

TECHNICAL MEMORANDUM



TM 3.10 – Long-Term Conveyance Plan

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INTRODUCTION

The City of Bend (City) sanitary sewer collection system was constructed in the late 1970's. The system consists of 330 miles of gravity sewer, 87 miles of pressure sewer and 82 pump stations that are maintained by City staff. There is a core system of gravity sewers that flow to the northeast area of the City to an interceptor of approximately five miles in length that transports the wastewater to the Wastewater Reclamation Facility. The collection system on the west side of the Deschutes River flows to the Westside Pump Station where the wastewater is then pumped across the Deschutes River to the gravity system on the east side of the river.

The City has grown from a population of 17,300 in 1980 to 70,330 in 2005. Over this period the wastewater collection system has been expanded as areas are developed. These expansions have connected to the original core system. Much of this expansion has incorporated pump stations to avoid deep sewer construction. All new sewers were oriented to discharge to the core area and ultimately flow through the plant interceptor to the Wastewater Reclamation Facility. Due to the extraordinary growth the City has experienced, major revisions to the system must be made. Primary among these is the creation of a framework of interceptors that will accommodate growth with a gravity collection system and relieve the core area system deficiencies. These include:

- The plant interceptor is reaching capacity and will not be able to meet the future wastewater flows that will be generated by the growing system
- Many of the sewers in the existing core system are already at capacity
- Many of the service areas that are being served by pump stations have caused a barrier to system development on the expanding periphery of the City
- The Westside pump station and collection system is limited in its capacity to serve the developing areas on the west side of the City
- The large number of pump stations have become an Operations and Maintenance (O&M) burden on City staff resulting in increased O&M costs

These issues are the primary focus of the 2006 Collection System Master Plan.

The Master Plan is a Long-term Conveyance Plan that has been developed to provide adequate capacity in the collection system at build-out of the existing Urban Growth Boundary (UGB) and Urban Reserve Area (UAR). The plan assumes that all treatment will be done on the existing treatment plant site and that gravity collection systems will be encouraged to eliminate pump stations wherever possible. This plan has three distinct elements. These are construction of new gravity interceptors, pump station upgrades and removal and providing correction of capacity deficiencies in the existing gravity system.

BACKGROUND

This Technical Memorandum (TM) provides the results of all of the planning that has been done to date. This planning effort has been done in three tasks:

- Task 1 was the model development phase of planning. During this task the current and future service areas of the City were divided into sewer drainage basins and sub-basins and a dynamic model of the existing collection system was developed and calibrated. This model has been used to evaluate system capacity under existing flows as well as in a variety of planning scenarios that were evaluated to determine the final plan. One of the outcomes of Task 1 was the identification of capacity limitations that currently exist in the system as well as the new limitations that will occur as the City population grows to build-out densities.
- Task 2 developed a concept plan for North and Southeast (SE) Interceptors. A preliminary report for each interceptor was developed providing an alternative alignment for each interceptor. This work demonstrated that with the construction of these two interceptors many of the capacity limitations in the existing system can be mitigated.
- Task 3, which is the actual development of the Master Plan. Using the planning criteria developed earlier, wastewater generated by future development throughout the service area was accounted for and service alternatives were developed. An evaluation of the alternatives was performed and the preferred options were refined and documented.

In Task 3, a more detailed look at the major interceptor alignments was performed. This allowed for refinement of the conceptual work performed in Task 2. The vertical alignments were developed to be sure that gravity service can be provided wherever possible. In several cases, options for service to individual sub-basins were developed. This refinement of the interceptor concept also provided the basis for a more detailed cost estimate and a long-term conveyance plan that can be incorporated into the 2006 Collection System Master Plan. The new interceptors will provide these basic functions:

- Provide sanitary service to the Juniper Ridge and north Bend drainage basins
- Provide sanitary service to the SE Bend drainage basins
- Reroute flows away from the downtown core area of Bend relieving current and projected future capacity deficiencies
- Provide system capacity necessary to allow the growth of sanitary service to portions of Bend west of the Deschutes River
- Provide a second (parallel) interceptor to the treatment plant providing additional capacity and system redundancy
- Provide a means to remove pump stations from service by providing gravity sewer service wherever possible

The planning work that was performed in Task 3 has been documented in nine technical memos (TM). This technical memorandum (TM 3-10, Long-Term Conveyance Plan) summarizes the results and recommendations put forth in the other TMs. This Long-term Conveyance Plan is the Master Plan that the City will follow as they continue to grow and expand the collection system.

A planning level cost estimate has been developed for each of the projects identified in the Master Plan. All cost estimates are in 2006 dollars based on an ENR-CCI of 8449. Local

construction factors were applied to the cost estimates to the greatest extent possible. A detailed summary of the basis for all cost estimates is provided in TM 3.6 – Cost Criteria.

PLANNING STUDY AREA

The planning area for this project consists of two areas that are defined in the 1998 Bend Area General Plan. The two areas consist of the area bound by the City Limits (or Urban Growth Boundary, UGB) and the Urban Reserve Area (UAR). The planning area for the Master Plan is shown in *Figure 1*. In addition, there are three other areas that are also included in the Master Plan. The three additional areas include: Juniper Ridge, Section 11, and a west side destination resort known as “**Tetherow**.”

There are 21,241 acres within the current UGB. An additional 8,443 acres are in the UAR or are areas served not in the UGB or UAR (i.e. Widgi Creek). It is important to consider the UAR in the planning effort, as there may be specific instances where construction of new interceptors can serve future areas will be the most cost-effective long-term solution for the City.

INTERCEPTOR MASTER PLAN

The interceptor master plan recommends the construction of four new gravity interceptors. These new interceptors will provide the following basic functions:

- Provide sanitary service to the Juniper Ridge and north Bend areas
- Provide sanitary service to the SE Bend areas
- Reroute flows away from the downtown core area of Bend relieving current and future capacity deficiencies
- Provide system capacity necessary to allow the growth of sanitary service to portions of Bend west of the Deschutes River
- Provide a second interceptor to the treatment plant providing additional capacity
- Provide a means to remove pump stations from service, wherever possible

The cost to construct these interceptors will be a considerable investment for the residents of the City. In order to manage cash flow, the City may need to construct these lines as areas develop and the additional sanitary service is required. For this reason, each interceptor has been divided into multiple capital projects to provide the City with an opportunity to construct each interceptor using a phased construction approach.

The Master Plan consists of four new gravity interceptors. The function of each of these interceptors is:

- Plant Interceptor – New parallel plant interceptor to provide additional capacity from the City to the Wastewater Reclamation Facility
- North Interceptor – Service to the new Juniper Ridge Development, future north Bend development and service to the northwest areas of Bend reducing flows through the Westside Pump Station Basin

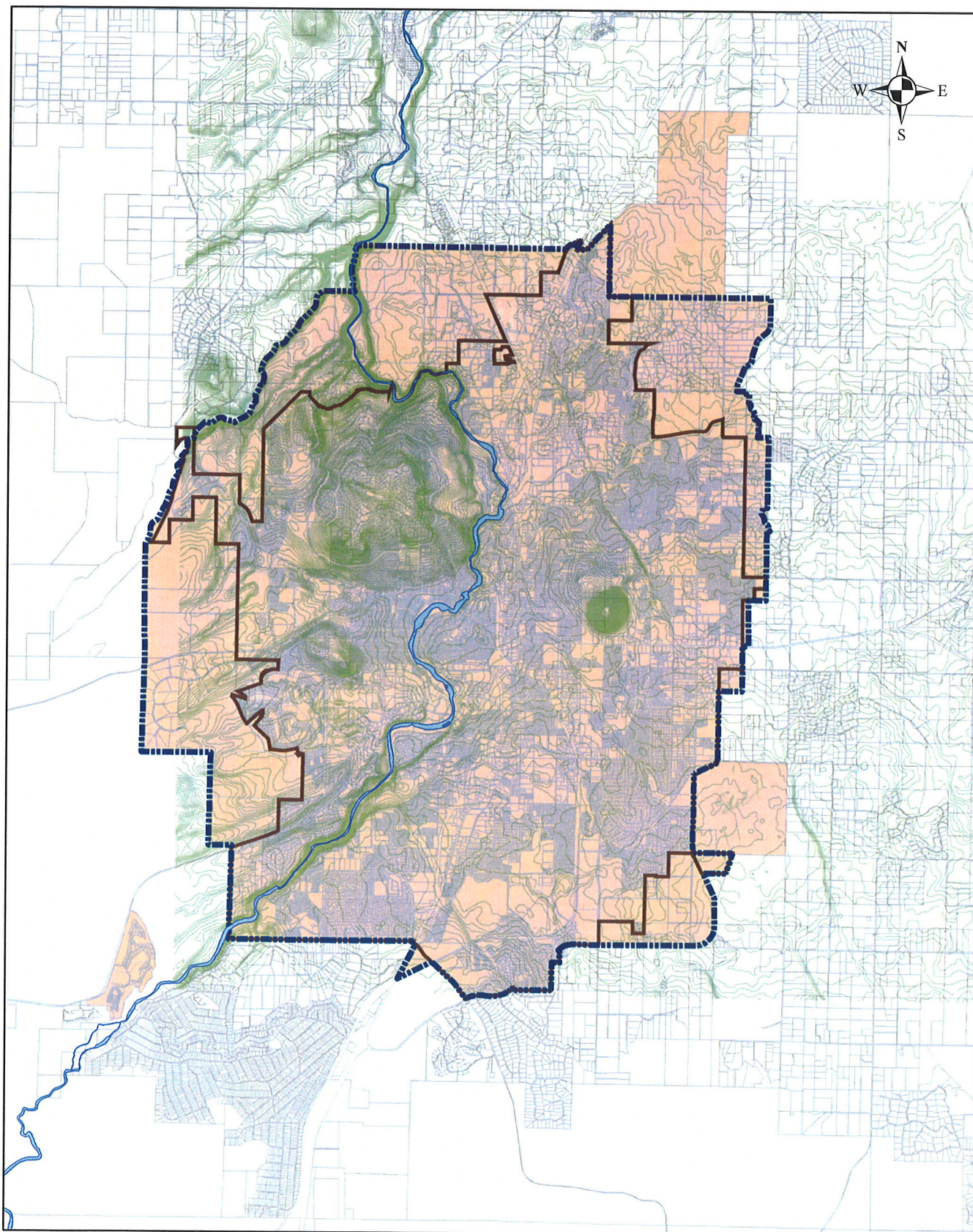


FIGURE 1
MASTER PLAN STUDY AREA

- SE Interceptor – Service to unsewered areas and new development in the southeast and south Bend areas, relief of flows through the Murphy Road Pump Station (old Juniper Ridge Utility) and relief of flows from the SW Bend areas west of the Deschutes River
- Westside Interceptor – Rerouting the flows discharged from the Westside Pump Station, Sawyer Park Pump Station and Wyndemere Pump Station to relieve the core area system by diverting these flows out of the core to the North Interceptor.

A recommended alignment has been developed for each of these four interceptors. In addition, sizing and the development of a cost estimate to construct each of the interceptors has been developed. A description of each of these interceptors is summarized in the following sections. The conceptual alignment of each of the four interceptors is shown in *Figure 2*. An itemized cost estimate for each of the interceptors is provided in *Attachment A*.

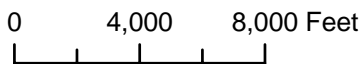
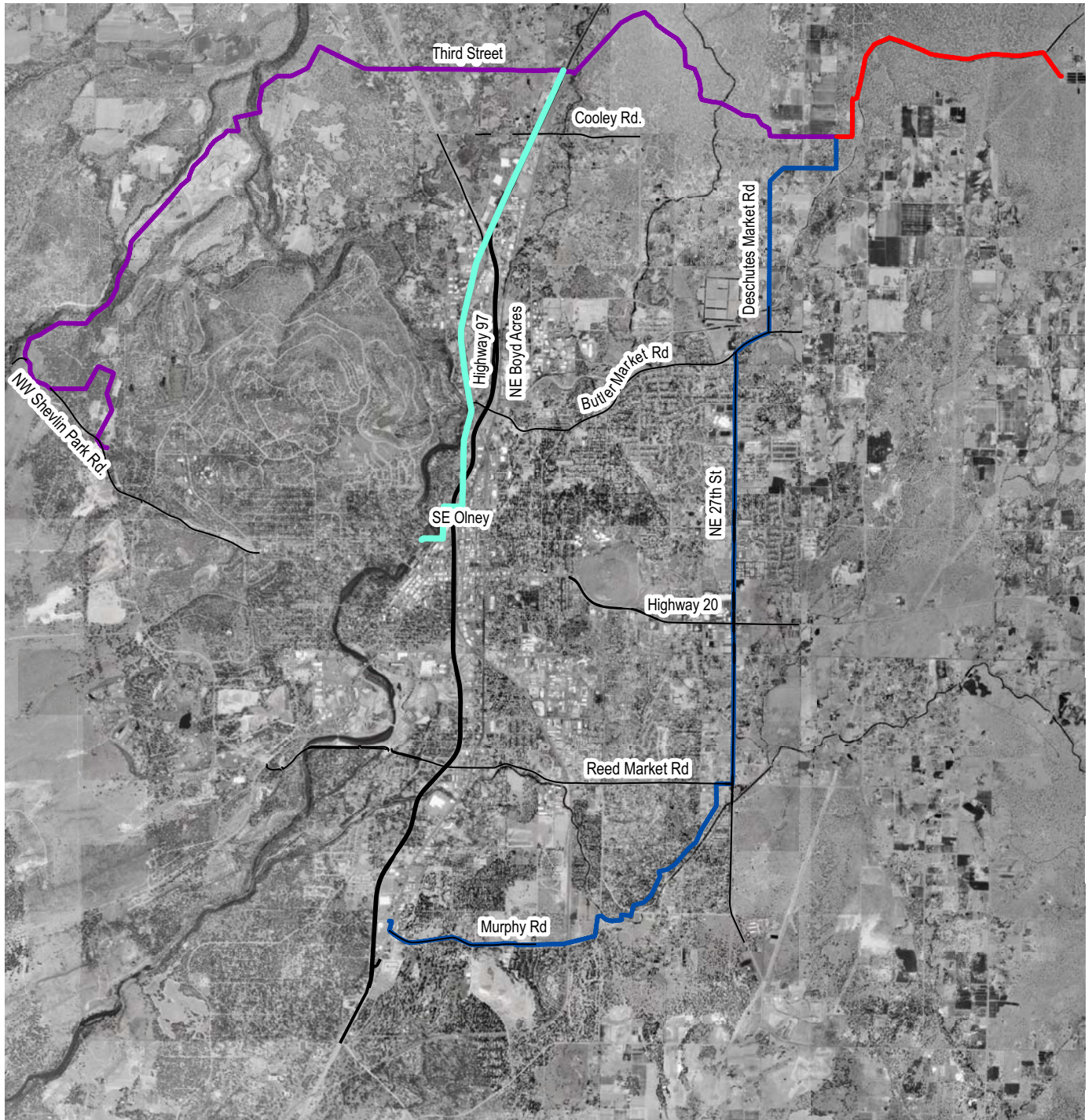
Plant Interceptor

The existing plant interceptor is currently limited to a peak hydraulic flow of 20 to 22-mgd. The City is currently designing new headworks for the Wastewater Reclamation Facility (WRF). Included with this design is a new distribution box. The plant interceptor alignment is shown on *Figure 3*.

The existing plant interceptor is a gravity interceptor varying in diameters between 30, 36 and 42-inches in diameter, depending on slope, that parallels the NUID main canal on the north side to a siphon box about 5,100-feet upstream of the plant. At that point, the system becomes pressurized (an inverted siphon) and flow continues through two pipes, one a 21-inch and one a 36-inch. The flow then goes under the NUID main canal to the treatment plant. At the treatment plant, these two lines combine into one 30-inch line that takes the flow to the headworks. This 30-inch line limits the flow to the headworks structure.

The new plant interceptor will take flow through a 48-inch gravity sewer to an expanded inverted siphon structure. A new 48-inch siphon line will parallel the two existing inverted siphons to the treatment plant. The existing 30-inch line will be decommissioned and each of the three inverted siphon lines will be connected to the new distribution box. This new interceptor arrangement will provide a peak hydraulic capacity of up to 68-mgd which will meet the build-out flows for the current planning area. The new plant interceptor will parallel the existing line to Pioneer Loop Road. At this point, the interceptor will follow Pioneer Loop Road to Margaret Lane. The plant interceptor terminates at station 130+94 at the intersection of Margaret Lane and Pioneer Loop Road.

This new plant interceptor consists of three distinct elements. These are (1) the inverted siphon, (2) the siphon box and (3) the 48-inch interceptor from the siphon box to the junction with the North Interceptor and SE Interceptor. The estimated cost for the Plant Interceptor is \$9.45 Million (M). An itemized summary of the cost estimate is provided in *Table A1* in *Attachment A*.

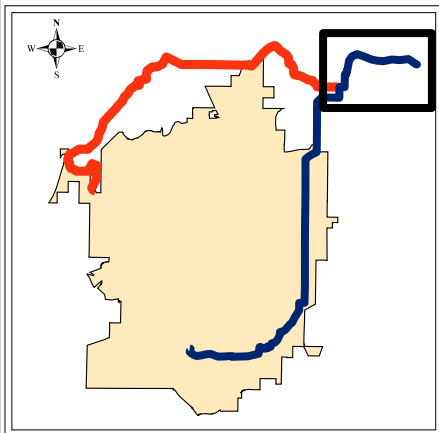


- Plant Interceptor
- Southeast Interceptor
- North Interceptor
- Westside Interceptor Preferred Alternative



Figure 2
Interceptor Plan





- SE Interceptor
- North Interceptor
- Existing Lines

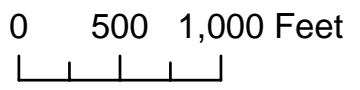


Figure 3
Plant Interceptor



North Interceptor

The North Interceptor takes flow from the northwest areas of Bend near Shevlin Park, around Awbrey Butte on the northern border of the Urban Area Reserve (UAR) to the Deschutes River. Raw wastewater is then pumped across the Deschutes River to continue by gravity on the northern border of the UAR to Highway 97. The alignment then crosses the new Juniper Ridge development to its downstream terminus at the South end of the new Plant Interceptor. The interceptor has been divided into four parts:

- Plant Interceptor to Highway 97 – Provides service to Juniper Ridge Development and accepts flow from new Westside Interceptor
- Highway 97 to Deschutes River – Provides service to undeveloped north areas of City
- North Interceptor Pump Station and Force Main – Provides the transmission of flow across the Deschutes River canyon
- Deschutes River to Shevlin Park – Provides service to undeveloped northwest areas of City and provides opportunity to remove Awbrey Glen and Shevlin Commons Pump Stations from service

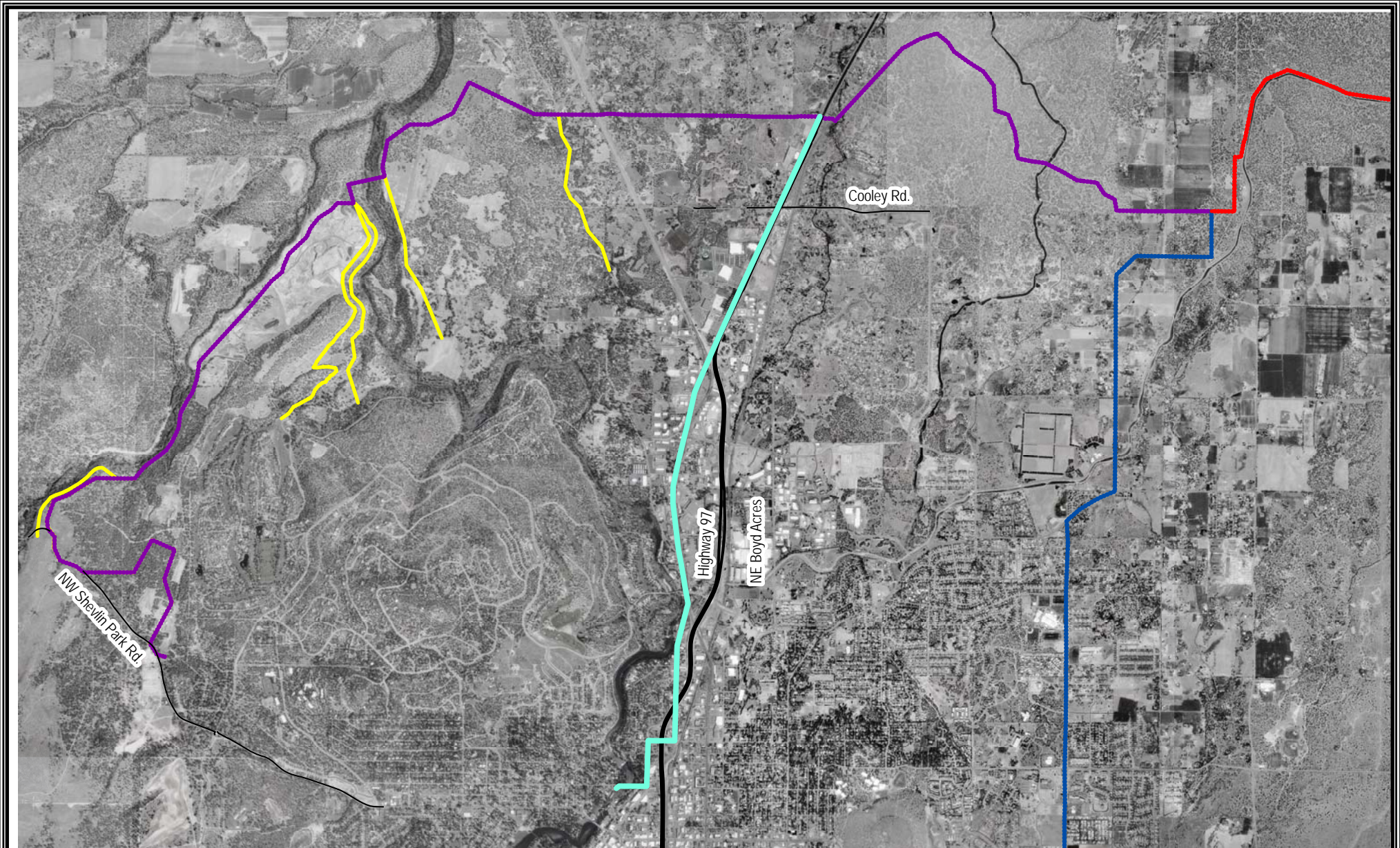
The recommended alignment is shown in **Figure 4**. The estimated cost for the Plant Interceptor is \$25.0M (excludes \$4.8M for trunk lines 1 through 5). An itemized summary of the cost estimate is provided in **Table A2** in **Attachment A**.

SE Interceptor

The SE Interceptor takes flow from the east, southeast, southwest and south areas of Bend. The recommended alignment goes east from the intersection of Highway 97 and Murphy Road to SE 15th Street. It then turns north up SE 15th to the Central Oregon Irrigation District (COID) canal where it goes through a neighborhood paralleling the canal on the north side of the canal to Reed Market Road and 27th Street. It then goes north in the 27th Street right-of-way to Butler Market Road, following Butler Market Road where it intersects with the North Interceptor and discharges into the Plant Interceptor.

The SE Interceptor has been divided into five parts:

- Plant Interceptor to Highway 20 – Provides service to undeveloped areas on the west side of Butler Market Road, sub-basins east of SE 27th Street and sub-basins currently in the UAR on the east side of Study Area 9
- Highway 20 to Reed Market Road – Follows the right-of-way on SE 27th Street taking existing flow from developed and undeveloped areas east and west of SE 27th Street.
- Reed Market Road to SE 15th Street – Parallels the COID canal on the north side of the canal within local street rights-of-ways providing service to the unsewered area to the north of the canal between SE 15th and SE 27th Streets.
- SE 15th Street to Murphy Road Pump Station - Provides for the decommissioning of the Murphy Road Pump Station and redirecting the flow from the Murphy Road Pump Station (old Juniper Utilities) away from the downtown core system



- North Interceptor
- Southeast Interceptor
- Plant Interceptor
- Trunk Sewers
- Westside Interceptor Preferred Alternative

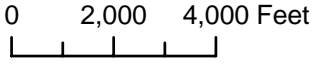
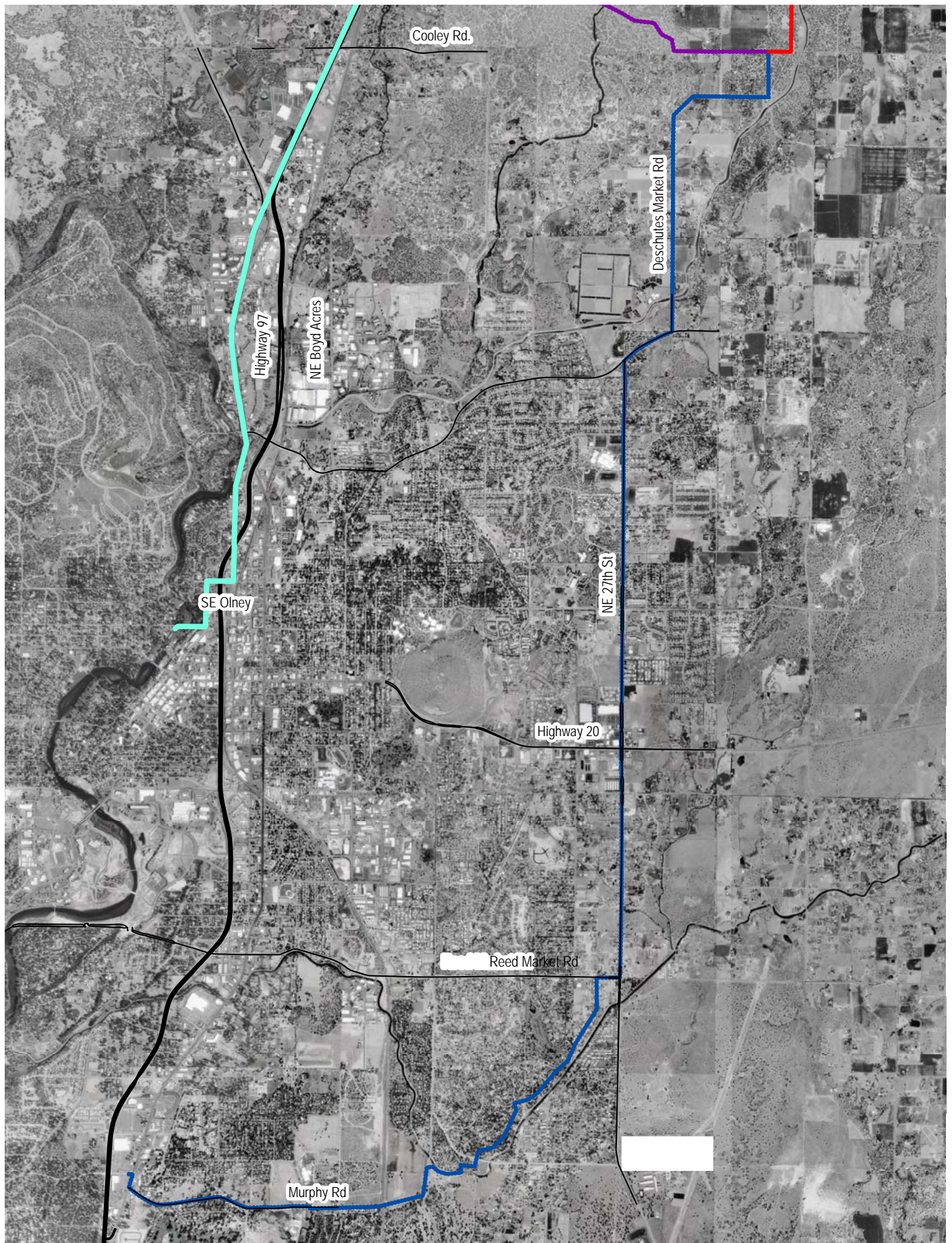


Figure 4
North Interceptor





- Junction to Plant
 - Southeast Interceptor
 - North Interceptor
 - Westside Interceptor Preferred Alternative
- 0 2,000 4,000 Feet
-

Figure 5
City of Bend
Southeast Interceptor



- Murphy Road Pump Station to Highway 97 – Connects to the existing gravity sewer serving the south and southwest Bend area redirecting flows away from the downtown core system

The recommended alignment is shown in *Figure 5*. The estimated cost for the SE Interceptor is \$19.03M. An itemized summary of the cost estimate is provided in *Table A3* in *Attachment A*.

Westside Interceptor

The Westside Interceptor redirects the flow from the Westside Pump Station to the North Interceptor providing capacity relief for the downtown core system. Raw wastewater is pumped from the Westside pump station to a gravity interceptor that discharges into the North Interceptor as the latter crosses Highway 97 on the north end of the City. This interceptor will also receive flow from the Sawyer Park and Wyndemere Pump Stations. This will relieve many of the capacity restrictions that exist now and in the future in the NE Bend gravity system.

Two alignments have been proposed for this interceptor. These alignments are shown in *Figure 6*. An alternative alignment to the preferred alignment is shown as the Alternative 1 alignment. Additional evaluation of a final alignment should be performed by the City during predesign of this interceptor. Factors such as traffic management and utility coordination will determine the best final alignment. One possible alternative alignment is to follow the preferred alternative alignment to the intersection with Highway 20, then go east to the Alternative 1 alignment and follow it to the North Interceptor. This alternative will allow for some pump stations to be removed earlier and will eliminate other projects that will be required along NE Vogt Street. The final alignment of the interceptor will be somewhere between the two alternatives shown in *Figure 6*.

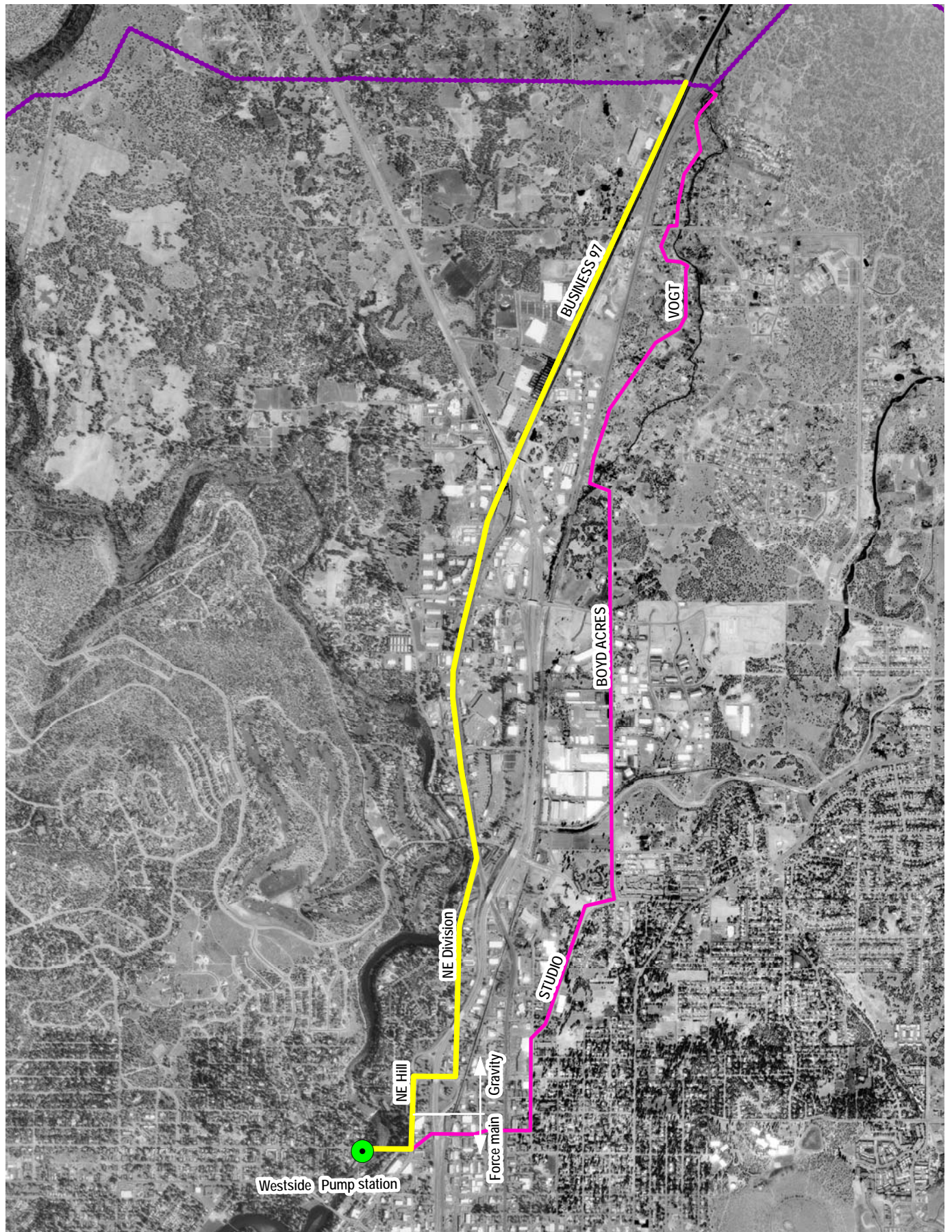
The estimated cost of the complete Westside Interceptor is \$9.07M. An itemized summary of the cost estimate is provided in *Table A4* in *Attachment A*. This cost estimate is based on the preferred Alternative 2 alignment.

Preferred Westside Alternative

The preferred Westside Interceptor alignment is the westerly alternative. In this alternative, the alignment crosses the river on the NW Portland Avenue bridge and turns north on NW Hill Street. The alignment then follows NW Hill Street north to NE Revere Avenue where it turns east to Division Street. The alignment then turns north onto Division Street and follows Division Street north until it intersects with 3rd Street. It then follows 3rd Street north to Business 97, then follows Highway 97 north to where it intersects and discharges into the North Interceptor.

PUMP STATION CAPITAL PROJECTS

Capital improvement projects will be required to upgrade the capacity of some of the existing pump stations due to population growth in the selected station's service area. As other capital projects are being performed, the removal of existing stations from service will be allowed.



0 1,000 2,000 4,000 Feet

- Westside Alternative 1
- North Interceptor
- Westside Interceptor Preferred Alternative

FIGURE 6

WESTSIDE INTERCEPTOR ALIGNMENTS



Required Pump Station Capacity Improvements

Some of the pump stations do not meet the projected capacity requirements for their service areas. This is due to a variety of factors including:

- Expansion of the original station service area
- Increase in the density of dwelling units
- Changes in zoning

Whatever the factor may be, capacity improvements will be required on numerous pump stations in the system. The exact timeframe for capacity improvement is unknown. The timing cannot be estimated because specific growth rates of the selected areas have not been established. However, this process of reaching capacity can be charted. As flows to the station increase and pump starts begin to exceed 4-per hour or capacity cannot maintain the upper wet well levels during diurnal peaks, plans for capacity improvements should be underway. For this reason, the City staff should monitor development activity within each pump station basin including tracking of the run times of each station to determine when specific stations are reaching their design capacity.

The stations requiring a capacity increase prior to the build-out of their service area are listed in *Table 1*. These stations are shown on *Figure 7*. The estimated cost for all pump station improvements is \$8.0 Million (M). A more detailed description of the basis for the required upgrades is discussed in TM 3.8 – Pump Station Master Plan.

Removing Pump Stations from Service

Out of an existing eighty-two (82) pump stations, twenty (20) pump stations can be removed from service by constructing a gravity trunk to an existing gravity system or to one of the new gravity interceptors that will be constructed as part of the Master Plan. A summary of the stations that can be removed from service with their associated removal costs are listed in *Table 2*. The estimated cost for removal of the 20 pump stations is \$3.5 Million (M). These stations are shown on *Figure 8*. A detailed description of the basis for the required upgrades is discussed further in TM 3.8 – Pump Station Master Plan. Included in the analysis for the removal of each station is a 20 and 50-year Present Value Analysis comparing the continued operation of each pump station to the cost of removing the station. In each situation, it was cost effective over a 50-year analysis to remove the station. In all but a few instances, the 20-year present worth analysis showed that it is cost effective to remove the station from service.

Table 1
Pump Stations Requiring Improvements

Study Area	Station Name	Station Capacity (gpm)		Required Improvements	Project Cost (\$x1000)
		Existing	Build-out		
1	Shevlin Commons	118	200	Increase pumping capacity and construct new force main	\$889
2	Awbrey Glen	450	1747	Increase pumping capacity, construct new force main and improve downstream gravity sewers	\$2,531 ¹
2	Shevlin Meadows	145	464	Increase pumping capacity and includes odor control	\$91
2	Westside Regional	3600	10,800	Build new pump station	\$3,770 ²
3	Sunrise Village #1	250	660	Increase pumping capacity	\$80
3	Wigi Creek	297 ³	420	Evaluate system to determine cause of capacity limitation	\$15
5	Deschutes Co. Jail	115	130	Evaluate RDII and increase pumping capacity, if required.	\$25
5	Empire	50	100	Increase pumping capacity	\$25
6	Drake	650	500	Replace pump station with new 500-gpm station	\$363
7	Desert Skies	95	175	Increase pumping capacity	\$31
7	Nottingham #2	55	200	Increase pumping capacity	\$31
8	Deschutes River Crossing	148	100	Reduce pumping capacity to 100-gpm when pumps are replaced	NA
8	Old Mill	300	600	Increase pumping capacity and evaluate installation of VFDs	\$60
8	River Rim	150	200	Increase pumping capacity	\$40
8	South Village	265	330	Increase pumping capacity	\$25
8	Tri-Peaks	120	150	Increase pumping capacity	\$25
	Total Cost				\$8,001

Note 1: Awbrey Glen pump station cost does not include \$508,000 cost to upgrade downstream gravity lines, because this cost was included as Capital Project 2-15.

Note 3: Westside Regional cost is for pump station only; cost of associated forcemain is addressed in the Westside Interceptor section in order to avoid “double counting” when costs are summed.

Note 3: Wigi Creek actual measured capacity is 297-gpm. Design capacity is 450-gpm.

NA: Not Applicable; costs for this removal associated with routine maintenance.

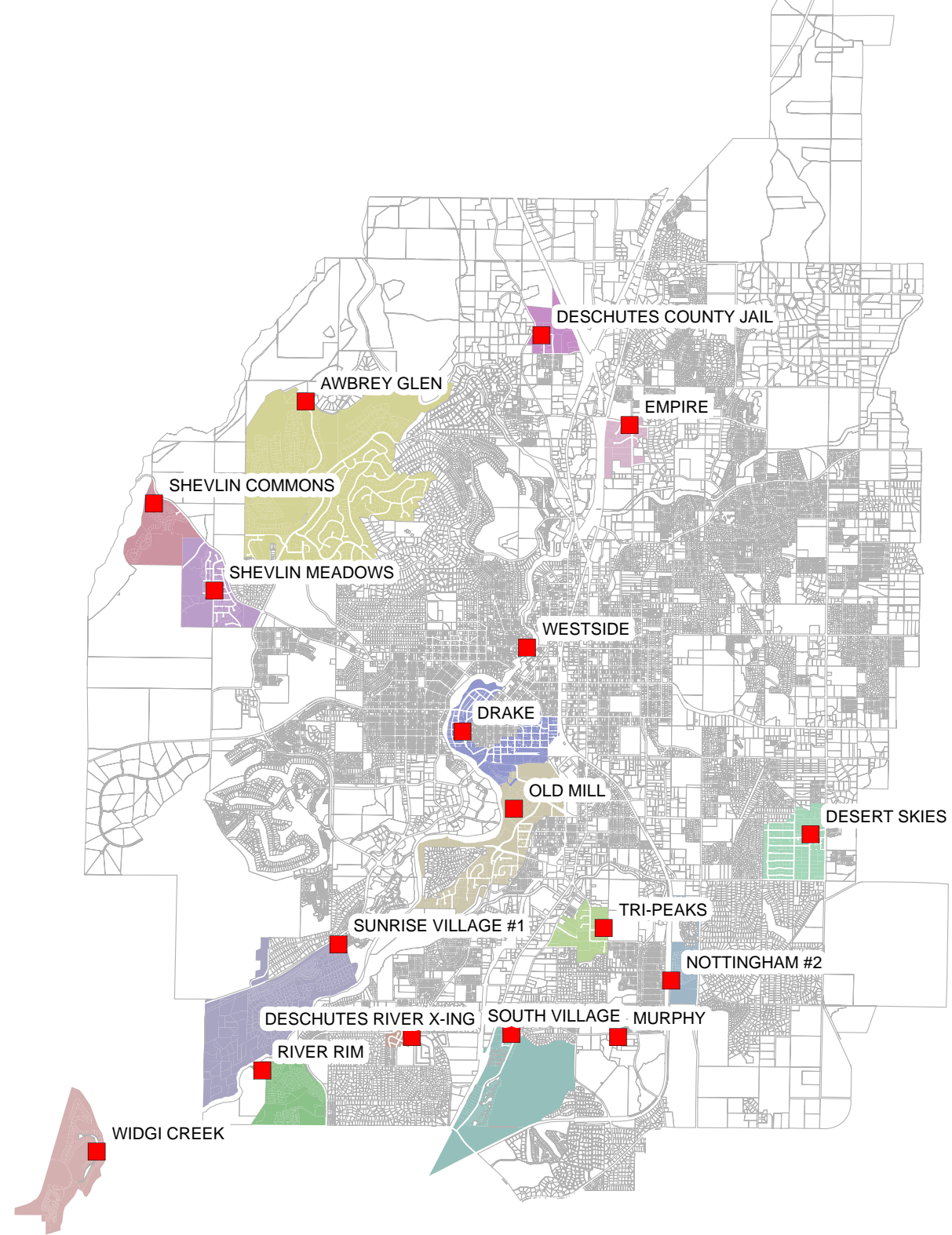
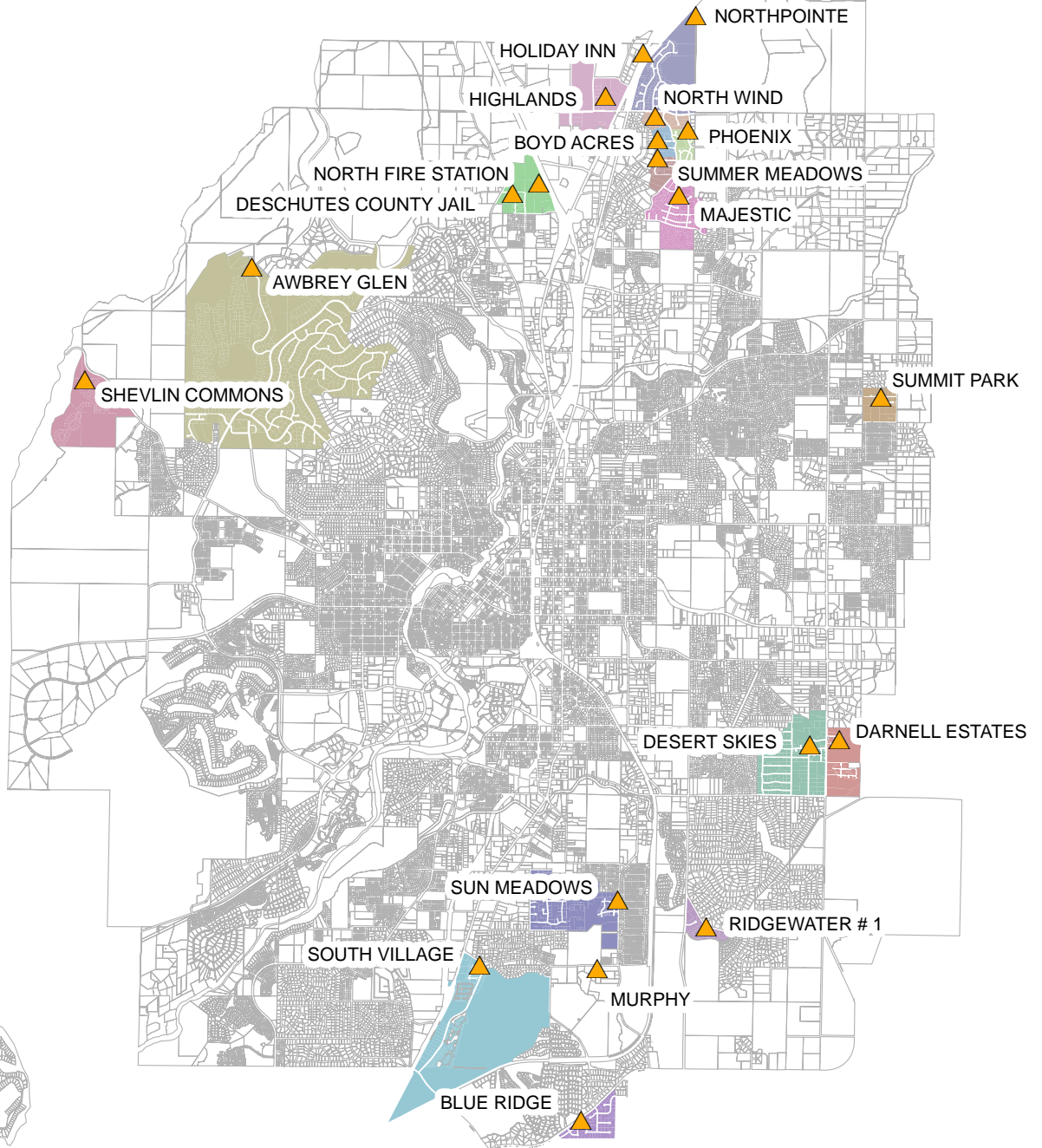


Figure 7
 City of Bend
 Pump Stations Requiring
 Improvements

Table 2
Pump Stations to be Removed from Service

Study Area	Station Name	Project Description	Project Cost (\$x1000)
1	Shevlin Commons	Construct 380-foot trunk sewer to North Interceptor	\$97.5
2	Awbrey Glen	Construct North Interceptor Trunk 4	\$1,483
4	Boyd Acres	Construct 460-foot trunk sewer	\$97
4	Highlands	Construct 2512-foot trunk sewer	\$418
4	Holiday Inn	Construct 382-foot trunk sewer	\$70
4	Northpointe	Construct 350-foot trunk sewer	\$80
4	North Wind	Construct 400-foot trunk sewer when area north of pump station is sewerred	\$88
4	Phoenix	Connect to new gravity system to the north when it is constructed	\$41
4	Summer Meadows	Construct 450-foot trunk sewer	\$95
5	Deschutes Co. Jail	Connect to gravity sewer system when it is constructed to the northeast of the station	\$25
5	Majestic	Construct 1800-foot gravity sewer to Summer Meadows PS basin when Summer Meadows PS is removed from service	\$306
5	North Fire Station	Connect to gravity sewer system when it is constructed to the northeast of the station	\$25
7	Blue Ridge	Connect to new gravity system to the east when it is constructed	\$41
7	Darnell Estates	Construct 300-foot trunk sewer to SE Interceptor on 27 th Ave.	\$74
7	Desert Skies	Construct 550-foot trunk sewer to SE Interceptor on 27 th Ave.	\$111
7	Murphy Road Regional	Remove station when SE Interceptor is constructed on Murphy Road	NA
7	Ridgewater #1	Construct 250-foot trunk sewer to SE Interceptor on 15 th Ave.	\$64
7	Sun Meadows	Construct 1500-foot trunk sewer to connect to new gravity system east of the basin when it is constructed	\$229
8	South Village	Construct 400-foot sewer to connect to the SE Interceptor on Murphy Road	\$88
9	Summit Park	Construct 500-foot sewer to connect to the SE Interceptor on 27 th Street	\$93.5
	Total Cost		\$3,526

NA: Not Applicable; costs for this removal associated with construction of the southeast interceptor.



NOTE: SEE TM 3.8 FOR PUMP STATION DETAIL.

Figure 8
 City of Bend
 Pump Stations to be
 Removed from Service

SYSTEM CAPACITY IMPROVEMENTS

A number of scenarios were evaluated to develop the final system master plan. The first evaluation was to model the existing system under 2005 flows to determine the existing capacity limitations. The existing system was then modeled under build-out flows. This was done to develop the capacity issues of the existing system at build-out. This was used as the Base Case condition. The rest of the modeling was done at build-out conditions to evaluate the various alternatives.

Existing System Deficiencies

In the existing flow scenario, the 2005 peak flows, both dry weather and wet weather were applied to the existing system in separate evaluations. There were no changes made to the existing system in this scenario. This scenario identified the capacity limitations that exist under the existing peak wet weather flow conditions. The existing system deficiencies are shown in *Figure 9*.

This analysis showed that there are currently a few capacity deficiencies in the system under peak flow conditions. The most critical of these deficiencies are:

- Deficient capacity at the discharge of the Murphy Road Pump Station
- Deficient capacity at the discharge of the Westside Regional Pump Station
- Deficient capacity at the discharge of the Wyndemere and Sawyer Park Pump Stations

Each of these capacity limitations will be addressed in the Study Area Plans.

Required Capacity Improvements

A number of scenarios were modeled to determine capacity deficiencies that would occur under build-out flows. The scenarios were refined with a Master Plan that included four new interceptors: Parallel Plant Interceptor, North Interceptor, SE Interceptor and Westside Interceptor. The final modeled scenario identified the deficiencies that will exist in the system when build-out flows are experienced. These deficiencies are shown in *Figure 10*. The capacity deficiencies that have been determined in this modeling effort have been evaluated and an estimated cost to upgrade each deficiency has been developed. The status of each capacity deficiency has also been noted as existing or future. An existing deficiency is one that exists under a 2005 peak flow situation. The specific time period when a future capacity limitation will occur has not been determined. This will be dependent on how the growth occurs in each area throughout the City. A project has been identified to correct each of these capacity deficiencies. These projects are quantified below in their respective planning area. A detailed description of each project by manhole number is summarized in each Study Area Plan.

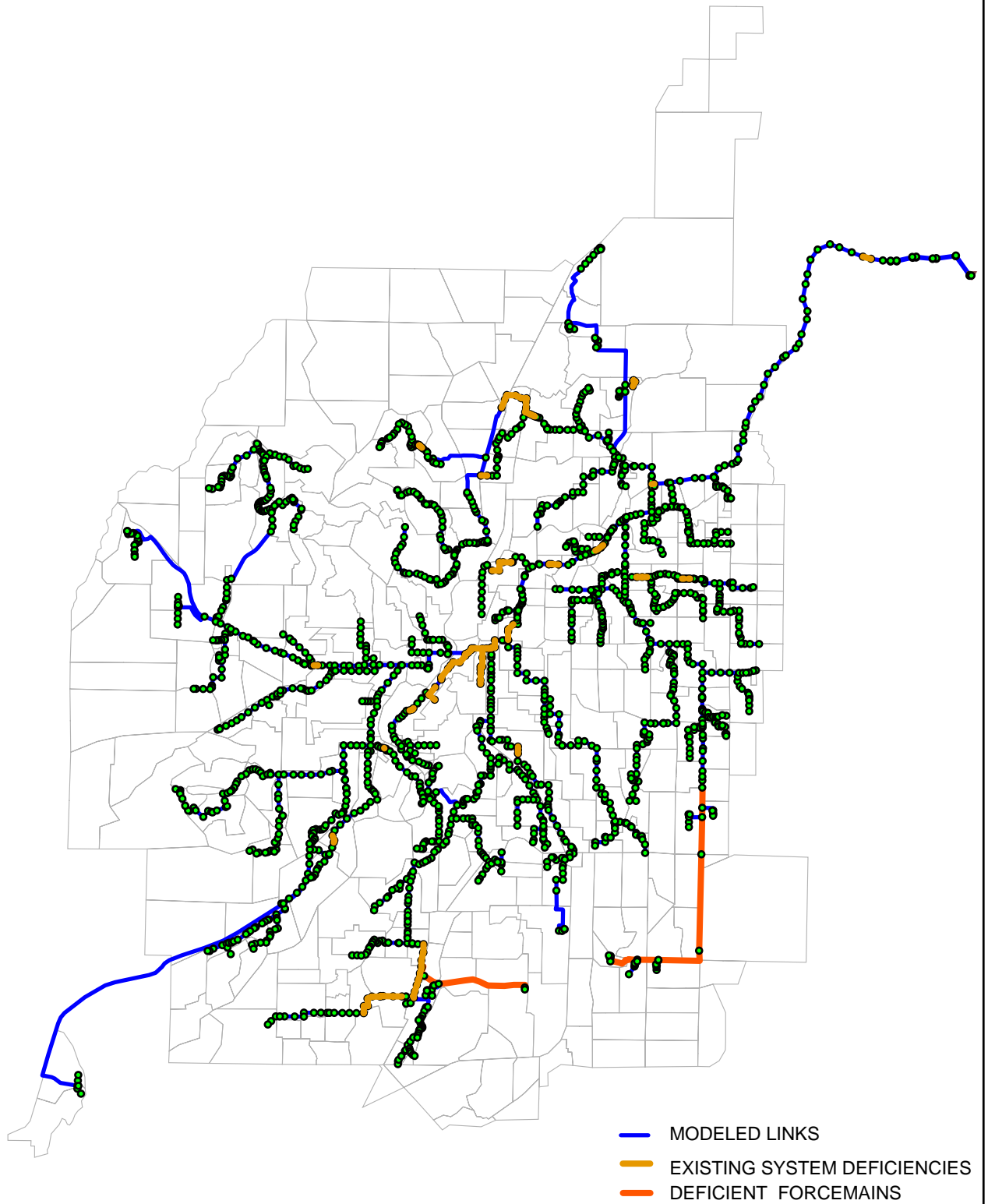
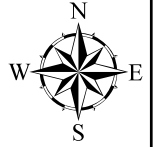
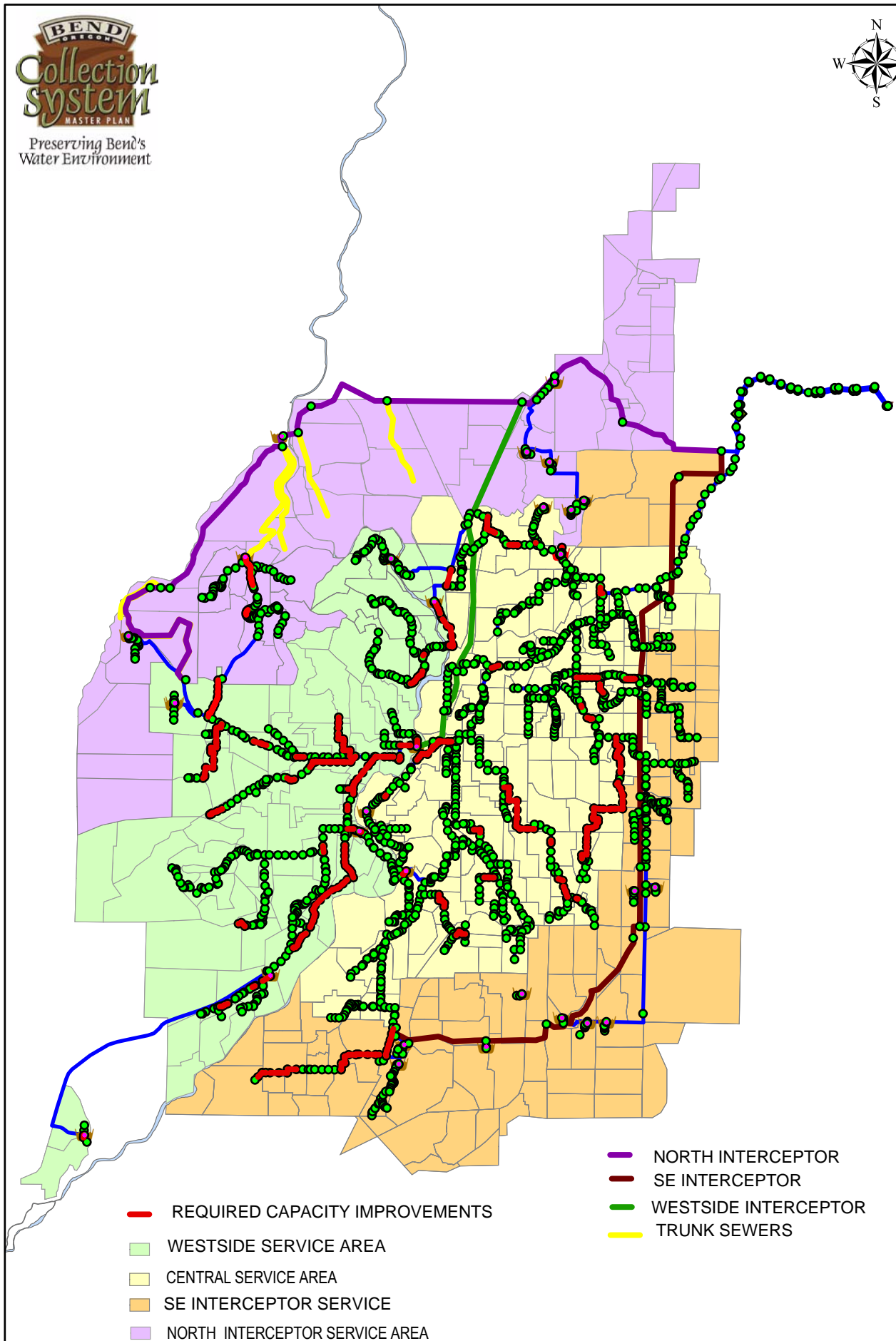


FIGURE 9
EXISTING SYSTEM DEFICIENCIES



- REQUIRED CAPACITY IMPROVEMENTS
- WESTSIDE SERVICE AREA
- CENTRAL SERVICE AREA
- SE INTERCEPTOR SERVICE
- NORTH INTERCEPTOR SERVICE AREA
- NORTH INTERCEPTOR
- SE INTERCEPTOR
- WESTSIDE INTERCEPTOR
- TRUNK SEWERS

FIGURE 10
REQUIRED CAPACITY IMPROVEMENTS
AT SYSTEM BUILD-OUT

Planning by Study Area

The City of Bend, as bounded by the UAR, has been divided into nine study areas to provide for a more focused presentation of the final planning information. The study areas were defined so that they follow “natural” drainage basins and provide the best possible connectivity to the existing and future sewer system in terms of capacity and cost effectiveness. **Figure 11** shows the nine defined study areas. The system capacity deficiencies have been organized by study area and are discussed in each of the following sections.

Study Area 1

Study Area 1 is located on the northwest corner of the Bend planning area. Most of this 1,376-acre study area is located outside of the UGB. Approximately 375 acres are within the current UGB with the rest of the study area in the UAR. The area is largely undeveloped with only 36 acres (19 parcels) currently receiving sanitary sewer service. No capacity deficiencies were identified in Study Area 1.

Study Area 2

Study Area 2 is located on the west side of the Bend planning area. This is the largest of the planning areas at 4,927 acres. This planning area includes the Awbrey Glenn and Shevlin Subdivisions. Most of this study area is within the UGB with only 834 acres outside of the UGB. There has been quite a bit of development in this study area over the past five years. 58% of the area is currently served with 1,424 acres within the UGB available for development.

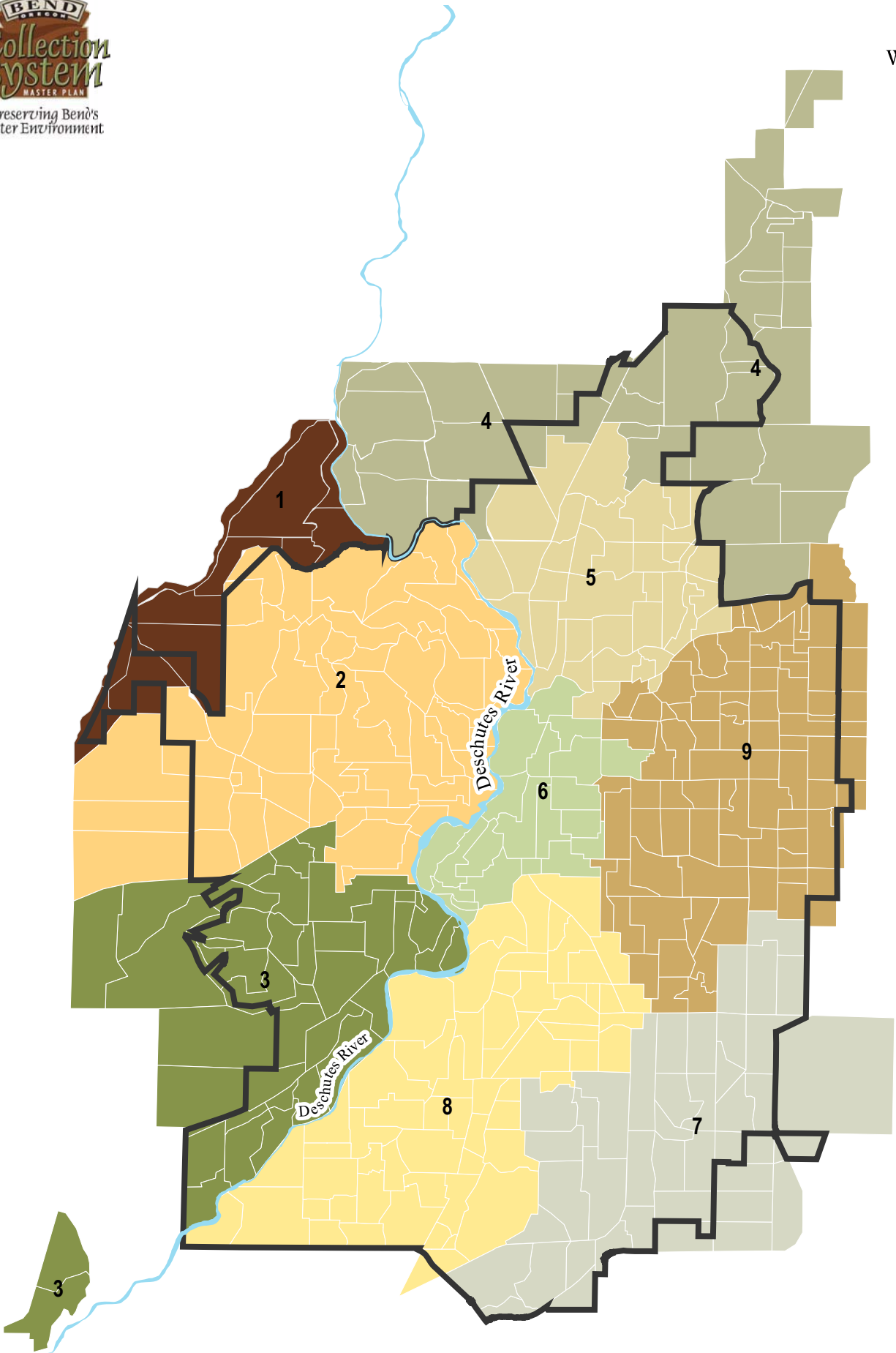
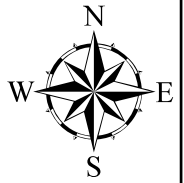
There are 15 capacity improvements that need to be performed in Study Area 2. The total value of these upgrades is estimated at \$5,799,415. The segments of the collection system requiring improvements are shown in **Figure 12**. The scope of each project and the estimated cost for each project is itemized in **Table 3**.

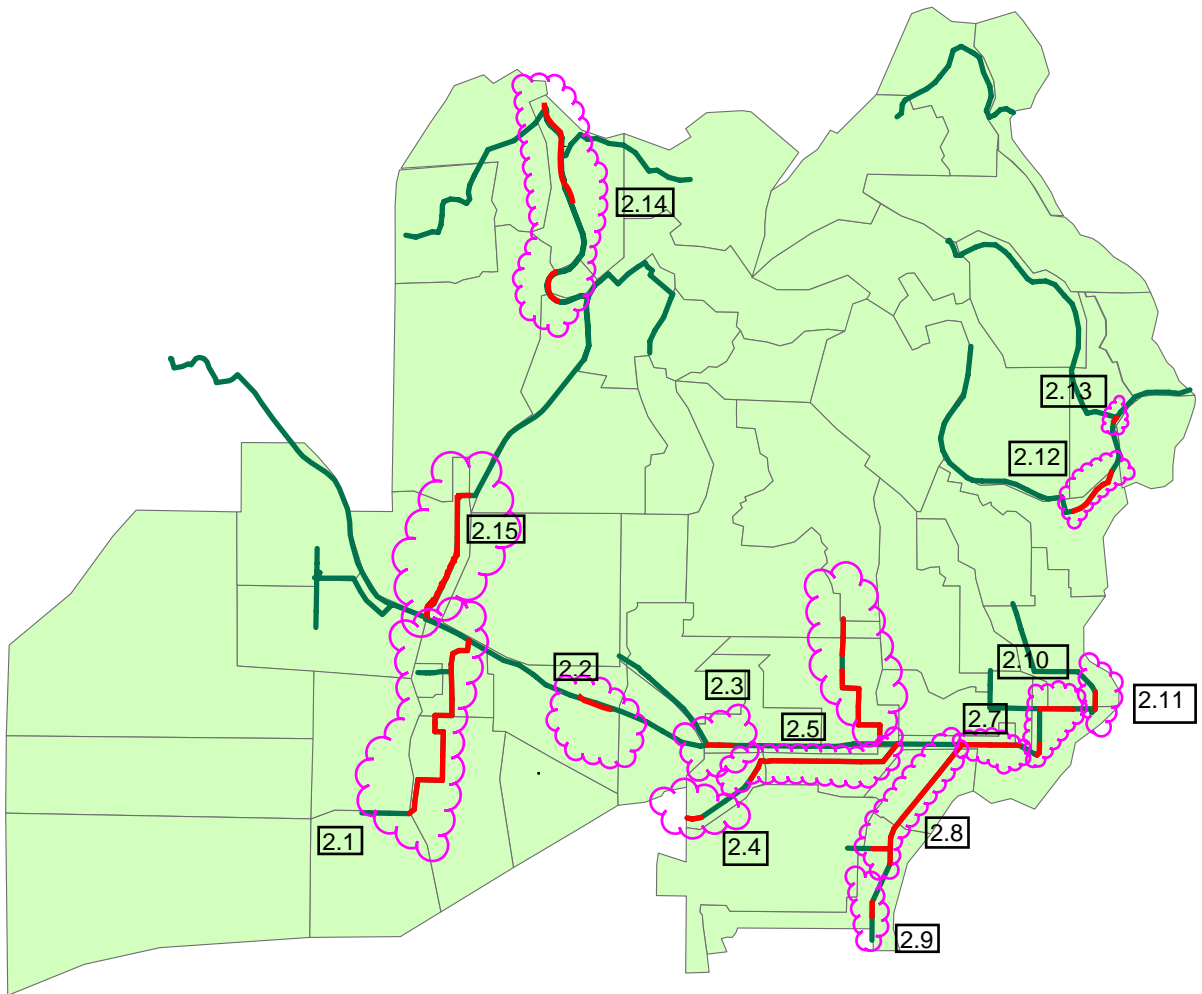
Two capacity deficiencies exist today. These are noted as projects 2-3 and 2-15.

Study Area 3

Study Area 3 is located on the southwest side of the Bend planning area. This study area is 3920 acres in size with 1,655-acres in the UAR. Approximately 1,253 acres is undeveloped and is available for development. This planning area includes the Widgi Creek service area and “Tetherow”, a proposed 706-acre planned development. The Widgi Creek service area is served by the City under a special agreement and is not located within the UGB or UAR.

There are 8 capacity improvements that need to be performed in Study Area 3. The total value of these upgrades is estimated at \$2,547,757. The segments of the collection system requiring improvements are shown in **Figure 13**. The scope of each project and the estimated cost for each project is itemized in **Table 4**. One capacity deficiency exists today. This is noted as project 3-3.





- AREA 2 EXISTING SEWERS
- AREA 2 MASTER PLAN DEFICIENCIES

Table 3
 City of Bend Collection System Master Plan
 Study Area 2 System Capacity Improvements

Project	Status	Description	Parameters			Project Cost \$X1000
			Existing (in)	Future (in)	Length (ft)	
2-1	Future	Gravity Sewer Upgrade	10	12	775	\$932.84
			8	12	464	
			8	10	2892	
2-2	Future	Gravity Sewer Upgrade	12	15	309	\$183.18
			10	12	450	
2-3	Existing	Gravity Sewer Upgrade	8	12	425	\$99.05
2-4	Future	Gravity Sewer Upgrade	8	10	252	\$56.12
2-5	Future	Gravity Sewer Upgrade	8	15	624	\$666.58
			8	12	819	
			8	10	1,426	
2-6	Future	Gravity Sewer Upgrade	10	15	325	\$596.29
			8	18	690	
			8	12	435	
			8	10	1,020	
2-7	Future	Gravity Sewer Upgrade	27	30	989	\$465.10
2-8	Future	Gravity Sewer Upgrade	21	27	1,606	\$1,056.26
			21	24	877	
			8	24	305	
2-9	Future	Gravity Sewer Upgrade	21	24	249	\$84.70
2-10	Future	Gravity Sewer Upgrade	30	36	798	\$412.36
2-11	Future	Gravity Sewer Upgrade	10	15	294	\$74.5
2-12	Future	Gravity Sewer Upgrade	8	10	986	\$219.59
2-13	Future	Gravity Sewer Upgrade	8	10	93	\$20.71
2-14	Future	Gravity Sewer Upgrade	8	10	914	\$423.97
			8	12	759	
			8	15	504	
			10	12	40	
2-15	Existing	Gravity Sewer Upgrade	8	10	1311	\$508.16
			8	12	612	
			8	15	67	

TOTAL: \$5,799.42

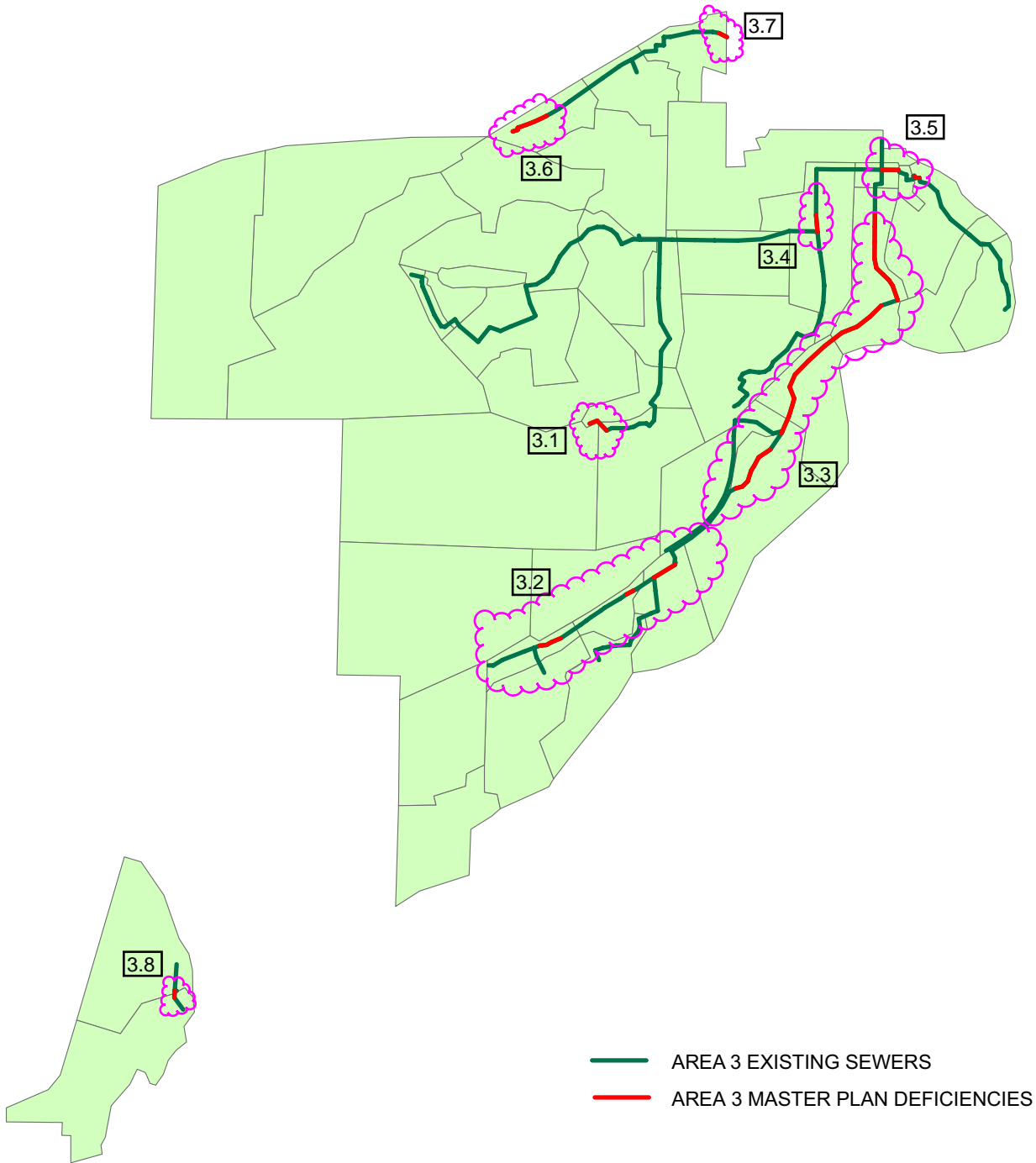


Table 4
 City of Bend Collection System Master Plan
 Study Area 3 System Capacity Improvements

Project	Status	Description	Parameters			Project Cost \$X1000
			Existing (in)	Future (in)	Length (ft)	
3-1	Future	Gravity Sewer Upgrade	8	12	446	\$107.8
3-2	Future	Gravity Sewer Upgrade	8	15	504	\$280.25
			8	10	640	
3-3	Existing	Gravity Sewer Upgrade	10	15	3,914	\$1,694.37
			10	12	1,269	
			8	15	364	
			8	10	1,141	
3-4	Future	Gravity Sewer Upgrade	15	18	352	\$98.08
3-5	Future	Gravity Sewer Upgrade	8	12	347	\$109.27
3-6	Future	Gravity Sewer Upgrade	8	10	796	\$183.84
3-7	Future	Gravity Sewer Upgrade	8	10	185	\$42.73
3-8	Future	Gravity Sewer Upgrade	6	8	143	\$31.41

TOTAL: \$2,547.76

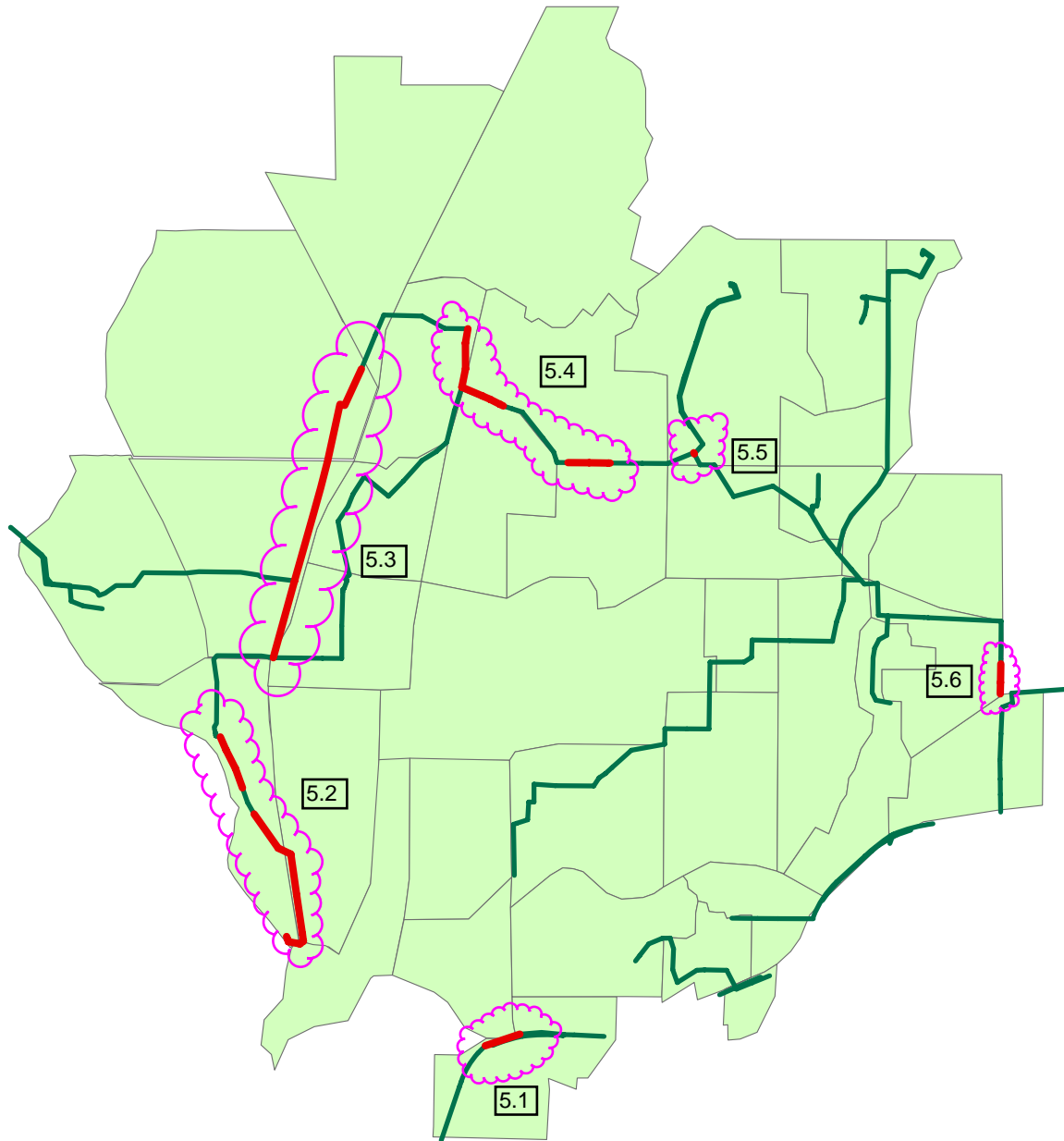
Study Area 4

Study Area 4 is located on the north side of the Bend planning area. This is the second largest of the planning areas at 4,625 acres. This study area has the most UAR area at 4,218 acres. This area will be served in the future by the North Interceptor. This study area includes the new Juniper Ridge Development that is a 1,500+ acre area on the northeastern corner of the City. Approximately 500 acres of the proposed Juniper Ridge Development are currently part of the UGB

Study Area 5

Study Area 5 is located in the north-central Bend planning area providing service on the east side of the Deschutes River. This study area is 2,186 acres in size with no acres in the UAR. Approximately 642 acres is available for development.

There are 6 capacity improvements that need to be performed in Study Area 5. The total value of these upgrades is estimated at \$2,186,000. The segments of the collection system requiring improvements are shown in **Figure 14**. The scope of each project and the estimated cost for each project is itemized in **Table 5**. There are three capacity deficiencies that currently exist. These are noted as projects 5-1, 5-4 and 5-6.



- AREA 5 EXISTING SEWERS
- AREA 5 MASTER PLAN DEFICIENCIES

Table 5
 City of Bend Collection System Master Plan
 Study Area 5 System Capacity Improvements

Project	Status	Description	Parameters			Project Cost \$X1000
			Existing (in)	Future (in)	Length (ft)	
5-1	Existing	Gravity Sewer Upgrade	24	30	425	\$176.63
5-2	Future	Gravity Sewer Upgrade	12	15	2582	\$678.48
5-3	Future	Gravity Sewer Upgrade	6	8	3,586	\$787.75
5-4	Existing	Gravity Sewer Upgrade	12	15	494	\$415.15
			8	12	268	
			8	10	955	
5-5	Future	Gravity Sewer Upgrade	15	18	15	\$4.18
5-6	Existing	Gravity Sewer Upgrade	21	24	351	\$123.81

TOTAL: \$2,186.00

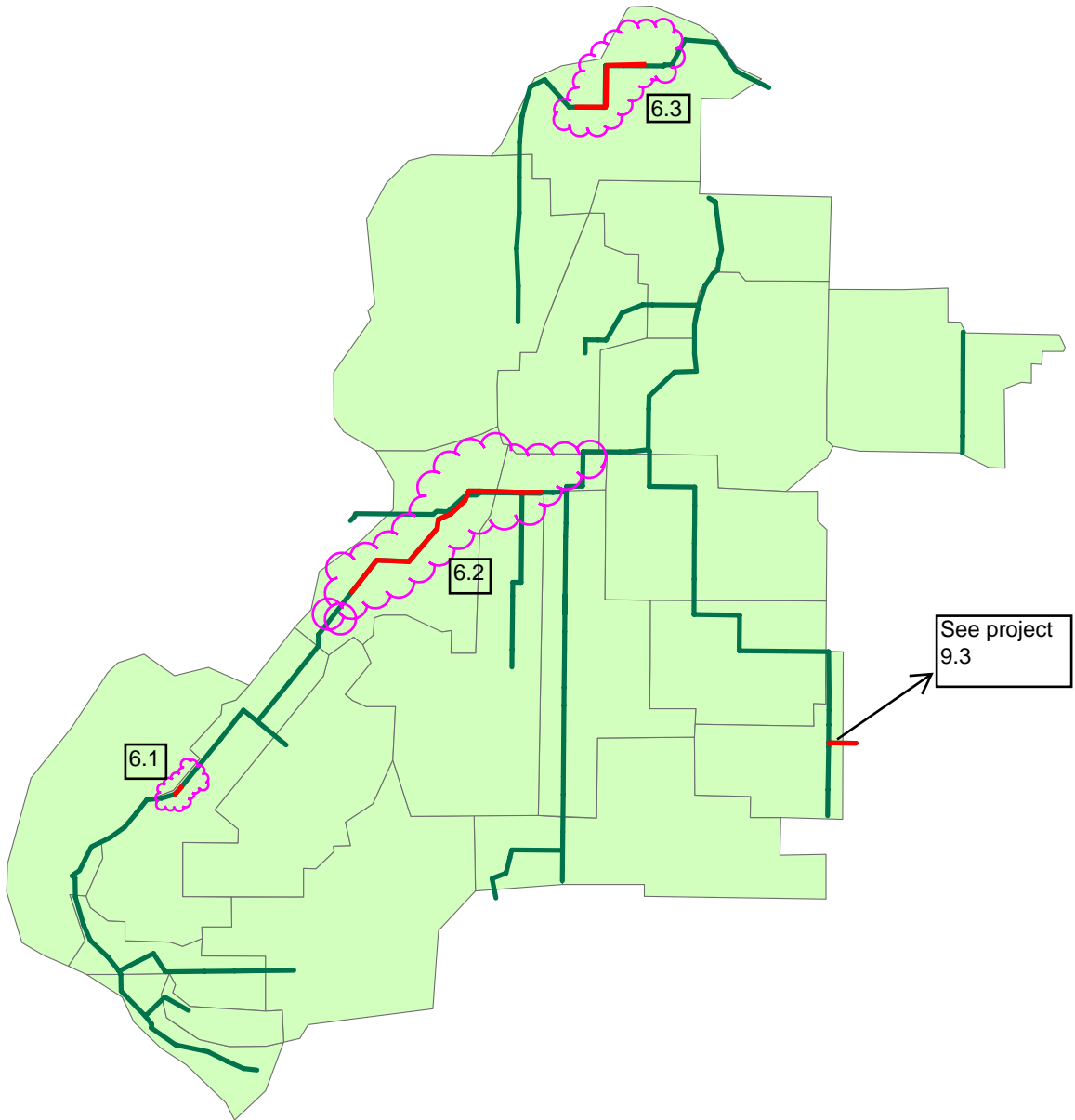
Study Area 6

Study Area 6 serves the downtown core of the Bend planning area. This study area is 1,218-acres in size with no acres in the UAR. Approximately 611 acres receive sewer service and 195 acres are undeveloped but buildable within the UGB. Approximately 28 acres are developed but do not receive sewer service from the City.

There are three (3) capacity improvements that need to be performed in Study Area 6. The total value of these upgrades is estimated at \$1,236,500. The segments of the collection system requiring improvements are shown in **Figure 15**. The scope of each project and the estimated cost for each project is itemized in **Table 6**.

Two deficiencies exist today that are capacity limitations in gravity sewers. These are noted as projects 6-1 and 6-2.

Project 6-3 is due to a grade problem in the system where a new pump station needs to be constructed. The City did a project in 2001 to remove the 4th and Addison Pump Station. The pump station was replaced with a manhole and 14.6-feet of 21-inch PVC line. The flow enters this manhole 4.5-feet lower than it exits the manhole. This results in the surcharge of 1200-feet of gravity sewer upstream of this manhole. The upstream gravity sewer is located in an area that would be extremely difficult to replace with one at a grade that would not cause surcharging of the system. The gravity sewer upstream of this manhole crosses Highway 97. For this reason, it is recommended that a new pump station be constructed to lift this flow and eliminate the system surcharging. This pump station will need to pump a peak flow of 300-gpm at system build-out. The estimated cost for this station is \$575,000. This includes an estimated cost for land of \$200,000.



- AREA 6 EXISTING SEWERS
- AREA 6 MASTER PLAN DEFICIENCIES

Table 6
 City of Bend Collection System Master Plan
 Study Area 6 System Capacity Improvements

Project	Status	Description	Parameters			Project Cost \$X1000
			Existing (in)	Future (in)	Length (ft)	
6-1	Existing	Gravity Sewer Upgrade	8	12	95	\$22.96
6-2	Existing	Gravity Sewer Upgrade	12	15	2,430	\$638.54
6-3	Existing	New Pump Station	300-gpm			\$575.00

TOTAL: \$1,236.50

Study Area 7

Study Area 7 is located in the southeast corner of the Bend planning area. This study area is 3,941-acres in size with 1,155-acres in the UAR. Approximately 898 acres is undeveloped and is available for development. No capacity deficiencies were identified in Study Area 7 for the modeled system. It needs to be noted that the previous Juniper Utilities system was not modeled or included in this analysis.

The Murphy Road Pump Station and force main is currently operating beyond its rated capacity. The Master Plan assumes that this pump station will be removed from service with the construction of the SE Interceptor.

Study Area 8

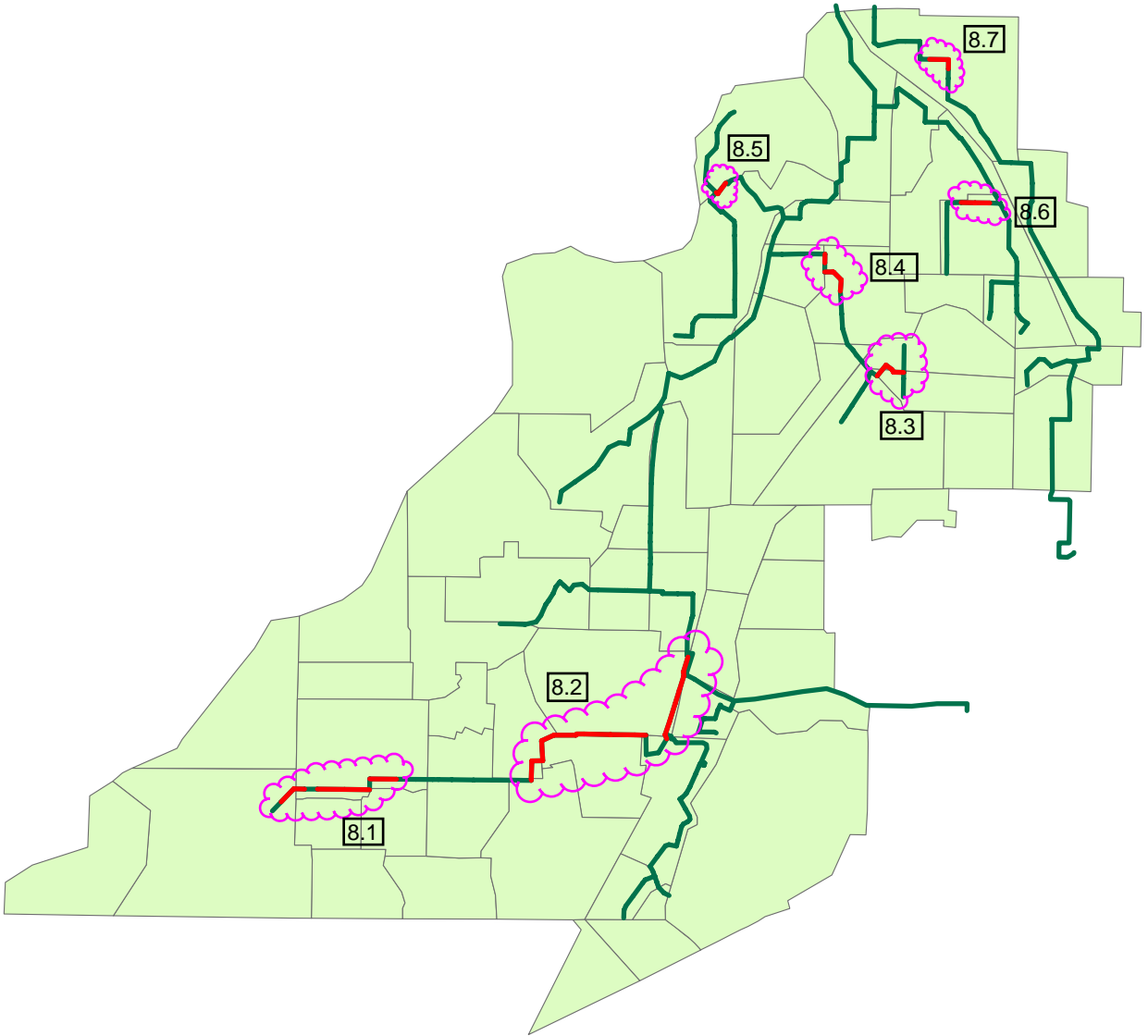
Study Area 8 is located on the south end of the Bend planning area, east of the Deschutes River. This study area is 3,925-acres in size. Approximately 1,313 acres receive sewer service from the City. Approximately 1,181 acres are undeveloped and is available for development.

There are 7 capacity improvements that need to be performed in Study Area 8. The total value of these upgrades is estimated at \$2,266,186. The segments of the collection system requiring improvements are shown in **Figure 16**. The scope of each project and the estimated cost for each project is itemized in **Table 7**.

There are two capacity deficiencies that currently exists. This deficiency is noted as project 8-2 and 8-7.

Study Area 9

Study Area 9 is located on the east-central side of the Bend planning area. This study area is 3,853-acres in size. Approximately 703 acres are undeveloped but are buildable within the UGB. Approximately 1,005 acres are outside the UGB or within the UGB but will not be developed, as it consists of streets, utility corridors, areas zoned as public facilities and unbuildable lands.



- AREA 8 EXISTING SEWERS
- AREA 8 MASTER PLAN DEFICIENCIES

There are 8 capacity improvements that need to be performed in Study Area 9. The total value of these upgrades is estimated at \$3,834,660. The segments of the collection system requiring

Table 7
 City of Bend Collection System Master Plan
 Study Area 8 System Capacity Improvements

Project	Status	Description	Parameters			Project Cost \$X1000
			Existing (in)	Future (in)	Length (ft)	
8-1	Future	Gravity Sewer Upgrade	10	12	962	\$463.56
			8	12	1027	
8-2	Existing	Gravity Sewer Upgrade	15	18	80	\$1,181.45
			12	18	2433	
			12	15	1949	
8-3	Future	Gravity Sewer Upgrade	8	10	640	\$142.53
8-4	Future	Gravity Sewer Upgrade	12	15	737	\$186.75
8-5	Future	Gravity Sewer Upgrade	10	12	250	\$58.27
8-6	Future	Gravity Sewer Upgrade	8	10	527	\$117.37
8-7	Existing	Gravity Sewer Upgrade	8	10	522	\$116.25

TOTAL: \$2,266.18

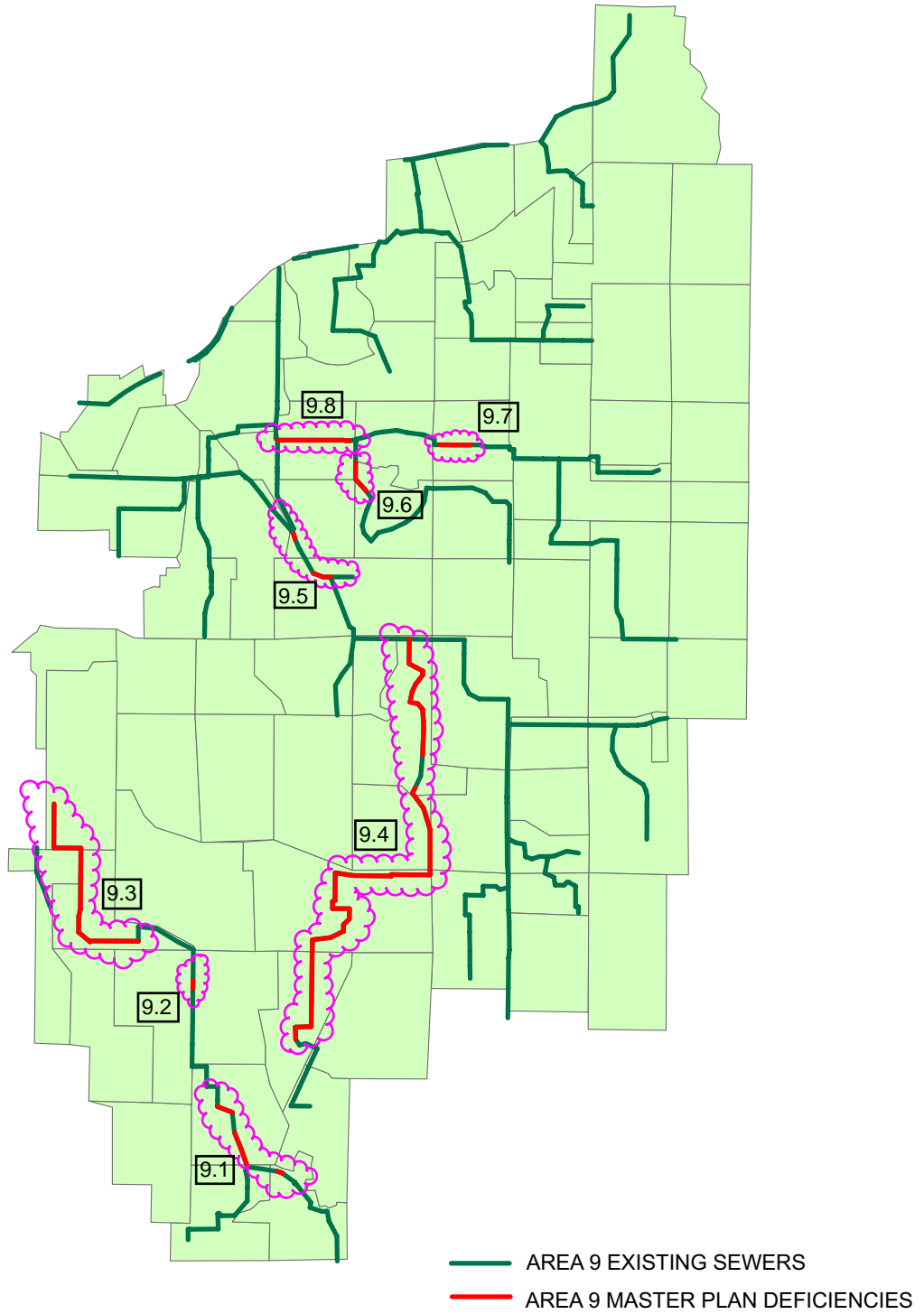
improvements are shown in **Figure 17**. The scope of each project and the estimated cost for each project is itemized in **Table 8**.

Two capacity deficiencies exist today. These are noted as projects 9-7 and 9-8.

SUMMARY OF CAPITAL COSTS

Project costs have been developed for each of the capital improvements that will be required to provide sanitary service to the planning area between now and system build-out. These costs are summarized in **Table 9**. The total program cost through build-out is \$97,131,000 which includes system capacity improvements, four (4) interceptors, and upgrades or removal of existing pump stations. This cost will be distributed over the period of time that it takes the City to reach its planned build-out condition.

Five of the pump stations identified as needing capacity upgrades were also identified as cost-effective for removal. However, prior to removal, associated conveyances must be built (for example, the Southeast Interceptor). Because the timing of the need for upgrades and the timing of construction of the associated conveyances was not evaluated, it was not possible to determine if these pump stations could be removed prior to requiring upgrades. Therefore, it was conservatively assumed that all five pump stations would undergo upgrades prior to removal. If all five pump stations were removed from service prior to upgrades, it would reduce the total



program cost by approximately \$2.3M (\$1.8M from pump station upgrades, \$0.5M because Capital Project 2-15 is not required if Awbrey Glen Pump Station is removed).

Table 8
 City of Bend Collection System Master Plan
 Study Area 9 System Capacity Improvements

Project	Status	Description	Parameters			Project Cost \$X1000
			Existing (in)	Future (in)	Length (ft)	
9-1	Future	Gravity Sewer Upgrade	10	12	268	\$227.14
			8	10	703	
9-2	Future	Gravity Sewer Upgrade	8	10	136	\$31.41
9-3	Future	Gravity Sewer Upgrade	12	15	3,919	\$1,034.53
			8	15	18	
9-4	Future	Gravity Sewer Upgrade	10	12	1,020	\$1,853.66
			8	12	313	
			8	10	6,631	
9-5	Future	Gravity Sewer Upgrade	15	18	397	\$110.62
9-6	Future	Gravity Sewer Upgrade	10	12	538	\$130.03
9-7	Existing	Gravity Sewer Upgrade	8	10	515	\$118.94
9-8	Existing	Gravity Sewer Upgrade	12	18	515	\$328.32
			12	15	693	

TOTAL: \$3,834.66

Table 9
 City of Bend Collection System Master Plan
 Project Cost Summary

Project Segment	Project Cost (\$)
Interceptors	
Plant Interceptor (for details see Table A-1)	9,448,000
North Interceptor (for details see Table A-2)	25,026,500
North Interceptor Trunk Lines 1-5	4,803,000
SE Interceptor (for details see Table A-3)	19,032,806
Westside Interceptor (for details see Table A-4)	9,067,153
Total Interceptor Cost	62,574,459
Pump Stations	
Stations Requiring Capacity Upgrades	8,001,000
Stations to be Removed from Service	3,526,000
Total Pump Station Cost	11,883,000
System Capacity Improvements	
Study Area 1	0
Study Area 2	5,799,000
Study Area 3	2,548,000
Study Area 4	0
Study Area 5	2,186,000
Study Area 6	1,237,000
Study Area 7	0
Study Area 8	2,266,000
Study Area 9	3,835,000
Total System Capacity Improvement Cost	17,871,000
Total Capital Program Cost at Build-out	97,131,459

Note: No capacity improvements were needed for Study Areas 1, 4, and 7. Therefore, no costs were calculated.

Attachment A
Interceptor Cost Estimates

Table A1
 2006 Collection System Master Plan
 Plant Interceptor Cost Estimate

Project Element	Diam	Total Length	Construction Cost					Allowances		Project Total
			Pipe Material	Installation	Manholes	Restoration	Easements	Engr/Admin	Contingency	
			(in)	(ft)	(\$)	(\$)	(\$)	(\$)	(\$)	
WWTP to Siphon Inlet - Gravity	48	5,100	367,200	1,275,000	0	42,500	100,000	464,700	722,800	2,972,000
North Trunk Junction to Siphon	48	7,994	575,568	2,081,060	316,900	121,500	150,000	1,135,800	1,314,200	5,695,000
Canal Crossings (1)		100		75,000				26,250	30,400	132,000
Traffic Control/Management		1 EA		20,000				7,000	8,100	35,000
Erosion Control		1 EA		200,000				70,000	81,000	351,000
Siphon Structure		1 EA		150,000				52,500	60,800	263,000
Total										9,448,000

NOTES:

1. Construction Costs based on ENR-CCI of 8449
2. Allowances for engineering, administration and contingencies are set at 25%, 10% and 30% respectively
3. Assumed manhole spacing at an average of 400 ft.
4. Assumed WWTP to Sta. 125+00 restoration as native cover, rest as local road
7. Assumed 72" manholes for the 48" gravity (non-siphon) section
8. Easement allowance for the line from the WWTP to Sta.125+00 and 1000' at the south end of the project

Table A2
2006 Collection System Master Plan
North Interceptor Cost Estimate

Project Element	Diam	Total Length	Construction Cost					Allowances		Project Total
			Pipe Material	Installation	Manholes	Restoration	Easements	Engr/Admin	Contingency	
	(in)	(ft)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	
Plant Interceptor to Juniper Ridge	48	12,405	893,200	3,441,800	560,700	124,100	0	1,757,000	2,033,000	8,809,800
Juniper Ridge to Hwy 97	42	2,605	148,500	630,500	74,400	26,100	0	307,900	356,200	1,543,600
Hwy 97 to the Deschutes River	30	14,340	573,600	2,677,500	201,100	138,200	143,400	1,306,900	1,512,200	6,552,900
Deschutes River to Shevlin Park								0		
27" Segment	27	1,605	56,200	216,700	14,600	17,700	16,100	112,400	130,100	563,800
15" Segment	15	10,455	196,600	788,300	101,800	82,400	104,600	445,800	515,900	2,235,400
10" Segment	10	1,110	9,800	77,700	10,100	8,200	11,100	40,900	47,300	205,100
8" Segment	8	10,640	60,100	810,600	114,900	78,200	106,400	409,600	473,900	2,053,700
Deschutes River Force Main	15	1,610	42,400	115,900				55,400	64,100	277,800
North Interceptor Pump Station				1,226,400						1,226,400
Canal Crossings (3)		300		225,000				78,800	91,100	394,900
Traffic Control/Management		1 EA		50,000				17,500	20,300	87,800
Erosion Control		1 EA		212,640				74,500	86,100	373,200
Hwy 97 and Hwy 20 Bores		250		250,000				87,500	101,300	438,800
Railroad Undercrossing		150		150,000				52,500	60,800	263,300
										25,026,500

NOTES:

1. Construction Costs based on ENR-CCI of 8449
2. Allowances for engineering, administration and contingencies are 25%, 10% and 30% respectively
3. Assumed manhole spacing at an average of 400 ft.
4. Assumed North Trunk Junction to Hwy 97 restoration as native cover
5. Assumed Hwy 97 to Deschutes River restoration as half local street and half as native
6. Assumed 72" manholes for the 48" section, 60" manholes for the 42" and 48" manholes for the remainder.
7. Assumed no easement costs through Juniper Ridge
8. North Interceptor Pump Station - 4400-gpm, 6.3-mgd
9. Deschutes River crossing force main (1610+/- feet); Pipeline on bridge
10. Cost Estimate for North Interceptor Trunk Lines 1 through 5 (\$4.8M) are not included in this table.

Table A3
2006 Collection System Master Plan
SE Interceptor Cost Estimate

Project Element	Diam	Total Length	Construction Cost					Allowances		Project Total
			Pipe Material	Installation	Manholes	Restoration	Easements	Engr/Admin	Contingency	
	(in)	(ft)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	
North Trunk Junction to JD Estates Drive	36	3,678	169,188	744,090	95,595	52,154	0	371,359	429,716	1,862,102
JD Estates Drive to Hwy 20	24	19,986	439,692	2,729,702	292,678	383,321	0	1,345,888	1,557,384	6,748,665
Hwy 20 to Reed Market Road	24	6,324	139,128	829,350	86,047	135,840	0	416,628	482,098	2,089,091
Reed Market Road to SE 15 th St.	24	8,554	188,188	946,316	83,603	80,835	0	454,630	526,072	2,279,644
SE 15 th to Murphy Road PS	24	4,278	94,116	542,464	54,661	40,427	10,000	259,584	300,375	1,301,627
Murphy Road PS to Hwy 97	18	5,980	101,660	723,886	92,605	114,158	0	361,308	418,085	1,811,702
Canal Crossings (2)		200		150,000				52,500	60,750	263,250
Railroad Undercrossing		230		230,000				80,500	93,150	403,650
Intertie Structures		2 EA		400,000				140,000	162,000	702,000
Traffic Control/Management		1 EA		450,000				157,500	182,250	789,750
Erosion Control		1 EA		195,200				68,320	79,055	342,575
US Hwy 20 Undercrossing		250		250,000				87,500	101,250	438,750
Totals		48,800	1,131,972	8,191,008	705,188	806,735	10,000	3,795,716	4,392,186	19,032,806

NOTES:

1. Construction Costs based on ENR-CCI of 8449
2. Allowances for engineering, administration and contingencies are set at 25%, 10% and 30% respectively
3. Assumed manhole spacing at an average of 400 ft.
4. Assumed Junction Sta. 00+00 to Sta. 75+00 restoration as local street
5. Assumed Sta. 75+00 to Sta. 299+88 restoration as arterial (27th Street)
5. Assumed Sta. 299+88 to Sta. 428+20 restoration as local street
6. Assumed Sta. 428+20 to 488+00 restoration to arterial (Murphy Road)
7. Assumed 60" manholes for the 36" section and 48" manholes for the 24" and 18" sections.
8. Easement allowance for 1000' east of Murphy Road

Table A4
 2006 Collection System Master Plan
 Westside Interceptor Cost Estimate

Project Element	Diam	Total Length	Construction Cost					Allowances		Project Total
			Pipe Material	Installation	Manholes	Restoration	Easements	Engr/Admin	Contingency	
	(in)	(ft)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	
Westside Force Main	24	1,600	86,905	181,000	0	39,700	0	107,650	124,566	539,821
Gravity Interceptor	27	15,610	546,350	2,853,875	208,595	359,658	0	1,388,968	1,607,234	6,964,680
US Hwy 97 Undercrossing		400		400,000				140,000	162,000	702,000
Railroad Undercrossing		230		230,000				80,500	93,150	403,650
Traffic Control/Management		1 EA		176,400				61,740	71,442	309,582
Erosion Control		1 EA		84,000				29,400	34,020	147,420
Totals		21,581	633,255	3,925,275	208,595	390,202	0	1,783,415	2,063,666	9,067,153

NOTES:

1. Construction Costs based on ENR-CCI of 8449
2. Allowances for engineering, administration and contingencies are set at 25%, 10% and 30% respectively
3. Assumed manhole spacing in the gravity segment at an average of 400 ft.
4. Assumed restoration as improved cover along Hwy 97
5. Assumed force main in arterial street pavement
6. Costs do not include extending force mains from existing pump stations
7. Assumed 48" manholes for the 27" gravity interceptor.
8. Assumed construction on public right-of-way, therefore no easements