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City of Battle Ground

2015 General Sewer Plan

Prepared for
City of Battle Ground, Washington

Prepared by
BergerABAM Inc.

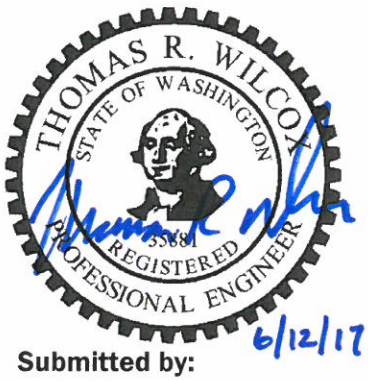
June 2017

City of Battle Ground
2015 General Sewer Plan

Submitted to

City of Battle Ground
Battle Ground, Washington

June 2017



Submitted by:

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City of Battle Ground | 2015 General Sewer Plan

Revised June 2017

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Executive Summary

This update to the 2015 General Sewer Plan (GSP) was completed in coordination with Clark Regional Wastewater District and Clark County's planning processes. The update to the 2015 GSP also updated the model calibration to consider a series of significant rainfall events that occurred in December 2015. December of 2015 had a total rainfall of 18.1 inches whereas recent historical maximum month rainfall totals were 12.1 inches. This significant increase in rainfall resulted in observed maximum day flows that were considered statistically significant and therefore calibration to these events is included.

The 2015 General Sewer Plan was prepared in coordination with the City of Battle Ground's Comprehensive Planning process. The sewer plan provides the necessary documentation to demonstrate that the City can accommodate the estimated long term growth described within the comprehensive plan. The planning process is a high level review of sewer adequacy and schematic level design for future improvements. In coordination with the Growth Management Act, Department of Commerce Guidelines and the Department of Ecology Orange Book, this sewer plan provides information related to the existing sewer system, an evaluation of potential growth on the sewer infrastructure, and a review of financial capability to support and construct necessary improvements.Since the previous sewer plan, completed in 2007 and formally adopted by Ecology in 2011, the City has experienced a period of rather slow growth.

As a result the sewer service area is largely similar to that of 2007. Smaller infill projects and a few spots of commercial development have occurred, but the City has not experienced the aggressive growth that it had prior to 2008. The urban growth area assumed in development of this plan excludes the City's previous proposal to add an additional 80-acres to the Urban Growth Area.

The population data was largely obtained from the County for expected growth within the existing Urban Growth Area. The analysis for sewer capacity considered the following items:

- Overall City-wide residential population growth for determining growth impacts on large city-wide sewer systems.
- Proposed zoning data and developable land analysis to determine sizing for gravity sewers and smaller neighborhood sewer systems.

A hydraulic model was prepared using Hydra 7.1 software to generate sewer flows and simulate system hydraulics. The model included all key infrastructure elements that require improvements identified within this plan. The model also using a 48-hour analysis duration to model flow attenuation in the system, as well as predict peak factors and system performance. Model was calibrated within 1% error for the maximum 24-hour design event.

Flow monitoring data was used in the development of the diurnal curves. The dry-weather diurnal curves were obtained from a study completed in April 2012. Additionally, pump station meter records were obtained for the 7-year study period and were used to determine model inputs and confirm assumptions behind the sewer model.

The model showed that under current flows the gravity conveyance system has sufficient capacity for the existing condition. Pump Station No. 8, Winchester Ranch, was shown to be at or nearing capacity and requires a short-term upgrade. Model results for the 2035 condition showed that improvements to the existing collection system are needed. These improvements are detailed in the plan but largely are not unexpected based upon previous sewer plans and studies conducted in the City. A long term sizing analysis was completed for an assumed 50-year boundary. The resulting 50-year sizing was only applied and shown for the gravity sewers.

The transmission station, transmission force main, and downstream interceptors are discussed generally throughout the report. A regional sewer Alliance was formed and will be completing capital upgrades and assessments of the transmission force main and downstream system as part of their planning process.

The transmission station does require an upgrade within the planning period and that improvement has been identified.

In general the City's sewer system, with the projects identified within, can serve the anticipated development and growth that is projected for the next 20-years. It is recommended that the City update its 6-year Capital Improvement Program every year based upon the results of additional flow monitoring records and system assessments to make the best use of capital funds.

A detailed summary of capital improvement projects is included in Section 9. The City maintains a detailed project list that contains the projects that have been determined to be SDC creditable.

1. Introduction and Purpose

The purpose of this general sewer plan (plan) update is to provide a sustainable and economic approach for the operation, management, and extension of the wastewater collection system of the City of Battle Ground (City). The City of Battle Ground is located in central Clark County, Washington and shown in Figure 1-1.

The previous plan was prepared in 2007 and requires updating to comply with Clark County (County) and the City's comprehensive planning processes currently underway. The City has not developed as anticipated because of the Great Recession that began in 2008.

The plan relied heavily upon expensive off-site improvements driven by significant and on-going growth. The plan requires updating to adjust growth rates and capture current population trends and the proposed improvements must be adjusted to be more sustainable.

1.1 Background and Need

The City owns and operates a wastewater collection system to manage the wastewater needs of the community. The City's system is a conventional sewer system with a series of gravity sewer mains and pump stations. Topographically, the City is fairly flat and the system therefore requires a significant number of pump stations. The City pumps its wastewater from a transmission station before discharging into the collection system operated by the Clark Regional Wastewater District (CRWWD), the regional sewer district.

CRWWD is the administrative lead under contract with the Discovery Clean Water Alliance (Alliance) which owns the conveyance system from the City's transmission station to the Salmon Creek Wastewater Treatment Plant (SCWTP). The treatment plant eventually discharges treated wastewater to the Columbia River. The City purchases conveyance and treatment plant capacity from the Alliance through an interlocal agreement.

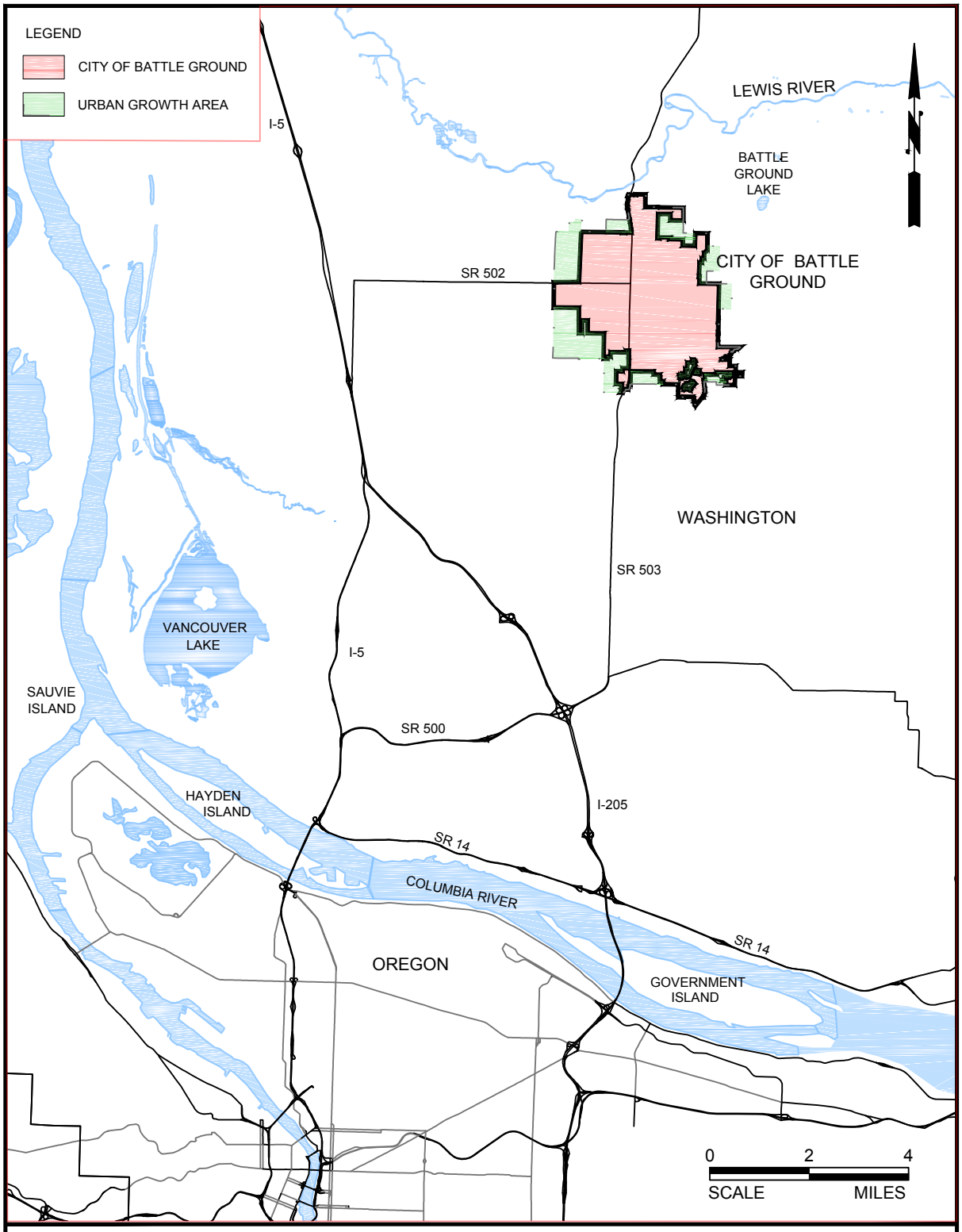
A number of changes have occurred with the City since the last plan update in 2007. The significant changes since 2007 include an expansion of the Urban Growth Boundary (UGB), dramatically lower than anticipated growth rates, and participation by the City in the formation of a regional sewerage agency (Alliance) spearheaded by CRWWD; the regional agency is responsible for the transmission system, regional conveyance systems and the future operation of the SCWTP. The County will continue to operate the SCWTP.

State law (Revised Code of Washington 90.48.110) requires the review and approval of general sewer plans by the Washington State Department of Ecology (Ecology). General sewer plans are required to be sufficiently complete such that engineering reports can be developed from them without substantial alternations of concept. The plan must address all of the required elements included in Washington Administrative Code (WAC) 173-240-050.

1.2 Growth Management Compliance

Clark County identified urban growth areas (UGA) for all of the cities within the county. The UGA assigned to the City of Battle Ground is shown on Figure 3 1. Additionally, portions of the UGA within the City and those outside city limits but currently served by CRWWD are shown in Figure 4 2. This plan addresses the coordination between the City and CRWWD and includes a brief summary of anticipated growth for those service areas as well.

This general sewer plan shows how sewer service will be extended throughout the City's UGA in accordance with the Growth Management Act (GMA). Table 1-1 identifies the sections of the plan that satisfy the minimum requirements of RCW 36.70A.070 (3) for capital facility planning.



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VICINITY MAP

City of Battle Ground
2015 General Sewer Plan

FIGURE
1-1

Table 1-1. Growth Management Act Requirements

Growth Management Act Requirements	Plan Section
RCW 36.70A.070 (3)(a) An inventory of existing capital facilities owned by public entities, showing the locations and capacities of the capital facilities	Section 4.0 Existing Facilities
RCW 36.70A.070 (3)(b) A forecast of the needs for such capital facilities	Section 6.3.4 Wastewater Flow Projection by Basin
RCW 36.70A.070 (3)(c) The proposed locations and capacities of expanded or new capital facilities	Section 7.6 Collection System Capital Improvements
RCW 36.70A.070 (3)(d) An at least 6-year plan to finance such capital facilities within the projected funding capacities that clearly identifies sources of public money for such purposes	Section 10.0 Financial Implications
RCW 36.70A.070 (3)(e) Requires the reassessment of the land use element if probable funding falls short of meeting existing needs; intended to ensure that the land use element, capital facilities plan element, and capital facilities financing plan are coordinated and consistent	City's Comprehensive Plan Section 10

1.3 Scope of Work

The scope of work for this plan includes the following:

- **Review Available Data** – Collect and review all pertinent flow data for the City's collection system to complete the analysis of existing and projected flow rates per unit.
- **System Mapping** – Using the existing system map, add additional sewer system from as-built data provided by the City.
- **Wastewater Flow Analysis** – Analyze flow rates for the City for each pump station and transmission system and determine flow projections for the study periods.
- **Collection System Analysis** – Update City's hydraulic model using City-provided as-built data. Analyze system performance for deficiencies under current and future scenarios.
- **Collection System Improvements** – Identify collection system improvements required for maintenance and operation and for developer extension and expanded sewer service area.
- **Capital Improvement Plan** – Develop a 6-year capital improvement plan (CIP) of recommended wastewater collection system improvements. The CIP will include project descriptions, anticipated implementation schedules, and project delivery costs.
- **Update General Sewer Plan Document** – Provide a newly formatted and organized general sewer plan.
- **Financial Summary** – Review and summarize existing sewer related development and maintenance related costs including system development charges, rates, and regional fees.

2. Goals and Policies

2.1 Approach

Chapter 13.137 of the BGMC deals with the pretreatment of industrial and commercial wastewater. The chapter states an objective to generally prevent the introduction of pollutants into the sanitary sewer system that would be harmful to the receiving waters and the treatment plant itself. Pollution control is to be implemented through regulation and control of the quantity and quality of wastewater discharged by industrial and commercial users which requires pre-treatment in accordance with the Federal Clean Water Act of 1977, the General Pretreatment Regulations (40 CFR 403), and any subsequent amendments. The objectives of this title of the BGMC are to:

- Protect the health, safety, and welfare of the publicly owned treatment works and its personnel and general public;
- Avoid or abate public nuisances;
- Make provisions for the collection and treatment of all wastewater generated by domestic and non-domestic sources under the jurisdiction of the City;
- Protect the City's wastewater collection system from pollutants which may interfere with the operation of the system or contaminate the sludges or other waste products generated by the downstream treatment works;
- Prevent pollutants from entering the collection system and downstream treatment works which could pass through the system, inadequately treated, into the receiving waters (Columbia River); and
- Generate sufficient revenues to operate, maintain, repair, improve, and construct the wastewater collection and treatment system.

2.2 Utility Management and Operation

The City wastewater facilities are managed by the Department of Public Works. Key personnel responsible for the management and operations of the sewer utility are listed in Table 2-1.

Table 2-1. Sewer Management & Operations Staff

Staff Title	Assigned Staff
Public Works Director	Scott Sawyer, PE
City Engineer	Mark Herceg, PE
Public Works Supervisor	Don Ristro Rich Wanke

2.3 Cooperation and Coordination

The City has a long cooperative relationship with CRWWD, which operates two septic tank effluent pump (STEP) systems within unincorporated Clark County that discharge directly to the City's transmission station. The Hockinson STEP system is located to the southeast of the City and serves a small rural center including properties owned by the Hockinson School District. The Meadow Glade STEP system is located southwest of the City core, with portions of the Meadow Glade service boundary contained within the City limits and UGB.

The City has a formation agreement with the Discovery Clean Water Alliance[1] (Alliance) for the ownership and maintenance of the transmission force main and conveyance systems extending from the City's transmission pump station. Currently under the formation agreement the infrastructure is owned by the Alliance and operated by Clark County. The formation agreement also addresses the City's capacity allocation for the SCWTP. The agreement for the Alliance is included in Appendix E.

2.4 Sewer System Design

Ecology establishes statewide standards for the design of wastewater facilities and construction. The standard, Criteria for Sewage Works Design (Orange Book) (current edition), is the basis for the City's sewer system design.

The City supplements the Orange Book with its own standards (see section 5.6.2). Additionally, the City has established a set of sanitary sewer standard details for use during the engineering design and construction process. The Standard Specifications for Road, Bridge & Municipal Construction as prepared by the Washington State Department of Transportation are the adopted materials and construction methods for the City. Sewage pretreatment is addressed separately by BGMC Chapter 13.137.

2.5 Operations and Maintenance

The City will maintain and operate the collection system in accordance with Ecology requirements. The Public Works Department is tasked with operating and maintaining the facilities.

Sanitary sewer pump stations will be maintained in accordance with the requirements of Chapter C2 of the Orange Book. The primary design consideration required by this reference is that stations be sized for a 20-year useful life and be able to provide peak design flow with the largest pump-out of service. The City defines peak design flow as the peak hour flow projected for the 20-year planning horizon.

Interceptor and trunk sewers will be maintained to exceed the standards of Chapter C1 of the Orange Book. The City's adopted design standards require pipe capacities to convey 75 percent of the peak hour flow for the 20-year planning horizon.

The design of the sewer collection system will be based on conveying all wastewater resulting from the projected effects on the sewer system resulting from wet weather effects including infiltration and inflow (I&I). Collection system design standards include the addition of an I&I factor provided in gallons per acre per day (GPAD) for the maximum day flows. Surcharging of manholes may occur during instantaneous peak flow rates during maximum day events. Overflows to surface water or to ground are to be avoided during all design storms, including the 100-year rainfall event.

2.6 Financial Policies

Rates: The City will maintain and update a sewer rate structure adequate to fund routine sewer operations, maintenance, administration costs including service debt obligation, and to accumulate an appropriate reserve fund.

System Development Charges: The City will update the sewer connection charge periodically to reflect the equitable value of facilities of general benefit to the sewer system. In particular, the system

[1] The Discovery Clean Water Alliance includes the City of Battle Ground, Clark County, Clark Regional Wastewater District, and the City of Ridgefield. The Alliance came together to determine the optimum long-term framework for delivery of regional wastewater transmission and treatment services to the urban growth areas in the central portion of Clark County. The members of the Alliance will jointly own and jointly manage regional wastewater assets through a formation framework established under the Joint Municipal Utility Services Act (RCW 39.106).

development charges (SDCs) are intended to cover the cost to the City of building infrastructure which benefits an area greater than the proposed development—including identified pump stations, force mains, and gravity sewers—that are necessary to support development.

Regional Charges: Periodically, the City will participate with the Alliance to re-evaluate the City's regional development charge. The Alliance will develop an overall capital improvement plan for the infrastructure owned by the Alliance. Proportionate shares of capacity will be negotiated between the City and the Alliance as the basis of the regional development charge.

Special Charges: Under the direction and approval of the City Council, the City may develop one or more special charges applicable to the cost of sewerage facilities for new development within a defined benefit area.

Onsite Septic Sewer Systems: Individual property owners are responsible for the operation and maintenance of their existing onsite sewer systems in accordance with applicable state and county regulations. The Clark County Health Department administers and enforces the regulation of onsite sewerage systems.

3. Sewer Service Area

3.1 Urban Growth Area

The City of Battle Ground is located approximately 15 miles northeast of Vancouver, Washington in Clark County. The study area comprises the City and the undeveloped areas surrounding it; these include rural housing, estate style lots, forest, and farms. The current City limits encompass approximately 5,140 acres.

The UGA remains largely unchanged from the 2007 comprehensive plan. Figure 3-1 shows the comprehensive plan designations within the City's UGA. The UGA represents an additional 1,680 acres that, when annexed, will be part of the City. If the entire UGA is annexed within the 20-year planning horizon, the total acreage of the City will be 6,820 acres.

A large number of parcels inside the City limits and UGA remain undeveloped or underutilized. Approximately 25 percent of the City's population is not connected to the City's sewer system. These developed yet unconnected parcels continue to onsite sewage systems. A portion of the City and UGA is overlapped by the Meadow Glade sewer service area, which is served by the CRWWD. Figure 4-2 shows the limits of the Meadow Glade service area.

3.2 Topography and Natural Features

3.2.1 Topography

The topography of the study area is relatively flat, slightly sloping to the south-southwest, with elevations ranging between 270 and 350 feet above mean sea level. Tukes Mountain, located east of the City, features the only steep slopes in the area. Rising over 600 feet in elevation, a significant portion of the mountain lies within the UGA.

The Woodin Creek, Salmon Creek, Mill Creek, and Lewis River drainages provide minor topographic relief to the north, south, and west of the City. For further discussion, see section 3.2.5. The topography of the planning area and surface water bodies is shown in Figure 3-2.

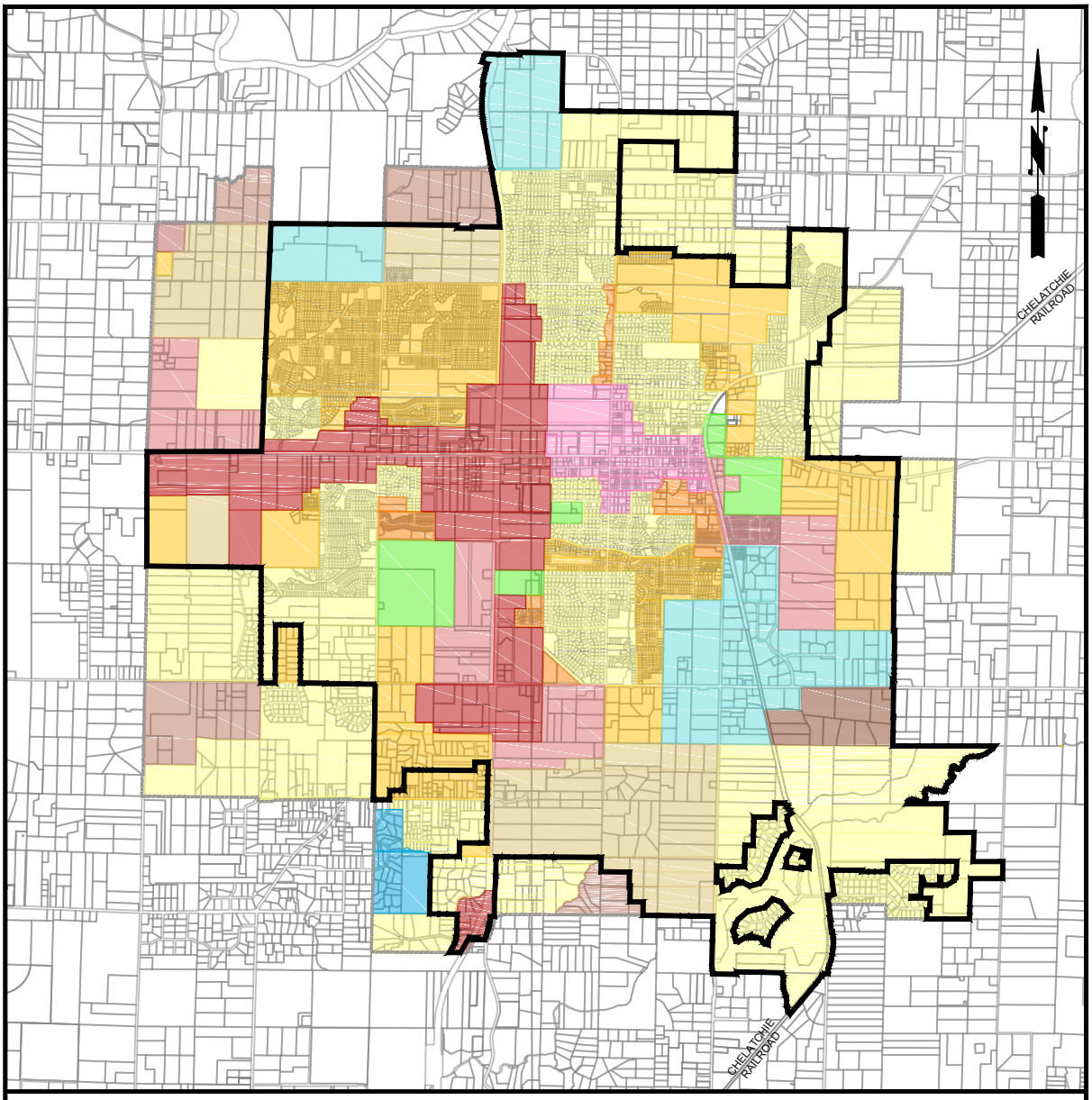
3.2.2 Climate

Battle Ground has a mild climate typical of the valleys between the Coast Range and Cascade Range in Oregon and Washington. Precipitation averages approximately 52 inches annually, most of which falls in a 6-month period, November through April.

3.2.3 Soils

Based on the Soil Survey of Clark County, Dollar loam and Hockinson loam represent most soil conditions within the study area. These soils, developed in deposits of old Columbia River alluvium, are characterized by their low permeability and moderate to high corrosivity. These soil characteristics are conducive to the development of wetlands, which are common in the Battle Ground area.

Tukes Mountain consists of soils in the Olympic Series. These soils are well-drained, gently sloping to moderately steep soils, underlain by basalt bedrock at a depth of 40 inches or more, and are characterized by their moderately slow permeability and moderate to high corrosivity. These soils were formed in weathered igneous lava of the Boring Lava upwelling that formed Tukes Mountain.



LEGEND

- URBAN LOW RESIDENTIAL
- URBAN MEDIUM RESIDENTIAL
- URBAN HIGH RESIDENTIAL
- NEIGHBORHOOD COMMERCIAL
- MIXED USE
- INDUSTRIAL
- MIXED USE RESIDENTIAL
- MIXED USE EMP
- MIXED USE EMP - EXPANSION
- DOWNTOWN
- REGIONAL CENTER
- EMP CAMPUS
- LIGHT INDUSTRIAL
- PARK
- RURAL 5
- RURAL 10
- RURAL CENTER RESIDENTIAL
- AGRICULTURE
- AIRPARK
- CITY LIMITS
- URBAN GROWTH BOUNDARY
- TAX LOTS

0 2000 4000
scale feet

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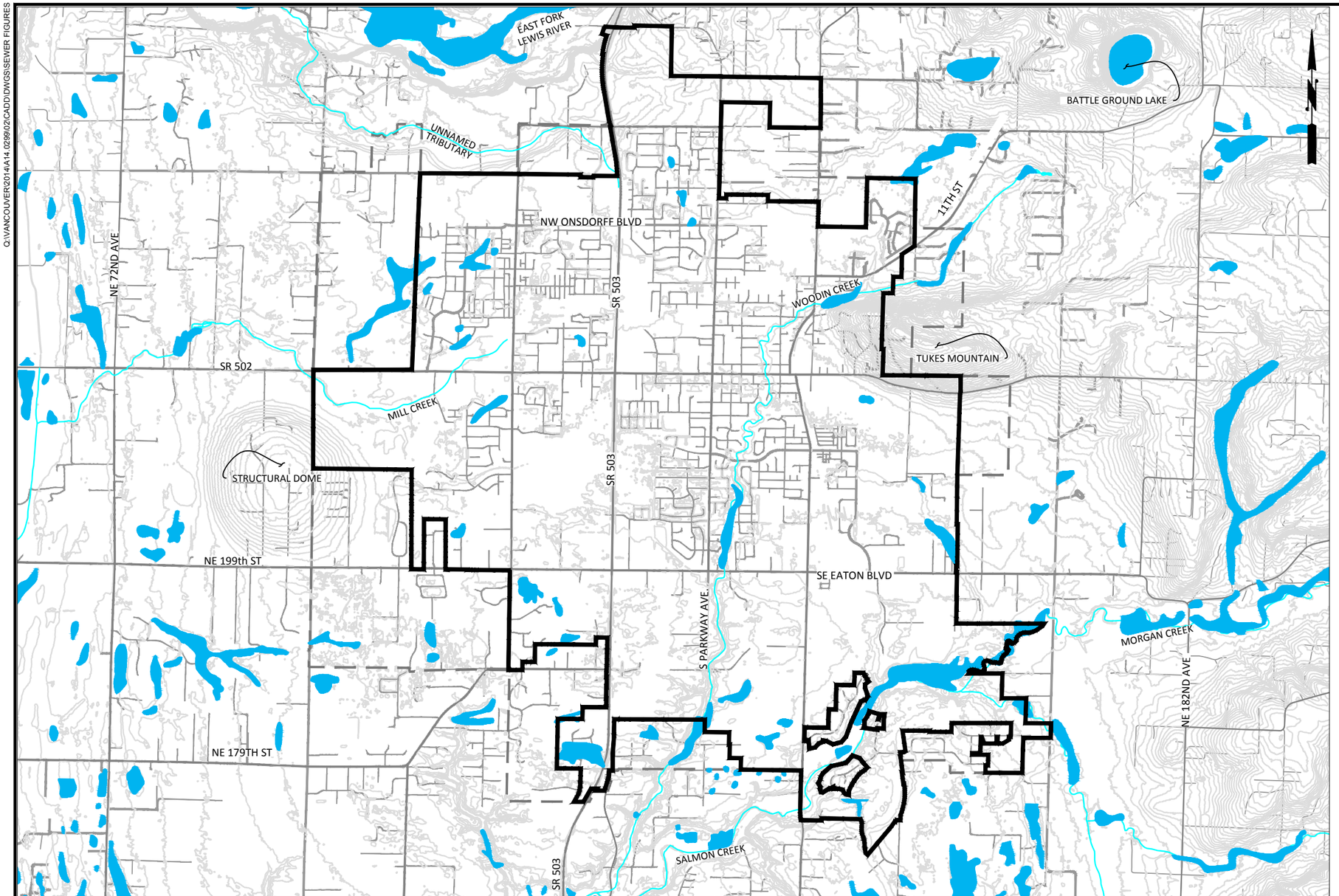
THE CITY OF BATTLE GROUND

COMPREHENSIVE PLAN MAP

City of Battle Ground
2015 General Sewer Plan

FIGURE
3-1

Q:\VANCOUVER\2014\A14.0299\02\CADD\DWGS\SEWER FIGURES



LEGEND

- CITY LIMITS
- URBAN GROWTH BOUNDARY
- STREAMS
- ROADWAYS
- 10 FOOT CONTOURS
- WETLANDS

0 1500 3000
scale feet

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EXISTING TOPOGRAPHY & SURFACE WATER

City of Battle Ground
2015 General Sewer Plan, Rev. 5/17

FIGURE
3-2

3.2.4 Groundwater

The groundwater resources in the Battle Ground area are generally good within the Pleistocene alluvial deposits, the Upper Troutdale formation, and the Sandy River Mudstone formation. The Upper Troutdale formation provides the bulk of the high quality water in the area, with a static water table near the 250-foot elevation.

Compared to most other cities in the area, Battle Ground is unusual: groundwater (perched or otherwise) is shallow for much of the wet weather months. Most of the City is located in an area that originally had significant wetlands, which has great significance relative to the City's problems with I&I. Battle Ground's sewers, both main line and house laterals, are submerged for extended periods during the wet weather months. In cases like this, sewers are prone to high levels of infiltration. Another consequence of high groundwater is that during wet weather, water often ponds in yards and under homes, a circumstance that tempts homeowners to improve drainage by making illegal connections to house sewers.

3.2.5 Surface Water

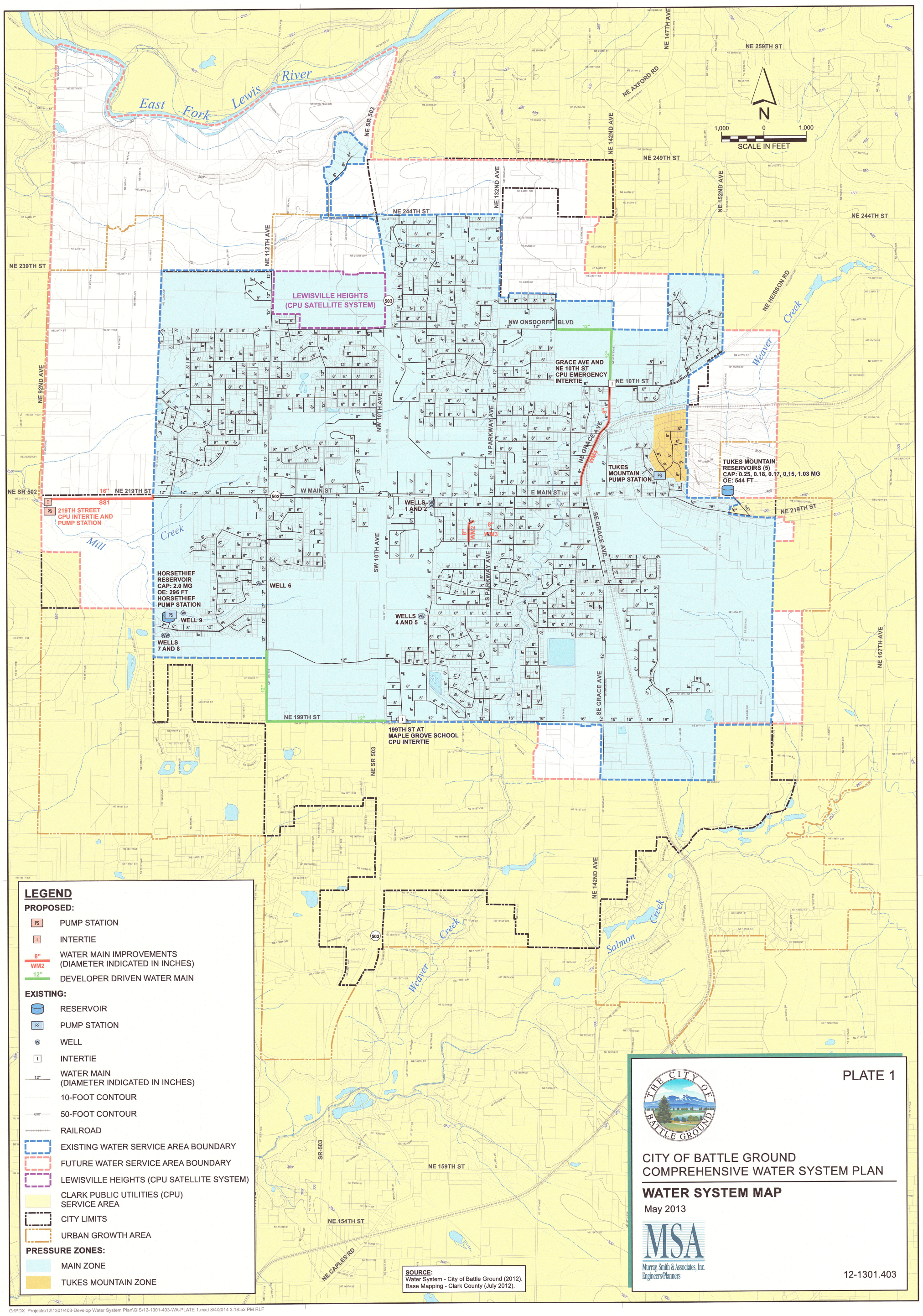
The main surface water features in the Battle Ground UGA are Woodin Creek and Salmon Creek. Woodin Creek flows north-south through the City and into Salmon Creek. Salmon Creek is located in the southeast corner of the UGA and flows from east to west, eventually discharging into the Columbia River. Mill Creek is located in the western portion of the UGA and flows to the west. The East Fork Lewis River is less than a mile north of the existing city limits but is outside the Battle Ground UGA.

3.3 Water Systems

The City developed its water system beginning in 1954. The system is shown in Figure 3-3. The water source for the system is groundwater obtained from eight production wells. In general, the wells are an excellent source of high quality water. In past years, the City has used interties with Clark Public Utilities and the Battle Ground High School system to supplement their water supply. Treatment in the form of disinfection is provided by chlorination systems.

The City's distribution system consists of a network of pipelines ranging from 6 to 16 inches in diameter and six water storage reservoirs totaling 3.7 million gallons. Five of the reservoirs are located on Tukes Mountain, at an elevation that can adequately provide gravity service to the majority of the City's residents. The remaining storage reservoir is the Horsethief Reservoir, which is a ground-level tank with a booster pump station to supply water to the system.

The City's water system serves areas currently located outside the existing city limits. Some residents in the rural areas surrounding Battle Ground rely upon private wells for their water supply. Although there have been no detailed studies, there have been no known incidences of groundwater or well contamination problems.



LEGEND

PROPOSED:

- PS — PUMP STATION
- I — INTERTIE
- 8" WM2 — WATER MAIN IMPROVEMENTS (DIAMETER INDICATED IN INCHES)
- 12" — DEVELOPER DRIVEN WATER MAIN

EXISTING:

- RESERVOIR
- PS — PUMP STATION
- W — WELL
- I — INTERTIE
- 12" — WATER MAIN (DIAMETER INDICATED IN INCHES)
- 10-FOOT CONTOUR
- 600' — 50-FOOT CONTOUR
- RAILROAD
- EXISTING WATER SERVICE AREA BOUNDARY
- FUTURE WATER SERVICE AREA BOUNDARY
- LEWISVILLE HEIGHTS (CPU SATELLITE SYSTEM)
- CLARK PUBLIC UTILITIES (CPU) SERVICE AREA
- CITY LIMITS
- URBAN GROWTH AREA

PRESSURE ZONES:

- MAIN ZONE
- TUKES MOUNTAIN ZONE

SOURCE:
Water System - City of Battle Ground (2012).
Base Mapping - Clark County (July 2012).

PLATE 1

THE CITY OF BATTLE GROUND

CITY OF BATTLE GROUND COMPREHENSIVE WATER SYSTEM PLAN

WATER SYSTEM MAP

May 2013

MSA
Murray, Smith & Associates, Inc.
Engineers/Planners

12-1301.403

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4. EXISTING FACILITIES

4.1 History of the Sewerage System

In 1958, the City of Battle Ground constructed the first portions of its sanitary sewer system, consisting of a collection system and a facultative lagoon. Since that time, the sanitary sewer system has been expanded and upgraded to accommodate growth.

Following the construction of the facultative lagoon in 1958, the City's treatment facility was upgraded twice. In 1976, the treatment facility was modified by adding a primary clarifier, rotating biological contactors, a secondary clarifier, and a chlorine contact chamber. The lagoon was used for sludge storage and as an overflow basin. The treatment plant was expanded in 1981 with the construction of additional rotating biological contactors, another secondary clarifier, and an expanded chlorine contact chamber. Following the 1981 expansion, the capacity of the treatment plant was 0.77 million gallons per day (mgd).

The City's treatment facility discharged into Woodin Creek, a tributary to Salmon Creek. Woodin Creek is small, classified as a Class A stream, and has limited capacity to receive treatment plant effluent. Because of these characteristics of Woodin Creek, the City's waste discharge permit required that the effluent be treated to tertiary standards. Due to the increasing demands on the treatment facility, particularly with respect to hydraulic loading from I&I contributions, violations of the effluent standards were frequent.

Violations of the effluent standards resulted in Ecology placing limitations on new sewer connections and requiring the City to evaluate available options for long-term sewer needs. From 1985 to mid-1989, the City was limited to a maximum of 50 equivalent residential sewer connections per year. Between 1989 and July 1992, only 150 additional connections were allowed. After July 1992, a moratorium was placed on new connections to the City sewer system.

In May 1985, Whiteley, Jacobsen, and Associates completed Infiltration/Inflow, Sewage, Treatment Plant and Receiving Stream Evaluation Report. The report evaluated alternatives for the long-term sewer needs of the Battle Ground area. The report concluded that the City should discharge treatment plant effluent to the East Fork Lewis River. However, with stringent treatment requirements, public opposition, and environmental concerns, this alternative became undesirable. The final preferred alternative was to transport wastewater to the SCWTP. A significant factor in the City's decision to proceed with this option was a proposal by Clark County to sewer the Meadow Glade community with a pressure sewer extending nearly 9 miles to the SCWTP collection system. Clark County offered Battle Ground the opportunity to pay the cost of oversizing the Meadow Glade pressure sewer, thus greatly reducing the cost of Battle Ground's buy-in. The City opted to abandon its wastewater treatment plant and construct a pumping station and force main to deliver wastewater flows to the County treatment facility.

An interlocal agreement was signed on 21 December 1988, between Clark County and the City for the construction and operation of the wastewater facilities that would convey Battle Ground's wastewater to Clark County. By April 1993, the new pump station and force main were on line, and the City's treatment facilities were abandoned or incorporated into the new wastewater transmission system. The moratorium on sewer connections was removed on 15 April 1993.

After the moratorium was lifted, growth was extremely rapid until 2008. A general sewer plan was completed in 1995 based on a growth rate forecast of 6 percent a year. Actual growth far exceeded this estimate, forcing the City in early 1998 to stop accepting new applications for residential land divisions. A sewer plan update was again approved by Ecology in 2000 and 2003. These plan updates addressed this surge in population and reexamined impacts to the collection system, regional transmission system, and SCWTP capacity allocations.

In March 2006, the City updated the plan. The 2007 update forecast a more reasonable flat growth rate through 2026 using an additional 1,090 new residents per year. The growth rates for schools and commercial/industrial users were kept at the previous rates of 1.8 and 3.5 percent per year respectively. In 2008, the Great Recession halted development in Clark County as unemployment rates rose and private investment ceased. Through 2014 the City experienced very little residential growth and some minor commercial/industrial infill consisting largely of projects in the pipeline before 2008.

The City completed the construction of modifications to the City's headworks and transmission pump station in 2011. The project included the abandonment of the existing open-air surge lagoon. A second and larger equalization basin was installed and is hydraulically connected to the existing aerated basin. Submersible pumps were installed within the equalization basin which replaced the existing pump house.

In 2014, development began to reemerge and interest in undeveloped properties has been strong. The City is anticipating growth to resume, although not to the historic levels of 1993–2008.

4.2 Current Service Area

The area served by the City's sewer system is outlined in the existing sewer system map (Figure 4-1). A more detailed map of the existing collection system is included in Appendix A; that map includes line size information. The existing city limits and UGA boundary, which define the future service area extents for the 20-year planning period, are both shown in Figure 4-1. In the southeast corner of the UGA, outside the current city limits but within the UGA, is the Cedars subdivision. This development consists of housing and a golf course. By agreement, the City operates and maintains the Cedars wastewater collection and pumping facilities. The Cedars is the only area outside the existing city limits that is provided sewer service by the City.

Two other areas outside the city limits, Meadow Glade and Hockinson, pump wastewater to the City's wastewater transmission system, which conveys it directly to the Salmon Creek wastewater management system. CRWWD operates the Meadow Glade and the Hockinson systems. A portion of the Meadow Glade service area is located within the City's UGA. The Meadow Glade and Hockinson sewer service areas and their relation to the City are shown in the sewer service area map, Figure 4-2. A more detailed discussion on the impacts of Meadow Glade and future extension of City sewer within the CRWWD service area is included in section 5.5.

4.3 Collection System

4.3.1 Description

The City owns, operates, and maintains over 60 miles of sanitary sewer collection lines and mains.

Most of the collection system consists of 8-inch-diameter pipe with trunk and interceptor sewers constructed of larger diameter pipe, ranging in size from 10- to 30-inch diameter. A large portion of the system was constructed in 1958 and 1966, and consists of concrete and asbestos cement pipe. More recent sewer construction consists of PVC sewer pipe. A detailed map of the existing collection system is included in Appendix A.

As discussed in section 3.2.1, the topography of the sewer service area is relatively flat, generally sloping to the south-southwest. A slight ridge traverses the City creating multiple drainage basins and the need for numerous pump stations to convey flow to the transmission pump station. In all, the collection system utilizes 11 sewage pumping stations and force mains. All pump stations, with the exception of pump stations No. 1 and No. 2, are duplex systems, with each pump capable of pumping the design capacity. Pump stations No. 1 and No. 2 are triplex submersible facilities with equally sized pumps. All pump stations, except for Pump Station No. 6, have a backup power supply in the form of an on-site generator.

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NW ONSDORFF BLVD
NE 72ND AVE
NE 92ND AVE
11TH ST
SR 503
SR 502
PS#7
PS#11
PS#3
PS#8
PS#10
PS#1
PS#2
PS#9
NE 199th ST
SE EATON BLVD
S PARKWAY AVE
NE 182ND AVE
TRANSMISSION FORCEMAIN
NE 179TH ST
PS#4
PS#5

LEGEND

- GRAVITY SEWER SYSTEM
- MODELED GRAVITY SEWER
- CRWWD STEP MAIN
- FORCE MAIN
- PUMP STATION
- TAX LOTS
- CRWWD SERVICE AREA
- DIRECTION OF FLOW
- URBAN GROWTH BOUNDARY
- CITY LIMITS

PUMP STATION	NAME	DESIGN CAPACITY GPM
1	TREATMENT PLANT	2,700
2	GARDNER	5,200
3	BG WEST	250
4	CEDARS	160
5	CEDARS EAST	54
6	INDUSTRIAL	235
7	COUNTRY TERRACE	140
8	WINCHESTER RANCH	220
9	CLOVER MEADOWS	125
10	HORSE THIEF CANYON	100
11	LEWISVILLE	1,325

0 1250 2500
scale feet

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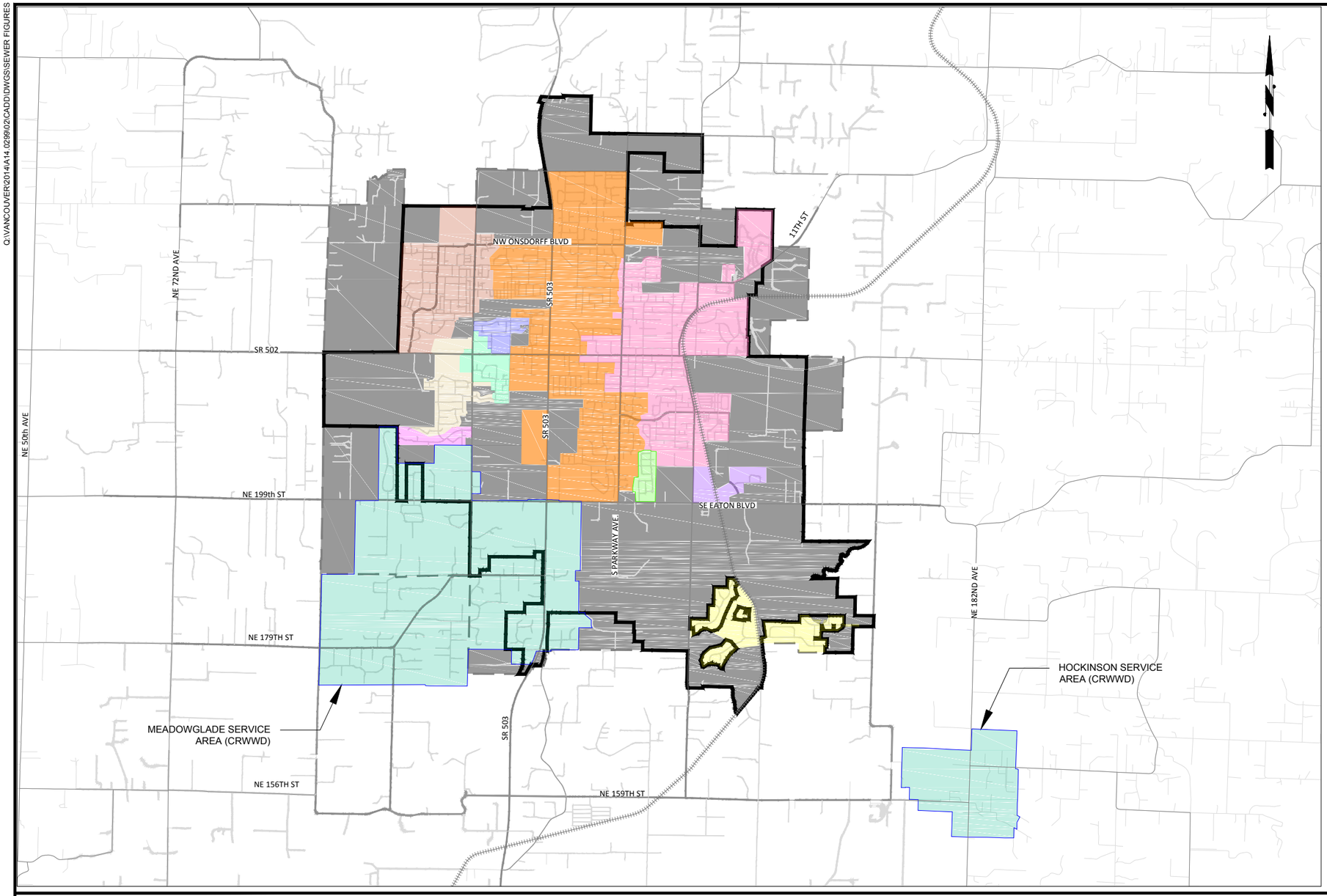
THE CITY OF BATTLE GROUND

EXISTING SEWER SYSTEM

City of Battle Ground
2015 General Sewer Plan, Rev. 5/17

FIGURE
4-1

Q:\VANCOUVER\2014\A14.0299\02\CADD\DWGS\SEWER FIGURES



LEGEND

- URBAN GROWTH BOUNDARY
- CITY LIMITS
- PUMP STATION
- ROADS
- CRWWD SERVICE AREAS
- PS #1
- PS#2
- PS #3
- PS #4
- PS #5
- PS #6
- PS #7
- PS #8
- PS #9
- PS #10
- PS #11
- UNDER DEVELOPED OR PROPERTIES WITH SEPTIC ONSITE

PUMP STATIONS	NAME	SERVICE AREA (AC)
1	TREATMENT PLANT	637
2	GARDNER	918
3	BG WEST	59
4	CEDARS	169
5	CEDARS EAST	78
6	INDUSTRIAL	84
7	COUNTRY TERRACE	36
8	WINCHESTER RANCH	104
9	CLOVER MEADOWS	29
10	HORSE THIEF CANYON	32
11	LEWISVILLE	291

0 2000 4000
scale feet

BergerABAM

SEWER SERVICE AREAS

City of Battle Ground
2015 General Sewer Plan, Rev. 5/17

FIGURE
4-2

Over time, the City has completed several pump station improvement projects. The City has also installed flow meters on all of the pump stations to provide basin-specific flow monitoring to help identify future I&I reduction projects.

Table 4-1 summarizes the data for each pump station. The horsepower and capacities listed in Table 4-1 represent a single pump of the duplex pump stations

Table 4-1. Sewage Pump Station Summary

Pump Station No.	Location	Pump (horsepower)	Design Capacity	Emergency Generator
1	Treatment Plant	25	2,700* (triplex)	Diesel
2	Gardner	98	5,200* (triplex)	Diesel
3	BG West	12	250	Propane
4	Cedars	10	160	Propane
5	Cedars East	7.5	54	Propane
6	Industrial	5	235	None
7	Country Terrace	3	140	Propane
8	Winchester Ranch	5	220	Propane
9	Clover Meadows	3	125	Propane
10	Horsetheif Canyon	3.2	100	Propane
11	Lewisville	30	1,325	Propane

* Variable Speed Pumps

4.3.2 Capacity Evaluation

The capacity of the existing collection system, particularly sections of the original sewers, is greatly influenced by I&I during extended periods of heavy rain when the level of groundwater rises to ground level and submerges private sewer laterals. From television inspection, the main line sewers are in good condition. Components of the existing sewer system do surcharge during periods of high rainfall. According to City staff, historical surcharge areas included the lower reaches of Interceptor 1 and three sewers between Pump Station No. 1 and Rasmussen Boulevard. However, the surcharging of these reaches was confirmed to be fixed following improvements to Pump Station No. 1.

The existing sewer system was hydraulically modeled using the techniques described in sections 7.2 and 7.3. The hydraulic model indicates that there are isolated sections of gravity sewer that experience minor surcharging that were not previously identified. The capacity deficient reaches of gravity sewer have been identified in Figure 7-1.

Overall, despite the surcharging, the collection system has capacity to accommodate current flows without overflow. A more detailed evaluation of existing collection system capacity, based on projected 20-year flows, is included in section 7.0.

4.4 Transmission System Facilities

As previously discussed, the City conveys wastewater to the SCWTP, which is operated under contract by Clark County Public Works. The transmission system consists of two major components: the pumping facilities, which include grinding and equalization/detention facilities, and the 9-mile, 16-inch force main. The equalization/detention facility is owned, operated, and maintained by the City of Battle Ground. The transmission force main and downstream conveyance systems are owned by the Alliance and maintained under contract by Clark County Public Works.

Constructed in 1992–1993, the wastewater transmission system was activated in April 1993, at which time the existing Battle Ground wastewater treatment plant was abandoned. Wastewater is delivered to the transmission system from the Battle Ground and Cedars collection systems. The wastewater transmission system also serves two systems operated by the CRWWD – Hockinson and Meadow Glade. Both of these systems are STEP systems. The City has an interlocal agreement with the Alliance concerning the allocation of Meadow Glade and Hockinson wastewater flows with respect to the capacities of the transmission system, interceptor sewer, or treatment plant.

4.4.1 Pumping Facilities

The transmission pumping facilities were constructed at the site of the City's existing wastewater treatment plant. Many features of that plant were incorporated into the pumping facilities, which are owned and operated by the City.

The City recently completed an upgrade to the existing headworks and facility. The project added a second grinder to the existing headworks structure and constructed a new equalization basin. The existing aeration/equalization basin was retained as a backup facility. The total capacity of the pretreatment grinders is 14.0 mgd.

The operating speed of the pumps is regulated by a programmable logic controller, which monitors the discharge rate from the pump station and the water level in the wet well. The discharge flow rate is measured by a magnetic flow meter located downstream of the pump station and the wet well level is monitored by a pressure transducer.

Equalization is provided through two basins for short-term storage of peak wastewater flows. Aeration is available in the first (backup) basin to keep the solids in suspension and to freshen the wastewater. The aeration system is a coarse bubble diffuser with air supply provided by two blowers that are alternately operated by a variable speed drive, with the speed based upon the depth of wastewater.

The second (primary) basin has a capacity of 3.5 million gallons and is constructed of reinforced concrete with an aluminum roof and new transmission pump station. The flow equalization basin floor is sloped at a 2 percent grade to a center trench, which slopes to the wet well of the new transmission pump station (which is integral to the equalization basin). The equalization basin is actively ventilated but not scrubbed for odor control. Construction included provisions for the future installation of both mixers and a scrubber. The total equalization capacity of both basins is 4.15 million gallons.

The transmission pump station includes five variable-speed-drive pumps. A summary of the pump data is presented in Table 4-2.

Table 4-2. Transmission Pump Station Summary

Pump No.	Pump (horsepower)	Design Capacity
1	34	702 gpm
2	34	702 gpm
3	130	1,600 gpm
4	130	1,600 gpm
5	130	1,600 gpm
Total Firm Capacity		**4.6 mgd**

The transmission pump station has a firm capacity of 4.6 mgd. The pump station is integral with the flow equalization basin, and uses submersible pumps. The pump station includes emergency power provisions that start and stop a generator automatically in response to power failure and restoration.

4.4.2 Transmission Force Main

The 16-inch transmission system force main conveys wastewater from the Battle Ground pumping facility to the Alliance interceptor sewer system, which in turn flows to the SCWTP. The force main flows 9 miles southwest to the point of discharge into the interceptor sewer located at 127th and Salmon Creek Avenue.

The force main is constructed of 16-inch DR-18 PVC pressure pipe with gasketed joints. The force main has six isolation and drain valve assemblies for the purpose of isolating particular sections of pipe and draining the section through a 4-inch drain pipe. Fifteen air release valves or combination air valves are located at the high points along the force main or at locations of major grade changes and where the hydraulic grade line can be lower than the force main under operating conditions.

Pig launch stations are located at the pump station and two other points along the force main route. The stations consist of pipe and valve assemblies where a polyurethane pig can be inserted into the force main to remove accumulated sediments and debris. There is a pig retrieving station at the end of the force main that consists of a hinged screen that can be positioned in the waste flow to catch the pig when it exits the pipe. In July 1994, the City pigged the entire pipeline. The maintenance operation was successful and City staff observed no excessive build-up of solids in the force main. The lower third of the force main was pigged in June 2003.

To maintain aerobic conditions, the transmission system was designed with an air injection system. This system included a duplex air compressor installation located in the pump station and 2-inch and 1-inch ABS air pipes installed along the entire length of force main connecting to five air injection stations along the force main route. The air injection stations included valving, piping, and airflow meters located in a buried concrete vault. That system was abandoned in 2006 and replaced with a chemical feed system that uses Bioxide. The chemical injection facility is located immediately south of the equalization basin and is owned by the Allliance and operated under contract by Clark County Public Works.

4.5 Treatment and Disposal System

The interlocal agreement between the Alliance and the City governs the treatment of Battle Ground's sewage by the SCWTP. This agreement originally allocated 18 percent of the treatment plant capacity to the City with a corresponding 18 percent investment in the capital costs of constructing the various

phases of the plant. The City must also pay operation and maintenance costs according to its flow rate of sewage.

The SCWTP has only two customers, Battle Ground and the CRWWD. Therefore, the flow capacities and costs that are not allocated to the City are allocated to the CRWWD. The City's current capacity allocation is based on the maximum monthly flow, or 3.47 mgd, as provided under the recently completed Phase 4 expansion. Copies of the interlocal agreements and addendums are included in Appendix E.

5. LAND USE AND PLANNING CRITERIA

In order to evaluate alternatives for sewer service within the Battle Ground UGA and update the plan, it is necessary to develop general planning criteria for the sewer system. The planning criteria presented in this section establish the basis for analyzing the system and recommending improvements.

The planning criteria were developed based on the review of existing system studies and reports, applicable regulations, discussions with City staff, and standard textbook design criteria. Also, general assumptions regarding growth and system operations were made to develop system criteria as identified within this section. It is important to note that the planning criteria are general. Detailed engineering reports are necessary to develop specific design criteria and to identify conditions that will influence the design and construction of particular facilities.

5.1 Planning Period

For the purpose of this plan, the planning period is 20 years and the final year of the planning period is 2035.

5.2 Land Use

Land use in the City is established by zoning ordinance. Most of the area is residential. Most commercial activity is concentrated in the downtown core area along Main Street and State Route 503. Industrial development is generally located near the railroad tracks east of the commercial business area and in the southeast part of the City. The 2015 comprehensive plan also includes areas of mixed-use employment and mixed-use residential development adjacent to the commercial core of the City.

Land use within the Battle Ground UGA is addressed in the 2015 Comprehensive Plan. The 2035 Land Use and UGA are presented in the comprehensive plan in Figure 5-1.

Land use outside Battle Ground's UGA is governed by the Clark County comprehensive plan.

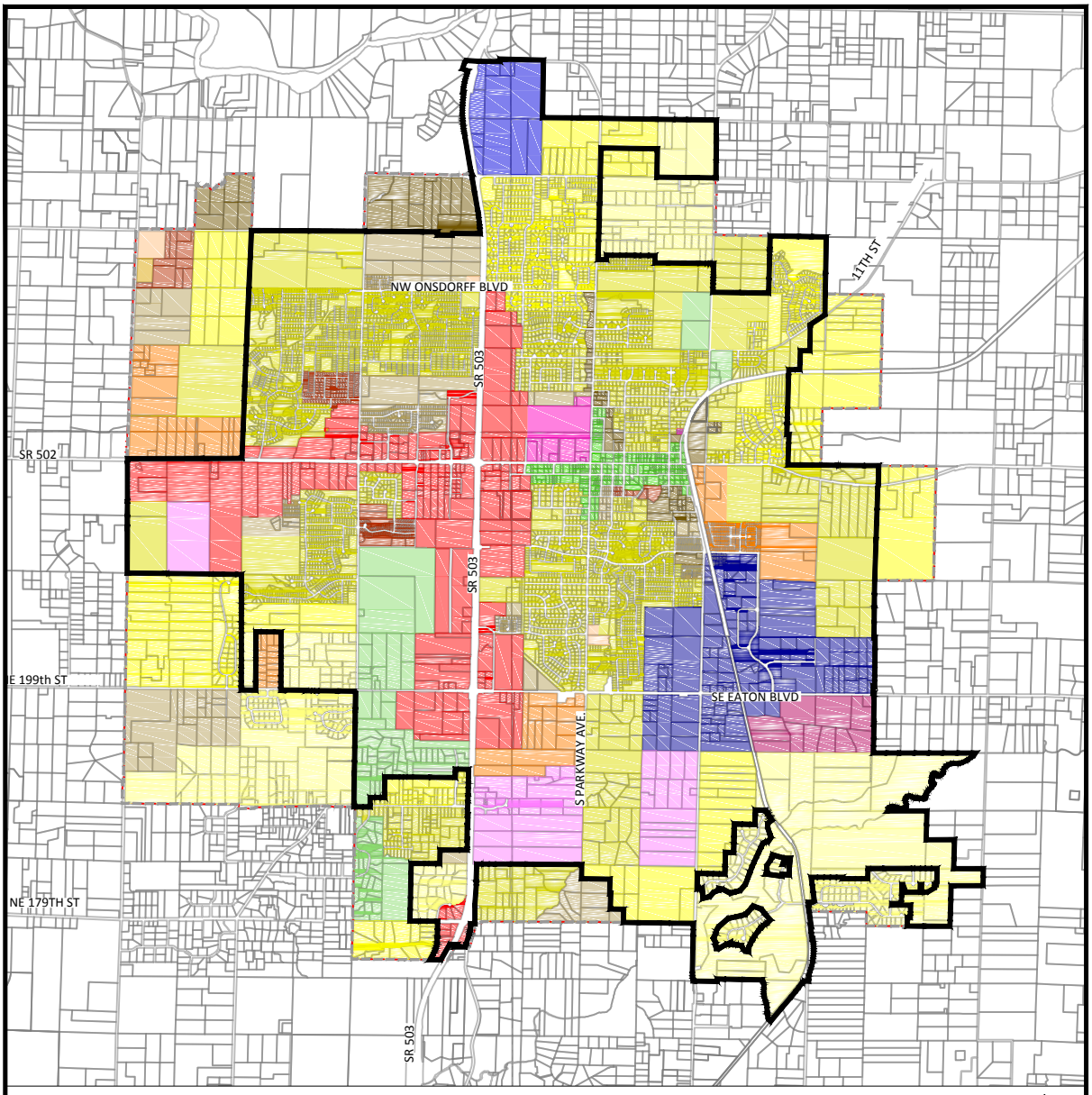
5.3 Population Projections

Wastewater flows are contributed by residential and non-residential land uses. The latter include industrial, institutional, and commercial uses. For purposes of sewer planning, residential flow is described in equivalent dwelling units (EDUs) and non-residential flows are generalized in flow per areas units as discussed in detail below. Where necessary for comparison, the non-residential flows are converted back to EDUs.

As with the planning area, population and EDU projections were based on the City’s comprehensive planning efforts. In the county-wide comprehensive plan, the County has proposed population projections for the City of Battle Ground. The County estimates that the current (1 January 2014) population in the Battle Ground UGB was 20,163. The estimate for the total population within the UGB in 2035 is 39,309, an increase of 87 percent.

5.4 Commercial and Industrial Wastewater

The City has a limited industrial customer base. Non-residential sewer connections consist primarily of commercial businesses with wastewater contributions. These commercial businesses are service-oriented and include restaurants and stores. The City administers an industrial pretreatment program in coordination with the Alliance. Potential new industrial customers are identified during the site plan development review process.



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THE CITY OF BATTLE GROUND

URBAN GROWTH AREA LAND USE MAP

City of Battle Ground
2015 General Sewer Plan

FIGURE
5-1

Old Castle Glass is the only permitted significant industrial user (SIU). The City will continue to work with CRWWD regarding industrial discharge inspections. The inspection of existing identified industrial waste dischargers and potential dischargers will help eliminate the potential discharge of harmful pollutants to the wastewater collection system and also educate the City's industrial and commercial customers.

Anderson Dairy is the City's second largest industrial user. Ecology determined that Anderson Dairy is not a SIU and, therefore, the regulating jurisdiction is the City. Effluent includes milk waste and washdown chemicals. A wastewater discharge permit application was submitted to Ecology by Anderson Dairy in 1997. The application addressed the discharge of effluent with a negative pH impact on the wastewater stream. The application also addressed proposed process modifications to eliminate the acid/caustic cleaning system for low temperature cleaning operations and a caustic separator for high temperature equipment cleaning.

5.5 Meadow Glade Service Area

The Meadow Glade area is served by a pressure sewer system owned and operated by the CRWWD. The Meadow Glade service area lies within a portion of the urban area of Battle Ground, yet its available capacity is limited to land uses equivalent to approximately one EDU per acre. Since the 2007 expansion of the UGB into the Meadow Glade service development within the area has not yet extended conventional gravity sewers into the basin. The overlapping service areas provides opportunites for joint agency coordination.

It is generally understood by engineers and planners that gravity sewer service is preferred to serve urban land use. In extending gravity sewers into an undeveloped area, or an area served by septic tanks, all or part of the cost of sewer service is paid as an incentive to encourage property owners to connect. That incentive is greatly reduced in an area such as Meadow Glade, where large parcels are mixed in with small parcels served by pressure sewers.

Battle Ground and the CRWWD commissioned a report assessing the capacity of the Meadow Glade system. The report concluded that the existing sewer system requires significant upgrades to accommodate the area at build-out under current zoning. The report did not address the land use issues. CRWWD estimates that there is only sufficient capacity remaining in the Meadow Glade system to accommodate equivalent residential densities at one EDU per acre.

This plan assumes the conversion of Meadow Glade to gravity sewer in order to support the land use assigned during the comprehensive planning work completed by the County and the City. If the Meadow Glade area is to be annexed and urbanized an additional coordination and planning effort is needed to address the feasibility, financing, and conversion of Meadow Glade to gravity sewer. Until that effort is completed, development within Meadow Glade should only be allowed at equivalent residential densities of one EDU per acre.

5.6 Sewerage Planning Criteria

5.6.1 Service Area

The City's service area boundary comprises the area within the currently proposed UGA as shown in Figure 4-2. That proposed UGA has been developed as part of an ongoing process of updating the City's comprehensive plan. Land use zoning for the area within the UGA is part of the ongoing comprehensive planning process. Zoning within the UGA is primarily divided into residential, commercial, and industrial uses and parks. For the basis of flow calculations, the acreage that is used for schools is anticipated to remain as school property through the planning period.

5.6.2 Collection System Design Criteria

Standard textbook design criteria, along with the guidelines presented in the Orange Book, were used in the conceptual design of the collection facilities presented in the plan.

Gravity sewers are sized using a Manning's Roughness Coefficient of n = 0.013. All proposed sewers were sized assuming minimum slope. Table 5-1 specifies the minimum design slope and pipe design capacities per the City's engineering standards.

Table 5-1. Gravity Sewer Design Capacities

Nominal Diameter	Minimum Pipe Slope (design)	Minimum Pipe Slope (as-built)	Design Capacity (cfs)	Design Capacity (mgd)
8	0.0045	0.0040	0.61	0.40
10	0.0033	0.0028	0.93	0.60
12	0.0027	0.0022	1.34	0.87
15	0.0020	0.0015	2.01	1.30
18	0.0017	0.0012	2.92	1.89
21	0.0015	0.0010	4.02	2.60
24	0.0013	0.0008	5.13	3.32
27	0.0012	0.0007	6.57	4.25
30	0.0011	0.0006	8.06	5.21
36	0.0010	0.0005	11.96	7.73
42	0.0008	0.0004	16.14	10.43
48	0.0006	0.0003	21.70	12.90

Gravity sewers are sized to accommodate a 50-year development basin assuming current zoning within the UGA and an assumed five residential units per acre for all areas outside the UGA. Sewers are sized for 80 percent of peak hour flow assuming no surcharge. The sizing of pump station and force main capacity is based on 20-year flow projections. Consideration was given to sizing wet wells for ultimate capacity, depending on the location of the pump station and the possibility of future relocation.

5.6.3 Treatment and Disposal Planning Criteria

This plan does not address wastewater treatment and disposal. Currently, all of Battle Ground wastewater discharges to the Salmon Creek wastewater management system, which discharges to the SCWTP for treatment and disposal.

Battle Ground participated in the expense of the most recent SCWTP expansion and capacity upgrades to the Salmon Creek interceptor system. The City's participation in upgrades to the Salmon Creek interceptor will provide a maximum month flow capacity of 14.95 mgd. The expansion allocation provided Battle Ground with a maximum month flow capacity of 3.47 mgd.

6. EXISTING AND PROJECTED SEWER FLOWS

6.1 Existing Sewer Flows

The transmission station includes influent flow meters for the three sources of contributing flow, Battle Ground, Meadow Glade and Hockinson. The flow records are summarized on monthly flow monitoring reports. Influent flow data from January 2007 to December 2015 was compiled and reviewed to establish the wastewater flow characteristics. The information is summarized in Table 6-1. These flows include only contributions from the Battle Ground collection system; flows from Meadow Glade and Hockinson are not included. Annual rainfall data, as recorded at the Battle Ground wastewater transmission site, is also included in Table 6-1.

Table 6-1. 2007-2015 Influent Wastewater Flow

Parameter	2007	2008	2009	2010	2011	2012	2013	2014	2015
Annual Average Daily Flow (mgd)	1.18	1.19	1.17	1.39	1.30	1.84	1.63	1.61	1.46
Average Dry Weather Flow (mgd)	0.85	0.91	0.90	0.98	0.92	1.21	1.34	1.06	1.01
Average Wet Weather Flow (mgd)	1.44	1.38	1.47	1.77	1.51	2.31	1.89	1.82	2.04
Maximum Monthly Flow (mgd)	1.71	1.61	1.61	1.86	1.81	2.59	2.05	2.30	2.75
Maximum 24-Hour Flow (mgd)	3.21	2.56	2.97	2.69	2.80	4.39	3.72	3.747	4.85
Annual Rainfall (inches)	50.3	43.8	41.6	60.9	50.4	56.6	47.1	56.6	54.7

6.2 Existing Unit Flows

In addition, influent flow data from January 2007 to December 2014 was compiled and reviewed to establish the wastewater flow characteristics in terms of gallons per capita per day. Table 6-2 summarizes these flows.

Table 6-2. 2007-2015 Unit Flows

Parameter	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Equivalent dwelling units	6,253	6,396	6,538	6,639	6,741	6,842	6,943	7,031	7,269
Equivalent Population	16,196	16,565	16,934	17,196	17,458	17,720	17,983	18,211	18,826
Hydraulic Loading (gpcd)									
Annual Average Daily Flow	73	72	69	81	75	104	91	89	78
Average Dry Weather Flow	53	55	53	57	52	69	75	58	54
Average Wet Weather Flow	89	84	87	103	87	130	105	100	108
Maximum Monthly Flow	106	97	95	108	104	146	114	126	146
Maximum 24-Hour Flow	198	155	175	156	160	248	207	207	257

6.2.1 Existing Peak Factors

Peak factors were calculated using the flow data inTable 6-3. The wet weather, max month, and max day flows were compared with the annual average flow in accordance with Ecology planning standards. The Orange Book recommends standard peak factors for use during planning for new gravity sewers. The observed maximum day peak factor in 2015 is greater than the standard Ecology peak factor. The peak factors presented by Ecology are not sufficient to model the I&I observed within the system.

Table 6-3. Existing Peak Factors

Parameter	2007	2008	2009	2010	2011	2012	2013	2014	2015
Average Wet Weather Flow	1.23	1.17	1.26	1.28	1.16	1.25	1.16	1.13	1.40
Maximum Monthly Flow	1.46	1.36	1.37	1.34	1.39	1.41	1.26	1.43	1.88
Maximum 24-Hour Flow	2.73	2.16	2.53	1.93	2.15	2.38	2.28	2.33	3.32
Ecology Peak Factor	2.74	2.73	2.73	2.72	2.71	2.71	2.70	2.69	2.68

The Ecology peak factor equation does not model the system flows for Battle Ground accurately. However, as a result of detailed pump station basin-specific flow monitoring, a more accurate depiction of seasonal I&I can be determined. Dry weather flow monitoring was completed in 2011 and provides the basis for actual Battle Ground-specific diurnal flow patterns to more accurately model and predict peak flows for each modeled pipe.

The diurnal curves used in the model were developed using industry standard assumptions and compared to the results of the 2011 flow monitoring report. Figure 6-1 shows the diurnal curves used for each major land use type.

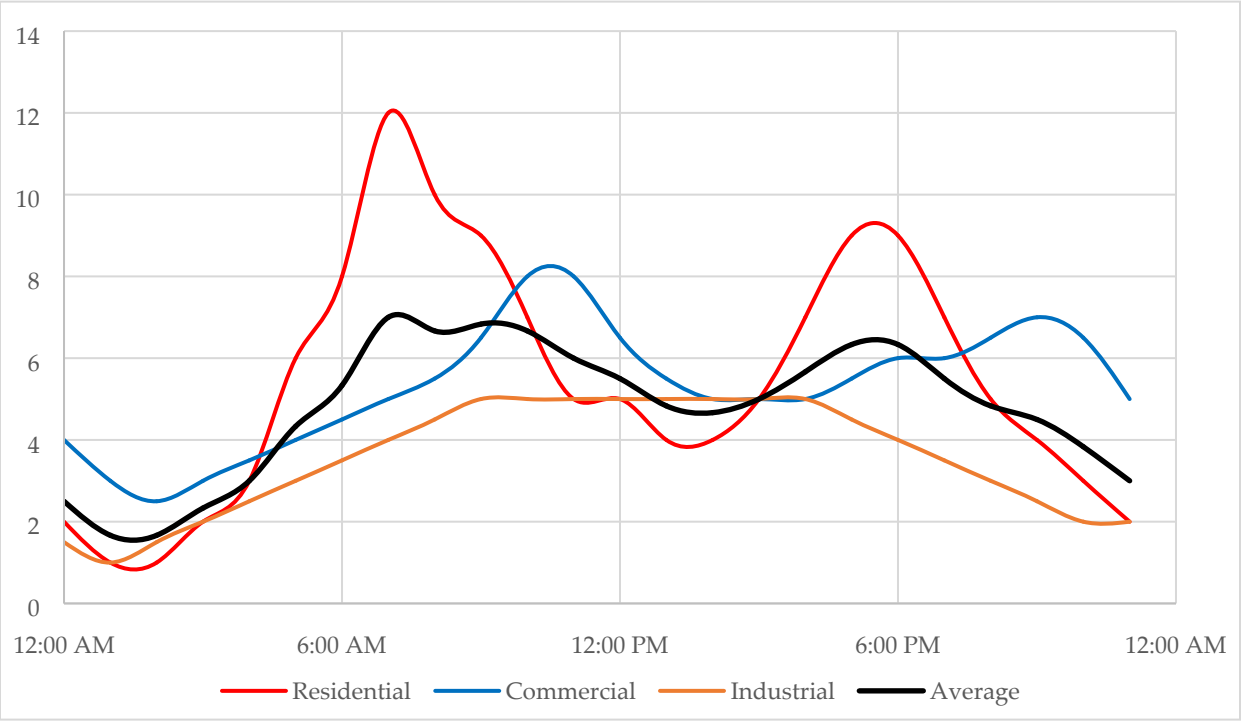
6.2.2 Infiltration and Inflow

Infiltration is defined as subsurface water that enters the wastewater collection system through cracks, joints, or other defects in the system. Infiltration is directly influenced by the local groundwater table and the structural integrity of the collection system. All collection systems experience some degree of infiltration. Those who plan the system must allow additional capacity to accommodate this flow contribution.

There are two forms of I&I which are rainfall dependent. Rainfall-dependent infiltration is a short-term peak in the infiltration component caused by short-term rises in the groundwater table, or super-saturated soils in which the added moisture enters the wastewater system through cracks, joints, or other defects in the collection system. Rainfall-dependent infiltration usually peaks in flow after the rainfall peak runoff and continues between 5 and 48 hours afterward, depending on groundwater levels and antecedent soil conditions.

The other form of I&I is inflow; this includes direct connections made from downspouts, basement sump pumps, catch basins, area inlets, depressed manhole lids, and other means that collect rainfall, which is then discharged into the wastewater system through surface features. Inflow is directly influenced by storm events and usually occurs over a short period (less than 6 hours), during and after a storm. Inflow can usually be prevented by eliminating non-sewerage connections to the system. With older systems, however, identifying illegal sewer connections can be difficult.

Figure 6-1. Diurnal Curves



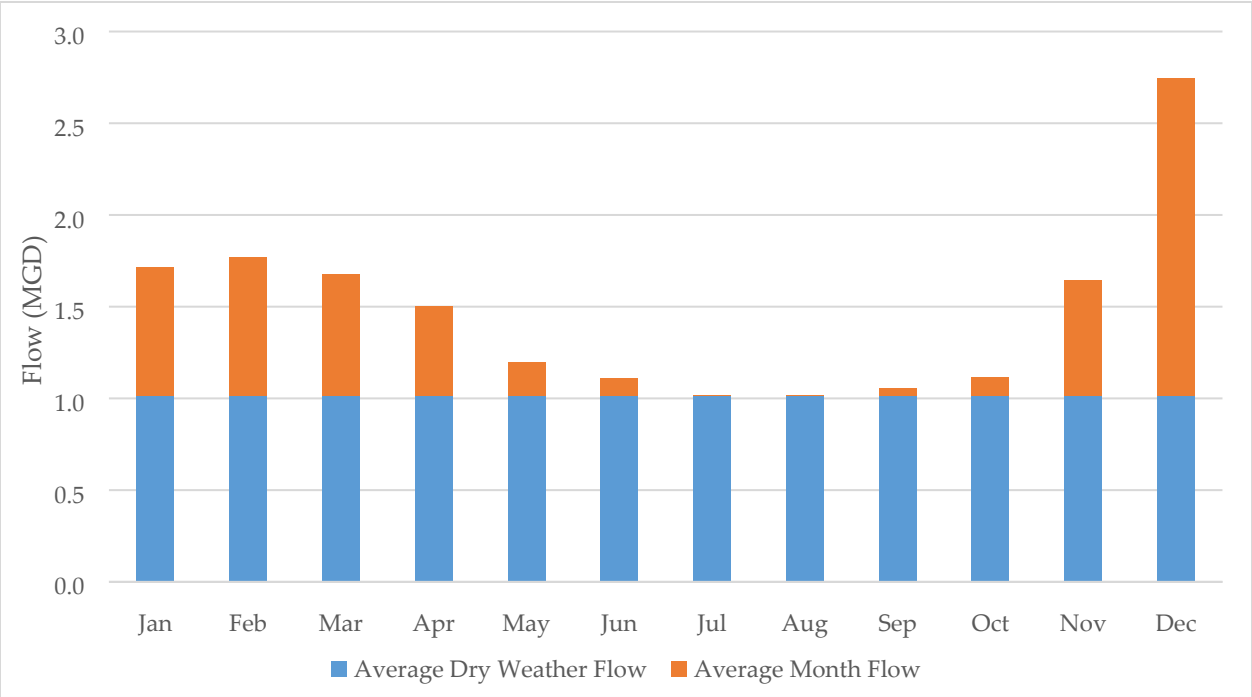
Extensive I&I studies over 20 years demonstrate that infiltration is a major flow contributor to the Battle Ground wastewater collection system. Most of the original wastewater collection system was installed before 1966. Constructed primarily of concrete sewer pipe or asbestos cement pipe, the older portions of the system are prone to infiltration. This is compounded by the fact that the Battle Ground area has soils with low permeability, a seasonally high groundwater table, and poor drainage because of the relatively flat terrain. The impact of I&I on Battle Ground sewage flows is illustrated by Figure 6-2, which separates average dry weather base flow and monthly average flow for 2015.

6.2.2.1 Historical Infiltration and Inflow Reduction Programs

For the past 32 years, the City has had an active I&I removal program. The first major effort was started in 1984. The May 1985 Whiteley, Jacobsen, and Associates report, which evaluated I&I, used pump station operation records, wastewater treatment plant flow data, sewer main video inspections, and interviews with operations personnel to determine the extent and sources of I&I. The report concluded that I&I appeared to be uniformly distributed throughout the collection system originally constructed in the 1950s–80s, which is served by Pump Station No. 1 and Pump Station No. 2.

From 1985–1995, City efforts focused on the elimination of inflow sources. Extensive smoke testing was completed with follow-up disconnection of inflow sources. Extensive manhole repair efforts were also completed. A second I&I report, which was completed in 1995, included field inspections of collection system manholes to identify areas suspected of elevated levels of I&I. Based on these observations, television inspection of sewers in certain areas was recommended. Follow-up memorandums summarized observed leaks and recommended areas for repair.

Figure 6-2. Average Daily Influent Composition



The City initiated rehabilitation work to remedy the problem areas identified in the 1995 report with mainline cured-in-place rehabilitation, mainline slip lining, and point repairs. A pilot corrective program was also initiated for a small subarea identified as experiencing significant I&I, with flow monitoring before and after corrective work. The initial conclusions were that extensive rehabilitation could be cost effective.

Following 15 years of extensive efforts to correct inflow problems and repair mainline sewers, the City shifted its focus to repairing leaking lateral sewers. In 2001, the City implemented an ambitious I&I reduction program that focused on the replacement of private laterals in older neighborhoods identified as experiencing high I&I. The first phase of construction began in 2002 with a second phase in 2003. Approximately 10,600 linear feet of sewer laterals on 278 properties were replaced at a cost of approximately $1.4 million. Ninety cleanouts were installed to allow the future inspection of laterals.

In 2003, the City purchased a television inspection truck that can record video and is equipped with a computer database. The truck will be used to identify I&I problem areas and inspect repair work. The City also installed permanent flow meters on all its pump stations to perform long-term sub-basin flow analysis.

In 2011, the City– with the assistance from the City of Vancouver – conducted an extensive study of dry weather flow conditions. Although hydraulic conditions and meter performance were not ideal, portions of the data were able to produce reasonable dry weather flow estimates. Flow levels were monitored using a FLO-DAR portable device. The report did not estimate wet-season dry weather flows or the influences of storm events.

6.2.2.2 Evaluation of Excessive Infiltration and Inflow Evaluation against EPA Benchmarks

The U.S. Environmental Protection Agency (EPA) has guidelines for evaluating sewer systems for excessive I&I. The guidelines have established fixed threshold flow values that apply to all systems.

6.2.2.3 Infiltration

The EPA guidelines define 120 gpcd as a threshold value for excessive infiltration, based on the average influent flow of a 7 to 14-day low rainfall period during the rainy season (November through February). As presented in Table 6-4, 13 low rainfall periods during 2007–2015 were identified to evaluate infiltration in the Battle Ground collection system.

Table 6-4. Wet Weather Flows, 7-14 Day Low Rainfall Periods

Period	Days	Rainfall (inches)	Average Influent Flow (mgd)	Equivalent Population	gpcd
Jan 22–31, 2007	10	0.00	1.59	15,903	100
Nov 1–8, 2007	8	0.00	0.89	15,903	56
Jan 15–25, 2008	11	0.10	1.62	15,927	102
Feb 14–20, 2008	7	0.07	1.39	15,927	87
Jan 14–23, 2009	10	0.00	1.77	15,951	111
Dec 1–11, 2009	11	0.00	1.41	15,951	88
Feb 16–22, 2010	7	0.00	1.53	15,975	96
Jan 26–Feb 3, 2011	9	0.12	1.54	15,999	96
Jan 31–Feb 7, 2012	8	0.05	1.47	16,023	92
Jan 16–23, 2013	8	0.02	1.3	16,047	81
Nov 21–29, 2013	9	0.00	1.36	16,047	85
Jan 20–27, 2014	8	0.02	1.25	16,071	78
Nov 15–21, 2014	7	0.07	1.25	16,071	78
Nov 25-Dec 1, 2015	7	0.07	1.53	18,826	81
Average	**8**	**0**	**1.41**	**16,209**	**87**

As shown in Table 6-4, the eight-year average per capita flows during low rainfall periods is below EPA standards for excessive infiltration. Analysis revealed the highest per capita flow of 111 gpcd for 2009; which is approaching the EPA's threshold for excessive infiltration.

6.2.2.4 Inflow

EPA guidelines recommend 275 gpcd as a threshold value for evaluating excessive inflow. A comparison of peak flow and significant rainfall events shows a trend that is typical of the Battle Ground sewer system – rainfall has a direct influence on wastewater flows. Table 6-5 presents monthly maximum daily flows and peak 24-hour rainfall between January 2007 and December 2015.

Table 6-5. 2007-2015 Maximum Flows

Rain Event	24-Hour Maximum Rainfall (inches)	Influent Flow (mgd)	Equivalent Population	gpcd
Dec 2–3, 2007	4.22	3.09	15,903	194
Nov 12, 2008	1.25	2.41	15,927	152
Dec 31, 2008–Jan 1, 2009	3.41	3.02	15,927	190
Jan 7–8, 2009	1.18	2.93	15,951	184
Jan 15, 2011	1.97	2.48	15,999	155
Jan 19–20, 2012	1.93	3.54	16,023	221
Jan 29–30, 2013	2.65	2.76	16,047	172
Mar 5–6, 2014	1.47	2.77	16,071	172
Dec 9-10, 2015	3.06	4.85	18,826	257
Average	**2.26**	**2.88**	**15,981**	**180**

Using the EPA benchmark, it can be concluded that over the past few years, inflow has not been excessive. This analysis simply addresses I&I from the perspective of EPA benchmarks.

6.2.2.5 Conclusions Regarding Infiltration and Inflow

Since the installation of flow meters at all pump stations, data has become available to analyze I&I. The meter installed at Pump Station No. 10 (Horsethief Canyon) failed in August 2008 and was repaired in June 2016. Additionally, Pump Station No. 11 (Lewisville) was non-operational from November 2008 to February 2012. Furthermore, multiple pump station meters have been down for periods of approximately one month for scheduled maintenance. These factors account for missing data. An analysis of data missing for the period of 1 January 2007 to 31 December 2015 for all pump stations concluded that city-wide data was missing 12.7 percent of the time. Horsethief Canyon recorded the highest proportion of missing data at 82 percent, and Lewisville data was missing 37 percent of the time. In addition, influent flow data was interrupted between March and November 2011 because of construction at the headworks.

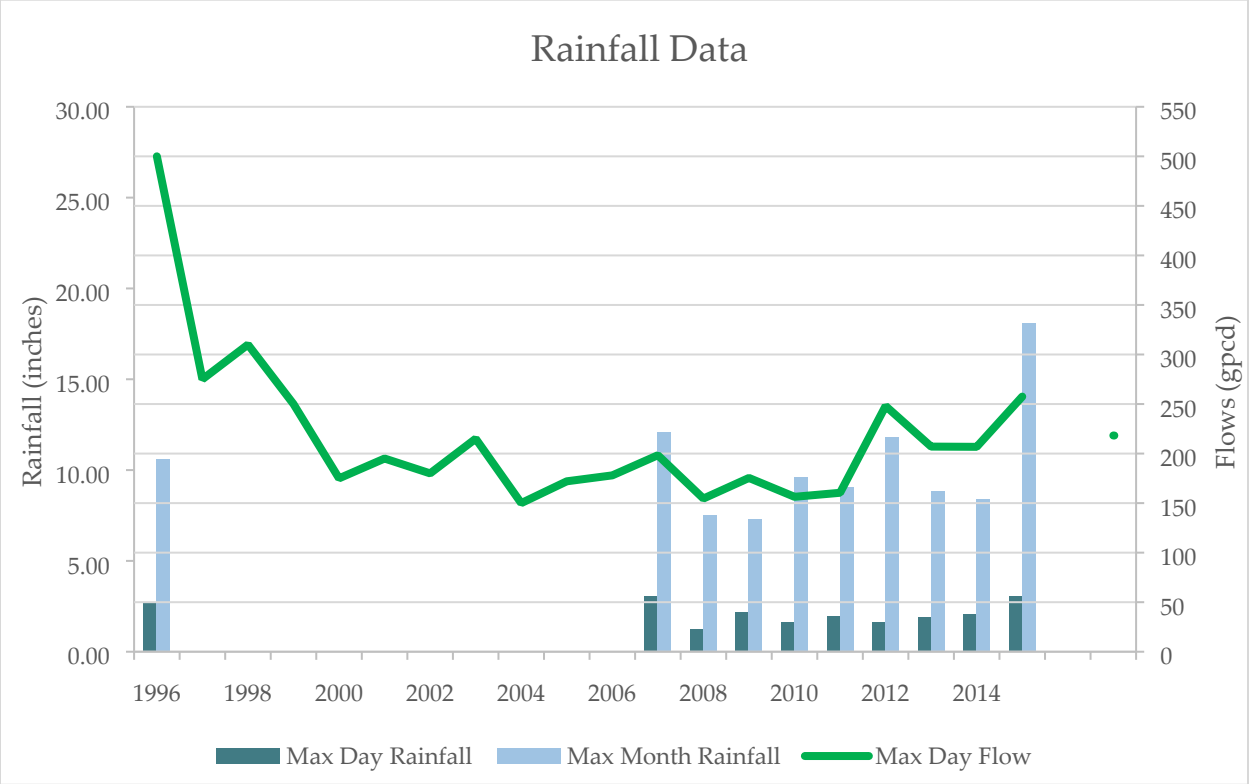
Despite these interruptions, some reasonable conclusions can be drawn, although additional flow data is needed to solidify these conclusions.

Infiltration is dependant upon groundwater levels. In the Battle Ground area in a year of average rainfall, the level fluctuates approximately 12 feet throughout the year, from a late summer low of approximately 15 feet below ground surface to a late winter high of about 3 feet below ground surface. This fluctuation is very gradual and responds to rainfall. Short duration rainfall events may affect the groundwater level, but only slightly. Heavy rainfall that occurs over days, weeks, or even a month, will cause a temporary rise in the groundwater level, but only a foot or two. That extra foot or two is significant, however, because it can submerge private laterals, and thus produce a surge of groundwater-induced infiltration.

Studies over the past 20 years show that infiltration varies with groundwater level. In the summer, the groundwater level is below most of the sewer laterals and mainline, so there is very little infiltration during the late summer months, but as the groundwater level rises with the fall and winter rains, infiltration increases.

Battle Ground's wastewater flows track largely with max monthly rainfall. In many locales, high wastewater flows track with high rainfall over shorter periods. The relationship between maximum day wastewater flow and max monthly and max daily rainfall is shown in Figure 6-3.

Figure 6-3. Rainfall Data 1996-2014



A peak daily flow of 4.85 mgd was recorded in December 2015. The 2015 peak daily flow total was approximately 3.8 mgd above the average dry weather base flow for the year. The peak daily flow of 4.85 mgd corresponds to a max monthly rainfall period of 18.10 inches. The previous historical max monthly rainfall was 12.09 recorded in 2007. The total annual rainfall for 2015 was 55 inches.

The previously recorded peak daily flow of 3.56 mgd was recorded in 1996, which residents recall as a year of notable floods. The February 1996 peak flow corresponded to an annual rainfall total of 78 inches, the wettest in 50 years. The average annual rainfall for Battle Ground is approximately 52 inches.

Historically, reliable flow records were available only at the combined influent flow meter at the wastewater transmission site. Since 2003, flow meters installed at 10 pump stations have yielded a more accurate depiction of I&I. An analysis of the thirteen years of basin flows shows that I&I tends to be less in areas with new construction, which confirms earlier conclusions that I&I is related to the age of the system.

The peak flow into a sewer system typically has little to do with the capacity of that system, but this does not seem to be the case in Battle Ground. An evaluation of rainfall and flow records shows that as the capacity of the sewer system has increased, peak flows into the system appear to have been attenuated. What follows is a description of our analysis of this phenomenon.

- The older part of the sewer system performs as follows during those periods of very high infiltration.
- Prior to an unusually high rainfall event, the groundwater is high (within approximately 3 feet of the top of the ground surface).
- Storm events of two to three days duration gradually raise the groundwater level to within a foot or so of the ground surface, progressively increasing infiltration rates as laterals are submerged. As infiltration rates increase, the sewer system surcharges.
- Through this period, base wastewater flows vary diurnally. During periods of diurnal peak flows, the surcharging increases.
- As the surcharging increases because of the combination of infiltration and diurnal peak wastewater flows, the infiltration rates decrease due to an equalization of head (pressure) over the empty pipes. In other words, as the diurnal wastewater flows go up, the infiltration rate goes down, basically resulting in a steady state condition with flow into the section of the surcharged sewer controlled by the discharge rate of the sewer under high surcharge.

Table 6-6 shows the analysis of I&I and peak factors for specific pump station basins. This table also includes the recommended planning level max day I&I for each pump station basin. Where 2015 data was unavailable the 2014 data was used. The recommended 2035 I&I figures were increased approximately 20% to allow for increases in I&I contribution as the system ages and to account for uncertainty in the ultimate rainfall month. These values are anticipated to be conservative as the City continues to invest in I&I reduction programs. Additionally, the 2015 calibration event which included in max month rainfall of 18.1 inches far exceeded the previous max month record of 12.1 inches.

Table 6-6. 2015 Pump Station Influent Wastewater Flows

Pump Station	Service Area (acres)	Average Annual (gpd)	Wet Weather (gpd)	Max Month (gpd)	Max Day (gpd)	Accuracy (%)
Gardner	1,149.15	921,996	1,236,967	1,596,080	2,674,570	100
Winchester Ranch*	104.00	94,552	101,576	106,086	286,673	96
Horsethief Canyon	32.00	No Data	No Data	No Data	No Data	19
Clover Meadows	29.36	24,711	27,353	29,917	63,368	100
Cedars East	77.88	8,848	10,727	14,961	33,652	100
Cedars/Industrial	253.18	62,227	86,206	125,569	342,604	98
Country Terrace	35.90	33,651	41,422	44,791	62,096	99
BG West	59.11	76,867	119,133	177,956	268,448	100
Lewisville*	291.27	204,139	213,711	237,370	519,636	63
Pump Station #1	636.64	541,869	781,651	1,085,030	1,814,196	99

* Data for Winchester Ranch and Lewisville are presented as 2014 values.

Table 6-7. 2015 Pump Station Peak Factors and I&I

Pump Station	Peak Factor			I&I (gpad)			2035 Max Day I&I (gpad)
	Wet Weather	Max Month	Max Day	Wet Weather	Max Month	Max Day	
Gardner	1.34	1.73	2.90	219	468	1,217	1,500
Winchester Ranch*	1.10	1.12	3.03	90	111	1,847	3,500
Horsethief Canyon	No Data	No Data	No Data	No Data	No Data	No Data	3,500
Clover Meadows	1.11	1.21	2.56	90	177	1,317	1,500
Cedars East	1.21	1.69	3.80	24	78	318	400
Cedars/Industrial	1.39	2.02	5.51	95	250	1,107	1,500
Country Terrace	1.23	1.33	1.85	216	310	667 792	1,000
BG West	1.55	2.32	3.49	715	1,710	3,241	3,500
Lewisville*	1.08	1.16	2.55	57	114	1,083	2,000
Pump Station #1	1.44	2.00	3.35	377	853	1,998	2,500

* Data for Winchester Ranch and Lewisville are presented as 2014 values. 2014 values on average are approximately 64% of the observed values for the December 2015 calibration event.

6.3 Future Wastewater Flows

6.3.1 Service Population

The current collection system does not serve the entire City limit or UGB. The utility billing software employed by the City indicates a total number of sewer EDUs 7,269. A detailed inventory of connected residential units and actively connected commercial, industrial and institutetional properties was completed for 2014. The existing residential connections totaled 5,834 EDUs or an approximate population of 15,101 of the City's 20,163 total population.

For flow projections outside the existing service areas, or where the vacant buildable lands model indicates that the property within the existing service boundary is vacant or underutilized, zoning data was used to calculate total future residential development. The following assumptions were used in the models calculation to determine the 2035 residential flows:

- Gross zoning area is reduced by 35 percent for an infrastructure allowance (on-site roads, stormwater mitigation, buffers etc.).
- Gross zoning area is reduced for areas that are delineated as wetlands according to the NWI wetland layer in the Clark County GIS database.
- The zoning area does not include the areas of existing rights-of-way.

- Flows are based on the maximum possible residential density per zoning code (BGMC Title 17) as summarized in Table Table 6-8.
- Flow was estimated using the annual average flow rate (gpcd) plus an I&I component calibrated to the maximum day flow rate.

Table 6-8. Maximum Residential Density

Zoning Designation	Maximum Residential Density (EDUs per acre)
R3	3
R5	5
R7	7
R10	10
R12	12
R16	16
R20	20
MU-R	22
MU-E	22

6.3.2 Per Capita Wastewater Flow

Future per capita flows were estimated based on existing per capita flows and the Ecology guidelines. The following table contains the per capita average contribution from 2000–2015, the Ecology-recommended design values for new wastewater treatment facilities, and the value used for future population loading. The Ecology guidelines use direct population, which assumes a higher per capita flow contribution. The projected per capita values are based on either the Ecology guidelines or historical averages, whichever is higher. Peak hourly projections are not included because current available data is only a daily average. Instantaneous monitoring is not available in Battle Ground.

Table 6-9. Per Capita Flow Projections

Parameter	Historical Average (2000-2015)	Max Occurance (2007-2015)	Ecology Guidelines	Future (2035)
Annual Average	84	104	100	100
Dry Average	64	75	n/a	70
Wet Average	104	130	n/a	130
Max Month	129	146	n/a	150
Peak Day	189	257	n/a	260

6.3.3 Commercial and Industrial Wastewater Flow

The inventory for commercial and industrial wastewater was completed like the inventory of the residential EDUs. GIS and aerial mapping were used to determine the number of developed commercial, institutional, and industrial acres. Once summarized by pump station, the amount of industrial flow was determined by evaluating the basins with only residential and industrial flows. The total residential flow calculated using the flow averages from Table 6-10 was subtracted from the total daily flow; the remaining flow was divided by the industrial acres. The existing commercial and institutional flow rates were calculated the same way and summarized in gpad.

Table 6-10. Average Annual Commercial and Industrial Unit Flows

Zoning Designation	Average Annual Flow (gpad)
Commercial	500 to 1,100
Industrial	700 to 1,050

As with the discussion of service population in section 6.3.1, for flow projections outside the existing service areas, or where the vacant buildable lands model indicates that property within the existing service boundary is vacant or underutilized, zoning data was used to calculate total future commercial and industrial development. The following assumptions were used in the models calculation to determine the 2035 commercial and industrial flows.

- Gross zoning area is reduced by 35 percent for an infrastructure allowance (on-site roads, stormwater mitigation, buffers, etc.).
- Gross zoning area is reduced for areas that are delineated as wetlands according to the NWI Wetland layer in the Clark County GIS database.
- The zoning area does not include the areas of existing rights-of-way.
- The resultant flows are based on the resulting net developable land multiplied by the unit flows shown above inTable 6-10.

Flow projections for the institutional flow rates (schools) were included with the residential growth rate for the UGB. The City tracks school connections/billing for schools at the time that new fixtures are constructed and not proportionate to the amount of children in attendance producing wastewater flows.

Table 6-11 summarizes the unit flows for commercial, industrial, and institutional flows. As a result of the decision to model I&I separately, only the base average annual flow is provided for the non-residential flow rates. Increases due to the development of commercial and industrial flows are captured in the increased amount of utilized land and not in increasing flow rates.

Table 6-11. 2035 Non-Resdiential Flow Rates

Zoning Designation	2007-2014 Average (gpad)	Future (gpad)
Commercial	500 to 1,100	1,000
Industrial	700 to 1,050	1,000

6.3.4 Wastewater Flow Projections

Projected wastewater flows for the City were developed using data from Table 6-9 and Table 6-11. Each 2035 pump station service area was summarized according to the following attributes:

- Existing connected residential EDUs
- Existing commercial, institutional, and industrial acreages
- Proposed residential, commercial, and industrial zoning

The results of the data compilation for the existing conditions are presented for each pump station in Table 6 14.

Table 6-12. Basis of Existing Flow by Pump Station

Pump Station	Residential EDUs	Commercial	Institutional	Industrial
Pump Station No. 1	1,980	29	24	24
Gardner	2,090	183	105	0
BG West	295	21	0	0
Cedars/Industrial	157	0	0	25
Cedars East	45	0	0	0
Country Terrace	138	6	0	0
Winchester Ranch	363	15	0	0
Clover Meadows	137	0	0	1
Horsethief Canyon	108	0	0	0
Lewisville Meadows	892	2	188	0

Detailed information regarding the basis of proposed flows for 2035 and 2055 are included in Appendix B.

7. COLLECTION SYSTEM ANALYSIS

7.1 Overview of Evaluation Process

The collection system for the City is modeled in two primary hydraulic models using Hydra version 7.1 by Pizer. The collection system as of 2014 is modeled using information provided by the City including layouts, locations, and pipe diameters. Most of the model uses GIS contour data to determine rim elevations for the manholes and the suitability of the routing of the proposed system.

The model uses inputs for EDUs, and zoning as the basis of flow projection. These are inserted into the model using a land use layer. These land use layers were digitized based on the land use map shown in Figure 5-1. The land use layers in the model were divided into smaller portions to limit the boundary to existing and proposed pump station service areas as well as to separate areas of developed and vacant properties.

The land use layer is intersected during the modeling process through a service area layer that assigns the flows developed from the land use layer to specific manholes for routing through the collection system. The service area layer and the acreages associated with it are the basis for the I&I applied into the collection system at the assigned manhole.

The collection system was simplified to include major sewer lines – interceptors, trunks, laterals, and some collection sewers – where future extensions may be considered. The existing system, including manholes and pipes, was digitized using the City's sewer map. Sewer extensions to the collection system were input with manholes spaced every 400 feet to better allocate future sewer flows and to check the feasibility of service areas based on the 10-foot contour GIS data.

Existing flows were developed using total residential EDUs and developed commercial, institutional, and industrial acreages. Future flows were developed for the net developable land using residential zoning, maximum residential densities, and commercial, institutional and industrial acreages. Diurnal curves were used to mimic daily variations in sewer flow and predict the actual peak sewer flow rate. In addition, I&I was added to the model separately and was calculated by the connected sewer service area.

The model was calibrated to the max day flow rates for the pump station basins. The max day calibration was confirmed by comparing the average flow rate with the maximum day observed flow rates in 2014. The design flow rate from the model is greater than the maximum day to design for the 1-hour peak flow rate.

7.2 Evaluation of Existing Pump Stations

The existing pump stations were evaluated using the 2014 existing model to determine their adequacy to meet existing planning standards. Pump stations are designed for a 20-year life expectancy. An engineering report should be prepared for each pump station redevelopment as it occurs to confirm its adequacy for 20 years. The existing pump stations are tabulated below with their design capacity, the 2014 max day observed flow rate, and the modeled peak hour.

Table 7-1. Existing Pump Station Evaluation

Pump Station No.	Location	Design Capacity	2015 Max Day (gpm)	2015 Modeled Max Day (gpm)	2015 Modeled Peak Hour (gpm)
1	Treatment Plant	2,700	1,260	1,260	1,436
2	Gardner	5,200	1,857	1,869	2,123
3 and 7	BG West and Country Terrace[a]	390	230[b]	Not in Model	Not in Model
4 and 6	Cedars/Industrial[a]	395	238	231	254
5	Cedars East		23	24	27
8	Winchester Ranch	220	No Data	235	269
9	Clover Meadows	125	44	Not in Model	Not in Model
10	Horsethief Canyon	100	No Data	74	84
11	Lewisville Meadows	1,325	No Data	568	647

a) Country Terrace and Industrial Pump Stations are to be abandoned for 2035 model.

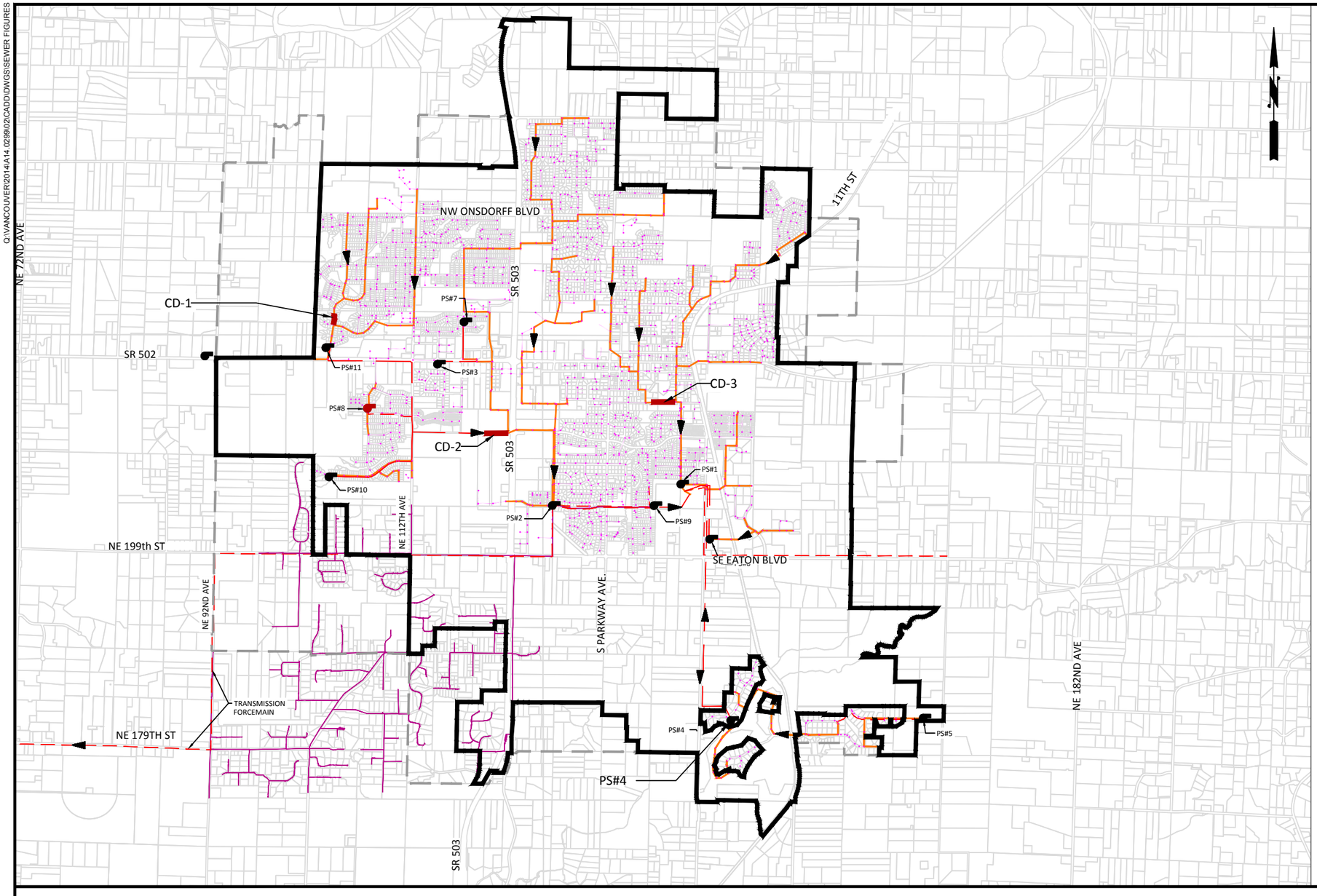
b) Data points were developed by the combined total of design flow rates and modeled results.

Winchester Ranch (Pump Station No. 8) is identified as not meeting the current planning standards. Based on the actual observed (2014) max day flow rate of 199 gpm compared to the design capacity of 220 gpm. 2015 modeled peak hour results exceeded the design capacity and therefore it is highly likely that peak flows to the pump station have exceeded its rated capacity. Winchester Ranch is proposed to be abandoned within the 2035 planning horizon. Therefore, to avoid overflows we recommend a temporary improvement with either pump or motor replacement to achieve a higher rated capacity. Future development within this basin will need to address capacity deficiencies at the Winchester Ranch Pump Station. An interim capacity of 400 gpm is recommended, as the timeline for the construction of the off-site sewer that is required for abandonment is unknown. The pump station listed for improvement are included inTable 7-2.

Table 7-2. Existing Pump Station Capacity Deficiency

Pump Station	Existing Diameter	Current Capacity (gpm)	Proposed Capacity (gpm)
Winchester Ranch	8’ Diameter Wetwell	220	400

Q:\VANCOUVER\2014\A14.0299\02\CADD\DWGS\SEWER FIGURES



LEGEND

- GRAVITY SEWER SYSTEM
- MODELED GRAVITY SEWER
- CRWWD STEP MAIN
- CITY LIMITS
- URBAN GROWTH BOUNDARY
- FORCE MAIN
- PUMP STATION
- CAPACITY DEFICIENT PUMP STATION
- CAPACITY DEFICIENT SEWER
- DIRECTION OF FLOW
- TAX LOTS

CAPACITY DEFICIENT	EXISTING SIZE	PROPOSED SIZE
PS# 8, WINCHESTER RANCH	220 GPM	400 GPM
CD-1, 168 LF	8"	12"
CD-2, 421 LF	12"	36"/42"
CD-3, 626 LF	8"	12"

0 1500 3000
scale feet

BergerABAM

EXISTING SEWER CAPACITY DEFICIENCIES

City of Battle Ground
2015 General Sewer Plan, Rev. 5/17

FIGURE
7-1

7.3 Evaluation of Existing Gravity Collection System

The existing gravity sewers were evaluated using the 2015 existing model to determine their adequacy to meet existing planning standards. Sewers are recommended for improvement when capacity will meet or exceed 80 percent of the peak flow. The analysis showed that three existing gravity sewer reaches currently experience surcharging. The locations of the necessary sewers are shown in Figure 7-1 and summarized below in

Table 7-3. Existing Gravity Sewer Capacity Deficiency

Existing Gravity Sewer	2035 Diameter	2065 Diameter
CD-1, 168 LF 8” diameter	12”	12”
CD-2, 421 LF 12” diameter	36”	42”
CD-3, 626 LF 8” diameter	12”	12”

7.4 Meadow Glade STEP System

According to the CRWWD, the Meadow Glade STEP system is capacity-limited. The STEP system can provide service only to lots within the service area of 1 acre or larger. Development in which densities will be greater than 1 EDU per acre will require connection to the City’s sewer system. For the basis of sewer service within the overlap between the City’s UGB and the Meadow Glade service area, all properties within the boundary are assumed to be connected to the City’s system.

Most of the developed properties within the Meadow Glade area were assumed to be unlikely to redevelop and, therefore, the flow contribution from Meadow Glade is reduced to reflect the vacant and buildable lands model.

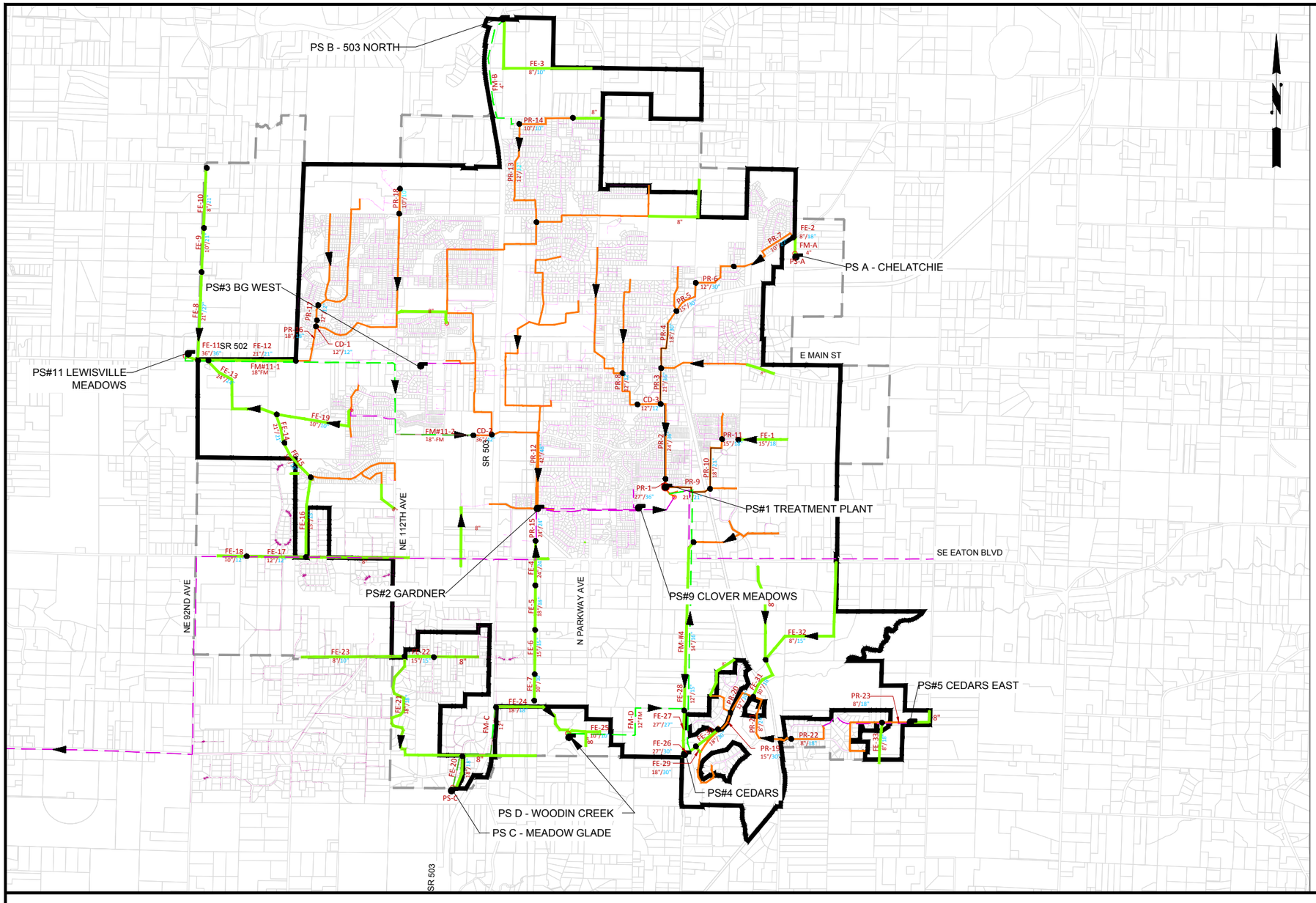
Before the transfer of service for existing CRWWD customers from the CRWWD to the City, a detailed system analysis needs to be completed and the cost implications of the transfer of service need to be addressed; including specifically the payment of City SDC’s for existing CRWWD customers. The overlapping of service areas within this region of the City is a complex issue that will require coordination between the City and the CRWWD.

7.5 Results of 2035 Hydraulic Modeling

The results of the 2035 hydraulic model are the basis for improvements within the City. Pump stations and force mains are sized for a 20-year lifecycle for electrical and mechanical components. The gravity sewers, including interceptors, trunks, laterals, and collection sewers, must be sized adequately to prevent surcharging and overflows. The 2035 model results are greatly affected by developer-related sewer extensions and the service of new developable area within the UGB.

The 20-year flow rates for the pump stations and gravity sewers are discussed below. An overview of the proposed improvements is shown in Figure 7-2. Detailed subarea specific improvements are included in Figure 7-4 through Figure 7-8.

Q:\VANCOUVER\20141\A14.0299\02\CADD\DWGS\SEWER FIGURES



LEGEND

- GRAVITY SEWER SYSTEM
- MODELED GRAVITY SEWER
- CRWWD STEP MAIN
- FUTURE SEWER EXTENSION
- CITY LIMITS
- URBAN GROWTH BOUNDARY
- FUTURE FORCE MAIN 2035
- PUMP STATION
- PIPE DIAMETER CHANGE
- TAX LOTS
- DIRECTION OF FLOW
- 20 YEAR PIPE SIZE
- XX/XX 50 YEAR PIPE SIZE

0 1500 3000
scale feet

BergerABAM

SEWER SYSTEM EXTENSION IMPROVEMENTS

City of Battle Ground
2015 General Sewer Plan, Rev. 5/17

FIGURE
7-2

7.5.1 Pump Stations and Force Mains

In general, sewer pump stations are permanent structures and include wet wells and/or drywells, valve vaults, an exterior kiosk, and miscellaneous underground infrastructure sized for 50-year flows. Mechanical and electrical equipment, including pumps, valves, and discharge piping, is sized for the estimated peak hourly flow at the 20-year planning horizon, the typical life expectancy of this equipment. The requirements for overall physical site space and easements are established by the 50-year flows so facilities can be expanded when the space needed exceeds the City's minimum standard.

The general design criteria of the City of Battle Ground for sewage pump stations and pressure sewer force mains will be applied to the design of the new pump stations. Additional guidelines set forth in Ecology's Orange Book and by the EPA and Hydraulic Institute (HI) may be followed where applicable.

At a minimum, each pump station will include two submersible pumps installed in a circular concrete wet well with pump isolation and check valves installed in a below-ground valve vault with a pump-around port. The flow meter, instrumentation, controls and telemetry equipment will be housed in weatherproof enclosures. Each pump station will include provisions for backup power and occupy a site within a dedicated easement or on property owned by the City. Additional features that may be incorporated include a maintenance building, dedicated on-site standby generator, odor and noise controls, hydrogen sulfide controls, pigging port, and force main surge protection. The need for these additional features will be determined during design and in consultation with the City. The design of each pump station will include provisions for future expansion; these include:

- setting aside sufficient space for larger pumps or a third pump and the associated pumps and piping,
- adding variable frequency drives to pump motors, and
- specifying pumps that can be upsized with replacement motors and impellers.

The general design criteria are summarized in Table 7-4.

Table 7-4. General Design Criteria for Pump Stations

Pump Type	Submersible, non-clog, capable of passing a 3-inch sphere
Minimum Number Pumps	Two
Wet Well Size	Per HI standards. 8-foot minimum diameter
Wet Well Operating Volume	Sized for six pump cycles per hour maximum
Wet Well Depth	Based on inlet sewer elevation, minimum pump submergence, and operating volume.
Discharge Pipe Size and Material	Ductile iron. Sized to maintain flow velocity between 5 and 10 feet per second (fps). A 4-inch minimum was additionally set.
Force Main Pipe Size	Sized to maintain average flow velocity between 3.5 and 5 fps (8 fps max). A 4-inch minimum standard was additionally set.
Minimum Site Footprint	50 feet by 50 feet
Provision for Backup Power	Yes

The pump station planning methodology varies depending upon the size and regional service level. Most of the City's pump stations are small or neighborhood specific pump stations. These pump stations generally were constructed to serve a specific development and have grown slightly to serve adjacent

commercial or mixed use areas. The threshold for small pump stations was determined to be approximately 350 gpm (max day).

Small pump stations and future neighborhood pump stations are sized for the full buildout of their basin. These pump stations are typically built for a specific area that is developed by a single or group of developers within the vesting period of a given development which results in near buildout of their immediate service basin.

The pump stations were evaluated using the 2035 model to determine their adequacy to meet a 20-year planning horizon. An engineering report should be prepared for each pump station improvement as it occurs to confirm its adequacy for 20 years at the time of development. The pump stations that should be sized for basin buildout are summarized in Table 7-5 with their current design capacity and the 2035 peak hour flow.

Table 7-5. 2035 Neighborhood (Small) Pump Station Evaluation

Pump Station No.	Location	Existing Design Capacity (gpm)	Recommended 2035 Peak Hour (gpm)
3	BG West	250	250
5	Cedars East	54	85
6	Industrial	235	To be abandoned
7	Country Terrace	140	To be abandoned
8	Winchester Ranch	220	To be abandoned
9	Clover Meadows	125	125
10	Horsethief Canyon	100	To be abandoned
PS-A	Chelatchie	n/a	230
PS-B	503 North	n/a	100

Larger pump stations which generally are sized greater than 350 gpm and provide service to a much broader portion of the City require additional analysis to project sizing. This analysis includes a number of factors:

- Existing max day flow rate and review of I&I.
- Proposed number of pending developments that have platted, filed for pre-application consultations, or developers who have informally approached City staff.
- Number of existing properties that could be served by sewer if extended.
- Range of growth rates depending upon likelihood of near-term development.

The pump stations were evaluated using the criteria above to determine their adequacy to meet a 20-year planning horizon. An engineering report should be prepared for each pump station improvement as it occurs to confirm its adequacy for 20 years at the time of development. The pump stations that should be sized for conservative growth and existing conditions are summarized in Table 7-6 with their current design capacity and the 2035 peak hour flow.

Higher assumed growth rates were assumed for Cedars and Lewisville Meadows basins. These basins are likely to see greater development intensity in these basins within the next 20-years. Other inflill and less intense development is still likely to occur in Gardner. On average since 1996 the city has observed growth rates average 4.9%.

Table 7-6. Regional (Large) Pump Station Evaluation

Pump Station No.	Location	Existing Design Capacity (gpm)	2015 Peak Hour (gpm)	Buildout Peak Hour (gpm)	Assumed 2035 Annual Growth Rate	Recommended 2035 Peak Hour (gpm)
1	Treatment Plant	2,700	1,436	3,782	3.5%	2,900
2	Gardner	5,200	2,123	9,723	5.0%	5,500
4	Cedars	160	254	3,487	9.0%	1,500*
11	Lewisville Meadows	1,325	647	5,311	7.0%	2,500
PS-C	Meadow Glade	n/a	n/a	993	N/A	900*
PS-D	Woodin Creek	n/a	n/a	1,402	N/A	1,000*

* Note that sizing of these pump station assumes significant contribution of flow conversion from Meadow Glade contributing from PS-C, into PS-D and ultimately to PS #4. There remains significant coordination that must be resolved prior to annexation and conversion of Meadow Glade to gravity sewers.

7.5.2 Gravity Sewers

Gravity sewers within the City are sized for the life expectancy of the sewer infrastructure. In this case, a 50-year planning horizon was identified. Ecology recommends that trunk and interceptors be evaluated based on the ultimate service area and the cost, operations, and maintenance of larger diameter sewers to determine sizing. For this reason, staff determined that a 50-year evaluation was appropriate.

A 50-year service area was identified outside the City's UGB as shown inFigure 7-3. Land use within the expanded 50-year planning area was assumed to be five residential units per acre outside the UGB.

Two pipe diameters are listed in the capital improvement plans. The 2035 pipe diameter is the size that is required to serve development within the UGB. The listed 2065 pipe diameter is the diameter that is required to serve the 50-year life expectancy of the gravity sewer mains. The different pipe sizes are provided to help developers and the City determine the appropriate pipe diameter to be installed at the time of development. Detailed subarea-specific improvements are identified in Figure 7 4 through Figure 7-8.

Q:\VANCOUVER\2014\A14.0299\02\CADD\DWGS\SEWER FIGURES

PS B 503 NORTH

PS A CHELATCHIE

PS#3

PS#11

SR 502

E MAIN ST

SR 503

NE 112TH AVE

PS#1

SE EATON BLVD

PS#2

NE 92ND AVE

N PARKWAY AVE

PS#9

PS#4 CEDARS

PS#5

PS D WOODIN CREEK

PS C MEADOW GLADE

SR 503

NE 159TH ST

LEGEND

- GRAVITY SEWER SYSTEM
- MODELED GRAVITY SEWER
- CRWWD STEP MAIN
- FUTURE IMPROVEMENTS 2035
- CITY LIMITS
- URBAN GROWTH BOUNDARY
- FORCE MAIN
- FUTURE FORCE MAIN 2035
- PUMP STATION
- FUTURE PUMP STATION 2035
- TAX LOTS
- 50 YEAR PLANNING AREA

0 1725 3450

scale feet

BergerABAM

50-YEAR PLANING AREA

City of Battle Ground
2015 General Sewer Plan, Rev. 5/17

FIGURE
7-3

7.5.2.1 Pump Station No.1 Subarea

The Pump Station No.1 subarea consists primarily of gravity interceptor improvements. This area of the City was one of the first areas of the City to receive sanitary sewer in the early 60s. Pump Station No.1 also known is the “Treatment Plant” pump station was constructed as a lift station into the City’s now abandoned and dismantled treatment plant. The main sewer trunk in this area is located within Clark Avenue. A parallel sewer was eventually constructed in this area to provide additional capacity as the City grew.

There remains significant development potential east of the Chelatchie Railroad south of Main Street and future extensions of Rasmussen Boulevard. Trunk sewer improvements are also required extending from Pump Station No.1 east to provide sufficient capacity.

Long term interceptor improvements in Clark Avenue and east through Battle Ground Village and further east along Rasmussen Boulevard are required to accommodate annexation and urban growth expansions in the northwest area of the City. The collection sewers in this subarea have sufficient capacity for infill and redevelopment.

The extent of improvements required to serve the 2035 Urban Growth Boundary UGB) are shown in Figure 7-4. The table below identifies specific improvements within this subarea. Projects are named and categorized according to whether they are existing pipe replacements (PR) or upgrades, future sewer extensions (FE), or pump station and force main (PS) projects.

Table 7-7. Pump Station No. 1 Subarea Improvements

Project Name	Description	Project Construction Costs (2015 Dollars)
PR-1	Clark Interceptor: 240 LF 27" diameter	$128,000
PR-2	Clark Interceptor: 2100 LF 24" diameter	$1,050,000
PR-3	Clark Interceptor: 960 LF 21" diameter	$461,000
PR-4	Clark Interceptor: 1,761 LF 18" diameter	$793,000
PR-5	Clark Interceptor: 1,050 LF 15" diameter	$378,000
PR-6	Clark Interceptor: 1,395 LF 12" diameter	$461,000
PR-7	Clark Interceptor: 2,113 LF 10” diameter	$656,000
CD-3	Trunk 3: 626 LF 12" diameter	$207,000
PR-8	Trunk 3: 1,253 LF 12" diameter	$414,000
PR-9	BG Village Trunk: 1367 LF 21" diameter	$657,000
PR-10	BG Village Trunk: 1611 LF 18" diameter	$725,000
PR-11	BG Village Trunk: 398 LF 15" diameter	$144,000
FE-1	BG Village Trunk: 1615 LF 15" diameter	$582,000
PS-1	Pump Station 1 – Treatment Plant, 2,900 gpm	$100,000

7.5.2.2 Chelatchie Subarea

The Chelatchie subarea is located in the far northwest of the urban growth area south of 11th Street. This small subarea is defined by two obstructions to gravity sewer service: Woodin Creek and the Chelatchie Railroad. Topography in this area slopes towards the creek. A small neighborhood pump station will be required to serve future development in this area. Improvements in this unsewered basin will require extension of collector sewers and construction of the pump station and force main. The force main is planned to discharge into the existing 8-inch gravity sewer stubbed into 11th Street.

The extent of improvements required to serve the 2035 UGB are shown in Figure 7-4. The table below identifies specific improvements within this subarea. Projects are named and categorized according to whether they are existing pipe replacements (PR) or upgrades, future sewer extensions (FE), or pump station and force main (PS) projects.

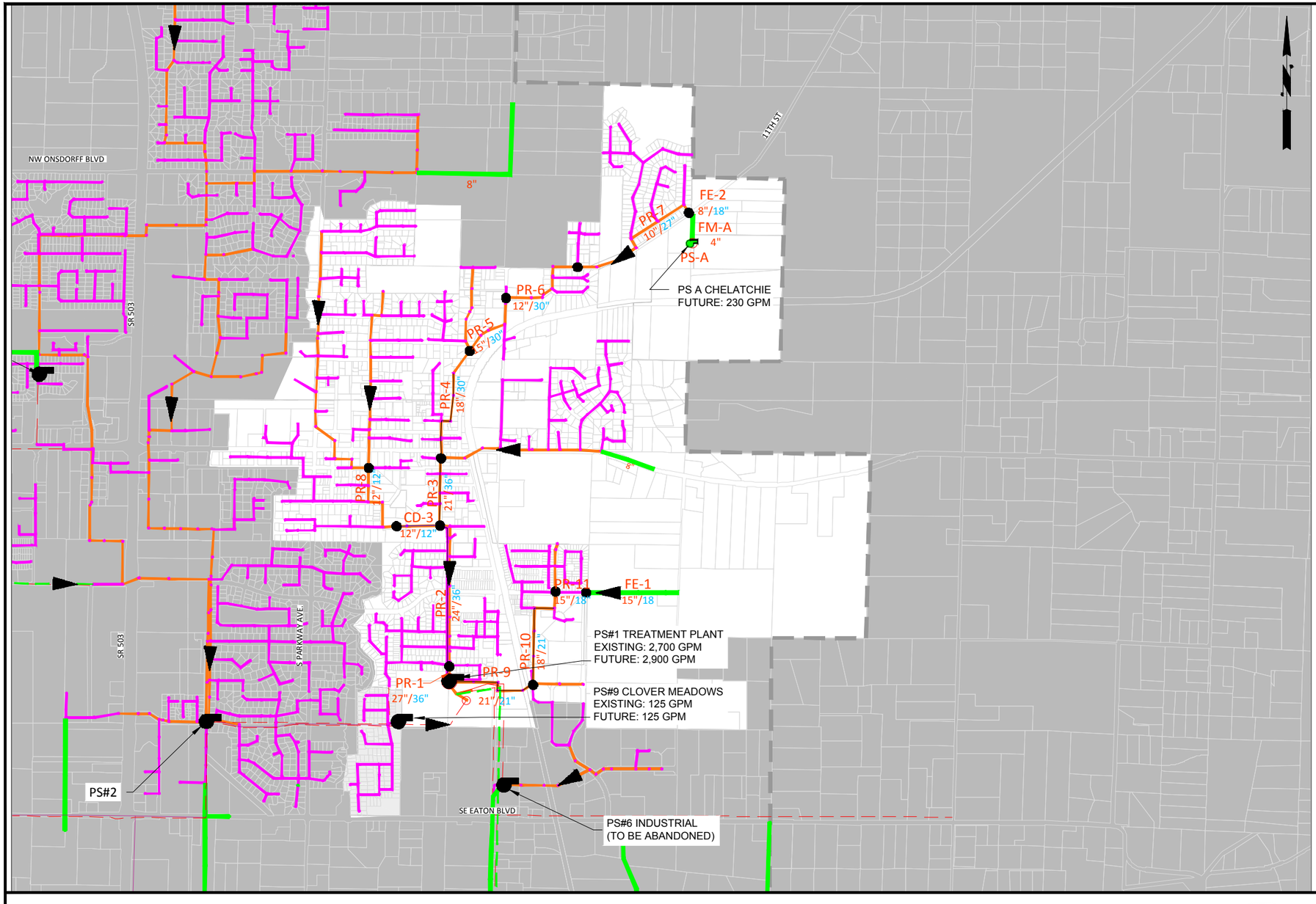
Table 7-8. Chelatchie Subarea Improvements

Project Name	Description	Project Construction Costs (2015 Dollars)
FE-2	Clark Interceptor: 78 LF 8" diameter	$ 24,000
PS-A	Pump Station A – Chelatchie Pump Station, 230 gpm	$ 300,000
FM-A	Pump Station A Force Main – 790 LF 4” diameter force main	$ 160,000

7.5.2.3 Clover Meadows Subarea

Clover Meadows subarea is a fully developed residential neighborhood located immediately west of the former surge lagoon located west of Pump Station No.1. Collection sewers in this basin have capacity for infill and minor redevelopment. Pump Station records indicate that Pump Station No.9 has sufficient capacity for the next 20-years.

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LEGEND

- GRAVITY SEWER SYSTEM
- MODELED GRAVITY SEWER
- CRWWD STEP MAIN
- FUTURE SEWER EXTENSION
- URBAN GROWTH BOUNDARY
- FORCE MAIN
- FUTURE FORCE MAIN
- EXISTING SEWER CAPACITY UPGRADE
- PUMP STATION
- FUTURE PUMP STATION
- PIPE DIAMETER CHANGE
- TAX LOTS
- DIRECTION OF FLOW
- 20 YEAR PIPE SIZE
- XX/XX 50 YEAR PIPE SIZE

IMPROVEMENT PROJECT	2035 SIZE	2065 SIZE
CD-3	12"	12"
PR-1	27"	36"
PR-2	24"	36"
PR-3	21"	36"
PR-4	18"	30"
PR-5	15"	30"
PR-6	12"	30"
PR-7	10"	27"
PR-8	12"	12"
PR-9	21"	21"
PR-10	18"	21"
PR-11	15"	18"
FE-1	15"	18"
FE-2	8"	8"
PS-A	230 GPM	
FM-A	4"	
PS #1	2,900 GPM	

0 800 1600
scale feet

BergerABAM

PUMP STATION #1, CHELATCHIE AND CLOVER MEADOWS SUBAREAS

City of Battle Ground
2015 General Sewer Plan, Rev. 12/16

FIGURE **7-4**

7.5.2.4 503 North Subarea

The 503 North subarea is currently not sewered. The subarea is located at the far north of the urban growth area and east of SR 503. This site is zoned for institution and low density urban residential. Topography in this north area of the City begins to slope towards the East Fork of the Lewis River. A small neighborhood pump station is required to serve this area. Collector sewers will need to be extended throughout the subarea. The force main from this subarea will discharge into the sewers located in NW 8th Avenue and NW 24th Street.

The extent of improvements required to serve the 2035 UGB are shown in Figure 7-5. The table below identifies specific improvements within this subarea. Projects are named and categorized according to whether they are existing pipe replacements (PR) or upgrades, future sewer extensions (FE), or pump station and force main (PS) projects.

Table 7-9. 503 North Subarea Improvements

Project Name	Description	Project Construction Costs (2015 Dollars)
FE-3	503 North Lateral: 3706 LF 8" diameter	$ 1,112,000
PS-B	Pump Station B – 503 North Pump Station, 100 gpm	$ 200,000
FM-B	Pump Station B Force Main – 3,586 LF 4” diameter force main	$ 690,000

7.5.2.5 Gardner Subarea

The Gardner subarea serves the majority of the north central part of the City. It also receives significant flows from smaller or adjacent pump stations. The Gardner subarea drains to the Gardner Pump Station which is located near Scotton Way and 5th Avenue. The Gardner Pump Station discharges directly to the transmission station and is additionally connected for emergency bypass to the transmission force main.

The sewers within the area flow into the station through a section of parallel sewers in 5th Avenue. Improvements within this basin consist primarily of pipe replacements for capacity improvements along the westside relief sewer. Additionally, this basin will receive flows from the south of Gardner Pump Station through the development of a new trunk line capable of serving the commercial and multi-use properties south along the east side of SR-503.

The extent of improvements required to serve the 2035 UGB are shown in Figure 7-5. The table below identifies specific improvements within this subarea. Projects are named and categorized according to whether they are existing pipe replacements (PR) or upgrades, future sewer extensions (FE), or pump station and force main (PS) projects.

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PS B 503 NORTH
FUTURE: 100 GPM

FE-3
8"/10"

FM-B
4"

PR-14
10"/10"

8"

PR-13
12"/12"

NW ONSDORFF BLVD

11TH ST

PS#7

SR 503

PS#11 LEWISVILLE

SR 502

PS#11

PS#3

E MAIN ST

SE GRACE AVE

PS#8

CD-2
36"/42"

PR-12
42"/48"

SR 503

PARKWAY AVE

PS#1

PS#10

PS#2 GARDNER
EXISTING: 5700 GPM
FUTURE: 5900 GPM

PR-15
24"/24"

PS#9

NE 199th ST

NE 112TH AVE

SE EATON BLVD

PS#6

FE-4
24"/24"

FE-5
18"/18"

AVE

MATCHLINE SEE FIGURE 7-7

LEGEND

- GRAVITY SEWER SYSTEM
- MODELED GRAVITY SEWER
- CRWWD STEP MAIN
- FUTURE SEWER EXTENSION
- URBAN GROWTH BOUNDARY
- FORCE MAIN
- FUTURE FORCE MAIN 2035
- PUMP STATION
- FUTURE PUMP STATION
- PIPE DIAMETER CHANGE
- DIRECTION OF FLOW
- TAX LOTS
- XX/XX — 20 YEAR PIPE SIZE / 50 YEAR PIPE SIZE

IMPROVEMENT PROJECT	2035 SIZE	2055 SIZE
CD-2	36"	42"
PR-12*	42"	48"
PR-13	12"	12"
PR-14	10"	10"
PR-15	24"	24"
FE-3	8"	10"
FE-4	24"	24"
FE-5	18"	18"
PS-B	100 GPM	
FM-B	4"	
PS #2	5,900 GPM	

* PR-12 IS APPLICABLE TO THE WESTSIDE RELIEF SEWER FROM GARDNER PS TO LIMIT OF "CD-2"

0 1000 2000
scale feet

BergerABAM

THE CITY OF BATTLE GROUND

503 NORTH AND GARDNER SUBAREAS

City of Battle Ground
2015 General Sewer Plan, Rev. 5/17

FIGURE
7-5

Table 7-10. Gardner Subarea Improvements

Project Name	Description	Project Construction Costs (2015 Dollars)
PR-12	Westside Relief Sewer: 3301 LF 42" diameter	$2,443,000
PR-13	503 North Trunk: 3264 LF 12" diameter	$1,078,000
PR-14	503 North Trunk: 1599 LF 10" diameter	$496,000
PR-15	503 South Trunk: 876 LF 24" diameter	$438,000
FE-4	503 South Trunk: 1690 LF 24 "diameter	$845,000
FE-5	503 South Trunk: 1250 LF 18" diameter	$563,000
FE-6	503 South Trunk: 1200 LF 15" diameter	$432,000
FE-7	503 South Trunk: 715 LF 10" diameter	$222,000
CD-2	Westside Discharge: 421 LF 36" diameter	$274,000
PS-2	Pump Station #2 - Gardner Pump Station, 5,500 gpm	$100,000

7.5.2.6 Lewisville Subarea

The Lewisville Subarea is generally defined as the northwest quadrant of the City. The improvement plan within the Lewisville subarea includes the abandonment of four pump stations and the construction of a single large regional pump station. This portion of the City includes large amounts of development property and will require the construction of new sewer extensions to serve the basin.

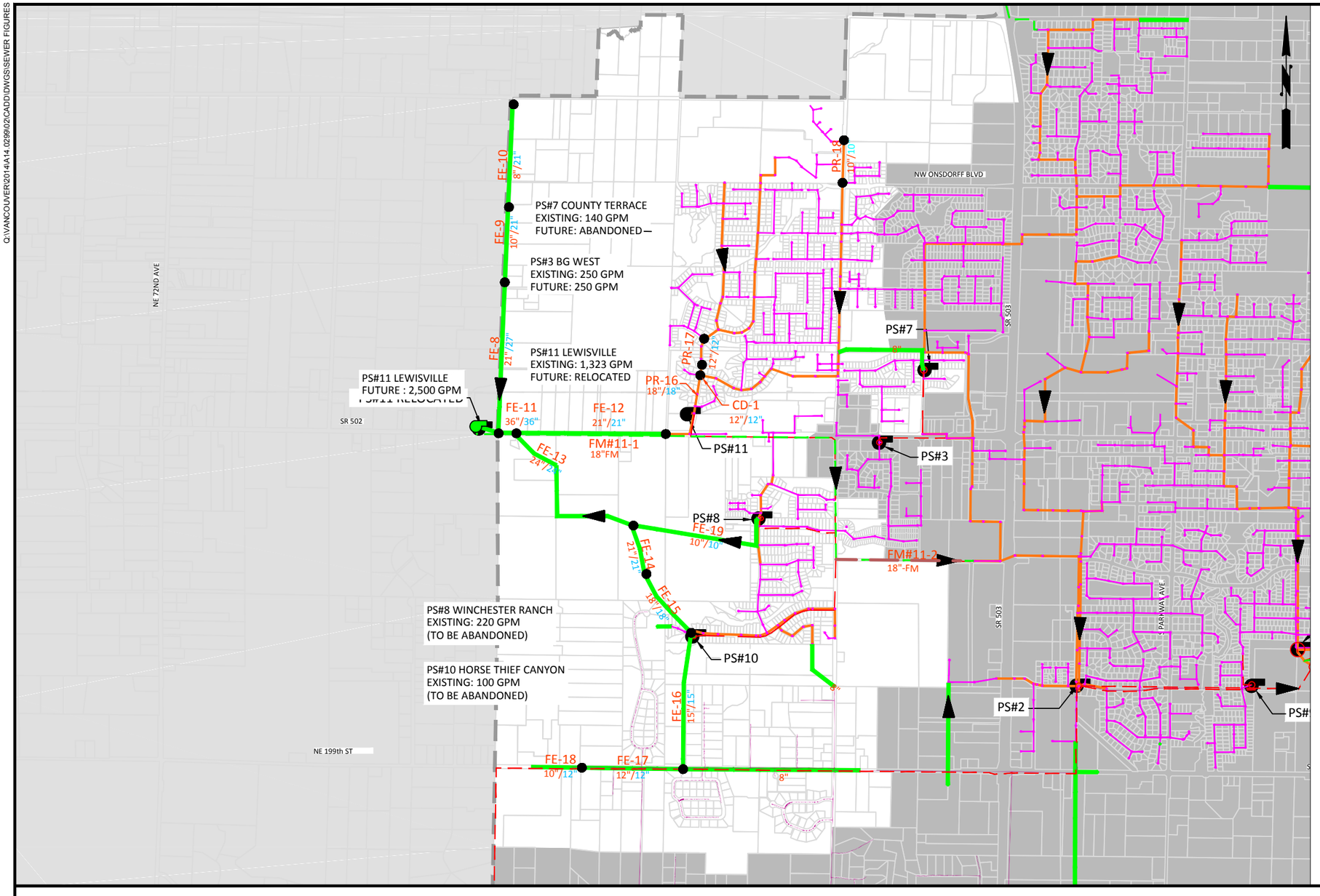
The Lewisville pump station that is to be relocated west along the SR-502 corridor is intended to serve as a major regional pump station. Eventually, (between 10 and 30-years) a new force main should be constructed south of the pump station along the NE 92nd Avenue alignment to divert the pump station flows away from Gardner and into a second transmission station located in the southwest area of the City.

The extent of improvements required to serve the 2035 UGB are shown in Figure 7-6. The table below identifies specific improvements within this subarea. Projects are named and categorized according to whether they are existing pipe replacements (PR) or upgrades, future sewer extensions (FE), or pump station and force main (PS) projects.

Table 7-11. Lewisville Subarea Improvements

Project Name	Description	Project Construction Costs (2015 Dollars)
CD-1	502 Interceptor: 168 LF 12" diameter	$56,000
PR-16	502 Interceptor: 1,322 LF 18" diameter	$595,000
PR-17	502 Interceptor: 419 LF 12" diameter	$139,000
FE-11	502 Interceptor: 247 LF 36" diameter	$161,000
FE-12	502 Interceptor: 2,342 LF 21" diameter	$1,125,000
FE-8	92nd Avenue Trunk: 2,415 LF 21" diameter	$1,160,000
FE-9	92nd Avenue Trunk: 1,200 LF 10" diameter	$372,000
FE-10	92nd Avenue Trunk: 1,600 LF 8" diameter	$480,000
FE-13	Mill Creek Trunk: 2,835 LF 24" diameter	$1,418,000
FE-14	Mill Creek Trunk: 820 LF 21" diameter	$394,000
FE-15	Mill Creek Trunk: 1,149 LF 18" diameter	$518,000
FE-16	Mill Creek Trunk: 2,158 LF 15" diameter	$777,000
FE-17	Mill Creek Trunk: 1,600 LF 12" diameter	$528,000
FE-18	Mill Creek Trunk: 800 LF 10" diameter	$248,000
PR-18	Trunk 6: 654 LF 10" diameter	$203,000
FE-19	Winchester Trunk: 2,510 LF 10" diameter	$779,000
PS #7	Pump Station #7 - Country Terrace Pump Station, abandonment	$50,000
PS #8	Pump Station #8 - Winchester Ranch, abandonment	$50,000
PS #8	Pump Station #8 - Winchester Ranch, temporary capacity upgrade	$300,000
PS #10	Pump Station #10 - Horsethief Canyon, abandonment	$50,000
PS #11	Pump Station #11 - Lewisville Pump Station, relocated 2,500 gpm	$1,250,000
FM #11-1	Pump Station #11 Force Main – 3,380 LF 18” diameter force main extension	$1,521,000
FM #11-2	Pump Station #11 Force Main – 6,328 LF 18” diameter force main replacement	$2,847,600

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LEGEND

- GRAVITY SEWER SYSTEM
- MODELED GRAVITY SEWER
- CRWWD STEP MAIN
- FUTURE SEWER EXTENSION
- URBAN GROWTH BOUNDARY
- FORCE MAIN
- FUTURE FORCE MAIN 2014
- FUTURE FORCE MAIN 2035
- PUMP STATION
- FUTURE PUMP STATION
- PIPE DIAMETER CHANGE
- TAX LOTS
- PIPE DIAMETER CHANGE
- 20 YEAR PIPE SIZE
- XX/XX
- 50 YEAR PIPE SIZE

IMPROVEMENT PROJECT	2035 SIZE	2065 SIZE
CD-1	12"	12"
PR-16	18"	18"
PR-17	12"	12"
PR-18	10"	10"
FE-8	21"	27"
FE-9	10"	21"
FE-10	8"	21"
FE-11	36"	36"
FE-12	21"	21"
FE-13	24"	24"
FE-14	21"	21"
FE-15	18"	18"
FE-16	15"	15"
FE-17	12"	12"
FE-18	10"	12"
FE-19	10"	10"
PS #7	TO BE ABANDONED	
PS #8	TO BE ABANDONED	
PS #10	TO BE ABANDONED	
PS #11	2,500 GPM	
FM 11-1	18"	
FM 11-2	18"	

0 800 1600
scale feet

BergerABAM

LEWISVILLE SUBAREA

City of Battle Ground
2015 General Sewer Plan, Rev. 5/17

FIGURE
7-6

7.5.2.7 Meadow Glade Subarea

This area of Meadow Glade is particularly difficult to extend conventional gravity sewer service through. Large portions of the subarea is developed and currently served with STEP systems provided through CRWWD. This area lying west of SR-503 is also scattered with wetlands and largely without gridded street systems making sewerage using gravity sewer costly. Additional coordination with CRWWD is necessary to derive a strategy prior to any conversion or extension of sewer service in this area is completed. The intent of the sewer plan in this area is to intercept existing STEP mains with gravity sewer and direct those flows to a conventional City owned pump station.

Long term as development trends southwest the City should build a large regional transmission main pump station to collect Meadow Glade flows, and Lewisville and pump those directly into the transmission main. Improvements within this subarea consist of a pump station located at the furthest south urban growth boundary and gravity sewers along the south and west boundaries to serve the developable parcels.

The extent of improvements required to serve the 2035 UGB are shown in Figure 7-7. The table below identifies specific improvements within this subarea. Projects are named and categorized according to whether they are existing pipe replacements (PR) or upgrades, future sewer extensions (FE), or pump station and force main (PS) projects.

Table 7-12. Meadow Glade Subarea Improvements

Project Name	Description	Project Construction Costs (2015 Dollars)
FE-20	Meadow Glade Trunk: 1,050 LF 18" diameter	$473,000
FE-21	Meadow Glade Trunk: 4,972 LF 18" diameter	$2,238,000
FE-22	Meadow Glade Trunk: 800 LF 15" diameter	$288,000
FE-23	Meadow Glade Trunk: 2,850 LF 8" diameter	$855,000
PS-C	Pump Station C - Meadow Glade Pump Station, 900 gpm	$350,000
FM-C	Pump Station C Forcemain – 3,036 LF 12” diameter force main	$910,800

7.5.2.8 Woodin Creek Subarea

Located in the south central portion of the UGB this subarea is one of the smallest. The Woodin Creek subarea is a small area of largely developed residential properties along NE 184th Street and 181st Street. This subarea is a crucial link for the future development of the Meadow Glade Area. The Meadow Glade force main discharges into the future gravity sewer in 184th and all sewer flows are pumped again at the proposed Woodin Creek Pump Station for eventual discharge further east at Cedars Pump Station.

Development in this basin will require the construction of the Woodin Creek Pump Station located near the intersection of Woodin Creek and NE 181st Street. The force main will travel east through private property to NE 142nd Avenue. It is additionally recommended that the force main be upsized to allow for reversible flows from Cedars eventually west to the future regional transmission station located in the southwest portion of the City.

The extent of improvements required to serve the 2035 Urban Growth Boundary are shown in Figure 7-7. The table below identifies specific improvements within this subarea. Projects are named and categorized according to whether they are existing pipe replacements (PR) or upgrades, future sewer extensions (FE), or pump station and force main (PS) projects.

Q:\VANCOUVER\2014\A14.0299\02\CADD\DWGS\SEWER FIGURES

PS#8
PS#10
PS#1
PS#9
PS#2
PS#6
PS#4
199th ST
NE 179TH ST
SR 503
PARKWAY AVE.
SE EATON BLVD
GARDENER BASIN
MEADOW GLADE BASIN
MEADOW GLADE BASIN
MATCHLINE SEE FIGURE 7-5
FE-5 18"/18"
FE-6 15"/15"
FE-7 10"/10"
FE-23 8"/10"
FE-22 15"/15"
8"
FE-21 18"/18"
GARDENER BASIN MEADOW GLADE BASIN
FE-24 18"/18"
GARDENER BASIN WOODIN CREEK BASIN
FE-25 10"/10"
8"
FM-C 12"
FM-D 12"FM
FE-20 18"/18"
8"
PS-C
TRANSMISSION FORCEMAIN
PS C MEADOW GLADE FUTURE 900 GPM
PS D WOODIN CREEK FUTURE 1000 GPM

LEGEND

- GRAVITY SEWER SYSTEM
- MODELED GRAVITY SEWER
- CRWWD STEP MAIN
- FUTURE SEWER EXTENSION
- URBAN GROWTH BOUNDARY
- EXISTING SEWER CAPACITY UPGRADE
- FORCE MAIN
- FUTURE FORCE MAIN 2035
- PUMP STATION
- FUTURE PUMP STATION
- DIAMETER CHANGE
- TAX LOTS
- DIRECTION OF FLOW

IMPROVEMENT PROJECT	2035 SIZE	2065 SIZE
FE-5	18"	18"
FE-6	15"	15"
FE-7	10"	10"
FE-20	18"	18"
FE-21	18"	18"
FE-22	15"	15"
FE-23	8"	10"
FE-24	18"	18"
FE-25	10"	10"
PS-C	900 GPM	
PS-D	1,000 GPM	
FM-C	12"	
FM-D	12"	

0 800 1600
scale feet

BergerABAM

MEADOW GLADE AND WOODIN CREEK SUBAREAS

City of Battle Ground
2015 General Sewer Plan, Rev. 3/17

FIGURE
7-7

Table 7-13. Woodin Creek Subarea Improvements

Project Name	Description	Project Construction Costs (2015 Dollars)
FE-24	Woodin Creek Trunk: 2,400 LF 18" diameter	$1,080,000
FE-25	Woodin Creek Trunk: 890 LF 10" diameter	$276,000
PS-D	Pump Station D Woodin Creek, 1,000 gpm	$ 750,000
FM-D	Pump Station D Forcemain – 3,909 LF 12” diameter force main	$ 1,290,000

7.5.2.9 Cedars Subarea Improvements

Cedars subarea is located in the southeast corner of the Urban Growth Boundary. This area of the City has a few potential developments already underway and other properties interested at possible development. Originally constructed as part of a golf course community in unincorporated Clark County, the pump station and conveyance system did not consider future surrounding urban development.

Development within this subarea includes the abandonment of Pump Station No.6 Industrial and centrally located flows from the southeast portion of the city at a regional pump station to be located near the intersection of NE 142nd Avenue and Salmon Creek. Additionally, since Salmon Creek is the definitive drainage in this area long term urban growth expansions can also be served through gravity sewers in this areas.

The extent of improvements required to serve the 2035 Urban Growth Boundary are shown in Figure 7-8. The table below identifies specific improvements within this subarea. Projects are named and categorized according to whether they are existing pipe replacements (PR) or upgrades, future sewer extensions (FE), or pump station and force main (PS) projects.

Table 7-14. Cedars Subarea Improvements

Project Name	Description	Project Construction Costs (2015 Dollars)
FE-26	Grace Interceptor: 250 LF 27" diameter	$133,000
FE-27	Grace Interceptor: 1,200 LF 27" diameter	$636,000
FE-28	Grace Interceptor: 4,600 LF 12" diameter	$1,518,000
PR-19	Cedars Interceptor: 608 LF 15" diameter	$219,000
PR-20	Cedars Interceptor: 903 LF 12" diameter	$298,000
PR-21	Cedars Interceptor: 2192 LF 8" diameter	$658,000
PR-22	Cedars Interceptor: 1,231 LF 8" diameter	$370,000
FE-29	Cedars Interceptor: 300 LF 18" diameter	$135,000
FE-30	Cedars Interceptor: 750 LF 18" diameter	$338,000
PR-23	Cedars East Trunk: 760 LF 8" diameter	$228,000
FE-33	Cedars East Trunk: 1,475 LF 8" diameter	$443,000
FE-31	Airpark Trunk: 1298 LF 10" diameter	$403,000
FE-32	Airpark Trunk: 4,140 LF 8" diameter	$1,242,000
PS #4	Pump Station #4 – Cedars:1,500 gpm	$ 900,000
FM #4	Pump Station #4 Forcemain – 5,320 LF 14” diameter force main	$ 1,870,000

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SR 503

NE 112TH AVE

N PARKWAY AVE

SE EATON BLVD

PS#1

PS#2

PS#9 CLOVER MEADOWS

PS#6 INDUSTRIAL
(TO BE ABANDONED)

FM-#4
14"/16"

8"

FE-32
8"/15"

FE-31
10"/18"

FE-28
12"/15"

PR-20
12"/30"

PR-21
8"/24"

FM-D
12"FM

FE-27
27"/27"

FE-30
18"/30"

FE-26
27"/30"

FE-29
18"/30"

PR-19
15"/30"

PR-22
8"/18"

PR-23
8"/18"

FE-33
8"/18"

8"

PS#5 CEDARS EAST
EXISTING: 54 GPM
FUTURE: 85 GPM

PS C MEADOW GLADE
FUTURE 900 GPM

PS D WOODIN CREEK
FUTURE 1,000 GPM

PS#4 CEDARS
(TO BE RELOCATED)
EXISTING: 160 GPM
FUTURE: 1,500 GPM

LEGEND

- GRAVITY SEWER SYSTEM
- MODELED GRAVITY SEWER
- CRWWD STEP MAIN
- FUTURE SEWER EXTENSION
- URBAN GROWTH BOUNDARY
- FORCE MAIN
- FUTURE FORCE MAIN 2014
- FUTURE FORCE MAIN 2035
- PUMP STATION
- FUTURE PUMP STATION
- PIPE DIAMETER CHANGE
- TAX LOTS
- DIRECTION OF FLOW
- XX/XX 20 YEAR PIPE SIZE / 50 YEAR PIPE SIZE

IMPROVEMENT PROJECT	2035 SIZE	2065 SIZE
PR-19	15"	30"
PR-20	12"	30"
PR-21	8"	24"
PR-22	8"	18"
PR-23	8"	18"
FE-26	27"	30"
FE-27	27"	27"
FE-28	12"	15"
FE-29	18"	30"
FE-30	18"	30"
FE-31	10"	18"
FE-32	8"	15"
FE-33	8"	18"
PS #4	1,500 GPM	
PS #5	85 GPM	
FM #4	14"	16"

0 800 1600
scale feet

BergerABAM

CEDARS AND CEDARS EAST SUBAREAS

City of Battle Ground
2015 General Sewer Plan, Rev. 4/17

FIGURE
7-8

7.5.2.10 Cedars East Subarea

The cedars east subarea is largely a built-out neighborhood developed in unincorporated Clark County east of the Cedars golf course. The development includes a small pump station location at the east end of 183rd Street. The Urban Growth boundary constricts expansion and redevelopment in this area to a few isolated parcels. The large open space in this area is part of the Legacy Land Program and will not be redeveloped. The Cedars East pump station is currently planned for redevelopment in Summer 2017 to address aging mechanical and electrical equipment.

7.5.3 Maintenance-Related Improvements

Over the course of completing the system assessment and planning for expansions a few maintenance related recommendations were developed. The following list is intended to provide a basis for future maintenance related activities for the City.

System wide television/condition assessment: The City should develop a condition assessment program that schedules each area of the City to be inspected through closed circuit television at a minimum every 6 or 7 years to correspond with the planning windows and updates to the General Sewer Plan. The results of the condition assessment, if performed in accordance with NAASCO standards can better inform I&I reduction work and reduce system emergency maintenance.

1. On-going I&I reduction programs: These programs within the City have shown dramatic decreases in I&I and have allowed for better utilization of existing infrastructure. Some of the long-term pipe capacity issues may be resolved with extensive I&I reduction programs. Because of the cross connections and expected leaky laterals, this program is best used in areas where the condition assessment above indicates significant levels of I&I.
2. It is recommended that the City begin I&I related work in the BG West basin which appears to have significant levels of I&I. Additionally, known areas of stormwater cross connections should be disconnected from the sewer system and re-routed appropriately.
3. Telemetry Replacement: Telemetry improvements to allow operators and engineers to monitor systems in real time and with greater accuracy will allow the City to respond to maintenance or capacity problems at its lift stations faster. Better data can also drive decisions for scheduling upgrades, and I&I projects. Additionally, using ultrasonic flow meters on the gravity inlet pipes can better inform future updates with peak 15-minute data rather than maximum day data. This change in modeling protocol will likely reduce some of the conservatism but also reduce capital improvement costs.

8. REGIONAL AND TREATMENT FACILITY ASSESSMENT

8.1 Transmission System

8.1.1 Pumping Facilities

The existing transmission pumping facilities are described in detail in section 4.4.1. The evaluation of existing capacities, existing observed flows, and the 2035 flows is presented inTable 8-1.

Table 8-1. Transmission Pumping Evaluation

	Existing Design Capacity	2015 Max Day	2015 Max Month	2035 Max Day	2035 Max Month
Transmission Station Pumping Facilities (total influent)	4.6 mgd	5.4 mgd	3.0 mgd	12.8	7.1
Battle Ground (influent)	-	4.8 mgd	2.7 mgd	11.7 mgd	6.8 mgd

The 2015 modeled max day is considered to be accurate to reflect existing max day conditions. The model is calibrated to the max day in 2015.

Maximum day values were selected for the basis of analysis of the transmission pumping facilities as a result of 4.15 million gallons of equalization basin storage available as part of the transmission pump station.

The combined capacity of both grinders in the headworks is 7.0 mgd. They are located upstream of the equalization basin and therefore need to have capacity for the peak hour flows.

The 2035 max day flowrate was determined using 260 gpcd planning standard and an equivalent population of 45,060 people or 17,398 EDUs. The 2035 comprehensive plan uses a 2035 population of 39,309 as assigned by the Office of Financial Management. The rate of commercial and industrial growth was assumed to grow at an annual growth rate of 3.0 percent.

The overall growth of the transmission flow rates from a 2015 maximum day of 4.85 to a 2035 flow of 11.72 corresponds to the city adding approximately 506 EDUs per year for 20-years. Historically (1996-2015) the City has added an average of 227 EDUs per year. As a result of this discrepancy it is important to monitor EDU growth, actual effluent flows and storage capacity use of the transmission station prior to proceeding with major capacity related improvements.

The maximum day influent flow rates have already exceeded the effluent pumping capacity of the transmission station. This occurred in 2015 with a maximum influent flow rate (combined Battle Ground, Meadow Glad, and Hockinson) of 5.4 mgd. For two consecutive days in 2015 the influent capacity exceeded the rated pumping capacity. Over the course of the two days approximately 900,000 gallons were stored in the equalization basin. The combined storage and pumping volume available for a max day event is 8.75 million gallons.

The Distrct completed an additional modeling analysis of the transmission pump station and long-term growth trends with a planning year of 2036. The analysis used the 2036 planning standard consistent with the Comprehensive Planning values for population growth and a more realistic growth using the historical

average of 250 ERU's per year while maintaining a 3% annual growth rate for commercial and industrial flows. The following table summarizes the model input and alternative used for the Districts 2036 modeling.

Table 8-2. 2036 Transmission Pump Station Model Inputs

Parameter	2036-GMA	2036-Alternative
Hockinson		
ERUs[1]	80	80
Equiv. Population	245	245
Max Day I&I	529 GPAD	529 GPAD
Battle Ground		
Residential ERUs[2]	15,615	11,289
Residential Population	40,443	29,239
Commercial/Industrial ERUs	2,288	2,288
I&I (Max Day)	1,072 GPAD	1,072 GPAD
I&I (Multi-Day)	954 GPAD	954 GPAD

1. ERUs for Hockinson and District are calculated using 3.05 persons per ERU
2. ERUs for Battle Ground are calculated using 2.59 person per ERU

The transmission station was modeled assuming the implemtnation of the planned updgrade to the equalization basin for a total storage of 5.0 mgd and pumping capacity to 8.0 mgd. It is recommended that engineering and construction of this project begin when max day influent flows reach 6.6 mgd.

The max day model indicated that the the peak hour flow rate is the firm rated capacity of the pump station. This occurs because, in either of the 2036 scenarios evaluated, the influent flow exceeds the capacity of the transmission station. The excess flow is then stored in the equalization basin. Using the 2036 GMA planning values, the total volume stored totals 80 percent of the rated capacity. Using the alternate planning data, the total volume stored totals 57 percent of the rated capacity. In either scenario, the pump discharge was modeled at 12.47 cubic feet per second or approximately 8.0 MGD.

With the alternative (lesser) planning data, the multiday I&I factor, and a full 48-hour timestep, the transmission pump station operates as designed and is capable of storing 559,466 cubic feet of wastewater. The total capacity of the transmission pump station and equalization basin was reached at hour 39 of the 48-hour simulation using the full GMA population and multiday I&I factor, meaning that the firm capacity of the pump station would need to be increased to a minimum 8.8 MGD. Under the most aggressive planning assumptions, a firm capacity of 10.0 MGD would be sufficient for a three-day event consistent with the storm of December 2015.

Table 8-3. Battle Ground Flow Summary

Year	Total UGB Population	Connected* (Sewered)			Battle Ground (city only in mgd)				
		Equivalent Residential Units			Annual Average Daily	Average Dry Weather	Average Wet Weather	Max Month	Max Day
		Residential	Comm/Ind	Total					
2014	20,163	5,834	1,197	7,031	1.82	1.27	2.37	2.73	4.73
2015	21,075	6,039	1,230	7,269	1.88	1.32	2.45	2.82	4.89
2016	21,986	6,495	1,266	7,761	2.01	1.41	2.61	3.02	5.23
2017	22,898	6,951	1,304	8,255	2.14	1.50	2.78	3.21	5.56
2018	23,810	7,407	1,344	8,751	2.27	1.59	2.95	3.40	5.89
2019	24,722	7,863	1,384	9,247	2.39	1.68	3.11	3.59	6.23
2020	25,633	8,319	1,425	9,744	2.52	1.77	3.28	3.79	6.56
2021	26,545	8,775	1,468	10,243	2.65	1.86	3.45	3.98	6.90
2022	27,457	9,231	1,512	10,743	2.78	1.95	3.62	4.17	7.23
2023	28,368	9,687	1,558	11,245	2.91	2.04	3.79	4.37	7.57
2024	29,280	10,143	1,604	11,747	3.04	2.13	3.96	4.56	7.91
2025	30,192	10,599	1,652	12,251	3.17	2.22	4.13	4.76	8.25
2026	31,104	11,055	1,702	12,757	3.30	2.31	4.30	4.96	8.59
2027	32,015	11,511	1,753	13,264	3.44	2.40	4.47	5.15	8.93
2028	32,927	11,967	1,806	13,773	3.57	2.50	4.64	5.35	9.27
2029	33,839	12,423	1,860	14,283	3.70	2.59	4.81	5.55	9.62
2030	34,750	12,879	1,916	14,795	3.83	2.68	4.98	5.75	9.96
2031	35,662	13,335	1,973	15,308	3.96	2.78	5.15	5.95	10.31
2032	36,574	13,791	2,032	15,823	4.10	2.87	5.33	6.15	10.66
2033	37,486	14,247	2,093	16,340	4.23	2.96	5.50	6.35	11.00
2034	38,397	14,703	2,156	16,859	4.37	3.06	5.68	6.55	11.35
2035	39,309	15,177	2,221	17,398	4.51	3.15	5.86	6.76	11.72

8.1.2 Transmission Force Main

A detailed description of the 16-inch transmission force main that conveys wastewater from the Battle Ground pumping facility to the CRWWD Alliance interceptor sewer system is included in section 4.4.2.

The force main is sized for max day flows from the upstream transmission pump station. The flow rates for the pump station are included in section 8.1.1. The evaluation of the existing capacity, existing observed flows, and the 2035 flows are presented in Table 8-4. The formation agreement with the Alliance allocates specific capacities between CRWWD and the City of Battle Ground. The City has an allocated 3.44 mgd (max month) of force main capacity.

Table 8-4. Transmission Force Main Evaluation

	Existing Design Capacity	2015 Max Day	2015 Max Month	2035 Max Day	2035 Max Month
Transmission Station Pumping Facilities (total influent)	4.6 mgd	5.4 mgd	3.0 mgd	12.8 mgd	7.1 mgd
Battle Ground (influent)	3.44-mgd	4.8 mgd	2.7 mgd	11.7 mgd	6.8 mgd

Current capital improvement plans include the upgrade of the transmission force main with a parallel line extending from the discharge of the force main to the transmission pump station. The location of the transmission main is shown in Figure 8-1.

The force main system including the odor control is owned by the Alliance and specifics related to the upgrade are planned for by the Alliance.

8.1.3 Transmission Station and Force Main Expansions

With the equalization basin expansion to 5.0 mgd and pumping system improvement to 8.0 mgd as described above the existing transmission system will have max day capacity until approximately 2026. Similar to treatment plant capacity, Ecology recommends that municipalities address significant capacity concerns when flows approach 85 percent of the maximum rated capacity. The system is estimated to approach this threshold in 2023.

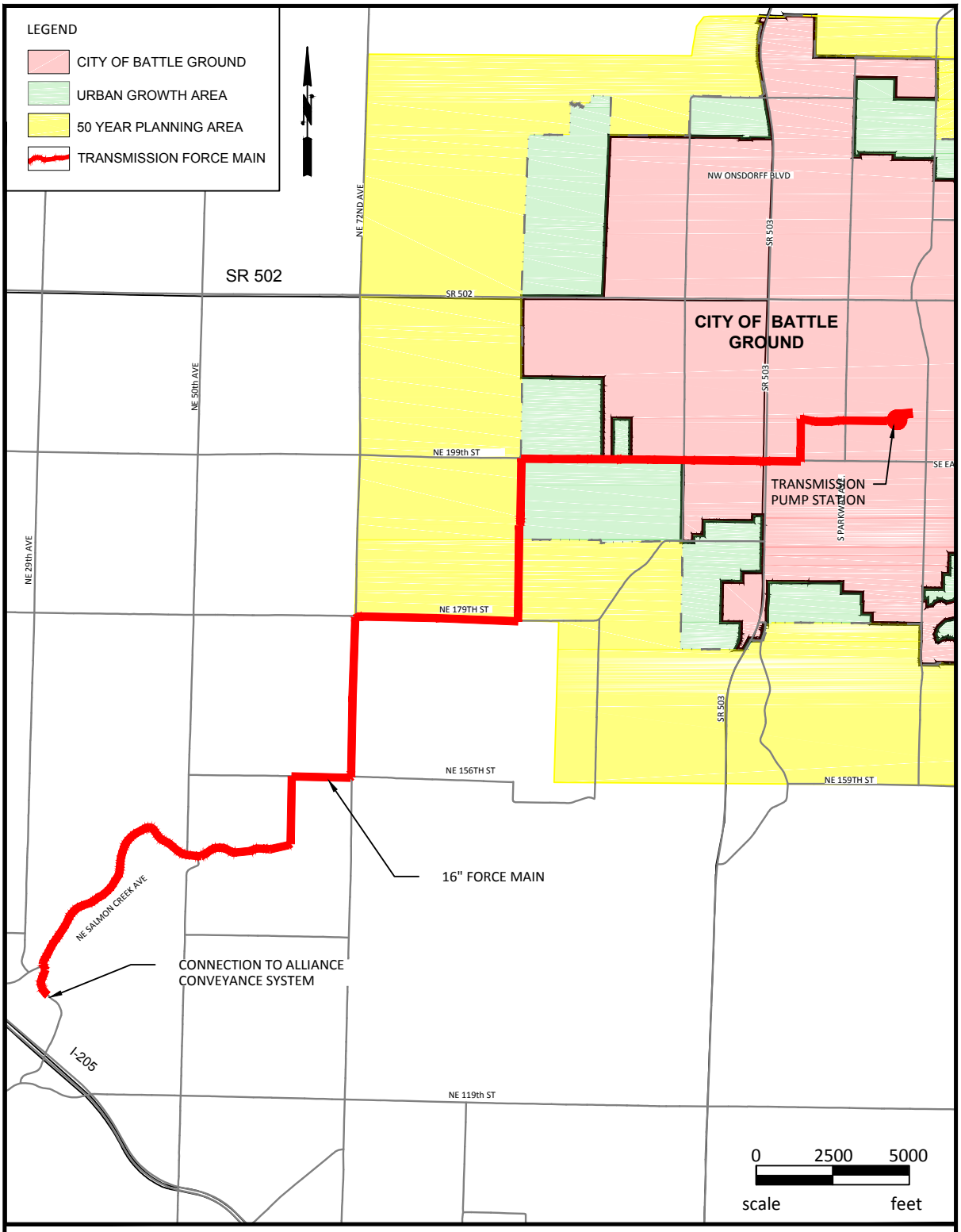
The Alliance should begin detailed planning and engineering of either of the major improvements above within the 20-year planning horizon. Planning and engineering dollars have been included in the SDC calculations.

8.2 Regional System

As discussed in section 4.4, the City discharges its wastewater from the McClure Pump Station to the Alliance's 16-inch force main, which discharges to the Salmon Creek interceptor where it is conveyed to the SCWTP for treatment and disposal.

Sewer planning related to the regional system is being completed by the CRWWD and the Alliance. Current agreements between these agencies and the City address regional conveyance and treatment of Battle Ground wastewater. With the completion of Phase 4 improvements to the SCWTP, the City capacity (in max month) allocation in the regional facilities is as follows:

- Battle Ground Force Main system capacity of 3.44 mgd
- Salmon Creek Interceptor system capacity of 10.1 mgd
- Klineline Pump Station capacity of 4.47 mgd
- Klineline Force Main capacity of 6.30 mgd
- Treatment / outfall capacity of 3.47 mgd



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THE CITY OF BATTLE GROUND

TRANSMISSION FORCEMAIN ALIGNMENT

City of Battle Ground
2015 General Sewer Plan

FIGURE
8-1

9. CAPITAL IMPROVEMENT PROGRAM

The CIP described below is divided into two sections. The first section is intended to cover the costs and program that will be completed principally by the City. This program includes improvements to existing capacity-related deficiencies, maintenance activities, and restoration and replacement projects. The second section addresses the projects and costs related to the expansion of the sewer service area. These developer-related extensions are chiefly the obligation of the developer with the exception of project components that are related to the City's SDCs.

The basis for the costs identified below is summarized in Section 9.3.

9.1 Six-Year Capital Improvement Program

The City's Public Works Department maintains a detailed 6-year capital improvement program. The program includes upgrades and activities to the existing system necessitated by capacity deficiencies, required maintenance, or the restoration and replacement program. The implementation schedule and timing of projects is based on the actual growth rate observed. The 6-year Capital Improvement Program is available for review at the City offices.

Because of uncertainties regarding potential additional maintenance or defect propagation, we recommend that the City put a routine program in place to perform CCTV of the sewer system.

The six-year capital improvement program should be updated annually as additional data becomes available about the existing facilities. Each year it is recommended that the City invest at a minimum the following to maintain existing sanitary sewer services.

Table 9-1. Recommended Capital Improvement Program Components

Description	Annual Costs (2015 Dollars)
Sewer Main Oversizing	$ 200,000/ Yr
Small Project Allowance	$ 25,000 / Yr
I&I Replacement and Rehabilitaton Projects	$ 300,000/ Yr
City Funded Sewer Extensions	$ 75,000/ Yr
Replacement and Repair	$ 50,000/ Yr
Transmission Station Improvements	$ 100,000/ Yr

9.2 Sewer Extensions into Undeveloped Basins

Improvements to the existing system and developer-related extensions are summarized in Figure 7-2. These projects are identified by their project type; primarily by pipe replacement (PR), or future extension (FE). A schedule for the development of sewer extensions is not provided, as the basis for these improvements is market and developer driven. Due to uncertainties regarding the time it will take for development to occur, we recommend close monitoring of the growth in the various basins.

9.3 Basis of Opinions of Probable Costs

The projects were selected in consultation with City staff and represent individual lift station packages and trunk sewer segments.

Basic planning-level assumptions were built into the cost estimates. The 50-year pipe sizes and 20-year pipe sizes are indicated separately in the sub-area figures, where applicable. The 50-year pipe diameters

were used in the basis of cost and for the underground components of pump stations. Twenty-year flows were used as the basis of cost for the pump station electrical and mechanical components.

Preliminary cost estimates generally wrap additional costs of construction and contingency into each bid item. Detailed cost estimates cannot be produced until connection details, specific site constraints, and construction methods can be determined. As a result, preliminary cost estimates make extensive use of assumptions:

- Mobilization, demobilization, insurance, and other non-specified items for complete construction installation are assumed to be 10 percent of remaining project cost.
- Construction staking, erosion and sediment control, and habitat restoration are all assumed values.
- Pavement restoration assumes that no new road networks will be built prior to sanitary sewer construction. Quantity assumes a 12-foot-wide, full-lane replacement with 6 inches of hot mix asphalt pavement.
- Shoring is assumed to be approximately $2 per foot of sanitary sewer.
- Traffic control is assumed to be approximately $5 per foot of roadway alignment.
- Manhole costs are assumed to increase $1,500 for each additional 4 feet of depth.
- Sanitary sewer construction costs are assumed to increase $30 a foot for each 4 feet of depth beyond depths of 12 feet.
- Force main construction is assumed to be constructed at minimum bury of 30 to 36 inches of cover.
- Acquisition and costs related to property and easements were included in the cost estimate for each relocated or new pump station assuming a 2,500 square foot footprint. Trunk sewer or off-site easements are assumed to be dedicated by the developer.
- Pump station site preparation, including grading, is included in the cost estimates.
- Pump station equipment is assumed to match City standards.
- Odor control is omitted at pump stations larger than 1,000 gpm and included at all other pump stations.
- Backup power generators are included at all pump stations.

10. FINANCIAL IMPLICATIONS

10.1 Introductions

The implementation of the general sewer plan depends on a number of factors: rate of growth and associated management policies, costs of improvements, method of financing, and regulator input. Of these, funding is the primary factor under the control of the City, and is thus the focus of discussion in this section of the plan.

10.2 Institutional Responsibilities

The City owns and operates the collection system serving the area within the Battle Ground UGB and the wastewater transmission pump station. The City has sole responsibility for the operation, maintenance, and improvement activities associated with the collection system and transmission pump station. It is logical to assume that the City will continue to own and be responsible for the sewer system and its growth throughout the 20-year planning period.

The Alliance, is responsible for operating the transmission force main and downstream conveyance and wastewater treatment facilities. Additionally, the Alliance is the owner/operator of the Bioxide chemical dosing facility located at the transmission pump station.

Monthly sewer service charges and sewer connection fees are established and collected by the City and include a regional component for the facilities owned and operated by the Alliance.

10.3 Funding Options for Capital Improvements

Funding issues regarding the City's sewerage facilities have historically been addressed in an independent rate study. Connection fees have been used to fund new capital improvements that increase system capacity, while monthly rate revenues have been used to fund operation and maintenance costs. While this funding structure will likely continue, additional funding options are summarized in the following paragraphs.

10.3.1 Existing Capacity Deficiencies and Pump Station Maintenance

The sewer plan modeling effort and flow monitoring identified a single capacity deficient upgrade that may not be necessitated by developer-related sewer extensions. Funding for these improvements had historically been considered part of the sewer rates. We recommend completing an independent rate study to identify the effect upon sewer rates that would result from the improvements identified in this plan.

10.3.2 Developer Related Capital Improvements.

Currently, Battle Ground finances capital improvements associated with capacity expansion with revenue from system development charges (SDCs). This general sewer plan, once adopted, will be the basis for a revised calculation of the SDCs based on the capital facilities plan component of the comprehensive plan.

The current SDC collected by the City is $8,854 per EDU. This amount was calculated in consulatation with FCS group in consideration of costs for system improvements (both within the City and the City’s proportionate share of costs with the Alliance) necessitated by development and system expansion.

Battle Ground previously collected an SDC from Hockinson, but not from Meadow Glade. This rate structure was recently revised so that no SDC is charged to either user; however, a usage rate was implemented as a capital and maintenance charge for the wastewater transmission facilities. This rate is

billed at $0.50 per 100 cubic feet, which is billed directly to CRWWD for both Hockinson and Meadow Glade.

Although Battle Ground currently relies completely upon SDC financing to fund capacity-related capital improvements, we suggest that consideration be given to local improvement district (LID) financing for improvements associated with gravity sewer extensions down drainage ways. LID financing may be the best option for these sewers because it could avoid the cost of interim pump stations. As it stands, a vacant parcel in the basin served by the proposed sewer has three options: (1) wait until sufficient demand in the basin develops to join with others and implement developer financing to complete the sewer; (2) construct an interim pump station and the upstream sewer segment needed for that particular parcel; or (3) wait until the City generates the funds to construct the entire sewer. Given the lengthy time associated with obtaining easements and related environmental permits for sewers down these drainage ways, significant challenges are associated with each option. LID financing would avoid many of these challenges.

10.4 Financing System Operation and Maintenance

Current monthly charges are $34.00 per EDU with an additional charge of $1.30 per 100 cubic feet of water consumption.

Wastewater flows from Hockinson and Meadow Glade are discharged to Battle Ground for transmission to the Salmon Creek wastewater management system. As previously discussed, CRWWD is billed monthly at a flat rate of $0.50 per 100 cubic feet based on monthly flow meter recordings.

Battle Ground relies on periodic studies to determine the adequacy of rates. Current revenue is adequate to cover operating expenses and depreciation. Periodic updates will continue in order to provide the revenue necessary to cover increases in operating costs.

10.5 Effect of Capital Improvement Plan on System Development Charges

The planned population growth within the next 20-years is estimated to be approximately 19,146 people. At 2.59 people per EDU, the resulting growth in EDUs alone is 7,392 EDUs. SDCs for the improvements are based upon the total capital cost of improvements that are SDC eligible and the total number of SDCs to be added within the next 20-years. A detailed summary of capital improvement projects is included in Section 9. The City maintains a detailed project list that contains the projects that have been determined to be SDC creditable.

The City will review the SDC creditble project list annually as part of the revolving annual update to the 6-year Capital Improvement Plan. The SDC rate will be adjusted if necessary through action by the City Council. It is recommended that a full financial rate analysis be completed to derive actual SDC rates prior to Council action related to modifications of the SDC rate.

11. ENVIRONMENTAL ASSESSMENT

11.1 General

The implementation of the general sewer plan would have the potential to result in temporary and short-term environmental effects related to construction activities. These would be expected to involve heavy construction equipment, earth-moving activities (excavation and fill), pipe laying, and above-ground construction activities related to the pump stations. During operation, the general sewer plan would result in increased wastewater flows to the existing collection system and the SCWTP, which discharges treated wastewater to the Columbia River.

11.2 State Environmental Policy Act Requirements

The City of Battle Ground is expected to update its comprehensive plan in 2016. In accordance with GMA requirements, this update would address public facilities planning, including planning for sanitary sewer service to the City's expanded UGA. The City will be required to conduct an environmental review of the comprehensive plan update under the State Environmental Policy Act (SEPA) pursuant to WAC 197-11.

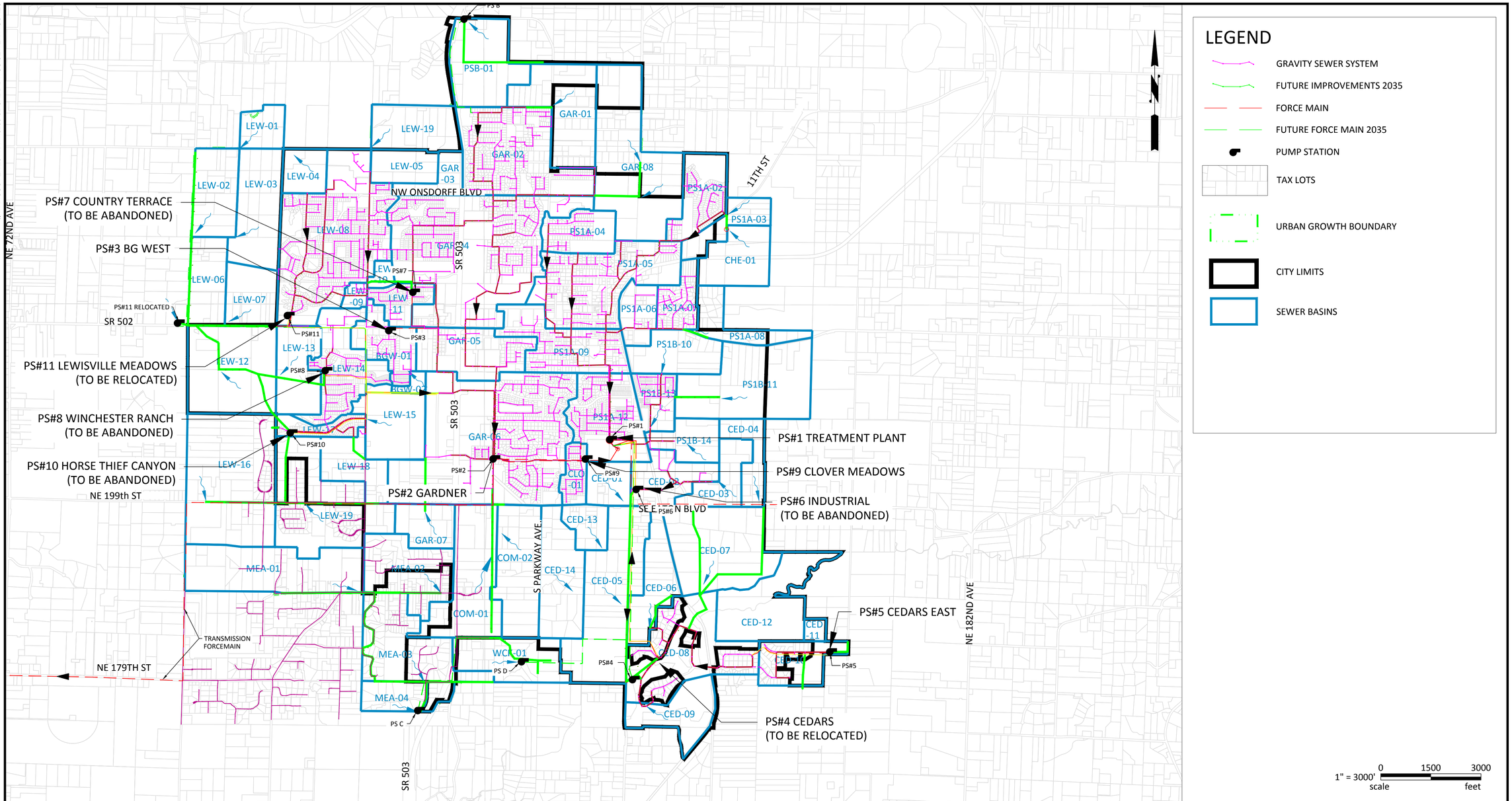
11.3 Comprehensive Growth Management Plan Environmental Impact Statement

A supplemental environmental impact statement (SEIS) is being completed by Clark County in conjunction with the growth management planning process that is currently underway. The draft SEIS is expected to assess four future growth alternatives and is scheduled to be issued in late summer 2015. A link to the County 2016 comprehensive growth management plan update and EIS information is located below.

http://www.clark.wa.gov/planning/2016update/alternatives.html

APPENDIX A

Q:\VANCOUVER\2014\A14.0299\02\CADD\DWGS\SEWER FIGURES



BergerABAM

THE CITY OF BATTLE GROUND

SEWER SYSTEM BASIN MAP

City of Battle Ground
2015 General Sewer Plan, Rev. 5/17

FIGURE
A

Figure A5
Existing Sewer System
Battle Ground General Sewer Plan

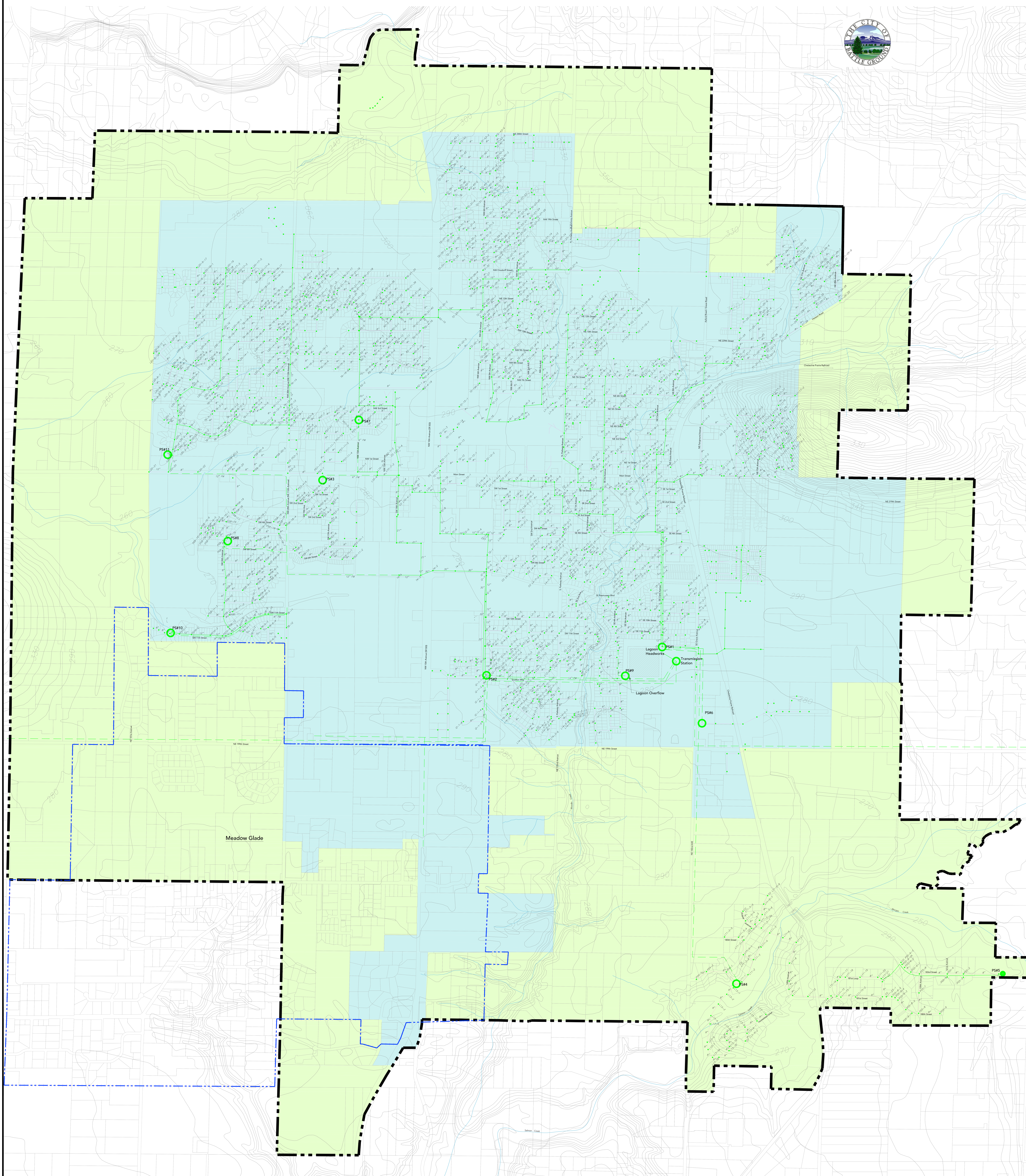
June 2009

Legend

- UGA Boundary
- Existing City Limits
- Existing Meadow Glade Service Area Boundary
- Existing Contours
- Existing Sewer Line (size noted)
- Existing Force Main
- Existing Pump Station
- Existing Manhole (ID noted)

NORTH

0 600 1200
SCALE IN FEET



APPENDIX B

Year	Total UGB Population	Equivalent Residential Units			Battle Ground (city only in mgd)				
		Residential	Comm/Ind	Total	Average Daily	Average Dry Weather	Average Wet Weather	Max Month	Max Day
2014	20,163	7,785	884	8,669	1.43	1.00	1.73	1.94	2.77
2015	21,075	8,137	915	9,052	1.48	1.04	1.79	2.00	2.87
2016	21,986	8,489	947	9,436	1.53	1.07	1.86	2.07	2.97
2017	22,898	8,841	980	9,821	1.58	1.11	1.92	2.15	3.07
2018	23,810	9,193	1,015	10,208	1.64	1.15	1.99	2.22	3.18
2019	24,722	9,545	1,050	10,595	1.70	1.19	2.06	2.30	3.29
2020	25,633	9,897	1,087	10,984	1.76	1.23	2.13	2.38	3.41
2021	26,545	10,249	1,125	11,374	1.82	1.27	2.21	2.46	3.52
2022	27,457	10,601	1,164	11,765	1.88	1.32	2.28	2.55	3.65
2023	28,368	10,953	1,205	12,158	1.95	1.36	2.36	2.64	3.78
2024	29,280	11,305	1,247	12,552	2.01	1.41	2.45	2.73	3.91
2025	30,192	11,657	1,291	12,948	2.08	1.46	2.53	2.83	4.04
2026	31,104	12,009	1,336	13,345	2.16	1.51	2.62	2.93	4.19
2027	32,015	12,361	1,383	13,744	2.23	1.56	2.71	3.03	4.33
2028	32,927	12,713	1,431	14,144	2.31	1.62	2.81	3.14	4.48
2029	33,839	13,065	1,481	14,546	2.39	1.68	2.91	3.25	4.64
2030	34,750	13,417	1,533	14,950	2.48	1.73	3.01	3.36	4.80
2031	35,662	13,769	1,587	15,356	2.56	1.79	3.11	3.48	4.97
2032	36,574	14,121	1,642	15,763	2.65	1.86	3.22	3.60	5.15
2033	37,486	14,473	1,700	16,173	2.75	1.92	3.33	3.72	5.33
2034	38,397	14,825	1,759	16,584	2.84	1.99	3.45	3.85	5.51
2035	39,309	15,177	1,821	16,998	2.94	2.06	3.57	3.99	5.70

G_ID	LENGTH	SIZE	SAN_AREA	Q_OUT
73	4	4	37.612	0.0884
14	131.01	8	37.612	0.0884
72	4	4	37.612	0.0884
13	129.21	8	37.612	0.0884
71	4	4	37.612	0.0884
12	80.45	8	37.612	0.0884
70	4	4	37.612	0.0884
11	234.78	8	37.612	0.0884
69	4	4	37.612	0.0884
10	124.51	8	37.612	0.0884
68	4	4	37.612	0.0884
9	175.33	8	37.612	0.0884
67	4	4	37.612	0.0884
8	143.89	8	37.612	0.0884
66	4	4	37.612	0.0884
7	358.56	8	37.612	0.0884
65	4	4	37.612	0.0884
6	162.78	8	37.612	0.0884
64	4	4	37.612	0.0884
5	268.24	8	37.612	0.0884
63	4	4	37.612	0.0884
4	250.07	8	37.612	0.0884
62	4	4	58.926	0.1425
3	178.56	8	58.926	0.1425
61	4	4	58.926	0.1425
2	102.39	8	58.926	0.1425
101	4	4	13.34	0.0138
41	412.53	8	13.34	0.0138
100	4	4	13.34	0.0138
40	397.08	8	13.34	0.0138
99	4	4	13.34	0.0138
39	370.07	8	13.34	0.0138
98	4	4	36.357	0.0377
38	541.99	8	36.357	0.0377
97	4	4	36.357	0.0377
37	315.02	8	36.357	0.0377
96	4	4	36.357	0.0377
36	685.49	8	36.357	0.0377
95	4	4	36.357	0.0377
35	79.63	8	36.357	0.0377
94	0	10	36.357	0.0377
189	2555	3	36.357	0.0377
93	4	4	63.198	0.1168
34	63.14	8	63.198	0.1168
92	4	4	63.198	0.1168
33	293.5	8	63.198	0.1168

91	4	4	63.198	0.1168
32	522	8	63.198	0.1168
90	4	4	63.198	0.1168
31	285.01	8	63.198	0.1168
89	4	4	63.198	0.1168
30	81.01	8	63.198	0.1168
88	4	4	63.198	0.1168
29	113.1	8	63.198	0.1168
87	4	4	63.198	0.1168
28	84.82	8	63.198	0.1168
86	4	4	63.198	0.1168
27	386.13	8	63.198	0.1168
85	4	4	63.198	0.1168
26	298.57	8	63.198	0.1168
84	4	4	100.547	0.1949
25	138.49	8	100.547	0.1949
83	4	4	100.547	0.1949
24	160.01	8	100.547	0.1949
82	4	4	100.547	0.1949
23	349.57	8	100.547	0.1949
81	4	4	100.547	0.1949
22	422.96	8	100.547	0.1949
80	4	4	100.547	0.1948
21	275.03	8	100.547	0.1948
79	4	4	100.547	0.1948
20	272.32	8	100.547	0.1948
78	4	4	129.962	0.2694
19	321.67	8	129.962	0.2694
77	4	4	129.962	0.2693
18	285.72	8	129.962	0.2693
113	4	4	14.162	0.0309
52	185.52	8	14.162	0.0309
112	4	4	14.162	0.0309
51	190.19	8	14.162	0.0309
111	4	4	14.162	0.0309
50	345.73	8	14.162	0.0309
110	4	4	14.162	0.0309
49	120	8	14.162	0.0309
109	4	4	14.162	0.0309
48	129.9	8	14.162	0.0309
108	4	4	14.162	0.0309
47	115.61	8	14.162	0.0309
115	4	4	0	0.0128
54	245.04	8	0	0.0128
114	4	4	0	0.0128
53	240.56	8	0	0.0128
107	4	4	14.162	0.0309

46	208.4	8	14.162	0.0309
106	4	4	14.162	0.0309
45	303.88	8	14.162	0.0309
105	4	4	14.162	0.0309
44	196.52	8	14.162	0.0309
104	4	4	14.162	0.0309
43	335.55	8	14.162	0.0309
103	4	4	28.485	0.0621
42	263.57	8	28.485	0.0621
102	0	120	28.485	0.0621
224	1881	4	28.485	0.0621
120	4	4	0	0.0128
58	271.54	8	0	0.0128
119	4	4	0	0.0128
57	117.87	8	0	0.0128
118	4	4	0	0.0128
56	286.13	8	0	0.0128
117	4	4	0	0.0128
55	216.91	8	0	0.0128
121	4	4	129.962	0.2691
17	311.09	8	129.962	0.2691
75	4	4	129.962	0.269
16	186.5	8	129.962	0.269
74	4	4	129.962	0.2689
15	111.12	8	129.962	0.2689
60	4	4	188.889	0.4113
1	84	8	188.889	0.4113
59	0	120	188.889	0.4112
226	7468.4668	4	188.889	0.4112
229	4	4	217.374	0.4733
223	230.5636	8	217.374	0.4733
170	4	4	0	0.0128
137	199.4988	8	0	0.0128
169	4	4	8.487	0.044
136	265.9964	8	8.487	0.044
168	4	4	8.487	0.044
135	353.4999	12	8.487	0.044
167	4	4	8.487	0.044
134	62.4956	8	8.487	0.044
166	4	4	8.487	0.044
133	222.9392	12	8.487	0.044
165	4	4	8.487	0.044
132	200.6722	12	8.487	0.044
164	4	4	8.487	0.044
131	132.9186	12	8.487	0.044
175	4	4	6.836	0.0354
142	301.9999	10	6.836	0.0354

174	4	4	6.836	0.0354
141	145.9854	10	6.836	0.0354
173	4	4	6.836	0.0354
140	225.343	10	6.836	0.0354
172	4	4	6.836	0.0354
139	193.2007	10	6.836	0.0354
171	4	4	6.836	0.0354
138	98.3462	10	6.836	0.0354
163	4	4	15.323	0.0794
130	210.7517	12	15.323	0.0794
162	4	4	15.323	0.0794
129	114.1258	12	15.323	0.0794
161	4	4	27.265	0.1413
128	66.4976	12	27.265	0.1413
160	4	4	27.265	0.1413
127	235.8041	12	27.265	0.1413
159	4	4	27.265	0.1413
126	366.7423	12	27.265	0.1413
158	4	4	27.265	0.1413
125	235.862	12	27.265	0.1413
157	4	4	27.265	0.1413
124	144.2349	8	27.265	0.1413
156	4	4	27.265	0.1412
123	56.7661	8	27.265	0.1412
155	4	4	34.175	0.1771
122	73.9326	8	34.175	0.1771
154	0	10	34.175	0.177
188	5315.2556	8	34.175	0.177
222	4	4	21.346	0.1131
205	89.26	8	21.346	0.1131
221	4	4	21.346	0.1131
204	232.82	8	21.346	0.1131
220	4	4	21.346	0.1131
203	376.92	8	21.346	0.1131
219	4	4	21.346	0.1131
202	234.39	8	21.346	0.1131
218	4	4	50.558	0.3019
201	287.54	8	50.558	0.3019
217	4	4	50.558	0.3019
200	329.55	8	50.558	0.3019
216	4	4	50.558	0.3019
199	361.08	8	50.558	0.3019
215	4	4	50.558	0.3019
198	397.54	8	50.558	0.3019
214	4	4	50.558	0.3019
197	177.65	8	50.558	0.3019
213	4	4	55.246	0.308

196	364	8	55.246	0.308
212	4	4	60.28	0.314
195	118.91	8	60.28	0.314
211	4	4	60.28	0.314
194	355.62	8	60.28	0.314
210	4	4	60.28	0.314
193	344.95	8	60.28	0.314
233	4	4	72.596	0.1813
231	355.8617	8	72.596	0.1813
232	4	4	72.596	0.1813
230	98.9836	8	72.596	0.1813
257	4	4	24.975	0.0717
252	139.6281	8	24.975	0.0717
256	4	4	66.011	0.1679
251	296.0912	12	66.011	0.1679
309	4	4	31.358	0.085
283	431.0637	8	31.358	0.085
308	4	4	31.358	0.085
282	256.5161	8	31.358	0.085
307	4	4	31.358	0.085
281	356.5914	8	31.358	0.085
306	4	4	31.358	0.085
280	210.5448	8	31.358	0.085
305	4	4	31.358	0.085
279	189.0412	8	31.358	0.085
304	4	4	31.358	0.085
278	55.0047	8	31.358	0.085
303	4	4	58.588	0.137
277	287.065	8	58.588	0.137
302	4	4	58.588	0.137
276	314.0296	8	58.588	0.137
301	4	4	113.061	0.2063
275	230.2859	8	113.061	0.2063
300	4	4	113.061	0.2063
274	343.3428	8	113.061	0.2063
321	4	4	14.867	0.0403
315	306.0182	8	14.867	0.0403
320	4	4	14.867	0.0403
314	338.7553	8	14.867	0.0403
319	4	4	14.867	0.0403
313	245.6477	8	14.867	0.0403
318	4	4	14.867	0.0403
312	80.1107	8	14.867	0.0403
317	4	4	14.867	0.0403
311	230.6349	8	14.867	0.0403
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310	424.5119	8	14.867	0.0403

299	4	4	127.928	0.2465
273	259.8178	8	127.928	0.2465
298	4	4	127.928	0.2465
272	363.6164	8	127.928	0.2465
297	4	4	127.928	0.2465
271	375.504	8	127.928	0.2465
296	4	4	150.118	0.2683
270	294.8978	8	150.118	0.2683
295	4	4	150.118	0.2682
269	324.1028	8	150.118	0.2682
294	4	4	150.118	0.2682
268	96.6795	8	150.118	0.2682
293	4	4	150.118	0.2681
267	85.6271	8	150.118	0.2681
292	4	4	150.118	0.2681
266	251.9474	10	150.118	0.2681
291	4	4	168.25	0.2875
265	178.6362	10	168.25	0.2875
290	4	4	168.25	0.2874
264	384.9989	10	168.25	0.2874
289	4	4	195.865	0.4178
263	413.5297	10	195.865	0.4178
288	4	4	195.865	0.4175
262	227.5275	10	195.865	0.4175
287	4	4	195.865	0.4173
261	235.0137	10	195.865	0.4173
286	4	4	195.865	0.4171
260	242.5748	10	195.865	0.4171
285	4	4	195.865	0.4168
259	203.5032	12	195.865	0.4168
284	4	4	195.865	0.4165
258	36.2637	10	195.865	0.4165
255	4	4	261.877	0.5842
250	395.2579	12	261.877	0.5842
254	4	4	261.877	0.5835
249	273.5247	12	261.877	0.5835
253	4	4	261.877	0.583
248	47.0258	12	261.877	0.583
247	4	4	261.877	0.5828
240	80.5084	12	261.877	0.5828
246	4	4	261.877	0.5825
239	362.0233	12	261.877	0.5825
245	4	4	261.877	0.5818
238	447.0212	12	261.877	0.5818
244	4	4	322.99	0.727
237	261.0614	15	322.99	0.727
243	4	4	337.78	0.7622

236	299.029	15	337.78	0.7622
242	4	4	349.724	0.7904
235	243.0237	15	349.724	0.7904
241	4	4	349.724	0.7898
234	358.1949	15	349.724	0.7898
341	4	4	65.856	0.5154
331	381.4387	8	65.856	0.5154
340	4	4	65.856	0.5154
330	66.4976	8	65.856	0.5154
339	4	4	65.856	0.5154
329	409.5667	8	65.856	0.5154
411	4	4	40.216	0.091
376	288.4963	8	40.216	0.091
410	4	4	40.216	0.091
375	299.1532	8	40.216	0.091
409	4	4	70.936	0.1606
374	285.1404	8	70.936	0.1606
408	4	4	70.936	0.1606
373	169.2073	8	70.936	0.1606
407	4	4	70.936	0.1606
372	521.5399	8	70.936	0.1606
406	4	4	86.873	0.1967
371	261.5713	8	86.873	0.1967
405	4	4	86.873	0.1967
370	153.5369	8	86.873	0.1967
404	4	4	86.873	0.1967
369	114.147	8	86.873	0.1967
403	4	4	86.873	0.1967
368	308.9981	8	86.873	0.1967
402	4	4	86.873	0.1967
367	276.4963	8	86.873	0.1967
401	4	4	115.324	0.2611
366	125.0073	8	115.324	0.2611
400	4	4	115.324	0.261
365	125.671	8	115.324	0.261
399	4	4	128.972	0.2919
364	164.2441	8	128.972	0.2919
398	4	4	128.972	0.2919
363	170.003	8	128.972	0.2919
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424	234.6567	8	0	0.0128
436	4	4	0	0.0128
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435	4	4	0	0.0128
422	276.0532	8	0	0.0128
434	4	4	0	0.0128
421	48.5209	8	0	0.0128

433	4	4	46.571	0.0621
420	354.5386	8	46.571	0.0621
432	4	4	46.571	0.0621
419	395.0491	8	46.571	0.0621
431	4	4	46.571	0.0621
418	352.0695	8	46.571	0.0621
430	4	4	46.571	0.0621
417	258.057	8	46.571	0.0621
702	4	4	80.78	0.2399
679	248.0046	8	80.78	0.2399
729	4	4	0	0.0128
723	308.9408	8	0	0.0128
728	4	4	0	0.0128
722	269.5046	8	0	0.0128
767	4	4	0	0.0128
757	166.001	8	0	0.0128
766	4	4	0	0.0128
756	232.0006	8	0	0.0128
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755	44.9997	8	2.887	0.0038
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600	216.0688	10	200.286	0.463
642	4	4	213.231	0.4873
599	278.0723	10	213.231	0.4873
641	4	4	219.497	0.5308
598	154.0019	10	219.497	0.5308
429	4	4	46.571	0.0621
416	451.9953	15	46.571	0.0621
428	4	4	78.164	0.1348
415	525.7802	15	78.164	0.1348
427	4	4	129.833	0.2552
414	175.5858	15	129.833	0.2552
426	4	4	129.833	0.2552
413	253.0005	15	129.833	0.2552
425	4	4	129.833	0.2552
412	434.504	15	129.833	0.2552
397	4	4	258.805	0.5471
362	169.997	15	258.805	0.5471
396	4	4	270.206	0.5779
361	351.0207	15	270.206	0.5779
395	4	4	270.206	0.5778
360	78.5039	15	270.206	0.5778
394	4	4	270.206	0.5778
359	429.9994	18	270.206	0.5778
393	4	4	290.077	0.5966
358	426.9934	18	290.077	0.5966
392	4	4	290.077	0.5966

357	149.6023	18	290.077	0.5966
391	4	4	290.077	0.5963
356	307.5083	18	290.077	0.5963
390	4	4	305.393	0.656
355	445.5313	18	305.393	0.656
389	4	4	315.667	0.6953
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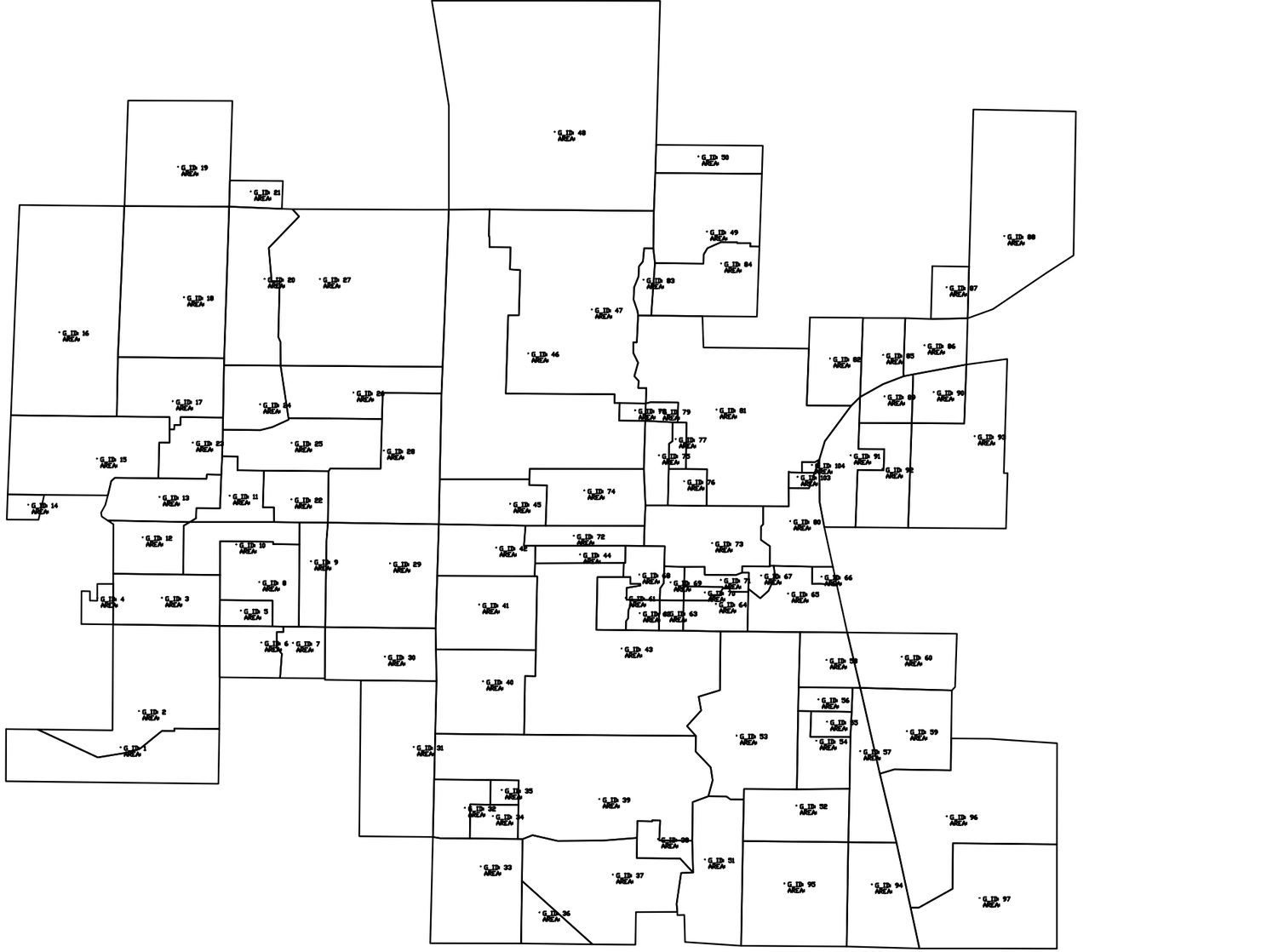
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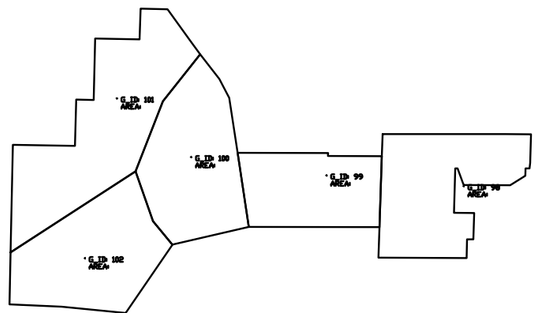
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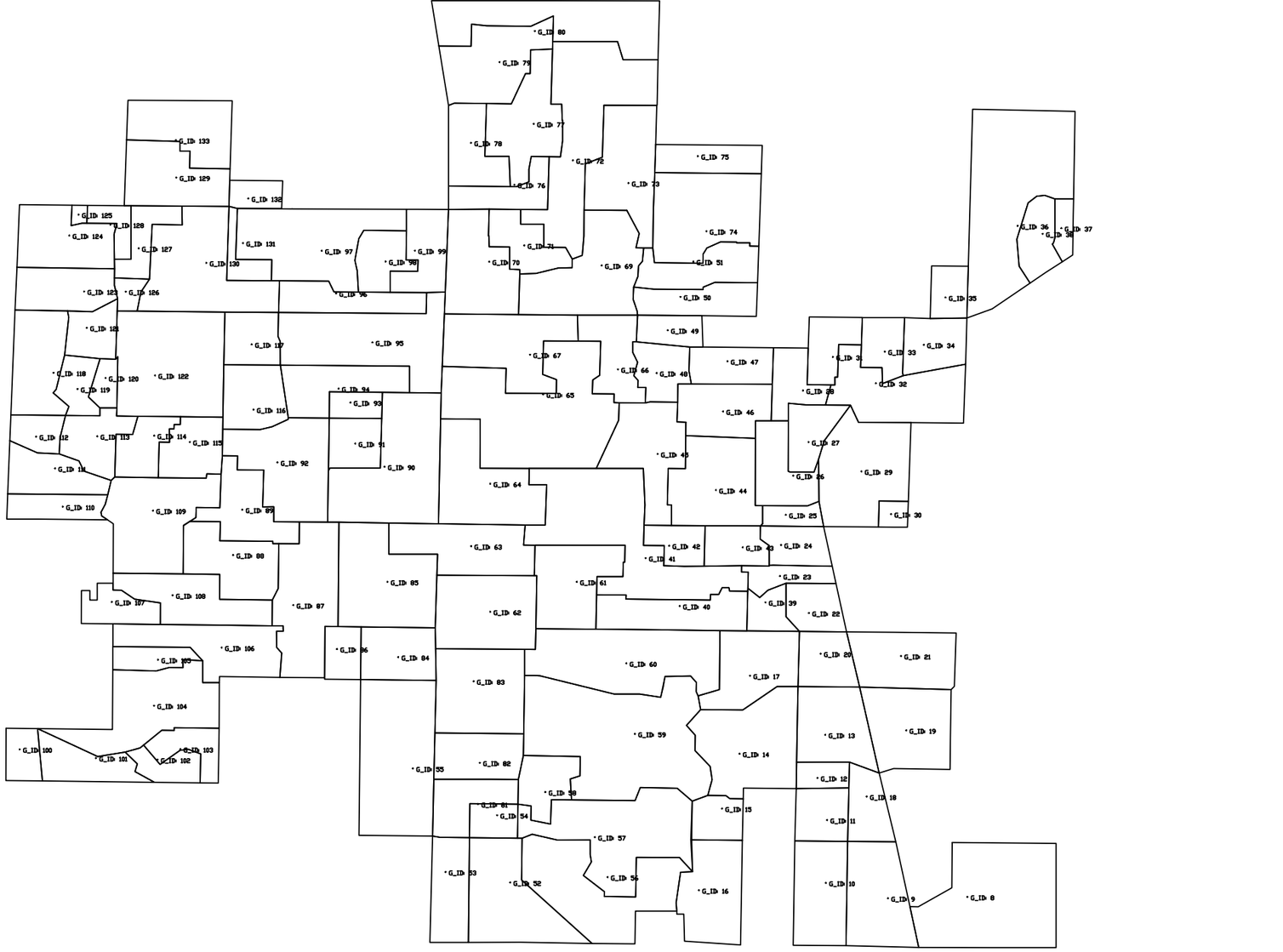
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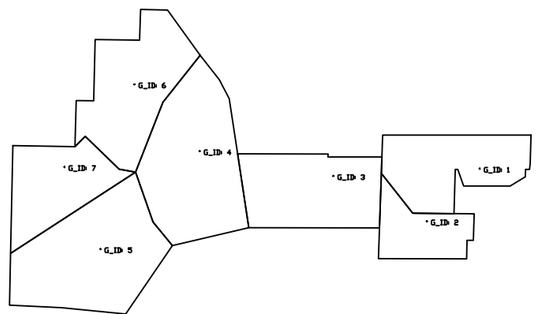
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72	4	4	37.612	0.1031
13	129.2111	8	37.612	0.1031
71	4	4	37.612	0.1031
12	80.448	8	37.612	0.1031
70	4	4	37.612	0.1031
11	234.7825	8	37.612	0.1031
69	4	4	101.572	0.2973
10	124.5084	8	101.572	0.2973
68	4	4	111.134	0.3412
9	175.3257	8	111.134	0.3412
67	4	4	111.134	0.3412
8	143.895	8	111.134	0.3412
66	4	4	111.134	0.3412
7	358.5575	8	111.134	0.3412
65	4	4	111.134	0.3412
6	162.7793	8	111.134	0.3412
64	4	4	111.134	0.3412
5	268.2422	8	111.134	0.3412
63	4	4	111.134	0.3412
837	249.7748	8	111.134	0.3412
101	4	4	13.34	0.0177
41	412.5262	8	13.34	0.0177
100	4	4	13.34	0.0177
40	397.0802	8	13.34	0.0177
99	4	4	13.34	0.0177
39	370.0698	8	13.34	0.0177
98	4	4	36.357	0.0483
38	541.985	8	36.357	0.0483
97	4	4	36.357	0.0483
37	315.0186	8	36.357	0.0483
96	4	4	56.737	0.1102
36	685.4862	8	56.737	0.1102
95	4	4	66.027	0.1348
35	79.6268	8	66.027	0.1348
94	0	10	66.027	0.1348
189	2555	3	66.027	0.1348
93	4	4	92.868	0.2282
34	63.1424	8	92.868	0.2282
92	4	4	92.868	0.2282
33	293.5002	8	92.868	0.2282
91	4	4	92.868	0.2282
32	521.9984	8	92.868	0.2282
90	4	4	92.868	0.2282
31	285.0099	8	92.868	0.2282

89	4	4	92.868	0.2281
30	81.0135	8	92.868	0.2281
88	4	4	92.868	0.2281
29	113.1036	8	92.868	0.2281
87	4	4	92.868	0.228
28	84.8202	8	92.868	0.228
86	4	4	92.868	0.228
27	386.1308	8	92.868	0.228
85	4	4	92.868	0.2279
26	298.5682	8	92.868	0.2279
84	4	4	130.217	0.3182
25	138.4895	8	130.217	0.3182
83	4	4	130.217	0.3182
24	160.0101	8	130.217	0.3182
82	4	4	130.217	0.3181
23	349.5688	8	130.217	0.3181
81	4	4	130.217	0.318
22	422.9594	8	130.217	0.318
80	4	4	130.217	0.3179
21	275.0287	8	130.217	0.3179
113	4	4	25.772	0.0231
52	185.5153	8	25.772	0.0231
112	4	4	25.772	0.0231
51	190.1909	8	25.772	0.0231
111	4	4	25.772	0.0231
50	345.7345	8	25.772	0.0231
110	4	4	25.772	0.0231
49	119.9993	8	25.772	0.0231
109	4	4	25.772	0.0231
48	129.8999	8	25.772	0.0231
108	4	4	25.772	0.0231
47	115.6139	8	25.772	0.0231
115	4	4	12.723	0.0103
54	245.0363	8	12.723	0.0103
114	4	4	12.723	0.0103
53	240.5594	8	12.723	0.0103
107	4	4	38.495	0.0334
46	208.4004	8	38.495	0.0334
106	4	4	38.495	0.0334
45	303.8806	8	38.495	0.0334
105	4	4	38.495	0.0334
44	196.5217	8	38.495	0.0334
104	4	4	38.495	0.0334
43	335.5476	8	38.495	0.0334
103	4	4	52.819	0.069
42	263.5687	8	52.819	0.069
102	0	120	68.337	0.1059

831	214.7093	8	68.337	0.1059
987	4	4	83.855	0.1187
830	400	8	83.855	0.1187
986	4	4	112.499	0.1417
829	400	8	112.499	0.1417
985	4	4	112.499	0.1417
828	400	8	112.499	0.1417
984	4	4	145.412	0.2523
827	400	8	145.412	0.2523
983	4	4	172.744	0.6433
826	400	8	172.744	0.6433
982	4	4	172.744	0.6433
825	400	8	172.744	0.6433
981	4	4	199.362	1.0356
824	400	8	199.362	1.0356
980	4	4	199.362	1.0356
823	400	8	199.362	1.0356
979	4	4	240.332	1.7448
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978	4	4	240.332	1.7447
821	400	8	240.332	1.7447
977	4	4	240.332	1.7447
820	400	8	240.332	1.7447
170	4	4	0	0.0159
137	199.4988	8	0	0.0159
169	4	4	8.487	0.0506
136	265.9964	8	8.487	0.0506
168	4	4	8.487	0.0506
135	353.4999	12	8.487	0.0506
167	4	4	8.487	0.0506
134	62.4956	8	8.487	0.0506
166	4	4	8.487	0.0506
133	222.9392	12	8.487	0.0506
165	4	4	8.487	0.0506
132	200.6722	12	8.487	0.0506
164	4	4	8.487	0.0506
131	132.9186	12	8.487	0.0506
187	4	4	10.945	0.015
153	421.4521	12	10.945	0.015
222	4	4	81.616	0.5349
205	89.2614	8	81.616	0.5349
221	4	4	81.616	0.5349
204	232.8188	8	81.616	0.5349
220	4	4	81.616	0.5349
203	376.918	8	81.616	0.5349
233	4	4	94.61	0.4922
231	355.8617	8	94.61	0.4922

232	4	4	94.61	0.4922
230	98.9836	8	94.61	0.4922
257	4	4	24.975	0.0918
252	139.6281	8	24.975	0.0918
256	4	4	66.011	0.2145
251	296.0912	12	66.011	0.2145
309	4	4	31.358	0.108
283	431.0638	8	31.358	0.108
308	4	4	31.358	0.108
282	256.5161	8	31.358	0.108
307	4	4	31.358	0.108
281	356.5914	8	31.358	0.108
306	4	4	31.358	0.108
280	210.5448	8	31.358	0.108
305	4	4	31.358	0.108
279	189.0412	8	31.358	0.108
304	4	4	31.358	0.108
278	55.0047	8	31.358	0.108
303	4	4	58.588	0.1749
277	287.065	8	58.588	0.1749
302	4	4	58.588	0.1749
276	314.0296	8	58.588	0.1749
301	4	4	113.061	0.2657
275	230.2859	8	113.061	0.2657
300	4	4	113.061	0.2657
274	343.3428	8	113.061	0.2657
321	4	4	14.867	0.0512
315	306.0182	8	14.867	0.0512
320	4	4	14.867	0.0512
314	338.7553	8	14.867	0.0512
319	4	4	14.867	0.0512
313	245.6477	8	14.867	0.0512
318	4	4	14.867	0.0512
312	80.1107	8	14.867	0.0512
317	4	4	14.867	0.0512
311	230.6349	8	14.867	0.0512
316	4	4	14.867	0.0512
310	424.5119	8	14.867	0.0512
299	4	4	127.928	0.3111
273	259.8178	8	127.928	0.3111
298	4	4	127.928	0.3109
272	363.6164	8	127.928	0.3109
297	4	4	127.928	0.3109
271	375.504	8	127.928	0.3109
296	4	4	150.118	0.3409
270	294.8978	8	150.118	0.3409
295	4	4	150.118	0.3409

269	324.1029	8	150.118	0.3409
294	4	4	150.118	0.3407
268	96.6795	8	150.118	0.3407
293	4	4	150.118	0.3406
267	85.6271	8	150.118	0.3406
292	4	4	150.118	0.3405
266	251.9474	10	150.118	0.3405
291	4	4	168.25	0.3671
265	178.6362	10	168.25	0.3671
290	4	4	168.25	0.367
264	384.9989	10	168.25	0.367
289	4	4	195.865	0.5261
263	413.5297	10	195.865	0.5261
288	4	4	195.865	0.5242
262	227.5275	10	195.865	0.5242
287	4	4	195.865	0.5229
261	235.0137	10	195.865	0.5229
286	4	4	195.865	0.5223
260	242.5748	10	195.865	0.5223
285	4	4	195.865	0.522
259	203.5032	12	195.865	0.522
284	4	4	195.865	0.5213
258	36.2637	10	195.865	0.5213
255	4	4	261.877	0.7317
250	395.2579	12	261.877	0.7317
254	4	4	261.877	0.7299
249	273.5247	12	261.877	0.7299
253	4	4	261.877	0.7285
248	47.0258	8	261.877	0.7285
247	4	4	261.877	0.7285
240	80.5084	12	261.877	0.7285
246	4	4	261.877	0.7285
239	362.0233	12	261.877	0.7285
245	4	4	261.877	0.7284
238	447.0212	12	261.877	0.7284
244	4	4	322.99	0.9096
237	261.0614	15	322.99	0.9096
243	4	4	337.78	0.952
236	299.029	15	337.78	0.952
242	4	4	349.724	0.9862
235	243.0237	15	349.724	0.9862
241	4	4	349.724	0.9861
234	358.1949	15	349.724	0.9861
341	4	4	49.088	0.4863
331	381.4387	8	49.088	0.4863
340	4	4	49.088	0.4863
330	66.4976	8	49.088	0.4863

339	4	4	49.088	0.4863
329	409.5667	8	49.088	0.4863
1214	4	4	40.818	0.095
874	411.0124	8	40.818	0.095
1213	4	4	92.701	0.3263
873	386.9875	8	92.701	0.3263
1212	4	4	92.701	0.3263
872	413.0125	8	92.701	0.3263
1211	4	4	92.701	0.3263
871	414.9901	8	92.701	0.3263
1210	4	4	92.701	0.3263
870	405.0467	8	92.701	0.3263
1215	4	4	92.701	0.3263
869	350.1518	8	92.701	0.3263
585	4	4	108.667	0.3481
578	288	8	108.667	0.3481
584	4	4	108.667	0.3481
577	161.999	8	108.667	0.3481
583	4	4	108.667	0.3481
576	163.4734	8	108.667	0.3481
582	4	4	119.547	0.3625
575	58.092	8	119.547	0.3625
581	4	4	119.547	0.3625
574	83.5704	8	119.547	0.3625
580	4	4	119.547	0.3625
573	408.0224	8	119.547	0.3625
1245	4	4	118.94	0.4226
893	377.2697	8	118.94	0.4226
1244	4	4	150.201	0.5778
892	400	8	150.201	0.5778
1243	4	4	150.201	0.5778
891	388.0161	8	150.201	0.5778
1242	4	4	150.201	0.5778
890	343.5112	8	150.201	0.5778
1241	4	4	150.201	0.5778
889	160.504	8	150.201	0.5778
1240	4	4	150.201	0.5778
888	305.4978	8	150.201	0.5778
1239	4	4	190.418	0.6942
887	400.9936	8	190.418	0.6942
437	4	4	76.98	0.2337
424	234.6567	8	76.98	0.2337
436	4	4	106.06	0.4229
423	276.5252	8	106.06	0.4229
435	4	4	106.06	0.4229
422	276.0532	8	106.06	0.4229
434	4	4	106.06	0.4229

421	48.5209	8	106.06	0.4229
433	4	4	167.17	0.7448
420	354.5386	8	167.17	0.7448
432	4	4	167.17	0.7448
419	395.0491	8	167.17	0.7448
431	4	4	178.33	0.7801
418	352.0695	8	178.33	0.7801
430	4	4	178.33	0.7801
417	258.057	8	178.33	0.7801
429	4	4	178.33	0.7801
416	451.9953	15	178.33	0.7801
428	4	4	209.922	0.8729
415	525.7802	15	209.922	0.8729
427	4	4	261.591	1.0267
414	175.5858	15	261.591	1.0267
426	4	4	261.591	1.0267
413	253.0005	15	261.591	1.0267
425	4	4	261.591	1.0267
412	434.504	15	261.591	1.0267
493	4	4	76.19	0.5299
466	652.9749	8	76.19	0.5299
492	4	4	81.976	0.5531
465	662.118	12	81.976	0.5531
491	4	4	86.752	0.5724
464	139.0096	12	86.752	0.5724
490	4	4	86.752	0.5724
463	131.1125	12	86.752	0.5724
489	4	4	121.636	0.7349
462	276.5571	12	121.636	0.7349
488	4	4	121.636	0.7349
461	273.6135	12	121.636	0.7349
487	4	4	121.636	0.7349
460	193.0791	12	121.636	0.7349
486	4	4	132.169	0.7776
459	208.5851	12	132.169	0.7776
485	4	4	132.169	0.7775
458	398.6068	12	132.169	0.7775
484	4	4	132.169	0.7775
457	400.0899	12	132.169	0.7775
521	4	4	41.544	0.2862
507	330.4018	8	41.544	0.2862
520	4	4	60.624	0.3642
506	242.7973	8	60.624	0.3642
519	4	4	60.624	0.3642
505	426.3506	8	60.624	0.3642
518	4	4	76.5	0.4291
504	177.1375	8	76.5	0.4291

517	4	4	76.5	0.4291
503	243.1412	8	76.5	0.4291
516	4	4	85.203	0.4647
502	392.8055	8	85.203	0.4647
515	4	4	85.203	0.4647
501	108.3806	8	85.203	0.4647
514	4	4	93.137	0.4972
500	279.0562	8	93.137	0.4972
513	4	4	93.137	0.4972
499	145.3459	8	93.137	0.4972
547	4	4	30.411	0.1426
534	280.1804	8	30.411	0.1426
546	4	4	30.411	0.1426
533	227.9969	8	30.411	0.1426
545	4	4	30.411	0.1426
532	122.994	8	30.411	0.1426
544	4	4	30.411	0.1426
531	105.1245	8	30.411	0.1426
543	4	4	34.751	0.1611
530	682.8893	8	34.751	0.1611
542	4	4	43.644	0.2036
529	416.0824	8	43.644	0.2036
541	4	4	47.278	0.2205
528	208.365	8	47.278	0.2205
540	4	4	47.278	0.2205
527	394.1531	8	47.278	0.2205
539	4	4	47.278	0.2204
526	386.2317	8	47.278	0.2204
538	4	4	88.463	0.4318
525	128.8522	8	88.463	0.4318
537	4	4	92.434	0.4478
524	128.2	8	92.434	0.4478
536	4	4	92.434	0.4474
523	122.492	8	92.434	0.4474
535	4	4	92.434	0.4471
522	257.7678	8	92.434	0.4471
512	4	4	185.571	0.9437
498	262.0763	8	185.571	0.9437
511	4	4	205.112	1.0233
497	127.2393	8	205.112	1.0233
510	4	4	205.112	1.0229
496	198.0089	8	205.112	1.0229
509	4	4	205.112	1.0228
495	93.4099	8	205.112	1.0228
508	4	4	212.188	1.0534
494	167.7659	8	212.188	1.0534
565	4	4	14.748	0.055

558	141.9942	8	14.748	0.055
564	4	4	35.18	0.1961
557	52.5091	8	35.18	0.1961
701	4	4	153.319	0.5346
678	255.0004	10	153.319	0.5346
700	4	4	153.319	0.5342
677	235.0539	10	153.319	0.5342
699	4	4	192.069	0.6333
676	204.5766	12	192.069	0.6334
641	4	4	498.305	2.0519
598	154.0019	10	498.305	2.0519
640	4	4	498.305	2.0518
597	311.0448	10	498.305	2.0518
639	4	4	720.725	2.7806
596	151.2999	12	720.725	2.7806
1216	4	4	113.075	0.5792
906	375.2656	8	113.075	0.5792
1062	4	4	113.075	0.5792
905	139.3849	8	113.075	0.5792
1084	4	4	0	0.0159
926	400	8	0	0.0159
1186	4	4	73.955	0.4053
1128	400	8	73.955	0.4053
1185	4	4	155.572	0.9889
1127	400	10	155.572	0.9889
1184	4	4	169.142	1.0707
1126	400	10	169.142	1.0707
563	4	4	35.18	0.1961
556	210.3693	8	35.18	0.1961
562	4	4	44.441	0.2654
555	282.5182	8	44.441	0.2654
561	4	4	44.441	0.2654
554	96.1559	8	44.441	0.2654
571	4	4	30.46	0.1942
568	308.4945	8	30.46	0.1942
570	4	4	37.074	0.2363
567	299.0029	8	37.074	0.2363
569	4	4	60.879	0.3908
566	120.016	8	60.879	0.3908
560	4	4	105.32	0.6562
1099	41.1294	8	105.32	0.6562
1231	4	4	105.32	0.6562
1098	400	8	105.32	0.6562
1230	4	4	117.451	0.7384
1097	400	8	117.451	0.7384
1229	4	4	117.451	0.7384
1096	400	8	117.451	0.7384

1228	4	4	117.451	0.7384
1095	400	8	117.451	0.7384
1227	4	4	117.451	0.7384
1094	400	8	117.451	0.7384
1226	4	4	117.451	0.7384
1093	400	8	117.451	0.7384
717	4	4	14.581	0.0756
694	304.6311	8	14.581	0.0756
716	4	4	28.523	0.1466
693	380.1911	8	28.523	0.1466
715	4	4	36.194	0.1724
692	253.9494	8	36.194	0.1724
714	4	4	36.194	0.1724
691	251.5607	8	36.194	0.1724
713	4	4	46.513	0.2071
690	278.0815	8	46.513	0.2071
712	4	4	46.513	0.2071
689	76.1657	8	46.513	0.2071
711	4	4	46.513	0.2071
688	247.0268	8	46.513	0.2071
710	4	4	46.513	0.2071
687	317.746	8	46.513	0.2071
709	4	4	46.513	0.2071
686	204.82	8	46.513	0.2071
708	4	4	69.789	0.2818
685	273.1635	8	69.789	0.2818
707	4	4	69.789	0.2816
684	224.5095	8	69.789	0.2816
706	4	4	69.789	0.2813
683	339.0438	8	69.789	0.2813
705	4	4	69.789	0.2807
682	260.5064	8	69.789	0.2807
704	4	4	80.78	0.3017
681	248.1013	8	80.78	0.3017
703	4	4	80.78	0.3017
680	122.7306	8	80.78	0.3017
702	4	4	80.78	0.3016
679	248.0046	8	80.78	0.3016
729	4	4	20.67	0.2127
723	308.9407	8	20.67	0.2127
728	4	4	24.824	0.2398
722	269.5046	8	24.824	0.2398
727	4	4	34.601	0.2695
721	68.2032	8	34.601	0.2695
726	4	4	34.601	0.2695
720	119.6253	8	34.601	0.2695
725	4	4	34.601	0.2695

719	313.0724	8	34.601	0.2695
724	4	4	44.642	0.3027
718	142.8571	8	44.642	0.3027
749	4	4	19.388	0.0888
739	351.7778	8	19.388	0.0888
748	4	4	19.388	0.0888
738	134.6287	8	19.388	0.0888
747	4	4	19.388	0.0888
737	359.9003	8	19.388	0.0888
746	4	4	34.475	0.1395
736	241.0634	8	34.475	0.1395
745	4	4	34.475	0.1395
735	345.0151	8	34.475	0.1395
744	4	4	34.475	0.1395
734	251.0168	8	34.475	0.1395
743	4	4	34.475	0.1395
733	300.0986	8	34.475	0.1395
742	4	4	60.215	0.2104
732	148.0971	8	60.215	0.2104
741	4	4	60.215	0.2104
731	118.5373	8	60.215	0.2104
740	4	4	60.215	0.2104
730	430.1044	8	60.215	0.2104
698	4	4	192.069	0.6333
675	356.517	12	192.069	0.6333
697	4	4	216.097	0.6985
674	201.7967	12	216.097	0.6985
696	4	4	216.097	0.6984
673	146.0006	8	216.097	0.6984
695	4	4	222.419	0.7336
672	468.6188	8	222.419	0.7336
948	4	4	37.173	0.3439
792	400	8	37.173	0.3439
947	4	4	37.173	0.3439
791	400	8	37.173	0.3439
946	4	4	37.173	0.3439
790	400	10	37.173	0.3439
945	4	4	37.173	0.3439
789	400	10	37.173	0.3439
944	4	4	77.143	0.6751
788	400	10	77.143	0.6751
943	4	4	77.143	0.6751
787	400	10	77.143	0.6751
942	4	4	77.143	0.6751
786	400	10	77.143	0.6751
941	4	4	289.393	3.0197
785	400	10	289.393	3.0197

940	4	4	289.393	3.0197
784	400	10	289.393	3.0197
939	4	4	289.393	3.0197
783	400	10	289.393	3.0197
938	4	4	289.393	3.0197
782	400	10	289.393	3.0197
937	4	4	289.393	3.0197
781	400	10	289.393	3.0197
936	4	4	289.393	3.0196
780	400	10	289.393	3.0196
960	4	4	206.555	0.7996
804	400	8	206.555	0.7996
959	4	4	206.555	0.7996
803	400	8	206.555	0.7996
958	4	4	206.555	0.7996
802	400	8	206.555	0.7996
957	4	4	206.555	0.7997
801	400	8	206.555	0.7997
956	4	4	206.555	0.7997
800	400	8	206.555	0.7997
955	4	4	206.555	0.7996
799	400	8	206.555	0.7996
962	4	4	76.68	0.3324
806	445.3317	8	76.68	0.3324
961	4	4	76.68	0.3324
805	400	8	76.68	0.3324
175	4	4	83.515	0.3731
142	301.9999	10	83.515	0.3731
174	4	4	83.515	0.3731
141	145.9854	10	83.515	0.3731
173	4	4	83.515	0.3731
140	225.343	10	83.515	0.3731
172	4	4	83.515	0.3731
139	193.2007	10	83.515	0.3731
171	4	4	83.515	0.3731
138	98.3462	10	83.515	0.3731
163	4	4	92.003	0.4236
130	210.7517	12	92.003	0.4236
162	4	4	92.003	0.4236
129	114.1258	12	92.003	0.4236
161	4	4	103.945	0.4947
128	66.4976	12	103.945	0.4947
160	4	4	103.945	0.4947
127	235.8041	12	103.945	0.4947
159	4	4	103.945	0.4947
126	366.7423	12	103.945	0.4947
158	4	4	103.945	0.4942

125	235.862	12	103.945	0.4942
157	4	4	103.945	0.4941
124	144.2349	8	103.945	0.4941
156	4	4	103.945	0.4939
123	56.7661	8	103.945	0.4939
969	4	4	19.3	0.189
813	400	8	19.3	0.189
968	4	4	19.3	0.189
812	400	8	19.3	0.189
967	4	4	19.3	0.189
811	400	8	19.3	0.189
966	4	4	56.247	0.2431
810	400	8	56.247	0.2431
965	4	4	95.027	0.3099
809	400	8	95.027	0.3099
964	4	4	95.027	0.3099
808	400	8	95.027	0.3099
963	4	4	112.944	0.3367
807	400	8	112.944	0.3367
954	4	4	361.22	1.1978
798	166.2598	10	361.22	1.1978
953	4	4	366.404	1.2135
797	400	10	366.404	1.2135
952	4	4	366.404	1.2134
796	400	10	366.404	1.2134
951	4	4	366.404	1.2134
795	400	10	366.404	1.2134
950	4	4	412.774	1.3417
794	400	12	412.774	1.3417
949	4	4	412.774	1.3416
793	400	12	412.774	1.3416
1217	4	4	557.73	2.0119
1104	400	12	557.73	2.0118
1235	4	4	564.64	2.0336
1103	400	15	564.64	2.0336
1234	4	4	564.64	2.0332
1102	400	15	564.64	2.0332
1233	4	4	564.64	2.0317
1101	400	15	564.64	2.0317
1232	4	4	632.31	2.7199
1100	400	15	632.31	2.7199
1225	4	4	749.761	3.4558
1092	400	18	749.761	3.4558
1224	4	4	749.761	3.4532
1091	400	18	749.761	3.4532
1223	4	4	749.761	3.4505
1090	400	18	749.761	3.4505

1222	4	4	793.651	3.6624
1089	400	18	793.651	3.6624
1221	4	4	793.651	3.6573
1088	400	18	793.651	3.6573
1220	4	4	793.651	3.6523
1087	400	18	793.651	3.6523
1219	4	4	793.651	3.6473
1086	400	18	793.651	3.6473
1218	4	4	793.651	3.6402
1085	57.0468	18	793.651	3.6402
971	4	4	51.165	0.084
815	400	8	51.165	0.084
970	4	4	51.165	0.084
814	400	8	51.165	0.084
769	4	4	51.165	0.084
759	305.1541	8	51.165	0.084
768	4	4	51.165	0.084
758	292.9962	8	51.165	0.084
767	4	4	51.165	0.084
757	166.001	8	51.165	0.084
766	4	4	51.165	0.084
756	232.0006	8	51.165	0.084
765	4	4	54.052	0.089
755	44.9997	8	54.052	0.089
764	4	4	54.052	0.089
754	382.4977	8	54.052	0.089
763	4	4	63.735	0.2613
753	37.6023	8	63.735	0.2613
762	4	4	95.518	0.3366
752	256.5297	8	95.518	0.3366
761	4	4	95.518	0.3366
751	295.0776	8	95.518	0.3366
760	4	4	95.518	0.3366
750	331.2959	8	95.518	0.3366
990	4	4	75.214	0.3772
834	400	8	75.214	0.3772
989	4	4	75.214	0.3772
833	300.7682	8	75.214	0.3772
988	4	4	75.214	0.3772
832	400	8	75.214	0.3772
120	4	4	75.214	0.3772
58	271.5357	8	75.214	0.3772
119	4	4	75.214	0.3772
57	117.8724	8	75.214	0.3772
118	4	4	75.214	0.3772
56	286.1316	8	75.214	0.3772
117	4	4	75.214	0.3772

55	216.9101	8	75.214	0.3772
1001	4	4	9.602	0.0114
847	400	8	9.602	0.0114
1000	4	4	9.602	0.0114
846	400	8	9.602	0.0114
999	4	4	9.602	0.0114
845	400	8	9.602	0.0114
998	4	4	19.175	0.0199
844	400	8	19.175	0.0199
997	4	4	19.175	0.0199
843	400	8	19.175	0.0199
1015	4	4	107.689	0.2971
862	405.6952	8	107.689	0.2971
1014	4	4	107.689	0.2971
861	397.9989	8	107.689	0.2971
1013	4	4	107.689	0.2971
860	402.0011	8	107.689	0.2971
1012	4	4	107.689	0.2971
859	397.9989	8	107.689	0.2971
1011	4	4	149.969	0.4255
858	401.0006	8	149.969	0.4255
1010	4	4	149.969	0.4255
857	512.5123	8	149.969	0.4255
1009	4	4	149.969	0.4254
856	398	8	149.969	0.4254
1008	4	4	149.969	0.4254
855	400.9973	8	149.969	0.4254
1007	4	4	149.969	0.4254
854	426.709	8	149.969	0.4254
1006	4	4	149.969	0.4254
853	401.3104	8	149.969	0.4254
1021	4	4	58.204	0.0478
868	399.597	8	58.204	0.0478
1020	4	4	58.204	0.0478
867	156.4655	8	58.204	0.0478
1019	4	4	58.204	0.0478
866	399.9913	8	58.204	0.0478
1018	4	4	97.094	0.1658
865	398.0112	8	97.094	0.1658
1017	4	4	97.094	0.1659
864	399.9999	8	97.094	0.1659
1016	4	4	97.094	0.1659
863	401	8	97.094	0.1659
1005	4	4	247.064	0.5913
852	461.64	8	247.064	0.5912
1004	4	4	247.064	0.5912
851	299.7036	8	247.064	0.5912

1003	4	4	247.064	0.5911
850	167.9839	8	247.064	0.5911
1002	4	4	247.064	0.5911
849	366.9411	8	247.064	0.5911
79	4	4	377.28	0.9089
20	272.3245	8	377.28	0.9089
78	4	4	406.696	0.9964
19	321.6667	8	406.696	0.9964
77	4	4	406.696	0.9963
18	285.7197	8	406.696	0.9963
121	4	4	481.91	1.3733
17	311.086	8	481.91	1.3733
75	4	4	481.91	1.3728
16	186.5034	8	481.91	1.3728
74	4	4	481.91	1.3726
15	111.1197	8	481.91	1.3726
60	4	4	481.91	1.3726
836	448.6966	8	481.91	1.3726
991	4	4	614.358	1.7766
835	400	8	614.358	1.7766
1039	4	4	74.35	0.4479
886	400	8	74.35	0.4479
1038	4	4	74.35	0.4479
885	400	8	74.35	0.4479
1037	4	4	74.35	0.4479
884	400	8	74.35	0.4479
1036	4	4	74.35	0.4479
883	400	8	74.35	0.4479
1035	4	4	74.35	0.4479
882	400	8	74.35	0.4479
1034	4	4	74.35	0.4479
881	400	8	74.35	0.4479
1033	4	4	74.35	0.4479
880	400	8	74.35	0.4479
1050	4	4	102.879	0.3729
896	400	8	102.879	0.3729
1049	4	4	102.879	0.3729
895	400	8	102.879	0.3729
1048	4	4	102.879	0.3729
894	68.2811	8	102.879	0.3729
671	4	4	102.879	0.3729
628	137.5932	8	102.879	0.3729
670	4	4	117.112	0.4179
627	445.7546	8	117.112	0.4179
669	4	4	171.886	0.5909
626	457.2713	8	171.886	0.5909
668	4	4	171.886	0.5909

625	147.8559	8	171.886	0.5909
667	4	4	177.343	0.5993
624	311.4681	8	177.343	0.5993
666	4	4	177.343	0.5993
623	324.2457	8	177.343	0.5993
665	4	4	177.343	0.5993
622	277.0102	8	177.343	0.5993
664	4	4	184.444	0.6235
621	355.5105	8	184.444	0.6235
663	4	4	184.444	0.6235
620	133.5927	8	184.444	0.6235
662	4	4	184.444	0.6235
619	24.0208	8	184.444	0.6235
661	4	4	184.444	0.6235
618	157.5949	8	184.444	0.6235
660	4	4	196.544	0.6649
617	155.3354	8	196.544	0.6649
659	4	4	196.544	0.6648
616	41.4861	8	196.544	0.6648
658	4	4	196.544	0.6648
615	163.063	8	196.544	0.6648
657	4	4	205.177	0.677
614	362.5218	8	205.177	0.677
656	4	4	279.527	1.1248
613	90.1675	8	279.527	1.1248
655	4	4	279.527	1.1248
612	294.7673	8	279.527	1.1248
654	4	4	305.877	1.2125
611	256.0279	8	305.877	1.2125
653	4	4	305.877	1.2125
610	129.1176	8	305.877	1.2125
652	4	4	305.877	1.2125
609	254.3833	8	305.877	1.2125
651	4	4	350.518	1.5151
608	409.7415	8	350.518	1.5151
650	4	4	361.735	1.5531
607	325.5226	8	361.735	1.5531
649	4	4	361.735	1.553
606	368.4575	8	361.735	1.553
648	4	4	361.735	1.5529
605	130.6371	8	361.735	1.5529
647	4	4	376.829	1.6156
604	248.5412	10	376.829	1.6156
646	4	4	376.829	1.6155
603	21.5036	10	376.829	1.6155
645	4	4	383.576	1.6315
602	253.6582	10	383.576	1.6315

644	4	4	479.094	1.9679
601	27.8807	10	479.094	1.9678
643	4	4	479.094	1.9678
600	216.0688	10	479.094	1.9678
642	4	4	492.039	1.9984
599	278.0723	10	492.039	1.9984
638	4	4	730.517	2.8385
595	177.9956	12	730.517	2.8385
637	4	4	730.517	2.8376
594	260.0043	12	730.517	2.8376
636	4	4	762.354	2.9913
593	425.4946	12	762.354	2.9913
635	4	4	762.354	2.9883
592	447.5083	12	762.354	2.9883
634	4	4	762.354	2.9853
591	269.9924	12	762.354	2.9853
633	4	4	779.879	3.1061
590	155.5011	12	779.879	3.1061
632	4	4	779.879	3.1041
589	61.9996	12	779.879	3.1041
631	4	4	812.814	3.2578
588	144.5066	12	812.814	3.2578
630	4	4	812.814	3.2557
587	57.4977	12	812.814	3.2557
629	4	4	847.57	3.4171
586	237.3142	12	847.57	3.4171
1064	4	4	113.075	0.5792
907	400	8	113.075	0.5792
1065	4	4	0	0.0159
908	402.0181	8	0	0.0159
1083	4	4	86.358	0.1038
925	400	8	86.358	0.1038
1082	4	4	86.358	0.1038
924	400	8	86.358	0.1038
1081	4	4	86.358	0.1038
923	400	8	86.358	0.1038
1080	4	4	86.358	0.1038
922	400	8	86.358	0.1038
1079	4	4	86.358	0.1038
921	400	8	86.358	0.1038
1078	4	4	86.358	0.1038
920	119.1881	8	86.358	0.1038
1077	4	4	86.358	0.1038
919	400	8	86.358	0.1038
1076	4	4	86.358	0.1038
918	400	8	86.358	0.1038
1075	4	4	86.358	0.1038

917	400	8	86.358	0.1038
1074	0	120	86.358	0.1038
1256	3586.0352	4	86.358	0.1038
1237	4	4	276.776	0.798
376	288.4963	8	276.776	0.798
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409	4	4	307.495	0.8869
374	285.1404	8	307.495	0.8869
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363	170.003	8	365.532	1.0546
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359	429.9994	18	638.524	2.12
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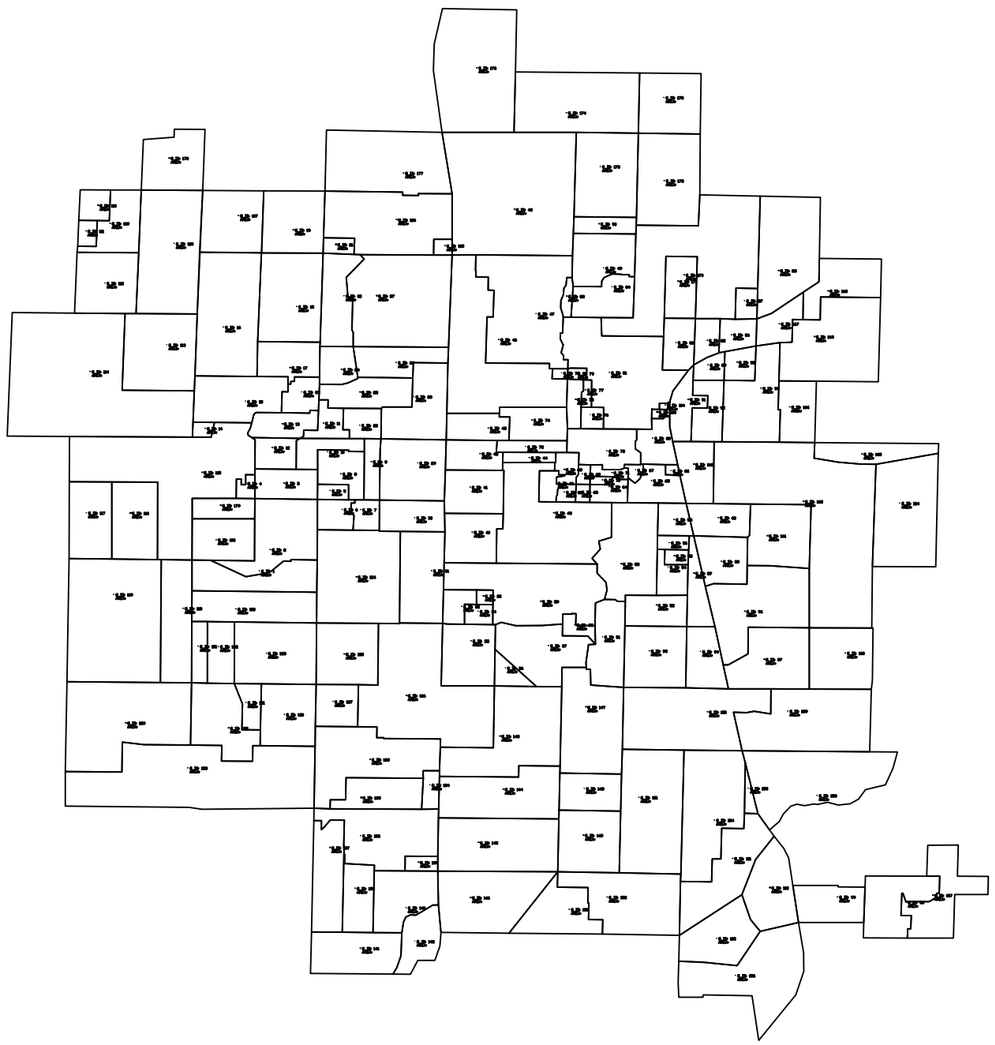
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842	101.4205	15	428.404	1.7593
995	4	4	428.404	1.759
841	400	15	428.404	1.759
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840	400	15	428.404	1.7586
993	4	4	428.404	1.7581
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913	388.7454	8	503.092	1.9507
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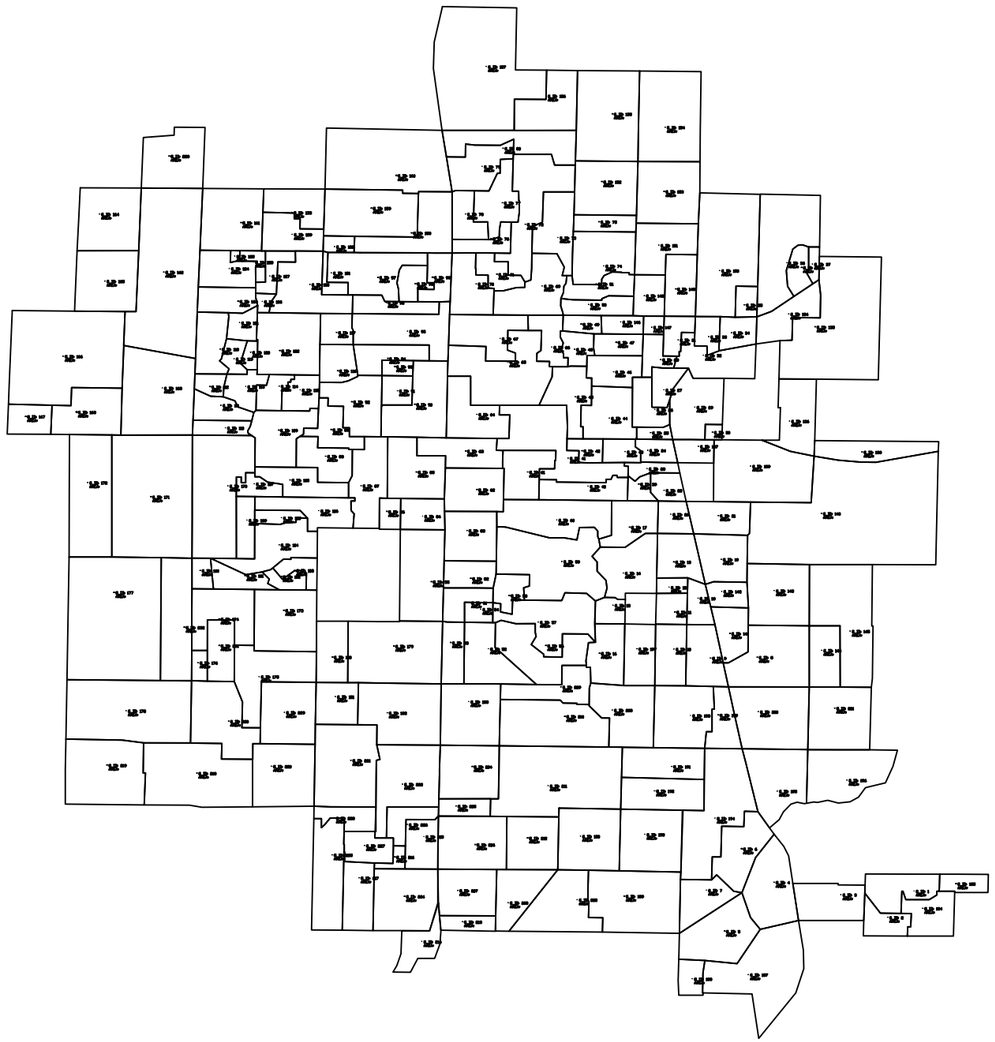
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201	287.5438	8	293.328	2.2196
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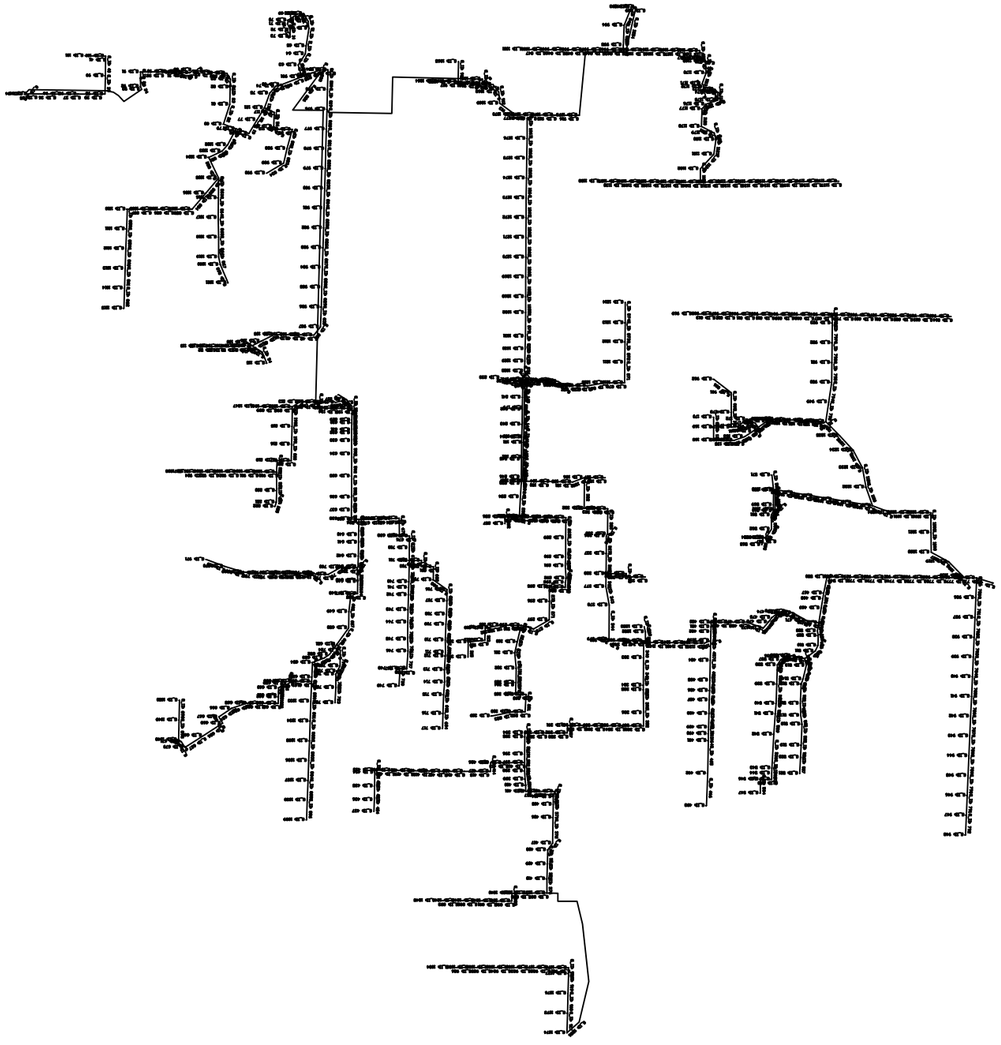
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209	4	4	1189.094	5.6839
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191	177.3864	8	1189.094	5.6839
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455	99.0309	12	153.334	0.81
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479	4	4	153.334	0.8099
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474	4	4	162.809	0.8471
447	162.996	15	162.809	0.8471
473	4	4	162.809	0.8457
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472	4	4	174.888	0.8955
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548	333.3229	12	400.57	1.9991
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773	400	12	512.895	3.0337
930	4	4	512.895	3.0303
774	400	15	512.895	3.0303
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775	400	15	512.895	3.0269
932	4	4	545.105	3.5798
776	400	15	545.105	3.5798
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778	247.3121	24	1338.756	7.2102
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878	252.4931	18	335.422	3.635
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877	250.035	18	359.299	3.7158
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876	200.0428	18	359.299	3.7158
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875	220.5997	18	359.299	3.7157
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53	240.5594	8	12.723	0.0103
107	4	4	38.495	0.0334
46	208.4004	8	38.495	0.0334
106	4	4	38.495	0.0334
45	303.8806	8	38.495	0.0334
105	4	4	38.495	0.0334
44	196.5217	8	38.495	0.0334
104	4	4	38.495	0.0334
43	335.5476	8	38.495	0.0334
103	4	4	52.819	0.069
42	263.5687	8	52.819	0.069
102	0	120	68.337	0.1059
831	214.7093	8	68.337	0.1059
987	4	4	83.855	0.1187
830	400	8	83.855	0.1187
986	4	4	112.499	0.1417
829	400	8	112.499	0.1417
985	4	4	112.499	0.1417
828	400	8	112.499	0.1417
984	4	4	145.412	0.2523
827	400	8	145.412	0.2523
983	4	4	172.744	0.6433
826	400	8	172.744	0.6433
982	4	4	172.744	0.6433
825	400	8	172.744	0.6433
981	4	4	199.362	1.0356
824	400	8	199.362	1.0356
980	4	4	199.362	1.0356
823	400	8	199.362	1.0356
979	4	4	240.332	1.7448
822	400	8	240.332	1.7448
978	4	4	240.332	1.7447
821	400	8	240.332	1.7447
977	4	4	240.332	1.7447
820	400	8	240.332	1.7447
170	4	4	0	0.0159
137	199.4988	8	0	0.0159
169	4	4	8.487	0.0506
136	265.9964	8	8.487	0.0506
168	4	4	8.487	0.0506
135	353.4999	12	8.487	0.0506

167	4	4	8.487	0.0506
134	62.4956	8	8.487	0.0506
166	4	4	8.487	0.0506
133	222.9392	12	8.487	0.0506
165	4	4	8.487	0.0506
132	200.6722	12	8.487	0.0506
164	4	4	8.487	0.0506
131	132.9186	12	8.487	0.0506
187	4	4	10.945	0.015
153	421.4521	12	10.945	0.015
222	4	4	81.616	0.5349
205	89.2614	8	81.616	0.5349
221	4	4	81.616	0.5349
204	232.8188	8	81.616	0.5349
220	4	4	81.616	0.5349
203	376.918	8	81.616	0.5349
233	4	4	94.61	0.4922
231	355.8617	8	94.61	0.4922
232	4	4	94.61	0.4922
230	98.9836	8	94.61	0.4922
257	4	4	24.975	0.0918
252	139.6281	8	24.975	0.0918
256	4	4	66.011	0.2145
251	296.0912	12	66.011	0.2145
309	4	4	31.358	0.108
283	431.0638	8	31.358	0.108
308	4	4	31.358	0.108
282	256.5161	8	31.358	0.108
307	4	4	31.358	0.108
281	356.5914	8	31.358	0.108
306	4	4	31.358	0.108
280	210.5448	8	31.358	0.108
305	4	4	31.358	0.108
279	189.0412	8	31.358	0.108
304	4	4	31.358	0.108
278	55.0047	8	31.358	0.108
303	4	4	58.588	0.1749
277	287.065	8	58.588	0.1749
302	4	4	58.588	0.1749
276	314.0296	8	58.588	0.1749
301	4	4	113.061	0.2657
275	230.2859	8	113.061	0.2657
300	4	4	113.061	0.2657
274	343.3428	8	113.061	0.2657
321	4	4	14.867	0.0512
315	306.0182	8	14.867	0.0512
320	4	4	14.867	0.0512

314	338.7553	8	14.867	0.0512
319	4	4	14.867	0.0512
313	245.6477	8	14.867	0.0512
318	4	4	14.867	0.0512
312	80.1107	8	14.867	0.0512
317	4	4	14.867	0.0512
311	230.6349	8	14.867	0.0512
316	4	4	14.867	0.0512
310	424.5119	8	14.867	0.0512
299	4	4	127.928	0.3111
273	259.8178	8	127.928	0.3111
298	4	4	127.928	0.3109
272	363.6164	8	127.928	0.3109
297	4	4	127.928	0.3109
271	375.504	8	127.928	0.3109
296	4	4	150.118	0.3409
270	294.8978	8	150.118	0.3409
295	4	4	150.118	0.3409
269	324.1029	8	150.118	0.3409
294	4	4	150.118	0.3407
268	96.6795	8	150.118	0.3407
293	4	4	150.118	0.3406
267	85.6271	8	150.118	0.3406
292	4	4	150.118	0.3405
266	251.9474	10	150.118	0.3405
291	4	4	168.25	0.3671
265	178.6362	10	168.25	0.3671
290	4	4	168.25	0.367
264	384.9989	10	168.25	0.367
289	4	4	195.865	0.5261
263	413.5297	10	195.865	0.5261
288	4	4	195.865	0.5242
262	227.5275	10	195.865	0.5242
287	4	4	195.865	0.5229
261	235.0137	10	195.865	0.5229
286	4	4	195.865	0.5223
260	242.5748	10	195.865	0.5223
285	4	4	195.865	0.522
259	203.5032	12	195.865	0.522
284	4	4	195.865	0.5213
258	36.2637	10	195.865	0.5213
255	4	4	261.877	0.7317
250	395.2579	12	261.877	0.7317
254	4	4	261.877	0.7299
249	273.5247	12	261.877	0.7299
253	4	4	261.877	0.7285
248	47.0258	8	261.877	0.7285

247	4	4	261.877	0.7285
240	80.5084	12	261.877	0.7285
246	4	4	261.877	0.7285
239	362.0233	12	261.877	0.7285
245	4	4	261.877	0.7284
238	447.0212	12	261.877	0.7284
244	4	4	322.99	0.9096
237	261.0614	15	322.99	0.9096
243	4	4	337.78	0.952
236	299.029	15	337.78	0.952
242	4	4	349.724	0.9862
235	243.0237	15	349.724	0.9862
241	4	4	349.724	0.9861
234	358.1949	15	349.724	0.9861
341	4	4	49.088	0.4863
331	381.4387	8	49.088	0.4863
340	4	4	49.088	0.4863
330	66.4976	8	49.088	0.4863
339	4	4	49.088	0.4863
329	409.5667	8	49.088	0.4863
1214	4	4	40.818	0.095
874	411.0124	8	40.818	0.095
1213	4	4	92.701	0.3263
873	386.9875	8	92.701	0.3263
1212	4	4	92.701	0.3263
872	413.0125	8	92.701	0.3263
1211	4	4	92.701	0.3263
871	414.9901	8	92.701	0.3263
1210	4	4	92.701	0.3263
870	405.0467	8	92.701	0.3263
1215	4	4	92.701	0.3263
869	350.1518	8	92.701	0.3263
585	4	4	108.667	0.3481
578	288	8	108.667	0.3481
584	4	4	108.667	0.3481
577	161.999	8	108.667	0.3481
583	4	4	108.667	0.3481
576	163.4734	8	108.667	0.3481
582	4	4	119.547	0.3625
575	58.092	8	119.547	0.3625
581	4	4	119.547	0.3625
574	83.5704	8	119.547	0.3625
580	4	4	119.547	0.3625
573	408.0224	8	119.547	0.3625
1245	4	4	118.94	0.4226
893	377.2697	8	118.94	0.4226
1244	4	4	150.201	0.5778

892	400	8	150.201	0.5778
1243	4	4	150.201	0.5778
891	388.0161	8	150.201	0.5778
1242	4	4	150.201	0.5778
890	343.5112	8	150.201	0.5778
1241	4	4	150.201	0.5778
889	160.504	8	150.201	0.5778
1240	4	4	150.201	0.5778
888	305.4978	8	150.201	0.5778
1239	4	4	190.418	0.6942
887	400.9936	8	190.418	0.6942
437	4	4	76.98	0.2337
424	234.6567	8	76.98	0.2337
436	4	4	106.06	0.4229
423	276.5252	8	106.06	0.4229
435	4	4	225.25	1.02
422	276.0532	8	225.25	1.02
434	4	4	225.25	1.02
421	48.5209	8	225.25	1.02
433	4	4	286.36	1.342
420	354.5386	8	286.36	1.342
432	4	4	286.36	1.342
419	395.0491	8	286.36	1.342
431	4	4	297.52	1.3772
418	352.0695	8	297.52	1.3772
430	4	4	297.52	1.3772
417	258.057	8	297.52	1.3772
429	4	4	297.52	1.3772
416	451.9953	15	297.52	1.3772
428	4	4	329.112	1.47
415	525.7802	15	329.112	1.47
427	4	4	380.781	1.6238
414	175.5858	15	380.781	1.6238
426	4	4	380.781	1.6238
413	253.0005	15	380.781	1.6238
425	4	4	380.781	1.6238
412	434.504	15	380.781	1.6238
493	4	4	76.19	0.5299
466	652.9749	8	76.19	0.5299
492	4	4	81.976	0.5531
465	662.118	12	81.976	0.5531
491	4	4	86.752	0.5724
464	139.0096	12	86.752	0.5724
490	4	4	86.752	0.5724
463	131.1125	12	86.752	0.5724
489	4	4	121.636	0.7349
462	276.5571	12	121.636	0.7349

488	4	4	121.636	0.7349
461	273.6135	12	121.636	0.7349
487	4	4	121.636	0.7349
460	193.0791	12	121.636	0.7349
486	4	4	132.169	0.7776
459	208.5851	12	132.169	0.7776
485	4	4	132.169	0.7775
458	398.6068	12	132.169	0.7775
484	4	4	132.169	0.7775
457	400.0899	12	132.169	0.7775
521	4	4	41.544	0.2862
507	330.4018	8	41.544	0.2862
520	4	4	60.624	0.3642
506	242.7973	8	60.624	0.3642
519	4	4	60.624	0.3642
505	426.3506	8	60.624	0.3642
518	4	4	76.5	0.4291
504	177.1375	8	76.5	0.4291
517	4	4	76.5	0.4291
503	243.1412	8	76.5	0.4291
516	4	4	85.203	0.4647
502	392.8055	8	85.203	0.4647
515	4	4	85.203	0.4647
501	108.3806	8	85.203	0.4647
514	4	4	93.137	0.4972
500	279.0562	8	93.137	0.4972
513	4	4	93.137	0.4972
499	145.3459	8	93.137	0.4972
547	4	4	30.411	0.1426
534	280.1804	8	30.411	0.1426
546	4	4	30.411	0.1426
533	227.9969	8	30.411	0.1426
545	4	4	30.411	0.1426
532	122.994	8	30.411	0.1426
544	4	4	30.411	0.1426
531	105.1245	8	30.411	0.1426
543	4	4	34.751	0.1611
530	682.8893	8	34.751	0.1611
542	4	4	43.644	0.2036
529	416.0824	8	43.644	0.2036
541	4	4	47.278	0.2205
528	208.365	8	47.278	0.2205
540	4	4	47.278	0.2205
527	394.1531	8	47.278	0.2205
539	4	4	47.278	0.2204
526	386.2317	8	47.278	0.2204
538	4	4	88.463	0.4318

525	128.8522	8	88.463	0.4318
537	4	4	92.434	0.4478
524	128.2	8	92.434	0.4478
536	4	4	92.434	0.4474
523	122.492	8	92.434	0.4474
535	4	4	92.434	0.4471
522	257.7678	8	92.434	0.4471
512	4	4	185.571	0.9437
498	262.0763	8	185.571	0.9437
511	4	4	205.112	1.0233
497	127.2393	8	205.112	1.0233
510	4	4	205.112	1.0229
496	198.0089	8	205.112	1.0229
509	4	4	205.112	1.0228
495	93.4099	8	205.112	1.0228
508	4	4	212.188	1.0534
494	167.7659	8	212.188	1.0534
565	4	4	14.748	0.055
558	141.9942	8	14.748	0.055
564	4	4	35.18	0.1961
557	52.5091	8	35.18	0.1961
563	4	4	35.18	0.1961
556	210.3693	8	35.18	0.1961
562	4	4	44.441	0.2654
555	282.5182	8	44.441	0.2654
561	4	4	44.441	0.2654
554	96.1559	8	44.441	0.2654
571	4	4	30.46	0.1942
568	308.4945	8	30.46	0.1942
570	4	4	37.074	0.2363
567	299.0029	8	37.074	0.2363
569	4	4	60.879	0.3908
566	120.016	8	60.879	0.3908
560	4	4	105.32	0.6562
1099	41.1294	8	105.32	0.6562
1231	4	4	105.32	0.6562
1098	400	8	105.32	0.6562
1230	4	4	117.451	0.7384
1097	400	8	117.451	0.7384
1229	4	4	117.451	0.7384
1096	400	8	117.451	0.7384
1228	4	4	117.451	0.7384
1095	400	8	117.451	0.7384
1227	4	4	117.451	0.7384
1094	400	8	117.451	0.7384
1226	4	4	117.451	0.7384
1093	400	8	117.451	0.7384

717	4	4	14.581	0.0756
694	304.6311	8	14.581	0.0756
716	4	4	28.523	0.1466
693	380.1911	8	28.523	0.1466
715	4	4	36.194	0.1724
692	253.9494	8	36.194	0.1724
714	4	4	36.194	0.1724
691	251.5607	8	36.194	0.1724
713	4	4	46.513	0.2071
690	278.0815	8	46.513	0.2071
712	4	4	46.513	0.2071
689	76.1657	8	46.513	0.2071
711	4	4	46.513	0.2071
688	247.0268	8	46.513	0.2071
710	4	4	46.513	0.2071
687	317.746	8	46.513	0.2071
709	4	4	46.513	0.2071
686	204.82	8	46.513	0.2071
708	4	4	69.789	0.2818
685	273.1635	8	69.789	0.2818
707	4	4	69.789	0.2816
684	224.5095	8	69.789	0.2816
706	4	4	69.789	0.2813
683	339.0438	8	69.789	0.2813
705	4	4	69.789	0.2807
682	260.5064	8	69.789	0.2807
704	4	4	80.78	0.3017
681	248.1013	8	80.78	0.3017
703	4	4	80.78	0.3017
680	122.7306	8	80.78	0.3017
702	4	4	80.78	0.3016
679	248.0046	8	80.78	0.3016
729	4	4	20.67	0.2127
723	308.9407	8	20.67	0.2127
728	4	4	24.824	0.2398
722	269.5046	8	24.824	0.2398
727	4	4	34.601	0.2695
721	68.2032	8	34.601	0.2695
726	4	4	34.601	0.2695
720	119.6253	8	34.601	0.2695
725	4	4	34.601	0.2695
719	313.0724	8	34.601	0.2695
724	4	4	44.642	0.3027
718	142.8571	8	44.642	0.3027
749	4	4	19.388	0.0888
739	351.7778	8	19.388	0.0888
748	4	4	19.388	0.0888

738	134.6287	8	19.388	0.0888
747	4	4	19.388	0.0888
737	359.9003	8	19.388	0.0888
746	4	4	34.475	0.1395
736	241.0634	8	34.475	0.1395
745	4	4	34.475	0.1395
735	345.0151	8	34.475	0.1395
744	4	4	34.475	0.1395
734	251.0168	8	34.475	0.1395
743	4	4	34.475	0.1395
733	300.0986	8	34.475	0.1395
742	4	4	60.215	0.2104
732	148.0971	8	60.215	0.2104
741	4	4	60.215	0.2104
731	118.5373	8	60.215	0.2104
740	4	4	60.215	0.2104
730	430.1044	8	60.215	0.2104
701	4	4	153.319	0.5346
678	255.0004	10	153.319	0.5346
700	4	4	153.319	0.5342
677	235.0539	10	153.319	0.5342
699	4	4	192.069	0.6333
676	204.5766	12	192.069	0.6334
698	4	4	192.069	0.6333
675	356.517	12	192.069	0.6333
697	4	4	216.097	0.6985
674	201.7967	12	216.097	0.6985
696	4	4	216.097	0.6984
673	146.0006	8	216.097	0.6984
695	4	4	222.419	0.7336
672	468.6188	8	222.419	0.7336
948	4	4	505.193	2.4641
792	400	8	505.193	2.4641
947	4	4	505.193	2.4641
791	400	8	505.193	2.4641
946	4	4	505.193	2.4641
790	400	10	505.193	2.4641
945	4	4	505.193	2.4641
789	400	10	505.193	2.4641
944	4	4	545.163	2.7953
788	400	10	545.163	2.7953
943	4	4	545.163	2.7952
787	400	10	545.163	2.7952
942	4	4	545.163	2.7953
786	400	10	545.163	2.7953
941	4	4	757.413	5.1399
785	400	10	757.413	5.1399

940	4	4	757.413	5.1399
784	400	10	757.413	5.1399
939	4	4	757.413	5.14
783	400	10	757.413	5.14
938	4	4	757.413	5.1401
782	400	10	757.413	5.1401
937	4	4	757.413	5.1401
781	400	10	757.413	5.1401
936	4	4	757.413	5.1402
780	400	10	757.413	5.1402
960	4	4	246.165	0.9791
804	400	8	246.165	0.9791
959	4	4	246.165	0.9791
803	400	8	246.165	0.9791
958	4	4	246.165	0.9791
802	400	8	246.165	0.9791
957	4	4	246.165	0.9791
801	400	8	246.165	0.9791
956	4	4	246.165	0.9791
800	400	8	246.165	0.9791
955	4	4	246.165	0.9791
799	400	8	246.165	0.9791
962	4	4	76.68	0.3324
806	445.3317	8	76.68	0.3324
961	4	4	76.68	0.3324
805	400	8	76.68	0.3324
175	4	4	83.515	0.3731
142	301.9999	10	83.515	0.3731
174	4	4	83.515	0.3731
141	145.9854	10	83.515	0.3731
173	4	4	83.515	0.3731
140	225.343	10	83.515	0.3731
172	4	4	83.515	0.3731
139	193.2007	10	83.515	0.3731
171	4	4	83.515	0.3731
138	98.3462	10	83.515	0.3731
163	4	4	92.003	0.4236
130	210.7517	12	92.003	0.4236
162	4	4	92.003	0.4236
129	114.1258	12	92.003	0.4236
161	4	4	103.945	0.4947
128	66.4976	12	103.945	0.4947
160	4	4	103.945	0.4947
127	235.8041	12	103.945	0.4947
159	4	4	103.945	0.4947
126	366.7423	12	103.945	0.4947
158	4	4	103.945	0.4942

125	235.862	12	103.945	0.4942
157	4	4	103.945	0.4941
124	144.2349	8	103.945	0.4941
156	4	4	103.945	0.4939
123	56.7661	8	103.945	0.4939
969	4	4	19.3	0.189
813	400	8	19.3	0.189
968	4	4	19.3	0.189
812	400	8	19.3	0.189
967	4	4	19.3	0.189
811	400	8	19.3	0.189
966	4	4	56.247	0.2431
810	400	8	56.247	0.2431
965	4	4	95.027	0.3099
809	400	8	95.027	0.3099
964	4	4	95.027	0.3099
808	400	8	95.027	0.3099
963	4	4	112.944	0.3367
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954	4	4	400.83	1.3772
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795	400	10	406.014	1.3929
950	4	4	452.384	1.5213
794	400	12	452.384	1.5213
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1217	4	4	597.34	2.1913
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1103	400	15	604.25	2.213
1234	4	4	604.25	2.2127
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1233	4	4	604.25	2.211
1101	400	15	604.25	2.211
1232	4	4	671.92	2.899
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1225	4	4	789.371	3.6348
1092	400	18	789.371	3.6348
1224	4	4	789.371	3.6319
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1223	4	4	789.371	3.6292
1090	400	18	789.371	3.6292

1222	4	4	833.261	3.8409
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1221	4	4	833.261	3.8356
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1220	4	4	833.261	3.8303
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970	4	4	51.165	0.084
814	400	8	51.165	0.084
769	4	4	51.165	0.084
759	305.1541	8	51.165	0.084
768	4	4	51.165	0.084
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767	4	4	51.165	0.084
757	166.001	8	51.165	0.084
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756	232.0006	8	51.165	0.084
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764	4	4	54.052	0.089
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763	4	4	63.735	0.2613
753	37.6023	8	63.735	0.2613
762	4	4	95.518	0.3366
752	256.5297	8	95.518	0.3366
761	4	4	95.518	0.3366
751	295.0776	8	95.518	0.3366
760	4	4	95.518	0.3366
750	331.2959	8	95.518	0.3366
990	4	4	75.214	0.3772
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989	4	4	75.214	0.3772
833	300.7682	8	75.214	0.3772
988	4	4	75.214	0.3772
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120	4	4	75.214	0.3772
58	271.5357	8	75.214	0.3772
119	4	4	75.214	0.3772
57	117.8724	8	75.214	0.3772
118	4	4	75.214	0.3772
56	286.1316	8	75.214	0.3772
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1001	4	4	9.602	0.0114
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846	400	8	9.602	0.0114
999	4	4	9.602	0.0114
845	400	8	9.602	0.0114
998	4	4	19.175	0.0199
844	400	8	19.175	0.0199
997	4	4	19.175	0.0199
843	400	8	19.175	0.0199
1015	4	4	313.219	1.2282
862	405.6952	8	313.219	1.2282
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861	397.9989	8	313.219	1.2282
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859	397.9989	8	313.219	1.2282
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858	401.0006	8	355.499	1.3566
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856	398	8	355.499	1.3566
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853	401.3104	8	355.499	1.3565
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866	399.9913	8	58.204	0.0478
1018	4	4	97.094	0.1658
865	398.0112	8	97.094	0.1658
1017	4	4	97.094	0.1659
864	399.9999	8	97.094	0.1659
1016	4	4	97.094	0.1659
863	401	8	97.094	0.1659
1005	4	4	452.594	1.5224
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1004	4	4	452.594	1.5223
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1003	4	4	452.594	1.5223
850	167.9839	8	452.594	1.5223
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19	321.6667	8	1320.166	5.4814
77	4	4	1320.166	5.4812
18	285.7197	8	1320.166	5.4812
121	4	4	1395.38	5.8582
17	311.086	8	1395.38	5.858
75	4	4	1395.38	5.8579
16	186.5034	8	1395.38	5.8579
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668	4	4	964.376	4.3983
625	147.8559	8	964.376	4.3983
667	4	4	969.833	4.4067
624	311.4681	8	969.833	4.4067
666	4	4	969.833	4.4068
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620	133.5927	8	976.934	4.431
662	4	4	976.934	4.4311
619	24.0208	8	976.934	4.4311
661	4	4	976.934	4.4312
618	157.5949	8	976.934	4.4312
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600	216.0688	10	1271.584	5.7776
642	4	4	1284.529	5.8081
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640	4	4	1290.795	5.8613
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639	4	4	1513.215	6.5803
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638	4	4	1523.007	6.6389
595	177.9956	12	1523.007	6.6389
637	4	4	1523.007	6.6389
594	260.0043	12	1523.007	6.6389
636	4	4	1554.844	6.7925
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632	4	4	1572.369	6.9061
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588	144.5066	12	1605.304	7.0589
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1062	4	4	113.075	0.5792
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1084	4	4	121.01	0.5482
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1083	4	4	207.368	0.652
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396	4	4	952.114	3.5982
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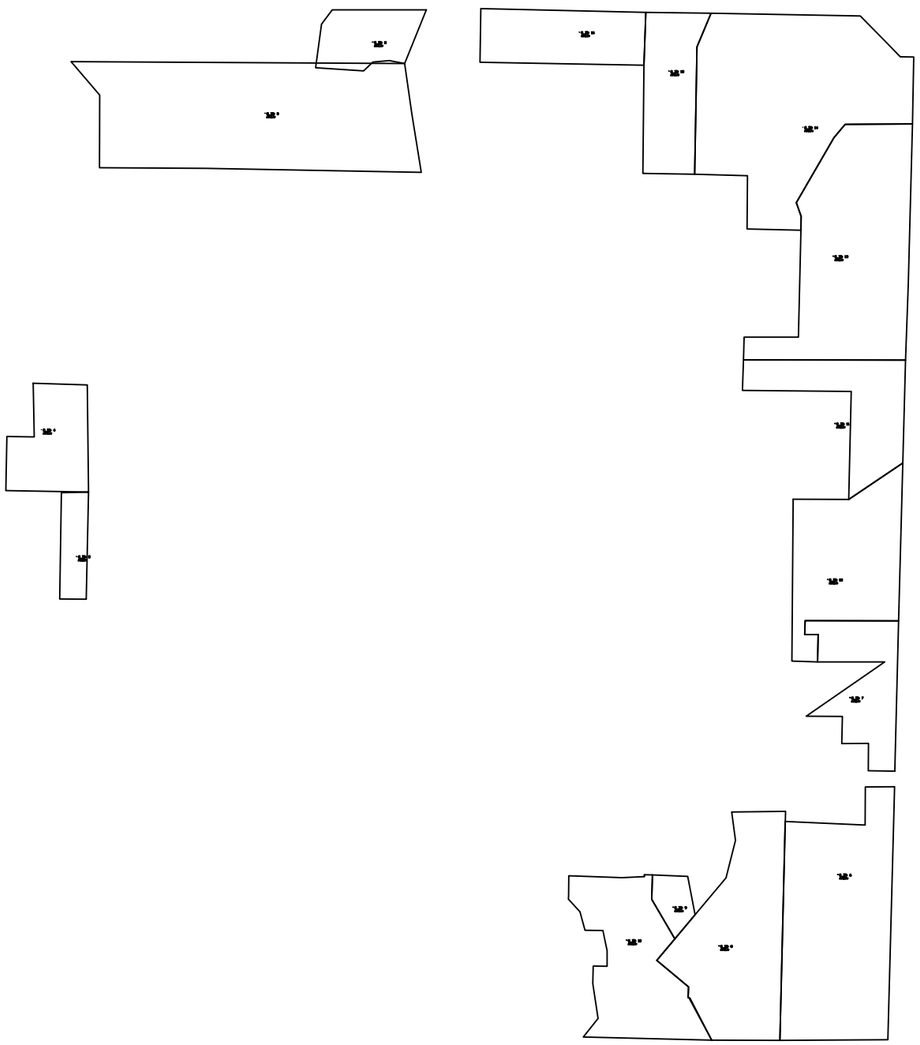
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915	401.0014	8	479.637	1.9271
1071	4	4	479.637	1.9249
914	398.0013	8	479.637	1.9249
1070	4	4	503.092	1.9507
913	388.7454	8	503.092	1.9507
1069	4	4	503.092	1.9485
912	230.3736	8	503.092	1.9485
1068	4	4	503.092	1.9463
911	192.9267	8	503.092	1.9463
1067	4	4	503.092	1.9454

910	213.2582	8	503.092	1.9454
1066	4	4	503.092	1.9445
909	95.9796	8	503.092	1.9445
1061	0	120	616.167	2.5226
1255	3899.829	15	616.167	2.5227
976	4	4	915.029	4.5331
819	400	8	915.029	4.5331
975	4	4	915.029	4.5306
818	400	8	915.029	4.5306
974	4	4	1103.879	5.3837
817	158.4103	8	1103.879	5.3837
973	4	4	2657.667	11.7989
838	115.9387	8	2657.667	11.8018
927	0	120	2657.667	11.8004
226	7468.4668	4	2657.667	11.8004
229	4	4	2657.667	11.8004
223	230.5635	8	2657.667	11.8004
1208	4	4	318.23	2.0635
904	175.8199	8	318.23	2.0635
1207	4	4	318.23	2.0635
903	400	8	318.23	2.0635
1206	4	4	318.23	2.0636
902	400	8	318.23	2.0636
1205	4	4	318.23	2.0636
901	400	8	318.23	2.0636
1204	4	4	318.23	2.0636
900	398.033	8	318.23	2.0636
1203	4	4	399.846	2.5984
202	234.3877	8	399.846	2.5984
218	4	4	429.058	2.8345
201	287.5438	8	429.058	2.8345
217	4	4	429.058	2.8345
200	329.5546	8	429.058	2.8345
216	4	4	429.058	2.8346
199	361.0776	8	429.058	2.8346
215	4	4	429.058	2.8346
198	397.5357	8	429.058	2.8346
1247	4	4	29.609	0.0239
899	345.6634	8	29.609	0.0239
1246	4	4	29.609	0.024
898	376.0685	8	29.609	0.024
1236	4	4	467.533	2.8699
197	177.6461	8	467.533	2.8699
213	4	4	472.221	2.8772
196	364.0009	8	472.221	2.8772
212	4	4	477.254	2.8847
195	118.9089	8	477.254	2.8847

211	4	4	477.254	2.8847
194	355.6247	8	477.254	2.8847
210	4	4	477.254	2.8846
193	344.9504	8	477.254	2.8846
209	4	4	2117.314	10.1003
192	35.2829	8	2117.314	10.1004
208	4	4	2117.314	10.1004
191	177.3864	8	2117.314	10.1004
207	4	4	4774.981	21.8933
190	185.1848	8	4774.981	21.9093
1253	4	4	0	0.0159
1143	105.0992	8	0	0.0159
1252	4	4	6.859	0.0079
1142	212.494	8	6.859	0.0079
1251	4	4	6.859	0.0079
1141	400	8	6.859	0.0079
1250	4	4	6.859	0.0079
1140	400	8	6.859	0.0079
1249	4	4	21.165	0.0326
1139	400	8	21.165	0.0326
1248	4	4	21.165	0.0326
1138	131.2667	8	21.165	0.0326
1238	4	4	153.334	0.8101
456	182.0469	12	153.334	0.8101
482	4	4	153.334	0.81
455	99.0309	12	153.334	0.81
481	4	4	153.334	0.81
454	95.5165	12	153.334	0.81
480	4	4	153.334	0.81
453	358.9958	12	153.334	0.81
479	4	4	153.334	0.8099
452	358.9958	12	153.334	0.8099
478	4	4	153.334	0.8097
451	356.2875	15	153.334	0.8097
477	4	4	162.809	0.8497
450	161.3426	15	162.809	0.8497
476	4	4	162.809	0.8488
449	111.1191	15	162.809	0.8488
475	4	4	162.809	0.848
448	178.1311	15	162.809	0.848
474	4	4	162.809	0.8471
447	162.996	15	162.809	0.8471
473	4	4	162.809	0.8457
446	122.2378	15	162.809	0.8457
472	4	4	174.888	0.8955
445	318.7753	15	174.888	0.8958
471	4	4	174.888	0.8956

444	255.0558	15	174.888	0.8956
470	4	4	387.076	1.9425
443	303.4014	8	387.076	1.9425
469	4	4	400.57	2.0002
442	193.005	8	400.57	2.0002
468	4	4	400.57	1.9991
441	114.5014	8	400.57	1.9991
467	4	4	400.57	1.9991
548	333.3229	12	400.57	1.9991
550	4	4	449.735	2.2591
549	377.9981	12	449.735	2.2591
551	4	4	512.895	3.0373
772	400	12	512.895	3.0373
929	4	4	512.895	3.0337
773	400	12	512.895	3.0337
930	4	4	512.895	3.0303
774	400	15	512.895	3.0303
931	4	4	512.895	3.0269
775	400	15	512.895	3.0269
932	4	4	545.105	3.5798
776	400	15	545.105	3.5798
933	4	4	545.105	3.5757
777	400	15	545.105	3.5757
934	4	4	1378.366	7.3873
778	247.3121	24	1378.366	7.3874
935	4	4	2236.699	12.9753
779	344.5155	27	2236.699	12.9753
1277	4	4	40.29	0.6973
1267	400	10	40.29	0.6973
1276	4	4	40.29	0.6974
1266	400	10	40.29	0.6974
1275	4	4	69.07	1.1955
1265	400	12	69.07	1.1955
1274	4	4	88.181	1.3711
1264	400	12	88.181	1.3711
1273	4	4	88.181	1.3711
1263	400	12	88.181	1.3711
1272	4	4	137.787	1.9789
1262	400	12	137.787	1.9789
1271	4	4	258.4	2.9508
1261	400	12	258.4	2.9508
1270	4	4	258.4	2.9508
1260	400	12	258.4	2.9508
1269	4	4	305.58	3.5572
1259	400	18	305.58	3.5572
1268	4	4	335.422	3.6351
1258	319.9937	18	335.422	3.6351

1032	4	4	335.422	3.6351
879	480.3287	18	335.422	3.6351
1031	4	4	335.422	3.635
878	252.4931	18	335.422	3.635
1030	4	4	359.299	3.7158
877	250.035	18	359.299	3.7158
1029	4	4	359.299	3.7158
876	200.0428	18	359.299	3.7158
1028	4	4	359.299	3.7157
875	220.5997	18	359.299	3.7157
579	4	4	484.987	4.1143
572	167.5129	8	484.987	4.1143
177	4	4	2213.333	10.3037
143	80.1507	8	2213.333	10.3043



APPENDIX C

“Battle Ground Odor Control & Lagoon Assessment”,
Technical Memo from HDR dated May 2, 2005

HDR | ONE COMPANY *Many Solutions*℠

Technical Memo

To:	Sam Adams, Steven Rommel, Rob Charles
From:	Mark Smith
CC:	
Date:	May 2, 2005
Project:	Battle Ground Odor Control Assessment — Project No: 19022/4.1.1
RE:	xxxxxx

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TECHNICAL MEMORANDUM SUMMARY

Introduction

For several years, the City of Battle Ground and the Hazel Dell Sewer District have received hydrogen sulfide (H_2S) related odor complaints along N.E. Salmon Creek Avenue. Previous attempts to prevent the stripping of gas phase H_2S at the forcemain discharge vault on N.E. Salmon Creek Road have been largely unsuccessful. These attempts have included the separate addition of ferrous chloride and ferric chloride.

The City has contracted with HDR Engineering, Inc. to assess and make recommendations on current odor control practices for the Battle Ground Pump Station/Forcemain and the wet weather overflow lagoon facility. This summary of the Technical Memorandum provides a brief description of the sampling efforts and subsequent data analysis. Conclusions and recommendations are made based on this analysis and are summarized herein.

Data Collection

HDR collected data on the following wastewater characteristics over a two-day period in the forcemain wet well and discharge vault:

- pH
- Temperature (degrees Fahrenheit)
- Dissolved Sulfide (mg/L)
- Orthophosphate (mg/L)

HDR collected data on the following vapor phase odor characteristics over a two-day period in the forcemain wet well and discharge vault:

- Hydrogen Sulfide (ppm)
- Ammonia (ppm)
- Mercaptan (ppm)

- Pilot the use of ferric chloride and calcium nitrate to determine most cost effective chemical for odor control on the forcemain. Calcium nitrate is recommended for the pilot test for the following reasons:
    - Its usefulness as an odor control chemical is not affected by the presence of any known wastewater constituents
    - Treatment plant processes would be unaffected
    - It is non-corrosive and relatively safe to handle
- Combine the information from a pilot with results from the sulfide model that was created for data analysis on this project to design a PLC-based optimized chemical feed system. This system would provide the following benefits:
    - Continuously monitor wastewater characteristic fluctuations and adjust chemical feed accordingly
    - Risk of overfeeding chemical would be greatly diminished. This would result in long-term O&M cost savings to the city.
- During warm weather months sample for odors on the above-ground headworks facility and near the fence line along the north end of the plant. Continuously monitor H_2S at the headworks and take low level H_2S grab samples near the fence line. Also, send gas-filled Tedlar bag samples to an outside laboratory for gas chromatography analysis to determine organic odor compounds, if any, released by the lagoon itself.
    - If the headworks facility proves to be a major source of warm weather odors, cover the open air channels and forcibly ventilate the air through a bioscrubber or biofilter.
    - If the lagoon proves to be a major source of warm weather odors, jar test the use of ferric chloride to remove orthophosphate nutrient source in lagoon. A bioassay should be performed by an outside laboratory to determine the effect that such nutrient removal would have on the existing algae population.
    - If jar testing of ferric chloride addition proves to be successful at reducing the algae count in the samples, a pilot test of chemical addition in the lagoon should be performed.

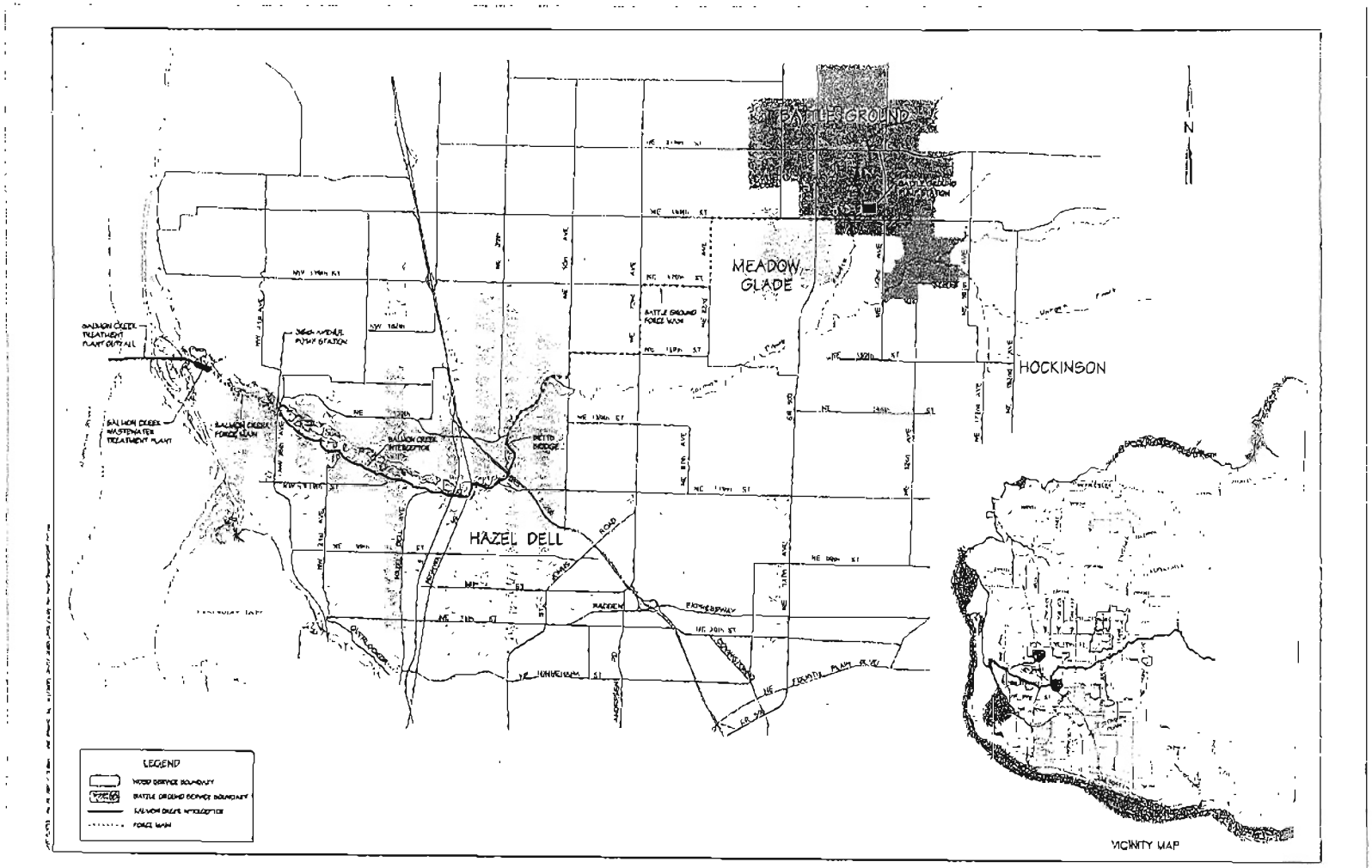


FIGURE 1

OVERALL MAP OF COLLECTION SYSTEM SERVICE AREA

- Surface area of pipe wall and/or wet well
- Detention time
- Wastewater turbulence

Dissolved Oxygen. When the dissolved oxygen level is below approximately 1.0 mg/L, as it is in most municipal waste streams, sulfate reduction will occur. Sulfate is present in abundance in most municipal waste streams. This reduction is performed by bacteria residing in the so-called "slime layer" that lies beneath the wastewater surface on the inside wall of the sewer pipe or wet well.

pH. The reduced sulfate exists as sulfide (S^{2-}), bi-sulfide (HS^-) and H_2S in varying concentrations, depending on pH of the wastewater. For example, at or above a pH of 8, most of the reduced sulfate exists as S_2. and HS-. At a pH at or below 7.1, the reduced sulfate exists as HS^- and H_2S. **Figure 3** below presents a chart of the percentage of each constituent as a function of wastewater pH.

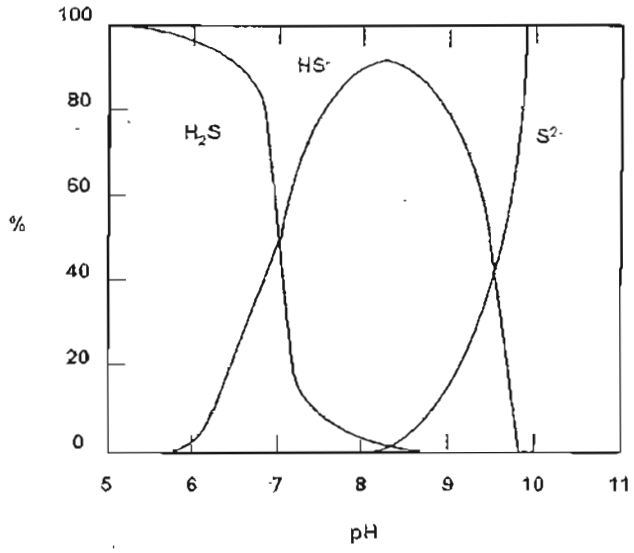


FIGURE 3
EFFECT OF WASTEWATER pH ON
SULFIDE-HYDROGEN SULFIDE EQUILIBRIUM

Concentration of Organic Material. Sulfate reducing bacteria in the slime layer utilize organic matter in the process of reducing sulfate to sulfide. It is generally accepted that the amount of organic material in wastewater is proportional to the five-day biochemical oxygen demand (BOD_5) and can be estimated by measuring BOD_5.

Temperature. Temperature has a direct impact on biological activity of the sulfate reducing bacteria that reside in the slime layer. As wastewater temperature increases, bioactivity increases. As wastewater temperature decreases, bioactivity decreases.

TABLE 1
SUMMARY OF SAMPLING RESULTS
12/20-12/21/04

Wet Well Location

Date	Time	pH	Sample Temp	S^{2-}	H_2S	$(PO_4)^{3-}$	R-SH	NH_3	R-NH_2
12/20/04	9:45 am	7.14, 7.24	57.7, 58.3	0.5, 0.5	ND, ND	---	ND, ND	ND, ND	ND, ND
12/20/04	2:20 pm	7.37, 7.41	57.9, 58.9	0.5, 0.5	ND, ND	---	ND, ND	ND, ND	ND, ND
12/21/04	9:20 am	7.10, 7.17	54.8, 53.7	0.5, 0.5	ND, ND	11.6, 11.2	ND, ND	ND, ND	ND, ND
12/21/04	4:00 pm	7.22	57.5	0.5, 0.5	ND, ND	12.0	ND, ND	ND, ND	ND, ND

Discharge Vault Location

Date	Time	pH	Sample Temp	S^{2-}	H_2S	$(PO_4)^{3-}$	R-SH	NH_3	R-NH_2
12/20/04	10:45 am	6.7, 6.75	56, 53.5	2.0, 2.0	ND, ND	---	ND, ND	ND, ND	ND, ND
12/20/04	3:45pm	7.01, 6.99	56.6, 57.2	1.5, 1.5	5.0, 2.0	---	ND, ND	ND, ND	ND, ND
12/21/04	10:30 am	6.85, 6.87	50.1, 50.8	1.8, 2.0	ND, ND	10.0, 10.1	ND, ND	ND, ND	ND, ND
12/21/04	4:35 pm	6.98	54.9	2.0	5.0	12.8	---	---	---

Lagoon Location

Date	Time	pH	Sample Temp	S^{2-}	$(PO_4)^{3-}$	NO_4	DO
12/20/04	1:30 pm	6.98, 7.07	53.0, 53.0	<0.5, <0.5	10.0, 9.8	2.0	1.4, 1.0
12/21/04	8:45 am	6.98	43.4	2.0, 2.0, 1.5	12, 11.2	2.0, 2.0	0.8, 1.4

Notes:
S^{2-} - dissolved sulfide (mg/L)
H_2S – hydrogen sulfide (ppm)
$(PO_4)^{3-}$ - orthophosphate (mg/L)
R-SH – mercaptans (ppm)
NH_3 – ammonia (ppm)
R-NH_2 – amines (ppm)
ND – Not detectable

Sample Temp, °F

DATA ANALYSIS

Liquid Phase Wet Well and Discharge Vault Data

Dissolved Sulfide

The dissolved sulfide concentration in the wet well remained constant at 0.5 mg/L during the two day sampling effort. The concentration of dissolved sulfide at the discharge vault, however, ranged from 1.5 to 2.0 mg/L. This increase is not surprising given the 8-mile length and 5 to 6 hour wastewater detention time in the pipe.

An analysis of the vertical alignment of the forcemain showed that there are several locations where the crown of the pipe is above the hydraulic grade line (HGL). This would result in pockets of air in which stripping of H_2S likely occurs and thiobacillus bacteria would thrive on the crown of the pipe. See **Figure 4** for a graphic example of this phenomenon. These bacteria oxidize the H_2S into sulfuric acid (H_2SO_4).

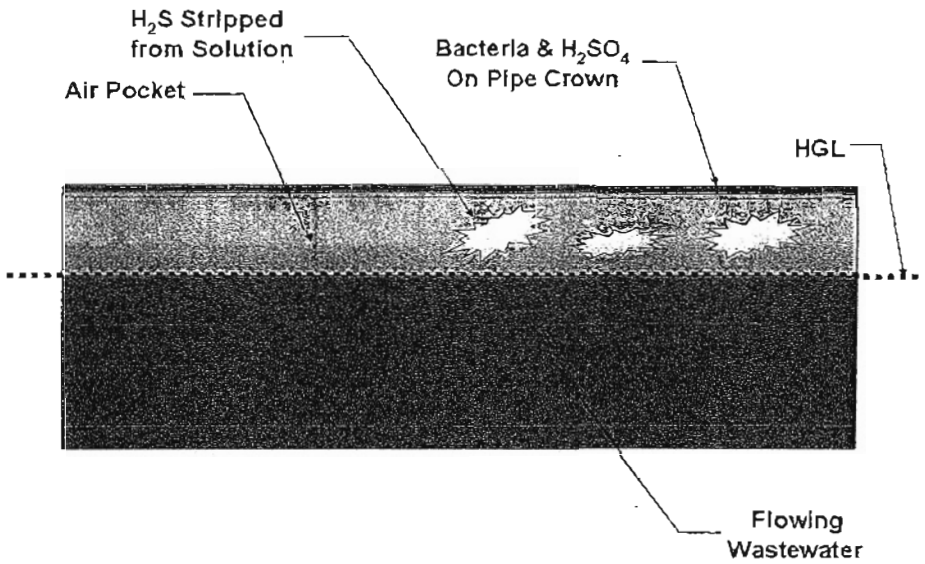


FIGURE 4
SECTION VIEW OF AIR POCKET IN FORCEMAIN WHERE PIPE CROWN LIES ABOVE HYDRAULIC GRADE LINE

The previous study was performed in the summer of 2003 by a third party. A sulfide generation model was run during the 2003 study. The resultant values were compared to the data that was obtained in the field as part of the sampling effort. A sulfide generation model on the 16-inch

Season	WW Temp. (°C)	pH	BOD_5 (mg/L)	Dissolved Sulfide In Wet Well (mg/L)
Summer	21	7.2	250	1.0
Winter	15	7.2	250	0.5

The model input parameters listed in **Table 3** were all based on actual field measured data. The dissolved sulfide grab sampling results obtained during the current study and the 2003 study closely resemble those predicted by the sulfide model that takes the HGL effect into account. The sulfide concentration predicted by the HGL enhanced model at the vault during summer temperature conditions was 2.2 mg/L. Grab samples of 3.0 mg/L and 5.0 mg/L were taken at the vault during the summer of 2003. The winter temperature version of the sulfide model that takes the HGL effect into account predicted a dissolved sulfide concentration of 1.4 mg/L. Grab sample sulfide concentrations between 1.5 and 2.0 mg/L were taken at the vault during the recent sampling effort.

Note that the recent summer version of the model that was run without the HGL effect closely resembles the sulfide concentration predicted by the model used in the 2003 study. Both models significantly overstate the predicted concentration (8.9 and 10.0 mg/L, respectively) versus the actual concentrations measured in the field in 2003 (3.0 and 5.0 mg/L) and 2004 (1.5-2.0 mg/L). **Figures 5, 6, 7 and 8** provide charts that show predicted and measured sulfide concentrations along the entire length of the 16-inch diameter force main. **Figures 5 and 6** represent data from the sulfide model that was run using the HGL effect on sulfide stripping for winter and summer conditions, respectively. **Figures 7 and 8** represent data from the sulfide model that was run **without** the HGL effect on hydrogen sulfide stripping. Plots are included on each chart to compare the modeled results with the data that was measured at the discharge vault in the field.

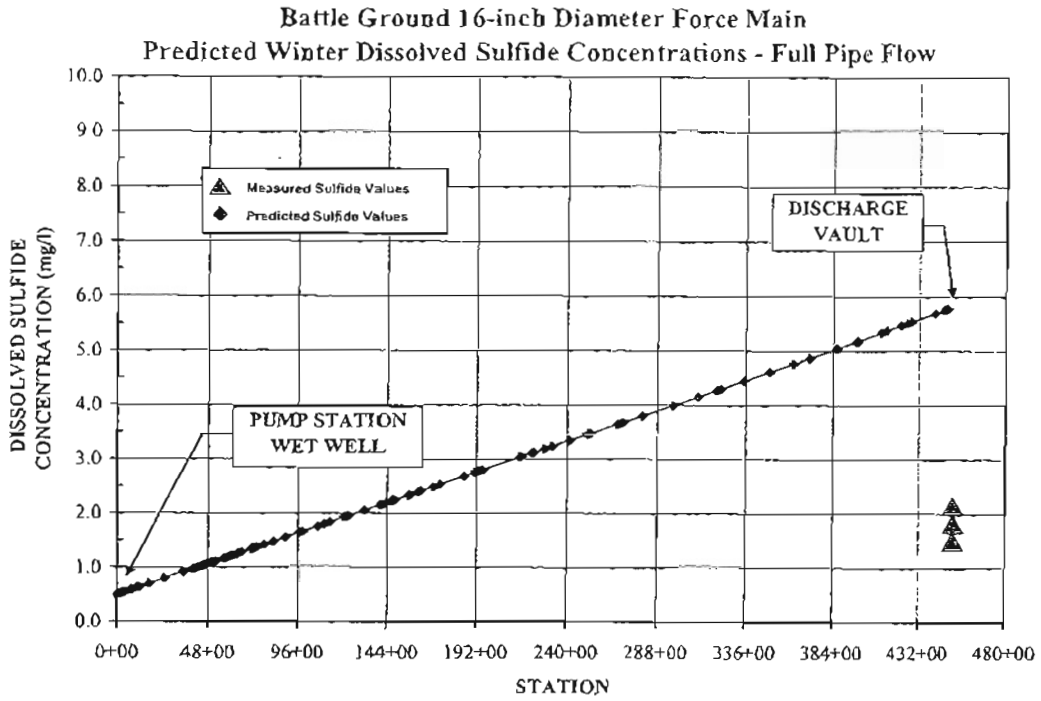


FIGURE 7

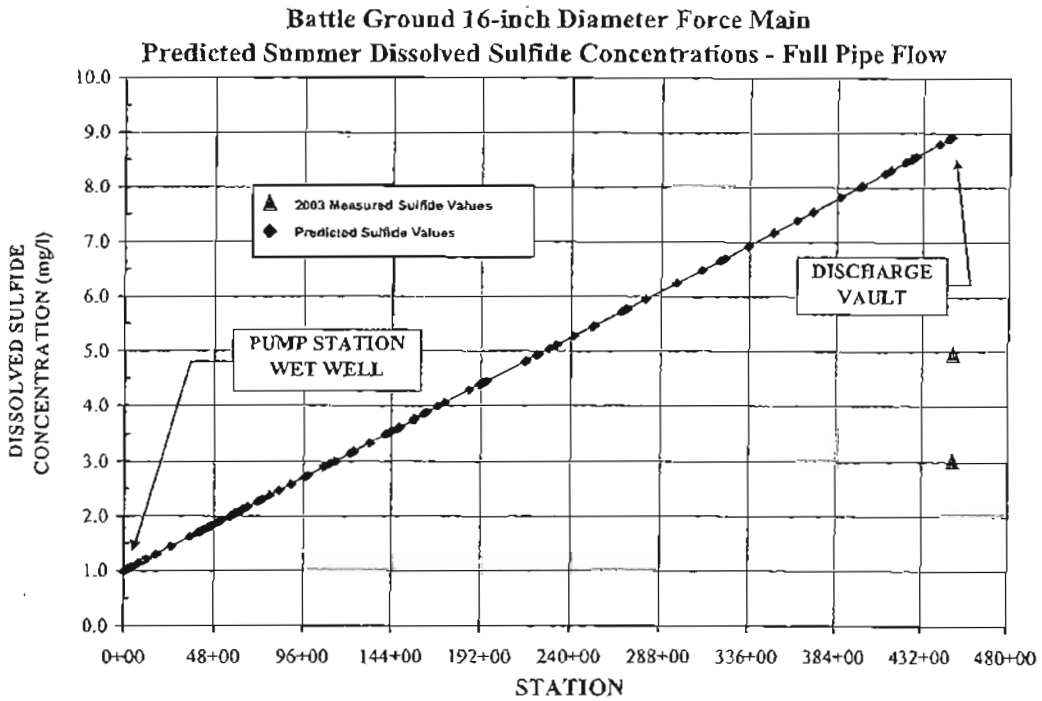


FIGURE 8

The results of the orthophosphate sampling in the wet well and discharge vault are significant when one considers the poor performance of the iron salts (ferrous and ferric chloride) used for odor control on the 16-inch diameter forcemain and the chemical mechanism by which iron salts work for odor control. The purpose of iron feed for odor control is to precipitate dissolved sulfide from the waste stream before it can be stripped from solution as odorous hydrogen sulfide. In order for this to occur, enough of the ferric cation must remain available to bond with the dissolved sulfide anion as the sulfide is reduced from sulfates by bacteria along the length of the forcemain. At the Battle Ground Pump Station, ferric chloride is introduced into the wastewater at the wet well in the presence of (among other compounds) three negatively charged ions: orthophosphates, sulfates and a small amount (0.5 – 1.0 mg/L) of dissolved sulfide.

The ferric ion will tend to bond with those negatively charged ions that will form the least soluble compounds in water. In the presence of sulfate, dissolved sulfide and orthophosphate the ferric ion will form ferric sulfide (Fe2S3) and ferric orthophosphate (FePO4). The ferric ion will precipitate very little (if any) of the sulfate due to the solubility of this compound in water. The sulfate is therefore carried into the forcemain with the wastewater. Because of the precipitation of the ferric sulfide and ferric phosphate, there is less iron available than is required to precipitate the dissolved sulfide that will be produced from sulfate by the bacteria in the forcemain. Sulfide is produced in the forcemain and hydrogen sulfide is stripped from solution at the discharge vault due to the turbulence of the incoming wastewater. **Figure 9** presents a graphic depiction of this situation.

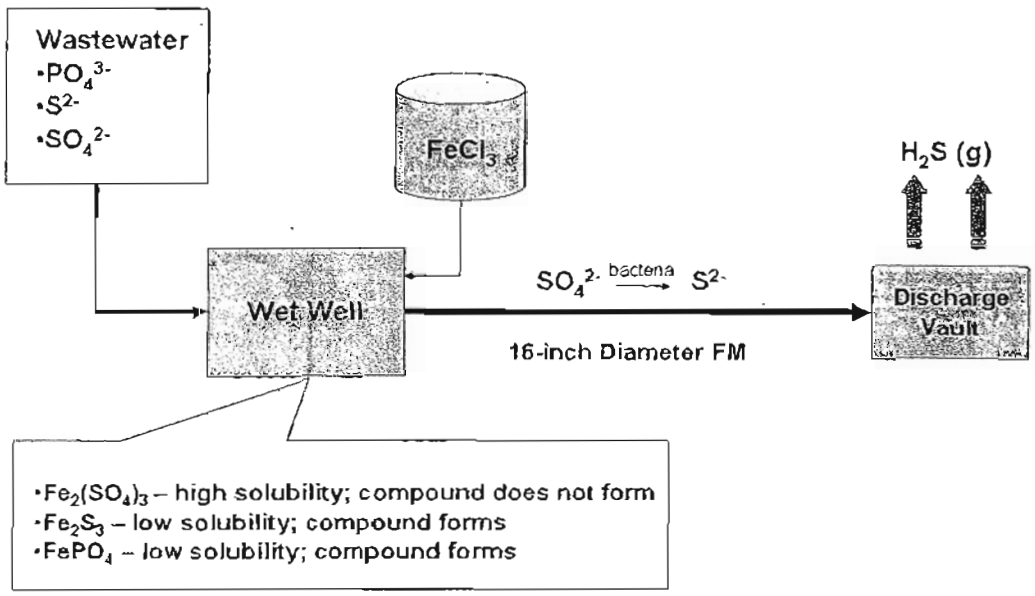


FIGURE 9
SCHEMATIC DEPICTION OF CHEMICAL MECHANISMS AT WORK IN WET WELL, FORCEMAIN AND DISCHARGE VAULT

Orthophosphate samples were taken at manholes 4, 5 and 6. The first sample was taken at manhole 4. An orthophosphate concentration of 7.75 mg/L was recorded. The next sample was taken at manhole 5 approximately 15 minutes later. This manhole is located approximately 50 feet upstream of manhole 4 on the 8-inch diameter sewer. The orthophosphate concentration recorded there was 4.4 mg/L. The last sample was taken at manhole 6 approximately 10 minutes later. Manhole 6 is located approximately 250 feet upstream of manhole 5 and is the next manhole upstream on the 8-inch diameter sewer. The orthophosphate concentration measured in manhole 6 was 2.4 mg/L. It should be noted that manhole 6 is located approximately 100 feet downstream of the upstream end of the 8-inch diameter sewer and approximately 200 feet downstream of the upstream end of a 6-inch diameter sewer. It appears that very little flow (compared to that in manhole 4) passes through manhole 6.

pH and Temperature

The pH and wastewater temperature values measured during grab sampling are within the normal range for domestic wastewater. pH values were consistently lower at the discharge vault than at the wet well. This is to be expected given the higher concentrations of dissolved sulfide (in the form of acidic hydrogen sulfide) that were measured at this location. Any of the sulfuric acid that makes its way back into the wastewater from exposed pipe crown segments could also depress the pH of the wastewater, depending on the wastewater alkalinity and amount of sulfuric acid produced in these locations.

Gas Phase Wet Well and Discharge Vault Data

As stated previously, gas phase concentration grab samples were taken of H_2S, mercaptans, amines and ammonia. As shown in **Table 1**, very little of any of these odor constituents were detected. A few H_2S grab sample concentrations were on the order of 5 ppm at the discharge vault. This low concentration is not surprising given the known, diurnal H_2S concentration trends such as those shown in **Figure 2**. It is also not surprising that no H_2S was detected in the pump station wet well. There was very little wastewater turbulence or evidence of corrosion observed in this structure during the sampling period. Presumably, very little H_2S stripping occurs here. It is not a known source of odors at this facility.

Lagoon Sampling

As discussed previously, four liquid samples were taken from the wet weather overflow lagoon between December 20 and 21, 2004. A summary of the parameters measured in the field is presented in **Table 6.** A summary of algae enumeration and identification results is presented in **Table 7**.

Based on observations and sampling made during site visits, the above-ground lagoon headworks structure appears to present the greatest potential for the offsite detection of H_2S on the grounds of the facility. This is apparent for several reasons, which include the following:

- It carries wastewater directly from the collection system which has been shown by others to contain a minimum of 1.0 mg/L of dissolved sulfide in the warm weather months
- The flow is quite turbulent as it is released from the forcemain to the open channel portion of the structure
- The flow channel is open to the atmosphere
- It is within close proximity to residential developments on the north side of the facility grounds

Grab samples of approximately 5 ppm of H_2S were taken just above the turbulent areas of the open channel. It is probable that this concentration is much higher in the warm weather months.

While the pump station wet well and lagoon both contained approximately 0.5 mg/L of dissolved sulfide during the sampling period, the wastewater contained in these facilities was observed to be quiescent. No H_2S was detected being stripped from the wastewater held by either of these structures.

The presence of algae in a water body such as the lagoon can elicit odor complaints that are described as musty-earthy type smells. Algae that produce these odors are typically most active during warm weather months. The odors are the product of substances left behind by the algae during metabolic processes.

Orthophosphate Sampling throughout Collection System

A summary of the orthophosphate and BOD_5 data collected in the wastewater collection system on February 24 and 25, 2005 is presented in **Table 8. Figures 11, 12, 13 and 14** present schematic maps showing the locations and corresponding orthophosphate data collected. All orthophosphate sampling results on the maps are circled and are in units of mg/L.

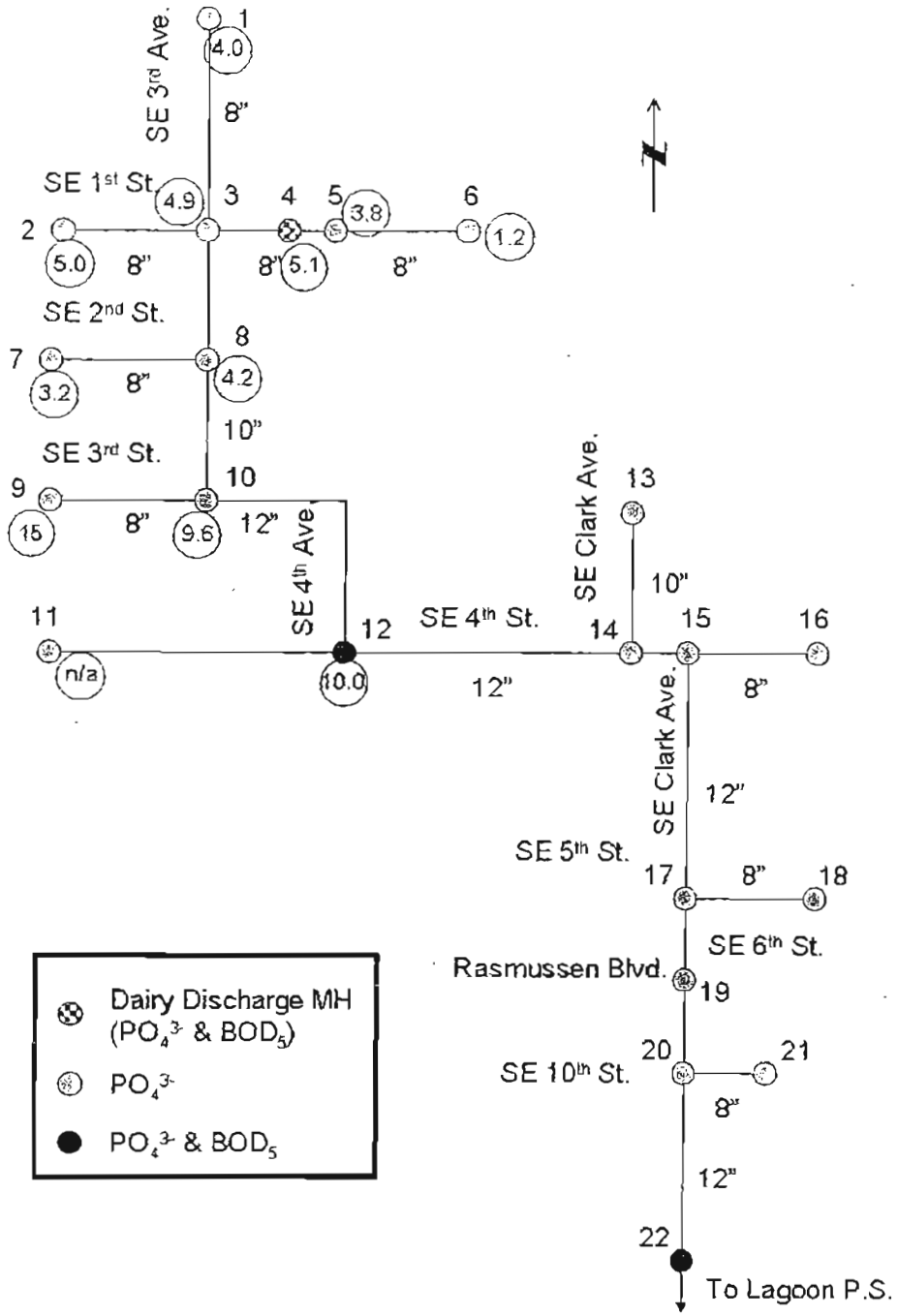


FIGURE 11
DAY 1 OF ORTHOPHOSPHATE SAMPLING
MORNING SESSION

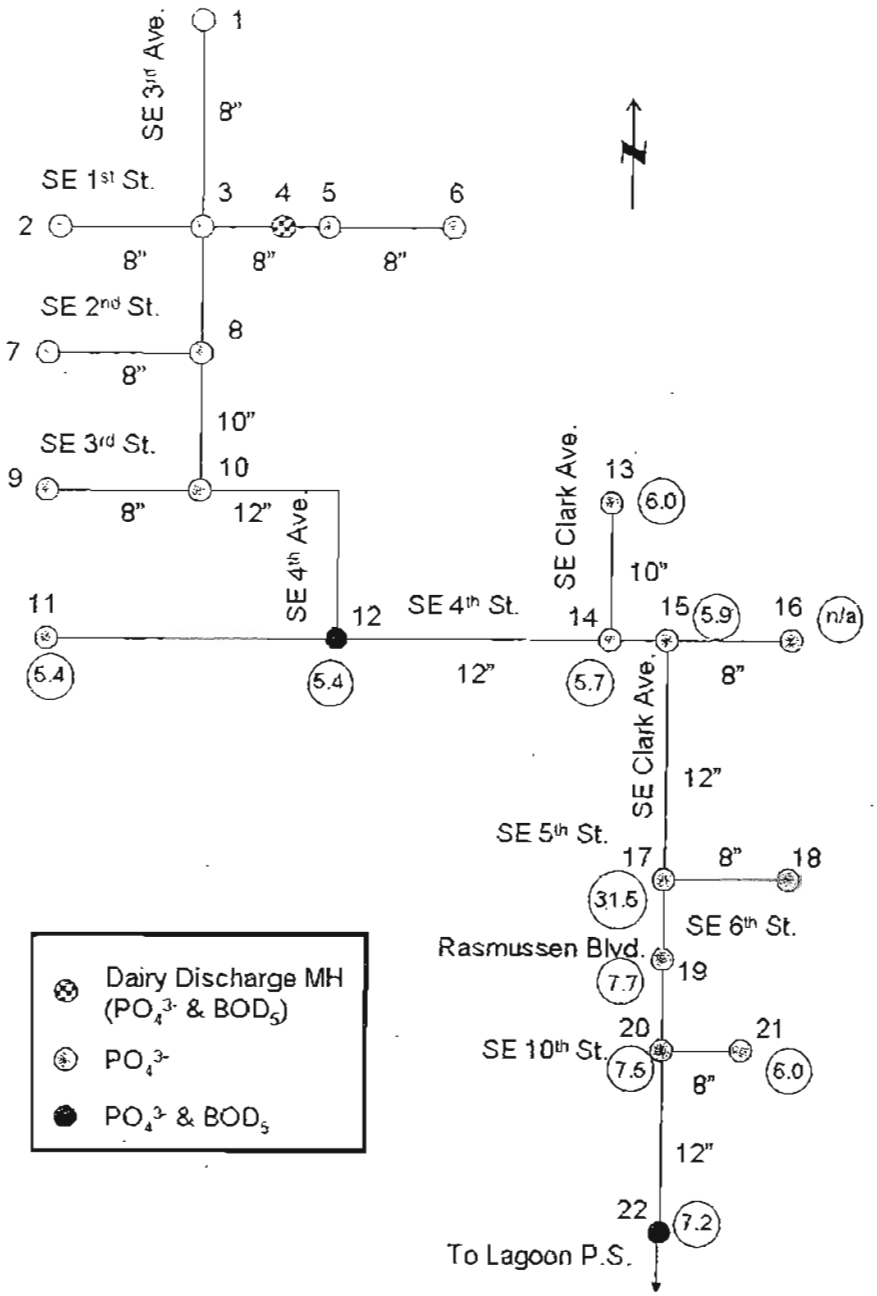


FIGURE 13
DAY 2 OFORTHOPHOSPHATE SAMPLING
MORNING SESSION

The data shown in **Figures 11 and 14** indicate that extremely high orthophosphate concentrations were measured on both days in the reach of sewer between SE 3rd Street and the intersection of SE 4th Street and SE 4th Avenue (i.e. between manholes 9 and 13). Given that more moderate concentration levels were measured in the other locations of the collection system it would appear that the high concentrations that were measured in the 12-inch diameter sewer along SE Clark Avenue were contributed by the flow that is discharged from the 8-inch sewer along S.E. 3rd Street.

The BOD_5 concentrations also fluctuated throughout the collection system. Measurements ranged between 330 and 1,200 mg/L. The wastewater sample containing 1,200 mg/L was taken at manhole 12. This sample was very cloudy and white and looked very similar to wastewater that was seen to be discharged into manhole 4 approximately 10 minutes before the sample was taken at manhole 12.

Ferric Depletion Jar Testing

Jar testing was performed on three wastewater samples taken from the wet well in an effort to determine the extent of potential ferric iron depletion due to the presence of orthophosphate. The samples were taken by HDR. The testing was performed by a third party laboratory. The procedure was as follows:

- Add 4 microliters of 42% ferric chloride to 1 liter of sample wastewater
- Following ferric addition, each sample was mixed for a different period of time according to the following schedule:
  - 1 sample mixed for 1.5 minutes
  - 1 sample mixed for 1 hour
  - 1 sample mixed for 2 hours
  - Measure the orthophosphate concentrations after mixing

A feed rate of 4 microliters of ferric chloride per liter of wastewater is equivalent to 2 gallons per hour of ferric chloride added to 1.3 MGD of wastewater.

Each sample consisted of a known orthophosphate concentration of 6.0 mg/L. The resulting orthophosphate concentrations, percentage removal and corresponding ferric iron depletion percentages are presented in **Table 9**.

TABLE 9

RESULTS OF FERRIC DEPLETION ANALYSIS

Sample Number	Initial $(PO_4)^3$ Concentration (mg/L)	Mixing Duration	Final $(PO_4)^3$ Concentration (mg/L)	% $(PO_4)^3$ Removal	% Ferric Iron Depletion
1	6.0	1.5 minutes	3.5	42	17
2	6.0	1 hour	3.1	48	20
3	6.0	2 hours	3.0	50	20

- It is a chemical that provides a preferred oxygen source to the bacteria that are responsible for sulfide reduction in the slime layer of the sewer. The bacteria prefer nitrate over sulfate. Because of this mechanism, its usefulness as an odor control chemical is not affected by the presence of other wastewater constituents
- No detrimental effects would be registered at Salmon Creek Wastewater Treatment Plant due to its use as an odor control chemical in the forcemain. It should be noted that the Hazel Dell Sewer District is currently using calcium nitrate successfully to control odors in a forcemain in its collection system
- It is non-corrosive and relatively safe to handle
- Although the unit cost of calcium nitrate (approximately $1.70/gal) is greater than that for ferric chloride (approximately $0.90/gal) the possibility exists that less calcium nitrate would be required for odor prevention than ferric chloride.

The pilot testing for both chemicals should be performed before a decision is made for the purchase of chemical for the upcoming warm weather "odor season".

- The information and analysis that results from the pilot testing should be combined with sulfide model prediction data to design an optimized, PLC-based chemical feed system at the Battle Ground Pump Station. Depending on which chemical is chosen for odor control, the feed system should be designed to measure certain wastewater characteristics at the wet well and send a feed signal to the PLC system to properly regulate the amount of chemical that is fed. Such a system would provide the following benefits:
  - To continuously monitor changing wastewater conditions that directly affect both the generation of odor-producing sulfide in the forcemain and the effectiveness of corresponding chemical treatment
  - By optimizing the chemical feed, the risk of overfeeding chemical would be greatly diminished. This would likely result in a long term chemical cost savings to the City.
- The City should conduct additional, simple odor analyses on the lagoon and headworks structure during the warm weather months. This could include continuously monitoring H_2S at the upstream (i.e. turbulent) end of the above-ground headworks using an OdaLog device, grab sampling at the plant fence line using a low-level Jerome 631-X H_2S sampling instrument and sending Tedlar bag-filled gas samples from the north and west end of the lagoon facility (i.e. near the lagoon) to an outside laboratory for gas chromatography analysis. The GC analysis would provide information on organic, gas phase compounds (if any) released from the lagoon that would be detectable by persons outside the fence line.
- If the above-ground headworks structure proves to be the prime source of odors from the facility, the City should cover the open-air channels on the structure. The channel would also need to be force ventilated through an odor scrubbing device such as a bioscrubber, biofilter, etc.
- If the lagoon itself proves to be a significant contributor of odors from the facility, jar testing should be conducted to determine the effectiveness and feasibility of ferric chloride addition to remove orthophosphate from the lagoon. The test could consist of dosing the chemical in various amounts and performing a bioassay to determine the effect on the algae population.
  - If jar testing with ferric chloride proves effective at reducing the algae population in the samples, a full scale pilot test should be performed on site to confirm the jar test

“Battle Ground Surge Basin Facility Odor Control Study”,
Draft Technical Memo from HDR dated September 26, 2005

HDR | ONE COMPANY *Many Solutions*™

Draft Technical Memo

To:	Sam Adams, Rob Charles, Steven Rommel – City of Battle Ground		
From:	Mark Smith		
CC:			
Date:	September 26, 2005		
Project:	Battle Ground Surge Basin Facility Odor Control Study	Project No:	21680/Task 5
RE:			

INTRODUCTION

An 8-acre surge basin is located next to the Battle Ground Pump Station (BGPS). This facility is used primarily as a wet weather retention facility to store sewage upstream of the Battle Ground Force Main (BGFM). Odors routinely emanate from the surge basin. Additionally, operators downstream at the Salmon Creek Wastewater Treatment Plant (SCWWTP) report that algae periodically enter their plant following the release of wastewater from the surge basin into the BGFM. The data obtained from this analysis will assist in developing recommendations for surge basin algae and odor control.

Prior to entering the BGPS, influent wastewater passes through an on-site, two-cell aerated flow equalization basin. High levels of turbulence have been observed in the flow equalization basin due to the aeration provided by two 1,200 cfm blowers. Each blower aerates a single cell.

SUMMARY OF SAMPLING EFFORTS

Over a two day period, gas phase grab samples were collected at the surface of the surge basin, the surface of the flow equalization basin, and at the west and north fence lines of the surge basin/BGPS property (see Figure 1 on the following page). Laboratory analyses were performed by two third party laboratories to determine the following odor characteristics:

- TO-12 total gaseous nonmethane organic compounds (TGNMO)
- Detection threshold
- Recognition threshold
- Intensity
- Character
- Hedonic tone
- Persistency

All lab analyses, except the TGNMO, were performed with the use of an odor panel.

Grab samples were also taken for hydrogen sulfide concentrations at several points around the west and north fence lines. Values for these samples were determined in the field using a Jerome 631-X hydrogen sulfide gas analyzer.

Hydrogen Sulfide Grab Sampling

Grab samples for hydrogen sulfide were taken at numerous locations on the grounds of the surge basin site. The results of this sampling are summarized graphically in **Figure 2**. Several hydrogen sulfide grab samples were also taken approximately one foot above the open air discharge point on the headworks structure. These results are summarized in **Table 2**.

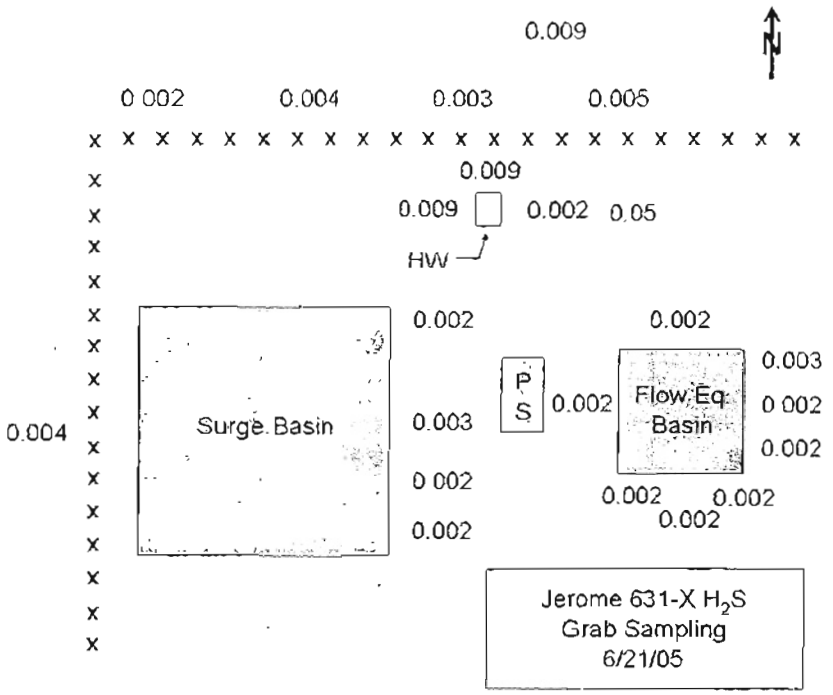


Figure 2
Hydrogen Sulfide Sampling Results

Table 2
Hydrogen Sulfide Grab Samples at Headworks Open Air Discharge Point
6/21/05, 1:00pm

[H_2S] (ppm)	Headworks Pump On/Off
0.16	off
0.04	off
4.7	on
6.2	on
0.15	off
0.38	off
0.11	off
0.40	on

DISCUSSION OF SAMPLING RESULTS

Total Gaseous Nonmethane Organic Compounds (TGNMO)

The results of the organic compound analysis show that the surge basin is likely the prime source of organic odor compounds. The grab sample that was analyzed produced a total organic nonmethane organic compound concentration of 1.8 ppm. The flow equalization basin sample, while not insignificant, produced a less concentrated organic compound value of 1.03 ppm. Note also that a concentration of 1.04 ppm was measured at the north fence line, just outside the surge basin site grounds.

Odor Panel Analysis

The odor panel data indicate that odors from the surge basin and aboveground, open air headworks discharge constitute the highest concentrated and most persistent odors. In addition, the hedonic tones of the odors from these two sources indicate they are considered to be the two most unpleasant of the air samples tested.

Hydrogen Sulfide Grab Sampling

Most of the hydrogen sulfide samples recorded on or near the surge basin site grounds were well below the human detection limit for hydrogen sulfide. This value is typically regarded to be approximately 6 parts per billion (0.006 ppm). The only areas of the surge basin site where grab samples exceeded this threshold were in and around the headworks structure (see **Figure 2** and **Table 2**). Hydrogen sulfide concentrations between 0.11 and 4.7 ppm were recorded in the headspace just above the discharge of the headworks structure. These values are several orders of magnitude greater than the detection threshold for hydrogen sulfide.

DISCUSSION OF ODOR EMISSION RATES

The three likeliest sources of odor emissions at the surge basin site are the surge basin, headworks, and flow equalization basin. Each of these facilities releases odorous compounds to the atmosphere by different means. The flow equalization basin releases odors due to the turbulence induced by the two 1,200 cfm blowers that are employed to aerate each of the two basins. The headworks releases odors from the open air, aboveground channel due to the action of the pump that raises the flow into the channel from the wet well. The surge basin releases odors from its surface by the least turbulent (and consequently least effective) method, namely wind-induced surface turbulence.

Once an understanding of odor unit concentration, facility geometry, and odor stripping mechanisms are understood, it is possible to calculate an "odor emission rate" from each of the three facilities. This provides a true measure of the most likely source(s) of odorous air from the surge basin site grounds. **Table 4** presents a summary of odor emission rates from the surge basin, flow equalization basin, and aboveground headworks channel structure.

Table 4
Summary of Odor Unit Emission Rate Estimates for Each Facility

Location	Reported DT	Blower Rate (cms)	Assumed Air Velocity (m/s)	Flux Rate (cms)	Emission Rate (OU/sec)
Headworks channel	4200	n/a	1	1.9	7980
Surge basin	3200	n/a	n/a	1.5	4800
Flow equalization basin	50	0.54	n/a	n/a	27

Notes:
CMS – cubic meters per second
OU – odor units

achieved with a ferric chloride feed system, the potential for significant odor control does not necessarily exist by utilizing this technology alone.

Dissolved Air Floatation (DAF) Facility

DAF facilities have been successfully used for algae reduction. Such a facility could be designed to treat and remove algae from the surge basin before it is released to the wastewater collection system. The high capital cost (approximately $1M) would have to be weighed against the fact that the surge basin will be relocated in the near future. The DAF would only have a useful life of about five years.

Floating Cover

An opaque floating cover would provide two significant benefits for the existing surge basin:

- Algae and duckweed control (due to the blockage of sunlight, thereby reducing the photosynthetic activity of organisms)
- Complete odor control; any fugitive odors ordinarily released from the water body would remain under the floating cover.

High capital cost (approximately $1M) would have to be weighed against the fact that the surge basin will be relocated in the near future. For comparison purposes, the new facility has been conceptualized as being totally enclosed with a structural cover. The new facility has also been conceptualized with a forced air ventilation odor control system.

The new surge basin could be designed to use a floating cover transferred from the existing site, thereby negating the need for forced air ventilation from the new surge basin. Also, it should be noted that the capital cost of a structural cover for a new surge basin constructed of cast-in-place concrete and aluminum could cost approximately $2M - $4M dollars.

Table 5 summarizes the issues related to each of the algae abatement options discussed above.

Table 5
Summary of Existing Surge Basin Algae and Odor Abatement Options

Option	Relative Cost	Algae Reduction Potential	Odor Reduction Potential	Additional Issues
$CuSO_4$ feed	Moderate	Significant	Small to moderate	Short life span
$FeCl_3$ feed	Moderate	Significant	Small to moderate	Short life span
DAF facility	High	Significant	None	Short life span
Floating cover	High	Significant	High	Potential to transfer use to new facility

CONCLUSIONS

The conclusions that follow are based on the results of the odor sampling and analysis. Also, the following assumptions were made in reaching these conclusions:

- The aboveground headworks facility will be abandoned and relocated to a new site on the surge basin site grounds. Odor control consisting of forced air ventilation through an odor scrubber will be provided.
- The existing surge basin will be abandoned. A new 8-acre surge basin will be designed and built (relocated well off-site) within five years' time.

Headworks Channel

This structure is a significant contributor of foul air. Turbulence induced by the pumps as the wastewater is lifted to the channel strips H2S and malodorous organic compounds from the solution. Winds from the southerly direction carry this odorous air toward houses on the north side of the surge basin site. The redesign

APPENDIX D

Figure 2-5 from Wastewater Engineering Treatment, Disposal and Reuse, Metcalf & Eddy Inc., Third Edition

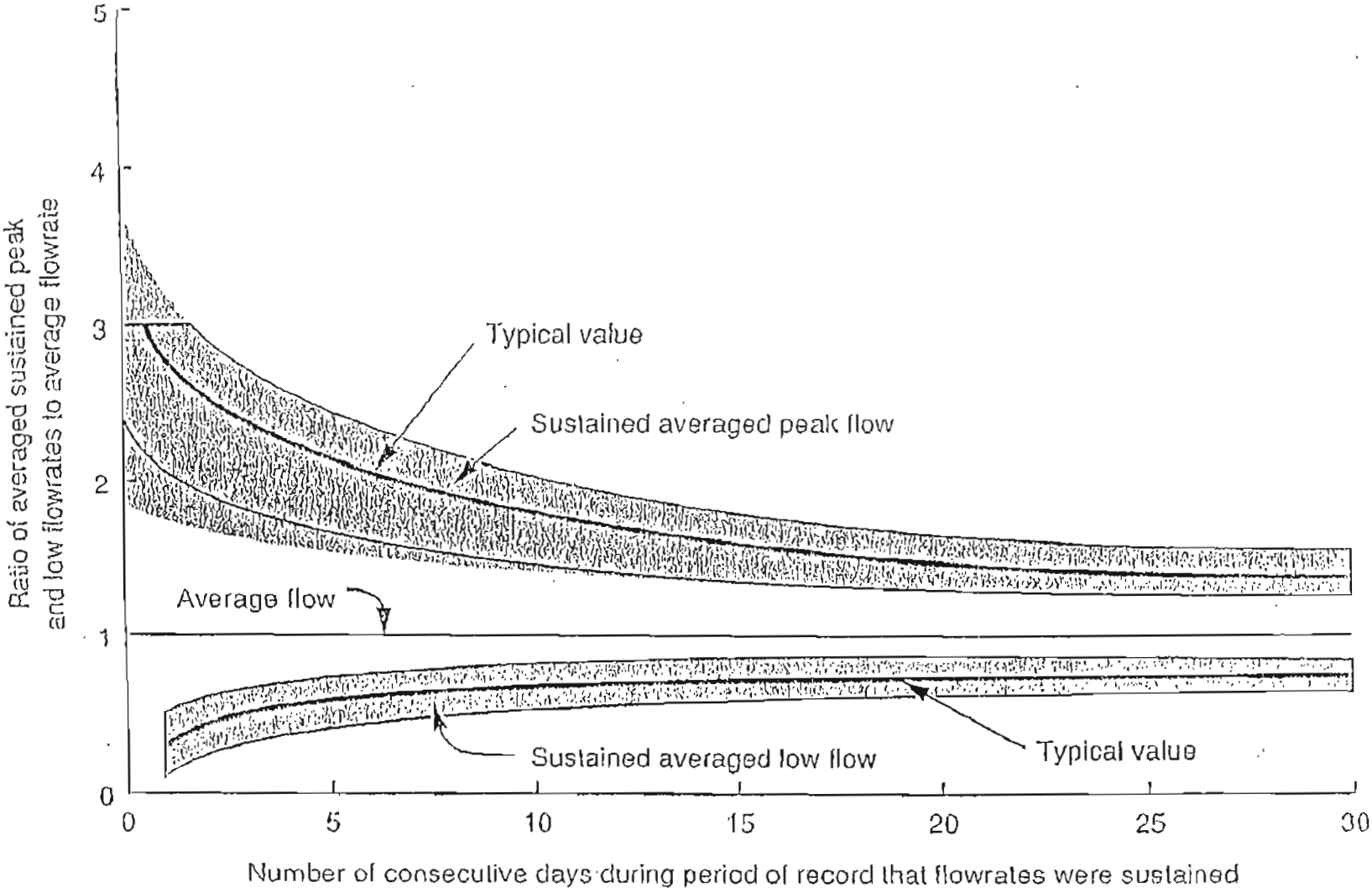
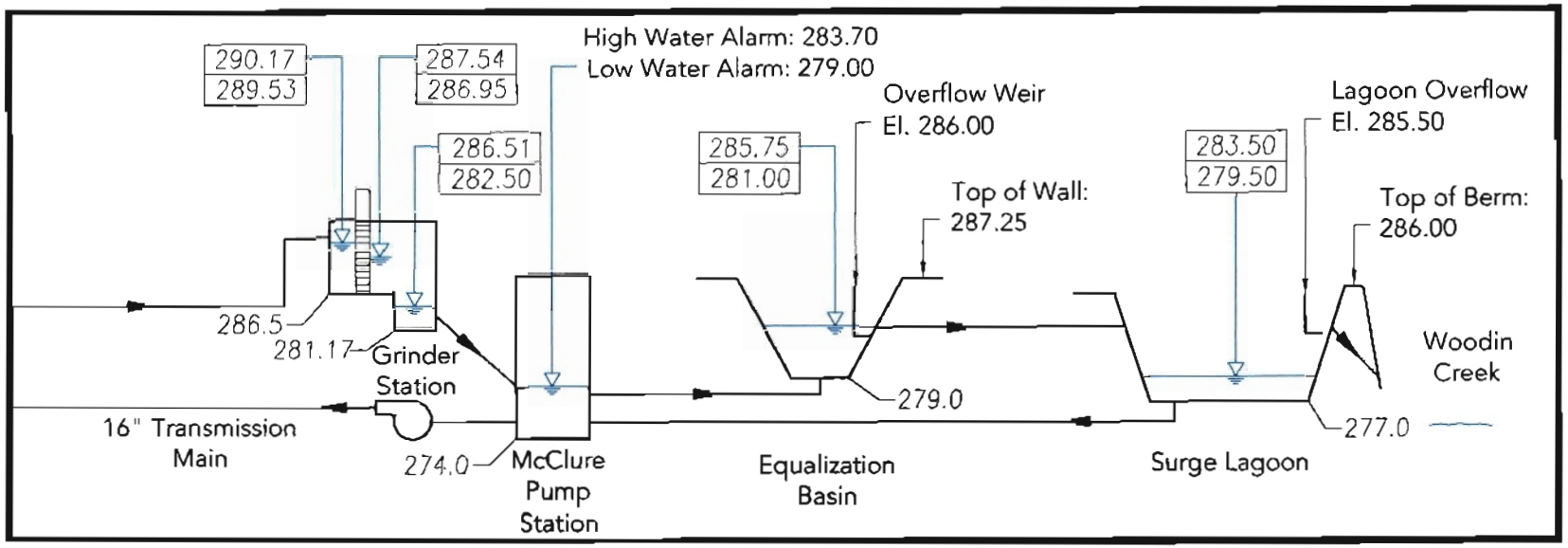


FIGURE 2-5

Typical ratios of averaged sustained peak and low daily flowrates to average annual daily flowrates for time periods up to 30 days.

Source: Wastewater Engineering Treatment, Disposal and Reuse, Metcalf & Eddy Inc., Third Edition.

Transmission System Hydraulic Profile



Legend:

Flow Direction

1 — 12 MGD Peak Flow Water Surface Elevation (Feet)

2 — 2.96 MGD Design Flow Water Surface Elevation (Feet)

Water Surface

Assumptions:

1. Surge Lagoon and Equalization Basin are full under peak flow conditions.
2. Under low flow conditions 2 feet of water in Surge Lagoon and Equalization Basin.

THE CITY OF BATTLE GROUND

Transmission System Hydraulic Profile

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APPENDIX E

Discovery Clean Water Alliance Interlocal Formation Agreement

September 27, 2012

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Discovery Clean Water Alliance Interlocal Formation Agreement

I. RECITALS: Purpose of Alliance**.** The purpose of the Discovery Clean Water Alliance is to provide cooperative municipal utility services to its Members in order to assist those Members with a cost-effective mechanism for supporting regional economic development in an environmentally-sound manner, to help manage Member service costs in a financially-transparent manner, to provide reliable and predictable service, and to provide a framework that encourages the participation of all Clark County municipal utilities that protects both regional and jurisdictional autonomy.

II. DEFINITIONS

II.A. "Additional Members" mean any municipal corporations, other than Original Members, that provide wastewater services and later join the Alliance pursuant to Section IV.G.

II.B. "Administrative Lead" means any Member or other entity serving in that capacity, consistent with Sections V.A and V.B. If the Alliance determines to undertake administrative responsibilities itself, using its own staff, then as used in this Agreement the term "Administrative Lead" shall mean the chief executive officer of the Alliance.

II.C. "Agreement" means this Discovery Clean Water Alliance Interlocal Formation Agreement.

II.D. "Alliance" means the Discovery Clean Water Alliance.

II.E. "Alliance Operations Date" means the date on which the Board has determined that (1) Regional Assets have been transferred to or for the benefit of the Alliance, (2) outstanding wastewater obligations have been retired, defeased, or transferred as necessary, (3) the Alliance is undertaking responsibility for providing service under this Agreement, and (4) the Members receiving service from the Alliance become responsible for paying Regional Service Charges. The Alliance Operations Date is expected to be January 1, 2015, unless the Board designates a different date.

II.F. "Allocated Capacity" means the MMF of wastewater that a Member may discharge into the Regional Assets, as described in Exhibit B and as supplemented or adjusted in a Capital Plan.

II.G. "Average Annual Flow" or "AAF" means the total flow of wastewater in millions of gallons during any 12 month consecutive period, or any shorter period approved by the Board, divided by the number of days in that period, expressed in MGD.

II.H. "Battle Ground" means the City of Battle Ground, Washington.

II.I. "Board" means the Board of Directors of the Alliance.

II.J. "Bonds" means bonds, notes or other evidences of indebtedness issued by the Alliance or by another entity (*e.g.,* by a Member) on behalf of the Alliance.

II.K. "Capital Plan" means one or more long-range capital improvement plans for the addition, replacement, or improvement of Regional Assets, and including an identification of Regional Assets and the allocation of transmission and treatment capacity, as they may be supplemented or adjusted from the initial Regional Assets and allocations described in Exhibit B.

II.L. "Capital Budget" or "Capital Budgets(s)" means one or more capital budgets adopted consistent with Section VI.A.

II.M. "Clark County" means Clark County, Washington.

II.N. "CRWWD" means Clark Regional Wastewater District.

II.O. "Director" means an individual who serves on the Board of the Alliance.

II.P. "Dual Majority Vote" means a Board vote requiring the affirmative vote of both (1) the Directors representing more than 50% of the Members, and (2) the Directors representing the Members comprising more than 50% of the Treatment Facilities Allocated Capacity for the year in which the vote is taken, as set forth in the then-current Capital Plan.

II.Q. "Dual Super-Majority Vote" means, except as provided in Section IV.F.3, a Board vote requiring the affirmative vote of both (1) the Directors representing more than 60% of the Members, and (2) the Directors representing the Members comprising more than 60% of the Treatment Facilities Allocated Capacity for the year in which the vote is taken, as set forth in the then-current Capital Plan.

II.R. "Financial Policies" mean the financial policies attached as Exhibit A and incorporated herein by reference, including such amended or replacement Financial Policies adopted consistent with this Agreement.

II.S. "Member" (collectively, "Members") means one or more governmental members of the Alliance, and includes Original Members and Additional Members.

II.T. "MGD" means million gallons per day, referring to a rate of flow.

II.U. "Maximum Monthly Flow" or "MMF" means a measure of flow expressed in MGDs and representing the highest average monthly flow, taking into account the total flow of wastewater discharged into the Regional Assets, measured in millions of gallons for any calendar month divided by the total number of days in that month.

II.V. "Operating Budget" means the periodic operating budget prepared consistent with Section VI.A.

II.W. "Operator(s)" means any Member or other entity serving in that capacity, consistent with Sections V.A and V.C. If the Alliance determines to undertake Operator responsibilities itself, using its own staff, then as used in this Agreement the term "Operator" shall mean the chief executive officer of the Alliance.

II.X. "Original Members" means the governmental entities initially executing this Agreement and forming the Alliance, *i.e.,* Clark County, the Clark Regional Wastewater District, the City of Battle Ground and the City of Ridgefield.

II.Y. "Pre-Alliance Agreements" means, collectively: (1) the Joint Contract Among Clark County, the City of Battle Ground and Hazel Dell Sewer District for Sewage Treatment, Disposal and Transport Services, dated March 28, 1995; (2) the Contract Between Hazel Dell Sewer District and the City of Battle Ground for Sewage Treatment Capacity and Payment, dated March 28, 1995; and (3) the Interlocal Agreement Concerning Phase IV Sewer Treatment Plant Improvements Between Clark County, the Hazel Dell Sewer District and the City of Battle Ground, dated August 9, 2005.

II.Z. "Regional Assets" means the assets listed in Exhibit B, attached and incorporated herein by reference, and such additional assets as the Board may later determine to be Regional Assets under Section VII.B.

II.AA. "Regional Service Charges" means charges for service imposed by the Alliance under Section VI.B.

II.BB. "Ridgefield" means the City of Ridgefield, Washington.

II.CC. "Significant Decisions" mean the decisions of the Board listed as such in Section IV.F.

II.DD. "Transmission Infrastructure" means transmission lines, force mains, interceptors, pump stations and other facilities required to transfer wastewater from a Member's collection system to a Treatment Facility.

II.EE. "Treasurer" means the person or entity appointed pursuant to RCW 39.106.050(13) and Section VI.E.

II.FF. "Treatment Facility" or "Treatment Facilities" means treatment plants, outfalls and other facilities required to treat wastewater.

III. FORMATION

III.A. Creation of Alliance. The Discovery Clean Water Alliance is formed under the Joint Municipal Utility Services Authority Act, Chapter 39.106 RCW.

III.B. Purpose and Powers. The purpose of the Alliance is to jointly provide regional wastewater transmission and treatment for Alliance's Members and other contracting municipal wastewater utilities. The Alliance may exercise all powers authorized by Chapter 39.106 RCW, subject to the terms of this Agreement. The Alliance will provide all necessary wastewater Treatment Facilities and services for its Members, together with all necessary Transmission Infrastructure facilities and services for its Members who opt for those services. The Alliance may provide additional utility services as the Members may determine appropriate.

III.C. Name of Entity. The name of the joint municipal utility authority formed under this Agreement is the Discovery Clean Water Alliance (the "Alliance").

III.D. Membership. The membership of the Alliance is comprised of Clark County, the Clark Regional Wastewater District, the City of Battle Ground and the City of Ridgefield (collectively, the "Original Members"), together with any other municipal corporations providing wastewater services that later join pursuant to Section IV.G ("Additional Members").

III.E. Termination of Existing Agreements. As of the Alliance Operations Date, the Pre-Alliance Agreements shall be terminated. All existing capacity rights of the Original Members under the terms of the Pre-Alliance Agreements are and will be transferred to each of the Original Members under this Agreement, subject to later adjustments under a future Capital Plan.

IV. ORGANIZATION STRUCTURE AND BOARD POWERS

IV.A. Board Composition. The Board of Directors of the Alliance consists of one Director and any alternate Directors appointed by each member. Directors and alternates must be elected officials of the appointing Member. More than one alternate may be appointed to serve on the Board when a Member's designated Director is unable to participate in a meeting, but only one Director from each Member may actively participate in a Board meeting at any time. The Members may appoint and remove their appointee Directors in such manner as they individually determine.

IV.B. Board Powers. The Board shall exercise all policy, oversight and governance powers of the Alliance, and carry out responsibilities specified in this Agreement. The Board shall adopt appropriate rules, including Board rules and operating procedures.

IV.C. Board Officers and Legal Counsel. Board officers will consist of a Chair, Vice-Chair and Secretary, and such other officers as the Board may deem appropriate. Legal counsel to the Alliance, if any, shall report directly to the Board.

IV.D. Board Committees and Advisory Boards. The Board will create such committees and advisory boards as it deems appropriate, including committees to consider finance issues, maintenance and operations matters, and capital planning and infrastructure. Committees and advisory boards may include either Directors or non-Directors, or both.

IV.E. Board Meetings. Notice of Board meetings must conform to the requirements of the Open Public Meetings Act (Chapter 42.30 RCW). Additional requirements regarding notice, preparation and distribution of agendas, minutes and conduct of meetings may be established by resolution or in rules adopted by the Board.

IV.F. Board Voting. Significant Decisions of the Board require either a Dual Majority Vote or a Dual Super-Majority Vote (*i.e.,* a "House & Senate" system).

IV.F.1. "Significant Decisions" requiring a Dual Majority Vote are:

IV.F.1.a. The borrowing of money and the issuance of Bonds by the Alliance or by another entity (*e.g.,* by a Member) on behalf of the Alliance;

IV.F.1.b. A change in the identity of the Administrative Lead and/or Operator(s), whether a change to a different governmental entity or to the Alliance itself, except as otherwise provided in Section V.A;

IV.F.1.c. A change in the ownership of material Regional Assets, *i.e.*, the sale, lease, mortgage or other encumbrance, transfer, or disposal of any part of the Regional Assets that are used, useful or material in the operation of those Regional Assets and the provision of services, but excluding Regional Assets or portions thereof that have become unserviceable, inadequate, obsolete or unfit to be used in the operation of the Regional Assets, or are no longer necessary, material to or useful to the operation of the Regional Assets;

IV.F.1.d. The adoption of an Operating Budget;

IV.F.1.e. The adoption of a Capital Budget; and

IV.F.1.f. The exercise of eminent domain by the Alliance.

IV.F.2. "Significant Decisions" requiring a Dual Super-Majority Vote are:

IV.F.2.a. Amendments to this Agreement;

IV.F.2.b. Amendments to the Financial Policies;

IV.F.2.c. The adoption of a Capital Plan and the allocation of costs pursuant to any such Capital Plan, except that upon the request of any Member, the Dual Super-Majority Vote with respect to the portion of the Capital Budget for any discrete Regional Asset will be taken with only the Members served or to be served by that Regional Asset voting based on Allocated Capacity in that Regional Asset, and only their votes being considered in calculating the required 60%-or-more of allocated flow under the Dual Super-Majority Vote;

IV.F.2.d. The material allocation or reallocation of treatment or transmission capacity (except that any reallocation that reduces an Original Member's capacity to less than the Allocated Capacity shown in Exhibit B shall require the agreement of that Original Member unless that Original Member is in default as described in Section VI.B.2);

IV.F.2.e. The determination of the appropriate payment obligations of a withdrawing Member under Section IV.H;

IV.F.2.f. Admissions of new Members (except as provided in Section IV.G); and

IV.F.2.g. Termination of this Agreement (see Section IX).

IV.F.3. If any Member is dissatisfied with a decision of the Board on a decision requiring a Dual Super-Majority vote, that Member may file with the Board Chair within 10 business days of the decision a request to refer the decision to mediation. The mediator shall be selected by the Board and approved by that Member. The mediator shall complete the mediation process within 30 days of the filing of the request, unless the Board and that Member agree to a longer period. If the Member is not satisfied with the outcome of the mediation process, that Member may file with the Board Chair within 10 business days of completion of the mediation process a request for mandatory final binding arbitration. The arbitrator shall be selected by the Board and approved by that Member. The arbitration hearing shall be completed within 45 days of the filing of the request for arbitration, unless the Board and that Member agree to a longer period. The arbitrator may reverse the Board's decision only if the arbitrator determines that Board's action was unlawful, arbitrary or capricious. Costs of mediation and arbitration will be divided equally between the Alliance and the Member requesting that mediation and/or arbitration.

IV.F.4. Except as provided in Sections IV.F.2.d and VII.C, decisions that are not listed as Significant Decisions are made by majority vote of the Directors present and voting.

IV.F.5. A Member may not exercise its voting rights so long as it is in default under Section VI.B.2.

IV.G. Additional Members. The inclusion of each Additional Member requires a Dual Super-Majority Vote. Each Additional Member will be expected to "buy in" to the Alliance by paying for its allocable share of Regional Assets and/or by contributing Regional Assets, in such amounts as will be determined by the Board. However, if a city other than an Original Member assumes service to a portion of a Member water-sewer district that is served by the Regional Assets, and the portion assumed represents (cumulatively) more than five percent of that water-sewer district's then-current service as measured by Average Annual Flow, the assuming city automatically may become a Member upon its application to do so. A later reduction of Average Annual Flow to less than five percent will not affect that entity's membership status.

IV.H. Withdrawal of a Member. In order to prevent remaining Members to be left with "stranded costs," if any Member withdraws it is responsible for the full cost of its withdrawal to the Alliance, including without limitation the payment or provision for payment of its allocable share of capital costs incurred (and Bonds issued) in anticipation of its needs while a Member, consistent with then-current Capital Plans and Capital Budgets. The Board, acting in its reasonable judgment, has the sole power to determine the appropriate payment obligations of a withdrawing Member. The Director representing a Member proposing to leave the Alliance may not vote on the determination of that leaving Member's payment obligations to the Alliance.

IV.I. Effects of Service Area Adjustments. Upon a service area adjustment, if customers are shifted from one Member to another, the Members' respective capacities, voting rights (based on Allocated Capacity), and obligations shall automatically adjust accordingly.

IV.J. Public Records. The Alliance will comply with the requirements of the State Public Records Law, Chapter 42.56 RCW.

V. ADMINISTRATION AND OPERATIONS

V.A. Administration and Operations: Allocation of Responsibilities. Alliance staff (if any) and/or a service provider by contract with the Alliance, shall administer and manage the Alliance and the Regional Assets. (A service provider shall be referred to in this Agreement as "Administrative Lead"). Alliance staff (if any) and/or one or more service providers by contract with the Alliance shall operate the Regional Assets (the service providers shall be referred to individually or collectively in this Agreement as "Operator" or "Operators"). CRWWD shall serve as the initial Administrative Lead for at least five years after the Alliance Operations Date. Clark County shall serve as Operator of the Salmon Creek Wastewater Management System and the Battle Ground Force Main System and Ridgefield shall serve as Operator of the Ridgefield Treatment System (all as described in Exhibit B) for at least five years after the Alliance Operations Date. The initial designation of CRWWD as Administrative Lead and the initial designation of Clark

County and Ridgefield as Operators may be adjusted upon the mutual agreement of the Board and the Member serving as Administrative Lead or as an Operator. The Board periodically, and at least every five years after the Alliance Operations Date shall review, and may adjust, Administrative Lead and Operator arrangements. Changes in Administrative Lead or Operator responsibilities shall take effect no sooner than the calendar year beginning at least 12 months after the decision to make the relevant change. In connection with the transfer of Administrative Lead or Operator responsibilities, the Alliance will use its best reasonable effort to provide that either the Alliance or the Member undertaking or contracting for the services provided by the Administrative Lead or Operator will hire each of the employees of the previous Administrative Lead or Operator who had previously performed the relevant services and who requests continued employment in that or a similar capacity.

V.B. **Administrative Lead's Responsibilities**. Under the Board's direction, and consistent with Board policies, the Administrative Lead will administer and manage the overall affairs of the Alliance, other than operation of the Regional Assets. The Administrative Lead shall have full power and authority to control the hiring and designating of staff and consultants to carry out its administrative and management functions. The Administrative Lead will prepare and oversee preparation of Operating Budgets, Capital Plans, Capital Budgets, and proposed Regional Service Charges (based on the Financial Policies) for the Board's review and approval. The Administrative Lead will administer and manage capital planning and capital improvements, including but not limited to expansion and/or upgrade of existing Regional Assets and acquisition, construction and/or upgrade of new Regional Assets, except that for improvements to existing Regional Assets where the cost of improvements is below a specified amount determined by the Board, an Operator may be charged with responsibility for managing those improvement projects. The Administrative Lead will report regularly to the Board on the administration and management of the Alliance. Neither the Board, nor an individual Board member or a governmental Member other than the Member serving as Administrative Lead, shall direct the Administrative Lead to appoint or remove its staff or consultants, nor shall the Board, an individual Board member or a governmental Member (other than the Administrative Lead) give orders to any employee or consultant working for the Administrative Lead. This restriction does not prohibit the Board, in open session, from fully and freely discussing, with representatives or staff of the Administrative lead, anything pertaining to appointments and removals of staff or consultants. The Administrative Lead will coordinate actively with the Operators.

V.C. **Operator's Responsibilities for Day-to-Day Operations**. Except as otherwise provided in this Agreement, and consistent with Board policies, the Operators will operate Regional Assets assigned to them. An Operator shall have full power and authority to control the operation of the Regional Assets for which it is responsible, including but not limited to hiring and designating of staff and consultants, making decisions on the use or application of processes, equipment and facilities and controlling other operating decisions. As part of its operational functions, an Operator will also manage capital

improvements to existing Regional Assets it is operating where the cost of those improvements is below a specified amount determined by the Board. Neither the Board, nor an individual Board member or a governmental Member other than the Member serving as Operator, shall direct an Operator to appoint or remove its staff or consultants , nor shall the Board, an individual Board member or a governmental Member (other than the Operator) give orders to any employee or consultant working for the operator. This restriction does not prohibit the Board, in open session, from fully and freely discussing, with representatives or staff of the Operator, anything pertaining to appointments and removals of staff or consultants. The Operators will coordinate actively with the Administrative Lead and report regularly to the Board on the operations for which it is responsible.

V.D. **Applicable Personnel Laws**. An Operator and/or an Administrative Lead shall apply personnel laws to its own employees in carrying out its responsibilities under this Agreement. To the extent that the Alliance directly employs personnel, the personnel laws pertaining to code cities under Chapter 35A.41 shall apply, and if any Member is a code city with a population of more than 20,000, then the provisions of RCW 35A.41.010 shall apply.

V.E. **Public Works and Procurement Laws**. An Operator and/or an Administrative Lead other than the Alliance shall apply the public works and procurement laws applicable to that Operator's and/or Administrative Lead's form of government. If the Alliance is the Administrative Lead and/or the Operator of Regional Assets, in either or both of those capacities the Alliance shall apply the public works and procurement laws applicable to code cities under RCW 35A.40.210 and RCW 35.23.352. Consistent with RCW 35A.40.210, for purchases RCW 35.22.620 shall apply if any Member has a population of 20,000 or more, and otherwise the provisions of RCW 35.23.352 shall apply.

V.F. **Eminent Domain Laws**. The Alliance will apply and exercise the powers of eminent domain under the laws applicable to code cities pursuant to Chapter 8.12 RCW. Notwithstanding the foregoing, if a Member that is an Operator or an Administrative Lead exercises eminent domain with respect to a Regional Asset or proposed Regional Asset, that Operator shall apply the eminent domain laws applicable to that Operator's form of government.

V.G. **Surplus Property**. The Alliance will apply and exercise the powers respecting surplus property under the laws applicable to code cities pursuant to RCW 35A.11.010. Notwithstanding the foregoing, if a Member that is an Operator surpluses property with respect to a Regional Asset, that Operator shall apply the surplus property laws applicable to that Operator's form of government.

V.H. **Regulatory Compliance**. The Alliance must operate and maintain Regional Assets consistent with state and federal laws and regulations.

V.I. **Indemnification**. The Alliance will indemnify the Members, their officers and employees for damages caused by the willful misconduct or negligence of the Alliance, its officers, employees and agents.

V.J. **Ethics**. The Alliance, its officers and employees (if any) shall be subject to the provisions of Chapter 42.23 RCW.

VI. FINANCE, BUDGET AND REGIONAL SERVICE RATES

VI.A. **Operating Budgets, Capital Plans and Capital Budgets**. An annual or biennial Operating Budget and periodic Capital Budgets will be prepared by Alliance staff or consultants (or, if there is a separate Administrative Lead, then by the staff of or consultants selected by that entity). Similarly, prior to Board action, comprehensive Capital Plans, including a renewal and replacement fund mechanism, will be periodically prepared by Alliance staff (or, if there is an Administrative Lead, by the staff of that entity in cooperation with staff of any Operator).

VI.B. **Regional Service Charges for Regional Services.**

VI.B.1. The determination of Regional Service Charges paid by Members shall be consistent with the Financial Policies attached as Exhibit A. Unless determined otherwise by the Board of Directors, a basic principle of the Financial Policies is that each Member's responsibility for Regional Asset operating costs will be based on actual use of regional services during the previous year or years, as measured by Average Annual Flow, and that each Member's responsibility for capital costs will be based on agreed-upon Allocated Capacity as set forth in Exhibit B, as it may be amended from time to time. (By way of illustration, if Clark County does not contribute any flow to the Regional Facilities and does not plan to do so, it will not be responsible for either operating costs or capital costs.) Administrative costs of the Alliance not related directly to the day-to-day operations or capital costs will be determined by Treatment Facilities Allocated Capacity. A Member shall not be responsible for paying Regional Service Charges with respect to Regional Assets that are not used for service to that Member or in which that Member has no Allocated Capacity. Annual or biennial adjustments to Regional Service Charges based on changes in capital and operating requirements, revenues, and other factors, will be proposed by consultants and staff of the Administrative Lead, provided to the appropriate committee or committees for review and comment, and then provided to the Board for its consideration and action.

VI.B.2. The Alliance shall provide each Member with periodic invoices showing the Regional Service Charges payable by that Member for the billing period and the due date. Invoices shall be provided monthly or on other such periodic schedule as determined by the Board, but no more frequently than monthly nor less frequently than once every six months. The Board will determine a due date for

all invoices. Payment of any and all invoices shall be due and payable on or before the due date, and shall be made by electronic, ACH, wire transfer or such other means as are agreed to by the Alliance and the Member. If a treasurer, trustee, fiscal agent or escrow agent is appointed in connection with the issuance of Bonds, the Alliance may require, and specify on the invoice, that certain amounts be provided directly to that entity, and the Member shall pay those amounts in the manner and to the entity so specified. If full payment of any invoice is not received on or before the due date, such payment shall be considered past due and a late payment charge shall accrue for each day that the invoice remains unpaid. The late payment charge shall equal the product of the unpaid amount and an interest rate established by the Board, plus an additional penalty established by the Board. Late payment charges shall continue to accumulate until the unpaid amount of the invoice and all late payment charges are paid in full. Further, if an invoice or any portion thereof remains unpaid for more than 60 days after the due date, the relevant Member shall be deemed in default, and the Alliance may pursue any legally available remedy at law or equity for the unpaid amount, including without limitation specific performance and collection of the late payment charge. The Alliance's right to enforce payments in this regard may be assigned to a treasurer, trustee, credit enhancement provider or other entity. If a Member is in default as described in this subsection VI.B.2, that Member shall have no right to vote on any matter before the Board until the default is fully remedied and the other Members are fully reimbursed for payments made in lieu of the defaulting Member.

VI.B.3. If any Member disputes all or any portion of an invoice, it shall notify the Alliance immediately upon receipt. If the Alliance does not concur, the Member shall remit payment of the invoice in full, accompanied by written notice to the Alliance indicating the portions of the invoice that the Member disputes and the reasons for the dispute. The Member and the Alliance shall make a good faith effort to resolve such dispute. If the Member fails to remit payment of the invoice in full pending resolution of the dispute, the Alliance may reduce or suspend the relevant services until the invoice and any late payment charges are paid. Further, the prevailing party in an action relating to the collection of that invoice shall be entitled to reasonable attorney fees and costs. If a Member substantially prevails in challenging Regional Service Charges that have been imposed, it will be repaid any overpayment together with interest computed at the interest rates earned by the State's local government investment pool. Whether a Member "substantially prevails" must be determined through the dispute resolution process, including a determination by a court or arbitrator.

VI.B.4. Upon an event of default as described in subsection VI.B.2 (*i.e.*, if a Member fails to pay an invoice within 60 days after the due date), the other Members that are also served by the Regional Assets providing the service for which Regional Service Charges are unpaid, shall promptly pay the Alliance (in addition to

Regional Service Charges otherwise due) the defaulting Member's Regional Service Charges in proportion to those other Members' Allocated Capacity (amongst themselves) of Regional Service Charges for service provided by those relevant Regional Assets. A Member shall not be responsible for paying a share of a defaulting Member's Regional Service Charges if and to the extent that the non-defaulting Member is not served by a Regional Asset that is used for service to the defaulting Member. The payment of a proportionate share of the existing defaulted Regional Service Charges by Members shall not relieve the defaulting Member of its liability for those payments. The Alliance shall have a right of recovery from the defaulting Member on behalf of the Members assuming the defaulting Member's obligations. The Alliance may commence such suits, actions or proceedings at law or in equity, including but not limited to suits for specific performance, as may be necessary or appropriate to enforce the obligations of this Agreement against any defaulting Member. The Alliance's right to enforce payments in this regard may be assigned to a treasurer, trustee, credit enhancement provider or other entity. Amounts recovered by the Alliance as payment of amounts due may be passed through to the Members assuming obligations in proportion to the share that each assumed, either in cash or in credit against future Regional Service Charges, as the Board shall determine. The prevailing party in any such suit, action or proceeding shall be entitled to recover its reasonable attorney fees and costs. To the extent that a Member is in default and its Regional Service Charges are paid by other Members, until the default is fully remedied and the other Members are fully reimbursed for payments made in lieu of the defaulting Member, those other Members shall have a right to the allocated capacity of the defaulting member in proportion to the payments they have made. Nothing in this Section VI.B.4 shall prevent a Member from entering into additional arrangements under which it agrees to provide assistance to another Member with respect to payment obligation under this Agreement.

VI.C. Contract Rates and "Spot Rates." Rates paid by non-Members under a contract with the Alliance will be determined in accordance with the relevant contract. Rates paid by non-Members without a contract will be determined by the Board.

VI.D. Finance and Borrowing. Borrowing for costs of Regional Assets, or for operating costs of the Alliance may be carried out either by the issuance of Bonds by the Alliance itself, or by or through any Member (on behalf of the Alliance or on behalf of that or another Member). The specific approach for any Alliance financing will be determined by the Board, based on the Board's determination of the best approach for producing the lowest interest rates, and other factors the Board deems relevant. The terms of Bonds, including such amounts, maturity dates, interest rates, covenants, debt service reserve requirements, rate stabilization mechanisms, and other terms and conditions, shall be approved by the Board. Any Member may determine to provide for the payment of its share of capital costs with available cash or by financing those costs independently of the Alliance. For the purpose of assisting the Alliance in financing and providing service

through Regional Assets, any Member may, with or without payment or other consideration, loan or transfer funds, or provide credit support, to the Alliance or to another Member.

VI.D.1. For as long as any Bonds are outstanding that are payable from net Alliance revenue (or any portion thereof) are outstanding, the Alliance irrevocably pledges to establish, maintain and collect all Regional Service Charges in amounts sufficient to pay when due the principal of and interest on the Bonds (and, if the Bonds are issued by a Member or entity other than the Alliance, in addition to the foregoing pledge, to pledge to make timely payments to that issuer for the payment of principal of and interest on the Bonds), together with amounts sufficient to satisfy all debt service reserve requirements, debt service coverage requirements, and other covenants with respect to the Bonds.

VI.D.2. Each Member hereby irrevocably covenants that, consistent with the Financial Policies, it shall establish, maintain and collect rates, fees or other charges for wastewater and other services, facilities and commodities related to the services it receives from the Alliance and its own wastewater utility, and maintain reserves it deems appropriate, at levels adequate to provide revenues sufficient to enable the Member to: (a) make the payments required to be made under this Agreement; and (b) pay or provide for payment of all other charges and obligations payable from or constituting a charge or lien upon such revenues. Each Member hereby acknowledges that this covenant may be relied upon by Bond owners, consistent with this Agreement. Each Member shall pay the Regional Service Charges imposed on it whether or not the Regional Assets to be financed through the issuance of Bonds are completed, operable or operating, and notwithstanding the suspension, interruption, interference, reduction or curtailment in the operation of any Regional Assets for any reason whatsoever, in whole or in part. Regional Service Charges shall not be subject to any reduction, whether by offset or otherwise (except consistent with Section VI.B), and shall not be conditioned upon the performance or nonperformance of any Member, or of any entity under this or any other agreement or instrument. If, in connection with the issuance of obligations, any Member establishes a new lien position on revenues relating to its wastewater utility, that Member shall (x) covenant in its bond authorizing document(s) that the amounts to be paid to Alliance as Regional Service Charges shall be treated as part of that Member's internal operation and maintenance costs payable prior to debt service on those obligations; and (y) provide in its bond authorizing document(s) that the Member may, without being required to deposit money into its own bond fund, lease, convey, transfer, assign assets to the Alliance, or otherwise make assets available to the Alliance, where those assets will serve as Regional Assets to provide service to the Members. If any Member has existing outstanding revenue obligations relating to its wastewater utility, it shall include substantially

similar "springing covenants" in the documents relating to any new parity obligations.

VI.D.3. To meet the requirements of United States Securities and Exchange Commission ("SEC") Rule 15c2-12(b)(5) (the "Rule") as applicable to participating underwriter for any Bonds and any obligation of each Member as an "Obligated Person" under the Rule, the Alliance and each Member agree to make an appropriate written undertaking, respectively, for the benefit of holders of the Bonds consistent with the requirements of the Rule.

VI.E. Treasurer. The Treasurer shall be appointed from time to time by resolution of the Board, consistent with the provisions of RCW 39.106.050(13).

VI.F. Applicable Lien Laws. If the Alliance provides direct retail services (*i.e.,* not through or on behalf of a Member), the Alliance will apply and exercise the powers of a water-sewer district under RCW 57.08.081 or other applicable water-sewer district law.

VII. ASSETS AND LIABILITIES

VII.A. Ownership of Regional Assets. Initial Regional Assets are listed in Exhibit B. The initial assumption, subject to adjustment or exception in a Capital Plan, is that Member assets that materially serve more than one Member will become Regional Assets. Regional Assets will be transferred to and owned by the Alliance on behalf of and for the benefit of its Members. In order to provide regional services, the Alliance also may, by contract, operate assets owned by any Member or other entity, in conjunction with Regional Assets. In the event that Regional Assets are no longer necessary, material to or useful to the Alliance, those assets will be sold, retired and/or distributed as the Board deems appropriate.

VII.B. Acquisition of Regional Assets. The Alliance will receive Regional Assets from its Members. Other Regional Assets may be contributed by Members or new Members who will receive, in exchange, a credit against the capital component of rates. Regional Assets may also be constructed or otherwise acquired by the Alliance. The Board may determine that facilities or other assets constitute Regional Assets, may add them to the list on Exhibit B, and the addition of assets to that list shall not constitute an amendment of this Agreement.

VII.C. Distribution of Assets Upon Dissolution. Regional Assets not subject to disposition pursuant to a contract among Members or a contract with another person or entity, shall, unless the Members unanimously determine otherwise, be distributed based on the original ownership of the Asset by a Member prior to transfer to the Alliance, and then, if the asset was not previously owned by a Member, based on the physical location of an asset within a Member jurisdiction other than Clark County. Notwithstanding the foregoing, upon dissolution the Salmon Creek Wastewater Management System (*i.e.*, the Regional Assets owned by Clark County at the time of

formation) shall not be transferred to Clark County unless Clark County chooses to receive that asset. Instead, the Salmon Creek Wastewater Management System shall become jointly owned by Members on the basis of tenants-in-common, with ownership percentages based on allocated capacity shares as of date of dissolution.

VII.D. Liabilities. The Board may cause the Alliance assume certain liabilities in connection with the receipt of Regional Assets, and may also create or assume liabilities consistent with Section VI.D.

VIII. DISPUTE RESOLUTION

VIII.A. Except as provided in Sections IV.F.3 and VI.B.3, whenever any dispute arises between the Members or between the Members and the Alliance (referred to collectively in this Article as the "parties") under this Agreement which is not resolved by routine meetings or communications, the parties agree to seek resolution of such dispute by the process described in this Article. This provision shall not prevent the parties from engaging in any alternative dispute resolution process of their choosing upon mutual agreement.

VIII.B. The parties shall seek in good faith to resolve any such dispute or concern by meeting, as feasible. The meeting shall include the Chair of the Board and the representative(s) of the Member(s) involved in the disputed matter, such representative(s) to be designated by the Member(s) involved. If the Chair is a Director from a Member involved in the disputed matter, an alternate Director from a Member determined by the Board to be the most neutral Member with respect to the disputed matter, shall participate in the meeting in lieu of the Chair.

VIII.C. If the parties do not come to an agreement on the dispute or concern, any party may demand mediation through a process to be mutually agreed to in good faith between the parties within 30 days, which may include binding or nonbinding decisions or recommendations. The mediator(s) shall be individuals skilled in the legal and business aspects of the subject matter of this Agreement. The parties shall share equally the costs of mediation and assume their own costs.

VIII.D. If the parties are unable to reach a mutually agreeable solution as a result of mediation under change to Section VIII.C, the conflict resolution procedures in this Article will be exhausted and the parties may pursue any and all available remedies under applicable law. Nothing in this section shall prevent the parties from agreeing to arbitration, including binding arbitration, if they choose to do so.

IX. TERM AND TERMINATION**.** Term of agreement is perpetual, and may be terminated by Dual Super-Majority Vote. Termination of the Alliance is subject to rights of owners or holders of outstanding Bonds and other obligations made or issued by or on behalf of the Alliance.

X. MISCELLANEOUS

X.A. **Applicable Law and Venue**. This Agreement shall be governed by and construed in accordance with the laws of the State of Washington. Venue shall be in the Superior Court for the State of Washington in Clark County.

X.B. **No Third Party Beneficiaries**. There are no third-party beneficiaries to this Agreement except for the rights of owners of Bonds as provided in Section VI.D. No person or entity other than a party to this Agreement shall have any rights hereunder or any authority to enforce its provisions, and any such rights or enforcement must be consistent with and subject to the terms of this Agreement.

X.C. **Severability**. The invalidity of any clause, sentence, paragraph, subdivision, section, or portion thereof, shall not affect the validity of the remaining provisions of this Agreement.

X.D. **Entire Agreement**. This Agreement constitutes the entire and exclusive agreement between the parties relating to the specific matters covered in this Agreement. All prior or contemporaneous verbal or written agreements, understandings, representations or practices relative to the foregoing are superseded, revoked and rendered ineffective for any purpose. This Agreement may be altered, amended or revoked only in writing and only subject to Section IV.F. No verbal agreement or implied covenant may be held to vary the terms of this Agreement, any statute, law or custom to the contrary notwithstanding.

X.E. **Filing**. As provided by RCW 39.106.030, this Agreement shall be filed prior to its entry in force with the Secretary of State.

X.F. **Execution**. This Agreement may be executed in one or more counterparts.

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CITY OF BATTLE GROUND

By: _____
City Manager

Date: 9/26/12

Attest:

By: Tamara Gunter
City Clerk

Approved as to Form:

By: _____
Battle Ground City Attorney

CLARK REGIONAL WASTEWATER DISTRICT

By: _____
General Manager

Date: 9-25-12

Attest:

By: Kim Thu
Clerk to the Board

Approved as to Form:

By: _____
CRWWD Legal Counsel

CLARK COUNTY

By: _____
County Administrator

Date: 10/3/12

Attest:

By: Tina Redline
Deputy County Clerk of Board

Approved as to Form:

By: _____
Clark County Attorney

CITY OF RIDGEFIELD

By: _____
City Manager

Date: 9-27-12

Attest:

By: _____
City Clerk

Approved as to Form:

By: _____
Ridgefield City Attorney

EXHIBIT A

FINANCIAL POLICIES

RESERVES: Reserve balances are funds that are set aside for a specific project, task, covenant requirement, and/or emergency. These balances are maintained in order to meet short-term cash flow requirements, while at the same time minimizing the risk associated with meeting financial obligations and continued operational needs under adverse conditions.

Policy	Overview	Policy Metric	Cost Allocation Basis
Operating Reserve	The purpose of the Operating Reserve is to maintain financial viability of the utility despite short-term variability in revenues and expenses.	Maintain minimum reserve of 90 days operating costs.	Proportional to share of use of capital assets as measured by Average Annual Flow.
Regional Service Charge Stabilization Reserve	Used to mitigate major year-to-year fluctuations in revenues and expenses. Use of the Regional Service Charge Stabilization Reserve should only occur by direct Alliance Board action based upon unplanned revenue shortfalls or expenditures. Funding of the Regional Service Charge Stabilization Reserve will be budgeted as an expenditure and when used by the Board, will be considered an expenditure for the purpose of debt coverage. Use of the Regional Service Charge Stabilization Reserve funds will, when allowed by the Board, be considered a revenue for purposes of debt coverage.	Maintain minimum reserve of 90 days operating costs.	Proportional to share of use of capital assets as measured by Average Annual Flow.
Debt Service Reserve	Reserves provide protection from financial shortfalls in future debt service requirements that may occur due to changes in market conditions (i.e. lower than anticipated investment returns or slower connection growth), and meet funding and reserve requirements to necessary to acquire low-cost financing in the bond markets, and reserve funds for future capital construction costs.	Maintain one year's debt service on all outstanding debt and loans issued/borrowed by the Alliance for regional capital program and projects.	*Debt Service Reserve on new capital assets:* proportional to Allocated Capacity in those new capital assets. *Debt Service Reserve on existing capital assets:* proportional to Allocated Capacity in those assets being restored and/or replaced.
Restoration and Replacement (R&R) Reserve	The investment level in existing assets to maintain system performance.	Maintain minimum reserve of 2% of original asset value at the time asset(s) placed in service. Additional funding from Regional Service Rates, if necessary, may be collected to meet R&R capital needs for 20 years.	Proportional to Allocated Capacity of the assets being restored and/or replaced.

DEBT: Market debt, non-market debt and loans are all potential funding sources to buy, build or rebuild/replace capital assets by the Alliance. All debt issuances require that debt service coverage ratios be met and compliance with continuing disclosure requirements.			
Policy	**Overview**	**Policy Metric**	**Cost Allocation Basis**
Debt Service	Principal and interest repayment on new debt or loans assumed by the Alliance for purchase, construction or restoration/replacement of a capital asset is an obligation to the Members. This repayment is passed on to Members as a component of their Regional Service Charges billed by and paid to the Alliance.	When the Alliance assumes new debt or loans for purchase, construction or restoration/replacement of a capital asset, each Member who elects to: (1) purchase a share of capacity in that new capital asset, or (2) owns capacity in that restored/replaced capital asset, is responsible for their relative share of that debt service or loan repayment, respectively.	*Debt on new capital assets:* proportional to Allocated Capacity in those new capital assets. *Debt on restored/replaced capital assets:* proportional to Allocated Capacity in those assets being restored and/or replaced.
Debt Service Coverage Ratio	Describes how much of the annual debt payment is covered by projected Regional Service Charge revenues.	Regional Service Charges shall be maintained at a level necessary to provide annual revenues that satisfy: (1) a debt service coverage ratio of no less than 1.25 times annual debt service on Alliance-issued market debt, and (2) a debt service coverage ratio of no less than 1.00 times debt service and loan payments on all other Alliance non-market debt and loans (e.g. USDA, CERB, PWTF, etc.). Annual net revenues divided by annual debt service.	Debt service coverage ratio tests will be funded by the component of Regional Service Charges to Members who benefit from the corresponding debt issuances for which the tests must meet.
Continuing Disclosure	Provide for the benefit of bondholders annual financial information and notice of material events.	*Arbitrage*: Alliance should engage an arbitrage consultant to assist the Alliance in meeting IRS arbitrage compliance and reporting requirements when applicable. *IRS Bond Post-Issuance Compliance*: Alliance should maintain and comply with the IRS checklist of bond post-issuance compliance requirements. *Annual Reporting NRMSIR*: Alliance will comply with bond covenants regarding the annual undertaking of reporting to the Nationally Recognized Municipal Securities Information Repository (NRMSIR) by electronically filing with the Electronic Municipal Market Access system (EMMA) or its successor.	NA
Debt Policy	Alliance has a debt policy, which is adopted and will be updated periodically.	Compliance with provisions outlined per debt policy.	NA

REVENUE SUFFICIENCY: The Alliance has ongoing revenue requirements from its Members to pay operating expenses, buy or build capital assets, service debt and maintain reserves. Revenue sufficiency insures that charges will be set at a level to remain a self-sufficient utility.			
Policy	**Overview**	**Policy Metric**	**Cost Allocation Basis**
Charge Adoptions	Alliance will establish charges to Members sufficient on an annual basis to meet all utility cash requirements including operating expenses, debt service, charge-funded capital costs and additions to reserves.	Charge modeling will be updated every 2-4 years, with multi-year charge adoptions. Changes in charge levels should be gradual and uniform to the extent costs can be forecast.	Charges will be assessed to Members proportional to Average Annual Flow (operating expenses, operating reserves, regional service charge stabilization reserves), Allocated Capacity (debt service, debt service reserves, R&R reserves on restored/ replaced capital assets), or by some other proportion / method as directed by the Board.
Revenue Pledge (Members)	Provide surety to all Members that each Member will fulfill financial obligations to the Alliance.	Each retail agency pledges to maintain a combination of retail rates and charges sufficient to meet all policy tests and retail and wholesale obligations for collection system, transmission system, treatment system and reserves (operating, capital and debt service costs).	NA
FINANCIAL PLANNING, REGULATORY COMPLIANCE AND INVESTMENTS: Policies which support financial planning, regulatory compliance and investing help promote the financial integrity and stability of the Alliance, and help provide guidance and consistency in decision-making for the Alliances' management and Board.			
Policy	**Overview**	**Policy Metric**	**Cost Allocation Basis**
Financial Planning	Adoption of an annual/biennial Alliance budget provides Member agencies assurance of conveyance and treatment costs key to their annual/biennial Member budget, for Regional Service Charges due to the Alliance.	Alliance will prepare an annual/biennial budget that provides a basic understanding of the planned spending for the coming year/biennium. A long-term financial plan for a 10-20 year horizon will be updated every 2-4 years. Single enterprise fund.	NA
Regulatory Compliance	Alliance is to maintain a uniform system of accounts, and maintain accounting practices that follow Generally Accepted Accounting Principles (GAAP). Alliance will comply with the State Auditor's Office (SAO) Budgeting Accounting Reporting Systems (BARS).	Alliance will prepare an annual CAFR (modified accrual basis of accounting) and will be audited by the SAO.	NA
Investment Policy	Alliance has an investment policy which is adopted and will be updated periodically.	Compliance with provisions outlined per investment policy.	NA

SUSTAINABILITY OF INFRASTRUCTURE: In conjunction with establishing or planning its capital program, Alliance will develop a corresponding capital-financing plan that supports execution of that program, and is capable of sustaining long-term capital requirements. The capital program will incorporate system expansion, upgrades and improvements, and system repair and replacement. The intention is to establish an integrated funding strategy.

Policy	Overview	Policy Metric	Cost Allocation Basis
Capital Facilities Planning	Alliance will maintain a capital projects schedule of at least six years in duration, and consistent with the comprehensive long-range plans, using a 20-year planning horizon.	The six-year capital project schedule will be adopted by the Alliance Board, including project description, scheduled year of construction, total estimated costs (including additional operating) and funding source.	NA
Capital Facilities Funding	Capital funding from Members is included in Regional Service Charges, to preserve the Alliance's existing infrastructure. Contributions should fund current construction and engineering costs. Funding level should target replacement cost depreciation expense. Debt funding will be used when it is judged to be appropriate based on the long-term capital needs and the Alliance's ability to repay the indebtedness in light of all sources and uses of cash. The term of the debt should not exceed the reasonable useful life of the asset being acquired or constructed.	A six-year capital funding plan, adopted by the Alliance Board, will be in place that anticipates capital cost requirements and determines the appropriate funding mechanism for those capital needs, either cash funding or debt/loan issuance.	NA

EXHIBIT B

LIST OF INITIAL REGIONAL ASSETS AND INITIAL ALLOCATED CAPACITIES

System Name	No.	Regional Asset Name	Regional Asset Description	Initial Allocated Capacities(values expressed in MGD of MMF)			
				Existing Allocated Capacity			
				BG	CRWWD	RF	Total
Salmon Creek Wastewater Management System (SCWMS)		Interceptor System		10.10	28.08	0.00	38.18
	1	Salmon Creek Interceptor	4.6 mile long gravity pipeline located on the south side of the Salmon Creek drainage. The interceptor collects and conveys wastewater from partner agencies to regional pump stations. Pipeline was constructed in segments from the mid to late 1970's (21-42-inch diameter pipe routed from Betts Bridge to 36 Ave).				
	2	Klineline Interceptor	1.8 mile long gravity pipeline located parallel to the Salmon Creek Interceptor. Pipeline was constructed in segments from 2002 to 2006 (48-inch diameter pipe routed from Salmon Creek Ave & NE 127 St to 117 St PS).				
		Pump Station (PS) System		4.47	13.57	0.00	18.04
	3	36 Avenue PS	Raw sewage PS located at 14014 NW 36 Ave in Vancouver, WA. The station pumps wastewater from the Salmon Creek interceptor to SCTP. Pump station was constructed in mid 1970's and remodeled in 1994 and 2005.				
	4	117 Street PS (aka Klineline PS)	Raw sewage PS located at 1110 NE 117 St in Vancouver, WA. The station pumps wastewater from Salmon Creek and Klineline interceptors to SCTP. Pump station was constructed in 2008.				
		Force Mains (FM) System		6.30	20.06	0.00	26.36
	5	36 Ave PS FM	24-inch diameter FM routed from 36 Ave PS to SCTP. The FM runs approximately 1.4 miles along the south side of the Salmon Creek and discharges to SCTP. Pipeline was constructed in mid 1970's.				
	6	117 Street PS FM	30-inch diameter FM routed from 117 St PS to SCTP. The FM runs approximately 4.9 miles along public rights-of-way to the SCTP. Pipeline was constructed in segments from 2004 to 2008.				
		Salmon Creek Treatment Plant (SCTP) & Outfall		3.47	11.48	0.00	14.95
	7		Secondary treatment plant originally constructed in the mid 1970s, with four major expansion phases. The plant is located at 15100 NW McCann Rd, in Vancouver, WA. The plant outfall is a 30-inch diameter pipeline routed west of the plant 1.3 miles, terminating in the Columbia River between mile 95 and 96. The discharge location is latitude 45° 43' 58" N, longitude 122° 45' 23" W.				
Ridgefield Treatment System		Ridgefield Treatment Plant & Outfall		0.00	0.00	0.70	0.70
	8		Secondary treatment plant originally constructed in 1959 with several upgrades since then. The plant is located on West Cook St in Ridgefield. The plant outfall is an 8-inch diameter pipeline routed west of the plant 0.2 miles, terminating in Lake River. The discharge location is latitude 45° 49' 18" N, longitude 122° 45' 09" W.				
Battle Ground Force Main System		Battle Ground FM		3.44	0.96	0.00	4.40
	9	(Including odor control system for FM)	9 mile long 16-inch diameter FM with bioxide chemical injection facility routed southwesterly from McClure PS to Klineline interceptor at Salmon Creek Ave. Pipeline was constructed in 1993.				

APPENDIX F

APPENDIX G

APPENDIX G

REFERENCES

[1] City of Battle Ground Sewer Plan Update, Wallis Engineering, March 2011.

[2] City of Battle Ground Comprehensive Plan, December 2004.

[3] Soil Survey of Clark County, Washington, November 1972.

[4] Criteria for Sewage Works Design. State of Washington, Department of Ecology. Revised August 2008.

APPENDIX H

APPENDIX H

WASTEWATER HANDLING

H.1 EXISTING WASTEWATER HANDLING

All of the City's wastewater is presently sent to the Salmon Creek Treatment Plant (SCTP). The City has purchased 3.47 million gallons per day (MGD) of maximum month flow capacity at the SCTP, and intends to own and use this capacity into the future. The SCTP is part of the Salmon Creek Wastewater Management System which is owned and operated by Clark County. The City has purchased conveyance and treatment capacity through an interlocal agreement with the Clark Regional Wastewater District (CRWWD) and Clark County (copies of various phases of this agreement are provided in Appendix E). The interlocal agreement identifies the maximum month capacity of the facilities allocated to the City. The maximum month capacities of the facilities purchased by the City through Phase 4 of the Salmon Creek Wastewater Management System include:

- Interceptor System 10.1 MGD
- Pump Stations 4.47 MGD
- Force Main Systems 6.3 MGD
- SCTP Treatment / Outfall 3.47 MGD

These facilities are presented in greater detail, with component locations and purchased capacities on Figure H.1. Figure H.2 illustrates these components in schematic form.

In addition, the City is currently constructing a new 3.5-MGal flow equalization basin and a new 4.6-MGD pump station. These facilities will be on line in Fall 2011.

Based on the projected flows discussed in Section 6, the City has maximum month capacity until the following years for each of the systems:

- Interceptor System 2050 (Extrapolated from current Projections)
- Pump Stations 2016
- Force Main Systems 2026
- SCTP Treatment / Outfall 2011[1]

The limiting facilities are those for treatment and discharge. The Interceptor and Force Main Systems have the capacity to carry the City through the planning period. The City needs to develop additional treatment and discharge capacity in order to provide sewer services through the planning period. The predicted maximum month flow rate in 2026 is 6.23 MGD. Therefore

[1] The City's treatment and outfall capacity is likely to be sufficient for five or more years beyond 2011 based on recent slowing in growth trends. However, based on the City's official comprehensive plan growth projections, the capacity would be utilized fully in 2011.

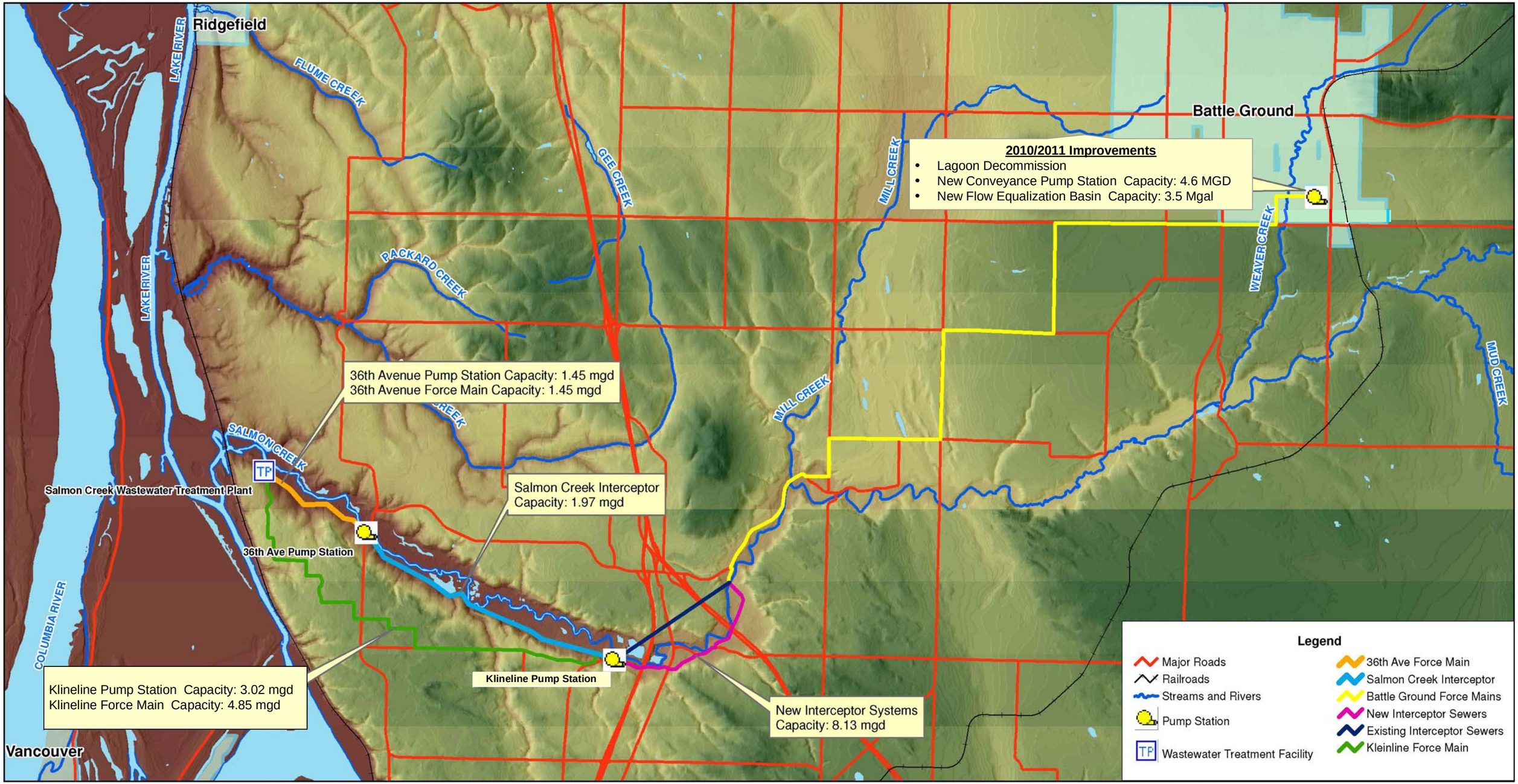
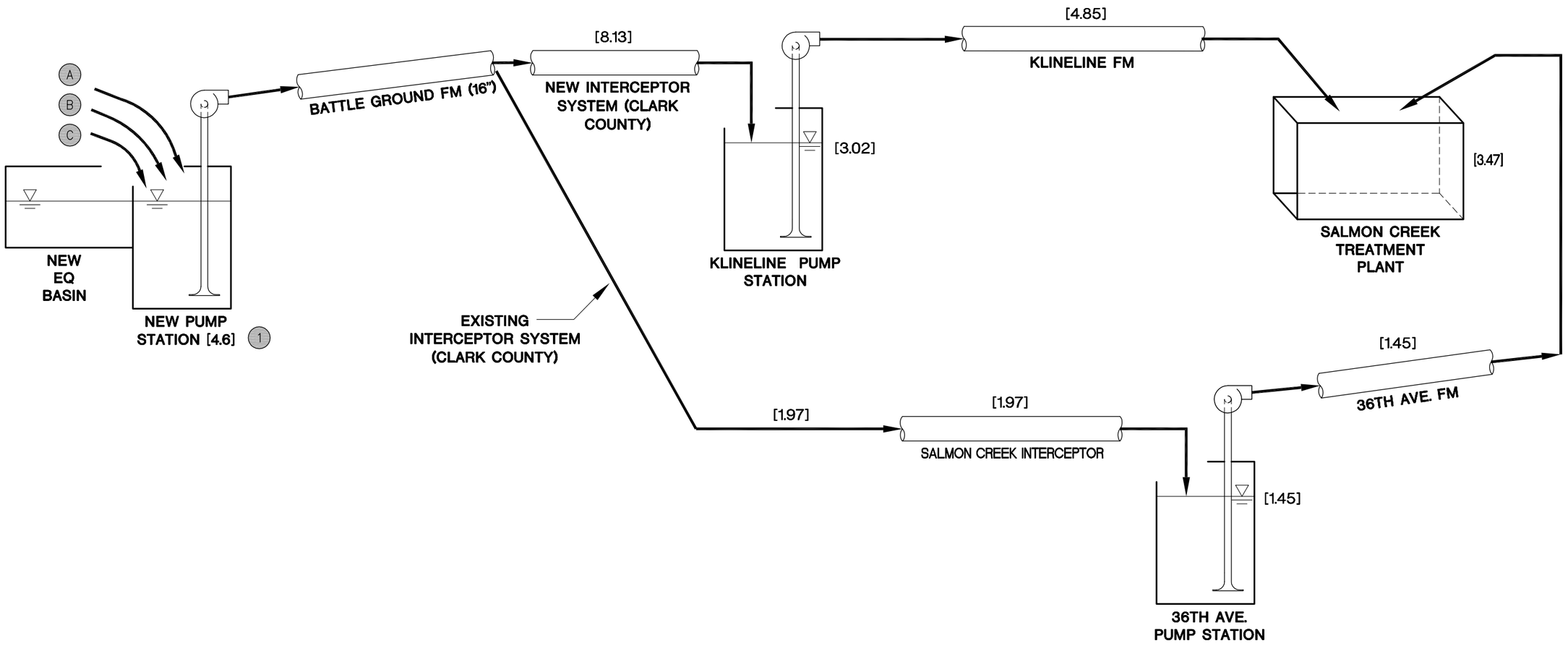


Figure H.1: Battle Ground and Clark County Transmission System Capabilities



P:\cad\09\0991002.00_BATTLE_GROUND\GSP_REVISIONS\0991002_FIGURE-H.2.dwg STEPHANIED 11/30/2010 2:46 PM



LEGEND

A	BATTLE GROUND SEWER SYSTEM
B	MEADOW GLADE SEWER SYSTEM
C	HOCKINSON SEWER SYSTEM
1	CONSTRUCTION TO BE COMPLETED FALL 2011
[CAPACITY]	CITY CAPACITY ALLOCATION PER (MAX MO.) INTERLOCAL AGREEMENT (APPENDIX)

SCHEMATIC: BATTLE GROUND AND CLARK COUNTY TRANSMISSION SYSTEM PURCHASED CAPACITY

FIGURE H.2

the City will need to purchase or construct 2.76 MGD of treatment and discharge capacity beyond the current capacity of 3.47 MGD in order to meet projected requirements to 2026. Additional pumping capacity will also be required. Note that the actual growth rate will be greater or less than projected, and thus implementation of planned improvements may be accelerated or delayed depending on the actual grow rate.

H.2 ALTERNATIVES

Three regional alternatives and one local alternative are considered for increasing treatment and disposal capacity to 6.23 MGD. The first regional alternative involves staying within the Salmon Creek Wastewater Management System and continuing to purchase additional treatment capacity as outlined in the SCTP Facility Plan/General Sewer Plan. The other regional alternatives involve conveyance of wastewater to the City of Vancouver's Westside Treatment Facility and the purchase of capacity in that facility. Note that the City's new flow equalization basin and new conveyance pump station, currently under construction, are not included as part of any alternative.

H.2.1 ALTERNATIVE DESCRIPTIONS AND ASSUMPTIONS

H.2.1.1 SCTP Alternative

The City would purchase additional treatment, outfall, and pump station capacity and would construct a new parallel force main from the City's Operations Center to the I-205 bridge structure. This alternative would require the City to make the following capital improvements over the planning period:

- Purchase 2.76 MGD additional capacity via SCTP Expansions: Phases 5, 6, 7, 8, 9
- Expand Flow Equalization (FE) Basin to 5 million gallons (MGal) from 3.5 MGal
- Increase Battle Ground Pump Station Capacity to 8 MGD from 4.6 MGD
- Construct Parallel Force Main (24-inch)
- Increase Klineline Pump Station Capacity

This alternative is based on the following assumptions:

- The required total capacity is based on a 2026 maximum month flow of 6.23 MGD
- No additional interceptor sewer capacity will be required.
- No additional County force main capacity will be required.

H.2.1.2 City of Vancouver Alternative 1: Via St. John's Road

In this alternative, the City would enter into an agreement with the City of Vancouver for treatment of future wastewater flow and would construct a new force main and interceptor system to convey wastewater to the City of Vancouver's Westside Treatment Facility. Sewage would be pumped from the expanded Battle Ground pump station / FE basin via a new pipeline that would end at N.E. 99th and NE. 117th. Sewage would then be pumped to the Westside plant by a new pump station and through a new pipeline that would follow St. John's Avenue.

This alternative would require the City to make the following improvements:

- Expand Flow Equalization Basin to 5 MGal from 3.5 MGal
- Increase Battle Ground Pump Station Capacity to 8 MGD from 4.6 MGD
- Construct new mid-way pumping station
- Construct new pressure (and gravity) pipeline sections
- Purchase treatment capacity at Vancouver's Westside Treatment Facility

This alternative is based on the following assumptions:

- The required total capacity is based on a 2026 maximum month flow of 6.23 MGD
- The City of Vancouver would be in agreement with this approach
- There would be no cost sharing from other communities in the project.

H.2.1.3 City of Vancouver Alternative 2: Via Klineline Interceptor

In this alternative also, the City would enter into an agreement with the City of Vancouver for treatment at the City of Vancouver's Westside Treatment Facility. The City also would construct a new parallel force main from the City to the I-205 bridge structure and expand capacities of the flow equalization basin / pump station, participate in the upgrades at the Klineline pump station, and participate in the construction of a new interceptor system to the Westside Treatment Facility.

This alternative is based on the following assumptions:

- The required total capacity will be based on a 2026 maximum month flow of 6.23 MGD
- The City of Vancouver is in agreement with this approach
- There could be cost sharing from other communities in the project and the City would be responsible for only a portion of the costs associated with upgrading the Klineline Pump Station and conveyance improvements from that pump station to the Westside Treatment Facility.

H.2.1.4 Local WRF Alternative

This alternative, discussed above, is based on developing a local water reclamation facility (WRF) which would produce a Class A effluent and would meet reclaimed water requirements of RCW 90.46. It is anticipated that a membrane bioreactor (MBR) would be utilized. Effluent from the WRF would be discharged into infiltration basins constructed on a 15-acre parcel of land in Manor Trough. As an alternative, there is potential for utilizing land parcels in the Venersborg / Hockinson areas, east or southeast of Battle Ground. A new pump station and a 16-inch force main would be constructed to transmit effluent to the infiltration basins. The WRF would be located within the existing lagoon site.

The unit processes of an MBR WRF for Battle Ground would include:

- Primary Treatment
  - Fine Screening
  - Grit Removal

- Secondary and Tertiary Treatment
  - Anoxic Basin
  - Mixed Liquor Pumping
  - Aerobic Basin
  - MBR Basins
  - Membrane Clean-in-Place System
  - Permeate Pumping
  - RAS Pumping

- Disinfection
  - Ultraviolet Disinfection and Standby Chlorination

- Biosolids Handling

This alternative would require the City to make the following capital improvements:

- Construct WRF (2.76 MGD)

- Effluent Disposal

- Solids Handling Facilities

This alternative is based on the following assumptions:

- Geology in either the Venersborg or Manor Trough areas is conducive to an infiltration system.

- The Washington State Department of Ecology (Ecology) would issue approval of the effluent disposal approach, and corresponding permits.

- The required total capacity is based on a 2026 maximum month flow of 6.23 MGD

- No additional Interceptor sewer capacity or County force main capacity will be required

- A new pump station and force main will be required to route WRF effluent to the selected application site.

H.2.2 ALTERNATIVES PROJECT COSTS

Tables H.1 through H.4 show the total project costs for each of the four alternatives. Collection system costs are not included, as they are discussed in Section 9.

Project costs for the SCTP Alternative are shown in Table H.1. It is assumed that the City would share in planned expansions to the plant, as required to provide capacity to 2026; this would involve expansion phases 5, 6, 7, 8, and 9. Costs for a new force main were estimated

assuming a 24-inch pipeline (of approx. 9 miles) from the Battle Ground Pump Station to the I-205 bridge crossing.

TABLE H.1
SCTP ALTERNATIVE

System Component	$ Million
Purchase 2.76 MGD Additional Capacity	18
Expand Flow Equalization Basin and Increase Battle Ground Pump Station Capacity	5
Parallel Force Main	16
Klineline Pump Station Improvements	2
Capital Cost Estimate:	**41**

Project costs for Vancouver Alternative 1 are shown in Table H.2. It is assumed that the City would pay $6.50 per gallon for treatment capacity at Vancouver's Westside Treatment Facility.

TABLE H.2
CITY OF VANCOUVER ALTERNATIVE 1: ST. JOHNS ROAD

System Component	$ Million
Expand Flow Equalization Basin and Increase Battle Ground Pump Station Capacity	5
New mid-way pumping station	3
Pressure (and gravity) flow pipeline sections	30
Westside WWTP capacity	18
Capital Cost Estimate:	**56**

Project costs for Vancouver Alternative 2 are shown in Table H.3. It is assumed that the City would pay $6.50 per gallon for treatment capacity at Vancouver's Westside Treatment Facility. The parallel force main costs were estimated as for the SCTP Alternative.

TABLE H.3
CITY OF VANCOUVER ALTERNATIVE 2: KLINELINE

System Component	$ Million
Expand Flow Equalization Basin and Increase Battle Ground Pump Station Capacity	5
Parallel Force Main	17
Gravity Sewer, Klineline to Vancouver	15
Westside WWTP capacity	18
Klineline Pump Station Upgrades	2
Capital Cost Estimate:	**57**

Project costs for the WRF Alternative are shown in Table H.4.

TABLE H.4
WRF LOCAL TREATMENT

System Component	$ Million
WRF	28
Effluent Disposal: Pipeline / Pump Station, Land, Permitting	10
Solids Handling Facilities	5
Capital Cost Estimate:	**43**

A comparison of estimated cost of the four alternatives is shown in Table H.5.

TABLE H.5
COMPARISON OF CAPITAL COSTS

Treatment Alternatives	Project Cost, Phases 1&2 ($ Millions)
SCTP	41
City of Vancouver 1 (St. Johns)	56
City of Vancouver 2 (Klineline)	57
WRF Local Treatment	43

The SCTP alternative carries the lowest capital cost. The local WRF alternative has a slightly higher capital cost, however its operational cost is significantly higher. This alternative also requires approval of the effluent disposal approach, and corresponding permits from Ecology. The two Vancouver alternatives have a significantly-higher capital cost. For these reasons, the SCTP alternative is recommended.

If the recent slowing in growth rates continues, then facility improvements could be postponed. In this case it may be feasible to reevaluate the local WRF alternative at a future time. A reevaluation may be warranted if relative importance of the selection criteria were to change in the interim period. Factors affecting alternative selection which may change in the future include: federal and state reclaimed water regulations; the regulatory / permitting environment in general; the cost of treatment and discharge from a local WRF and/or from the regional SCTP; and efficacy of MBR treatment technology.

The City and Kennedy/Jenks Consultants have investigated the local WRF alternative over the last few years. In particular, the subject of subsurface discharge of WRF Class A effluent has been evaluated and discussed with Ecology at length. This prior work should facilitate progress if the local WRF alternative were to be selected in the future.

H.2.3 DEVELOPMENT OF RECOMMENDED ALTERNATIVE

As described above, this alternative consists of expanding transmission facilities and purchasing additional capacity at the SCTP, in order to handle increasing sewage flows during the course of the planning period. Facility improvements associated with this alternative are described below.

H.2.3.1 Use of SCTP Treatment and Discharge Capacity

The SCTP currently has a maximum month rated capacity of 14.95 MGD. Additional expansion of the facility will be required to address anticipated permit requirements and to handle anticipated flows during the planning horizon. Flows to the SCTP will continue to be generated from customers in the Battle Ground and Clark Regional Wastewater District service areas, as well as potentially from the City of Ridgefield.

A Sewer Coalition Planning Study was completed in November 2009 with the participation of all sewer utilities in the County. This Study resulted in the development of a Regional General Sewer Plan outlining a long-term vision for sewer service in the County, and recommending that four agencies (Battle Ground, Ridgefield, Clark County, and Clark Regional Wastewater District) form a partnership to provide major conveyance and treatment for sewage from each agency's service area. The Regional Plan also determined that treatment of flow from Ridgefield could be provided more cost effectively at the SCTP rather than through further expansion of the Ridgefield WWTP.

The improvements required to convey flow from Ridgefield to the SCTP and the capital improvements required to accommodate the additional flow and load at the SCTP are being addressed in detail in an Engineering Report for the City of Ridgefield and in an update to the Salmon Creek Treatment Plant Facility Plan. At the time of preparation of this document, it was anticipated that five expansions to the SCTP will be required to serve the needs of the Clark Regional Wastewater District, Battle Ground, and Ridgefield. Table H-6 summarizes planned unit process improvements for each phase of expansion, along with estimates of total project costs and costs to Battle Ground.

TABLE H.6
PLANNED EXPANSIONS TO THE SCTP

	Repair Project (2012)	Estimated Cost	Phase 5 EDUs* : 41,874 (2012-2013)**	Estimated Cost	Phase 6 EDUs* : 47,227 (2015-2017)**	Estimated Cost	Phase 7 EDUs* : 56,044 (2019-2020)**	Estimated Cost	Phase 8 EDUs* : 63,645 (2022-2023)**	Estimated Cost	Phase 9 EDUs* : 72,951 (2025-2027)**	Estimated Cost	Total Cost
	Dewatering Upgrades	$1,500,000	Aeration Basin 7	$4,880,000	1 New Screen (25 mgd capacity)	$450,000	Primary Clarifier 5	$2,970,000	Primary Clarifier 6	$2,970,000	Aeration Basin 11	$4,880,000	
			Site Improvements	$244,000	Cover Primary Clarifiers (Odor)	$3,220,000	Aeration Basin 9	$4,880,000	Aeration Basin 10	$4,880,000	Anaerobic Digester 3	$4,480,000	
			New Outfall	$10,780,000	Aeration Basin 8	$4,880,000	1 New Large Blower	$1,380,000	1 New Large Blower	$1,380,000	Site Improvements	$1,310,400	
					1 New Large Blower	$1,380,000	Site Improvements	$462,000	Secondary Clarifier 6 (140')	$3,940,000			
					Secondary Clarifier 5 (140')	$3,940,000			Demolish Secondary Clarifier 2	$50,000			
					New Ras/WAS Pump Station	$3,140,000			Site Improvements	$661,000			
					1 New UV Disinfection Channel	$3,360,000							
					Anaerobic Digester 3	$4,480,000							
					Demolish Secondary Clarifier 1	$50,000							
					Site Improvements	$350,000							
SCTP Capacity (MMF, MGD)		14.95 (existing)	16.5		20.2		23.4		25.3		29.0		
Estimated Expansion Cost ($M)		(1.5)		15.9		25.25		9.69		13.88		10.67	76.89
Estimated Battle Ground Share of Cost ($M)		(0.3)		5.5		4.9		1.7		4.1		1.6	**18.1**

* Systemwide EDUs

** Improvements will be coordinated with EDUs / flowrates; timelines will be adjusted accordingly

It is anticipated that the City would participate in Phases 5 through 9, with a total cost to the City of approximately $18 million. This would provide an additional 2.95 MGD of capacity to the City, raising its total capacity share to 6.42 MGD, or 0.19 MGD beyond the required 6.23 MGD on a maximum month basis. If flow from the City of Ridgefield is not sent to the SCTP, the Phase 9 expansion would not be required within the planning horizon, and the timeline for implementation of Phases 5 through 8 would be extended.

H.2.3.2 Force Main

A 24-inch force main would be constructed to carry sewage from the City's pump station at the Operations Center to the newer section of Salmon Creek Interceptor near the I-205 Bridge. This pipeline would parallel the City's existing 16-inch force main, following the 9-mile route shown on Figure H.1. The capacity of this force main would handle projected requirements well beyond the planning period.

The force main would be constructed of polyvinyl chloride (PVC) (C905). It would contain a boring beneath a highway (SR 503), a crossing at Salmon Creek, and a crossing at Betts Bridge. It would also contain several vaults for sewer air/vacuum valves.

The estimated cost of the new force main is approximately $16 million. Table H-7 presents a list of items included in this pipeline construction. It is expected that timing of construction would coincide with a maximum month flowrate of 4.4 MGD.

H.2.3.3 Expansion of Pump Station and Equalization Basin

The flow equalization basin and pump station currently under construction (December 2010) were designed with the assumption that toward the end of the planning period, a WRF would handle 3.4 MGD of flow (on a maximum month basis).[2] For the SCTP alternative, a WRF will not be constructed, thus it will necessary to expand the basin and pumping capacity in order to provide storage and pumping capacity for the full inflow to be delivered to the City's Operations Center.

The flow equalization basin is being constructed with a volume of 3.5 MGal. For the SCTP alternative, this basin would be expanded to 5.0 MGal. (The current basin was designed and located so as to accommodate a future expansion to 5.0 MGal.)

The pump station is being constructed with a firm capacity of 4.6 MGD. For the SCTP alternative, the pump station would be expanded to a firm capacity of 8.0 MGD.

The estimated cost of these upgrades is $5 million, and it is expected that timing of construction would coincide with a maximum month flowrate of 3.4 MGD.

H.2.3.4 Increased Capacity from Klineline Pump Station

The City's capacity share in the existing Klineline Pump Station is 3.02 MGD. For the SCTP alternative, it would be necessary to increase this capacity to at least 4.85 MGD in order to match the City's capacity share in the Klineline Force Main. This would allow a delivery of 4.85 MGD to the SCTP, with an additional 1.97 MGD delivered to the SCTP by the 36th Ave. pump station and force main, as depicted on Figure H.2.

The estimated cost of these upgrades is $2 million.

[2] Engineering Report for Flow Equalization System Improvements at City of Battle Ground, Washington (January 2010), Kennedy/Jenks Consultants.

TABLE H.7
BATTLE GROUND 24-INCH FORCE MAIN

ITEM	QUANTITY	UNIT	ITEM DESCRIPTION
1	1	LS	MOBILIZATION
2	1	LS	TRAFFIC CONTROL
3	32013	SY	CONSTRUCTION GEOTEXTILE FOR SEPARATION
4	7403	TON	CRUSHED SURFACING BASE COURSE
5	2468	TON	CRUSHED SURFACING TOP COURSE
6	8203	TON	HMA CL. 1/2 INCH PG 64-22
7	1	EA	PIG LAUNCH VAULT
8	1	LS	UPSTREAM BG TIE IN
9	1	LS	DOWNSTREAM TIE IN
10	6	EA	AIR-VACUUM VAULT AND ASSEMBLY
11	47520	LF	TRENCH SAFETY SYSTEM
12	48020	LF	TESTING SEWER PIPE
13	47520	LF	SEWER FORCE MAIN, 24 INCH DIA. C 905
14	48020	LF	LOCATOR WIRE
15	47520	LF	LOCATE TAPE
16	288120	SF	GRIND 1 LANE FOR OVERLAY
17	300	LF	SEWER BORE, 24 INCH DIA. DR 13.5 HDPE At SR 503
18	350	LF	SEWER CROSSING At SAL CR, 24 INCH DIA. DR 13.5 HDPE
19	1	LS	BRIDGE CROSSING & CONNECTION -BETTS
20	97	EA	LOCATOR STATION
21	1	LS	TEMPORARY EROSION CONTROL
22	1	LS	PERMANENT EROSION CONTROL AND LANDSCAPING
TOTAL ESTIMATED PROJECT COST: $16 Million			