CITY OF PORT TOWNSEND

JEFFERSON COUNTY **WASHINGTON**

SOUTHWEST SEWER BASIN STUDY

G & O NO. 07377
DECEMBER 2009

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EXECUTIVE SUMMARY

The City of Port Townsend has undertaken the *Southwest Sewer Basin Study* in order to evaluate potential future development within and adjacent to existing City limits. This study was confined to the western portion of existing City limits currently not sewered and areas just west and southwest of City limits. When identifying areas to be served outside City limits, Jacob Miller Road was used as the west boundary since this is the current limit of City water service. The current City limits represent the Urban Growth Area (UGA) boundary, but the City and Jefferson County have examined the possibility of incorporating areas south of the City limits into the City's UGA boundary. Information in this study will be used by City staff as a planning tool as areas not currently sewered are developed.

An overview of this study is as follows:

- **Chapter 1 – Introduction** – Provides an overview of study area, objectives of study, and scope of study.
- **Chapter 2 – Service Area and Basins** – Provides information on sewer basin delineation and developable areas within each basin.
- **Chapter 3 – Wastewater Flow and Loading Projections** – Presents flow rates from each basin using flow information presented in CH2M Hill's *City of Port Townsend Wastewater Comprehensive Plan* (September, 1999).
- **Chapter 4 – Downstream Analysis of Existing Facilities** – Provides information on the model used and identification of existing sewer lines that need to be increased in size.
- **Chapter 5 – Evaluation of Sewer Service Alternatives** – Presents alternatives and associated costs for serving selected basins.

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CHAPTER 1

INTRODUCTION

BACKGROUND

The City of Port Townsend has undertaken the *Southwest Sewer Basin Study* in order to evaluate impacts from potential future development within and adjacent to existing City limits. This project was undertaken to provide a planning tool for City of Port Townsend as the western portion of existing City limits and areas west and southwest of the City limits become developed. This study was confined to the western portion of existing City limits currently not sewered and areas just west and southwest of City limits. When identifying areas to be served outside City limits, Jacob Miller Road was used as the west boundary since this is the current limit of City water service. The current City limits represent the UGA boundary; however, the City and Jefferson County have examined the possibility of including areas southwest of the City limits (Glen Cove area) into the City's UGA boundary.

OBJECTIVE

The objective of this report is to provide a planning tool to the City in order to assess impacts to existing wastewater infrastructure as unsewered areas in the western and southwestern vicinity of the City are developed. The City will use the information contained in this report in order to assess the following:

- Impacts to existing infrastructure as ultimate buildout occurs within the western portion of City limits and in areas west and southwest outside of current City limits.
- Alternatives to serving the southwestern areas within and adjacent to City limits, which are expected to be developed first.
- Estimated costs to serve selected areas as these areas are developed to allow the City to allocate costs between developers and the City.
- Wastewater rates and funding needs based on required wastewater infrastructure improvement costs not borne by developers.

SCOPE

Sewer basins were identified within the study area, along with infrastructure needed to connect these basins to existing wastewater collection and conveyance facilities. Flows from each basin were developed using flow information developed by CH2M Hill in the *City of Port Townsend Wastewater Comprehensive Plan* (September, 1999). These flow values were used as opposed to the revised flow values in Gray & Osborne's *Wastewater*

Treatment Facilities Plan (2000) since CH2M Hill's wastewater model was used for this project. In the event a new model is developed by the City, the revised flows presented by Gray & Osborne's *Wastewater Treatment Facilities Plan* (2000) should be used.

CH2M Hill's model was used to evaluate existing collection line capacity for ultimate buildout within the City and the impacts from additional flows from the basins identified outside the City limits. Existing sewer lines requiring increased size are identified and required pipeline size for the additional flows are presented.

Alternatives to serving the unsewered areas within the western portion of City limits and just west and southwest of City limits were examined. Costs were developed for these alternatives to allow the City to evaluate alternatives.

CHAPTER 2

SERVICE AREA AND BASINS

BASIN DELINEATION

Sewer basins were identified in the western portion of existing City limits currently not sewered and areas just west and southwest of City limits. When identifying areas to be served outside City limits, Jacob Miller Road was used as the west boundary since this is the current limit of City water service. The area just southwest of existing City limits was also examined in this study since developers have approached the City about servicing this area. The current City limits represent the current UGA boundary; however, the City and Jefferson County have examined the possibility of including areas south of the City limits into the City's UGA boundary.

Figures 2-1A and 2-1B show delineated sewer basin areas that could be served by the City wastewater system within the study area. Wastewater flows from each basin will either gravity flow or be pumped to existing or proposed sewer mains and lift stations. Sewer basin boundaries were dictated by existing topography and the ability to convey wastewater to one centralized location within each basin. Proposed sewer lines were placed to follow existing roads, extensions of existing roads, or property boundaries and to avoid critical areas for habitat and wetlands. Figure 2-2 presents proposed sewer line and lift station locations with respect to critical drainages and wetlands. Wetlands and critical areas within City limits were provided by City of Port Townsend. Wetlands depicted outside the City limits were obtained from Jefferson County's website. Figure 2-3 presents proposed sewer line and lift station locations with respect to seismic soils, as provided by Jefferson County.

Table 2-1 summarizes developable acreage information for each basin. Following is a detailed discussion of each basin.

TABLE 2-1

Proposed Sewer Basins and Developable Area

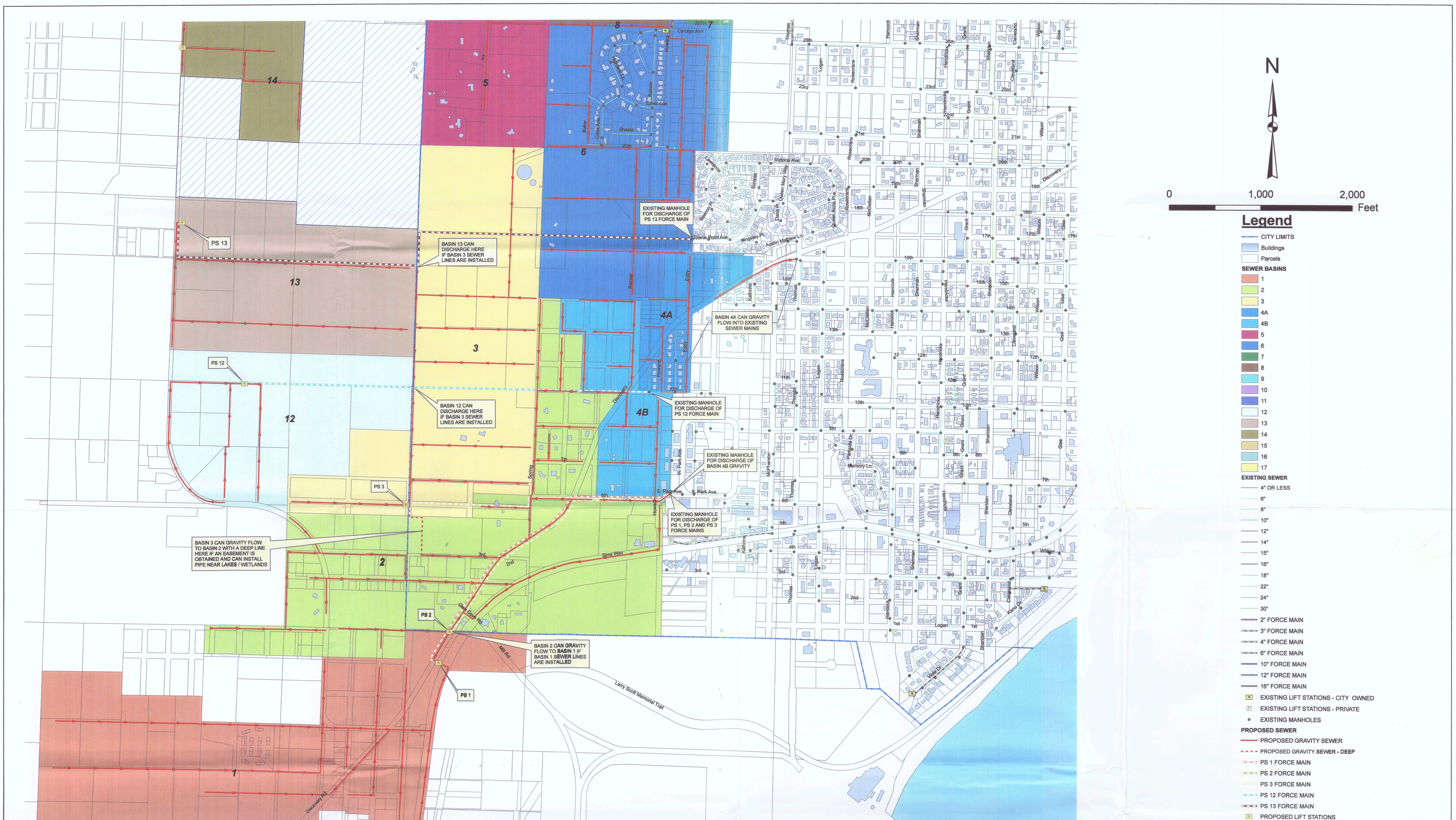
Basin	Developable Area, Acres
1	180
2	175
3	140
4A	25
4B	40
5	85
6	125
7	45
8	15
9	30
10	380
11	125
12	45
13	95
14	50
15	145
16	90
17	25

BASIN 1

Basin 1 consists of the area south and southwest of the existing City limits. Wastewater generated from Basin 1 will gravity flow to a lift station located near the intersection of Discovery Road and Sims Way. A force main will be installed, provided no limiting factors exist to prevent the force main installation, that will discharge to an existing gravity main where West Park and South Park Avenues intersect. Basin 1 has an area of approximately 180 acres and the entire area is assumed to be developable.

BASIN 2

Basin 2 consists of the southwest portion within City limits and property just west of the southwest City limit boundary. This basin can gravity flow to a new lift station located near the intersection of Discovery Road and South 8th Street, or can connect into proposed Basin 1 sewer mains and lift station, if Basin 1 sewer mains are constructed and active. If a lift station is installed, a force main will need to be constructed that connects into existing gravity lines on South Park Avenue. Basin 2 has an area of 175 acres and the entire area can be developed.



CITY OF PORT TOWNSEND

SOUTHWEST SEWER BASIN STUDY
FIGURE 2-1A
SOUTHERN BASIN STUDY AREA AND PROPOSED IMPROVEMENTS

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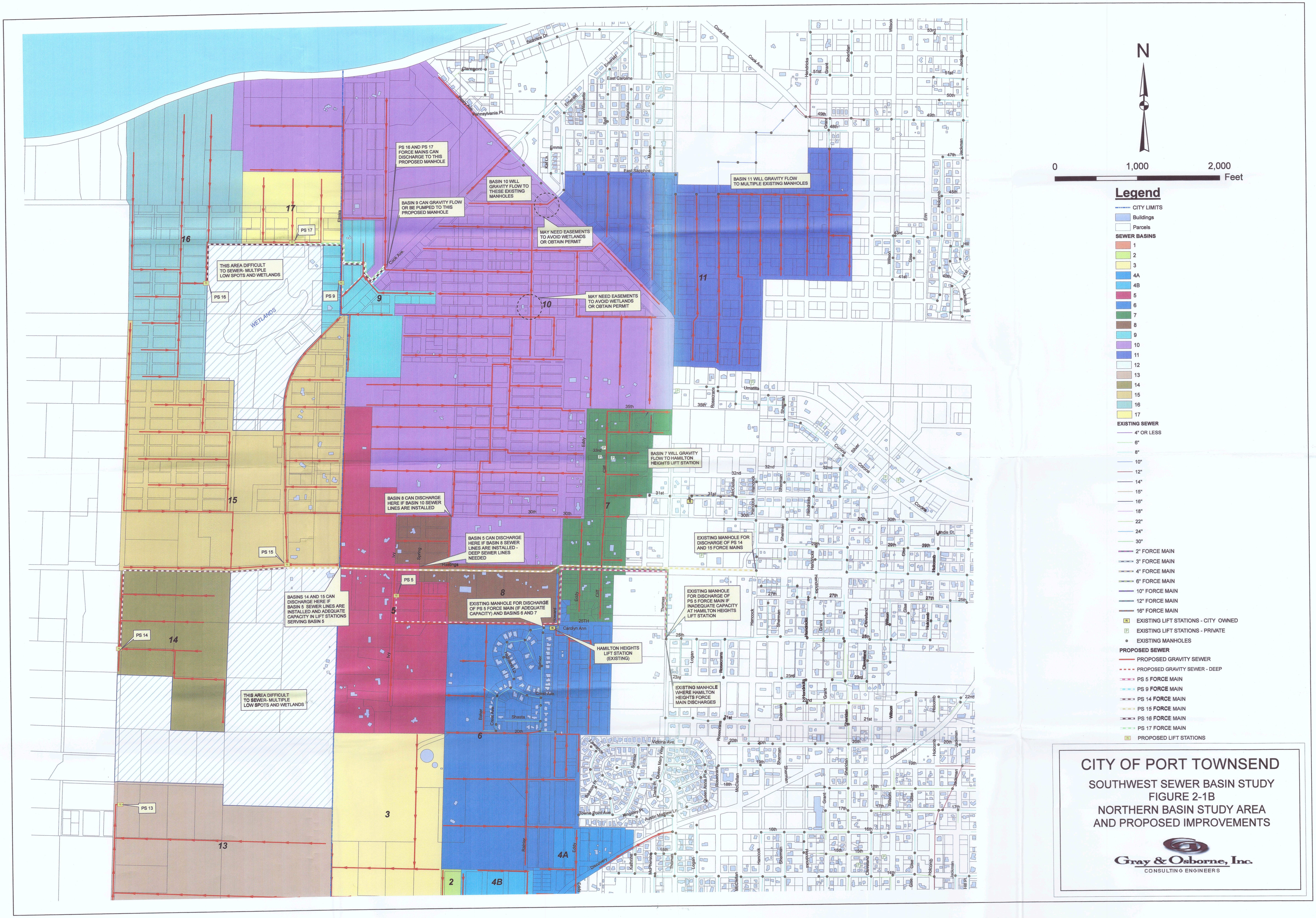
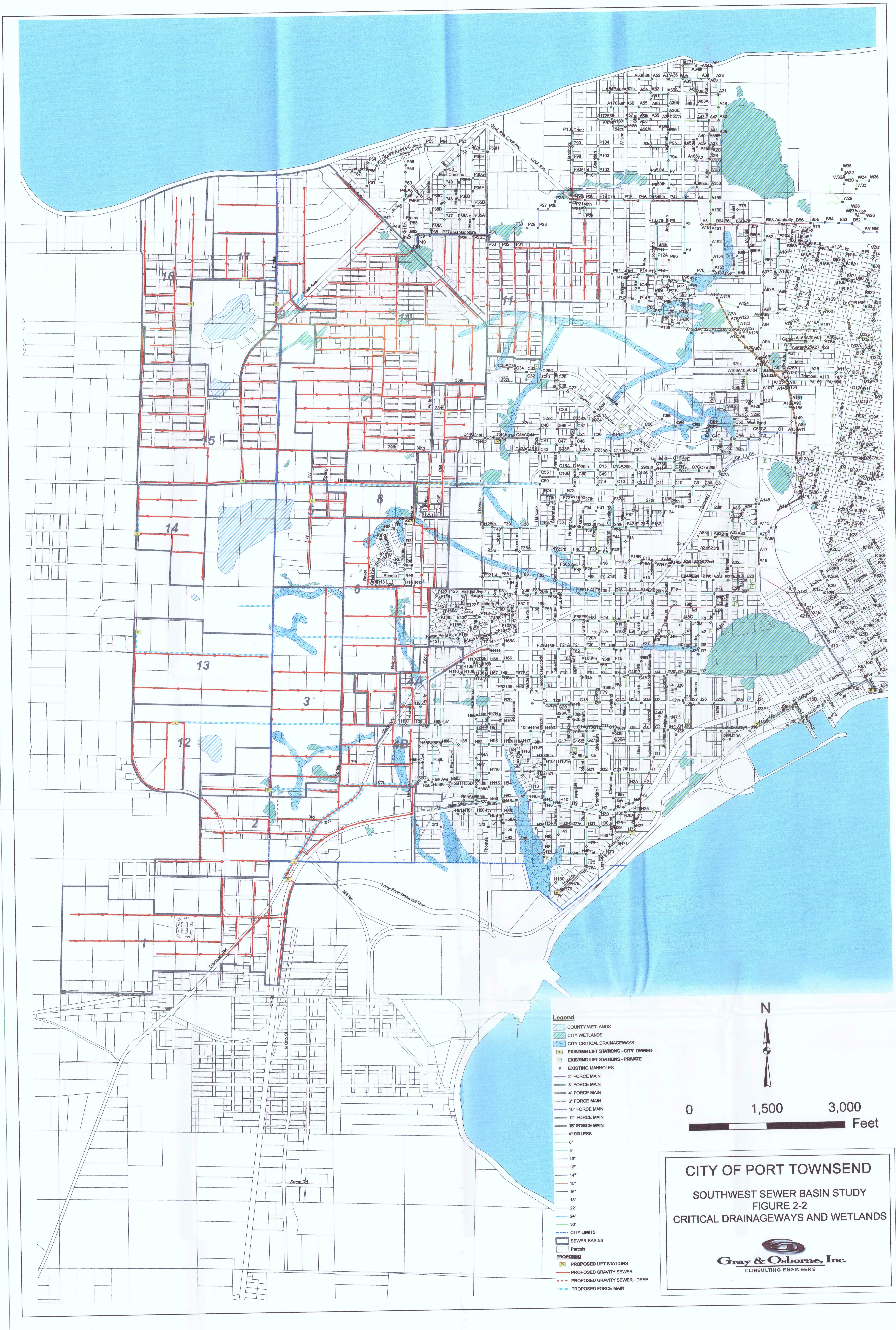
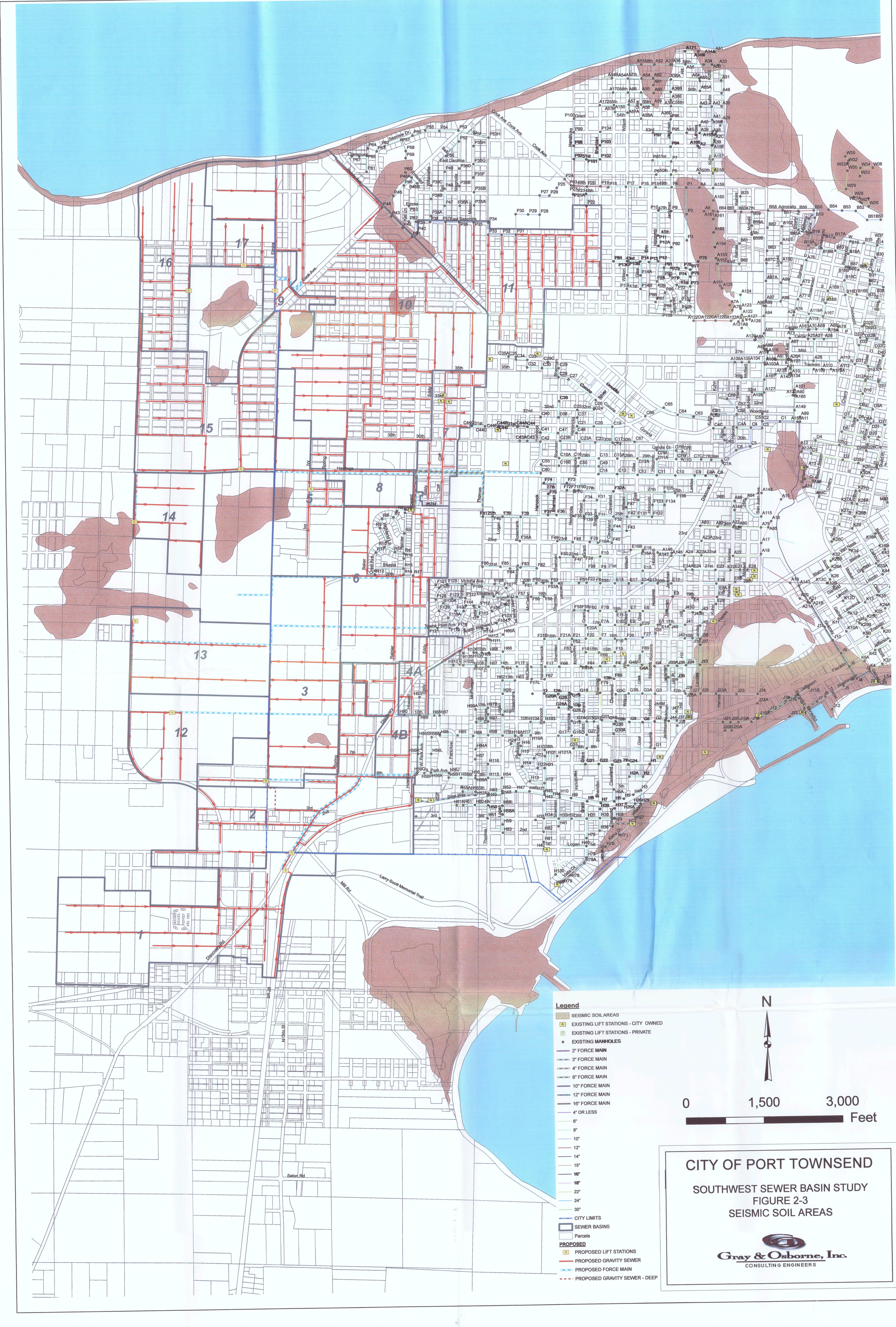

CITY OF PORT TOWNSEND
SOUTHWEST SEWER BASIN STUDY
FIGURE 2-1B
NORTHERN BASIN STUDY AREA
AND PROPOSED IMPROVEMENTS
Gray & Osborne, Inc.
CONSULTING ENGINEERS
N
0
1,000
2,000
Feet
Legend
CITY LIMITS
Buildings
Parcels
SEWER BASINS
1
2
3
4A
4B
5
6
7
8
9
10
11
12
13
14
15
16
17
EXISTING SEWER
4" OR LESS
6"
8"
10"
12"
14"
15"
16"
18"
22"
24"
30"
2" FORCE MAIN
3" FORCE MAIN
4" FORCE MAIN
6" FORCE MAIN
10" FORCE MAIN
12" FORCE MAIN
16" FORCE MAIN
EXISTING LIFT STATIONS - CITY OWNED
EXISTING LIFT STATIONS - PRIVATE
EXISTING MANHOLES
PROPOSED SEWER
PROPOSED GRAVITY SEWER
PROPOSED GRAVITY SEWER - DEEP
PS 5 FORCE MAIN
PS 9 FORCE MAIN
PS 14 FORCE MAIN
PS 15 FORCE MAIN
PS 16 FORCE MAIN
PS 17 FORCE MAIN
PROPOSED LIFT STATIONS
PS 16 AND PS 17 FORCE MAINS CAN DISCHARGE TO THIS PROPOSED MANHOLE
BASIN 10 WILL GRAVITY FLOW TO THESE EXISTING MANHOLES
BASIN 9 CAN GRAVITY FLOW OR BE PUMPED TO THIS PROPOSED MANHOLE
MAY NEED EASEMENTS TO AVOID WETLANDS OR OBTAIN PERMIT
BASIN 11 WILL GRAVITY FLOW TO MULTIPLE EXISTING MANHOLES
THIS AREA DIFFICULT TO SEWER- MULTIPLE LOW SPOTS AND WETLANDS
WETLANDS
MAY NEED EASEMENTS TO AVOID WETLANDS OR OBTAIN PERMIT
BASIN 7 WILL GRAVITY FLOW TO HAMILTON HEIGHTS LIFT STATION
BASIN 8 CAN DISCHARGE HERE IF BASIN 10 SEWER LINES ARE INSTALLED
BASIN 5 CAN DISCHARGE HERE IF BASIN 8 SEWER LINES ARE INSTALLED - DEEP SEWER LINES NEEDED
EXISTING MANHOLE FOR DISCHARGE OF PS 14 AND 15 FORCE MAINS
BASINS 14 AND 15 CAN DISCHARGE HERE IF BASIN 5 SEWER LINES ARE INSTALLED AND ADEQUATE CAPACITY IN LIFT STATIONS SERVING BASIN 5
EXISTING MANHOLE FOR DISCHARGE OF PS 5 FORCE MAIN (IF ADEQUATE CAPACITY) AND BASINS 6 AND 7
EXISTING MANHOLE FOR DISCHARGE OF PS 5 FORCE MAIN IF INADEQUATE CAPACITY AT HAMILTON HEIGHTS LIFT STATION
HAMILTON HEIGHTS LIFT STATION (EXISTING)
EXISTING MANHOLE WHERE HAMILTON HEIGHTS FORCE MAIN DISCHARGES
THIS AREA DIFFICULT TO SEWER- MULTIPLE LOW SPOTS AND WETLANDS
PS 17
PS 16
PS 9
PS 15
PS 5
PS 14
PS 13
17
16
9
10
11
15
7
5
8
14
6
3
13
4A
2
4B


CITY OF PORT TOWNSEND
SOUTHWEST SEWER BASIN STUDY
FIGURE 2-2
CRITICAL DRAINAGEWAYS AND WETLANDS
Gray & Osborne, Inc.
CONSULTING ENGINEERS
N
0
1,500
3,000
Feet
Legend
COUNTY WETLANDS
CITY WETLANDS
CITY CRITICAL DRAINAGEWAYS
EXISTING LIFT STATIONS - CITY OWNED
EXISTING LIFT STATIONS - PRIVATE
EXISTING MANHOLES
2" FORCE MAIN
3" FORCE MAIN
4" FORCE MAIN
6" FORCE MAIN
10" FORCE MAIN
12" FORCE MAIN
16" FORCE MAIN
4" OR LESS
6"
8"
10"
12"
14"
15"
16"
18"
22"
24"
30"
CITY LIMITS
SEWER BASINS
Parcels
PROPOSED
PROPOSED LIFT STATIONS
PROPOSED GRAVITY SEWER
PROPOSED GRAVITY SEWER - DEEP
PROPOSED FORCE MAIN


Legend
SEISMIC SOIL AREAS
EXISTING LIFT STATIONS - CITY OWNED
EXISTING LIFT STATIONS - PRIVATE
EXISTING MANHOLES
2" FORCE MAIN
3" FORCE MAIN
4" FORCE MAIN
6" FORCE MAIN
10" FORCE MAIN
12" FORCE MAIN
16" FORCE MAIN
4" OR LESS
6"
8"
10"
12"
14"
15"
16"
18"
22"
24"
30"
CITY LIMITS
SEWER BASINS
Parcels
PROPOSED
PROPOSED LIFT STATIONS
PROPOSED GRAVITY SEWER
PROPOSED FORCE MAIN
PROPOSED GRAVITY SEWER - DEEP
N
0
1,500
3,000
Feet
CITY OF PORT TOWNSEND
SOUTHWEST SEWER BASIN STUDY
FIGURE 2-3
SEISMIC SOIL AREAS
Gray & Osborne, Inc.
CONSULTING ENGINEERS

BASIN 3

Basin 3 is located in the southwest portion of the City limits and also includes property just west of the City limits. This basin can gravity flow to a new lift station located near the intersection of Laurel and 5th Streets, or can continue by gravity to sewer mains proposed for Basin 2. Gravity flow to Basin 2 may be limited by the following:

- The availability of sewer mains in Basin 2. It is possible Basin 3 could develop prior to any sewer main installation in Basin 2.
- The gravity flow path line from Basin 3 to Basin 2 is near wetlands and would require easements. Installation of this sewer line may be prohibited by high ground water, wetlands, and inability to procure easements.
- The gravity sewer line will be deep (up to 20-feet deep) to allow interconnection between Basins 2 and 3 based on existing topographic information.

If a lift station is installed, a force main will be needed that connects into existing gravity sewer lines near the intersection of West Park and South Park Avenues. Basin 3 has an area of 140 acres and the entire basin is assumed to be developable.

BASIN 4A

Basin 4A is located entirely in the western part of the City and within City limits. This basin will gravity flow into existing sewer lines located at the intersections of Thomas and 16th Streets or Eddy and 10th Streets. Basin 4A has a total developable area of 25 acres.

BASIN 4B

Basin 4B is located entirely in the western part of the City and within City limits. This basin will gravity flow into existing sewer lines located at the intersections of South Park and West Park Avenues. Basin 4B has an area of 40 acres and the entire basin can be developed.

BASIN 5

Basin 5 is located in the west portion of City limits. A new lift station is needed to convey wastewater from Basin 5 to a nearby existing sewer main. Several options exist to access existing sewer mains:

- Basin 5 force main can discharge into the existing manhole just prior to the Hamilton Heights Lift Station. The capacity of Hamilton Heights Lift Station needs to be evaluated since it will probably receive wastewater from other areas.

- Basin 5 force main can discharge into the manhole at the intersection of 25th and Thomas Streets (same location as where Hamilton Heights Lift Station force main terminates).

The possibility of gravity-flowing wastewater from Basin 5 was examined. The existing topographic information indicates a 20-foot deep sewer main will be needed in order to gravity flow to proposed sewer mains in Basin 8. To maintain gravity flow in Basin 8, the sewer lines in Basin 8 will also need to be deep (15- to 20-feet deep).

Basin 5 has an area of 85 acres and the entire area is assumed to be developable.

BASIN 6

Basin 6 is located within City limits and is adjacent to Hamilton Heights development. Basin 6 will gravity flow to existing sewer mains that ultimately discharge to the Hamilton Heights Lift Station. Hamilton Heights Lift Station is equipped with two, 250-gpm submersible pumps that discharge into a 6-inch force main. The 6-inch force main discharges into a manhole located at the intersection of 25th and Thomas Streets. Basin 6 has an area of 125 acres (this acreage includes the existing sewered area of Hamilton Heights). The capacity of Hamilton Heights Lift Station must be evaluated as new flows are added.

BASIN 7

Basin 7 is located within City limits, just northeast of Hamilton Heights, and will gravity flow to the Hamilton Heights Lift Station. Basin 7 has an area of 45 acres and all can be developed. Again, the capacity of Hamilton Heights Lift Station must be evaluated as new flows are added.

BASIN 8

Basin 8 is located in the western part of the City and is entirely within City limits. A wetlands area is located in the southeast portion of Basin 8 and this area is shown to not be sewered at this time. Basin 8 can gravity flow to proposed mains in Basins 10 provided an easement can be obtained and gravity flow can be maintained. Basin 8 can also gravity flow to Basin 5.

Basin 8 has a total area of 30 acres, but due to wetlands, only 15 acres are assumed to be developable at this time.

BASIN 9

Basin 9 is primarily located in the northwest portion of the City limits, with a small portion located outside City limits. A new lift station and force main are needed to convey wastewater to the nearest manhole in Basin 10 (assuming Basin 10 is developed prior to Basin 9). Alternatively, Basin 9 wastewater can gravity flow with a deep line (15- to 20-feet deep) to a line in Basin 10 if an easement can be obtained and no limiting factors (bedrock, high ground water, or critical areas) exist along the proposed sewer main route. Basin 9 has an area of 30 acres, all of which can be developed.

BASIN 10

Basin 10 is located in the northwest portion of the City limits and includes area to the west of the City limits. Wetland areas exist at two locations within Basin 10. Easements to avoid disturbance of wetlands or permits to construct within the wetlands may be needed to allow installation of gravity lines as shown on Figure 2-1B. Wastewater from this area will gravity flow to nearby existing mains. Basin 10 has an area of 380 acres and all of it can be developed.

BASIN 11

Basin 11 is located in the northwest portion of the City limits and wastewater generated from this area will be conveyed by gravity to existing nearby mains. Basin 11 has an area of 125 acres and all of this area can be developed.

BASIN 12

Basin 12 is located west of the City limits and is entirely outside current City limits. The western boundary of Basin 12 is Jacob Miller road. A new lift station and force main are needed to convey wastewater to the nearest existing manhole located near the intersection of 10th Avenue and Howard Street. Other alternatives may exist in the future as unsewered areas are developed in Basins 2 and 3 for possible connection locations for Basin 12. Basin 12 has a total area of 85 acres, but only a portion is developable due to wetlands. For this analysis, 45 acres are assumed to be developable.

BASIN 13

Basin 13 is located west of the City limits and the western boundary is Jacob Miller Road. A new lift station and force main are needed to convey wastewater to the nearest existing manhole located near the intersection of Eddy Street and Towne Point Avenue. Other alternatives may exist in the future as unsewered areas are developed between Basin 13 and existing sewer mains. Basin 13 has an area of 95 acres, all of which are developable.

BASIN 14

Basin 14 is located along Jacob Miller Road and is rather small due to nearby wetlands and multiple low spots. A new lift station and force main are needed to convey wastewater to the nearest existing manhole located near the intersection of Hancock Street and Hastings Avenue. Other alternatives may exist in the future as unsewered areas are developed between Basin 14 and existing sewer mains. Basin 14 has an area of 50 acres and the entire basin can be developed.

BASIN 15

Basin 15 is located west of the City limits, along Jacob Miller Road. A new lift station and force main are needed to convey wastewater to the nearest existing manhole located near the intersection of Hancock Street and Hastings Avenue. Other alternatives may exist in the future as unsewered areas are developed between Basin 15 and existing sewer mains. Basin 15 has an area of 145 acres and the entire area can be developed.

BASIN 16

Basin 16 is located west of the City limits, with Jacob Miller Road as the west boundary and Strait of Juan De Fuca as the north boundary. A new lift station and force main are needed to convey wastewater to Basin 10, assuming Basin 10 sewer lines are installed. Basin 16 has an area of 90 acres, all of which are developable.

BASIN 17

Basin 17 is located west of the City limits and is relatively small due to topography. A new lift station and force main are needed to convey wastewater to Basin 10, assuming Basin 10 sewer lines are installed. It may be possible to gravity flow from Basin 17 to another nearby basin with a deep main (approximately 20-feet deep), but a detailed site investigation is needed to make this determination. Other alternatives may exist in the future as unsewered areas are developed between Basin 17 and existing sewer mains. Basin 17 has an area of 25 acres and the entire basin can be developed.

CHAPTER 3

WASTEWATER FLOW AND LOADING PROJECTIONS

BACKGROUND

Projected wastewater flows were developed from each basin identified in Chapter 2. Ultimate peak day wastewater flow rates for each identified basin were based on ultimate peak day flows developed in the *City of Port Townsend Wastewater Comprehensive Plan* (CH2M Hill, September 1999). CH2M Hill assumed the ultimate peak day flow rates would be realized in the year 2046. These flow rates assume a percentage of land currently developed and to be developed based on land use zoning (excluding public right-of-ways), applies a wastewater loading rate with a peaking factor for each type of land use, and also includes infiltration and inflow values. The ultimate peak day flows were then divided by the total basin area, as presented in CH2M Hill's *Wastewater Comprehensive Plan*, to achieve an ultimate peak day flow rate per acre. Excerpts from the CH2M Hill's *Wastewater Comprehensive Plan* are included in Appendix A that provide the methodology used to develop ultimate peak day flows in each basin. Appendix A also includes a map of the sewer basins identified by CH2M Hill within City limits, which are referenced throughout this chapter with respect to flows developed for each basin identified in Chapter 2 of this study.

Flows presented in CH2M Hill's *Wastewater Comprehensive Plan* were updated by Gray & Osborne, Inc., in the *Wastewater Facilities Plan* (2000). The flows contained in the 2000 *Wastewater Facilities Plan* were slightly higher than the flows developed by CH2M Hill in the 1999 *Wastewater Comprehensive Plan*. However, the flows developed by CH2M Hill will be used for this analysis since CH2M Hill's wastewater model is used to assess existing collection and conveyance line capacity. If a new model is developed later by the City, then it is recommended that Gray & Osborne's flow information be utilized. In addition, infiltration and inflow rates may be further refined in the new model.

PROJECTED FLOWS PER BASIN

A discussion of flows from each basin follows and flow information is summarized in Table 3-1.

TABLE 3-1

Summary of Projected Ultimate Peak Day Flow for Each Basin

Basin	Area Acres	Ultimate peak day flow per Acre gpd/acre(1)	Projected Ultimate Peak Day Flow gpd(2)
1	180	1,230	221,400
2	175	1,230	215,250
3	140	1,230	172,200
4A	25	1,750	43,750
4B	40	1,750	70,000
5	85	1,020	86,700
6	125	1,000	125,000
7	45	1,000	45,000
8	15	1,020	15,300
9	30	665	19,950
10	380	665	252,700
11	125	940	117,500
12	45	1,020	45,900
13	95	1,020	96,900
14	50	1,020	51,000
15	145	1,020	147,900
16	90	1,020	91,800
17	25	1,020	25,500

(1) These values were obtained from CH2M Hill's *Wastewater Comprehensive Plan* (1999), as contained in Appendix A of this report.

(2) Flows were calculated by multiplying ultimate peak day flow per acre by the basin acreage.

BASIN 1

Basin 1 has an area of approximately 180 acres and is entirely outside existing City limits. Using the Southwest Basin flow information as presented in CH2M Hill's *Wastewater Comprehensive Plan*, the ultimate peak day flow per acre is 1,230 gallons per acre per day (gpad). The Southwest Basin flow rate information was used for Basin 1 since Basin 1 is in close proximity to the Southwest Basin and is assumed to develop in a similar manner. The ultimate peak day flow from Basin 1 is 221,400 gallons per day (gpd).

A lift station and force main are needed to access the existing gravity sewer main located near the intersection of West Park and South Park Avenues. Other alternatives to serving Basin 1 are presented in Chapter 5.

BASIN 2

Basin 2 has an area of 175 acres. Approximately two-thirds of Basin 2 is within the existing City limits and the remaining one-third is outside the City limits. The Southwest Basin ultimate peak day flow rate per acre of 1,230 gpad (as presented for Basin 1) was used since the majority of Basin 2 is within the Southwest Basin identified by CH2M Hill. The ultimate peak day flow from Basin 2 is 215,250 gpd. Basin 2 will be served by a lift station and a force main that connects into existing gravity lines on South Park Avenue. The hydraulic capacity analysis presented in Chapter 4 assumed this was the discharge location for Basin 2. Other alternatives to serving Basin 2 are presented in Chapter 5.

BASIN 3

Basin 3 has an area of 140 acres. The majority of Basin 3 is located in the southwest portion of the City limits, but a small portion also includes property just west of the City limits. The Southwest Basin ultimate peak day flow rate per acre of 1,230 gpad (as presented for Basin 1) was used since the majority of Basin 3 is within the Southwest Basin identified by CH2M Hill. The ultimate peak day flow from Basin 3 is 172,200 gpd.

This basin can gravity-flow to a new lift station located near the intersection of Laurel and 5th Streets, or can continue by gravity to sewer mains proposed for Basin 2. If a lift station is installed, a force main will be needed that connects into existing gravity sewer lines near the intersection of West Park and South Park Avenues. The hydraulic capacity analysis (Chapter 4) assumed this was the discharge location for Basin 3.

BASINS 4A AND 4B

Basins 4A and 4B have an area of 25 acres and 40 acres, respectively. Both basins are located entirely in the western part of the City and within the Sims Way Basin, as identified in CH2M Hill's *Wastewater Comprehensive Plan.* The ultimate peak day flow per acre of 1,750 gpad for Sims Way Basin was used to develop flows from Basins 4A and 4B. The ultimate peak day flow from Basin 4A is 43,750 gpd and the ultimate peak day flow from Basin 4B is 70,000 gpd. These basins can gravity flow into existing sewer lines located at the intersections of Thomas and 16th Streets, Eddy and 10th Streets, or South Park and West Park Avenues.

BASIN 5

Basin 5 is located in the west portion of City limits and has an area of 85 acres. Basin 5 is within the West Basin (as identified in the *1999 Wastewater Comprehensive Plan)*, with an ultimate peak day flow per acre of 1,020 gpad. The ultimate peak day flow for Basin 5 is 86,700 gpd. A new lift station will be needed to convey wastewater from

Basin 5 to a nearby existing sewer main. Several options exist to access existing sewer mains, as presented in Chapter 2.

BASIN 6

Basin 6 is located within City limits and is adjacent to Hamilton Heights development. Basin 6 has an area of 125 acres (this acreage includes the existing sewered area of Hamilton Heights) and is within the Hastings Avenue Basin (as identified by CH2M Hill in the *1999 Wastewater Comprehensive Plan*). The ultimate peak day flow per acre for Hastings Avenue Basin is 1,000 gpad, resulting in an ultimate peak day flow of 125,000 from Basin 6.

As discussed in Chapter 2, Basin 6 will gravity flow to existing sewer mains that ultimately discharge to the Hamilton Heights Lift Station. Hamilton Heights Lift Station is equipped with two, 250-gpm submersible pumps that discharge into a 6-inch force main. The 6-inch force main discharges into a manhole located at the intersection of 25th and Thomas Streets. Hamilton Heights Lift Station has sufficient capacity for Basin 6, but the capacity of this lift station needs to be evaluated as other basin flows are added.

BASIN 7

Basin 7 is located within City limits, just northeast of Hamilton Heights, and will gravity flow to the Hamilton Heights Lift Station. Basin 7 has an area of 45 acres and is within the Hastings Avenue Basin (as identified by CH2M Hill in the *1999 Wastewater Comprehensive Plan*). Using the flow information presented for Basin 6 of 1,000 gpad, the ultimate peak day flow for Basin 7 is 45,000 gpd. Again, the capacity of Hamilton Heights Lift Station must be examined as new flows are added to this lift station.

BASIN 8

Basin 8 has a total area of 30 acres, but due to wetlands, only 15 acres were assumed to be developable at this time. Basin 8 is located in the western part of the City and is entirely within City limits. Basin 8 is situated within the West Basin (as identified by CH2M Hill in the *1999 Wastewater Comprehensive Plan*). The West Basin ultimate peak day flow per acre of 1,020 gpad, resulting in an ultimate peak day flow of 15,300 gpd from Basin 8. Basin 8 can gravity flow to proposed mains in Basins 10 provided an easement can be obtained and gravity flow can be maintained. Basin 8 can also gravity flow to Basin 5.

BASIN 9

Basin 9 is located in the northwest portion of the City, with a small portion of Basin 9 located outside the City limits. Basin 9 has an area of 30 acres. Basin 9 is located within the Seaview/Howard Street Basin (as identified by CH2M Hill in the *1999 Wastewater Comprehensive Plan*). The ultimate peak day flow per acre for Seaview/Howard Street

Basin is 665 gpad, resulting in an ultimate peak day flow of 19,950 gpd from Basin 9. A new lift station and force main will be needed to convey wastewater to the nearest manhole in Basin 10 (assuming Basin 10 is developed prior to Basin 9). Alternatively, Basin 9 wastewater could gravity flow with a deep line (15 to 20 feet deep) to a line in Basin 10 if an easement can be obtained and no limiting factors (bedrock, high ground water, or critical areas) exist along the proposed sewer main route.

BASIN 10

Basin 10 is located in the northwest portion of the City and includes area to the west of the City limits. Basin 10 has an area of 380 acres and the majority of Basin 10 is within the Seaview/Howard Street Basin (as identified by CH2M Hill in the *1999 Wastewater Comprehensive Plan*). The ultimate peak day flow per acre for Seaview/Howard Street Basin is 665 gpad, resulting in an ultimate peak day flow of 252,700 gpd from Basin 10. Wastewater from this area will gravity-flow to nearby existing mains.

BASIN 11

Basin 11 is located in the northwest portion of the City limits and has an area of 125 acres. Basin 11 falls within two basins identified by CH2M Hill in the *1999 Wastewater Comprehensive Plan*: Seaview/Howard Street Basin and San Juan Avenue Basin. The ultimate peak day flow per acre, based on an average of the Seaview/Howard Street and San Juan Avenue Basins flows, is 940 gpad. The resulting ultimate peak day flow from Basin 11 is 117,500 gpd. Wastewater generated from this area will be conveyed by gravity to existing nearby mains.

BASIN 12

Basin 12 is located west of the City limits and is entirely outside current City limits. Basin 12 has a total area of 85 acres, but only a portion is developable due to wetlands. For this analysis, 45 acres were assumed to be developable. Basin 12 is near the West Basin (as identified by CH2M Hill in the *1999 Wastewater Comprehensive Plan*) and an ultimate peak day flow per acre of 1,020 gpad was determined for the West Basin. Applying this flow rate to Basin 12 results in an ultimate peak day flow rate of 45,900 gpd. A new lift station and force main are needed to convey wastewater to the nearest existing manhole located near the intersection of 10th Avenue and Howard Street. Other alternatives may exist in the future as unsewered areas are developed in Basins 2 and 3 for possible connection locations for Basin 12.

BASIN 13

Basin 13 is located west of the City limits and has an area of 95 acres. Basin 13 is near the West Basin (as identified by CH2M Hill in the *1999 Wastewater Comprehensive Plan*) and was assumed to develop similar to the West Basin. Using the West Basin flow rate of 1,020 gpad, as presented for Basin 12, the ultimate peak day flow from Basin 13 is

96,900 gpd. A new lift station and force main are needed to convey wastewater to the nearest existing manhole located near the intersection of Eddy Street and Towne Point Avenue. Other alternatives may exist in the future as unsewered areas are developed between Basin 13 and existing sewer mains.

BASIN 14

Basin 14 is located along Jacob Miller Road is rather small due to nearby wetlands and multiple low spots. Basin 14 has an area of 50 acres and was assumed to develop similar to the West Basin (as identified by CH2M Hill in the *1999 Wastewater Comprehensive Plan*). Using the West Basin flow rate value of 1,020 gpad, as presented for Basin 12, the ultimate peak day flow from Basin 14 is 51,000 gpd.

A new lift station and force main are needed to convey wastewater to the nearest existing manhole located near the intersection of Hancock Street and Hastings Avenue. Other alternatives may exist in the future as unsewered areas are developed between Basin 14 and existing sewer mains.

BASIN 15

Basin 15 is located west of the City limits, along Jacob Miller Road and has an area of 145 acres. Basin 15 was assumed to develop similar to the West Basin (as identified by CH2M Hill in the *1999 Wastewater Comprehensive Plan*), for an ultimate peak day flow of 147,900 gpd. A new lift station and force main are needed to convey wastewater to the nearest existing manhole located near the intersection of Hancock Street and Hastings Avenue. Other alternatives may exist in the future as unsewered areas are developed between Basin 15 and existing sewer mains.

BASIN 16

Basin 16 is located west of the City limits, with Jacob Miller Road as the west boundary and Strait of Juan De Fuca as the north boundary. Basin 16 has an area of 90 acres. Similar to Basin 15, Basin 16 ultimate peak day flow was calculated using West Basin information (as identified by CH2M Hill in the *1999 Wastewater Comprehensive Plan*). The ultimate peak day flow from Basin 16 is 91,800 gpd. A new lift station and force main are needed to convey wastewater to Basin 10, assuming Basin 10 sewer lines are installed.

BASIN 17

Basin 17 is located west of the City limits and is relatively small due to topography. Basin 17 has an area of 25 acres and was assumed to develop similar to the West Basin (as identified by CH2M Hill in the *1999 Wastewater Comprehensive Plan*), for an ultimate peak day flow of 25,500 gpd. A new lift station and force main are needed to convey wastewater to Basin 10, assuming Basin 10 sewer lines are installed. It may be possible to gravity-flow from Basin 17 to another nearby basin with a deep main, but a detailed site investigation is needed to make this determination. Other alternatives may exist in the future as unsewered areas are developed between Basin 17 and existing sewer mains.

CHAPTER 4

DOWNSTREAM ANALYSIS OF EXISTING FACILITIES

BACKGROUND

As the unsewered areas are developed (as shown in Figures 2-1A and 2-1B), the capacity of the existing collection lines affected by the increased flow must be examined. Impacts to the wastewater treatment plant from the additional flows must also be examined. Improvements, consisting of increased sewer line sizes, are identified in this Chapter to allow the City to plan for these future improvements.

SEWER LINE ANALYSIS

The existing sewer model developed by CH2M Hill (as presented in the *1999 Wastewater Comprehensive Plan*) was used to assess the adequacy of existing sewer lines. This model was developed using HydraGraphics software. CH2M Hill's model was run using ultimate peak hour flows from all basins within City limits. Ultimate peak hour flows assume all developable areas within City limits are developed, which is anticipated to occur in the year 2046, and include infiltration and inflow (I/I). A copy of CH2M Hill's model that was presented in the *1999 Wastewater Comprehensive Plan* is in Appendix B.

The existing model flows within City limits were not altered; however, pipe sizes were increased to reflect recent collection system improvements. Additional flows from basins, or portions of basins, outside City limits were added into the model at the discharge locations presented in Figures 2-1A and 2-1B. The model is based on ultimate peak hour flows, so the ultimate peak day flows presented in Chapter 3 were converted to peak hour flows for those basins outside the City limits. CH2M Hill applied a 1.27 peaking factor to peak day flows, that included both wastewater and I/I flows, to achieve peak hour flows. This peaking factor was considered low, and a higher peaking factor was investigated. A peaking factor of 1.7 was selected based on the diurnal fluctuations presented in CH2M Hill's *Wastewater Comprehensive Plan*, where the peak hourly flow was approximately 1.77 times the average daily flow. The peaking factor of 1.7 was thought to be conservative and provide model results that are conservative when evaluating sewer line capacity. The peaking factor of 1.7 was applied to the ultimate peak day flow presented in Chapter 3, and these flows contained both wastewater flows and I/I flows. The peaking factor may be further refined if a new model is developed and flows are revised. Table 4-1 presents the additional flows added from the basins outside City limits. Model results for the increased wastewater flows from basins outside City limits are contained in Appendix C.

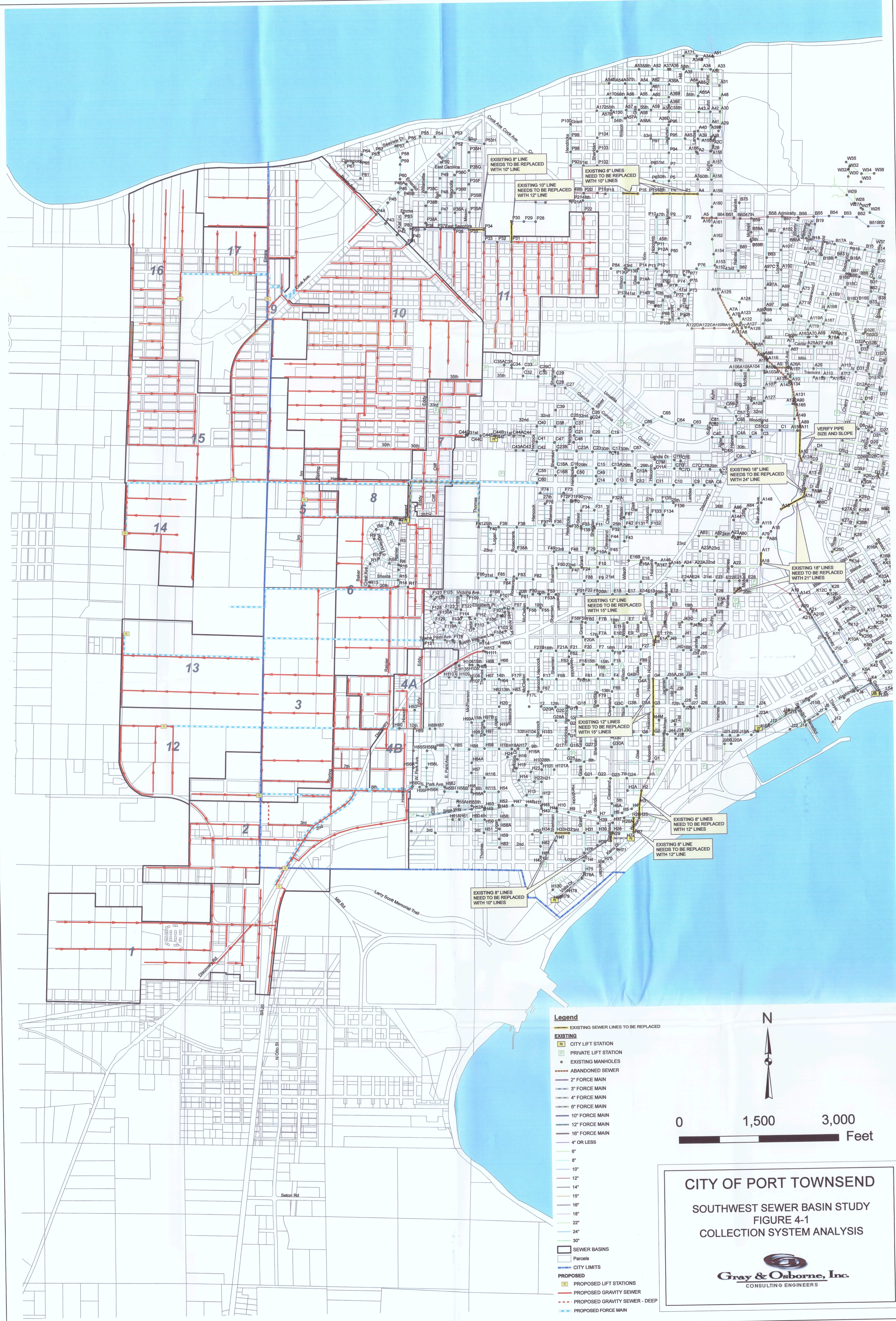
Figure 4-1 presents the lines that will exceed capacity and the required new sewer line size.

One area of concern on Figure 4-1 is near the golf course. A wastewater lift station and force main were installed near Gaines and Water Streets to divert flows from the existing gravity main in the golf course. This lift station (Gaines Street Lift Station) has a capacity of 2,300 gpm. This lift station is adequate for future flows based on ultimate peak flows predicted in CH2M Hill's model of 2,170 gpm (3.12 mgd). The existing 18-inch gravity line in the golf course (MH A12 to MH A18) will realize increased flows than previously analyzed due to the additional flows from new basins outside the City limits. The basins outside the City limits will contribute approximately 0.80 mgd during peak hourly flow conditions. Table 4-2 provides a summary of flows in this segment of sewer line. As seen in Table 4-2, some lines exceed the capacity of the existing 18-inch line due to the increased flows from basins outside the City limits. These lines should be further evaluated for surcharging. In addition, flows in this line can be further reduced as the City continues to address I/I within the system.

The model presents several limitations:

- When modeling the effects of the additional flow from each basin, it was assumed all flows peaked simultaneously and the lag time that will occur for peak flows to travel throughout the collection system was not considered. This assumption is conservative and more refined modeling may be necessary.

- For basins within City limits, the model assumed additional flows from unsewered areas would be evenly distributed throughout the existing collection system. This study indicates that the wastewater flows from new sewer basins within City limits will typically discharge to one location; therefore, the flows in the existing model need to be modified to reflect the discharge locations identified in this study.



CITY OF PORT TOWNSEND

SOUTHWEST SEWER BASIN STUDY
FIGURE 4-1
COLLECTION SYSTEM ANALYSIS

Gray & Osborne, Inc.
CONSULTING ENGINEERS

TABLE 4-2

Golf Course Line Analysis

Sewer Pipe Section	Existing Pipe Size, inches	Slope	Capacity, Mgd	Ultimate Peak Hourly Flow within City Limits, mgd(1)	Ultimate Peak Hourly Flow with Basins Outside City Limits, mgd(2)
A18-A17	18	0.0009	2.291	2.276	3.076
A17-85	18	0.0020	3.378	2.276	3.076
A85-A16	18	-0.0003	Need to Verify Slope	2.306	3.106
A16-A15	18	0.0025	3.778	2.344	3.144
A15-A14	18	0.0011	2.544	2.346	3.146
A14-A87	18	0.0006	1.909	2.348	3.148
A87-A13	18	0.0027	3.931	2.449	3.249
A13-A12A	18	0.0019	3.351	2.451	3.251
A12A-A12	18	-0.0021	Need to Verify Slope	2.639	3.439

(1) Ultimate peak hourly flows for basins within the City limits, as shown in CH2M Hill's Model, were reduced by 3.12 MGD to reflect the flow that is diverted around the golf course line.

(2) These flows were derived by adding 0.80 mgd, the additional flow from basins outside the City limits, to the flow values in the previous column.

TABLE 4-1

Wastewater Flows from Basins Outside City Limits

Basin	Percent of Basin Outside City Limits	Ultimate Peak Day Flow, gpd(1)	Peak Hourly Flow, mgd(2)
1	100	221,400	0.376
2	30	71,030	0.121
3	20	34,400	0.058
9	20	3,990	0.007
10	10	25,270	0.043
12	100	45,900	0.078
13	100	96,900	0.165
14	100	51,000	0.087
15	100	147,900	0.251
16	100	91,800	0.156
17	100	25,500	0.043

(1) Flows were developed by multiplying percent of basin outside City limits by the total basin flow presented in Chapter 3.

(2) Flows were calculated by multiplying Ultimate Peak Day Flow by a peaking factor of 1.7, then converting to million gallons per day (mgd).

CHAPTER 5

EVALUATION OF SEWER SERVICE ALTERNATIVES

BACKGROUND

Alternatives for serving Basins 1, 2, and 3 were examined since these basins are anticipated to develop first. Costs were developed for each alternative as Basin 1 service area changed. In addition, the costs for serving a local area of more intense rural development (LAMIRD) (south of existing City limits) and serving a recently City-acquired parcel of land (near Basins 12 and 13) for an educational facility are presented in this chapter.

The following alternatives were examined:

- **Alternative 1:** Basins 1 (180 acres), 2 (175 acres), and 3 (140 acres) all gravity flow to a common lift station near the intersection of Discovery Road and Sims Way.
- **Alternative 2:** Basins 1 (270 acres), 2 (175 acres), and 3 (140 acres) all gravity flow to a common lift station near the intersection of Thomas Street and Larry Scott Memorial Trail.
- **Alternative 3:** Basins 1 (1,245 acres), 2 (175 acres), and 3 (140 acres) all gravity flow to a common lift station on Mill Road. Basin 1 includes LAMIRD and surrounding area that can gravity-flow to a lift station on Mill Road.
- **Alternative 4:** Basins 1, 2, and 3 are each served by individual lift stations, with Basin 1 varying in size (180 acres, 270 acres, and 1,245 acres).
- **Alternative 5:** Basins 1 and 2 are served by a common lift station and Basin 3 is served by its own individual lift station, with Basin 1 varying in size (180 acres, 270 acres, and 1,245 acres).
- **Alternative 6:** Basins 2 and 3 are served by a common lift station and Basin 1 is served by its own individual lift station, with Basin 1 varying in size (180 acres, 270 acres, and 1,245 acres).
- **Alternative 7:** Basins 1, 2, and 3 are served by a common lift station, with Basin 1 serving LAMIRD and area north of LAMIRD.
- **Alternative 8:** This alternative examines the cost for serving the proposed educational facility near Basins 12 and 13.

Peak hourly flows were developed for each basin by applying a peaking factor of 1.7 to the maximum peak day flows presented in Table 3-1, or revised maximum peak day flows for Basin 1 as the service area was expanded. Following is a more detailed description of each alternative, along with benefits, limitations, and costs of each alternative. Costs for each alternative were developed for major trunk lines, force mains, and lift stations that were unique to each alternative to allow comparison between alternatives.

ALTERNATIVE 1: BASINS 1, 2, AND 3 SERVED BY COMMON LIFT STATION, BASIN 1 180 ACRES

Alternative 1 consists of serving Basins 1, 2, and 3 by a common lift station located near Discovery Road and Sims Way intersection, with the force main discharging at an existing manhole near the intersection of West Park and South Park Avenues. Figure 5-1 shows the areas to be served and the basic infrastructure layout for Alternative 1. For this alternative, Basin 1 serves 180 acres. The peak hourly flows from each basin are as follows:

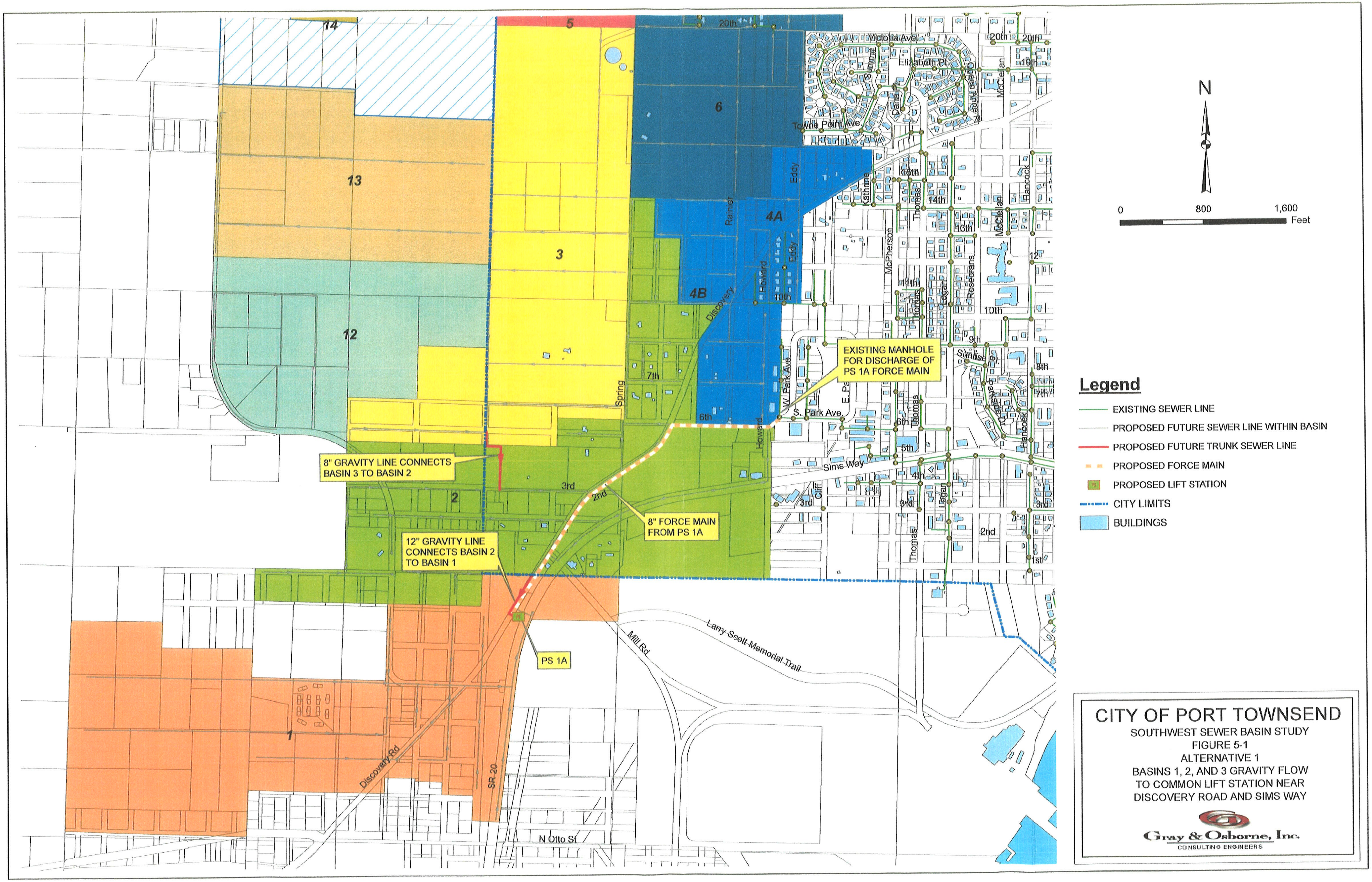
- Basin 1: 265 gpm
- Basin 2: 255 gpm
- Basin 3: 200 gpm

As seen in Figure 5-1, two major trunk lines are needed: an 8-inch gravity line to convey wastewater from Basin 3 to Basin 2 and a 12-inch gravity line in Basin 1 to convey wastewater flows from all three basins to the common lift station. The 8-inch line needed to interconnect Basin 3 with Basin 2 is approximately 750-feet long. This line will need to be deep (up to 20-feet deep) and is located near wetlands on private land. A relatively short (500 feet) 12-inch gravity line is needed to convey wastewater from Basin 2 to Basin 1. Manholes along these two gravity lines are assumed to be located every 300 feet. The lift station is designed for a peak hourly flow of 720 gpm and 170 feet total dynamic head (TDH). The force main from the lift station is 8 inches in diameter with a length of 3,600 feet to access an existing manhole in South Park Avenue. This force main is proposed to be located along existing public right-of-way in Discovery Road.

The benefit of this alternative is that only one lift station is needed to serve all three basins. Two limitations exist for this alternative:

- The 8-inch gravity line needed to interconnect Basins 2 and 3 is deep (up to 20 feet), and this line may not feasible due to existing wetlands and easements needed for installation of this line.
- A long force main (3,600 feet) is needed to access an existing manhole for this alternative.

The estimated cost for this alternative is approximately $2,916,700 (see Table 5-1). This cost estimate includes easement, right-of-way, and permit costs necessary for the installation of new infrastructure. The impacts to existing sewer lines from Basins 1, 2, and 3 flows exclusively were not examined; however, impacts would be similar to the findings presented in Chapter 4.



CITY OF PORT TOWNSEND

SOUTHWEST SEWER BASIN STUDY
FIGURE 5-1
ALTERNATIVE 1
BASINS 1, 2, AND 3 GRAVITY FLOW TO COMMON LIFT STATION NEAR DISCOVERY ROAD AND SIMS WAY

Gray & Osborne, Inc.
CONSULTING ENGINEERS

TABLE 5-1

Alternative 1 – Cost Estimate for Serving Basins 1 (180 Acres), 2, and 3 by Common Lift Station

NO.	ITEM	QUANTITY	UNIT PRICE	AMOUNT
1	Construction Surveying	1 LS	$ 10,000.00	$ 10,000.00
2	Spill Prevention, Control, and Countermeasure Plan	1 LS	$ 3,000.00	$ 3,000.00
3	Locate Existing Utilities	1 LS	$ 10,000.00	$ 10,000.00
4	Mobilization , Cleanup, and Demobilization	1 LS	$ 100,000.00	$ 100,000.00
5	Project Temporary Traffic Control	1 LS	$ 20,000.00	$ 20,000.00
6	Removal of Structure and Obstruction	1 LS	$ 10,000.00	$ 10,000.00
7	Manhole 48-inch Diameter	7 EA	$ 4,500.00	$ 31,500.00
8	Trench Excavation Safety System	1 LS	$ 6,000.00	$ 6,000.00
9	8-inch SDR 35 Sanitary Sewer Pipe and Fittings for Open Cut , Incl. Bedding, Backfill, & Surfacing , Connects Basin 3 to Basin 2	750 LF	$ 150.00	$ 112,500.00
10	12-inch SDR 35 Sanitary Sewer Pipe and Fittings for Open Cut , Incl. Bedding, Backfill, & Surfacing Connects Basin 2 to Basin 1	500 LF	$ 140.00	$ 70,000.00
11	8-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing	3,600 LF	$ 130.00	$ 468,000.00
12	Lift Station - 720 gpm, 170 TDH	1 LS	$1,000,000.00	$1,000,000.00
13	Temporary Erosion and Sediment Control	1 LS	$ 5,000.00	$ 5,000.00

Subtotal	$1,846,000.00
Sales Tax @ 8.40 %:	$ 155,100.00
Subtotal	$2,001,100.00
Construction Contingency (20%)	$ 400,300.00
TOTAL ESTIMATED CONSTRUCTION COST	$2,401,400.00
Easements/ROW	$ 20,000.00
Permits	$ 15,000.00
Engineering and Construction Management (20%)	$ 480,300.00
TOTAL ESTIMATED PROJECT COST	$2,916,700.00

ALTERNATIVE 2: BASINS 1, 2, AND 3 SERVED BY COMMON LIFT STATION, BASIN 1 270 ACRES

Alternative 2 consists of serving Basins 1, 2, and 3 by a common lift station located near the intersection of Thomas Street and Larry Scott Memorial Trail. Alternative 2 is similar to Alternative 1, except that a larger area is served in Basin 1 (270 acres) as opposed to the area served in Alternative 1 (180 acres). Figure 5-2 shows the basic infrastructure associated with this alternative. Using the same loading rates as presented in Chapter 3, the peak hourly flows from each basin are as follows:

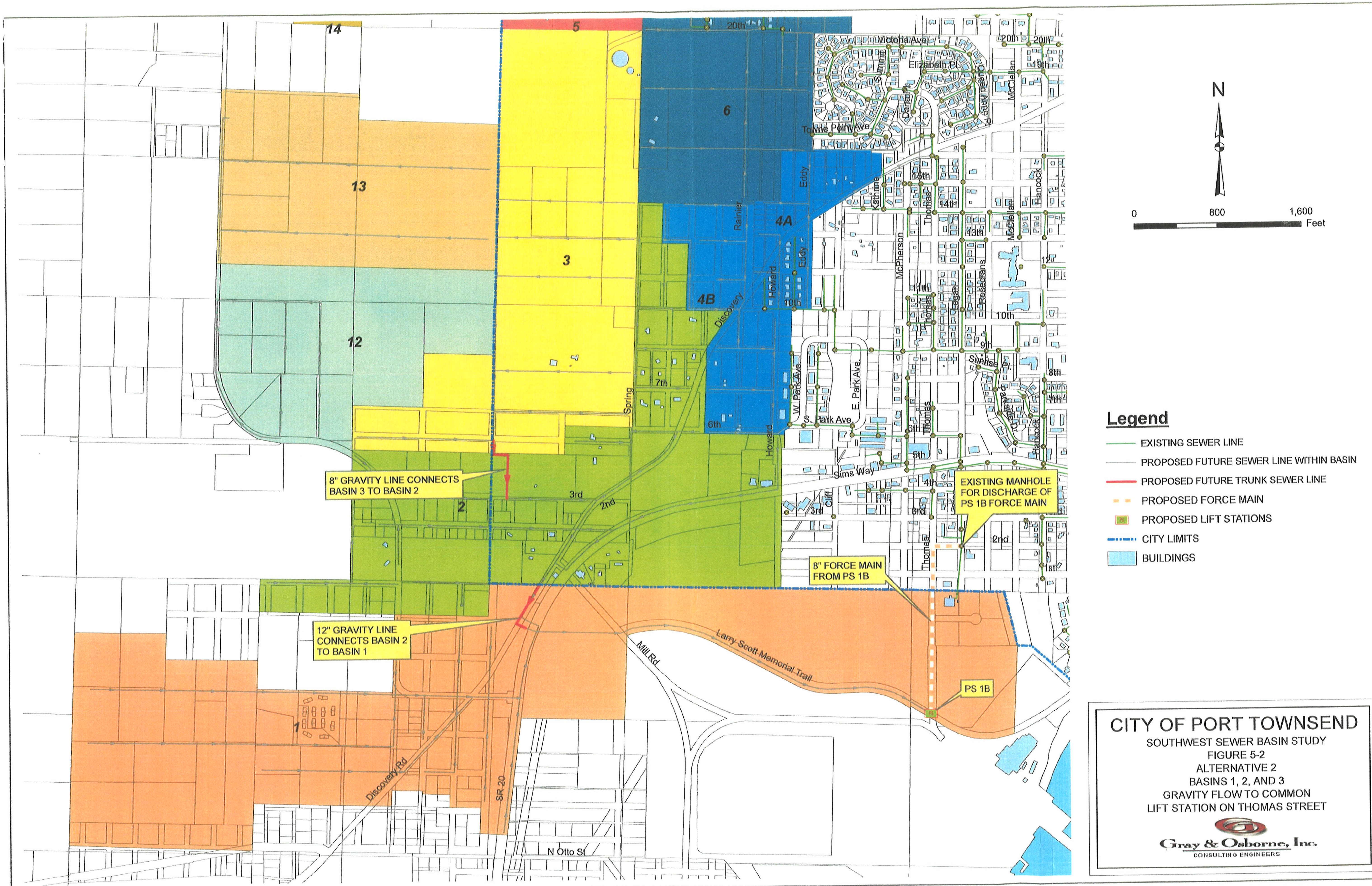
- Basin 1: 390 gpm
- Basin 2: 255 gpm
- Basin 3: 200 gpm

Again, a deep 8-inch gravity line is needed to convey wastewater from Basin 3 to Basin 2, as presented in Alternative 1 and a 500-foot long 12-inch gravity line is needed to interconnect Basin 2 flows with Basin 1. Manholes along these two gravity lines are assumed to be located every 300 feet. The lift station is assumed to have a flow of approximately 845 gpm and require 190 feet TDH. The proposed lift station is located near the intersection of Larry Scott Memorial Trail and Thomas Street on property owned by Port Townsend Paper Corporation. The main gravity line needed to access the lift station will be located in the Larry Scott Memorial Trail (old railroad grade). The force main from the lift station to the existing sewer line is approximately 1,900 lineal feet and assumed to be 8 inches in diameter. The force main will discharge into an existing manhole located at the intersection of 2nd and Logan Streets.

The benefit of this alternative is that only one lift station is needed to serve all three basins. Two limitations exist for this alternative:

- The 8-inch gravity line needed to interconnect Basins 2 and 3 is deep, and this line may not feasible due to existing wetlands and easements needed for installation of this line.
- A long gravity line (4,600 feet) is needed to convey wastewater to a lift station located near the intersection of the Larry Scott Memorial Trail and Thomas Street (see Figure 5-2). The area north of this line is located on steep ground and has limited potential to be fully developed; therefore, the gravity line traversing the Larry Scott Memorial Trail may not serve many future homes or businesses.

The cost for this alternative is approximately $2,742,700 and detailed cost information is contained in Table 5-2. This cost estimate includes easement and right-of-way costs for the gravity lines, force mains, and lift stations located outside public right-of-way. The cost estimate also includes permitting costs for installing infrastructure near wetlands or other sensitive areas. The impacts to existing sewer lines were not examined for this alternative, but upgrades to the existing collection system will be needed to accommodate this increased flow.



CITY OF PORT TOWNSEND

SOUTHWEST SEWER BASIN STUDY
FIGURE 5-2
ALTERNATIVE 2
BASINS 1, 2, AND 3
GRAVITY FLOW TO COMMON
LIFT STATION ON THOMAS STREET

Gray & Osborne, Inc.
CONSULTING ENGINEERS

TABLE 5-2

Alternative 2 – Cost Estimate for Serving Basins 1 (270 Acres), 2, and 3 by Common Lift Station

NO.	ITEM	QUANTITY	UNIT PRICE	AMOUNT
1	Construction Surveying	1 LS	$ 10,000.00	$ 10,000.00
2	Spill Prevention, Control, and Countermeasure Plan	1 LS	$ 3,000.00	$ 3,000.00
3	Locate Existing Utilities	1 LS	$ 10,000.00	$ 10,000.00
4	Mobilization , Cleanup, and Demobilization	1 LS	$ 100,000.00	$ 100,000.00
5	Project Temporary Traffic Control	1 LS	$ 20,000.00	$ 20,000.00
6	Removal of Structure and Obstruction	1 LS	$ 10,000.00	$ 10,000.00
7	Manhole 48-inch Diameter	7 EA	$ 4,500.00	$ 31,500.00
8	Trench Excavation Safety System	1 LS	$ 6,000.00	$ 6,000.00
9	8-inch SDR 35 Sanitary Sewer Pipe and Fittings for Open Cut , Incl. Bedding, Backfill, & Surfacing , Connects Basin 3 to Basin 2	750 LF	$ 150.00	$ 112,500.00
10	12-inch SDR 35 Sanitary Sewer Pipe and Fittings for Open Cut , Incl. Bedding, Backfill, & Surfacing Connects Basin 2 to Basin 1	500 LF	$ 140.00	$ 70,000.00
11	8-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing	1,900 LF	$ 130.00	$ 247,000.00
12	Lift Station - 845 gpm, 190 TDH	1 LS	$1,100,000.00	$ 1,100,000.00
13	Temporary Erosion and Sediment Control	1 LS	$ 5,000.00	$ 5,000.00

Subtotal	$ 1,725,000.00
Sales Tax @ 8.40 %:	$ 144,900.00
Subtotal	$ 1,869,900.00
Construction Contingency (20%)	$ 374,000.00
TOTAL ESTIMATED CONSTRUCTION COST	$ 2,243,900.00
Easements/ROW	$ 30,000.00
Permits	$ 20,000.00
Engineering and Construction Management (20%)	$ 448,800.00
TOTAL ESTIMATED PROJECT COST	$ 2,742,700.00

ALTERNATIVE 3: BASINS 1, 2, AND 3 SERVED BY COMMON LIFT STATION, BASIN 1 1,245 ACRES

The City has been requested to consider wastewater service to an area south of City limits, located along State Route 20. This area has been identified as a local area of more intense rural development (LAMIRD) and is currently zoned for light industrial and commercial purposes. The LAMIRD area is delineated in Figure 5-3. If the LAMIRD area is served, then a lift station is needed near Mill Road. Placing a lift station at this location and elevation (20 feet) allows a significant area to be served. Basin 1, as shown in Figure 5-3, has an area of approximately 1,245 acres and the entire area can gravity flow to the proposed lift station on Mill Road. Critical areas do not exist within this basin per information on Jefferson County's website and the entire area is assumed to be developable. A wastewater loading rate of 1,230 gpd/acre was used to be consistent with projected wastewater flows from Basin 1, as developed in Chapter 3. The peak hourly flows from each basin are as follows:

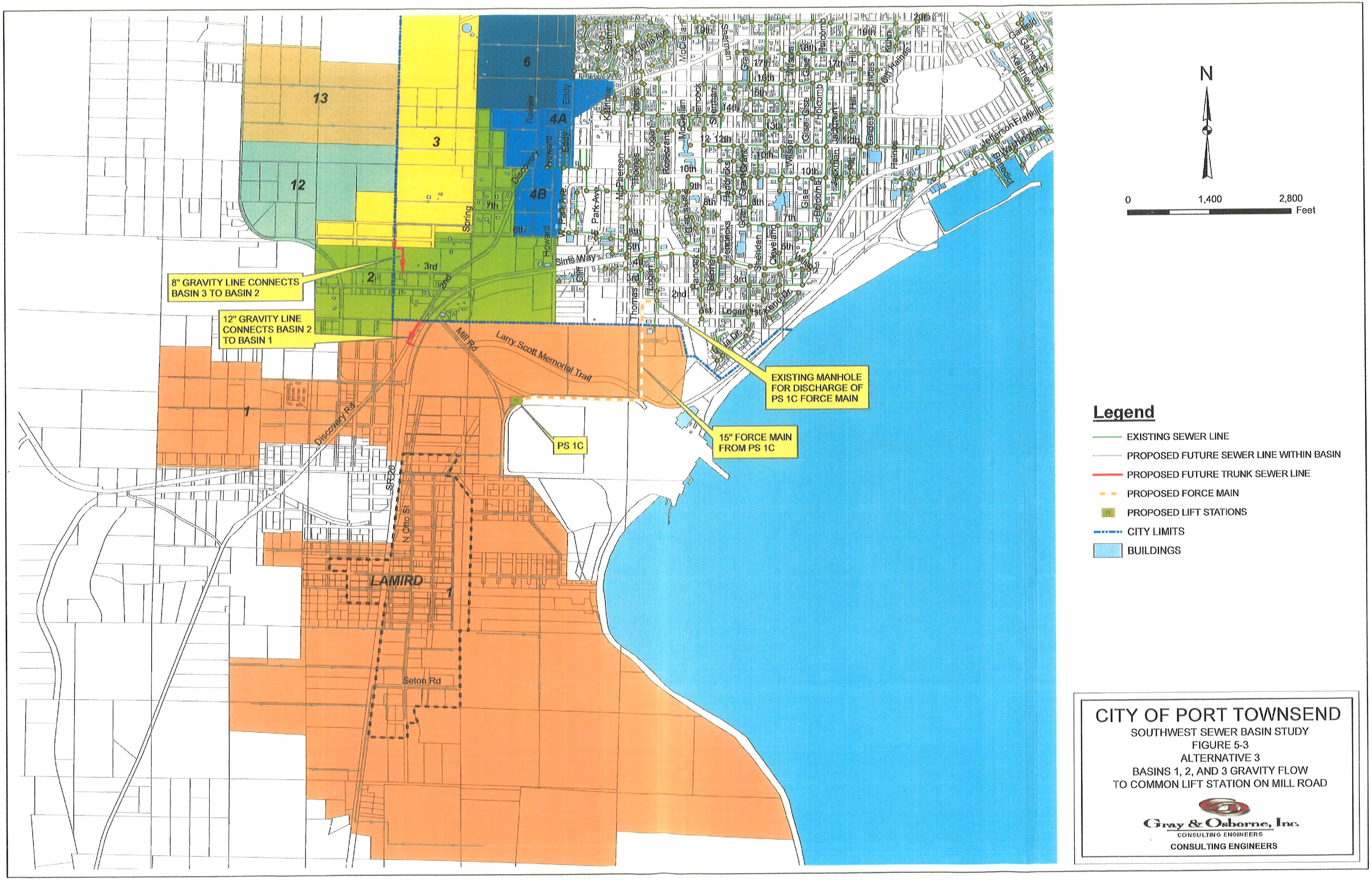
- Basin 1: 1,810 gpm
- Basin 2: 255 gpm
- Basin 3: 200 gpm

Again, a deep 8-inch gravity line is needed to convey wastewater from Basin 3 to Basin 2 and a 12-inch gravity line is needed to connect Basins 1 and 2, as presented in Alternatives 1 and 2. The lift station is assumed to have a flow of approximately 2,265 gpm and require 230-feet TDH. The proposed lift station is located on property owned by Port Townsend Paper Corporation. The force main from the lift station to the existing sewer line is approximately 3,900 lineal feet and assumed to be 15 inches in diameter. The force main will discharge into an existing manhole located at the intersection of 2^{nd} and Logan Streets.

The benefit of this alternative is that only one lift station is needed to serve all three basins. Three limitations exist for this alternative:

- The 8-inch gravity line needed to interconnect Basins 2 and 3 is deep, and this line may not feasible due to existing wetlands and easements needed for installation of this line.
- The proposed lift station requires large pumps at full build-out but initial lift station capacity will be much less than the projected 2,265 gpm and 230 TDH. The City will most likely build a smaller lift station initially, then conduct upgrades to the lift station as needed as Basins 1, 2, and 3 develop. The phasing of the lift station construction will increase costs.
- Existing gravity lines within City limits will need to be enlarged to accommodate the projected flow.

The cost for this alternative is approximately $5,614,600 and detailed cost information is contained in Table 5-3. This cost estimate includes easement and right-of-way costs for the gravity lines, force mains, and lift stations located outside public right-of-way. The cost estimate also includes permitting costs for installing infrastructure near wetlands or other sensitive areas. The cost estimate assumes the lift station will be constructed in phases, thus a rather high lift station cost is presented. The impacts to existing sewer lines were not modeled for this alternative. However, given the large amount flow generated in the proposed Basin 1 (as shown in Figure 5-3), existing gravity lines receiving this additional flow will need to be enlarged.



CITY OF PORT TOWNSEND

SOUTHWEST SEWER BASIN STUDY

FIGURE 5-3

ALTERNATIVE 3

BASINS 1, 2, AND 3 GRAVITY FLOW TO COMMON LIFT STATION ON MILL ROAD

Gray & Osborne, Inc.
CONSULTING ENGINEERS

CONSULTING ENGINEERS

TABLE 5-3

Alternative 3 – Cost Estimate for Serving Basins 1 (1,245 Acres), 2, and 3 by Common Lift Station

NO.	ITEM	QUANTITY	UNIT PRICE	AMOUNT
1	Construction Surveying	1 LS	$ 10,000.00	$ 10,000.00
2	Spill Prevention, Control, and Countermeasure Plan	1 LS	$ 3,000.00	$ 3,000.00
3	Locate Existing Utilities	1 LS	$ 10,000.00	$ 10,000.00
4	Mobilization , Cleanup, and Demobilization	1 LS	$ 150,000.00	$ 150,000.00
5	Project Temporary Traffic Control	1 LS	$ 20,000.00	$ 20,000.00
6	Removal of Structure and Obstruction	1 LS	$ 10,000.00	$ 10,000.00
7	Manhole 48-inch Diameter	7 EA	$ 4,500.00	$ 31,500.00
8	Trench Excavation Safety System	1 LS	$ 6,000.00	$ 6,000.00
9	8-inch SDR 35 Sanitary Sewer Pipe and Fittings for Open Cut , Incl. Bedding, Backfill, & Surfacing , Connects Basin 3 to Basin 2	750 LF	$ 150.00	$ 112,500.00
9	12-inch SDR 35 Sanitary Sewer Pipe and Fittings for Open Cut , Incl. Bedding, Backfill, & Surfacing Connects Basin 2 to Basin 1	500 LF	$ 140.00	$ 70,000.00
10	15-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing	3,900 LF	$ 160.00	$ 624,000.00
11	Lift Station 2,265 gpm, 230 TDH	1 LS	$ 2,500,000.00	$ 2,500,000.00
12	Temporary Erosion and Sediment Control	1 LS	$ 5,000.00	$ 5,000.00

Subtotal	$ 3,552,000.00
Sales Tax @ 8.40 %:	$ 298,400.00
Subtotal	$ 3,850,400.00
Construction Contingency (20%)	$ 770,100.00
TOTAL ESTIMATED CONSTRUCTION COST	$ 4,620,500.00
Easements/ROW	$ 50,000.00
Permits	$ 20,000.00
Engineering and Construction Management (20%)	$ 924,100.00
TOTAL ESTIMATED PROJECT COST	$ 5,614,600.00

ALTERNATIVE 4: BASINS 1, 2, AND 3 SERVED BY INDIVIDUAL LIFT STATIONS, BASIN 1 AREA VARIES

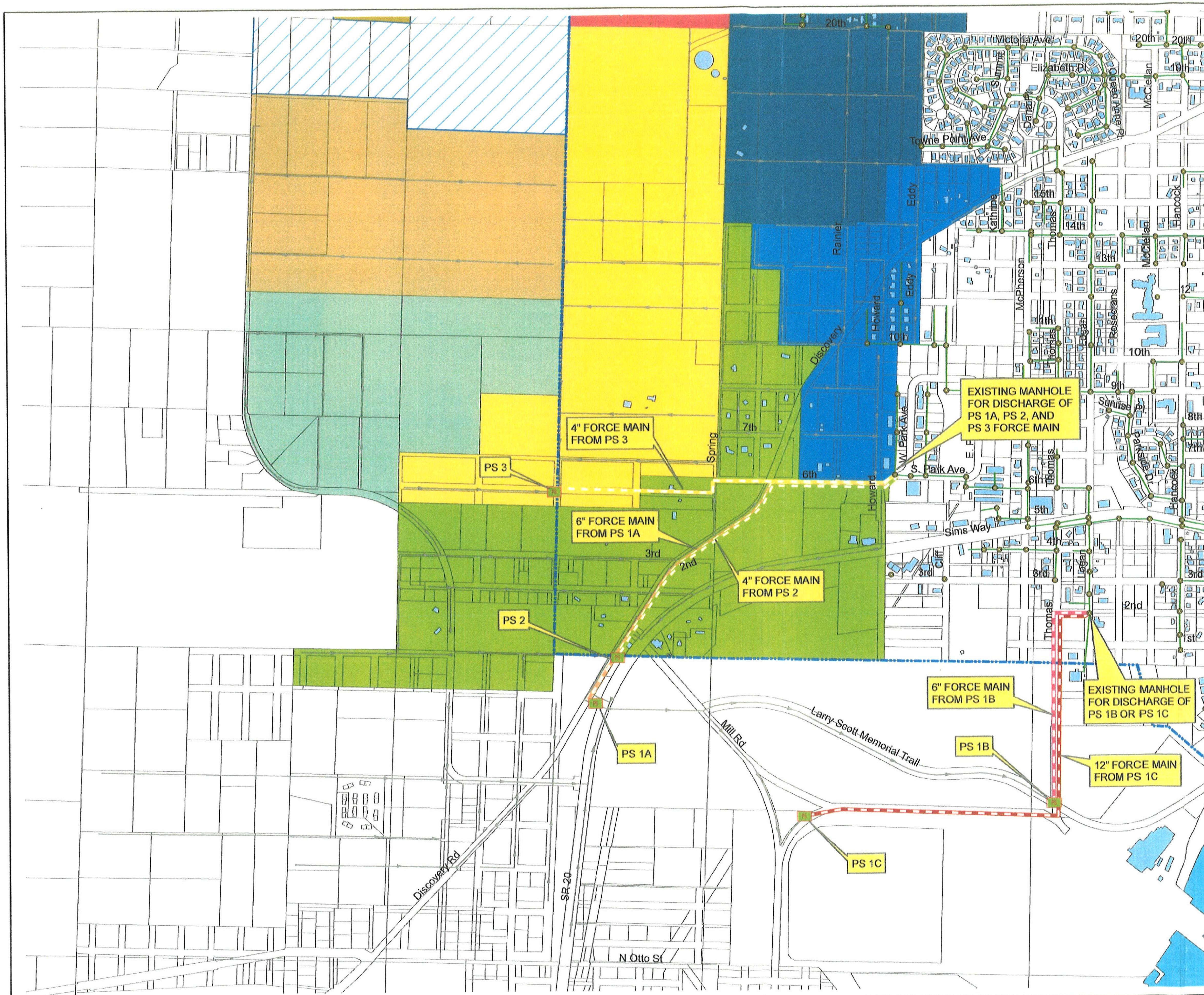
Alternative 4 consists of installing individual lift stations and force mains to serve Basins 1, 2, and 3. The peak hourly flows from each basin are the same as in Alternatives 1, 2, and 3:

- Basin 1: 265 gpm (180 acres), 390 gpm (270 acres), 1,810 gpm (1,245 acres)
- Basin 2: 255 gpm
- Basin 3: 200 gpm

Basin 1 lift station size and location will vary depending on the Basin 1 service area, effecting the force main size and length. The following lift stations and force mains are needed for Basin 1:

- Alternative 4A: If Basin 1 is 180 acres in size (as presented in Alternative 1 and Figure 5-1), the peak projected hourly flow is 265 gpm. As shown in Figure 5-4, a lift station (PS 1A) is located near the intersection of Discovery Road and Sims Way and a 6-inch force main is needed to access the nearest existing manhole on South Park Avenue. The length of the force main is approximately 3,600 feet. The lift station is designed for a peak hourly flow of 265 gpm and TDH of 150 feet.
- Alternative 4B: If Basin 1 is 270 acres in size (as presented in Alternative 2 and Figure 5-2), the peak projected hourly flow is 390 gpm. As shown in Figure 5-4, a lift station (PS 1B) is located near the intersection of Larry Scott Memorial Trail and Thomas Street. A 6-inch force main is needed and will discharge into the existing manhole as the intersection of 2nd and Logan Streets, for a distance of 1,900 lineal feet. The lift station is designed for a peak hourly flow of 390 gpm and TDH of 190 feet.
- Alternative 4C: If Basin 1 is 1,245 acres in size as presented in Alternative 3 and Figure 5-3, the peak projected hourly flow is 1,810 gpm. A lift station (PS 1C) is proposed to be located on Mill Road to serve all of Basin 1, as shown in Figure 5-4. The lift station is designed for a peak hourly flow of 1,810 gpm and 230 feet TDH at full build-out. This lift station is assumed to be constructed in phases as Basin 1 develops over time. A 3,900-foot long 12-inch force main is needed to access the nearest existing manhole at the intersection of 2nd and Logan Streets.

The lift station serving Basin 2 is proposed to be located near the intersection of Glen Cove and Discovery Roads, as shown in Figure 5-4. The lift station serving Basin 2 is designed for a peak hourly flow of 225 gpm and TDH of 150 feet. A 4-inch force main is needed to access an existing manhole in South Park Avenue and it is approximately 3,200-feet long.



CITY OF PORT TOWNSEND

SOUTHWEST SEWER BASIN STUDY

FIGURE 5-4

ALTERNATIVE 4

ALTERNATIVES TO SERVING BASINS 1, 2, AND 3 BY INDIVIDUAL LIFT STATIONS

Gray & Osborne, Inc.

CONSULTING ENGINEERS

The lift station serving Basin 3 is designed for a flow of 200 gpm and TDH of 160 feet. A 4-inch-diameter force main, approximately 3,020-feet long, is needed to convey wastewater from this lift station to the existing manhole located in South Park Avenue.

The limitation of this alternative is that three lift stations are needed, resulting in increased annual operation and maintenance costs. Costs for Basins 1, 2, and 3 being served by individual lift stations are presented in Tables 5-4 through 5-6 for the various lift station configurations in Basin 1. The impacts of the individual lift stations in Basins 1, 2, and 3 on existing gravity lines was not examined in detail, but existing lines within City limits will need to be increased in size to accommodate the additional flow as Basin 1 increases in size.

TABLE 5-4

Alternative 4A – Cost Estimate for Serving Basins 1 (180 Acres), 2, and 3 with Individual Lift Stations

NO.	ITEM	QUANTITY	UNIT PRICE	AMOUNT
1	Construction Surveying	1 LS	$ 20,000.00	$ 20,000.00
2	Spill Prevention, Control, and Countermeasure Plan	1 LS	$ 3,000.00	$ 3,000.00
3	Locate Existing Utilities	1 LS	$ 10,000.00	$ 10,000.00
4	Mobilization , Cleanup, and Demobilization	1 LS	$ 150,000.00	$ 150,000.00
5	Project Temporary Traffic Control	1 LS	$ 20,000.00	$ 20,000.00
6	Removal of Structure and Obstruction	1 LS	$ 10,000.00	$ 10,000.00
7	Trench Excavation Safety System	1 LS	$ 6,000.00	$ 6,000.00
8	6-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 1	3,600 LF	$ 120.00	$ 432,000.00
9	4-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 2	3,200 LF	$ 110.00	$ 352,000.00
10	4-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 3	3,020 LF	$ 110.00	$ 332,200.00
11	Lift Station (265 gpm, 150 TDH) to Serve Basin 1	1 LS	$ 700,000.00	$ 700,000.00
12	Lift Station (255 gpm, 150 TDH) to Serve Basin 2	1 LS	$ 650,000.00	$ 650,000.00
13	Lift Station (200 gpm, 160 TDH) to Serve Basin 3	1 LS	$ 600,000.00	$ 600,000.00
14	Temporary Erosion and Sediment Control	1 LS	$ 5,000.00	$ 5,000.00

Subtotal	$ 3,290,200.00
Sales Tax @ 8.40 %:	$ 276,400.00
Subtotal	$ 3,566,600.00
Construction Contingency (20%)	$ 713,400.00
TOTAL ESTIMATED CONSTRUCTION COST	$ 4,280,000.00
Easements/ROW	$ 40,000.00
Permits	$ 20,000.00
Engineering and Construction Management (20%)	$ 856,000.00
TOTAL ESTIMATED PROJECT COST	$ 5,196,000.00

TABLE 5-5

Alternative 4B – Cost Estimate for Serving Basins 1 (270 Acres), 2, and 3 with Individual Lift Stations

NO.	ITEM	QUANTITY	UNIT PRICE	AMOUNT
1	Construction Surveying	1 LS	$ 20,000.00	$ 20,000.00
2	Spill Prevention, Control, and Countermeasure Plan	1 LS	$ 3,000.00	$ 3,000.00
3	Locate Existing Utilities	1 LS	$ 10,000.00	$ 10,000.00
4	Mobilization , Cleanup, and Demobilization	1 LS	$ 150,000.00	$ 150,000.00
5	Project Temporary Traffic Control	1 LS	$ 20,000.00	$ 20,000.00
6	Removal of Structure and Obstruction	1 LS	$ 10,000.00	$ 10,000.00
7	Trench Excavation Safety System	1 LS	$ 6,000.00	$ 6,000.00
8	6-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 1	1,900 LF	$ 120.00	$ 228,000.00
9	4-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 2	3,200 LF	$ 110.00	$ 352,000.00
10	4-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 3	3,020 LF	$ 110.00	$ 332,200.00
11	Lift Station (390 gpm, 190 TDH) to Serve Basin 1	1 LS	$ 800,000.00	$ 800,000.00
12	Lift Station (255 gpm, 150 TDH) to Serve Basin 2	1 LS	$ 650,000.00	$ 650,000.00
13	Lift Station (200 gpm, 160 TDH) to Serve Basin 3	1 LS	$ 600,000.00	$ 600,000.00
14	Temporary Erosion and Sediment Control	1 LS	$ 5,000.00	$ 5,000.00

Subtotal	$ 3,186,200.00
Sales Tax @ 8.40 %:	$ 267,700.00
Subtotal	$ 3,453,900.00
Construction Contingency (20%)	$ 690,800.00
TOTAL ESTIMATED CONSTRUCTION COST	$ 4,144,700.00
Easements/ROW	$ 40,000.00
Permits	$ 20,000.00
Engineering and Construction Management (20%)	$ 829,000.00
TOTAL ESTIMATED PROJECT COST	$ 5,033,700.00

TABLE 5-6

Alternative 4C – Cost Estimate for Serving Basins 1 (1,245 Acres), 2, and 3 with Individual Lift Stations

NO.	ITEM	QUANTITY	UNIT PRICE	AMOUNT
1	Construction Surveying	1 LS	$ 20,000.00	$ 20,000.00
2	Spill Prevention, Control, and Countermeasure Plan	1 LS	$ 3,000.00	$ 3,000.00
3	Locate Existing Utilities	1 LS	$ 10,000.00	$ 10,000.00
4	Mobilization , Cleanup, and Demobilization	1 LS	$ 150,000.00	$ 150,000.00
5	Project Temporary Traffic Control	1 LS	$ 20,000.00	$ 20,000.00
6	Removal of Structure and Obstruction	1 LS	$ 10,000.00	$ 10,000.00
7	Trench Excavation Safety System	1 LS	$ 6,000.00	$ 6,000.00
8	12-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 1	3,900 LF	$ 150.00	$ 585,000.00
9	4-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 2	3,200 LF	$ 110.00	$ 352,000.00
10	4-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 3	3,020 LF	$ 110.00	$ 332,200.00
11	Lift Station (1,810 gpm, 230 TDH) to Serve Basin 1	1 LS	$ 2,000,000.00	$ 2,000,000.00
12	Lift Station (255 gpm, 150 TDH) to Serve Basin 2	1 LS	$ 650,000.00	$ 650,000.00
13	Lift Station (200 gpm, 160 TDH) to Serve Basin 3	1 LS	$ 600,000.00	$ 600,000.00
14	Temporary Erosion and Sediment Control	1 LS	$ 5,000.00	$ 5,000.00

Subtotal	$ 4,743,200.00
Sales Tax @ 8.40 %:	$ 398,500.00
Subtotal	$ 5,141,700.00
Construction Contingency (20%)	$ 1,028,400.00
TOTAL ESTIMATED CONSTRUCTION COST	$ 6,170,100.00
Easements/ROW	$ 60,000.00
Permits	$ 30,000.00
Engineering and Construction Management (20%)	$ 1,234,100.00
TOTAL ESTIMATED PROJECT COST	$ 7,494,200.00

ALTERNATIVE 5: BASINS 1 AND 2 SERVED BY COMMON LIFT STATION, BASIN 3 SERVED BY INDIVIDUAL LIFT STATION

This alternative examines Basins 1 and 2 being served by a common lift station, and Basin 3 being served by its own individual lift station. Again, different lift station configurations were examined as Basin 1 service area expands. Figure 5-5 shows the basic infrastructure needed for this alternative. A 500-foot long, 10-inch-diameter gravity line is needed to interconnect Basins 1 and 2.

The flows from each basin are the same as those presented in Alternatives 1, 2, and 3. The lift station and force main sizes for Basins 1 and 2 being served by a common lift station are as follows:

- Alternative 5A: If Basin 1 is 180 acres in size, the peak hourly flow to the lift station located near Discovery Road and Sims Way intersection (PS 1A) is 520 gpm (265 gpm from Basin 1 and 255 gpm from Basin 2). An 8-inch force main is necessary for this alternative and the lift station TDH is 150 feet.
- Alternative 5B: If Basin 1 is increased in size to 270 acres as shown in Figure 5-2, the peak hourly flow realized at PS 1B (on Larry Scott Memorial Trail) is 645 gpm (390 gpm from Basin 1 and 255 gpm from Basin 2). An 8-inch force main is required and the lift station will have a TDH of 180 feet.
- Alternative 5C: If Basin 1 is expanded to include the LAMIRD and all areas capable of gravity flowing to the lift station on Mill Road (PS 1C), the peak hourly flow for the lift station on Mill Road is 2,065 gpm (1,810 gpm from Basin 1 and 255 gpm from Basin 2). A 15-inch force main is required to serve the lift station at full build-out and the TDH for the lift station is 215 feet.

The lift station and force main for Basin 3 are the same as previously described in Alternative 4.

The limitation of this alternative is that two lift stations are needed, resulting in increased annual operation and maintenance costs. Another limitation is that the lift station serving Basins 1 and 2 when Basin 1 serves a projected 1,245-acre area will need to be constructed in phases as build-out occurs, resulting in higher costs for the lift station. Costs for serving Basins 1 and 2 by a common lift station for the three different Basin 1 scenarios are presented in Tables 5-7 through 5-9. The impacts to existing sewer lines were not examined for this alternative, but existing collections lines within City limits will exceed capacity as Basin 1 service area expands.

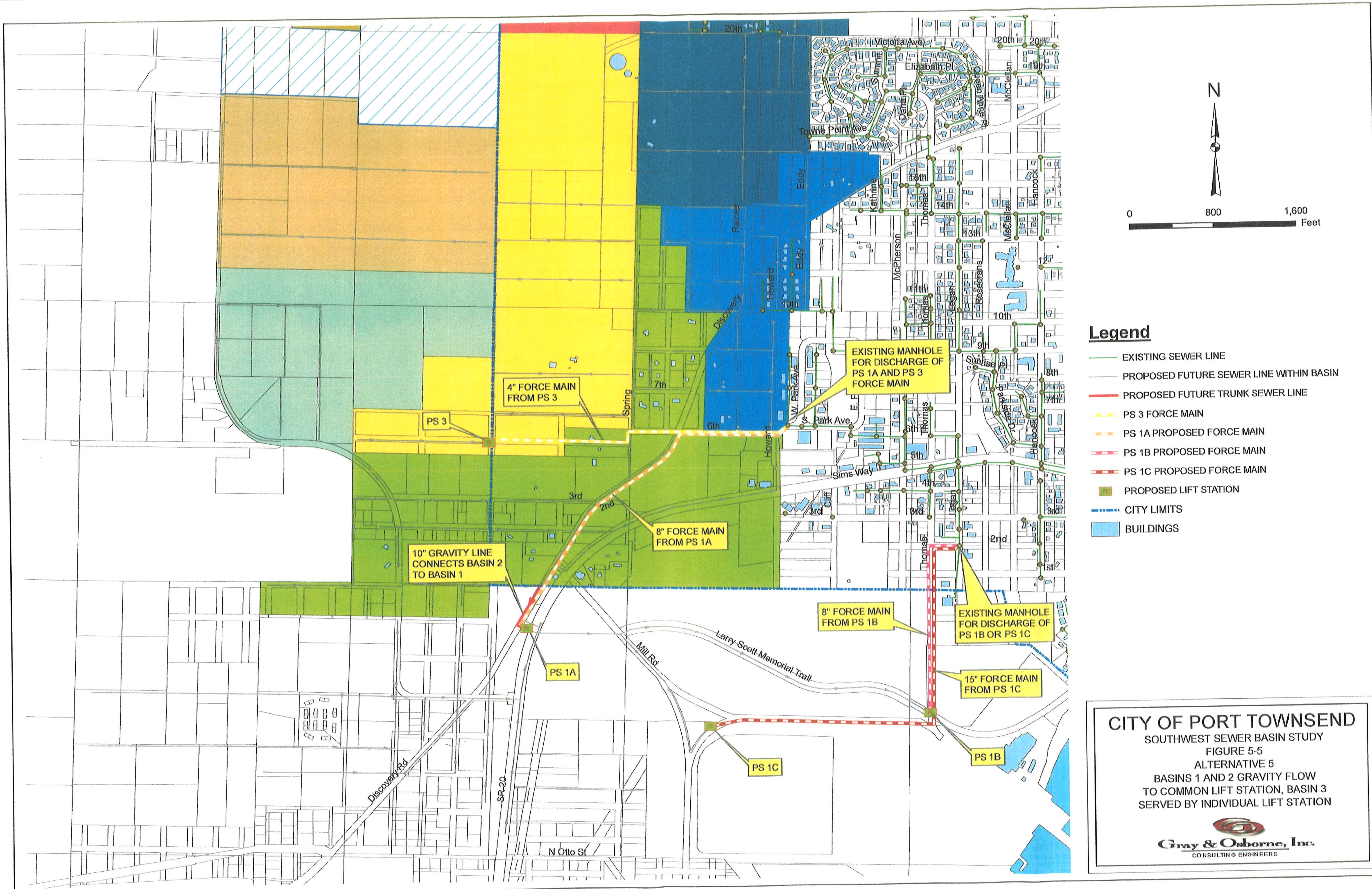

N
0
800
1,600
Feet
Legend
EXISTING SEWER LINE
PROPOSED FUTURE SEWER LINE WITHIN BASIN
PROPOSED FUTURE TRUNK SEWER LINE
PS 3 FORCE MAIN
PS 1A PROPOSED FORCE MAIN
PS 1B PROPOSED FORCE MAIN
PS 1C PROPOSED FORCE MAIN
PROPOSED LIFT STATION
CITY LIMITS
BUILDINGS
EXISTING MANHOLE FOR DISCHARGE OF PS 1A AND PS 3 FORCE MAIN
4" FORCE MAIN FROM PS 3
PS 3
8" FORCE MAIN FROM PS 1A
10" GRAVITY LINE CONNECTS BASIN 2 TO BASIN 1
PS 1A
8" FORCE MAIN FROM PS 1B
EXISTING MANHOLE FOR DISCHARGE OF PS 1B OR PS 1C
15" FORCE MAIN FROM PS 1C
PS 1C
PS 1B
Larry Scott Memorial Trail
Mill Rd
Discovery Rd
SR-20
N Otto St
Sims Way
S. Park Ave.
Discovery
Spring
Rainier
Howard
Eddy
McPherson
Thomas
Logan
McClellan
Hancock
Victoria Ave
Elizabeth Pl
Towne Point Ave
20th
10th
7th
6th
5th
4th
3rd
2nd
1st
CITY OF PORT TOWNSEND
SOUTHWEST SEWER BASIN STUDY
FIGURE 5-5
ALTERNATIVE 5
BASINS 1 AND 2 GRAVITY FLOW
TO COMMON LIFT STATION, BASIN 3
SERVED BY INDIVIDUAL LIFT STATION
Gray & Osborne, Inc.
CONSULTING ENGINEERS

TABLE 5-7

Alternative 5A – Cost Estimate for Serving Basins 1 (180 Acres) and 2 with Common Lift Station

NO.	ITEM	QUANTITY	UNIT PRICE	AMOUNT
1	Construction Surveying	1 LS	$ 20,000.00	$ 20,000.00
2	Spill Prevention, Control, and Countermeasure Plan	1 LS	$ 3,000.00	$ 3,000.00
3	Locate Existing Utilities	1 LS	$ 10,000.00	$ 10,000.00
4	Mobilization , Cleanup, and Demobilization	1 LS	$ 150,000.00	$ 150,000.00
5	Project Temporary Traffic Control	1 LS	$ 20,000.00	$ 20,000.00
6	Removal of Structure and Obstruction	1 LS	$ 10,000.00	$ 10,000.00
7	Manhole 48-inch Diameter	3 EA	$ 4,500.00	$ 13,500.00
8	Trench Excavation Safety System	1 LS	$ 6,000.00	$ 6,000.00
9	10-inch SDR 35 Sanitary Sewer Pipe and Fittings for Open Cut , Incl. Bedding, Backfill, & Surfacing Connects Basin 2 to Basin 1	500 LF	$ 130.00	$ 65,000.00
10	8-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basins 1 and 2	3,600 LF	$ 130.00	$ 468,000.00
11	4-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 3	3,020 LF	$ 110.00	$ 332,200.00
12	Lift Station (520 gpm, 150 TDH) to Serve Basins 1 and 2	1 LS	$ 900,000.00	$ 900,000.00
13	Lift Station (200 gpm, 160 TDH) to Serve Basin 3	1 LS	$ 600,000.00	$ 600,000.00
14	Temporary Erosion and Sediment Control	1 LS	$ 5,000.00	$ 5,000.00

Subtotal	$ 2,602,700.00
Sales Tax @ 8.40 %:	$ 218,700.00
Subtotal	$ 2,821,400.00
Construction Contingency (20%)	$ 564,300.00
TOTAL ESTIMATED CONSTRUCTION COST	$ 3,385,700.00
Easements/ROW	$ 40,000.00
Permits	$ 15,000.00
Engineering and Construction Management (20%)	$ 677,200.00
TOTAL ESTIMATED PROJECT COST	$ 4,117,900.00

TABLE 5-8

Alternative 5B – Cost Estimate for Serving Basins 1 (270 Acres) and 2 with Common Lift Station

NO.	ITEM	QUANTITY	UNIT PRICE	AMOUNT
1	Construction Surveying	1 LS	$ 20,000.00	$ 20,000.00
2	Spill Prevention, Control, and Countermeasure Plan	1 LS	$ 3,000.00	$ 3,000.00
3	Locate Existing Utilities	1 LS	$ 10,000.00	$ 10,000.00
4	Mobilization , Cleanup, and Demobilization	1 LS	$ 150,000.00	$ 150,000.00
5	Project Temporary Traffic Control	1 LS	$ 20,000.00	$ 20,000.00
6	Removal of Structure and Obstruction	1 LS	$ 10,000.00	$ 10,000.00
7	Manhole 48-inch Diameter	3 EA	$ 4,500.00	$ 13,500.00
8	Trench Excavation Safety System	1 LS	$ 6,000.00	$ 6,000.00
9	10-inch SDR 35 Sanitary Sewer Pipe and Fittings for Open Cut , Incl. Bedding, Backfill, & Surfacing Connects Basin 2 to Basin 1	500 LF	$ 130.00	$ 65,000.00
10	8-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basins 1 and 2	1,900 LF	$ 130.00	$ 247,000.00
11	4-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 3	3,020 LF	$ 110.00	$ 332,200.00
12	Lift Station (645 gpm, 180 TDH) to Serve Basins 1 and 2	1 LS	$ 1,000,000.00	$ 1,000,000.00
13	Lift Station (200 gpm, 160 TDH) to Serve Basin 3	1 LS	$ 600,000.00	$ 600,000.00
14	Temporary Erosion and Sediment Control	1 LS	$ 5,000.00	$ 5,000.00

Subtotal	$ 2,481,700.00
Sales Tax @ 8.40 %:	$ 208,500.00
Subtotal	$ 2,690,200.00
Construction Contingency (20%)	$ 538,100.00
TOTAL ESTIMATED CONSTRUCTION COST	$ 3,228,300.00
Easements/ROW	$ 40,000.00
Permits	$ 15,000.00
Engineering and Construction Management (20%)	$ 645,700.00
TOTAL ESTIMATED PROJECT COST	$ 3,929,000.00

TABLE 5-9

Alternative 5C – Cost Estimate for Serving Basins 1 (1,245 Acres) and 2 with Common Lift Station

NO.	ITEM	QUANTITY	UNIT PRICE	AMOUNT
1	Construction Surveying	1 LS	$ 20,000.00	$ 20,000.00
2	Spill Prevention, Control, and Countermeasure Plan	1 LS	$ 3,000.00	$ 3,000.00
3	Locate Existing Utilities	1 LS	$ 10,000.00	$ 10,000.00
4	Mobilization , Cleanup, and Demobilization	1 LS	$ 150,000.00	$ 150,000.00
5	Project Temporary Traffic Control	1 LS	$ 20,000.00	$ 20,000.00
6	Removal of Structure and Obstruction	1 LS	$ 10,000.00	$ 10,000.00
7	Manhole 48-inch Diameter	3 EA	$ 4,500.00	$ 13,500.00
8	Trench Excavation Safety System	1 LS	$ 6,000.00	$ 6,000.00
9	10-inch SDR 35 Sanitary Sewer Pipe and Fittings for Open Cut , Incl. Bedding, Backfill, & Surfacing Connects Basin 2 to Basin 1	500 LF	$ 130.00	$ 65,000.00
10	15-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basins 1 and 2	3,900 LF	$ 160.00	$ 624,000.00
11	4-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 3	3,020 LF	$ 110.00	$ 332,200.00
12	Lift Station (2065 gpm, 215 TDH) to Serve Basins 1 and 2	1 LS	$ 2,200,000.00	$ 2,200,000.00
13	Lift Station (200 gpm, 160 TDH) to Serve Basin 3	1 LS	$ 600,000.00	$ 600,000.00
14	Temporary Erosion and Sediment Control	1 LS	$ 5,000.00	$ 5,000.00

Subtotal	$ 4,058,700.00
Sales Tax @ 8.40 %:	$ 341,000.00
Subtotal	$ 4,399,700.00
Construction Contingency (20%)	$ 880,000.00
TOTAL ESTIMATED CONSTRUCTION COST	$ 5,279,700.00
Easements/ROW	$ 50,000.00
Permits	$ 20,000.00
Engineering and Construction Management (20%)	$ 1,056,000.00
TOTAL ESTIMATED PROJECT COST	$ 6,405,700.00

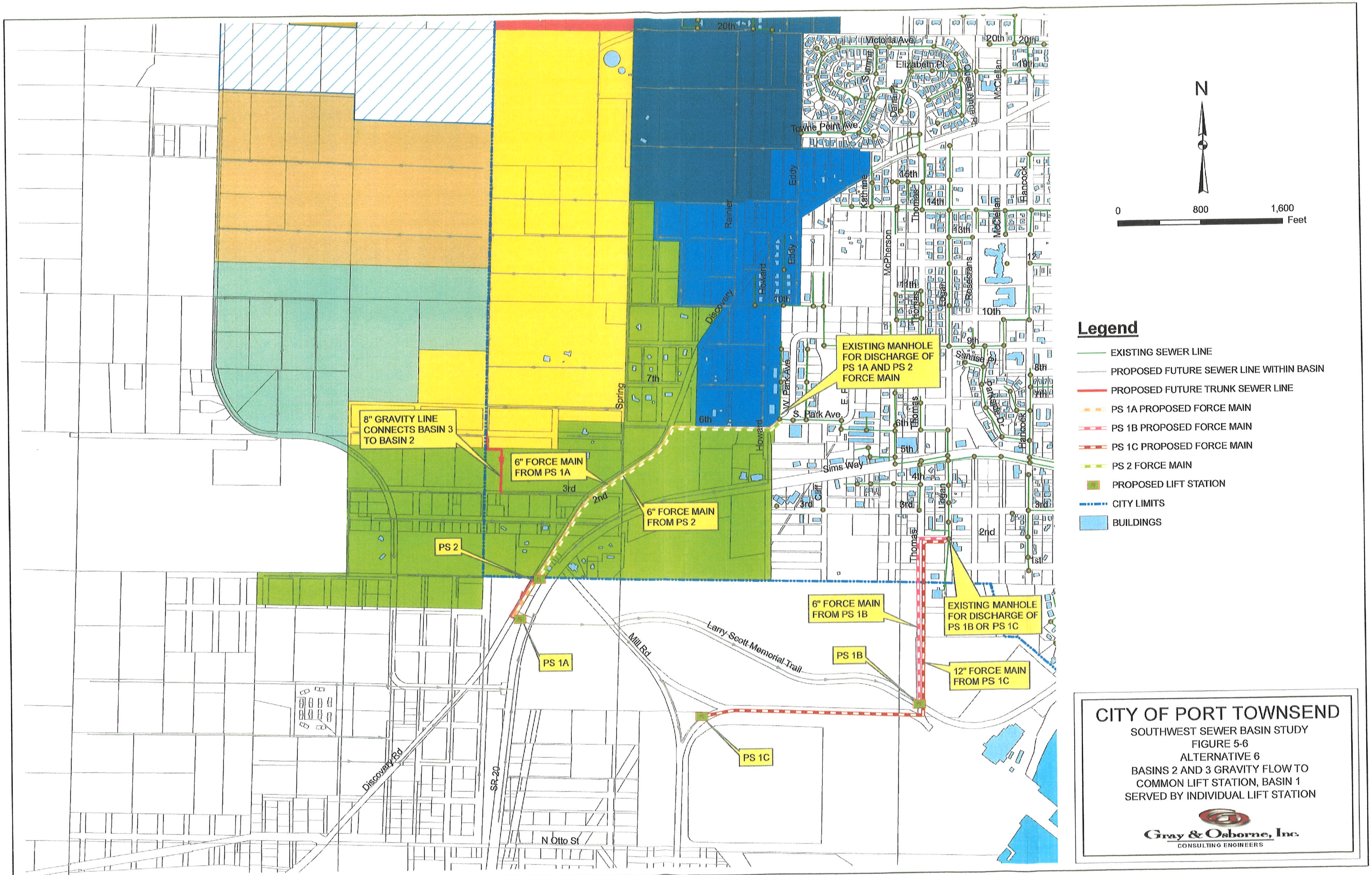
ALTERNATIVE 6: BASINS 2 AND 3 SERVED BY COMMON LIFT STATION, BASIN 1 SERVED BY INDIVIDUAL LIFT STATION

This alternative examines Basins 2 and 3 being served by a common lift station, and Basin 1 being served by its own individual lift station. Again, different lift station configurations were examined as Basin 1 service area expands. Figure 5-6 shows the basic infrastructure needed for this alternative. A 750-foot long, 8-inch-diameter gravity line is needed to interconnect Basins 2 and 3. The lift station serving Basins 2 and 3 would be located near the intersection of Glen Cove and Discovery Roads, as shown in Figure 5-6 and is designed for a peak hourly flow of 455 gpm and TDH of 180 feet. A 6-inch force main is needed to access an existing manhole in South Park Avenue and it is approximately 3,200 feet long.

The flows for Basin 1 are as follows:

- Alternative 6A: If Basin 1 is 180 acres in size, the peak hourly flow to the lift station located near Discovery Road and Sims Way intersection (PS 1A) is 265 gpm. A 6-inch force main is necessary for this alternative and the lift station TDH is 150 feet.
- Alternative 6B: If Basin 1 is increased in size to 270 acres as shown in Figure 5-2, the peak hourly flow realized at PS 1B (on Larry Scott Memorial Trail) is 390 gpm. A 6-inch force main is required and the lift station will have a TDH of 190 feet.
- Alternative 6C: If Basin 1 is expanded to include the LAMIRD and all areas capable of gravity flowing to the lift station on Mill Road (PS 1C), the peak hourly flow for the lift station on Mill Road is 1,810 gpm. A 12-inch force main (3,900 feet long) is required to serve the lift station at full build-out and the TDH for the lift station is 230 feet.

The limitation of this alternative is that two lift stations are needed, resulting in increased annual operation and maintenance costs. Another limitation is that the lift station serving Basins 1 for the projected 1,245-acre area will need to be constructed in phases as build-out occurs, resulting in higher costs for the lift station. Costs for serving Basins 2 and 3 by a common lift station for the three different Basin 1 scenarios are presented in Tables 5-10 through 5-12. The impacts to existing sewer lines were not examined for this alternative, but existing collections lines within City limits will exceed capacity as Basin 1 service area expands.



CITY OF PORT TOWNSEND
SOUTHWEST SEWER BASIN STUDY
FIGURE 5-6
ALTERNATIVE 6
BASINS 2 AND 3 GRAVITY FLOW TO COMMON LIFT STATION, BASIN 1 SERVED BY INDIVIDUAL LIFT STATION
Gray & Osborne, Inc.
CONSULTING ENGINEERS
N
0
800
1,600
Feet
Legend
EXISTING SEWER LINE
PROPOSED FUTURE SEWER LINE WITHIN BASIN
PROPOSED FUTURE TRUNK SEWER LINE
PS 1A PROPOSED FORCE MAIN
PS 1B PROPOSED FORCE MAIN
PS 1C PROPOSED FORCE MAIN
PS 2 FORCE MAIN
PROPOSED LIFT STATION
CITY LIMITS
BUILDINGS
8" GRAVITY LINE CONNECTS BASIN 3 TO BASIN 2
6" FORCE MAIN FROM PS 1A
6" FORCE MAIN FROM PS 2
EXISTING MANHOLE FOR DISCHARGE OF PS 1A AND PS 2 FORCE MAIN
EXISTING MANHOLE FOR DISCHARGE OF PS 1B OR PS 1C
6" FORCE MAIN FROM PS 1B
12" FORCE MAIN FROM PS 1C
PS 2
PS 1A
PS 1B
PS 1C
20th
Victoria Ave
Elizabeth Pl
Towne Point Ave
Discovery
Rainier
Eddy
Howard
Spring
Kathrine
McPherson
Thomas
Logan
Rosecrans
McClellan
Hancock
Sunrise Dr
W. Park Ave
S. Park Ave
Sims Way
Cliff
6th
5th
4th
3rd
2nd
1st
7th
10th
Larry Scott Memorial Trail
Mill Rd
Discovery Rd
SR 20
N Otto St

TABLE 5-10

Alternative 6A – Cost Estimate for Serving Basins 2 and 3 with Common Lift Station, Basin 1 180 Acres

NO.	ITEM	QUANTITY	UNIT PRICE	AMOUNT
1	Construction Surveying	1 LS	$ 20,000.00	$ 20,000.00
2	Spill Prevention, Control, and Countermeasure Plan	1 LS	$ 3,000.00	$ 3,000.00
3	Locate Existing Utilities	1 LS	$ 10,000.00	$ 10,000.00
4	Mobilization , Cleanup, and Demobilization	1 LS	$ 150,000.00	$ 150,000.00
5	Project Temporary Traffic Control	1 LS	$ 20,000.00	$ 20,000.00
6	Removal of Structure and Obstruction	1 LS	$ 10,000.00	$ 10,000.00
7	Manhole 48-inch Diameter	4 EA	$ 4,500.00	$ 18,000.00
8	Trench Excavation Safety System	1 LS	$ 6,000.00	$ 6,000.00
9	8-inch SDR 35 Sanitary Sewer Pipe and Fittings for Open Cut , Incl. Bedding, Backfill, & Surfacing , Connects Basin 3 to Basin 2	750 LF	$ 150.00	$ 112,500.00
10	6-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 1	3,600 LF	$ 120.00	$ 432,000.00
11	6-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basins 2 and 3	3,200 LF	$ 120.00	$ 384,000.00
12	Lift Station (265 gpm, 150 TDH) to Serve Basin 1	1 LS	$ 700,000.00	$ 700,000.00
13	Lift Station (455 gpm, 180 TDH) to Serve Basins 2 and 3	1 LS	$ 900,000.00	$ 900,000.00
14	Temporary Erosion and Sediment Control	1 LS	$ 5,000.00	$ 5,000.00

Subtotal	$ 2,770,500.00
Sales Tax @ 8.40 %:	$ 232,800.00
Subtotal	$ 3,003,300.00
Construction Contingency (20%)	$ 600,700.00
TOTAL ESTIMATED CONSTRUCTION COST	$ 3,604,000.00
Easements/ROW	$ 40,000.00
Permits	$ 15,000.00
Engineering and Construction Management (20%)	$ 720,800.00
TOTAL ESTIMATED PROJECT COST	$ 4,379,800.00

TABLE 5-11

Alternative 6B – Cost Estimate for Serving Basins 2 and 3 with Common Lift Station, Basin 1 270 Acres

NO.	ITEM	QUANTITY	UNIT PRICE	AMOUNT
1	Construction Surveying	1 LS	$ 20,000.00	$ 20,000.00
2	Spill Prevention, Control, and Countermeasure Plan	1 LS	$ 3,000.00	$ 3,000.00
3	Locate Existing Utilities	1 LS	$ 10,000.00	$ 10,000.00
4	Mobilization , Cleanup, and Demobilization	1 LS	$ 150,000.00	$ 150,000.00
5	Project Temporary Traffic Control	1 LS	$ 20,000.00	$ 20,000.00
6	Removal of Structure and Obstruction	1 LS	$ 10,000.00	$ 10,000.00
7	Manhole 48-inch Diameter	4 EA	$ 4,500.00	$ 18,000.00
8	Trench Excavation Safety System	1 LS	$ 6,000.00	$ 6,000.00
9	8-inch SDR 35 Sanitary Sewer Pipe and Fittings for Open Cut , Incl. Bedding, Backfill, & Surfacing , Connects Basin 3 to Basin 2	750 LF	$ 150.00	$ 112,500.00
10	6-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 1	1,900 LF	$ 120.00	$ 228,000.00
11	6-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basins 2 and 3	3,200 LF	$ 120.00	$ 384,000.00
12	Lift Station (390 gpm, 190 TDH) to Serve Basin 1	1 LS	$ 800,000.00	$ 800,000.00
13	Lift Station (455 gpm, 180 TDH) to Serve Basins 2 and 3	1 LS	$ 900,000.00	$ 900,000.00
14	Temporary Erosion and Sediment Control	1 LS	$ 5,000.00	$ 5,000.00

Subtotal	$ 2,666,500.00
Sales Tax @ 8.40 %:	$ 224,000.00
Subtotal	$ 2,890,500.00
Construction Contingency (20%)	$ 578,100.00
TOTAL ESTIMATED CONSTRUCTION COST	$ 3,468,600.00
Easements/ROW	$ 40,000.00
Permits	$ 15,000.00
Engineering and Construction Management (20%)	$ 693,800.00
TOTAL ESTIMATED PROJECT COST	$ 4,217,400.00

TABLE 5-12

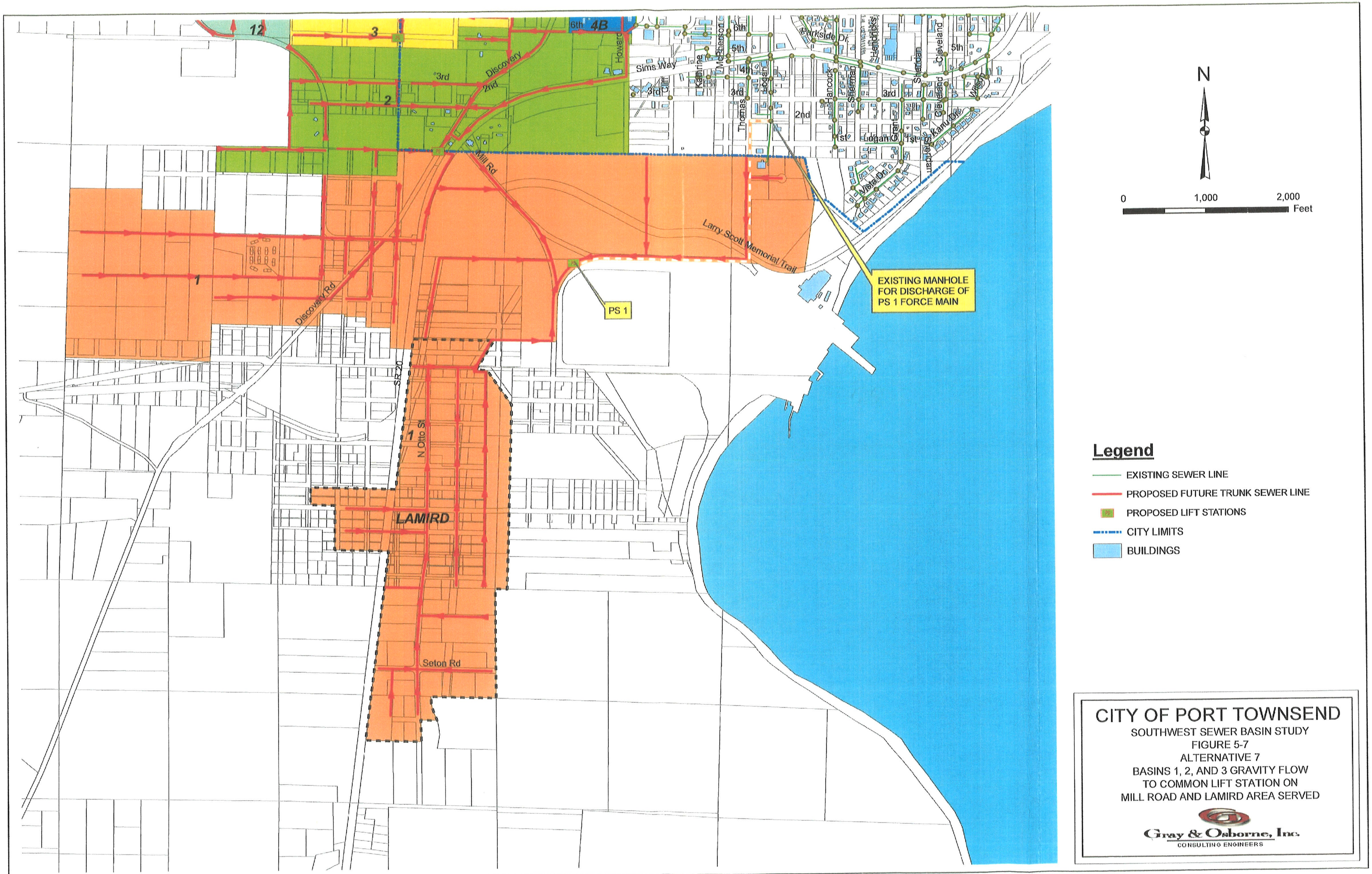
Alternative 6C – Cost Estimate for Serving Basins 2 and 3 with Common Lift Station, Basin 1 1,245 Acres

NO.	ITEM	QUANTITY	UNIT PRICE	AMOUNT
1	Construction Surveying	1 LS	$ 20,000.00	$ 20,000.00
2	Spill Prevention, Control, and Countermeasure Plan	1 LS	$ 3,000.00	$ 3,000.00
3	Locate Existing Utilities	1 LS	$ 10,000.00	$ 10,000.00
4	Mobilization , Cleanup, and Demobilization	1 LS	$ 150,000.00	$ 150,000.00
5	Project Temporary Traffic Control	1 LS	$ 20,000.00	$ 20,000.00
6	Removal of Structure and Obstruction	1 LS	$ 10,000.00	$ 10,000.00
7	Manhole 48-inch Diameter	4 EA	$ 4,500.00	$ 18,000.00
8	Trench Excavation Safety System	1 LS	$ 6,000.00	$ 6,000.00
9	8-inch SDR 35 Sanitary Sewer Pipe and Fittings for Open Cut , Incl. Bedding, Backfill, & Surfacing , Connects Basin 3 to Basin 2	750 LF	$ 150.00	$ 112,500.00
10	12-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Basin 1	3,900 LF	$ 150.00	$ 585,000.00
11	6-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serves Basin 2 and 3	3,200 LF	$ 120.00	$ 384,000.00
12	Lift Station (1,810 gpm, 230 TDH) to Serve Basin 1	1 LS	$ 2,000,000.00	$ 2,000,000.00
13	Lift Station (455 gpm, 180 TDH) to Serve Basins 2 and 3	1 LS	$ 900,000.00	$ 900,000.00
14	Temporary Erosion and Sediment Control	1 LS	$ 5,000.00	$ 5,000.00

Subtotal	$ 4,223,500.00
Sales Tax @ 8.40 %:	$ 354,800.00
Subtotal	$ 4,578,300.00
Construction Contingency (20%)	$ 915,700.00
TOTAL ESTIMATED CONSTRUCTION COST	$ 5,494,000.00
Easements/ROW	$ 50,000.00
Permits	$ 20,000.00
Engineering and Construction Management (20%)	$ 1,098,800.00
TOTAL ESTIMATED PROJECT COST	$ 6,662,800.00

ALTERNATIVE 7- BASINS 1, 2, AND 3 SERVED BY COMMON LIFT STATION, BASIN 1 SERVES LAMIRD

The City is interested in examining alternatives to serving the LAMIRD identified in Figure 5-3. This alternative specifically examines a Basin 1 service area that includes the LAMIRD and areas that can be served north of the LAMIRD, as depicted in Figure 5-7. For this alternative, the Basin 1 is approximately 500 acres and using a wastewater loading rate of 1,230 gpd/acre and peaking factor of 1.7, the peak hourly flow is projected to be 730 gpm. For this alternative, a lift station located on Mill Road was examined that has the capacity to serve Basins 1, 2 and 3, for a total design flow of 1,185 gpm and TDH of 240 feet. A 10-inch force main is needed to serve Basins 1, 2, and 3 given the size of Basin 1 shown in Figure 5-7. Costs for this alternative are presented in Table 5-13.



CITY OF PORT TOWNSEND
SOUTHWEST SEWER BASIN STUDY
FIGURE 5-7
ALTERNATIVE 7
BASINS 1, 2, AND 3 GRAVITY FLOW TO COMMON LIFT STATION ON MILL ROAD AND LAMIRD AREA SERVED

TABLE 5-13

Alternative 7 – Cost Estimate for Serving Basins 1, 2, and 3 with Common Lift Station, Basin 1 500 Acres

NO.	ITEM	QUANTITY	UNIT PRICE	AMOUNT
1	Construction Surveying	1 LS	$ 10,000.00	$ 10,000.00
2	Spill Prevention, Control, and Countermeasure Plan	1 LS	$ 3,000.00	$ 3,000.00
3	Locate Existing Utilities	1 LS	$ 10,000.00	$ 10,000.00
4	Mobilization , Cleanup, and Demobilization	1 LS	$ 150,000.00	$ 150,000.00
5	Project Temporary Traffic Control	1 LS	$ 20,000.00	$ 20,000.00
6	Removal of Structure and Obstruction	1 LS	$ 10,000.00	$ 10,000.00
7	Manhole 48-inch Diameter	7 EA	$ 4,500.00	$ 31,500.00
8	Trench Excavation Safety System	1 LS	$ 6,000.00	$ 6,000.00
9	8-inch SDR 35 Sanitary Sewer Pipe and Fittings for Open Cut , Incl. Bedding, Backfill, & Surfacing , Connects Basin 3 to Basin 2	750 LF	$ 150.00	$ 112,500.00
9	12-inch SDR 35 Sanitary Sewer Pipe and Fittings for Open Cut , Incl. Bedding, Backfill, & Surfacing Connects Basin 2 to Basin 1	500 LF	$ 140.00	$ 70,000.00
10	10-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing	3,900 LF	$ 140.00	$ 546,000.00
11	Lift Station 1,185 gpm, 240 TDH	1 LS	$ 1,800,000.00	$ 1,800,000.00
12	Temporary Erosion and Sediment Control	1 LS	$ 5,000.00	$ 5,000.00

Subtotal	$ 2,774,000.00
Sales Tax @ 8.40 %:	$ 233,100.00
Subtotal	$ 3,007,100.00
Construction Contingency (20%)	$ 601,500.00
TOTAL ESTIMATED CONSTRUCTION COST	$ 3,608,600.00
Easements/ROW	$ 50,000.00
Permits	$ 20,000.00
Engineering and Construction Management (20%)	$ 721,800.00
TOTAL ESTIMATED PROJECT COST	$ 4,400,400.00

ALTERNATIVE 8: 80-ACRE EDUCATIONAL FACILITY

The City has recently acquired an 80-acre parcel located just outside the City limits and just west of the water storage tanks (see Figure 5-8). This parcel is currently intended to be used for an educational facility. This area is relatively low and a lift station is needed to access existing sewer lines. The wastewater flow from this area was estimated by assuming an ultimate maximum peak day flow per acre of 1,750 gpad, the highest flow rate per acre value for the western sewer basins studied by CH2M Hill in the *Wastewater Comprehensive Plan*. This high flow rate per acre was chosen given the intended use as an educational facility and potential for large populations during certain events sponsored by the proposed facility. The flow was then peaked using a peaking factor of 1.7 to obtain a peak hourly flow rate of 165 gpm.

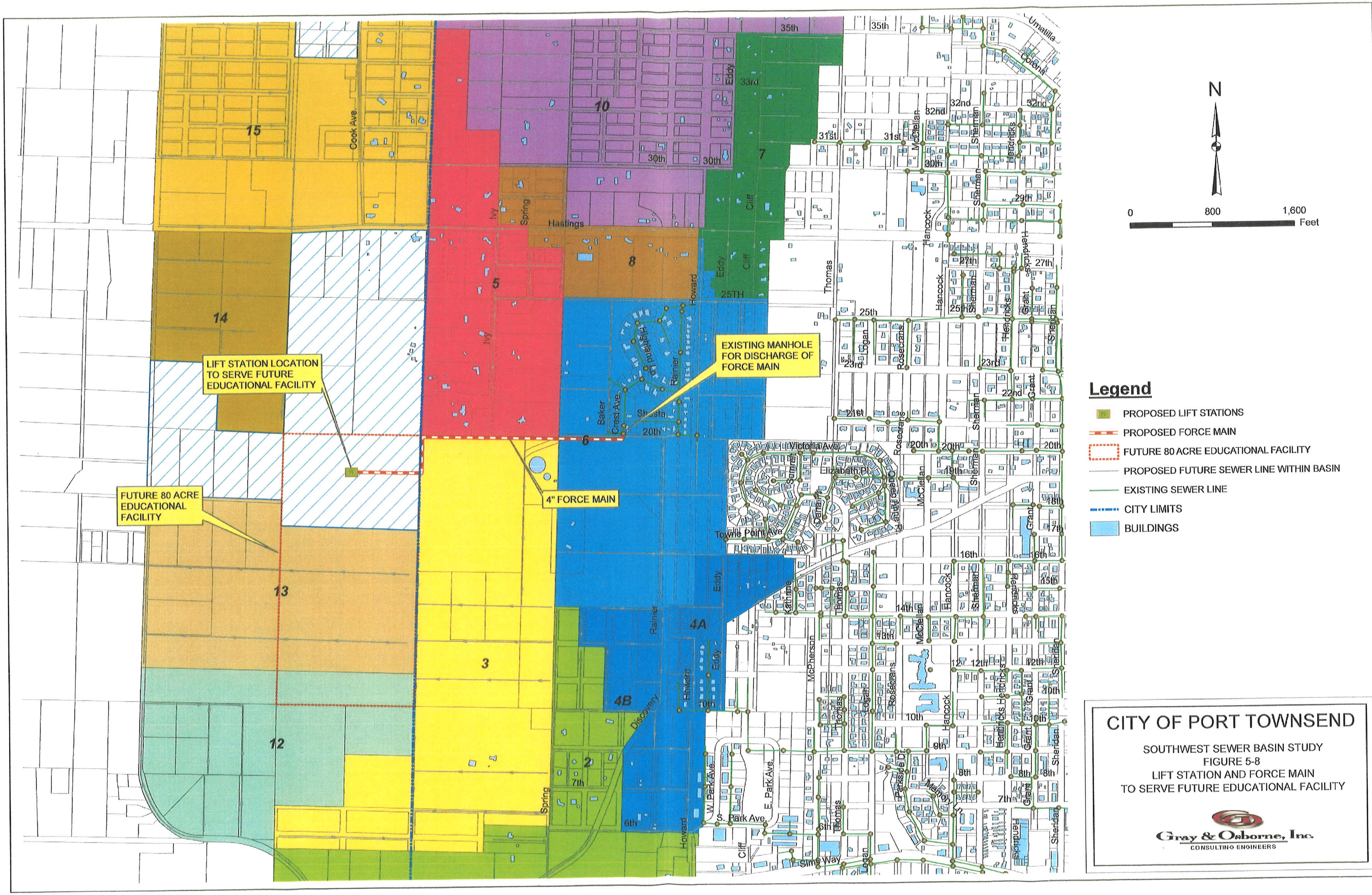
The lift station is designed for a peak hourly flow of 165 gpm and TDH of 160 feet. A 4-inch-diameter force main, approximately 2,970 feet long, is needed to access the existing sewer manhole at the intersection of 20th and Crest Avenue. The estimated cost of the lift station and force main is approximately $1,691,500 (Table 5-14). The possibility of gravity flowing from this area was not examined since other lines would need to be installed south of this area to allow gravity-flow and the timeframe in which this lines would be available is unknown. Also, the line would need to be very deep (up to 40-feet deep) to promote gravity flow. The capacity of Hamilton Heights Lift Station must be evaluated if the flow from the educational facility discharges at the manhole shown on Figure 5-8.

TABLE 5-14

Alternative 8 – Cost Estimate for Serving Educational Facility

NO.	ITEM	QUANTITY	UNIT PRICE	AMOUNT
1	Construction Surveying	1 LS	$ 10,000.00	$ 10,000.00
2	Spill Prevention, Control, and Countermeasure Plan	1 LS	$ 3,000.00	$ 3,000.00
3	Locate Existing Utilities	1 LS	$ 10,000.00	$ 10,000.00
4	Mobilization , Cleanup, and Demobilization	1 LS	$ 80,000.00	$ 80,000.00
5	Project Temporary Traffic Control	1 LS	$ 20,000.00	$ 20,000.00
6	Removal of Structure and Obstruction	1 LS	$ 10,000.00	$ 10,000.00
7	Trench Excavation Safety System	1 LS	$ 6,000.00	$ 6,000.00
8	4-inch PVC Force Main and Fittings for Open Cut, Incl. Bedding, Backfill, & Surfacing to Serve Educational Facility	2,970 LF	$ 110.00	$ 326,700.00
9	Lift Station (165 gpm, 160 TDH) to Serve Educational Facility	1 LS	$ 600,000.00	$ 600,000.00
10	Temporary Erosion and Sediment Control	1 LS	$ 5,000.00	$ 5,000.00

Subtotal	$ 1,070,700.00
Sales Tax @ 8.40 %:	$ 90,000.00
Subtotal	$1,160,700.00
Construction Contingency (20%)	$ 232,200.00
TOTAL ESTIMATED CONSTRUCTION COST	$1,392,900.00
Easements/ROW	$ 10,000.00
Permits	$ 10,000.00
Engineering and Construction Management (20%)	$ 278,600.00
TOTAL ESTIMATED PROJECT COST	$ 1,691,500.00



CITY OF PORT TOWNSEND
SOUTHWEST SEWER BASIN STUDY
FIGURE 5-8
LIFT STATION AND FORCE MAIN
TO SERVE FUTURE EDUCATIONAL FACILITY
Gray & Osborne, Inc.
CONSULTING ENGINEERS
Legend
PROPOSED LIFT STATIONS
PROPOSED FORCE MAIN
FUTURE 80 ACRE EDUCATIONAL FACILITY
PROPOSED FUTURE SEWER LINE WITHIN BASIN
EXISTING SEWER LINE
CITY LIMITS
BUILDINGS
N
0
800
1,600
Feet
LIFT STATION LOCATION TO SERVE FUTURE EDUCATIONAL FACILITY
EXISTING MANHOLE FOR DISCHARGE OF FORCE MAIN
4" FORCE MAIN
FUTURE 80 ACRE EDUCATIONAL FACILITY
15
10
7
14
5
8
6
13
3
4A
4B
12
2

COST SUMMARY AND RECOMMENDATIONS

Table 5-15 provides a summary of costs for each alternative presented in this chapter. With regard to alternatives examined for serving Basins 1, 2, and 3, it appears Alternative 2 is the most cost-effective. This alternative assumes Basins 1, 2, and 3 are served by a common lift station and Basin 1 serves an area of 270 acres. This alternative presents several limitations:

- Basins 1, 2, and 3 are assumed to develop simultaneously.
- Basin 1 serves 270 acres, but has the potential to serve more area if the lift station is located at a lower elevation (as presented in Alternative 3).
- The deep 8-inch gravity line interconnecting Basins 2 and 3 must be installed. This line may be prohibited by the inability to obtain easements or permits for construction near wetlands. Before Alternative 2 is more actively pursued, the City should further investigate the feasibility of this deep 8-inch gravity sewer line.

In the event the deep 8-inch gravity line proposed to interconnect Basins 2 and 3 is not feasible, the next best alternative is Alternative 5B where Basin 1 serves an area of 270 acres, Basins 1 and 2 are served by a common lift station, and Basin 3 is served by an individual lift station. Serving the LAMIRD area will be expensive (Alternatives 3, 4C, 5C, 6C, and 7), but expanding Basin 1 to include this area does allow a larger area (as shown in Figure 5-3) to be served.

As seen from the information presented in Table 5-15, the cost for serving the recently acquired 80-acre parcel for an educational facility is rather high. This cost may be modified and reduced if areas between this parcel and existing sewer collection lines become developed, decreasing the length of force main needed to discharge to an existing sewer line.

The impacts on the existing collection system due to the additional flows from unsewered areas require further evaluation. The City's existing model provided by CH2M Hill presents limitations with accurately identifying these impacts and the City should consider developing a new model that allows new flows to be precisely placed with respect to existing collection lines. Wastewater treatment plant impacts also need to be examined as additional flows are added to the existing collection system.

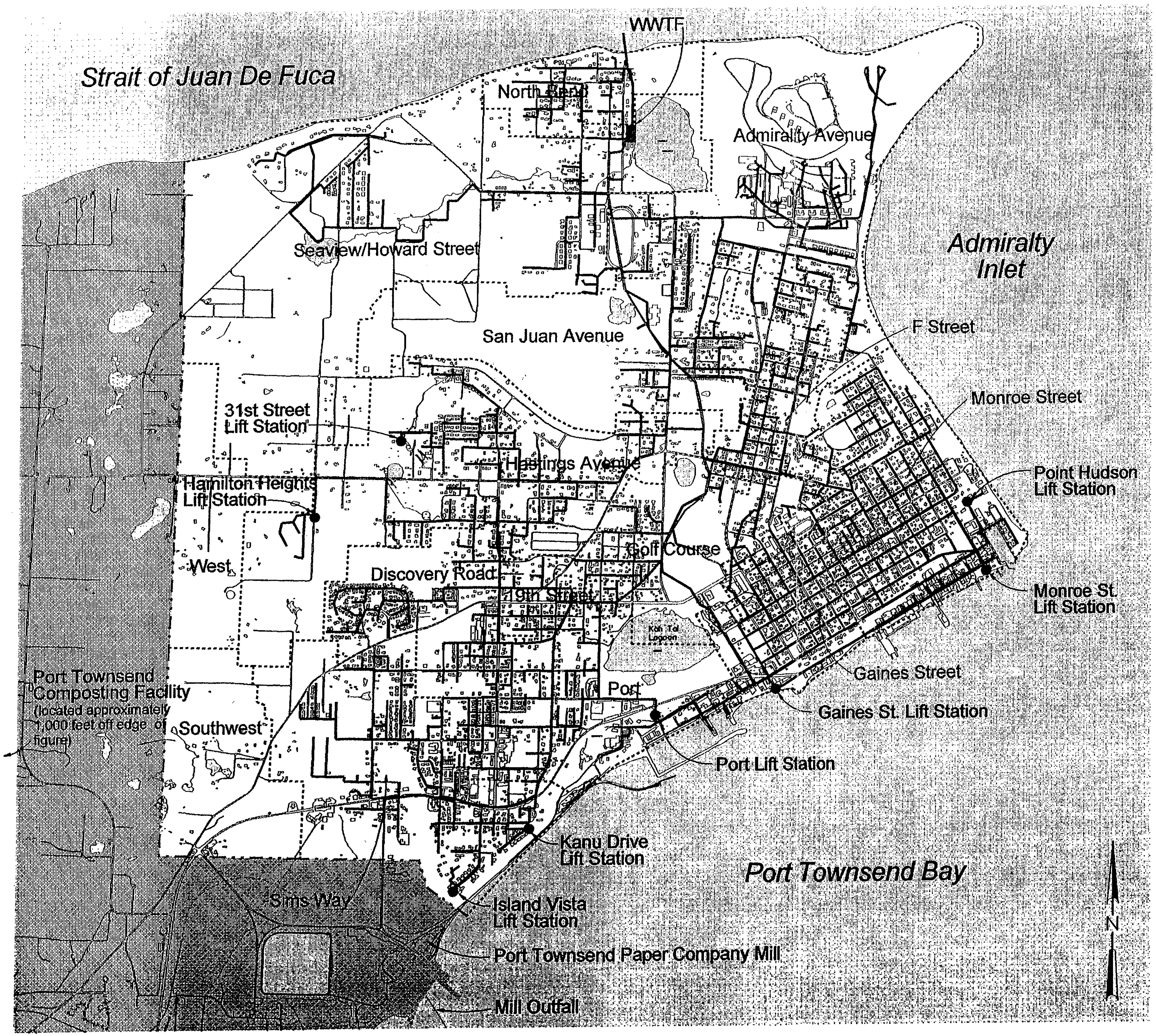
TABLE 5-15

Summary of Costs to Serve Basins 1, 2, and 3, LAMIRD Area, and 80-Acre Educational Facility

Sewer Alternative	Estimated Sewer Project Costs
Alternative 1 – Basins 1, 2, and 3 served by common lift station, Basin 1 180 acres.	$2,916,700
Alternative 2 – Basins 1, 2, and 3 served by common lift station, Basin 1 270 acres	$2,742,700
Alternative 3 – Basins 1, 2, and 3 served by common lift station, Basin 1 1,245 acres	$5,614,600
Alternative 4 – Basins 1, 2, and 3 each served by individual lift station, Basin 1 service area varies	4A: Basin 1 180 acres: $5,196,000
	4B: Basin 1 270 acres: $5,033,700
	4C: Basin 1 1,245 acres: $7,494,200
Alternative 5 – Basins 1 and 2 served by common lift station, Basin 3 served by individual lift station, Basin 1 service area varies	5A: Basin 1 180 acres: $4,117,900
	5B: Basin 1 270 acres: $3,929,000
	5C: Basin 1 1,245 acres: $6,405,700
Alternative 6 – Basins 2 and 3 served by common lift station, Basin 1 served by individual lift station, Basin 1 service area varies	6A: Basin 1 180 acres: $4,379,800
	6B: Basin 1 270 acres: $4,217,400
	6C: Basin 1 1,245 acres: $6,662,800
Alternative 7 – Basins 1, 2, and 3 served by common lift station, Basin 1 serves LAMIRD (500 acres)	$4,400,400
Alternative 8 – 80-Acre Educational Facility	$1,691,500

APPENDIX A

Basin Flow Information from *City of Port Townsend Wastewater Comprehensive Plan* (CH2M Hill, September 1999)



Legend

- City Limits
- Sewer
- Force Main
- Trunk Sewer
- Lift Station
- Sewer Drainage Basin Boundary (Basin Names in Red)

0 1000 2000 3000
SCALE IN FEET

City of Port Townsend
Comprehensive Sewer Plan

Figure 3-1
Existing Wastewater System

The total peak infiltration within the City is approximately 720,000 gpd. Similar to inflows, most of the infiltration occurs in the Gaines Street and Monroe Street sewer basins, where most of the sewers are older, deteriorating, vitrified clay or concrete pipe with joints every three or four feet. Many of the sewers in the downtown area are also within the tidal zone, where groundwater rises and falls within the sandy soils to match the tide level. When tides are higher than the sewers, any opening or leak in the joints or maintenance holes allows groundwater to flow into the sewers.

The City's *1976 Sewer System Evaluation Survey* stated that providing sufficient conveyance and treatment capacity in the wastewater system was more cost effective than eliminating these sources of infiltration. This is still true, given the widespread distribution of infiltration sources and the relatively low quantity of infiltration at any one point. Removal of infiltration requires rehabilitation or replacement of large portions of the collection system. However, some infiltration will be removed as sewers or maintenance holes are rehabilitated or replaced for structural reasons.

Existing and Projected Wastewater Flows by Sewer Drainage Basin

Table 5-11 shows a summary of the existing and projected ultimate average and peak wastewater flows by sewer drainage basin. This summary is based on the sanitary and inflow and infiltration contributions within each sewer basin.

These wastewater flows are based on the per capita residential unit, and non-residential acre flow rates, existing and planned land use and development and historical flow monitoring data. Appendix F contains a description of the methods used and the detailed calculations used to develop the existing and projected future flows within each basin. The ultimate peak day flows assume no increase or decrease from the current amount of stormwater inflows, and they include either the current infiltration or an infiltration allowance of 250 gallons per acre per day for the entire basin, whichever is greater.

TABLE 5-11
Existing and Projected Wastewater Flows

	Existing (1997) (gpd)		Ultimate (gpd)	
Basin	Average Dry Weather	Peak Day	Average Dry Weather	Peak Day
19th Street	24,210	104,535	39,122	115,772
Admiralty Avenue	160,045	585,667	333,160	800,178
Discovery Road	80,427	277,781	198,790	443,803
F Street	32,210	114,735	57,564	139,649
Gaines Street	118,599	1,320,178	169,509	1,107,548
Golf Course	40,918	147,956	116,408	256,671
Hastings Avenue	56,997	152,276	265,948	524,650
Monroe Street	201,113	1,064,690	292,501	1,035,609
North Beach	13,195	19,793	50,240	93,196
Port	25,080	45,359	113,605	198,299

TABLE 5-11
Existing and Projected Wastewater Flows

Basin	Existing (1997) (gpd)		Ultimate (gpd)	
	Average Dry Weather	Peak Day	Average Dry Weather	Peak Day
San Juan Avenue	48,295	121,043	273,696	471,505
Seaview/Howard Street	29,698	44,547	303,824	595,578
Sims Way	77,032	327,408	311,530	672,025
Southwest	5,462	8,194	139,988	240,521
West	2,030	3,045	89,875	159,172
Total	**915,310**	**4,337,206**	**2,755,761**	**6,854,174**

Flow Monitoring

As part of this Plan, City staff conducted an extensive flow monitoring program to verify existing wastewater flows from each basin and help confirm the location of the most significant sources of inflow and infiltration.

The City owns two Flo-Tote wastewater flow meters. To monitor flows, these meters are inserted into the pipe leading out of a maintenance hole; they measure the flow in the pipeline at five minute increments. To verify typical flows at a number of different locations, City staff placed the meters at different locations for periods of up to eight weeks. Figure 5-4 and Table 5-12 show the locations and dates where flows were monitored or where attempts to monitor were made. At several monitoring locations data was incomplete, inaccurate, or not measured because of difficulties with the measuring conditions at the location. These locations where average dry weather and peak flow are not available are indicated with a "-."

The data obtained from the two flow meters was reduced and used to identify the following at each site for the duration of the test:

- Average dry weather flow rate
- Dry weather diurnal variation from average flow rate
- Typical wet weather flow rates experienced during the monitoring period.

The pattern of flow rates at each location was consistent from day to day during dry weather conditions. Wet weather greatly affected areas with large inflows, and had little affect on areas with little or no inflow. Due to the limited amount of time available for monitoring flows at each site, some locations had very little data during rainfall events. Measured flows were used to verify average flows and the presence of inflow when possible. WWTF flow records were used to improve the hydraulic analysis model.

Existing and Future Wastewater Flows

The attached tables (F-1 through F-18), show estimated existing and ultimate wastewater flows within each sewer basin. Each table contains data including the total and developable areas within each basin and an estimate of current development levels.

Basin Areas

The basin area is simply the geographical area of that basin. The area excluding right-of-ways was determined by removing all platted right-of-ways from the basin area, and by reserving an estimated 20 percent of the unplatted areas for right-of-ways. For most of the City, the right-of-ways are well established and are not likely to change. However, in areas that are currently not platted or not developed, the right-of-ways are likely to change.

Development Factors

Wastewater flow estimates are based on a maximum number of residential units per acre, or on a maximum commercial development per acre. Many factors, however, prevent most acres of developable land to be developed to their maximum potential. Zoning and planned land use have generally changed to allow more dense development than in the past, and so many areas are underdeveloped by current standards. Wetlands, other environmentally sensitive areas, and open space requirements serve to reduce the developable area within each acre of land. Finally, as an example, if a parcel is zoned for up to 4 single family dwelling units per acre, and the parcel is 1.2 acres, the maximum density to which that parcel can actually be developed is only 3.33 dwelling units per acre.

To account for these factors that all combine to cause a certain amount of under-development, a factor is applied to the land use areas, exclusive of right-of-ways, before estimating the maximum wastewater flow that can be generated from that area. This is a "development factor". These development factors are assumptions taken from studies done for other municipalities.

There are two development factors shown for each basin. The existing development factor is based on the actual number of dwelling units that exist today, compared with the land that is currently developed. Because the residential contribution is a much larger portion of the overall wastewater flow than the non-residential contribution, non-residential land is assumed to be developed at the same rate as residential land.

As land prices escalate and construction profit margins are reduced, there is substantial pressure to increase the intensity of land use in the future. For this reason, a separate future development factor is applied to currently undeveloped land. This future development factor is based on the City's ultimate population projection and still takes into account some underdevelopment, but less than the existing development factor.

Development

The existing number of residences and developed non-commercial land are combined with the projected new residences and undeveloped non-commercial land to estimate the ultimate number of residences and level of non-residential development.

Wastewater Flows

The estimated sanitary wastewater flows are based on the numbers of residential units and non-residential acres, combined with the unit flow rates shown in **Table** F-3. The inflow and infiltration flows are based on the detailed inventories of each inflow or infiltration source. For these flow estimates, it is assumed that no additional storm sewer connections (inflows) into the sewer system will be allowed, but also that no existing connections will be removed. Also, it is assumed that areas with existing infiltration problems will see a ten percent increase in that infiltration in the future, as sewers and maintenance holes age and decay further.

Flow Monitoring Results

Where flow monitoring has been done within the basin, a summary of the flow monitoring results is included. These results help verify the estimate of existing flow rates.

Table F-1
Summary of Existing Wastewater Flows (gallons per day) Based on Existing Development and Average Flow Rates

Basin	Average Dry Weather				Peak Day			
	Sanitary	Inflow	Infiltration	Total	Sanitary	Inflow	Infiltration	Total
19th Street	13,050	0	11,160	24,210	19,575	29,189	44,640	93,404
Admiralty Avenue	142,765	0	17,280	160,045	214,147	218,921	69,120	502,188
Discovery Road	72,867	0	7,560	80,427	109,301	100,078	30,240	239,620
F Street	24,650	0	7,560	32,210	36,975	34,402	30,240	101,617
Gaines Street	80,439	0	38,160	118,599	120,658	757,884	152,640	1,031,183
Golf Course	36,238	0	4,680	40,918	54,356	54,209	18,720	127,285
Hastings Avenue	54,477	0	2,520	56,997	81,716	43,784	10,080	135,580
Monroe Street	136,673	0	64,440	201,113	205,010	435,758	257,760	898,528
North Beach	13,195	0	0	13,195	19,793	0	0	19,793
Port	22,560	0	2,520	25,080	33,839	1,042	10,080	44,962
San Juan Avenue	28,855	0	19,440	48,295	43,283	0	77,760	121,043
Seaview/Howard St.	29,698	0	0	29,698	44,547	0	0	44,547
Sims Way	72,352	0	4,680	77,032	108,528	144,905	18,720	272,153
Southwest	5,462	0	0	5,462	8,194	0	0	8,194
West	2,030	0	0	2,030	3,045	0	0	3,045
Total	**735,310**	**0**	**180,000**	**915,310**	**1,102,966**	**1,820,174**	**720,000**	**3,643,139**

Table F-2
Summary of Ultimate Wastewater Flows (gallons per day)

Basin	Average Dry Weather				Peak Day			
	Sanitary	Inflow	Infiltration	Total	Sanitary	Inflow	Infiltration	Total
19th Street	27,962	0	11,160	39,122	41,943	29,189	44,640	115,772
Admiralty Avenue	300,554	0	32,607	333,160	450,831	218,921	130,426	800,178
Discovery Road	180,574	0	18,216	198,790	270,860	100,078	72,864	443,803
F Street	50,004	0	7,560	57,564	75,007	34,402	30,240	139,649
Gaines Street	131,349	0	38,160	169,509	197,023	757,884	152,640	1,107,548
Golf Course	105,268	0	11,140	116,408	157,903	54,209	44,560	256,671
Hastings Avenue	233,170	0	32,778	265,948	349,755	43,784	131,110	524,650
Monroe Street	228,061	0	64,440	292,501	342,092	435,758	257,760	1,035,609
North Beach	43,106	0	7,134	50,240	64,660	0	28,536	93,196
Port	102,866	0	10,740	113,605	154,298	1,042	42,959	198,299
San Juan Avenue	249,312	0	24,384	273,696	373,967	0	97,538	471,505
Seaview/Howard St.	247,888	0	55,937	303,824	371,832	0	223,747	595,578
Sims Way	287,600	0	23,930	311,530	431,400	144,905	95,720	672,025
Southwest	127,772	0	12,216	139,988	191,659	0	48,862	240,521
West	80,131	0	9,744	89,875	120,197	0	38,975	159,172
Total	**2,395,617**	**0**	**360,144**	**2,755,761**	**3,593,425**	**1,820,174**	**1,440,576**	**6,854,174**

Table F-3
Flow Rates by Land Use, Flow Rate by Unit, and Peaking Factors

Land Use	Units/Acre	Flow/Unit	Flow/Acre
R-I(SF)	4	145	580
R-II(SF)	8	145	1,160
R-III(MF)	16	120	1,920
R-IV(MF)	24	120	2,880
C-I			1,000
C-II			1,500
C-II(H)			3,000
C-III			2,000
M-C			1,500
C-I/MU			1,000
C-II/MU			1,500
M-II(A)			1,500
M-II(B)			1,500
P/OS			500
P/OS(A)			500
P/OS(B)			500
P-I			1,500

Average Dry Weather Flow Rates

SF	145 gallons/unit/day
MF	120 gallons/unit/day
Infiltration Allowance	0 gallons/acre/day

Development Factors

Existing Development Factor:	75%
Future Development Factor:	80%
Residential Redevelopment Factor:	65%
Non-residential Redevelopment Factor:	75%

Peaking Factors (Peak Day:Average Day)

SF Residential	1.50
MF Residential	1.50
Non-residential	1.50
Inflow	1.00
Infiltration	1.00

Table F-4
West Basin

Basin Area (acres)	156	Development Factors	
Approximate Percentage Right-of-Ways	10%	Existing:	75%
Area excluding right-of-ways (acres)	140	Future:	80%

Land Use (acres)

	Developed	Un-developed	Total	Maximum Units/Acre	Net Future Units	Net Future Acres
R-I(SF)	12	2	14	4	7	
R-II(SF)	40	72	112	8	461	
R-III(MF)	9	0	9	16	0	
R-IV(MF)	0	0	0	24	0	
C-I	0	0	0			0
C-II	0	0	0			0
C-II(H)	0	0	0			0
C-III	0	0	0			0
M-C	0	0	0			0
C-I/MU	0	0	0			0
C-II/MU	0	0	0			0
M-II(A)	0	0	0			0
M-II(B)	0	0	0			0
P/OS	0	0	0			0
P/OS(A)	0	0	0			0
P/OS(B)	0	4	4			3
P-I	0	0	0			0
	61	**79**	**140**		**469**	**3**

Development

	Existing	Future	Total	Percent Developed
SF Units	14	527	541	3%
MF Units	0	0	0	#DIV/0!
Non-residential (ac)	0	4	4	0%

Wastewater Flows (gallons per day)

	Existing		Additional Future		Total	
	Average	Peak	Average	Peak	Average	Peak
SF Residential	2,030	3,045	76,435	114,652	78,465	117,697
MF Residential	0	0	0	0	0	0
Non-residential	0	0	1,666	2,500	1,666	2,500
Inflow		0		0		0
Infiltration	0	0		0		0
Total	**2,030**	**3,045**	**78,101**	**117,152**	**80,131**	**120,197**

Table F-5
Southwest Basin

Basin Area (acres)	195	**Development Factors**	
Approximate Percentage Right-of-Ways	21%	**Existing:**	75%
Area excluding right-of-ways (acres)	154	**Future:**	80%

Land Use (acres)

	Developed	Un-developed	Total	Maximum Units/Acre	Net Future Units	Net Future Acres
R-I(SF)	0	0	0	4	0	
R-II(SF)	33	71	104	8	455	
R-III(MF)	8	6	14	16	78	
R-IV(MF)	0	0	0	24	0	
C-I	0	0	0			0
C-II	1	21	23			17
C-II(H)	0	0	0			0
C-III	0	0	0			0
M-C	2	5	7			4
C-I/MU	0	0	0			0
C-II/MU	0	2	2			2
M-II(A)	0	0	0			0
M-II(B)	0	0	0			0
P/OS	0	4	4			3
P/OS(A)	0	0	0			0
P/OS(B)	0	0	0			0
P-I	0	0	0			0
	44	**110**	**154**		**533**	**26**

Development

	Existing	Future	Total	Percent Developed
SF Units	14	513	527	3%
MF Units	0	78	78	0%
Non-residential (ac)	3	32	35	9%

Wastewater Flows (gallons per day)

	Existing		Additional Future		Total	
	Average	Peak	Average	Peak	Average	Peak
SF Residential	2,030	3,045	74,446	111,668	76,476	114,713
MF Residential	0	0	9,340	14,011	9,340	14,011
Non-residential	3,432	5,149	38,524	57,786	41,956	62,934
Inflow		0		0		0
Infiltration	0	0		0		0
Total	**5,462**	**8,194**	**122,310**	**183,465**	**127,772**	**191,659**

Table F-6
Sims Way Basin

Basin Area (acres)	383	**Development Factors**		
Approximate Percentage Right-of-Ways	34%	**Existing:**	75%	
Area excluding right-of-ways (acres)	254	**Future:**	80%	

Land Use (acres)

	Developed	Un-developed	Total	Maximum Units/Acre	Net Future Units	Net Future Acres
R-I(SF)	0	0	0	4	0	
R-II(SF)	61	37	98	8	236	
R-III(MF)	17	22	38	16	277	
R-IV(MF)	1	8	9	24	154	
C-I	0	0	0			0
C-II	23	16	39			13
C-II(H)	2	2	3			1
C-III	0	0	0			0
M-C	2	48	50			39
C-I/MU	0	0	0			0
C-II/MU	0	7	7			6
M-II(A)	0	1	1			0
M-II(B)	0	0	0			0
P/OS	0	3	3			2
P/OS(A)	0	0	0			0
P/OS(B)	0	0	0			0
P-I	1	3	4			3
	106	**147**	**254**		**667**	**65**

Development

	Existing	Future	Total	Percent Developed
SF Units	273	295	568	48%
MF Units	0	431	431	0%
Non-residential (ac)	27	81	108	25%

Wastewater Flows (gallons per day)

	Existing		Additional Future		Total	
	Average	Peak	Average	Peak	Average	Peak
SF Residential	39,585	59,378	42,734	64,101	82,319	123,479
MF Residential	0	0	51,675	77,512	51,675	77,512
Non-residential	32,767	49,150	120,839	181,259	153,606	230,409
Inflow		200,160		0		200,160
Infiltration	4,680	4,680		468		5,148
Total	**77,032**	**313,368**	**215,248**	**323,340**	**287,600**	**636,708**

Table F-7
Seaview/Howard Street Basin

Basin Area (acres)	895	**Development Factors**	
Approximate Percentage Right-of-Ways	37%	**Existing:**	75%
Area excluding right-of-ways (acres)	564	**Future:**	80%

Land Use (acres)

	Developed	Un-developed	Total	Maximum Units/Acre	Net Future Units	Net Future Acres
R-I(SF)	139	299	437	4	955	
R-II(SF)	4	32	35	8	202	
R-III(MF)	0	2	2	16	23	
R-IV(MF)	0	0	0	24	0	
C-I	0	0	0			0
C-II	0	0	0			0
C-II(H)	0	0	0			0
C-III	0	0	0			0
M-C	0	0	0			0
C-I/MU	0	5	5			4
C-II/MU	0	0	0			0
M-II(A)	0	0	0			0
M-II(B)	0	0	0			0
P/OS	0	32	32			26
P/OS(A)	0	0	0			0
P/OS(B)	0	50	50			40
P-I	1	1	2			1
	143	420	564		1,180	71

Development

	Existing	Future	Total	Percent Developed
SF Units	198	1216	1414	14%
MF Units	0	23	23	0%
Non-residential (ac)	1	88	89	1%

Wastewater Flows (gallons per day)

	Existing		Additional Future		Total	
	Average	Peak	Average	Peak	Average	Peak
SF Residential	28,710	43,065	176,273	264,409	204,983	307,474
MF Residential	0	0	2,737	4,106	2,737	4,106
Non-residential	988	1,482	39,180	58,770	40,168	60,252
Inflow		0		0		0
Infiltration	0	0		0		0
Total	29,698	44,547	218,190	327,285	247,888	371,832

Table F-8

San Juan Avenue Basin

Basin Area (acres)	390	Development Factors	
Approximate Percentage Right-of-Ways	22%	Existing:	75%
Area excluding right-of-ways (acres)	306	Future:	80%

Land Use (acres)

	Developed	Un-developed	Total	Maximum Units/Acre	Net Future Units	Net Future Acres
R-I(SF)	0	2	2	4	6	
R-II(SF)	86	169	254	8	1,080	
R-III(MF)	3	8	11	16	99	
R-IV(MF)	0	0	0	24	0	
C-I	0	0	0			0
C-II	0	0	0			0
C-II(H)	0	0	0			0
C-III	0	0	0			0
M-C	0	0	0			0
C-I/MU	0	0	0			0
C-II/MU	0	0	0			0
M-II(A)	0	0	0			0
M-II(B)	0	0	0			0
P/OS	0	2	2			2
P/OS(A)	0	0	0			0
P/OS(B)	0	2	2			2
P-I	0	34	34			27
	89	217	306		1,184	31

Development

	Existing	Future	Total	Percent Developed
SF Units	199	1144	1343	15%
MF Units	0	99	99	0%
Non-residential (ac)	0	39	39	0%

Wastewater Flows (gallons per day)

	Existing		Additional Future		Total	
	Average	Peak	Average	Peak	Average	Peak
SF Residential	28,855	43,283	165,862	248,792	194,717	292,075
MF Residential	0	0	11,852	17,778	11,852	17,778
Non-residential	0	0	42,743	64,115	42,743	64,115
Inflow		0		0		0
Infiltration	19,440	19,440		1,944		21,384
Total	**48,295**	**62,723**	**220,457**	**332,629**	**249,312**	**395,351**

Table F-12
Hastings Avenue Basin

Basin Area (acres)	524	**Development Factors**	
Approximate Percentage Right-of-Ways	28%	**Existing:**	75%
Area excluding right-of-ways (acres)	379	**Future:**	80%

Land Use (acres)

	Developed	Un-developed	Total	Maximum Units/Acre	Net Future Units	Net Future Acres
R-I(SF)	9	32	40	4	101	
R-II(SF)	143	90	234	8	579	
R-III(MF)	31	21	52	16	268	
R-IV(MF)	0	0	0	24	0	
C-I	1	0	1			0
C-II	0	0	0			0
C-II(H)	0	0	0			0
C-III	0	0	0			0
M-C	0	0	0			0
C-I/MU	3	4	7			3
C-II/MU	0	0	0			0
M-II(A)	0	0	0			0
M-II(B)	0	0	0			0
P/OS	0	6	6			5
P/OS(A)	0	0	0			0
P/OS(B)	0	18	18			14
P-I	2	19	21			15
	190	**189**	**379**		**948**	**37**

Development

	Existing	Future	Total	Percent Developed
SF Units	335	738	1073	31%
MF Units	0	268	268	0%
Non-residential (ac)	7	47	53	13%

Wastewater Flows (gallons per day)

	Existing		Additional Future		Total	
	Average	Peak	Average	Peak	Average	Peak
SF Residential	48,575	72,863	107,081	160,621	155,656	233,483
MF Residential	0	0	32,147	48,220	32,147	48,220
Non-residential	5,902	8,853	39,465	59,198	45,368	68,051
Inflow		60,480		0		60,480
Infiltration	2,520	2,520		252		2,772
Total	**56,997**	**144,716**	**178,693**	**268,291**	**233,170**	**413,007**

Table F-16
Discovery Road Basin

Basin Area (acres)	291	Development Factors	
Approximate Percentage Right-of-Ways	40%	Existing:	75%
Area excluding right-of-ways (acres)	175	Future:	80%

Land Use (acres)

	Developed	Un-developed	Total	Maximum Units/Acre	Net Future Units	Net Future Acres
R-I(SF)	0	0	0	4	0	
R-II(SF)	79	46	125	8	296	
R-III(MF)	8	10	18	16	128	
R-IV(MF)	2	5	6	24	86	
C-I	0	0	0			0
C-II	3	0	3			0
C-II(H)	2	2	4			2
C-III	0	0	0			0
M-C	0	0	0			0
C-I/MU	0	0	0			0
C-II/MU	0	0	0			0
M-II(A)	0	0	0			0
M-II(B)	0	0	0			0
P/OS	0	0	0			0
P/OS(A)	0	0	0			0
P/OS(B)	0	0	0			0
P-I	8	11	19			9
	100	74	175		510	11

Development

	Existing	Future	Total	Percent Developed
SF Units	395	354	749	53%
MF Units	0	214	214	0%
Non-residential (ac)	12	14	26	47%

Wastewater Flows (gallons per day)

	Existing		Additional Future		Total	
	Average	Peak	Average	Peak	Average	Peak
SF Residential	57,275	85,913	51,402	77,102	108,677	163,015
MF Residential	0	0	25,696	38,544	25,696	38,544
Non-residential	15,592	23,389	30,609	45,913	46,201	69,302
Inflow		138,240		0		138,240
Infiltration	7,560	7,560		756		8,316
Total	80,427	255,101	107,706	162,315	180,574	417,416

APPENDIX B

Model Results from *City of Port Townsend Wastewater Comprehensive Plan*
(CH2M Hill, September 1999)

Table G-1
Hydraulic Analysis Results

Pipe Number	Pipe Tag	U/S MH	D/S MH	U/S IE (ft)	D/S IE (ft)	Length (ft)	Size	Slope (ft/ft)	Capacity (mgd)	Existing Peak Flow (mgd)	Existing % Capacity	Existing Replacement Size (in)	Ultimate Peak Flow (mgd)	Ultimate % Capacity	Ultimate Replacement Size (in)
14253	E5-E5A	E5	E5A	19.93	17.14	166	6	0.0168	0.471	0.931	198%	8	2.165	460%	12
14298	P17-P16	P17	P16	22.22	20.38	271	8	0.0068	0.645	0.061	9%	0	0.708	110%	10
14312	F134-F135	F134	F135	134.98	132.79	252	8	0.0087	0.730	0.017	2%	0	0.094	13%	0
14315	H45-H44	H45	H44	193.94	190.85	297	8	0.0104	0.799	0.062	8%	0	0.607	76%	0
14317	H28-H27	H28	H27	148.49	124.66	397	8	0.0601	1.919	0.094	5%	0	0.693	36%	0
14320	G2-G3	G2	G3	104.52	101.88	529	12	0.0050	1.630	0.496	30%	0	1.329	82%	0
14321	H19-H18	H19	H18	225.36	219.28	393	8	0.0155	0.973	0.028	3%	0	0.073	8%	0
14328	H104-H16A	H104	H16A	227.58	224.89	251	8	0.0107	0.810	0.003	0%	0	0.015	2%	0
14329	H97-H98	H97	H98	234.13	232.45	261	8	0.0064	0.628	0.005	1%	0	0.013	2%	0
14339	H56H-H56B	H56H	H56B	232.83	231.18	248	8	0.0066	0.638	0.001	0%	0	0.132	21%	0
14340	H56B-H56A	H56B	H56A	231.18	229.42	276	8	0.0064	0.625	0.002	0%	0	0.148	24%	0
14341	G12-G11	G12	G11	193.00	186.10	161	8	0.0429	1.622	0.034	2%	0	0.047	3%	0
14355	H56-H56A	H56	H56A	230.66	229.42	51	8	0.0241	1.216	0.003	0%	0	0.011	1%	0
14356	H56A-H55	H56A	H55	229.42	223.38	253	8	0.0239	1.210	0.008	1%	0	0.162	13%	0
14358	H34-H33	H34	H33	181.73	177.84	284	8	0.0137	0.915	0.005	1%	0	0.013	1%	0
14361	H3-H2	H3	H2	117.39	116.00	266	8	0.0052	0.566	0.426	75%	0	1.215	215%	12
14363	G13-G12	G13	G12	197.59	193.00	134	8	0.0343	1.449	0.029	2%	0	0.037	3%	0
14418	G1-G2	G1	G2	107.29	104.52	513	12	0.0054	1.695	0.442	26%	0	1.246	74%	0
14419	G8-G2	G8	G2	131.43	104.52	227	8	0.1183	2.692	0.054	2%	0	0.079	3%	0
14420	G9-G8	G9	G8	155.73	131.43	259	8	0.0939	2.399	0.053	2%	0	0.078	3%	0
14421	G10-G9	G10	G9	171.70	155.73	262	8	0.0610	1.933	0.053	3%	0	0.071	4%	0
14423	G11-G10	G11	G10	186.10	171.70	259	8	0.0555	1.845	0.044	2%	0	0.059	3%	0
14427	G14-G13	G14	G13	202.43	197.59	132	8	0.0366	1.496	0.026	2%	0	0.029	2%	0
14428	G15-G14	G15	G14	207.93	202.43	152	8	0.0362	1.489	0.022	1%	0	0.024	2%	0
14434	H2-H1	H2	H1	116.00	109.03	273	12	0.0256	3.690	0.427	12%	0	1.217	33%	0
14439	H4-H3	H4	H3	130.38	117.39	169	8	0.0771	2.173	0.110	5%	0	0.290	13%	0
14440	H5-H4	H5	H4	145.37	130.38	194	8	0.0771	2.173	0.110	5%	0	0.290	13%	0
14441	H6-H5	H6	H5	153.74	145.37	190	8	0.0440	1.641	0.109	7%	0	0.282	17%	0
14442	H7-H6	H7	H6	167.92	153.74	257	8	0.0552	1.839	0.109	6%	0	0.282	15%	0
14444	H8-H7	H8	H7	181.83	167.92	260	8	0.0535	1.811	0.098	5%	0	0.270	15%	0
14445	H9-H8	H9	H8	188.87	181.83	313	8	0.0225	1.174	0.094	8%	0	0.265	23%	0
14446	H10-H9	H10	H9	191.96	188.87	232	8	0.0133	0.903	0.078	9%	0	0.248	27%	0
14447	H11-H10	H11	H10	194.70	191.96	293	8	0.0094	0.757	0.069	9%	0	0.238	31%	0
14448	H12-H11	H12	H11	197.86	194.70	164	8	0.0192	1.085	0.068	6%	0	0.237	22%	0
14458	H13-H12	H13	H12	204.73	197.86	277	8	0.0248	1.232	0.062	5%	0	0.231	19%	0

Table G-1
Hydraulic Analysis Results

Pipe Number	Pipe Tag	U/S MH	D/S MH	U/S IE (ft)	D/S IE (ft)	Length (ft)	Size	Slope (ft/ft)	Capacity (mgd)	Existing Peak Flow (mgd)	Existing % Capacity	Existing Replacement Size (in)	Ultimate Peak Flow (mgd)	Ultimate % Capacity	Ultimate Replacement Size (in)
14253	E5-E5A	E5	E5A	19.93	17.14	166	6	0.0168	0.471	0.931	198%	8	2.165	460%	12
14298	P17-P16	P17	P16	22.22	20.38	271	8	0.0068	0.645	0.061	9%	0	0.708	110%	10
14312	F134-F135	F134	F135	134.98	132.79	252	8	0.0087	0.730	0.017	2%	0	0.094	13%	0
14315	H45-H44	H45	H44	193.94	190.85	297	8	0.0104	0.799	0.062	8%	0	0.607	76%	0
14317	H28-H27	H28	H27	148.49	124.66	397	8	0.0601	1.919	0.094	5%	0	0.693	36%	0
14320	G2-G3	G2	G3	104.52	101.88	529	12	0.0050	1.630	0.496	30%	0	1.329	82%	0
14321	H19-H18	H19	H18	225.36	219.28	393	8	0.0155	0.973	0.028	3%	0	0.073	8%	0
14328	H104-H16A	H104	H16A	227.58	224.89	251	8	0.0107	0.810	0.003	0%	0	0.015	2%	0
14329	H97-H98	H97	H98	234.13	232.45	261	8	0.0064	0.628	0.005	1%	0	0.013	2%	0
14339	H56H-H56B	H56H	H56B	232.83	231.18	248	8	0.0066	0.638	0.001	0%	0	0.132	21%	0
14340	H56B-H56A	H56B	H56A	231.18	229.42	276	8	0.0064	0.625	0.002	0%	0	0.148	24%	0
14341	G12-G11	G12	G11	193.00	186.10	161	8	0.0429	1.622	0.034	2%	0	0.047	3%	0
14355	H56-H56A	H56	H56A	230.66	229.42	51	8	0.0241	1.216	0.003	0%	0	0.011	1%	0
14356	H56A-H55	H56A	H55	229.42	223.38	253	8	0.0239	1.210	0.008	1%	0	0.162	13%	0
14358	H34-H33	H34	H33	181.73	177.84	284	8	0.0137	0.915	0.005	1%	0	0.013	1%	0
14361	H3-H2	H3	H2	117.39	116.00	266	8	0.0052	0.566	0.426	75%	0	1.215	215%	12
14363	G13-G12	G13	G12	197.59	193.00	134	8	0.0343	1.449	0.029	2%	0	0.037	3%	0
14418	G1-G2	G1	G2	107.29	104.52	513	12	0.0054	1.695	0.442	26%	0	1.246	74%	0
14419	G8-G2	G8	G2	131.43	104.52	227	8	0.1183	2.692	0.054	2%	0	0.079	3%	0
14420	G9-G8	G9	G8	155.73	131.43	259	8	0.0939	2.399	0.053	2%	0	0.078	3%	0
14421	G10-G9	G10	G9	171.70	155.73	262	8	0.0610	1.933	0.053	3%	0	0.071	4%	0
14423	G11-G10	G11	G10	186.10	171.70	259	8	0.0555	1.845	0.044	2%	0	0.059	3%	0
14427	G14-G13	G14	G13	202.43	197.59	132	8	0.0366	1.496	0.026	2%	0	0.029	2%	0
14428	G15-G14	G15	G14	207.93	202.43	152	8	0.0362	1.489	0.022	1%	0	0.024	2%	0
14434	H2-H1	H2	H1	116.00	109.03	273	12	0.0256	3.690	0.427	12%	0	1.217	33%	0
14439	H4-H3	H4	H3	130.38	117.39	169	8	0.0771	2.173	0.110	5%	0	0.290	13%	0
14440	H5-H4	H5	H4	145.37	130.38	194	8	0.0771	2.173	0.110	5%	0	0.290	13%	0
14441	H6-H5	H6	H5	153.74	145.37	190	8	0.0440	1.641	0.109	7%	0	0.282	17%	0
14442	H7-H6	H7	H6	167.92	153.74	257	8	0.0552	1.839	0.109	6%	0	0.282	15%	0
14444	H8-H7	H8	H7	181.83	167.92	260	8	0.0535	1.811	0.098	5%	0	0.270	15%	0
14445	H9-H8	H9	H8	188.87	181.83	313	8	0.0225	1.174	0.094	8%	0	0.265	23%	0
14446	H10-H9	H10	H9	191.96	188.87	232	8	0.0133	0.903	0.078	9%	0	0.248	27%	0
14447	H11-H10	H11	H10	194.70	191.96	293	8	0.0094	0.757	0.069	9%	0	0.238	31%	0
14448	H12-H11	H12	H11	197.86	194.70	164	8	0.0192	1.085	0.068	6%	0	0.237	22%	0
14458	H13-H12	H13	H12	204.73	197.86	277	8	0.0248	1.232	0.062	5%	0	0.231	19%	0

Table G-1
Hydraulic Analysis Results

Pipe Number	Pipe Tag	U/S MH	D/S MH	U/S IE (ft)	D/S IE (ft)	Length (ft)	Size	Slope (ft/ft)	Capacity (mgd)	Existing Peak Flow (mgd)	Existing % Capacity	Existing Replacement Size (in)	Ultimate Peak Flow (mgd)	Ultimate % Capacity	Ultimate Replacement Size (in)
14459	H14-H13	H14	H13	210.86	204.73	316	8	0.0194	1.090	0.056	5%	0	0.223	20%	0
14460	H15-H14	H15	H14	213.24	210.86	230	8	0.0104	0.797	0.053	7%	0	0.217	27%	0
14461	H16-H15	H16	H15	214.90	213.24	170	8	0.0098	0.773	0.050	6%	0	0.213	28%	0
14462	H24-H16	H24	H16	216.89	214.90	188	8	0.0106	0.805	0.001	0%	0	0.001	0%	0
14463	H17-H16	H17	H16	217.98	214.90	203	8	0.0152	0.965	0.047	5%	0	0.210	22%	0
14464	H16A-H17	H16A	H17	224.89	223.55	175	8	0.0076	0.684	0.003	0%	0	0.015	2%	0
14465	H98-H18	H98	H18	232.45	223.40	272	8	0.0333	1.428	0.014	1%	0	0.118	8%	0
14466	H84-H98	H84	H98	238.70	232.45	291	8	0.0215	1.147	0.007	1%	0	0.103	9%	0
14467	H25-H3	H25	H3	118.13	117.39	254	8	0.0029	0.422	0.097	23%	0	0.704	167%	10
14468	H26-H25	H26	H25	123.66	118.13	106	8	0.0524	1.791	0.096	5%	0	0.697	39%	0
14469	H27-H26	H27	H26	124.66	123.66	265	8	0.0038	0.480	0.096	20%	0	0.696	145%	10
14471	H29-H28	H29	H28	148.88	148.49	29	8	0.0136	0.913	0.091	10%	0	0.683	75%	0
14474	H30-H29	H30	H29	161.24	148.88	252	8	0.0490	1.733	0.089	5%	0	0.673	39%	0
14477	H31-H30	H31	H30	167.93	161.24	249	8	0.0268	1.282	0.086	7%	0	0.669	52%	0
14479	H32-H31	H32	H31	176.80	167.93	286	8	0.0310	1.377	0.074	5%	0	0.633	46%	0
14480	H33-H32	H33	H32	177.84	176.80	243	8	0.0043	0.512	0.072	14%	0	0.628	123%	10
14481	H44-H33	H44	H33	190.85	177.84	408	8	0.0319	1.397	0.064	5%	0	0.610	44%	0
14483	H35-H34	H35	H34	195.10	181.73	160	8	0.0835	2.262	0.002	0%	0	0.009	0%	0
14493	H46-H45	H46	H45	198.69	193.94	293	8	0.0162	0.997	0.060	6%	0	0.605	61%	0
14494	H47-H46	H47	H46	200.73	198.69	254	8	0.0080	0.701	0.057	8%	0	0.602	86%	0
14495	H48-H47	H48	H47	203.24	200.73	257	8	0.0098	0.773	0.056	7%	0	0.587	76%	0
14499	H49-H48	H49	H48	212.59	203.24	284	8	0.0329	1.419	0.013	1%	0	0.070	5%	0
14500	H52-H48	H52	H48	203.50	203.24	41	8	0.0063	0.621	0.029	5%	0	0.495	80%	0
14502	H53-H52	H53	H52	217.91	203.50	306	8	0.0470	1.698	0.026	2%	0	0.484	29%	0
14503	H52A-H53	H52A	H53	222.71	217.91	218	8	0.0220	1.162	0.026	2%	0	0.484	42%	0
14504	H55-H52A	H55	H52A	223.38	222.71	68	8	0.0099	0.779	0.011	1%	0	0.168	22%	0
14505	H55A-H55	H55A	H55	228.88	223.38	245	8	0.0225	1.173	0.003	0%	0	0.006	1%	0
14506	H57-H56	H57	H56	233.24	230.66	315	8	0.0082	0.708	0.003	0%	0	0.011	2%	0
14513	P43-P42	P43	P42	58.33	57.16	307	8	0.0038	0.483	0.010	2%	0	0.063	13%	0
14518	H90-H89	H90	H89	248.38	246.71	284	8	0.0059	0.600	0.002	0%	0	0.063	11%	0
14520	P44-P43	P44	P43	59.32	58.33	224	8	0.0044	0.520	0.010	2%	0	0.062	12%	0
14601	H99A-H99	H99A	H99	238.89	235.82	247	8	0.0124	0.873	0.001	0%	0	0.008	1%	0
14602	H103-H104	H103	H104	229.03	227.58	256	8	0.0057	0.589	0.002	0%	0	0.009	2%	0
14603	H99-H97	H99	H97	235.82	234.13	230	8	0.0073	0.671	0.002	0%	0	0.010	1%	0
14612	C4A-C4	C4A	C4	24.50	32.88	272	8	-0.0309	0.000	0.009		0	0.025		0

Table G-1
Hydraulic Analysis Results

Pipe Number	Pipe Tag	U/S MH	D/S MH	U/S IE (ft)	D/S IE (ft)	Length (ft)	Size	Slope (ft/ft)	Capacity (mgd)	Existing Peak Flow (mgd)	Existing % Capacity	Existing Replacement Size (in)	Ultimate Peak Flow (mgd)	Ultimate % Capacity	Ultimate Replacement Size (in)
14615	C18-C17	C18	C17	199.74	198.98	95	8	0.0080	0.700	0.048	7%	0	0.147	21%	0
14621	A95-A94	A95	A94	24.49	22.82	199	8	0.0084	0.717	0.015	2%	0	0.020	3%	0
14631	C15-C14	C15	C14	202.85	198.66	300	8	0.0140	0.925	0.003	0%	0	0.007	1%	0
14633	C42-C41	C42	C41	229.99	229.22	174	8	0.0044	0.521	0.007	1%	0	0.040	8%	0
14638	A9-A92	A9	A92	16.43	15.96	274	18	0.0017	2.819	4.278	152%	18	6.331	225%	27
14639	C35-C34	C35	C34	234.19	233.93	48	8	0.0054	0.575	0.002	0%	0	0.028	5%	0
14695	A91-A9	A91	A9	16.70	16.43	250	18	0.0011	2.237	4.243	190%	21	6.266	280%	27
14696	A10-A91	A10	A91	17.07	16.70	144	18	0.0026	3.447	4.237	123%	18	6.253	181%	24
14697	C51-C2	C51	C2	32.21	22.09	137	8	0.0739	2.128	0.001	0%	0	0.001	0%	0
14699	C1-A11	C1	A11	20.60	18.96	380	10	0.0043	0.932	0.120	13%	0	0.388	42%	0
14700	C2-C1	C2	C1	22.09	20.60	336	10	0.0044	0.945	0.120	13%	0	0.382	40%	0
14701	C3-C2	C3	C2	22.80	22.09	134	10	0.0053	1.033	0.119	12%	0	0.376	36%	0
14702	C4-C3	C4	C3	23.48	22.80	219	10	0.0031	0.791	0.116	15%	0	0.373	47%	0
14703	A90-A10	A90	A10	17.65	17.07	421	18	0.0014	2.527	4.235	168%	18	6.252	247%	27
14704	A89-A90	A89	A90	18.28	17.65	421	18	0.0015	2.631	4.235	161%	18	6.242	237%	27
14705	A11-A89	A11	A89	18.48	18.28	92	18	0.0022	3.171	4.235	134%	18	6.232	197%	24
14706	A12-A11	A12	A11	19.21	18.48	468	18	0.0016	2.687	4.037	150%	18	5.768	215%	27
14707	A12A-A12	A12A	A12	18.98	19.21	110	18	-0.0021	0.000	4.037		0	5.762		0
14711	A13-A12A	A13	A12A	19.59	18.98	315	18	0.0019	2.994	3.894	130%	18	5.574	186%	24
14712	A87-A13	A87	A13	20.22	19.59	236	18	0.0027	3.513	3.893	111%	18	5.572	159%	24
14713	A14-A87	A14	A87	20.32	20.22	159	18	0.0006	1.706	3.796	223%	21	5.471	321%	30
14714	A15-A14	A15	A14	20.86	20.32	484	18	0.0011	2.273	3.795	167%	18	5.469	241%	27
14759	C5-C4	C5	C4	25.18	23.48	361	10	0.0047	0.973	0.107	11%	0	0.348	36%	0
14760	C6-C5	C6	C5	45.50	25.18	273	10	0.0745	3.874	0.102	3%	0	0.343	9%	0
14761	C7-C6	C7	C6	79.38	45.50	349	10	0.0970	4.421	0.100	2%	0	0.340	8%	0
14763	C8-C7	C8	C7	82.87	79.38	282	8	0.0124	0.870	0.098	11%	0	0.335	39%	0
14764	C8A-C8	C8A	C8	91.32	82.87	209	8	0.0404	1.574	0.096	6%	0	0.309	20%	0
14765	C9-C8A	C9	C8A	100.19	91.32	210	8	0.0422	1.607	0.096	6%	0	0.308	19%	0
14766	C10-C9	C10	C9	116.09	100.19	369	8	0.0430	1.624	0.093	6%	0	0.304	19%	0
14767	C11-C10	C11	C10	146.25	116.09	350	8	0.0861	2.297	0.063	3%	0	0.178	8%	0
14768	C12-C11	C12	C11	175.36	145.25	369	8	0.0815	2.235	0.061	3%	0	0.174	8%	0
14769	C13-C12	C13	C12	192.87	175.36	388	8	0.0451	1.662	0.057	3%	0	0.167	10%	0
14773	C14-C13	C14	C13	198.66	192.87	356	8	0.0163	0.999	0.006	1%	0	0.011	1%	0
14774	C13A-C13	C13A	C13	197.28	192.87	296	8	0.0149	0.956	0.050	5%	0	0.152	16%	0
14775	C16-C15	C16	C15	214.12	202.85	381	8	0.0296	1.346	0.003	0%	0	0.004	0%	0

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Hydraulic Analysis Results

Pipe Number	Pipe Tag	U/S MH	D/S MH	U/S IE (ft)	D/S IE (ft)	Length (ft)	Size	Slope (ft/ft)	Capacity (mgd)	Existing Peak Flow (mgd)	Existing % Capacity	Existing Replacement Size (in)	Ultimate Peak Flow (mgd)	Ultimate % Capacity	Ultimate Replacement Size (in)
14778	C19-C18	C19	C18	201.47	199.74	302	8	0.0057	0.592	0.044	7%	0	0.138	23%	0
14779	C23B-C23A	C23B	C23A	224.94	215.17	369	8	0.0265	1.274	0.001	0%	0	0.001	0%	0
14780	C17-C13A	C17	C13A	198.98	197.28	306	8	0.0056	0.583	0.049	8%	0	0.150	26%	0
14782	C47-C48	C47	C48	224.50	219.47	355	8	0.0142	0.931	0.012	1%	0	0.046	5%	0
14783	C41-C47	C41	C47	229.22	224.50	334	8	0.0141	0.930	0.009	1%	0	0.042	5%	0
14784	C21-C20	C21	C20	218.45	206.20	321	8	0.0382	1.530	0.024	2%	0	0.062	4%	0
14785	C37-C21	C37	C21	219.23	218.45	167	8	0.0047	0.535	0.010	2%	0	0.014	3%	0
14787	C38-C37	C38	C37	228.26	219.23	357	8	0.0253	1.245	0.010	1%	0	0.014	1%	0
14788	C40-C38	C40	C38	232.63	228.26	341	8	0.0128	0.886	0.006	1%	0	0.008	1%	0
14792	C24-C20	C24	C20	207.81	206.20	328	8	0.0049	0.548	0.017	3%	0	0.069	13%	0
14793	C24A-C24	C24A	C24	209.12	207.81	19	8	0.0682	2.044	0.015	1%	0	0.067	3%	0
14795	C26-C24A	C26	C24A	210.15	209.12	162	8	0.0063	0.624	0.013	2%	0	0.065	10%	0
14796	C27-C26	C27	C26	227.99	210.15	653	8	0.0273	1.294	0.012	1%	0	0.057	4%	0
14797	C28-C27	C28	C27	229.23	227.99	198	8	0.0063	0.619	0.009	1%	0	0.046	7%	0
14798	C29-C28	C29	C28	230.12	229.23	172	8	0.0052	0.563	0.007	1%	0	0.039	7%	0
14799	C33-C32	C33	C32	232.96	232.39	147	8	0.0039	0.488	0.003	1%	0	0.031	6%	0
14800	C34-C33	C34	C33	233.93	232.96	222	8	0.0044	0.518	0.002	0%	0	0.030	6%	0
14801	F136-C10	F136	C10	117.90	116.09	335	8	0.0054	0.575	0.026	5%	0	0.106	18%	0
14802	F135-F136	F135	F136	132.79	117.90	203	8	0.0735	2.122	0.017	1%	0	0.094	4%	0
14803	F133-F134	F133	F134	147.39	134.98	233	8	0.0533	1.808	0.017	1%	0	0.073	4%	0
14804	F132-F133	F132	F133	148.35	147.39	227	8	0.0042	0.509	0.014	3%	0	0.070	14%	0
14805	F131-F132	F131	F132	165.46	148.35	257	8	0.0666	2.020	0.013	1%	0	0.068	3%	0
14806	F31-F30	F31	F30	193.76	191.69	298	8	0.0069	0.652	0.002	0%	0	0.008	1%	0
14809	F70-F35	F70	F35	210.40	201.29	453	8	0.0201	1.110	0.008	1%	0	0.016	1%	0
14810	F71-F70	F71	F70	210.79	210.40	30	8	0.0129	0.889	0.006	1%	0	0.013	1%	0
14811	F72-F71	F72	F71	215.47	210.79	137	8	0.0342	1.448	0.005	0%	0	0.011	1%	0
14812	F73-F72	F73	F72	218.49	215.47	136	8	0.0222	1.165	0.005	0%	0	0.010	1%	0
14813	F30-F32	F30	F32	191.69	185.69	285	8	0.0210	1.135	0.006	1%	0	0.015	1%	0
14814	F32-F42	F32	F42	185.69	175.47	292	8	0.0350	1.464	0.008	1%	0	0.021	1%	0
14815	F42-F131	F42	F131	175.47	165.46	221	8	0.0452	1.664	0.010	1%	0	0.030	2%	0
14816	F36-F35	F36	F35	215.05	201.29	324	8	0.0425	1.614	0.018	1%	0	0.197	12%	0
14817	F37-F36	F37	F36	215.84	215.05	161	8	0.0049	0.548	0.016	3%	0	0.195	36%	0
14819	F38-F37	F38	F37	222.88	215.84	521	8	0.0135	0.910	0.014	2%	0	0.191	21%	0
14820	F39-F38	F39	F38	230.34	222.88	344	8	0.0217	1.153	0.012	1%	0	0.179	16%	0
14821	F40-F39	F40	F39	234.93	230.34	189	8	0.0243	1.221	0.008	1%	0	0.175	14%	0

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Hydraulic Analysis Results

Pipe Number	Pipe Tag	U/S MH	D/S MH	U/S IE (ft)	D/S IE (ft)	Length (ft)	Size	Slope (ft/ft)	Capacity (mgd)	Existing Peak Flow (mgd)	Existing % Capacity	Existing Replacement Size (in)	Ultimate Peak Flow (mgd)	Ultimate % Capacity	Ultimate Replacement Size (in)
14822	F41-F40	F41	F40	238.29	234.93	186	8	0.0181	1.053	0.007	1%	0	0.173	16%	0
14823	A94-A93	A94	A93	22.82	20.03	335	8	0.0083	0.715	0.016	2%	0	0.021	3%	0
14824	A96-A95	A96	A95	24.53	24.49	40	8	0.0010	0.246	0.015	6%	0	0.020	8%	0
14825	A97-A96	A97	A96	25.11	24.53	100	8	0.0058	0.595	0.015	3%	0	0.020	3%	0
14827	A103-A92	A103	A92	25.65	16.42	241	8	0.0382	1.531	0.005	0%	0	0.036	2%	0
14828	A103A-A103	A103A	A103	27.50	25.65	37	8	0.0503	1.755	0.005	0%	0	0.036	2%	0
14829	A107-A103A	A107	A103A	41.57	27.50	288	8	0.0489	1.730	0.005	0%	0	0.034	2%	0
14834	A127-A107	A127	A107	45.39	41.57	247	8	0.0155	0.973	0.002	0%	0	0.031	3%	0
14936	F121-F120	F121	F120	260.90	260.37	178	8	0.0030	0.426	0.002	0%	0	0.009	2%	0
14937	F54-F53A	F54	F53A	205.41	202.86	161	8	0.0158	0.984	0.060	6%	0	0.145	15%	0
14938	F53A-F53	F53A	F53	202.86	200.50	135	8	0.0174	1.034	0.060	6%	0	0.145	14%	0
14939	F120-F119	F120	F119	260.37	255.05	236	8	0.0225	1.175	0.005	0%	0	0.014	1%	0
14940	F115A-F115	F115A	F115	250.23	249.53	115	8	0.0061	0.612	0.016	3%	0	0.038	6%	0
14944	F17B-F17	F17B	F17	235.75	234.00	264	8	0.0066	0.637	0.002	0%	0	0.023	4%	0
14959	E24A-E24	E24A	E24	83.53	76.41	129	8	0.0554	1.842	0.003	0%	0	0.004	0%	0
14996	F119-F116	F119	F116	255.05	251.55	147	8	0.0239	1.210	0.007	1%	0	0.027	2%	0
14998	F116-F115A	F116	F115A	251.55	250.23	354	8	0.0037	0.478	0.015	3%	0	0.036	8%	0
14999	F115-F114	F115	F114	249.53	249.26	143	8	0.0019	0.340	0.017	5%	0	0.038	11%	0
15063	A17-A85	A17	A85	22.60	21.95	330	18	0.0020	3.018	3.740	124%	18	5.399	179%	24
15064	A18-A17	A18	A17	22.79	22.60	210	18	0.0009	2.047	3.740	183%	21	5.399	264%	27
15065	A85-A16	A85	A16	21.95	21.99	129	18	-0.0003	0.000	3.758		0	5.429		0
15101	E28-A18	E28	A18	23.41	22.79	399	18	0.0016	2.682	0.955	36%	0	2.200	82%	0
15106	E27-E28	E27	E28	23.71	23.41	191	18	0.0016	2.694	0.948	35%	0	2.185	81%	0
15107	E5B-E27	E5B	E27	23.82	23.71	138	18	0.0008	1.918	0.932	49%	0	2.166	113%	21
15109	E22-E21	E22	E21	33.34	27.40	186	6	0.0320	0.650	0.015	2%	0	0.018	3%	0
15110	E23-E22	E23	E22	48.54	33.34	290	8	0.0523	1.790	0.013	1%	0	0.016	1%	0
15111	E24-E23	E24	E23	76.41	48.54	441	8	0.0632	1.968	0.009	0%	0	0.012	1%	0
15115	E4-E5	E4	E5	58.21	24.90	472	12	0.0706	6.134	0.844	14%	0	2.078	34%	0
15116	E3-E4	E3	E4	84.90	58.21	378	12	0.0706	6.132	0.840	14%	0	2.073	34%	0
15136	F49-F48	F49	F48	205.40	195.31	296	8	0.0341	1.445	0.002	0%	0	0.004	0%	0
15137	F48-F47	F48	F47	195.31	189.16	280	8	0.0220	1.160	0.030	3%	0	0.224	19%	0
15139	F9-F8	F9	F8	173.42	168.80	247	6	0.0187	0.497	0.039	8%	0	0.241	48%	0
15140	E2-E3	E2	E3	87.05	84.90	301	12	0.0071	1.950	0.558	29%	0	1.479	76%	0
15141	E1A-E2	E1A	E2	89.04	87.05	284	12	0.0070	1.931	0.556	29%	0	1.476	76%	0
15142	E1-E1A	E1	E1A	90.04	89.04	47	12	0.0212	3.357	0.554	17%	0	1.473	44%	0

Table G-1
Hydraulic Analysis Results

Pipe Number	Pipe Tag	U/S MH	D/S MH	U/S IE (ft)	D/S IE (ft)	Length (ft)	Size	Slope (ft/ft)	Capacity (mgd)	Existing Peak Flow (mgd)	Existing % Capacity	Existing Replacement Size (in)	Ultimate Peak Flow (mgd)	Ultimate % Capacity	Ultimate Replacement Size (in)
15143	F28-E1	F28	E1	90.95	90.04	170	12	0.0054	1.690	0.553	33%	0	1.472	87%	0
15151	E12-E3	E12	E3	98.91	84.90	257	8	0.0546	1.829	0.282	15%	0	0.593	32%	0
15152	E13-E12	E13	E12	115.53	98.91	259	8	0.0641	1.982	0.280	14%	0	0.591	30%	0
15153	E14-E13	E14	E13	135.92	116.16	296	8	0.0667	2.022	0.278	14%	0	0.587	29%	0
15155	E18-E17	E18	E17	160.44	146.56	258	8	0.0539	1.816	0.273	15%	0	0.577	32%	0
15156	E17-E14	E17	E14	146.56	135.92	261	8	0.0407	1.579	0.277	18%	0	0.583	37%	0
15160	F22-F8	F22	F8	174.03	168.80	261	8	0.0201	1.109	0.062	6%	0	0.160	14%	0
15161	F51-F22	F51	F22	174.61	174.03	146	8	0.0040	0.494	0.061	12%	0	0.157	32%	0
15162	F53-F51	F53	F51	200.50	174.61	380	8	0.0682	2.043	0.060	3%	0	0.152	7%	0
15163	F55-F54	F55	F54	206.60	205.41	252	8	0.0047	0.538	0.060	11%	0	0.142	26%	0
15164	F56-F55	F56	F55	221.44	206.60	240	8	0.0617	1.945	0.058	3%	0	0.141	7%	0
15165	F57-F56	F57	F56	234.07	221.44	271	8	0.0465	1.688	0.056	3%	0	0.099	6%	0
15166	F101-F57	F101	F57	234.64	234.07	166	8	0.0034	0.458	0.056	12%	0	0.092	20%	0
15167	F102-F101	F102	F101	235.19	234.64	84	8	0.0065	0.632	0.010	2%	0	0.015	2%	0
15170	F105-F102	F105	F102	237.31	235.19	90	8	0.0236	1.203	0.010	1%	0	0.015	1%	0
15171	F106-F105	F106	F105	240.33	237.31	290	8	0.0104	0.799	0.008	1%	0	0.012	2%	0
15175	F111-F101	F111	F101	241.40	234.64	273	8	0.0247	1.231	0.022	2%	0	0.045	4%	0
15176	F110-F111	F110	F111	247.06	241.40	202	8	0.0280	1.310	0.020	2%	0	0.043	3%	0
15178	F112-F110	F112	F110	248.56	247.06	210	8	0.0072	0.662	0.019	3%	0	0.041	6%	0
15179	F114-F112	F114	F112	249.26	248.56	114	8	0.0062	0.615	0.018	3%	0	0.041	7%	0
15181	F27-F28	F27	F28	101.00	90.95	259	10	0.0388	2.795	0.053	2%	0	0.130	5%	0
15182	F26-F27	F26	F27	128.00	101.00	326	10	0.0827	4.081	0.053	1%	0	0.128	3%	0
15183	F16-F26	F16	F26	135.91	128.00	206	8	0.0384	1.533	0.048	3%	0	0.121	8%	0
15184	F7B-F7A	F7B	F7A	156.38	150.53	268	6	0.0218	0.537	0.009	2%	0	0.011	2%	0
15185	F7A-F7	F7A	F7	150.53	144.47	261	6	0.0232	0.553	0.011	2%	0	0.012	2%	0
15189	F7-F16	F7	F16	144.47	135.91	276	8	0.0310	1.377	0.028	2%	0	0.089	6%	0
15190	F20-F7	F20	F7	159.78	144.47	277	6	0.0553	0.855	0.016	2%	0	0.076	9%	0
15192	F15-F16	F15	F16	143.74	135.91	260	8	0.0301	1.357	0.018	1%	0	0.029	2%	0
15193	F66-F15	F66	F15	148.98	143.74	295	6	0.0178	0.484	0.002	0%	0	0.002	0%	0
15194	F4-F15	F4	F15	153.47	143.74	276	8	0.0352	1.469	0.017	1%	0	0.025	2%	0
15195	F21-F20	F21	F20	178.41	159.78	261	8	0.0713	2.090	0.014	1%	0	0.073	3%	0
15198	F21A-F21	F21A	F21	206.25	178.41	244	8	0.1141	2.644	0.010	0%	0	0.067	3%	0
15201	F17-F68	F17	F68	234.00	223.73	272	8	0.0377	1.520	0.005	0%	0	0.032	2%	0
15203	F61-F3	F61	F3	175.00	164.46	263	6	0.0400	0.727	0.007	1%	0	0.014	2%	0
15204	F3-F4	F3	F4	164.46	153.47	273	8	0.0403	1.570	0.013	1%	0	0.020	1%	0

Table G-1
Hydraulic Analysis Results

Pipe Number	Pipe Tag	U/S MH	D/S MH	U/S IE (ft)	D/S IE (ft)	Length (ft)	Size	Slope (ft/ft)	Capacity (mgd)	Existing Peak Flow (mgd)	Existing % Capacity	Existing Replacement Size (in)	Ultimate Peak Flow (mgd)	Ultimate % Capacity	Ultimate Replacement Size (in)
15215	H88-H87	H88	H87	245.19	244.54	100	8	0.0065	0.632	0.007	1%	0	0.088	14%	0
15217	H89-H88	H89	H88	246.71	245.19	289	8	0.0053	0.567	0.006	1%	0	0.069	12%	0
15218	H20-H19	H20	H19	231.30	225.36	407	8	0.0146	0.946	0.025	3%	0	0.070	7%	0
15219	H62-H20	H62	H20	235.35	231.30	254	8	0.0159	0.988	0.018	2%	0	0.062	6%	0
15221	H64-H62	H64	H62	239.39	235.35	263	8	0.0154	0.970	0.015	2%	0	0.051	5%	0
15224	H67-H64	H67	H64	243.64	239.39	268	8	0.0159	0.986	0.012	1%	0	0.049	5%	0
15228	H108-H67	H108	H67	244.61	243.64	239	8	0.0041	0.499	0.009	2%	0	0.040	8%	0
15229	H109-H107	H109	H107	245.38	245.17	246	8	0.0009	0.229	0.003	1%	0	0.030	13%	0
15231	H110-H109	H110	H109	253.49	245.38	196	8	0.0414	1.592	0.001	0%	0	0.021	1%	0
15271	A21A-A21	A21A	A21	34.05	33.31	44	12	0.0167	2.987	2.718	91%	0	3.116	104%	15
15272	A20-A19	A20	A19	32.76	30.09	351	12	0.0076	2.013	2.720	135%	12	3.123	155%	15
15283	A16-A15	A16	A15	21.99	20.86	459	18	0.0025	3.376	3.794	112%	18	5.467	162%	24
15295	F35-F48	F35	F48	201.29	195.31	513	8	0.0116	0.845	0.028	3%	0	0.218	26%	0
15399	A39D-A39B	A39D	A39B	8.40	8.34	37	18	0.0016	2.758	5.132	186%	21	8.592	312%	30
15400	A39B-A39C	A39B	A39C	8.34	8.26	46	18	0.0017	2.833	5.135	181%	21	8.597	303%	30
15401	A38-A39B	A38	A39B	19.17	8.34	70	8	0.1553	3.084	0.003	0%	0	0.006	0%	0
15402	A39C-A39E	A39C	A39E	8.26	8.04	133	18	0.0017	2.771	5.169	187%	21	8.726	315%	30
15415	A4-A3	A4	A3	10.62	10.06	275	18	0.0020	3.070	5.130	167%	18	8.583	280%	27
15416	P1-A4	P1	A4	12.63	10.89	250	8	0.0070	0.653	0.076	12%	0	0.757	116%	10
15428	A5-A4	A5	A4	11.18	10.62	461	18	0.0012	2.372	5.054	213%	24	7.827	330%	30
15429	A5A-A5	A5A	A5	12.23	11.18	461	18	0.0023	3.249	4.306	133%	18	6.888	212%	24
15430	A6-A5A	A6	A5A	12.68	12.23	463	18	0.0010	2.120	4.306	203%	21	6.888	325%	30
15480	A39-A38	A39	A38	27.56	19.17	236	8	0.0356	1.477	0.003	0%	0	0.006	0%	0
15483	A3-A2	A3	A2	10.06	9.33	490	18	0.0015	2.627	5.132	195%	21	8.586	327%	30
15484	A6A-A6B	A6A	A6B	13.48	12.90	364	18	0.0016	2.717	4.306	158%	18	6.873	253%	27
15485	P4-P1	P4	P1	13.74	12.63	280	8	0.0040	0.492	0.076	15%	0	0.756	154%	10
15492	P5-P4	P5	P4	16.79	13.74	241	8	0.0126	0.880	0.008	1%	0	0.014	2%	0
15494	P7-P5	P7	P5	21.06	16.79	253	8	0.0169	1.017	0.007	1%	0	0.013	1%	0
15495	P8-P7	P8	P7	26.49	21.06	358	8	0.0152	0.964	0.006	1%	0	0.011	1%	0
15496	P15-P4	P15	P4	15.03	13.74	308	8	0.0042	0.507	0.062	12%	0	0.711	140%	10
15497	P16-P15	P16	P15	20.38	15.03	296	8	0.0181	1.052	0.061	6%	0	0.710	67%	0
15498	P18-P17	P18	P17	30.16	22.22	337	8	0.0235	1.201	0.061	5%	0	0.703	59%	0
15502	P23-P20	P23	P20	31.83	31.03	293	12	0.0027	1.205	0.056	5%	0	0.690	57%	0
15503	P24-P23	P24	P23	32.63	31.83	180	12	0.0044	1.537	0.055	4%	0	0.688	45%	0
15504	P25-P24	P25	P24	33.40	32.63	229	10	0.0034	0.824	0.050	6%	0	0.612	74%	0

Table G-1
Hydraulic Analysis Results

Pipe Number	Pipe Tag	U/S MH	D/S MH	U/S IE (ft)	D/S IE (ft)	Length (ft)	Size	Slope (ft/ft)	Capacity (mgd)	Existing Peak Flow (mgd)	Existing % Capacity	Existing Replacement Size (in)	Ultimate Peak Flow (mgd)	Ultimate % Capacity	Ultimate Replacement Size (in)
15505	P26-P25	P26	P25	38.29	33.40	204	10	0.0239	2.196	0.049	2%	0	0.611	28%	0
15506	P28-P27	P28	P27	40.51	39.44	369	10	0.0029	0.765	0.049	6%	0	0.607	79%	0
15507	P30-P29	P30	P29	42.22	41.30	239	10	0.0039	0.881	0.049	6%	0	0.587	67%	0
15508	P31-P30	P31	P30	43.11	42.22	390	10	0.0023	0.678	0.049	7%	0	0.581	86%	0
15509	P32-P31	P32	P31	44.37	43.41	267	10	0.0036	0.851	0.049	6%	0	0.571	67%	0
15510	P33-P32	P33	P32	44.95	44.37	255	10	0.0023	0.676	0.049	7%	0	0.567	84%	0
15511	P34-P33	P34	P33	45.97	44.95	234	10	0.0044	0.936	0.049	5%	0	0.562	60%	0
15512	P35-P34	P35	P34	46.76	45.97	274	8	0.0029	0.421	0.049	12%	0	0.562	133%	10
15513	P36-P35	P36	P35	50.02	46.76	276	10	0.0118	1.542	0.048	3%	0	0.551	36%	0
15518	P37-P36	P37	P36	53.24	50.02	272	10	0.0118	1.543	0.045	3%	0	0.544	35%	0
15519	P38-P37	P38	P37	54.34	53.24	290	10	0.0038	0.874	0.034	4%	0	0.526	60%	0
15520	P39-P38	P39	P38	55.00	54.34	257	10	0.0026	0.719	0.030	4%	0	0.519	72%	0
15521	P40-P39	P40	P39	55.74	55.00	207	10	0.0036	0.848	0.010	1%	0	0.064	8%	0
15522	P41-P40	P41	P40	56.18	55.74	136	10	0.0032	0.807	0.010	1%	0	0.063	8%	0
15523	P42-P41	P42	P41	57.16	56.18	253	8	0.0039	0.487	0.010	2%	0	0.063	13%	0
15659	H93-H89	H93	H89	249.08	246.71	346	8	0.0069	0.648	0.004	1%	0	0.006	1%	0
15661	REDUCER1-A18	R1	A18	26.52	23.49	395	10	0.0077	1.244	2.720	219%	12	3.128	251%	15
15662	A19-REDUCER1	A19	R1	30.09	26.52	462	12	0.0077	2.030	2.720	134%	12	3.123	154%	15
15663	A21-A20	A21	A20	33.31	32.76	162	12	0.0034	1.347	2.718	202%	15	3.116	231%	18
15665	F24-F10	F24	F10	183.54	178.30	298	6	0.0176	0.482	0.036	7%	0	0.237	49%	0
15666	F8-E18	F8	E18	168.80	160.44	280	8	0.0298	1.351	0.271	20%	0	0.572	42%	0
15670	A120-A121	A120	A121	15.52	15.16	400	30	0.0009	7.973	4.305	54%	0	6.762	85%	0
15671	A121-A122	A121	A122	15.11	15.00	114	30	0.0010	8.274	4.305	52%	0	6.762	82%	0
15672	A122-A123	A122	A123	14.95	14.84	125	30	0.0009	7.884	4.305	55%	0	6.802	86%	0
15673	A123-A124	A123	A124	14.79	14.55	269	30	0.0009	7.938	4.306	54%	0	6.806	86%	0
15674	A124-A125	A124	A125	14.45	14.08	477	30	0.0008	7.405	4.306	58%	0	6.806	92%	0
15677	A122A-A122	A122A	A122	17.57	17.05	236	12	0.0022	1.083	0.000	0%	0	0.040	4%	0
15680	A126-A123	A126	A123	21.96	16.80	93	6	0.0553	0.855	0.000	0%	0	0.000	0%	0
15688	A125-A6A	A125	A6A	14.08	14.02	20	18	0.0030	3.728	4.306	116%	18	6.869	184%	24
15896	A2C-A39D	A2C	A39D	8.56	8.40	95	18	0.0017	2.799	5.132	183%	21	8.592	307%	30
15897	A2B-A2C	A2B	A2C	8.98	8.56	118	18	0.0036	4.058	5.132	126%	18	8.589	212%	24
15899	C56-C4A	C56	C4A	25.54	24.50	251	8	0.0041	0.504	0.007	1%	0	0.019	4%	0
15903	C56A-C56	C56A	C56	34.63	25.64	150	6	0.0598	0.889	0.001	0%	0	0.002	0%	0
15908	C58-C56	C58	C56	27.24	25.64	397	8	0.0040	0.497	0.002	0%	0	0.006	1%	0
15909	C57-C56	C57	C56	26.14	25.64	131	8	0.0038	0.483	0.003	1%	0	0.010	2%	0

Table G-1
Hydraulic Analysis Results

Pipe Number	Pipe Tag	U/S MH	D/S MH	U/S IE (ft)	D/S IE (ft)	Length (ft)	Size	Slope (ft/ft)	Capacity (mgd)	Existing Peak Flow (mgd)	Existing % Capacity	Existing Replacement Size (in)	Ultimate Peak Flow (mgd)	Ultimate % Capacity	Ultimate Replacement Size (in)
15917	C59-C57	C59	C57	28.24	26.24	256	8	0.0078	0.692	0.003	0%	0	0.009	1%	0
15930	C59B-C59	C59B	C59	46.44	28.34	132	8	0.1376	2.903	0.003	0%	0	0.007	0%	0
15953	P71-P79	P71	P79	31.00	24.41	144	8	0.0456	1.672	0.000	0%	0	0.014	1%	0
15954	P72-P73	P72	P73	31.95	18.03	261	8	0.0533	1.807	0.000	0%	0	0.000	0%	0
15955	P73-P75	P73	P75	17.93	16.48	187	8	0.0078	0.689	0.000	0%	0	0.000	0%	0
15956	P75-P77	P75	P77	16.38	15.36	131	8	0.0078	0.692	0.000	0%	0	0.000	0%	0
15957	P78-P77	P78	P77	18.42	15.46	96	8	0.0308	1.373	0.000	0%	0	0.015	1%	0
15958	P77-P76	P77	P76	15.36	14.08	218	8	0.0059	0.600	0.000	0%	0	0.015	3%	0
15980	P79-P78	P79	P78	24.31	18.52	281	8	0.0206	1.124	0.000	0%	0	0.015	1%	0
16009	P76-A6C	P76	A6C	14.08	12.80	299	8	0.0043	0.512	0.000	0%	0	0.015	3%	0
16010	A6B-A6C	A6B	A6C	12.90	12.80	49	18	0.0021	3.088	4.306	139%	18	6.873	223%	27
16011	A6C-A6	A6C	A6	12.80	12.68	49	18	0.0025	3.383	4.306	127%	18	6.888	204%	24
16125	C32-C30	C32	C30	232.39	231.45	286	8	0.0033	0.449	0.004	1%	0	0.032	7%	0
16129	F50-F47	F50	F47	204.32	189.16	261	8	0.0581	1.886	0.002	0%	0	0.004	0%	0
16130	F47-F24	F47	F24	189.16	183.54	210	6	0.0268	0.594	0.033	6%	0	0.228	38%	0
16131	C20-C19	C20	C19	206.20	201.47	352	8	0.0134	0.907	0.043	5%	0	0.136	15%	0
16137	C23-C18	C23	C18	207.11	199.74	327	8	0.0225	1.174	0.003	0%	0	0.005	0%	0
16431	P27-P26	P27	P26	39.44	38.29	185	10	0.0062	1.119	0.049	4%	0	0.611	55%	0
16434	P29-P28	P29	P28	41.30	40.51	221	10	0.0036	0.849	0.049	6%	0	0.588	69%	0
16557	P20-P19	P20	P19	31.03	30.43	259	12	0.0023	1.110	0.058	5%	0	0.695	63%	0
16558	P19-P18	P19	P18	30.43	30.16	154	12	0.0018	0.968	0.058	6%	0	0.698	72%	0
16695	H18-H18A	H18	H18A	219.28	218.26	240	8	0.0042	0.510	0.043	8%	0	0.193	38%	0
16696	H18A-H17	H18A	H17	218.26	217.98	120	8	0.0023	0.379	0.043	11%	0	0.194	51%	0
16698	C44-C43	C44	C43	232.78	231.48	268	8	0.0048	0.545	0.003	1%	0	0.018	3%	0
16699	C43-C42	C43	C42	231.48	229.99	250	8	0.0059	0.604	0.004	1%	0	0.031	5%	0
16700	C23A-C23	C23A	C23	215.17	207.11	300	8	0.0269	1.283	0.002	0%	0	0.003	0%	0
16701	C43A-C43	C43A	C43	232.16	231.48	139	8	0.0049	0.547	0.001	0%	0	0.010	2%	0
16706	C48-C21	C48	C21	219.47	218.45	131	8	0.0078	0.690	0.012	2%	0	0.046	7%	0
16789	F61A-F61	F61A	F61	186.17	178.65	101	8	0.0741	2.131	0.003	0%	0	0.008	0%	0
16812	G3-G4	G3	G4	101.88	99.22	529	12	0.0050	1.636	0.499	31%	0	1.336	82%	0
16813	G4-F28	G4	F28	99.22	91.31	643	12	0.0123	2.559	0.500	20%	0	1.342	52%	0
16952	F74-F73	F74	F73	226.52	218.49	439	8	0.0183	1.058	0.005	0%	0	0.008	1%	0
17040	H87-H86	H87	H86	244.54	242.93	380	8	0.0042	0.509	0.007	1%	0	0.093	18%	0
17064	H86-H85	H86	H85	242.93	240.77	349	8	0.0062	0.616	0.007	1%	0	0.095	15%	0
17065	H85-H84	H85	H84	240.77	238.70	302	8	0.0069	0.648	0.007	1%	0	0.102	16%	0

Table G-1
Hydraulic Analysis Results

Pipe Number	Pipe Tag	U/S MH	D/S MH	U/S IE (ft)	D/S IE (ft)	Length (ft)	Size	Slope (ft/ft)	Capacity (mgd)	Existing Peak Flow (mgd)	Existing % Capacity	Existing Replacement Size (in)	Ultimate Peak Flow (mgd)	Ultimate % Capacity	Ultimate Replacement Size (in)
17190	H97A-H97	H97A	H97	235.67	234.13	167	8	0.0092	0.752	0.002	0%	0	0.002	0%	0
17384	F68-F21A	F68	F21A	223.73	206.25	542	8	0.0322	1.405	0.008	1%	0	0.038	3%	0
17450	H55B-H55A	H55B	H55A	229.22	228.88	89	8	0.0038	0.483	0.001	0%	0	0.004	1%	0
17690	F21B-F21A	F21B	F21A	219.22	206.25	282	8	0.0460	1.678	0.001	0%	0	0.020	1%	0
17704	C55-C42	C55	C42	231.68	229.99	438	8	0.0039	0.486	0.002	0%	0	0.008	2%	0
17708	E21-E27	E21	E27	27.40	24.37	136	8	0.0223	1.169	0.015	1%	0	0.018	2%	0
17715	C30-C29	C30	C29	231.45	230.12	318	8	0.0042	0.507	0.007	1%	0	0.039	8%	0
17731	H1-G1	H1	G1	109.03	107.29	319	12	0.0055	1.705	0.441	26%	0	1.245	73%	0
17739	H107-H108	H107	H108	245.17	244.61	30	8	0.0184	1.062	0.005	0%	0	0.033	3%	0
17740	F10-F9	F10	F9	178.30	173.42	266	6	0.0184	0.492	0.038	8%	0	0.240	49%	0
17741	H56J-H56H	H56J	H56H	233.20	232.83	83	8	0.0044	0.521	0.001	0%	0	0.128	25%	0
17742	H56K-H56J	H56K	H56J	235.01	233.20	343	8	0.0053	0.569	0.001	0%	0	0.112	20%	0
17743	H56P-H56K	H56P	H56K	235.69	235.01	128	8	0.0053	0.572	0.000	0%	0	0.092	16%	0
17744	H56Q-H56P	H56Q	H56P	236.33	235.69	134	8	0.0048	0.541	0.000	0%	0	0.090	17%	0
17745	H84A-H57	H84A	H57	232.20	233.24	191	8	-0.0054	0.000	0.003		0	0.008		0
17746	E5A-E5B	E5A	E5B	24.50	23.82	288	18	0.0024	3.307	0.932	28%	0	2.166	65%	0
17757	A93-A118	A93	A118	20.03	15.84	245	8	0.0171	1.023	0.017	2%	0	0.023	2%	0
17758	A118-A120	A118	A120	15.84	15.52	238	30	0.0013	9.739	4.305	44%	0	6.762	69%	0
17760	A117-A118	A117	A118	15.90	15.84	42	30	0.0014	10.048	4.288	43%	0	6.740	67%	0
17761	A92-A117	A92	A117	15.96	15.90	42	30	0.0014	10.033	4.288	43%	0	6.740	67%	0
17798	A2-A2B	A2	A2B	9.33	8.98	244	18	0.0014	2.576	5.132	199%	21	8.588	333%	30

APPENDIX C

Revised Sewer Model with New Flows

Following are the model results for additional flow from new basins to be served outside City limits, as shown in Figures 2-1A and 2-1B of this study. The additional flows from these basins were added into CH2M Hill's existing model, as presented in Appendix B of this study. Flows presented in the following model are ultimate day peak hourly flows (third column in the following model). The following model results are for the sewer lines contained within the study area boundaries or sewer lines that are affected by additional wastewater flows from new basins outside City limits (as opposed to CH2M Hill's model contained in Appendix B that covers all existing sewer lines). Sewer line sizes have been modified in the following model to reflect recently installed sewer lines and other upgrades.

The sewer line through the golf course has been separated from the main model since these flows were further adjusted (reduced by 3.12 MGD) to account for the flow that bypasses this line through the Gaines Street lift station.

In the event the projected ultimate peak hourly flow exceeds the pipe capacity, the required pipe size is provided (second to last column in the model).

Pipe Number	U/S MH To D/S MH	Ultimate Peak Hour Flow, MGD	Slope, ft/ft	Manning's n	Existing Pipe Diameter, Inches	Capacity Of Existing Pipe, MGD	Required Pipe Diameter, Inches	Capacity Of New Pipe, MGD
14705	A11-A89	7.3889	0.0022	0.0125	30	13.8548		
17760	A117-A118	7.8969	0.0014	0.0125	30	11.2429		
17758	A118-A120	7.9189	0.0013	0.0125	30	10.8970		
14706	A12-A11	6.5869	0.0016	0.0125	18	3.0068	24	6.6794
15670	A120-A121	7.9189	0.0009	0.0125	30	8.9210		
15671	A121-A122	7.9189	0.0010	0.0125	30	9.2571		
15672	A122-A123	7.9589	0.0009	0.0125	30	8.8214		
15673	A123-A124	7.9629	0.0009	0.0125	30	8.8822		
15674	A124-A125	7.9629	0.0008	0.0125	30	8.2850		
17798	A2-A2B	9.9940	0.0014	0.0125	30	11.2575		
15897	A2B-A2C	9.9950	0.0036	0.0125	30	17.7314		
15896	A2C-A39D	9.9980	0.0017	0.0125	30	12.2291		
15483	A3-A2	9.9920	0.0015	0.0125	30	11.4796		
15400	A39B-A39C	9.8382	0.0017	0.0125	30	12.3814		
15402	A39C-A39E	9.9672	0.0017	0.0125	30	12.1097		
15399	A39D-A39B	9.8332	0.0016	0.0125	30	12.0522		
15415	A4-A3	9.9890	0.0020	0.0125	30	13.4153		
15428	A5-A4	8.9839	0.0012	0.0125	30	10.3650		
15429	A5A-A5	8.0449	0.0023	0.0125	30	14.1957		
15430	A6-A5A	8.0449	0.0010	0.0125	30	9.2658		
15484	A6A-A6B	8.0299	0.0016	0.0125	30	11.8742		
16010	A6B-A6C	8.0299	0.0021	0.0125	30	13.4923		
16011	A6C-A6	8.0449	0.0025	0.0125	30	14.7812		
14704	A89-A90	7.3989	0.0015	0.0125	30	11.4985		
14638	A9-A92	7.4879	0.0017	0.0125	30	12.3197		
14703	A90-A10	7.4089	0.0014	0.0125	30	11.0422		
14695	A91-A9	7.4229	0.0011	0.0125	30	9.7772		
17761	A92-A117	7.8969	0.0014	0.0125	30	11.2255		
14699	C1-A11	0.7260	0.0043	0.0125	10	1.0437		
14766	C10-C9	0.6420	0.0430	0.0125	8	1.8174		
14767	C11-C10	0.5160	0.0861	0.0125	8	2.5709		
14768	C12-C11	0.5120	0.0815	0.0125	8	2.5018		
14769	C13-C12	0.5050	0.0451	0.0125	8	1.8605		

Pipe Number	U/S MH To D/S MH	Ultimate Peak Hour Flow, MGD	Slope, ft/ft	Manning's n	Existing Pipe Diameter, Inches	Capacity Of Existing Pipe, MGD	Required Pipe Diameter, Inches	Capacity Of New Pipe, MGD
14774	C13A-C13	0.4900	0.0149	0.0125	8	1.0700		
14780	C17-C13A	0.4880	0.0056	0.0125	8	0.6527		
14615	C18-C17	0.4850	0.0080	0.0125	8	0.7835		
14778	C19-C18	0.4760	0.0057	0.0125	8	0.6628		
14700	C2-C1	0.7200	0.0044	0.0125	10	1.0582		
16131	C20-C19	0.4740	0.0134	0.0125	8	1.0156		
14784	C21-C20	0.4000	0.0382	0.0125	8	1.7125		
14701	C3-C2	0.7140	0.0053	0.0125	10	1.1567		
14702	C4-C3	0.7110	0.0031	0.0125	10	0.8858		
14783	C41-C47	0.3800	0.0141	0.0125	8	1.0412		
14633	C42-C41	0.3780	0.0044	0.0125	8	0.5836		
14782	C47-C48	0.3840	0.0142	0.0125	8	1.0424		
16706	C48-C21	0.3840	0.0078	0.0125	8	0.7729		
14759	C5-C4	0.6860	0.0047	0.0125	10	1.0893		
17704	C55-C42	0.3460	0.0039	0.0125	8	0.5442		
14760	C6-C5	0.6810	0.0745	0.0125	10	4.3358		
14761	C7-C6	0.6780	0.0970	0.0125	10	4.9479		
14763	C8-C7	0.6730	0.0124	0.0125	8	0.9738		
14764	C8A-C8	0.6470	0.0404	0.0125	8	1.7620		
14765	C9-C8A	0.6460	0.0422	0.0125	8	1.7993		
15142	E1-E1A	2.1271	0.0212	0.0125	12	3.7576		
15151	E12-E3	0.7578	0.0546	0.0125	8	2.0468		
15152	E13-E12	0.7558	0.0641	0.0125	8	2.2188		
15153	E14-E13	0.7518	0.0667	0.0125	8	2.2631		
15156	E17-E14	0.7478	0.0407	0.0125	8	1.7676		
15155	E18-E17	0.7418	0.0539	0.0125	8	2.0333		
15141	E1A-E2	2.1301	0.0070	0.0125	12	2.1616		
15140	E2-E3	2.1331	0.0071	0.0125	12	2.1825		
15106	E27-E28	3.0039	0.0016	0.0125	18	3.0145		
15101	E28-A18	3.0189	0.0016	0.0125	18	3.0014		
15116	E3-E4	2.8919	0.0706	0.0125	12	6.8636		
15115	E4-E5	2.8969	0.0706	0.0125	12	6.8648		
14253	E5-E5A	2.9839	0.0168	0.0125	18	9.8757		
17746	E5A-E5B	2.9849	0.0024	0.0125	18	3.7011		
15107	E5B-E27	2.9849	0.0008	0.0125	18	2.1467	21	3.2381

Pipe Number	U/S MH To D/S MH	Ultimate Peak Hour Flow, MGD	Slope, ft/ft	Manning's n	Existing Pipe Diameter, Inches	Capacity Of Existing Pipe, MGD	Required Pipe Diameter, Inches	Capacity Of New Pipe, MGD
15166	F101-F57	0.2568	0.0034	0.0125	8	0.5128		
15176	F110-F111	0.2078	0.0280	0.0125	8	1.4668		
15175	F111-F101	0.2098	0.0247	0.0125	8	1.3778		
15178	F112-F110	0.2058	0.0072	0.0125	8	0.7411		
15179	F114-F112	0.2058	0.0062	0.0125	8	0.6880		
14999	F115-F114	0.2028	0.0019	0.0125	8	0.3804		
14940	F115A-F115	0.2028	0.0061	0.0125	8	0.6848		
14998	F116-F115A	0.2008	0.0037	0.0125	8	0.5352		
14996	F119-F116	0.1918	0.0239	0.0125	8	1.3540		
14939	F120-F119	0.1788	0.0225	0.0125	8	1.3149		
14936	F121-F120	0.1738	0.0030	0.0125	8	0.4774		
15160	F22-F8	0.3248	0.0201	0.0125	8	1.2412		
15143	F28-E1	2.1261	0.0054	0.0125	12	2.1265		
15295	F35-F48	0.5560	0.0116	0.0125	8	0.9456		
14816	F36-F35	0.5350	0.0425	0.0125	8	1.8062		
14817	F37-F36	0.5330	0.0049	0.0125	8	0.6139		
14819	F38-F37	0.5290	0.0135	0.0125	8	1.0185		
14820	F39-F38	0.5170	0.0217	0.0125	8	1.2908		
14821	F40-F39	0.5130	0.0243	0.0125	8	1.3669		
14822	F41-F40	0.5110	0.0181	0.0125	8	1.1788		
15161	F51-F22	0.3218	0.0040	0.0125	8	0.5529		
15162	F53-F51	0.3168	0.0682	0.0125	8	2.2872		
14938	F53A-F53	0.3098	0.0174	0.0125	8	1.1573		
14937	F54-F53A	0.3098	0.0158	0.0125	8	1.1011		
15163	F55-F54	0.3068	0.0047	0.0125	8	0.6021		
15164	F56-F55	0.3058	0.0617	0.0125	8	2.1768		
15165	F57-F56	0.2638	0.0465	0.0125	8	1.8898		
15666	F8-E18	0.7368	0.0298	0.0125	8	1.5127		
14418	G1-G2	1.9001	0.0054	0.0125	12	1.8973		
14320	G2-G3	1.9831	0.0050	0.0125	12	1.8248	15	3.4127
16812	G3-G4	1.9901	0.0050	0.0125	12	1.8316	15	3.4254
16813	G4-F28	1.9961	0.0123	0.0125	12	2.8641		
17731	H1-G1	1.8991	0.0055	0.0125	12	1.9082		

Pipe Number	U/S MH To D/S MH	Ultimate Peak Hour Flow, MGD	Slope, ft/ft	Manning's n	Existing Pipe Diameter, Inches	Capacity Of Existing Pipe, MGD	Required Pipe Diameter, Inches	Capacity Of New Pipe, MGD
14447	H11-H10	0.3162	0.0094	0.0125	8	0.8472		
14448	H12-H11	0.3152	0.0192	0.0125	8	1.2144		
14458	H13-H12	0.3092	0.0248	0.0125	8	1.3787		
14459	H14-H13	0.3012	0.0194	0.0125	8	1.2206		
14460	H15-H14	0.2952	0.0104	0.0125	8	0.8916		
14461	H16-H15	0.2912	0.0098	0.0125	8	0.8651		
14463	H17-H16	0.2882	0.0152	0.0125	8	1.0804		
16695	H18-H18A	0.2712	0.0042	0.0125	8	0.5706		
16696	H18A-H17	0.2722	0.0023	0.0125	8	0.4241		
14434	H2-H1	1.8711	0.0256	0.0125	12	4.1295		
14467	H25-H3	1.2799	0.0029	0.0125	8	0.4727	12	1.4374
14468	H26-H25	1.2729	0.0524	0.0125	8	2.0048		
14469	H27-H26	1.2719	0.0038	0.0125	8	0.5378	12	1.6354
14317	H28-H27	1.2689	0.0601	0.0125	8	2.1477		
14471	H29-H28	1.2589	0.0136	0.0125	8	1.0224	10	1.8918
14361	H3-H2	1.8691	0.0052	0.0125	8	0.6337	12	3.4943
14474	H30-H29	1.2489	0.0490	0.0125	8	1.9401		
14477	H31-H30	1.2449	0.0268	0.0125	8	1.4352		
14479	H32-H31	0.8120	0.0310	0.0125	8	1.5419		
14480	H33-H32	0.8070	0.0043	0.0125	8	0.5729	10	1.7422
14439	H4-H3	0.3682	0.0771	0.0125	8	2.4319		
14481	H44-H33	0.7890	0.0319	0.0125	8	1.5639		
14315	H45-H44	0.7860	0.0104	0.0125	8	0.8939		
14493	H46-H45	0.7840	0.0162	0.0125	8	1.1160		
14494	H47-H46	0.7810	0.0080	0.0125	8	0.7847		
14495	H48-H47	0.7660	0.0098	0.0125	8	0.8653		
14440	H5-H4	0.3682	0.0771	0.0125	8	2.4325		
14500	H52-H48	0.6740	0.0063	0.0125	8	0.6946		
14503	H52A-H53	0.6630	0.0220	0.0125	8	1.3006		
14502	H53-H52	0.6630	0.0470	0.0125	8	1.9002		
14504	H55-H52A	0.2260	0.0099	0.0125	8	0.8722		
14356	H56A-H55	0.3410	0.0239	0.0125	8	1.3547		
14340	H56B-H56A	0.3270	0.0064	0.0125	8	0.6994		
14339	H56H-H56B	0.3110	0.0066	0.0125	8	0.7141		

Pipe Number	U/S MH To D/S MH	Ultimate Peak Hour Flow, MGD	Slope, ft/ft	Manning's n	Existing Pipe Diameter, Inches	Capacity Of Existing Pipe, MGD	Required Pipe Diameter, Inches	Capacity Of New Pipe, MGD
17741	H56J-H56H	0.3070	0.0044	0.0125	8	0.5834		
17742	H56K-H56J	0.2910	0.0053	0.0125	8	0.6365		
17743	H56P-H56K	0.2710	0.0053	0.0125	8	0.6398		
17744	H56Q-H56P	0.2690	0.0048	0.0125	8	0.6056		
14441	H6-H5	0.3602	0.0440	0.0125	8	1.8370		
14442	H7-H6	0.3602	0.0552	0.0125	8	2.0588		
14444	H8-H7	0.3482	0.0535	0.0125	8	2.0268		
14466	H84-H98	0.1812	0.0215	0.0125	8	1.2837		
17065	H85-H84	0.1802	0.0069	0.0125	8	0.7256		
17064	H86-H85	0.1732	0.0062	0.0125	8	0.6892		
17040	H87-H86	0.1712	0.0042	0.0125	8	0.5703		
15215	H88-H87	0.1662	0.0065	0.0125	8	0.7072		
15217	H89-H88	0.1472	0.0053	0.0125	8	0.6351		
14445	H9-H8	0.3432	0.0225	0.0125	8	1.3142		
14518	H90-H89	0.1412	0.0059	0.0125	8	0.6720		
14465	H98-H18	0.1962	0.0333	0.0125	8	1.5986		
15416	P1-A4	1.0061	0.0070	0.0125	8	0.7309	10	1.3524
15496	P15-P4	0.9601	0.0042	0.0125	8	0.5673	10	1.0497
15497	P16-P15	0.9591	0.0181	0.0125	8	1.1779		
14298	P17-P16	0.9571	0.0068	0.0125	8	0.7220	10	1.3359
15498	P18-P17	0.9521	0.0235	0.0125	8	1.3443		
16558	P19-P18	0.9471	0.0018	0.0125	12	1.0831		
16557	P20-P19	0.9441	0.0023	0.0125	12	1.2427		
15502	P23-P20	0.9391	0.0027	0.0125	12	1.3492		
15503	P24-P23	0.9371	0.0044	0.0125	12	1.7202		
15504	P25-P24	0.8611	0.0034	0.0125	10	0.9220		
15505	P26-P25	0.8601	0.0239	0.0125	10	2.4578		
16431	P27-P26	0.8601	0.0062	0.0125	10	1.2529		
15506	P28-P27	0.8561	0.0029	0.0125	10	0.8557		
16434	P29-P28	0.8371	0.0036	0.0125	10	0.9498		
15507	P30-P29	0.8361	0.0039	0.0125	10	0.9858		
15508	P31-P30	0.8301	0.0023	0.0125	10	0.7584	12	1.2720
15509	P32-P31	0.8201	0.0036	0.0125	10	0.9520		

Pipe Number	U/S MH To D/S MH	Ultimate Peak Hour Flow, MGD	Slope, ft/ft	Manning's n	Existing Pipe Diameter, Inches	Capacity Of Existing Pipe, MGD	Required Pipe Diameter, Inches	Capacity Of New Pipe, MGD
15510	P33-P32	0.8161	0.0023	0.0125	10	0.7569		
15511	P34-P33	0.8111	0.0044	0.0125	10	1.0481		
15512	P35-P34	0.8111	0.0029	0.0125	8	0.4707	10	0.8710
15513	P36-P35	0.8001	0.0118	0.0125	10	1.7259		
15518	P37-P36	0.7931	0.0118	0.0125	10	1.7270		
15519	P38-P37	0.7751	0.0038	0.0125	10	0.9786		
15520	P39-P38	0.7681	0.0026	0.0125	10	0.8052		
15485	P4-P1	1.0051	0.0040	0.0125	8	0.5511	10	1.0198
15521	P40-P39	0.3131	0.0036	0.0125	10	0.9491		
15522	P41-P40	0.3121	0.0032	0.0125	10	0.9027		

Golf Course Flows
These flows have been reduced by 3.12 MGD to account for the flows diverted from the golf course.

Pipe Number	U/S MH To D/S MH	Ultimate Peak Hour Flow, MGD	Slope, ft/ft	Manning's n	Existing Pipe Diameter, Inches	Capacity Of Existing Pipe, MGD	Required Pipe Diameter, Inches	Capacity Of New Pipe, MGD
15064	A18-A17	3.0760	0.0009	0.0125	18	2.2912	21	3.4561
15063	A17-A85	3.0760	0.0020	0.0125	18	3.3779		
15065	A85-A16	3.1060	-0.0003	0.0125	18	Check Slope		Check Slope
15283	A16-A15	3.1440	0.0025	0.0125	18	3.7779		
14714	A15-A14	3.1460	0.0011	0.0125	18	2.5437	21	3.8370
14713	A14-A87	3.1480	0.0006	0.0125	18	1.9091	24	4.1114
14712	A87-A13	3.2490	0.0027	0.0125	18	3.9313		
14711	A13-A12A	3.2510	0.0019	0.0125	18	3.3509		
14707	A12A-A12	3.4390	-0.0021	0.0125	18	Check Slope		Check Slope