (CFS) FILE: N_FOREST DATE: 12-12-2001

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
104.60	0	0	0	0	0	0	0	0	1
104.71	50	50	0	0	0	0	0	0	1
104.73	101	101	0	0	0	0	0	0	1
104.77	151	151	0	0	0	0	0	0	1
104.83	202	202	0	0	0	0	0	0	1
104.91	252	252	0	0	0	0	0	0	1
105.00	302	302	0	0	0	0	0	0	1
105.02	353	353	0	0	0	0	0	0	1
105.15	403	403	0	0	0	0	0	0	1
105.19	415	415	0	0	0	0	0	0	1
104.88	504	504	0	0	0	0	0	0	1
110.00	1244	1244	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: N_FOREST DATE: 12-12-2001

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
104.60	0.00	0	0	0.00
104.71	0.00	50	0	0.00
104.73	0.00	101	0	0.00
104.77	0.00	151	0	0.00
104.83	0.00	202	0	0.00
104.91	0.00	252	0	0.00
105.00	0.00	302	0	0.00
105.02	0.00	353	0	0.00
105.15	0.00	403	0	0.00
105.19	0.00	415	0	0.00
104.88	0.00	504	0	0.00

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 12-12-2001 FILE DATE: 12-12-2001
CURRENT TIME: 11:18:50 FILE NAME: N_FOREST

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PERFORMANCE CURVE FOR CULVERT # 1 - 3 (6 BY 6) RCB

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DIS- CHARGE FLOW (cfs)	HEAD- WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	104.60	0.00	4.60	0-NF	0.00	0.00	0.00	0.00	0.00	4.80
50	104.71	1.06	4.71	3-M1t	0.38	0.63	0.58	4.80	0.00	4.80
101	104.73	1.70	4.73	3-M1t	0.68	0.99	1.17	4.80	0.00	4.80
151	104.77	2.21	4.77	3-M1t	0.88	1.30	1.75	4.80	0.00	4.80
202	104.83	2.68	4.83	3-M1t	1.08	1.58	2.33	4.80	0.00	4.80
252	104.91	3.10	4.91	3-M1t	1.27	1.83	2.92	4.80	0.00	4.80
302	105.00	3.49	5.00	3-M1t	1.43	2.07	3.50	4.80	0.00	4.80
353	105.02	3.86	5.02	3-M1t	1.60	2.29	4.08	4.80	0.00	4.80
403	105.15	4.21	5.15	3-M1t	1.76	2.50	4.67	4.80	0.00	4.80
415	105.19	4.29	5.19	3-M1t	1.80	2.55	4.80	4.80	0.00	4.80
504	104.88	4.88	4.88	1-S2n	2.06	2.90	11.16	2.51	0.00	4.80

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El. inlet face invert 100.00 ft El. outlet invert 99.80 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

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***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	1022.00
INLET ELEVATION (FT)	100.00
OUTLET STATION (FT)	1000.00
OUTLET ELEVATION (FT)	99.80
NUMBER OF BARRELS	3
SLOPE (V-FT/H-FT)	0.0091
CULVERT LENGTH ALONG SLOPE (FT)	22.00

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	BOX
BARREL SPAN	6.00 FT
BARREL RISE	6.00 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION	NONE

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CURRENT DATE: 12-12-2001
CURRENT TIME: 11:18:50

FILE DATE: 12-12-2001
FILE NAME: N_FOREST

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CONSTANT WATER SURFACE ELEVATION
104.60

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ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	15.00
CREST LENGTH (FT)	50.00
OVERTOPPING CREST ELEVATION (FT)	110.00

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CURRENT DATE: 12-12-2001 FILE DATE: 12-12-2001
CURRENT TIME: 11:10:15 FILE NAME: HWY213

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.1

CULV	SITE DATA INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	CULVERT SHAPE, MATERIAL, INLET BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	93.80	93.40	32.00	2 RCB	3.70	4.00	.012	CONVENTIONAL
2	94.00	93.50	45.00	1 CSP	4.00	4.00	.024	CONVENTIONAL
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: HWY213 DATE: 12-12-2001

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
96.70	0	0	0	0	0	0	0	0	0
96.88	55	41	14	0	0	0	0	0	4
96.98	110	110	23	0	0	0	0	0	13
97.32	166	128	39	0	0	0	0	0	5
97.98	221	163	58	0	0	0	0	0	3
98.69	276	200	76	0	0	0	0	0	3
99.57	331	242	89	0	0	0	0	0	2
100.21	386	269	102	0	0	0	0	14	4
100.49	442	280	107	0	0	0	0	52	3
100.56	455	282	108	0	0	0	0	63	3
100.95	552	297	114	0	0	0	0	140	3
100.00	358	260	98	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: HWY213 DATE: 12-12-2001

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
96.70	0.00	0	0	0.00
96.88	-0.01	55	0	0.25
96.98	0.00	110	-22	-20.21
97.32	0.01	166	-1	-0.81
97.98	-0.00	221	0	0.06
98.69	0.00	276	-0	-0.02
99.57	-0.01	331	0	0.10
100.21	-0.01	386	2	0.40
100.49	-0.01	442	2	0.56
100.56	-0.00	455	1	0.19
100.95	-0.00	552	1	0.24

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 12-12-2001 FILE DATE: 12-12-2001
CURRENT TIME: 11:10:15 FILE NAME: HWY213

PERFORMANCE CURVE FOR CULVERT # 1 - 2 (3.7 BY 4) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	96.70	0.00	2.90	0-NF	0.00	0.00	0.00	0.00	0.00	3.30
41	96.88	1.66	3.08	3-M1t	0.63	0.98	1.66	3.30	0.00	3.30
110	96.98	3.18	3.18	1-S2n	1.28	1.90	11.56	1.28	0.00	3.30
128	97.32	3.52	3.52	1-S2n	1.43	2.10	12.06	1.43	0.00	3.30
163	97.98	4.18	4.18	5-S2n	1.71	2.47	12.85	1.71	0.00	3.30
200	98.68	4.88	4.88	5-S2n	2.00	2.83	13.51	2.00	0.00	3.30
242	99.57	5.77	5.77	5-S2n	2.31	3.22	14.13	2.31	0.00	3.30
269	100.21	6.41	6.41	5-S2n	2.51	3.45	14.47	2.51	0.00	3.30
280	100.49	6.69	6.69	5-S2n	2.59	3.55	14.60	2.59	0.00	3.30
282	100.56	6.76	6.76	5-S2n	2.61	3.57	14.63	2.61	0.00	3.30
297	100.95	7.15	7.15	5-S2n	2.71	3.69	14.79	2.71	0.00	3.30

El. inlet face invert 93.80 ft El. outlet invert 93.40 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	1032.00
INLET ELEVATION (FT)	93.80
OUTLET STATION (FT)	1000.00
OUTLET ELEVATION (FT)	93.40
NUMBER OF BARRELS	2
SLOPE (V-FT/H-FT)	0.0125
CULVERT LENGTH ALONG SLOPE (FT)	32.00

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	BOX
BARREL SPAN	3.70 FT
BARREL RISE	4.00 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION	NONE

CURRENT DATE: 12-12-2001 FILE DATE: 12-12-2001
CURRENT TIME: 11:10:15 FILE NAME: HWY213

PERFORMANCE CURVE FOR CULVERT # 2 - 1 (4 BY 4) CSP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	96.70	0.00	2.70	0-NF	0.00	0.00	0.00	0.00	0.00	3.20
14	96.87	1.64	2.87	3-M1t	1.13	1.10	1.34	3.20	0.00	3.20
23	96.98	2.10	2.98	3-M1t	1.44	1.41	2.14	3.20	0.00	3.20
39	97.32	2.87	3.32	3-M1t	1.95	1.86	3.65	3.20	0.00	3.20
58	97.97	3.70	3.97	3-M1t	2.48	2.28	5.36	3.20	0.00	3.20
76	98.68	4.59	4.68	3-M1t	3.06	2.64	7.09	3.20	0.00	3.20
89	99.57	5.29	5.57	6-FFn	4.00	2.86	7.10	4.00	0.00	3.20
102	100.21	6.09	6.21	6-FFn	4.00	3.05	8.11	4.00	0.00	3.20
107	100.49	6.45	6.49	6-FFn	4.00	3.12	8.53	4.00	0.00	3.20
108	100.56	6.53	6.56	6-FFn	4.00	3.14	8.62	4.00	0.00	3.20
114	100.94	6.94	6.89	6-FFn	4.00	3.22	9.07	4.00	0.00	3.20

El. inlet face invert 94.00 ft El. outlet invert 93.50 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	1045.00
INLET ELEVATION (FT)	94.00
OUTLET STATION (FT)	1000.00
OUTLET ELEVATION (FT)	93.50
NUMBER OF BARRELS	1
SLOPE (V-FT/H-FT)	0.0111
CULVERT LENGTH ALONG SLOPE (FT)	45.00

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	4.00 FT
BARREL MATERIAL	CORRUGATED STEEL
BARREL MANNING'S N	0.024
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	THIN EDGE PROJECTING
INLET DEPRESSION	NONE

CURRENT DATE: 12-12-2001
CURRENT TIME: 11:10:15

FILE DATE: 12-12-2001
FILE NAME: HWY213

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CONSTANT WATER SURFACE ELEVATION
96.70

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ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	30.00
CREST LENGTH (FT)	50.00
OVERTOPPING CREST ELEVATION (FT)	100.00

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CURRENT DATE: 12-14-2001
CURRENT TIME: 08:31:13

FILE DATE: 12-13-2001
FILE NAME: MKT

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.1

CULV	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	316.50	315.10	130.51	1 CSP	4.00	4.00	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: MKT DATE: 12-13-2001

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
318.30	0	0	0	0	0	0	0	0	1
318.46	9	9	0	0	0	0	0	0	1
318.72	17	17	0	0	0	0	0	0	1
319.00	26	26	0	0	0	0	0	0	1
319.38	34	34	0	0	0	0	0	0	1
319.78	43	43	0	0	0	0	0	0	1
320.15	52	52	0	0	0	0	0	0	1
320.52	60	60	0	0	0	0	0	0	1
320.87	69	69	0	0	0	0	0	0	1
320.96	71	71	0	0	0	0	0	0	1
321.61	86	86	0	0	0	0	0	0	1
323.00	99	99	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: MKT DATE: 12-13-2001

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
318.30	0.00	0	0	0.00
318.46	0.00	9	0	0.00
318.72	0.00	17	0	0.00
319.00	0.00	26	0	0.00
319.38	0.00	34	0	0.00
319.78	0.00	43	0	0.00
320.15	0.00	52	0	0.00
320.52	0.00	60	0	0.00
320.87	0.00	69	0	0.00
320.96	0.00	71	0	0.00
321.61	0.00	86	0	0.00

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 12-14-2001 FILE DATE: 12-13-2001
CURRENT TIME: 08:31:13 FILE NAME: MKT

PERFORMANCE CURVE FOR CULVERT # 1 - 1 (4 BY 4) CSP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	318.30	0.00	1.80	0-NF	0.00	0.00	0.00	0.00	0.00	3.20
9	318.46	1.30	1.96	3-M1t	0.87	0.84	0.80	3.20	0.00	3.20
17	318.72	1.79	2.22	3-M1t	1.25	1.22	1.60	3.20	0.00	3.20
26	319.00	2.24	2.50	3-M1t	1.55	1.49	2.39	3.20	0.00	3.20
34	319.38	2.65	2.88	3-M1t	1.82	1.74	3.19	3.20	0.00	3.20
43	319.78	3.04	3.28	3-M1t	2.08	1.96	3.99	3.20	0.00	3.20
52	320.15	3.42	3.65	3-M1t	2.32	2.15	4.79	3.20	0.00	3.20
60	320.52	3.81	4.02	3-M1t	2.58	2.33	5.59	3.20	0.00	3.20
69	320.87	4.22	4.37	3-M1t	2.84	2.50	6.38	3.20	0.00	3.20
71	320.96	4.32	4.46	3-M1t	2.92	2.54	6.59	3.20	0.00	3.20
86	321.61	5.11	5.11	3-M2t	3.60	2.81	7.98	3.20	0.00	3.20

El. inlet face invert 316.50 ft El. outlet invert 315.10 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	1000.00
INLET ELEVATION (FT)	316.50
OUTLET STATION (FT)	869.50
OUTLET ELEVATION (FT)	315.10
NUMBER OF BARRELS	1
SLOPE (V-FT/H-FT)	0.0107
CULVERT LENGTH ALONG SLOPE (FT)	130.51

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	4.00 FT
BARREL MATERIAL	CORRUGATED STEEL
BARREL MANNING'S N	0.024
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	THIN EDGE PROJECTING
INLET DEPRESSION	NONE

CURRENT DATE: 12-14-2001 FILE DATE: 12-13-2001
CURRENT TIME: 08:31:13 FILE NAME: MKT

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CONSTANT WATER SURFACE ELEVATION
318.30

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ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	23.00
CREST LENGTH (FT)	50.00
OVERTOPPING CREST ELEVATION (FT)	323.00

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CURRENT DATE: 12-12-2001
CURRENT TIME: 10:49:39

FILE DATE: 12-12-2001
FILE NAME: FOREST

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.1

C U L V	SITE DATA INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	CULVERT SHAPE, MATERIAL, INLET BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	100.00	99.70	32.00	1 CSP	3.00	3.00	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: FOREST DATE: 12-12-2001

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
102.10	0	0	0	0	0	0	0	0	1
102.39	15	15	0	0	0	0	0	0	1
103.12	30	30	0	0	0	0	0	0	1
104.43	46	46	0	0	0	0	0	0	1
105.86	61	61	0	0	0	0	0	0	1
107.39	76	71	0	0	0	0	0	4	11
107.55	91	72	0	0	0	0	0	18	5
107.66	106	73	0	0	0	0	0	33	4
107.76	122	74	0	0	0	0	0	48	4
107.77	124	74	0	0	0	0	0	49	2
107.94	152	75	0	0	0	0	0	77	4
107.30	71	71	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: FOREST DATE: 12-12-2001

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
102.10	0.00	0	0	0.00
102.39	0.00	15	0	0.00
103.12	0.00	30	0	0.00
104.43	0.00	46	0	0.00
105.86	0.00	61	0	0.00
107.39	-0.01	76	1	0.94
107.55	-0.01	91	0	0.54
107.66	-0.01	106	1	0.55
107.76	-0.01	122	0	0.31
107.77	-0.00	124	1	0.85
107.94	-0.01	152	0	0.23

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 12-12-2001 FILE DATE: 12-12-2001
CURRENT TIME: 10:49:39 FILE NAME: FOREST

PERFORMANCE CURVE FOR CULVERT # 1 - 1 (3 BY 3) CSP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	102.10	0.00	2.10	0-NF	0.00	0.00	0.00	0.00	0.00	2.40
15	102.39	1.88	2.39	3-M1t	1.38	1.24	2.51	2.40	0.00	2.40
30	103.12	2.94	3.12	3-M1t	2.16	1.79	5.01	2.40	0.00	2.40
46	104.43	4.17	4.43	6-FFn	3.00	2.19	6.45	3.00	0.00	2.40
61	105.86	5.86	5.78	6-FFn	3.00	2.50	8.60	3.00	0.00	2.40
71	107.39	7.39	6.95	6-FFn	3.00	2.67	10.10	3.00	0.00	2.40
72	107.55	7.55	7.07	6-FFn	3.00	2.68	10.24	3.00	0.00	2.40
73	107.66	7.66	7.16	6-FFn	3.00	2.70	10.34	3.00	0.00	2.40
74	107.76	7.76	7.23	6-FFn	3.00	2.71	10.43	3.00	0.00	2.40
74	107.77	7.77	7.24	6-FFn	3.00	2.71	10.44	3.00	0.00	2.40
75	107.94	7.94	7.36	6-FFn	3.00	2.72	10.58	3.00	0.00	2.40

El. inlet face invert 100.00 ft El. outlet invert 99.70 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	1032.00
INLET ELEVATION (FT)	100.00
OUTLET STATION (FT)	1000.00
OUTLET ELEVATION (FT)	99.70
NUMBER OF BARRELS	1
SLOPE (V-FT/H-FT)	0.0094
CULVERT LENGTH ALONG SLOPE (FT)	32.00

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	3.00 FT
BARREL MATERIAL	CORRUGATED STEEL
BARREL MANNING'S N	0.024
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	THIN EDGE PROJECTING
INLET DEPRESSION	NONE

CURRENT DATE: 12-12-2001 FILE DATE: 12-12-2001
CURRENT TIME: 10:49:39 FILE NAME: FOREST

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CONSTANT WATER SURFACE ELEVATION
102.10

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ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ROADWAY OVERTOPPING DATA ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	25.00
CREST LENGTH (FT)	50.00
OVERTOPPING CREST ELEVATION (FT)	107.30

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City of Molalla

2nd Street/Old Railway Alignment Storm System

Project Estimate

Item	Description	Unit	Unit Price	Quantity	Total Cost
1	Mobilization (10%)				74,550
2	15" Pipe	LF	$75.00	250	18,750
3	24" Pipe	LF	$120.00	900	108,000
4	30" Pipe	LF	$135.00	850	114,750
5	60" Pipe	LF	$240.00	350	84,000
6	Channel	LF	$120.00	3500	420,000
	Sub-Total				**820,050**
	Construction Contingencies (20%)				**164,010**
	Total Project Construction Cost				**984,060**
	Allied Costs (25%)				**246,015**
	Total Project Cost				**1,230,075**

City of Molalla

2nd Street/Kennel Storm System

Project Estimate

Item	Description	Unit	Unit Price	Quantity	Total Cost
1	Mobilization (10%)				85,449
2	15" Pipe	LF	$75.00	250	18,750
3	24" Pipe	LF	$120.00	900	108,000
4	30" Pipe	LF	$135.00	800	108,000
5	36" Pipe	LF	$162.00	270	43,740
6	48" Pipe	LF	$192.00	3000	576,000
	Sub-Total				**939,939**
	Construction Contingencies (20%)				**187,988**
	Total Project Construction Cost				**1,127,927**
	Allied Costs (25%)				**281,982**
	Total Project Cost				**1,409,909**

City of Molalla

Heintz Street Stormwater Collector Replacement Project

Project Estimate

Item	Description	Unit	Unit Price	Quantity	Total Cost
1	Mobilization (10%)				72,690
2	18" Pipe	LF	$90.00	300	27,000
3	21" Pipe	LF	$105.00	750	78,750
5	36" Pipe	LF	$162.00	950	153,900
6	42" Pipe	LF	$189.00	730	137,970
7	48" Pipe	LF	$192.00	340	65,280
8	60" Pipe	LF	$240.00	1100	264,000
	Sub-Total				**799,590**
	Construction Contingencies (20%)				**159,918**
	Total Project Construction Cost				**959,508**
	Allied Costs (25%)				**239,877**
	Total Project Cost				**1,199,385**

City of Molalla

Industrial Way Stormwater Improvements

Project Estimate

Item	Description	Unit	Unit Price	Quantity	Total Cost
1	Mobiliztion (10%)				3,096
2	36" Pipe	LF	$180.00	108	19,440
3	48" Pipe	LF	$240.00	48	11,520
	Sub-Total				**34,056**
	Construction Contingencies (20%)				**6,811**
	Total Project Construction Cost				**40,867**
	Allied Costs (25%)				**10,217**
	Total Project Cost				**51,084**

City of Molalla

Shirley St Drainage Improvements

Project Estimate

Item	Description	Unit	Unit Price	Quantity	Total Cost
1	Mobilization (10%)				5,502
2	18" Pipe	LF	$90.00	90	8,100
3	24" Pipe	LF	$120.00	391	46,920
	Sub-Total				**60,522**
	Construction Contingencies (20%)				**12,104**
	Total Project Construction Cost				**72,626**
	Allied Costs (25%)				**18,157**
	Total Project Cost				**90,783**

City of Molalla

Heintz Street Outfall Project

Project Estimate

Item	Description	Unit	Unit Price	Quantity	Total Cost
1	Mobiliztion (10%)				34,560
2	Twin 48" Pipe	LF	$384.00	900	345,600
	Sub-Total				**380,160**
	Construction Contingencies (20%)				**76,032**
	Total Project Construction Cost				**456,192**
	Allied Costs (25%)				**114,048**
	Total Project Cost				**570,240**

City of Molalla

Dixon Avenue Drainage Improvements

Project Estimate

Item	Description	Unit	Unit Price	Quantity	Total Cost
1	Mobilization (10%)				8,400
2	24" Pipe	LF	$120.00	700	84,000
	Sub-Total				**92,400**
	Construction Contingencies (20%)				**18,480**
	Total Project Construction Cost				**110,880**
	Allied Costs (25%)				**27,720**
	Total Project Cost				**138,600**

City of Molalla

Mathias Detention Pond

Project Estimate

Item	Description	Unit	Unit Price	Quantity	Total Cost
1	Mobilization (10%)				3,900
2	Earthwork	CY	$20.00	1200	24,000
4	Outfall Structure	LS	$15,000.00	1	15,000
	Sub-Total				**42,900**
	Construction Contingencies (20%)				**8,580**
	Total Project Construction Cost				**51,480**
	Allied Costs *				**45,000**
	Total Project Cost				**96,480**

* Design Cost and permitting would be higher percentage for this project.

APPENDIX F
Pipe Size Increases for 25-year Storm

U/S Manhole	Diameter or Depth Existing (inches)	Future (inches)	Projects* (inches)	U/S Invert	D/S Invert	Length (ft)	Slope (%)	Shape	Peak Flow Existing (CFS)	Future (CFS)	Projects* (CFS)
PC100	36	36	36	313.81	313.34	47	0.99	Trapezoidal	35.8	42.7	260.3
PC101	54	54	54	314.66	313.81	438	0.19	Trapezoidal	22.8	29.7	42.2
PC102	36	36	36	314.98	314.66	60	0.53	Circular	22.8	29.7	40.8
PC103	8	96	96	316.36	314.98	714	0.19	Trapezoidal	23.0	32.9	52.6
PC104	36	36	36	331.95	316.36	1905	0.82	Trapezoidal	32.0	33.8	59.4
PC106	36	36	36	333.98	331.95	247	0.82	Trapezoidal	26.8	29.3	57.5
PC108	36	36	36	338.54	333.98	558	0.82	Trapezoidal	23.9	26.5	55.2
PC110	50	50	50	339.28	338.54	89	0.83	Circular	20.2	20.8	50.0
PC112	24	36	36	339.55	339.28	34	0.80	Circular	11.3	11.3	22.3
PC114	14	36	36	340.04	339.55	60	0.82	Circular	11.3	11.3	22.3
PC116	12	15	15	342.29	340.04	264	0.85	Circular	3.1	3.1	4.0
PC118	10	15	15	343.21	342.29	144	0.64	Circular	3.1	3.1	4.1
PC120	10	15	15	343.92	343.21	99	0.72	Circular	3.1	3.1	4.1
PC122	10	15	15	345.32	343.92	239	0.59	Circular	3.2	3.2	4.1
PC123	24	24	24	341.07	340.04	82	1.26	Circular	15.4	16.1	18.5
PC124	24	24	24	345.40	341.07	343	1.26	Circular	15.4	16.1	18.5
PC126	24	27	27	348.48	345.40	308	1.00	Circular	15.5	16.8	18.5
PC128	24	24	24	351.77	348.48	329	1.00	Circular	4.7	5.9	2.4
PC132	18	24	24	345.00	340.04	70	7.09	Circular	9.1	9.8	27.7
PC134	12	24	24	348.80	345.00	305	1.25	Circular	6.2	6.3	24.3
PC136	12	21	21	349.10	348.80	298	0.10	Circular	3.7	3.7	20.9
PC138	12	21	21	350.46	349.10	136	1.00	Circular	5.8	5.8	17.7
PC140	12	18	18	351.47	350.46	101	1.00	Circular	4.7	4.7	14.7
PC142	12	18	18	353.22	351.47	175	1.00	Circular	5.2	5.2	13.6
PC144	12	18	18	355.71	353.22	249	1.00	Circular	5.2	5.2	12.0
PC146	12	15	15	356.18	355.71	47	1.01	Circular	5.1	5.2	6.0
PC148	12	12	12	360.16	356.18	398	1.00	Circular	1.7	1.7	1.7
PC200	36	60	60	344.83	313.81	4348	0.71	Trapezoidal	13.0	13.0	223.1
PC202	24	24	24	346.15	344.83	129	1.02	Trapezoidal	18.1	18.5	18.3
PC204	24	24	24	347.39	346.15	116	1.07	Circular	18.0	18.4	18.3
PC206	12	12	12	359.48	347.39	586	2.06	Circular	6.6	6.7	6.7
PC208	12	12	12	360.24	359.48	120	0.63	Circular	3.0	3.1	3.1
PC210	12	12	12	360.73	360.24	51	0.96	Circular	3.0	3.1	3.1
PC212	12	12	12	364.58	360.73	384	1.00	Circular	3.0	3.1	3.1
PC214	24	24	24	347.05	347.39	218	-0.16	Circular	11.5	11.7	11.6
PC216	24	24	24	348.08	347.05	244	0.42	Circular	8.2	8.4	8.4
PC218	24	24	24	350.74	348.08	54	4.95	Circular	4.1	4.1	4.1
PC220	12	12	12	352.86	350.74	339	0.62	Circular	1.8	1.9	1.9
PC222	12	12	12	354.63	352.86	253	0.70	Circular	0.7	0.7	0.7
PC224	12	18	12	348.50	348.08	212	0.20	Circular	4.1	4.2	4.2
PC226	12	12	12	351.08	348.50	466	0.55	Circular	1.7	1.7	1.7
PC230	10	10	10	355.73	347.05	394	2.20	Circular	1.2	1.3	1.3
PC250	36	36	36	345.50	344.83	95	0.71	Trapezoidal	54.2	54.3	16.8
PC260	36	36	36	345.65	345.50	20	0.75	Trapezoidal	54.2	54.3	17.2
PC265	12	12	0	361.33	354.40	1639	0.00	Circular	3.5	3.5	
PC300	30	30	30	346.18	345.65	75	0.71	Trapezoidal	54.2	54.3	17.3
PC302	48	48	48	346.95	346.18	77	1.00	Trapezoidal	4.5	4.6	4.0
PC304	12	12	12	347.38	346.95	82	0.52	Circular	4.5	4.6	4.1
PC306	60	60	60	347.73	347.38	72	0.48	Trapezoidal	5.6	5.7	5.5
PC308	24	24	24	348.01	347.73	171	0.16	Circular	7.2	7.3	7.3
PC310	15	15	15	348.31	348.01	114	0.26	Circular	7.2	7.4	7.4
PC312	15	15	15	354.07	348.31	226	2.55	Circular	7.2	7.4	7.4
PC314	15	15	15	355.23	354.07	170	0.68	Circular	7.2	7.4	7.4
PC316	15	15	15	356.47	355.23	157	0.79	Circular	3.9	4.0	4.0
PC318	12	12	12	358.72	356.47	187	1.20	Circular	2.1	2.2	2.2
PC320	12	12	12	359.36	358.72	105	0.61	Circular	2.1	2.2	2.2
PC350	30	30	30	351.90	346.18	802	0.71	Trapezoidal	49.7	49.7	14.3
PC400	30	0	30	352.31	351.90	70	0.59	Circular	49.7	49.7	14.6
PC401	36	36	36	353.43	352.31	29	3.89	Trapezoidal	1.9	1.6	7.1
PC402	12	15	15	355.30	353.43	187	1.00	Circular	1.9	1.6	7.1
PC404	12	15	15	355.10	355.30	32	-0.62	Circular	1.9	1.6	7.1
PC406	12	12	15	357.30	355.10	310	0.71	Circular	2.2	2.2	3.2
PC500	36	60	36	353.48	353.47	4	0.28	Trapezoidal	22.8	22.3	-0.3
PC502	36	0	36	354.75	353.48	328	0.39	Circular	22.8	22.4	0.0
PC504	36	0	60	357.31	354.75	663	0.39	Circular	31.2	31.2	195.0

APPENDIX F
Pipe Size Increases for 25-year Storm

U/S Manhole	Diameter or Depth Existing (inches)	Future (inches)	Projects* (inches)	U/S Invert	D/S Invert	Length (ft)	Slope (%)	Shape	Peak Flow Existing (CFS)	Future (CFS)	Projects* (CFS)
PC506	36	0	60	357.38	357.31	41	0.17	Circular	31.2	31.2	195.2
PC508	36	48	0	358.78	357.38	418	0.33	Circular	15.0	19.2	
PC510	36	48	0	360.90	358.78	212	1.00	Circular	15.0	19.2	
PC550	30	48	30	358.62	357.93	500	0.14	Circular	18.1	16.9	33.4
PC552	30	42	30	359.38	358.62	195	0.39	Circular	15.4	14.5	27.7
PC554	12	24	12	360.36	359.38	60	1.64	Circular	2.1	1.9	2.1
PC556	12	24	12	361.33	360.36	335	0.29	Circular	2.0	2.0	1.8
PC558	12	21	12	364.03	361.33	270	1.00	Circular	4.7	4.7	4.5
PC560	12	21	12	364.81	364.03	78	1.00	Circular	4.7	4.7	4.5
PC562	12	15	12	367.47	364.81	266	1.00	Circular	3.6	3.6	4.5
PC570	30	30	30	359.60	359.38	12	1.83	Circular	14.6	12.7	23.8
PC572	30	30	30	360.93	359.60	359	0.37	Circular	20.4	20.5	19.4
PC574	21	24	21	364.03	360.93	304	1.02	Circular	15.8	15.9	15.1
PC606	15	15	15	366.14	363.42	38	7.19	Circular	9.4	10.4	10.4
PC608	15	15	15	369.10	366.14	327	0.91	Circular	6.6	7.0	7.0
PC610	12	12	12	375.00	369.10	597	0.99	Circular	2.4	2.6	2.6
PC612	12	12	12	393.50	375.00	640	2.89	Circular	2.5	2.6	2.6
PC700	60	60	60	353.47	352.31	198	0.59	Trapezoidal	85.4	108.2	7.6
PC702	60	60	60	356.80	353.47	571	0.58	Circular	71.3	94.5	7.8
PC704	60	60	0	357.60	356.80	208	0.39	Circular	64.9	88.2	
PC706	60	60	60	357.97	357.60	70	0.53	Circular	64.9	88.2	162.2
PC708	60	60	60	360.17	357.97	413	0.53	Circular	60.3	83.0	157.5
PC710	60	60	60	361.20	360.17	194	0.53	Circular	42.8	65.3	138.5
PC712	60	60	60	363.47	361.20	269	0.84	Circular	57.6	84.4	138.2
PC714	60	60	60	364.12	363.47	77	0.84	Circular	51.4	78.4	125.9
PC716	48	42	18	368.25	364.12	490	0.84	Circular	31.2	58.9	14.6
PC718	48	48	21	374.40	368.25	783	0.79	Circular	24.5	53.2	13.2
PC720	48	48	30	376.02	374.40	324	0.50	Circular	16.3	45.1	31.8
PC722	48	48	48	376.75	376.02	73	1.00	Trapezoidal	14.9	44.3	30.6
PC724	34	30	30	377.30	376.75	55	1.00	Special	14.9	44.6	30.6
PC802	15	15	15	365.59	360.17	75	7.27	Circular	6.6	6.7	7.5
PC804	15	15	15	365.77	365.59	298	0.06	Circular	2.5	2.6	2.5
PC806	15	15	15	366.20	365.77	702	0.06	Circular	0.9	0.8	0.6
PC808	15	30	15	368.60	366.20	339	0.71	Circular	8.6	8.6	7.7
PC810	15	24	30	373.00	368.60	346	1.27	Circular	6.3	6.3	40.8
PC812	15	24	18	377.40	373.00	352	1.25	Circular	5.7	5.7	13.4
PC814	12	24	21	378.50	377.40	202	0.54	Circular	4.9	4.9	12.2
PC816	12	18	18	381.00	378.50	357	0.70	Circular	2.9	3.0	8.0
PC818	12	12	12	373.20	368.60	300	1.53	Circular	3.9	3.9	2.4
PC820	12	12	24	377.60	373.20	350	1.26	Circular	3.5	3.6	28.9
PC822	12	12	12	379.60	377.60	300	0.67	Circular	1.7	1.8	1.8
PC1002	12	24	18	373.84	366.97	331	2.08	Circular	6.4	6.4	12.5
PC1004	12	24	18	374.84	373.84	425	0.24	Circular	2.6	2.8	7.3
PC1006	12	24	18	376.32	374.84	600	0.25	Circular	1.9	1.9	6.1
PC1008	10	21	15	378.00	376.32	681	0.25	Circular	1.6	1.4	2.4
PC1010	10	15	24	385.20	378.00	420	1.71	Circular	2.7	2.7	22.9
PC1012	10	15	15	389.70	385.20	655	0.69	Circular	2.8	2.8	4.3
PC1014	10	15	15	390.70	389.70	922	0.11	Circular	1.3	1.3	2.4
PC1100	60	60	60	364.67	364.12	52	1.06	Circular	18.7	18.6	124.2
PC1102	12	36	36	369.80	364.67	478	1.07	Circular	4.1	4.0	20.8
PC1104	12	27	27	373.59	369.80	398	0.95	Circular	3.7	3.6	18.6
PC1106	12	21	21	378.04	373.59	500	0.89	Circular	3.6	3.6	8.2
PC1108	12	15	15	386.02	378.04	300	2.66	Circular	5.8	6.0	8.2
PC1110	13	13	13	387.02	386.02	135	0.74	Circular	1.1	0.9	1.6
PC1116	12	18	18	376.72	373.59	313	1.00	Circular	3.7	3.7	7.7
PC1118	12	12	12	384.92	376.72	820	1.00	Circular	2.5	2.6	2.9
PC1250	24	30	48	367.99	364.67	341	0.97	Circular	14.8	15.0	103.2
PC1252	24	30	42	372.86	367.99	500	0.97	Circular	14.1	14.5	88.5
PC1254	21	30	42	375.12	372.86	231	0.98	Circular	14.8	14.8	68.1
PC1256	21	24	24	378.17	375.12	314	0.97	Circular	15.7	15.7	32.2
PC1258	21	24	24	380.80	378.17	270	0.97	Circular	20.4	20.4	28.9
PC1260	15	18	18	387.00	380.80	211	2.94	Circular	8.8	8.6	13.0
PC1262	15	18	18	387.61	387.00	36	1.71	Circular	9.0	8.7	12.9
PC1264	12	12	12	395.67	387.61	233	3.46	Circular	3.1	3.0	2.5
PC1270	15	18	18	385.90	380.80	510	1.00	Circular	4.5	4.9	7.5
PC1290	15	18	18	388.70	387.61	230	0.47	Circular	5.7	5.7	8.7

APPENDIX F

Pipe Size Increases for 25-year Storm

U/S Manhole	Diameter or Depth			U/S Invert	D/S Invert	Length (ft)	Slope (%)	Shape	Peak Flow		
	Existing (inches)	Future (inches)	Projects* (Inches)						Existing (CFS)	Future (CFS)	Projects* (CFS)
PC1292	15	15	15	390.84	388.70	88	2.42	Circular	7.5	8.6	8.7
PC1294	15	15	15	399.13	390.84	342	2.43	Circular	7.5	8.7	8.7
PC1296	0	0	0								
PC1402	12	27	18	372.38	368.25	402	1.03	Circular	4.2	4.2	11.5
PC1404	12	24	15	375.77	372.38	330	1.03	Circular	4.5	4.5	9.3
PC1406	12	21	12	380.82	375.77	330	1.53	Circular	4.1	4.3	2.9
PC1408	12	21	12	381.06	380.82	80	0.30	Circular	3.6	3.4	-0.1
PC1410	12	21	24	382.70	381.06	350	0.47	Circular	4.2	4.2	16.2
PC1412	12	12	12	386.80	382.70	335	1.23	Circular	2.5	2.5	4.8
PC1414	12	12	12	389.70	386.80	330	0.88	Circular	2.3	2.3	2.2
PC1416	10	18	15	386.03	382.70	265	1.26	Circular	1.9	1.9	8.3
PC1418	10	15	15	386.90	386.03	342	0.25	Circular	1.3	1.3	1.9
PC1420	10	10	10	389.70	386.90	350	0.80	Circular	0.8	0.8	0.8
PC1422	12	12	12	388.33	386.03	230	1.00	Circular	1.2	1.4	5.1
PC1424	10	10	10	391.59	388.33	326	1.00	Circular	1.7	2.1	2.1
PC1502	12	21	21	374.89	374.40	168	0.29	Circular	4.6	4.3	7.8
PC1504	12	15	15	385.45	374.89	415	2.54	Circular	5.0	5.6	7.0
PC1506	12	15	12	385.73	385.45	32	0.87	Circular	5.0	5.6	7.0
PC1508	12	15	15	387.07	385.73	148	0.91	Circular	3.7	4.2	5.4
PC1510	12	15	15	388.21	387.07	172	0.66	Circular	3.0	3.5	4.1
PC1512	12	15	15	388.90	388.21	124	0.56	Circular	2.4	2.9	2.9
PC1514	12	15	15	389.53	388.90	148	0.43	Circular	2.1	2.7	2.7
PC1600	36	36	36	377.94	376.02	8	23.68	Circular	1.4	1.3	1.4
PC1602	36	36	36	378.15	377.94	80	0.26	Circular	1.4	1.4	1.4
PC1604	36	36	36	378.49	378.15	126	0.27	Circular	1.4	1.4	1.4
PC1700	36	36	36	389.75	377.30	611	2.04	Trapezoidal	12.5	60.2	27.4
PC1702	18	18	18	394.00	389.75	76	5.61	Circular	2.3	2.4	2.4
PC1800	36	36	36	389.92	389.75	62	0.27	Circular	10.3	41.8	25.3
PC1802	12	24	24	392.97	389.92	161	1.90	Circular	6.5	6.3	19.5
PC1804	12	24	24	395.51	392.97	179	1.42	Circular	5.2	5.1	17.7
PC1806	12	24	24	399.88	395.51	237	1.84	Circular	4.9	4.8	16.5
PC1808	12	21	21	401.66	399.88	237	0.75	Circular	4.0	3.9	13.1
PC1810	12	21	21	405.15	401.66	297	1.18	Circular	3.2	3.2	6.8
PC1900	36	36	36	392.21	389.92	198	1.16	Circular	2.3	32.5	4.3
PC2000	36	36	24	397.60	392.21	465	1.16	Trapezoidal	2.3	32.5	4.3
PC2002	12	15	0	398.40	397.60	184	0.43	Circular	2.3	1.9	
PC2100	36	36	36	402.00	397.60	740	0.59	Trapezoidal	0.0	31.4	6.1
PC2200	36	36	8	402.30	402.00	30	1.00	Circular	0.0	31.5	6.1
PC556A	12	0	12	358.98	358.98	50	0.00	Circular	4.4	3.8	3.2
PC710A	36	36	0	361.20	360.90	44	0.68	Circular	14.9	19.2	
PC806A	21	24	21	366.20	364.03	195	1.11	Circular	15.7	15.8	15.1
PC1110A	12	12	12	387.02	380.80	364	1.71	Circular	3.3	3.6	3.1
PC565			12								3.2
PC0002			48								224.8
PC0004			36								62.4
PC0006			24								53.8

* Projects indicate that the Railroad Alignment Project and The Heintz Collector Project are Constructed

City of Molalla, Oregon
Storm Drainage System
Ten Year Capital Improvement Plan Summary

PROJECT	OPINION OF PROBABLE COST	SCOPE OF WORK	PROJECT YEAR	FUNDING SOURCE	GRANT PORTION	CITY PORTION	GROWTH PORTION
Dixon Avenue Drainage Improvements	$ 89,410	Install Drainage Improvements from Hoyt St. to W. Main St.	1999-2000	Public Works Grant	$ 89,410		
Master Plan	$ 75,000	Develop Storm Drainage Master Plan	1999-2000	SDCs			$ 75,000
Kennel Avenue Drainage Improvments	$ 43,324	Install Drainage Improvements from W. Main St. to W. Ross St.	2001-2	SDCs			$ 43,324
May Street Drainage Improvments	$ 29,235	Install Drainage Improvemens from E. 6th St. to Swiegle Ave.	2002-3	Public Works Grant, CDBG	$ 29,235		
Miller Street Drainage Improvments	$ 45,480	Install Drainage Improvements from N. Molalla Ave	2002-3	General Fund, CDBG	$ 38,305	$ 7,176	
Heintz Street Drainage Improvments	$ 251,047	Install Drainage Improvements between Kennel Ave. and Cole Ave.	2003-4	Public Works Grant, CDBG	$ 188,285		$ 62,762
Shirley Street Drainage Improvments	$ 88,292	Install Drainage Improvements between N. Molalla Ave. and Cole Ave.	2003-4	CDBG	$ 88,292		
Sunrise Acres Drainage Improvments - Phase 1	$ 62,277	Install Drainage Improvements East of Stowers Lane Between E. 5th St. and E. 7th St.	2004-5	General Fund, CDBG	$ 55,259	$ 7,018	
Sunrise Acres Drainage Improvments - Phase 2	$ 16,804	Install Drainage Improvements West of Stowers Lane Between E. Main St. and E. 7th St.	2005-6	General Fund, CDBG	$ 14,910	$ 1,894	
Sunrise Acres Drainage Improvments - Phase 3	$ 41,740	Install Drainage Improvements East of Stowers Lane on E. 4th St. and E. 5th St.	2006-7	General Fund, CDBG	$ 37,036	$ 4,704	

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City of Molalla, Oregon
Storm Drainage System
Ten Year Capital Improvement Plan Summary

Storm Drainage System Cont.										
Hart Avenue Drainage Improvments	$	149,371	Install Drainage Improvements along Hart Ave. from Section St. to W. Main St.	2008-9	CDBG	$	149,371			
TOTAL	$	891,980				$	690,103	$ 20,792	$ 181,086	

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City of Molalla, Oregon
Five Year Capital Improvement Plan

Capital Project Summary

Department:	Public Works		
Project:	Storm Drain Master Plan	Project Year:	1999-2000
Location Map:			
Scope of Work:	Develop an updated storm drain master plan for the City of Molalla.		
Objective:	To plan future drainage improvements.		

Preliminary Budget

	Budget Number		Project Funding	
	Cost	Acct.	Amount	Source
Permitting				
Design/Engineering				
Right-of-Way				
Construction				
Construction Engineering/Inspection				
Contingency (10%)				
Planning, Modeling	*75,000.00		75,000.00	System Development Charges
Total Cost	75,000.00		75,000.00	

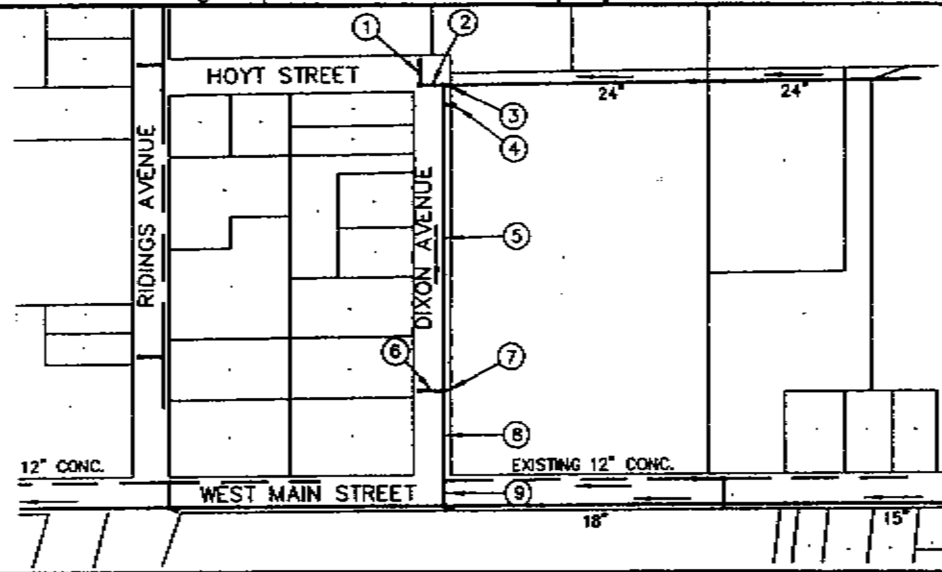
Remarks/Status: * This is a very preliminary estimate.

City of Molalla, Oregon
Five Year Capital Improvement Plan

Capital Project Summary

Department:	Public Works		
Project:	Dixon Avenue Drainage Improvements	**Project Year:**	1999-2000

Location Map:



Scope of Work: Construct drainage improvements from Hoyt Street along Dixon Avenue and crossing West Main Street.

Objective: To relieve drainage problem at Hoyt Street and Dixon Avenue by conveying drainage to the ditches on the South side of Main Street.

Preliminary Budget

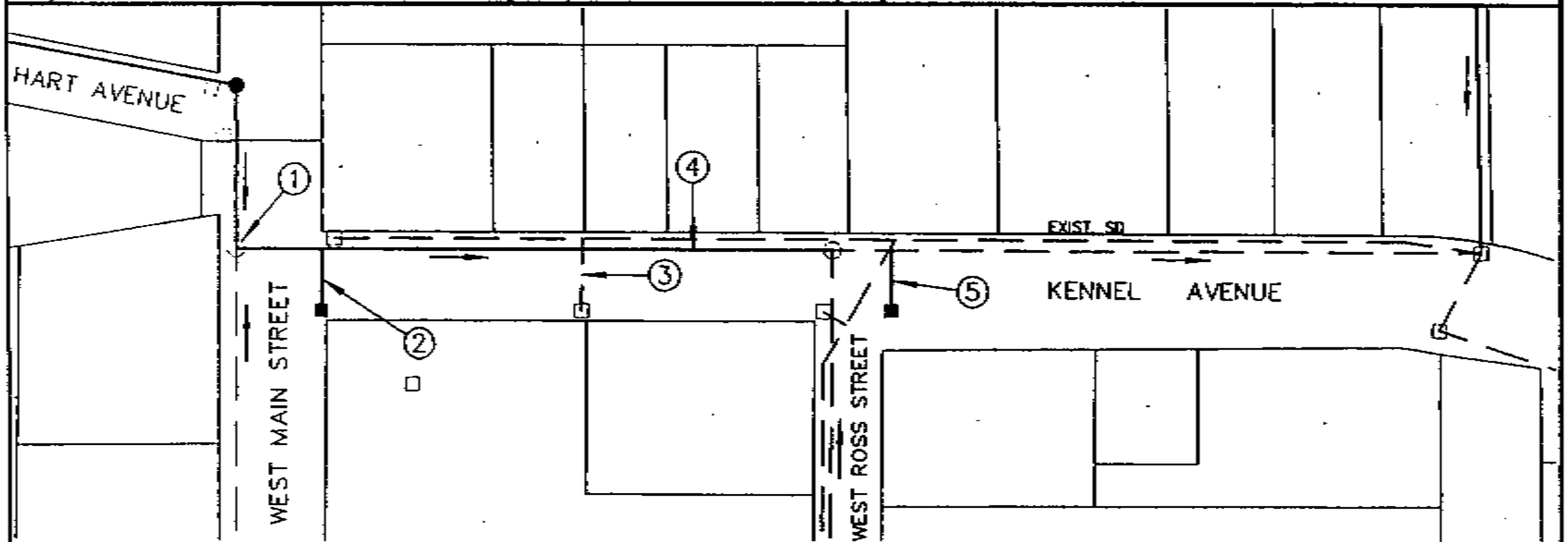
	Budget Number		**Project Funding**	
	Cost	Acct.	Amount	Source
Permitting				
Design/Engineering	10,076.25		10,076.25	Public Works Grant
Right-of-Way				
Construction	67,175.00		67,175.00	Public Works Grant
Construction Engineering/Inspection	4,030.50		4,030.50	Local Funds/Public Works Grant
Contingency (10%)	8,128.18		8,128.18	Public Works Grant
Total Cost	89,409.93		89,409.93	

Remarks/Status:

City of Molalla, Oregon
Five Year Capital Improvement Plan

Capital Project Summary

Department:	Public Works		
Project:	Kennel Avenue Drainage Improvements	Project Year:	2001-2002



Scope of Work: Construct drainage improvements along Kennel Avenue from West Main Street to West Ross Street.

Objective: To relieve drainage problem on Kennel Avenue by constructing the remainder of the drainage system for that area per the 1977 drainage master plan.

Preliminary Budget

	Budget Number			Project Funding	
	Cost	Acct.		Amount	Source
Permitting					
Design/Engineering	4,882.50			4,882.50	System Development Charges
Right-of-Way					
Construction	32,550.00			32,550.00	System Development Charges
Construction Engineering/Inspection	1,953.00			1,953.00	System Development Charges
Contingency (10%)	3,938.55			3,938.55	System Development Charges
Total Cost	43,324.05			43,324.05	

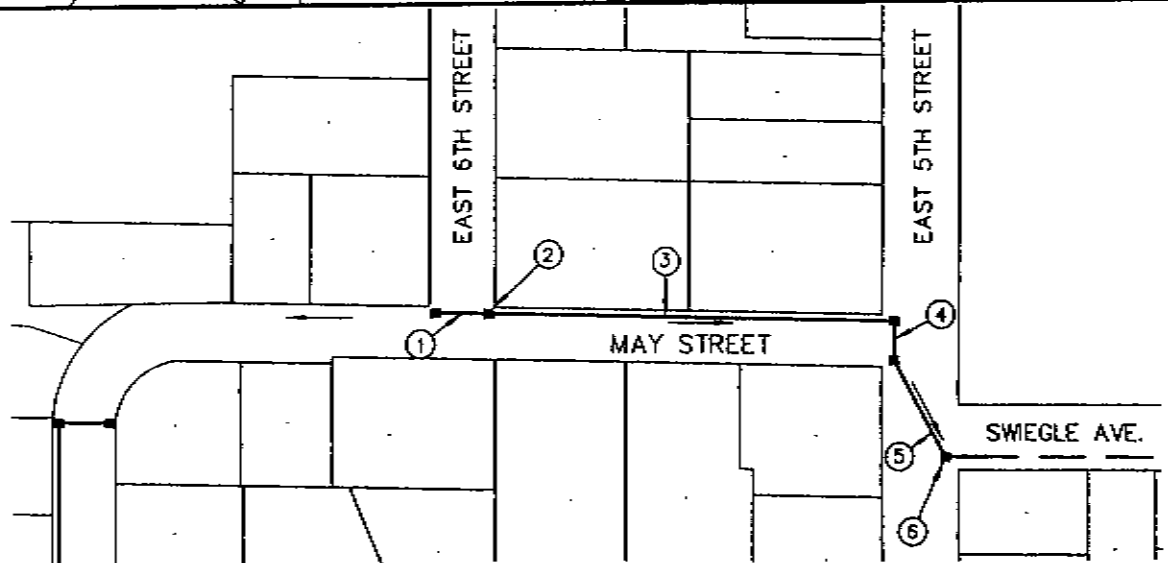
Remarks/Status:

City of Molalla, Oregon
Five Year Capital Improvement Plan

Capital Project Summary

Department:	Public Works		
Project:	May Street Drainage Improvements	Project Year:	2002-2003

Location Map:



Scope of Work: Construct drainage improvements along May Street from East 6th Street Northward to Swiegle Avenue.

Objective: To relieve the drainage problems on a street which has no drainage system.

Preliminary Budget

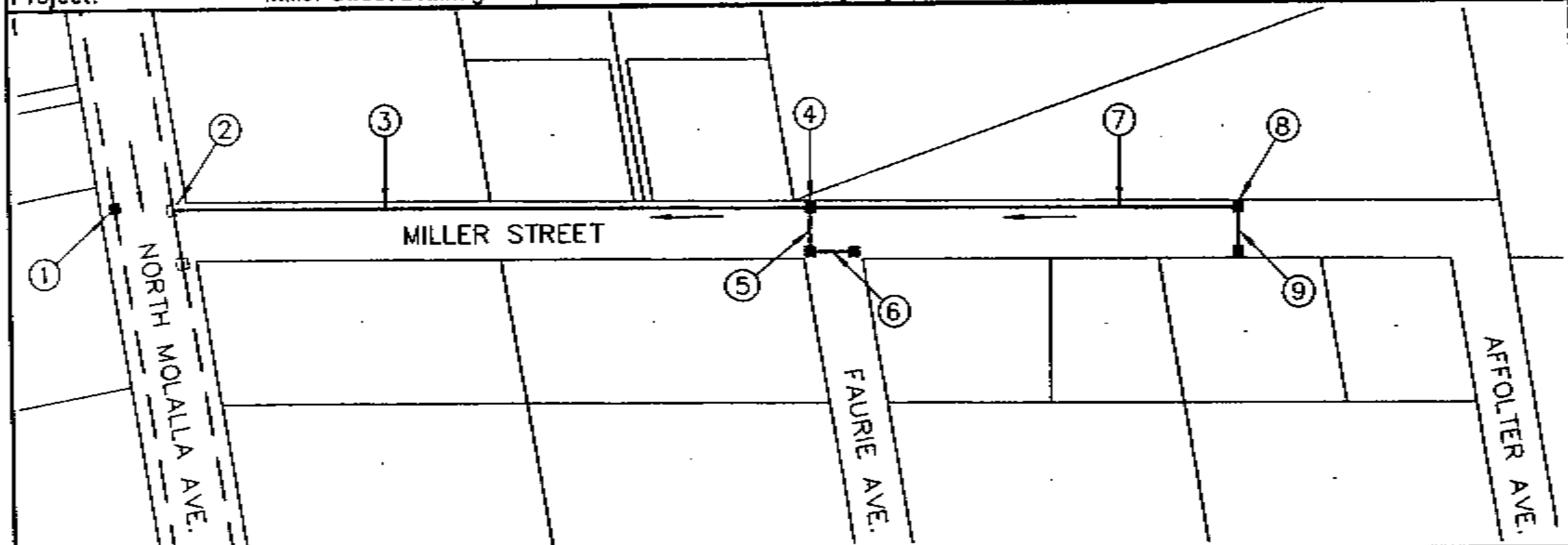
	Budget Number		Project Funding	
	Cost	Acct.	Amount	Source
Permitting				
Design/Engineering	3,294.75		3,294.75	Public Works Grant/CDBG Grant
Right-of-Way				
Construction	21,965.00		21,965.00	Public Works Grant/CDBG Grant
Construction Engineering/Inspection	1,317.90		1,317.90	Public Works Grant/CDBG Grant
Contingency (10%)	2,657.77		2,657.77	Public Works Grant/CDBG Grant
Total Cost	29,235.42		29,235.42	

Remarks/Status:

City of Molalla, Oregon
Five Year Capital Improvement Plan

Capital Project Summary

Department:	Public Works		
Project:	Miller Street Drainage Improvements	Project Year:	2002-2003



Scope of Work: Construct drainage improvements from North Molalla Avenue along a block and a half of Miller Street.

Objective: To relieve the drainage problems on a street which has no drainage system.

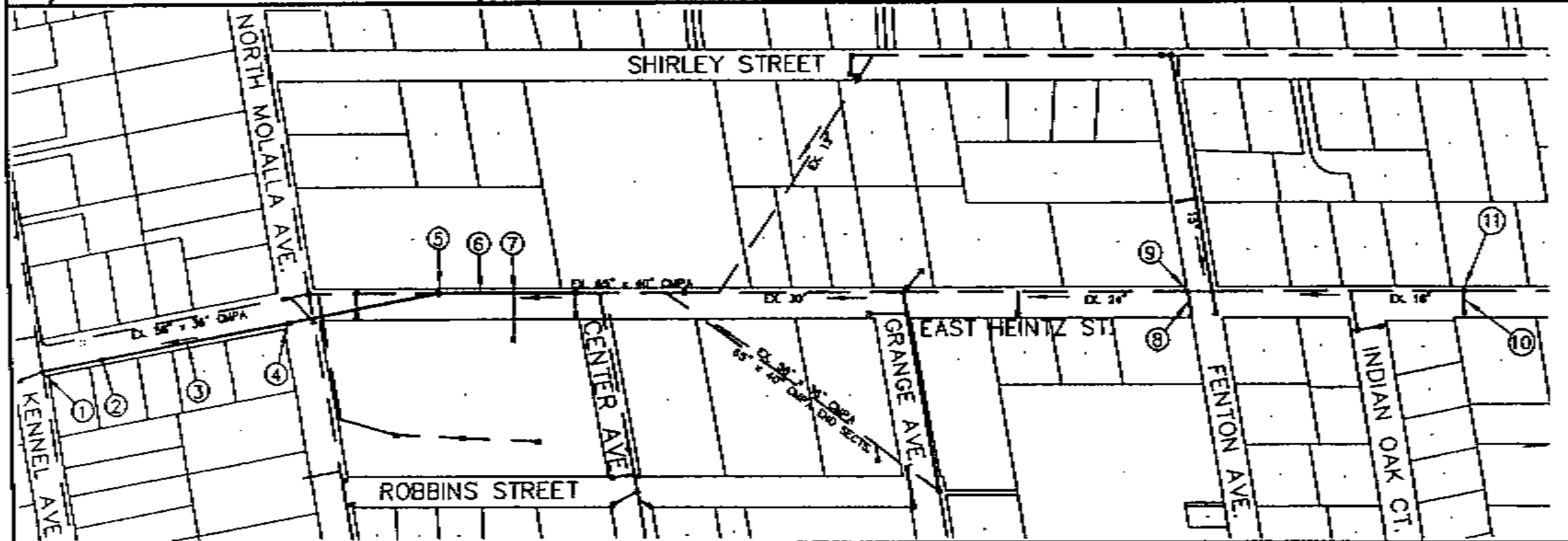
Preliminary Budget	Budget Number		Project Funding	
	Cost	Acct.	Amount	Source
Permitting				
Design/Engineering	5,125.50		5,125.50	General Fund
Right-of-Way				
Construction	34,170.00		34,170.00	CDBG Grant
Construction Engineering/Inspection	2,050.20		2,050.20	General Fund
Contingency (10%)	4,134.57		4,134.57	CDBG Grant
Total Cost	45,480.27		45,480.27	

Remarks/Status:

City of Molalla, Oregon
Five Year Capital Improvement Plan

Capital Project Summary

Department:	Public Works		
Project:	Heintz Street Drainage Improvements	Project Year:	2003-2004



Scope of Work: Construct drainage improvements along Heintz Street between Kennel Avenue and Cole Avenue.

Objective: To relieve the drainage problems on Heintz Street between Fenton Avenue and Cole Avenue and to construct the remainder of the Heintz Street drainage system per the 1977 drainage master plan.

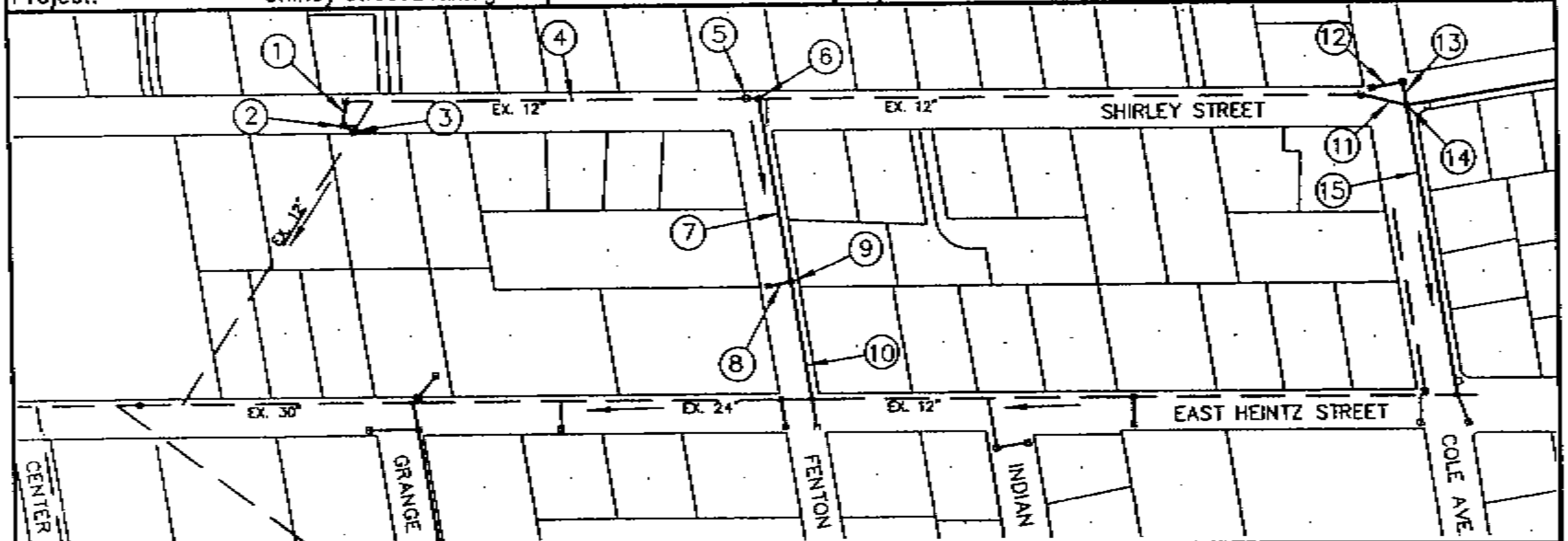
Preliminary Budget

	Budget Number		Project Funding		
	Cost	Acct.	Amount (75%)	Amount (25%)	Source
Permitting					
Design/Engineering	28,292.25		21,219.19	7,073.06	Public Works Grant/SDC
Right-of-Way					
Construction	188,615.00		141,461.25	47,153.75	Public Works Grant/SDC
Construction Engineering/Inspection	11,316.90		8,487.68	2,829.23	Public Works Grant/SDC
Contingency (10%)	22,822.42		17,116.81	5,705.60	Public Works Grant/SDC
Total Cost	251,046.57		188,284.92	62,761.64	
Remarks/Status:			251,046.57	Total Funding	

City of Molalla, Oregon
Five Year Capital Improvement Plan

Capital Project Summary

Department:	Public Works		
Project:	Shirley Street Drainage Improvements	Project Year:	2003-2004



Scope of Work: Construct drainage improvements along Shirley Street between North Molalla Avenue and Cole Avenue.

Objective: To relieve the drainage problems on Shirley Street by diverting flow down Fenton Avenue and down Cole Avenue.

Preliminary Budget

	Budget Number		Project Funding	
	Cost	Acct.	Amount	Source
Permitting				
Design/Engineering	9,950.25		9,950.25	CDBG Grant
Right-of-Way				
Construction	66,335.00		66,335.00	CDBG Grant
Construction Engineering/Inspection	3,980.10		3,980.10	CDBG Grant
Contingency (10%)	8,026.54		8,026.54	CDBG Grant
Total Cost	88,291.89		88,291.89	

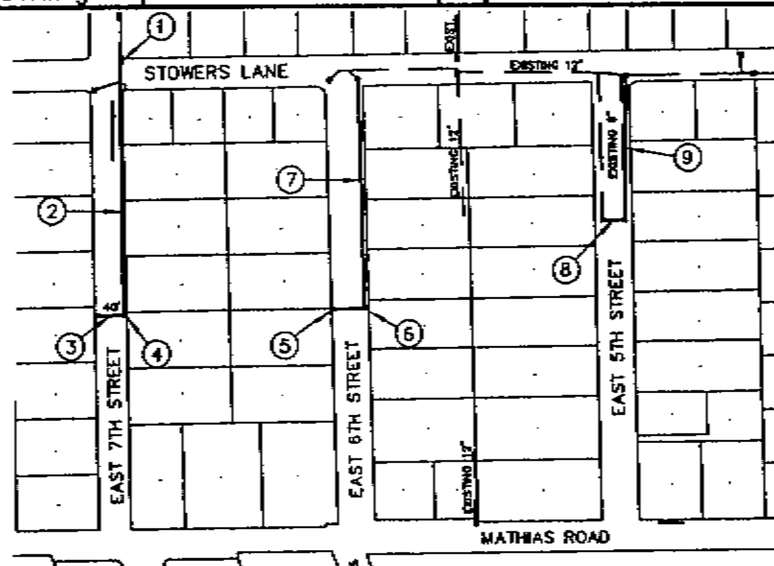
Remarks/Status:

City of Molalla, Oregon
Five Year Capital Improvement Plan

Capital Project Summary

Department:	Public Works		
Project:	Sunrise Acres Drainage Improvements Phase 1	Project Year:	2004-2005

Location Map:



Scope of Work:	Construct drainage improvements East of Stowers Lane between East 5th Street and East 7th Street.
Objective:	To improve drainage in the Sunrise Acres Subdivision.

Preliminary Budget

	Budget Number		Project Funding	
	Cost	Acct.	Amount	Source
Permitting				
Design/Engineering	7,018.50		7,018.50	General Fund
Right-of-Way				
Construction	46,790.00		46,790.00	CDBG Grant
Construction Engineering/Inspection	2,807.40		2,807.40	CDBG Grant
Contingency (10%)	5,661.59		5,661.59	CDBG Grant
Total Cost	62,277.49		62,277.49	

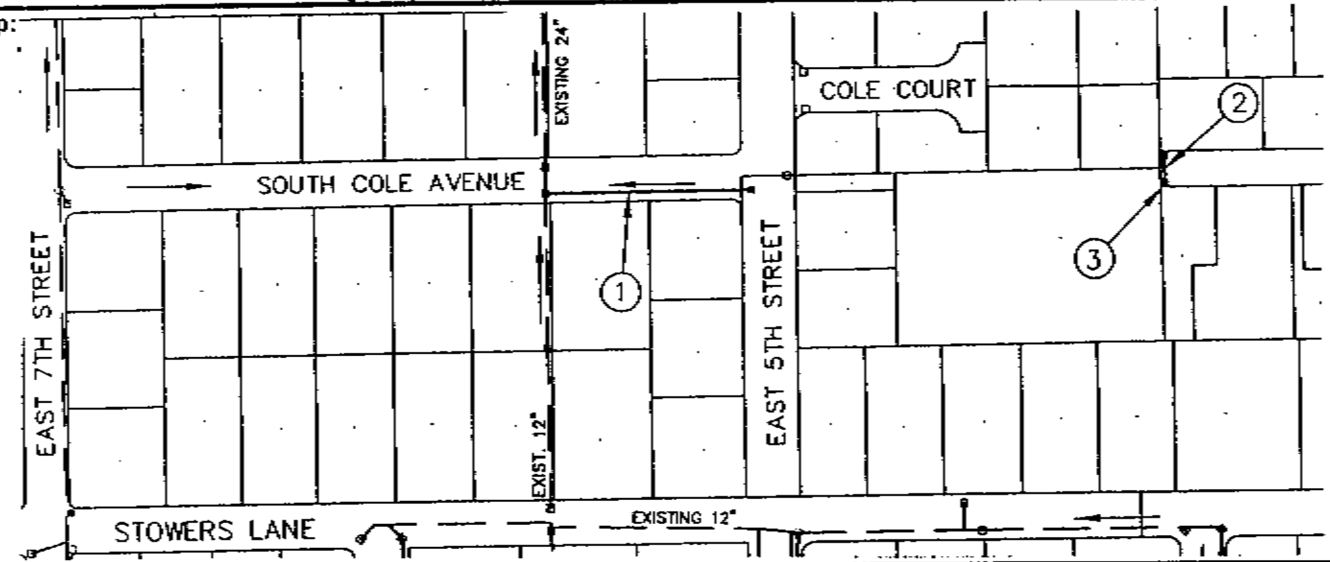
Remarks/Status:

City of Molalla, Oregon
Five Year Capital Improvement Plan

Capital Project Summary

Department:	Public Works
Project:	Sunrise Acres Drainage Improvements Phase 2
Project Year:	2005-2006

Location Map:



Scope of Work: Construct drainage improvements West of Stowers Lane between East 7th Street and East Main Street.

Objective: To improve drainage in the Sunrise Acres Subdivision.

Preliminary Budget

	Budget Number		Project Funding	
	Cost	Acct.	Amount	Source
Permitting				
Design/Engineering	1,893.75		1,893.75	General Fund
Right-of-Way				
Construction	12,625.00		12,625.00	CDBG Grant
Construction Engineering/Inspection	757.50		757.50	CDBG Grant
Contingency (10%)	1,527.63		1,527.63	CDBG Grant
Total Cost	16,803.88		16,803.88	

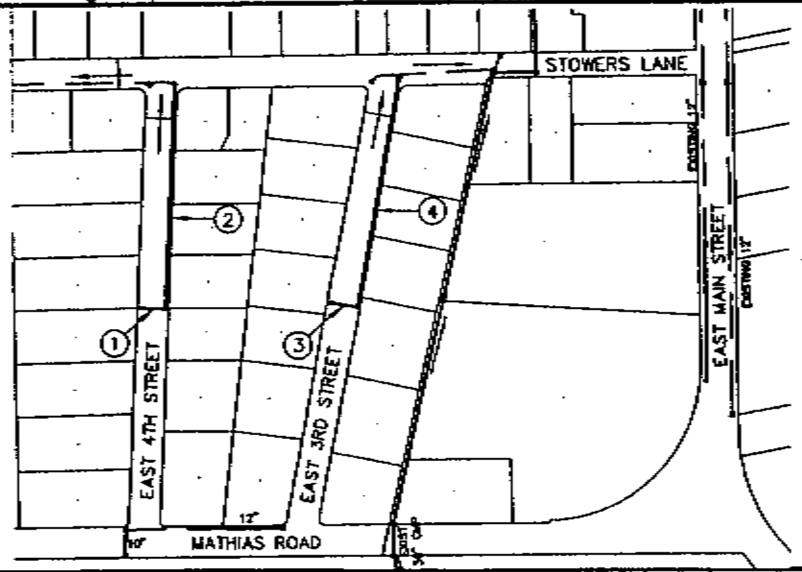
Remarks/Status:

City of Molalla, Oregon
Five Year Capital Improvement Plan

Capital Project Summary

Department:	Public Works		
Project:	Sunrise Acres Drainage Improvements Phase 3	Project Year:	2006-2007

Location Map:



Scope of Work: Construct drainage improvements East of Stowers Lane on East 4th Street and East 5th Street.

Objective: To improve drainage in the Sunrise Acres Subdivision.

Preliminary Budget

	Budget Number		Project Funding	
	Cost	Acct.	Amount	Source
Permitting				
Design/Engineering	4,704.00		4,704.00	General Fund
Right-of-Way				
Construction	31,360.00		31,360.00	CDBG Grant
Construction Engineering/Inspection	1,881.60		1,881.60	CDBG Grant
Contingency (10%)	3,794.56		3,794.56	CDBG Grant
Total Cost	41,740.16		41,740.16	

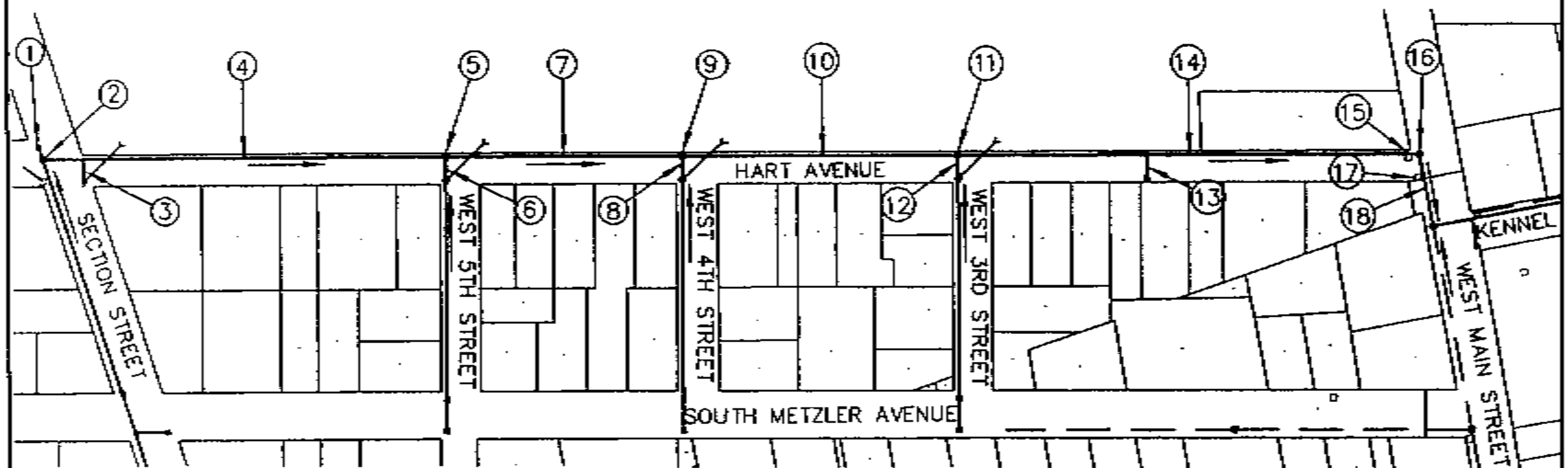
Remarks/Status:

City of Molalla, Oregon
Five Year Capital Improvement Plan

Capital Project Summary

Department:	Public Works		
Project:	Hart Avenue Drainage Improvements	Project Year:	2008-2009

Location Map:



Scope of Work: Construct drainage improvements along Hart Avenue from Section Street to East Main Street.

Objective: To improve drainage on Hart Avenue.

Preliminary Budget

	Budget Number		Project Funding	
	Cost	Acct.	Amount	Source
Permitting				
Design/Engineering	16,833.75		16,833.75	CDBG Grant
Right-of-Way				
Construction	112,225.00		112,225.00	CDBG Grant
Construction Engineering/Inspection	6,733.50		6,733.50	CDBG Grant
Contingency (10%)	13,579.23		13,579.23	CDBG Grant
Total Cost	149,371.48		149,371.48	

Remarks/Status:

EXECUTIVE SUMMARY

The City of Molalla is developing a stormwater master plan to inventory the City's existing drainage system and address existing and potential problems. The City contracted with Tetra Tech/KCM, Inc. to evaluate drainage conditions and future requirements within the City's urban growth boundary (UGB). The master plan identifies existing drainage problems and proposed solutions and recommends future actions by the City and private developers to enhance the City's creek corridors, improve water quality, and handle future storm flows. Wetlands in the City are being inventoried by others concurrently with this study. Together with the wetland inventory, this report will form a comprehensive stormwater plan that addresses natural and man-made elements of the drainage system.

STUDY AREA DESCRIPTION

The City of Molalla is in Clackamas County, approximately 30 miles south of Portland. Highway 213 runs north-south through the west end of the City and Highway 211 runs east-west through the middle. The Molalla River is located just east of the City. The 1,763-acre study area is defined by the existing urban growth boundary (UGB) plus areas outside the UGB that discharge runoff to areas within the UGB are.

The City is primarily zoned residential, with a downtown commercial center and an industrial area in the southwest. Wood-product mills are the largest industries in Molalla; however, significant industrial land exists within the UGB for diversified industrial growth in the future. Lands surrounding Molalla are predominantly used for agricultural purposes. Significant stands of timber are located nearby to the east in the Cascade Range foothills.

The existing UGB is expected to reach buildout (the maximum amount of development allowed by zoning) within the 20-year planning period. Future conditions in this report are defined as the buildout condition.

EXISTING DRAINAGE SYSTEM DESCRIPTION

Creek Systems

Stormwater runoff in the City flows directly to one of three natural systems: the Molalla River, Bear Creek or Creamery Creek. Two branches of Creamery Creek flow through the north end of the City, generally from southeast to northwest, and meet east of Highway 213; Creamery Creek flows into the Molalla River several miles outside the UGB. Bear Creek runs generally parallel to and south of Creamery Creek and eventually flows into the Pudding River. The Pudding River flows into the Molalla River just before the Molalla River enters the Willamette River.

Modeled Storm Sewers and Culverts

Computer modeling of public systems and pipes greater than 8 inches in diameter was performed for this master plan. Models were developed for the storm systems in the Creamery Creek and Bear Creek basins. The area inside the UGB that discharges directly to the Molalla River has no identifiable storm system and therefore was not modeled. The Creamery Creek basin model included culverts; for the Bear Creek basin, culverts were analyzed separately using a culvert program.

Reported Flooding Problems

The City has identified five culverts along Bear Creek that have flooded in recent history. The culvert under Ona Way has been upgraded since reports of flooding and is not expected to flood in the future. The other four culverts are below Highway 213, below Highway 211, below Molalla Avenue and below Mathias Road. Other areas identified with recent flooding are near the Industrial Road and Toliver Road intersection, on Hoyt Street between Dixon and Ridings, the area along Heintz Street east of Ridings, Main Street at Kennel Avenue and at Molalla Avenue, Creamery Creek between Main Street and Stowers Avenue, on Stowers Avenue between 5th Street and 6th Street, and along 5th Street.

Water Quality

The Oregon Department of Environmental Quality (DEQ) has established total maximum daily load (TMDL) limitations for flow, bacteria and temperature on the Molalla River and TMDL limitations for bacteria, temperature and toxics on the Pudding River. At this time, the City of Molalla is not required to regulate stormwater quality, but eventually the City will need to develop methods to reduce the amount of pollutants being discharged through the City's storm system.

DRAINAGE SYSTEM EVALUATION

The hydrology and hydraulics of the City's piped storm system were evaluated using XP-SWMM 2000 for the Creamery Creek basin and urbanized sections of the Bear Creek basin. The Santa Barbara Urban Hydrograph model was used to generate hydrographs for the rest of the Bear Creek basin in the study area, which is open channel with culverts. Culvert hydraulics were evaluated using the program HY-8, developed for the Federal Highway Administration.

Evaluation of the Piped Storm System

The modeling predicts that the following systems are undersized for existing and future land use conditions:

- The main stem of the Creamery Creek system, which enters the City below Mathias Road and travels in an open channel with culverts to north of Highway 211, where it enters a piped storm system. The piped system continues to Heintz Street, Kennel Street, and Toliver Road.
- Five major pipe reaches south of the main pipeline, along Fenton Avenue, Grange Avenue, Center Avenue, Molalla Avenue and Kennel Avenue.
- A large pipe system that comes down Heintz Street.
- The western fork of the Creamery Creek system, from the vicinity of Hoyt Street and Dixon Avenue to a channel north of Toliver Road that travels

through the Big Meadows subdivision and joins the main branch of Creamery Creek north of Big Meadows.

The City's storm system has not experienced all the flooding predicted by the modeling. In developing storm system improvement projects, the highest priority is given to those that address actual past problems. Lower priority is given to measures to address problems predicted by the computer modeling.

Bear Creek Culvert Evaluation

Table ES-1 summarizes results of the evaluation of culverts in the Bear Creek basin. The overtopping flows listed represent the levels at which flow starts passing over the road. Culverts are defined as undersized when their predicted peak flow exceeds the overtopping flow. Some culverts, such as the Bear Creek culvert under Highway 211, were found to have adequate capacity for a 100-year storm. Others, such as the Bear Creek culvert under Mathias Road, have capacities inadequate to pass the 25-year storm.

TABLE ES-1.
CULVERT HYDRAULIC ANALYSIS RESULTS

		Length	Peak Flow (cfs)			Overtopping
Location	Structure	(feet)	25-Year	50-Year	100-Year	Flows (cfs)
Mathias Road	(2) 36" CMP	175	232	266	324	104
Molalla Road	72" x 44" CMPA 60" x 36" CMPA	27 24	311	355	432	203
Ona Way	64" x 42" CMPA (2) 72" x 44" CMPA	30 30	364	415	504	317
Highway 211	6' x 15' Bridge	30	364	415	504	600
North Forest Rd.	(3) 6' x 6' Wooden Box	22	364	415	504	950
Highway 213	(2) 48" RCP (1) 48" CMP	32 45	398	455	552	358
Highway 211	48" CMP	131	63	71	86	99
Forest Road	36" CMP	32	108	124	152	71

CMP = corrugated metal pipe; CMPA = corrugated metal arch pipe; RCP = reinforced concrete pipe; cfs = cubic feet per second

POTENTIAL IMPROVEMENT PROJECTS

Four types of improvements were developed to address identified problems in the City's stormwater system: storm sewer improvements, culvert improvements, creek improvements, and nonstructural improvements. Nonstructural improvements include maintenance programs, regulations, education programs, and other projects that do not address individual problem locations.

Storm Sewer Improvements

All flow from the Creamery Creek system drains into one series of pipes through the middle of downtown. This pipeline is shallow, undersized and nearing the end of its design life. Replacing this line with adequately sized pipe at a proper depth would be difficult and expensive. The alignment of an old railroad that is in the process of being removed is conveniently located to allow the construction of a new drainage channel that would relieve capacity problems on the Creamery Creek main system. If the railroad right of way is available and not cost-prohibitive, then system improvements throughout the basin could discharge to this new drainage channel. The following projects were developed for addressing the deficiencies in this central pipeline:

- **2nd Street Relief Project**—A new storm system along 2nd Street is proposed to relieve excess flows in the existing Grange Avenue, Center Avenue, Molalla Avenue and Kennel Avenue storm systems and to allow for increased future storm runoff. Two alternatives were developed:
  - Alternative 1, 2nd Street/Railroad Alignment Storm System—This alternative, which is recommended if the railroad alignment is available and not cost-prohibitive, has an estimated cost of $1.23 million.
  - Alternative 2, 2nd Street/Kennel Avenue Storm System—This alternative, which is recommended if the railroad alignment is not available or its use is cost-prohibitive, has an estimated cost of $1.4 million:
- **Heintz Street Collector Replacement Project**——This project is to intercept Creamery Creek at the south end of Indian Oak Court and divert the creek down to Heintz Street. A new pipe would then be constructed down Heintz Street to the corner of Kennel Avenue and Heintz Street. The estimated cost of the project is $1.2 million.
- **Heintz Street Outfall Project**—If the old railway alignment is not obtainable, the storm systems downstream of Kennel Avenue and Heintz Street will need to be upgraded. This will require a new system from this intersection down to Toliver Road. The estimated cost of the project is $570,000.
- **Detention Pond at Mathias Avenue and Creamery Creek**—A detention pond to store storm flows upstream of Mathias Avenue could reduce or eliminate flooding downstream along Creamery Creek. The estimated cost of the project is $96,000, not including the cost of easements. This project could reduce the cost of the Heintz Street Outfall and Heintz Street Collector projects by allowing the use of smaller pipes for those projects.
- **Industrial Way**—If flooding near Industrial Way along Toliver Road persists, the existing 36-inch pipe would need to be upgraded to a 48-inch pipe. The estimated cost of the project is $51,000. The upgrade should be implemented only if a persistent problem is noted.

- **Shirley Street Drainage Improvements—**These improvements would allow the drainage system on Shirley Street to discharge to the proposed Heintz Street system. Implementing these improvements would eliminate the need for one project included in the City's existing stormwater CIP. The estimated cost of the project is $91,000.
- **Dixon Avenue Improvements**— Recent channel improvements along Hoyt Street may have solved reported flooding problems in this area, so this area should be monitored to determine the need for further improvements. Drainage improvements along Dixon Avenue could be developed as part of a long-term plan when this area is developed. The estimated cost of the project is $139,000.

Implementing the improvements described above, as well as others currently planned by the City, could allow many projects in the City's existing 10-year stormwater capital improvement program (CIP) to be eliminated.

Culvert Improvements

The following Bear Creek culverts were identified for potential improvement, based on existing flooding problems or the potential for flooding in the future:

- **Bear Creek at Mathias Road**—Replace two 36-inch corrugated metal pipes (CMPs) with a 12-foot span bridge or arch span with a natural creek bottom. The estimated cost of the project is $280,000.
- **Bear Creek at Molalla Avenue**—Replace two arch CMPs with a 14-foot span bridge or arch span with a natural creek bottom. The estimated cost of the project is $300,000.
- **Bear Creek at Ona Way**—Replace two arch CMPs with a 15-foot span bridge with a natural creek bottom. The estimated cost of the project is $320,000.
- **Bear Creek at Highway 213**—Replace two arch CMPs with an 18-foot span bridge with a natural creek bottom. The estimated cost of the project is $350,000.

Many culverts in the City have adequate flow capacity but could be improved for fish passage and habitat; these are not included in the list of improvements. When new culverts or culvert replacements are proposed along Bear Creek, the design review should include fish passage in accordance with Oregon Department of Fish and Wildlife guidelines.

Creek Improvements

Enhancement of creek corridors has the effect of protecting property, protecting and enhancing water quality, and enhancing riparian habitat. Opportunities to look for include the following types of projects:

- **Channel Stabilization**—Stabilize streambeds and streambanks to protect property and infrastructure and alleviate sedimentation problems.

- **Riparian Corridor Restoration**—Restore natural plant communities as much as practical to reduce stream temperature and sedimentation and to restore riparian wildlife habitat.
- **Community-Based Enhancement**—Provide water quality benefits and riparian habitat enhancements through local neighborhood improvements using volunteer involvement with some City resources. The focus of these projects is to eliminate blackberry and other invasive exotic plants and to plant desirable native species that will reestablish the riparian forest canopy and wildlife habitat.
- **Protection from Future Development**—Protect existing riparian corridors and native vegetation by implementing stream buffer zone regulations in areas where future development might occur.

Nonstructural Measures

Nonstructural alternatives consist of regulations, operation and maintenance activities, and public education. Their costs vary with the level of complexity at which they are implemented and often can be passed on to developers, so cost estimates are not included with these recommendations. The following nonstructural measures were identified as part of this master plan:

- Periodically review stormwater standards in the City's published Design Standards. This would allow developers guidance when designing a project.
- Develop and implement an inspection and maintenance plan for all drainageways, catchbasins, drainage channels, detention facilities, flow control structures, and pump stations.
- Outline maintenance operations to clean catchbasins, remove channel debris, clear culvert obstructions, remove sediment from detention facilities, plant vegetation to control channel erosion, remove intrusive vegetation to increase channel conveyance capacity, and remove trash.
- Adopt stream dumping regulations and inform residents about the regulations and how to report violations.

CAPITAL IMPROVEMENT PROGRAM

The improvement projects described above and summarized in Table ES-1 make up the proposed new stormwater CIP. The CIP includes a priority for each project as follows:

- High priority—Projects that have an immediate, regional benefit, or resolve an existing observed problem.
- Medium priority—Projects that meet overall goals and objectives but require private land or private cooperation for implementation.
- Low priority—Projects that are needed in conjunction with future land development according to local Comprehensive Plan zoning. Projects that resolve future problems identified by system analysis.

TABLE ES-2.
CAPITAL IMPROVEMENT PROJECTS

Project	Estimated Cost	Priority
2nd Street/Railway Alignment Storm System	$1,230,000	High
Detention Pond at Mathias Avenue and Creamery Creek	$96,000	High
Heintz Street Collector Replacement Project	$1,200, 000	Medium
Shirley Street Drainage Improvements	$91,000	Medium
Miller Street Drainage Improvements	$45,480	Medium
Sunrise Acres Drainage Improvements	$41,740	Medium
Bear Creek at Molalla Avenue Culvert Replacement	County Road	Medium
Bear Creek at Highway 213 Culvert Replacement	State Road	Medium
Bear Creek at Mathias Culvert Replacement	County Road	Low
Bear Creek at Ona Way Culvert Replacement	County Road	Low
Industrial Way Stormwater Improvements		Monitor
Dixon Avenue Drainage Improvements		Monitor

- No action—Projects to address problems identified by the analysis process that don't present a threat to property. If the problem is identified by complaints in the future, then it should be addressed.
- Internal—Projects that can be conducted by City staff with no external cost.

High priority projects should be implemented within five years, medium priority projects in five to 10 years, and low priority projects in 10 to 20. No-action projects and internal projects are not included in the CIP phasing plan.

The Shirley Street Project should be constructed concurrently or following the completion of the Heintz Street Collector Replacement Project. The remaining projects are independent and can be moved in priority depending on flooding problems or opportunities to combine with other projects.

FUNDING ALTERNATIVES

Following the adoption of this master plan, an evaluation of financing techniques and a re-calibration of the City's stormwater service charges will be required. This will provide the revenue to implement the CIP outlined in this document. Other options for funding the improvements include general obligation bonds, revenue bonds, state or federal grants and loans and system development charges.