City of Portland - Environmental Services
Systems Planning Program

System Plan Update - DRAFT

FANNO AND BURLINGAME BASIN RECOMMENDED PLAN

To:	Fanno and Burlingame Basin Technical Review Committee
From:	David Collins
Reviewed By:	
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Task:	Sanitary Sewer System Plan
Subject:	Background and Alternatives Analysis

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Introduction

The City of Portland Bureau of Environmental Services (BES) is in the process of developing and evaluating improvement alternatives to address basement sewer backup risk (BSBR), street-flooding risk, and pipeline capacity deficiencies in the Fanno and Burlingame Sanitary Sewer basin study area. The failure of the Fanno Pump Station force main and capacity issues at the pump station necessitated an accelerated schedule for the design and construction of pumping capacity, force mains, and gravity pipe to meet projected build out capacity needs of the Fanno Basin.

The purpose of this technical memorandum is to document the development of the recommended plan for the study areas that is the basis for pump station sizing. The recommended plan will also be used to guide future project predesigns as well as infiltration and inflow reduction activities.

Background

This section provides additional details …

Fanno Pump Station Capacity

The Fanno Pump Station was put in service in 2000 as the result of a planning effort developed in the mid-90s. The pump station was designed to replace five aging pump stations and provide service to a larger part of the Fanno Basin service area.

The pump station was originally planned for a firm capacity of 29 cfs and a full capacity of 32 cfs[1] as documented in the Tryon Creek Wastewater Treatment Plant Facilities Plan published in 1999. The firm capacity was determined based on a model calibrated to seven flow monitoring sites within the basin. The model predicted that the basin would experience rainfall derived inflow and infiltration (RDII) rates as high as 20,000 gallons per acre day (gpad) or over ten times normal design. The planned firm capacity of 29 cfs also included an assumption that peak flows would be reduced by 2 cfs though RDII reduction efforts[2]. During start-up, pump vibration problems were found that were resolved in part by trimming the pump impellors. Pump tests showed the actual firm capacity of the pump station at start-up was 26 cfs or 30 cfs with all four pumps operating. The current firm capacity of the pump station is 24 cfs or 28 cfs with all four pumps operating.

Peak influent flows have exceeded pump station capacity in January 2003, December 2007 and January 2009. A basinwide flow monitoring plan was initiated following the January 2003 storm. The monitoring plan was designed to identify areas with high RDII and provide calibration and verification data to be used as the basis for developing a RDII and collection system model. Flow monitoring was conducted in three phases from February 2003 to July 2005 with a total of 30 monitors installed in the Fanno Basin. The monitoring data isolated several areas with RDII rates of over 15,000 gpad and some areas with RDII rates of over 30,000 gpad. A revised model was calibrated to the monitoring data and verified with intense storms that occurred during November 2006. A five-year design storm was applied to the model and a peak pumping requirement of 39 cfs determined to be required to avoid spills to CWS under existing conditions[3].

Capacity Alternatives

A preliminary alternatives analysis to resolve capacity issues focused solely on conveyance, pumping, and storage options to convey existing flows in the Fanno and Burlingame basins. The modeling and cost estimates were documented in the *Draft Capacity Improvements Alternatives Analysis Technical Memorandum* (B&C March 2008). The analysis reviewed the following options; offline storage upstream, but in the vicinity of the existing Fanno Pump Station; installation of a new pump station at the existing Fanno Pump Station site; installation of a new pump station in the vicinity of the intersection of SW Beaverton-Hillsdale Hwy and SW Oleson Road. Both pump station options were estimated to cost $32 million and

[1] Tryon Creek Wastewater Treatment Plant Facilities Plan Page 2-11, Table 2-1

[2] Tryon Creek Wastewater Treatment Plant Facilities Plan Page 4-10

[3] Sanitary Sewer System Plan Technical Memorandum 5.6A, 5 March 2007

the storage option was estimated to cost $22 million. However, the risks associated with the storage option and the public impacts resulted in the decision to abandon this option.

DECISION: The pumping option at the existing Fanno site was selected because no additional property would be required, the impact to the public would be minimized. These options were in the process of being evaluated at the time the Force pressure line failed as described below.

Fanno Pressure Line

The Fanno Pressure Line was designed as a thirty-inch welded steel pipe that was bid in two separate segments. The contractor on the 6,730-foot Garden Home section of the force main submitted a request to substitute High Density Polyethylene (HDPE) pipe instead of steel. The contractor on the 10,070-foot Multnomah section of the force main submitted a request to substitute PVC pipe for the steel. Both substitution requests were approved and BES benefited from reduced material costs.

The Garden Home section of the Fanno pressure line had significant difficulty during startup. At least three failures occurred during initial pressure testing. In the seven years of operation, the HDPE Garden Home section has failed an additional six times. The PVC Multnomah Section of the Fanno pressure line has failed once at the point of transition between the HDPE and the PVC segments. This failure was catastrophic and resulted in washing out a portion of SW Railroad near SW 69th Ave. The analysis of the Multnomah section shows that a significant portion of the PVC line does not meet engineering or industry standards for the operating conditions.

On April 9, 2008, a leak of the Garden Home section of the Fanno pressure line was reported by residents of SW 77th Ave. BES determined that it would be irresponsible to restore the pressure line to service until the cause of the failure is identified and corrected. This decision was arrived at in consultation with CWS, which is currently treating the bypassed flow.

BES ultimately determined that the existing force main was would be replaced in the long term and that in the short term the force main would be repaired and the pump station operated only during extreme events per the *Fanno Wet Weather Response Plan* discussed below. The repaired force main was operated during the January 1-2, 2009 storm without incident.

Interagency Planning

A series of bi-weekly meetings between BES and CWS staff were held during August though December 2008 to develop short and long-term solutions. BES contract staff built and calibrated a model of the CWS collection system for the purpose of determining the effect of Fanno Flows on the CWS Fanno Basin collection system. The modeling results demonstrated that with the additional flows from Portland's Fanno Basin:

- The CWS Fanno Interceptor will convey all flows for storms up to a 1.7-inch storm in 24-hours (slightly under a 1-year storm).
- The CWS Fanno Interceptor will be fully utilized and near overflow conditions for storms at or above 2.3 inches in 24-hours (a 2-year storm level).

This analysis showed that to avoid compromising the structural integrity of the CWS Fanno there is no feasible alternative to bypassing treatment under certain storm conditions.

In September of 2008 a Mutual Agreement and Order (MAO) between CWS, BES and DEQ was signed that stipulated the City develop a Wet Weather Response Plan to address short term mitigation and control strategies and a Capital Improvement Plan to address long term strategies. The *Fanno Wet*

Weather Monitoring & Response Plan developed in under the MAO describes the procedure that would lead to a decision to operate the Fanno Pump Station or discharge sewage to Fanno Creek.

The interagency team explored long-term options that would result in CWS conveying and treating flow ranging from 0-100% of the flow from the Fanno Pump Station service area. Table x summarizes the options considered and the 20-year net present value (NPV) costs.

Table 1
Net Present Value Cost (millions) of Options for Conveying and Treating Fanno Pump Station Basin Flows

	BES Debt Service	BES Operating	Payments to CWS	Total
Option 1: Turn Fanno Basin PS off, divert all Portland flows to CWS for treatment; pay CWS for Areas A and C.	$0	$0	$61	$61
Option 2: Pump at existing capacity (24 cfs), with peak flows diverted to CWS; pay CWS for net of Area C and Area B plus peak diversions.	$14.5	$6.5	$10	$31
Option 3: Pump only Portland's allocated share of flow (= Area A), divert CWS Area B flows continuously to CWS; pay CWS only for Area C.	$14.5	$4.5	$31	$50
Option 4: Increase Fanno Basin PS & FM capacity to 39 cfs, pump all basin flows to Portland; pay CWS only for net of Area C and Area B.	$34	$7	$10	$51
Area A: Tax lots within that Fanno Pump Station Service area that are within the City of Portland **Area B:** Tax lots within that Fanno Pump Station Service area that are outside the City of Portland **Area C:** Tax lots outside the Fanno Pump Station Service area, within the City of Portland, and flow by Gravity to CWS				

BES debt service is related to new Fanno pumping and conveyance facilities and required downstream gravity system improvements. The BES operating cost includes the operating costs of the pump station, downstream collection system and treatment costs. Payments to CWS represent the cost under the current wholesale agreement between BES and CWS. The following discussion summarizes pros and cons of the four options.

Option 1: Under this option CWS would likely require BES to perform extensive I/I reduction activities. Therefore, the true cost to BES in no reflected in the BES operating costs.

Option 2: Under the current agreement, when BES discharges flow to CWS at the Fanno diversion structure, CWS assesses charges based on the volume spilled. The total volume spilled during extreme events is very small compared to the total annual flow. For this reason, the payment to CWS under Options 2 and 4 is essentially the same. The lowest cost option, Option 2 was not acceptable to CWS as they would be required to increase conveyance and pumping to accommodate the peak flows and would receive essentially no compensation for managing this flow.

Option 3: This option would require CWS to increase collection system capacity. In addition, the monitoring of flow from the interconnected system would be very difficult.

Option 4: This option is essentially the same NPV cost as Option 3. BES was much farther along in the design process and therefore the completion of the increased pumping and conveyance was more certain than Option 3.

DECISION: Option 4 was selected.

The CIP plan submitted to DEQ in March 2009 committed BES to reestablishing the existing Fanno Pump Station firm capacity of 24 cfs with surge protection by August 2011 and increasing the total firm pumping capacity to 40 cfs by November 2012.

Sewer Hydraulic Characterization

The Sanitary Sewer System Plan hydraulic characterizations of the Fanno and Burlingame basins are documented in the *Draft Fanno Basin Study Area Sewer Hydraulic Characterization Technical Memorandum* (BES, March 3, 2008) and the *Draft Burlingame Basin Study Area Sewer Hydraulic Characterization Technical Memorandum* (BES, April 23, 2008). These technical memoranda identify predicted locations for street flooding, basement sewer backup risk, and pipe segments with deficient hydraulic capacity.

The sewer hydraulics characterization identified facilities at risk of failing to meet the following City of Portland Bureau of Environmental Services (BES) levels of service:

- Prevention of sewage releases to the street, ground surface, or basements during the 5-year winter storm
- Compliance with State of Oregon standards regarding sewer releases to receiving waters
- Operation of pump stations within firm capacity

BES performed hydrologic and hydraulic modeling of the Fanno basin study area to characterize collection system performance. In accordance with Oregon Department of Environmental Quality (DEQ) guidelines, performance was evaluated for the 5-year winter storm. Existing conditions assume the calibrated I/I rates. Future conditions assume existing RDII rates increase by 10%. Tax lots that are will develop or redevelop in the future are assumed to have an I/I rate of 2000 gpad or twice the design manual rate.

The model was run using the existing pipe network was for both existing and future flow conditions. Collection system performance results are summarized in Table 2.

Table 2. Flooding Risk for Existing and Future Conditions
Fanno and Burlingame Basin Study Areas

FE Catchment	Surface Flooding Risk Count		Basement Sewer Backup Risk Count	
	Existing	Future	Existing	Future
Fanno	48	57	109	140
Burlingame	20	28	22	31

System Plan Alternatives Analysis

Alternatives were developed to identify items of work that would be required to convey and treat flow generated by a 5-year storm in the Fanno and Burlingame basins.

Alternative Development

The following summarizes concepts and assumptions used in developing the basin alternatives.

Burlingame Trunk

The Burlingame Trunk receives discharge from the Fanno Pressure Line at SW 31st and Multnomah. Hydraulic modeling and monitoring data demonstrate that the Burlingame Trunk is undersized and causes surface flooding during events where Fanno Pump station operates with four pumps. The trunk requires upsizing under existing conditions and all alternatives described below.

Cambridge Village Pump Station

During wet weather, the Cambridge Village Pump Station pumps flow from the upper Fanno Basin into the Burlingame Basin. In 2003 after the capacity limitations of Fanno Pump Station were recognized, the scheduled decommissioning of Cambridge Village was cancelled.

Cambridge Village should be able to operate for the next 5 to 10 years without major maintenance. The force main has required spot repairs in the past and may require repairs in the future.

All of the alternatives assume that Cambridge Village Pump Station would remain in service at current capacity

Dosch Road Relief

The Burlingame Basin has a high flow relief to the Fanno Basin upstream of the Cambridge Village Pump Station. This relief reduces the risk of local surface flooding in the Burlingame Basin. Future alternatives assume that the high flow relief will be eliminated.

Fanno Pump Station Diversion Structure

The Diversion structure will be rehabilitated to eliminate the passive overflow to Clean Water Services and provide a passive overflow to Fanno Creek. The overflow weir will be constructed at an elevation of 200.5 feet.

I/I Increases Due to System Degradation

Two base I/I conditions were simulated. Existing conditions, 2012 conditions and 2016 conditions assume the I/I rates are the same as the calibrated model. Future conditions assume I/I rates increase by 10% above existing conditions.

I/I Reduction Assumptions

The planning level assumptions used to develop I/I reduction options is based on the King County Infiltration Control Program documented in several reports. The explicit model document EMD097 provides details of how BES applied the King County methodology. The following summarizes the approach used to develop I/I reduction alternatives:

1. For all subbasins analyzed, more than 60% of the peak I/I rate is due to a combination of fast response and rapid infiltration. In accordance with King County Guidelines, I/I reduction efforts were assumed to be focused on private property with some and direct disconnects[4]. No specific I/I source information was available, so the total number of tax lots in each subbasin was used as the basis to develop quantities for cost estimates. Table X lists the percentages used to develop quantities and the unit costs applied.

2. Phase 1 Cost-effective I/I reduction projects were developed on a project specific basis rather than a need to meet specific I/I reduction targets at the Fanno Pump Station. The benefit/cost ratio is the savings from a reduction of local conveyance system improvements after I/I reduction divided by the cost of the proposed I/I reduction. The Phase 1 I/I projects were considered cost effective if the benefit/cost ratio is greater than 1. An iterative process was used to determine the lowest cost combination of RDII reduction and pipe upsizing.

3. Phase 2 I/I reduction projects were prioritized based on the peak unit I/I rates. The 60% reduction was applied to subcatchments with the highest I/I rates until the peak inflow to Fanno Pump Station did not cause the water level to rise above the weir elevation of the rehabilitated Fanno Diversion structure.

4. No costs associated with stormwater collection system improvements were included.

Table 3
Quantities and Unit Costs Applied for I/I Reduction C/E Analysis

Description	Percent of Total	Unit Cost
Public and Private Laterals	50%	$6,800
Private Laterals Only	45%	$3,500
Direct Disconnect	5%	$3,000

An iterative process was used to determine the lowest cost combination of RDII reduction and pipe upsizing for each focus area.

2012 Start-up Condition

The 2012 Start-up condition represents projects that are currently in design to meet the requirement of the Mutual Agreement and Order. By November 2012 to BES must have the ability to pump and convey flows associated with the 5-year storm without discharging to Clean Water Services. The following projects were assumed to be completed.

- Dual 30-inch pressure lines
- Burlingame Trunk improvements
- Southwest Parallel Interceptor Improvements and Upsizing
- New 16 cfs pump station for total firm capacity of 40 cfs at Fanno Pump Station

[4] Benefit/Cost Analysis Report (Pages 3-32 to 3-34)

- Reconstructed Fanno Diversion Structure

Alternative 1 Results: 2012 Startup

This alternative meets Mutual Agreement and Order (MAO) requirement of pumping all flows associated with the 5-year design storm at Fanno Pump station without discharging to Clean Water Services or Fanno Creek. The model predicts surcharged conditions in the Fanno Trunk upstream of the Pump station but does not predict surface flooding. Table X lists the number of locations where the model predicts a failure to meet surface or basement flooding risk level of service. Peak flow to the SW parallel interceptor is 65 cfs.

Table 4
Flooding Risk for 2012 Startup Conditions

Basin	Surface Flooding Risk Count	Basement Sewer Backup Risk Count
Fanno	58	109
Burlingame	16	14
Total	74	123

Alternative 1: Increase Fanno to 40 cfs Firm, Phased I/I Reduction and Local Pipe Upsizing

This alternative was developed to fully investigate in-basin and downstream requirements associated with the CIP plan submitted to DEQ. This alternative builds on the 2012 startup discussed above by adding I/I reduction projects and local pipe upsizing in the following Phases.

Phase 1 (Estimated Completion Date 2016): Resolve local capacity problems via Phase 1 RDII reduction with some local conveyance improvements.

Phase 2 (Estimated Completion Date 2028): Flows are projected to increase due to system degradation and additional EDUs. Offset the projected flow increases via Phase 2 RDII reduction.

Alternative 1 Results: Phase 1 I/I Reduction

This alternative resolves all local flooding risk in the Fanno and Burlingame Basins. Peak flow to the SW parallel interceptor is xx cfs.

Alternative 1 Results: Phase 2 I/I Reduction

This alternative resolves local flooding risk in the Fanno and Burlingame Basins. Peak flow to the SW parallel interceptor is xx cfs.

Alternative 2: Conveyance

This alternative shows the effect of meeting the surface and basement flooding level of service by increasing pumping and gravity pipe capacity. This alternative simulated for the future design condition only.

Alternative 2 Results

This alternative resolves all local flooding risk in the Fanno and Burlingame Basins. Peak flow to the SW parallel interceptor is 83 cfs.

Alternative 3: Maximum I/I Reduction

This purpose of this alternative is to investigate whether it would be theoretically possible to eliminate the need to increase the capacity at Fanno Pump station solely through I/I reduction efforts. I/I reduction was applied to all Fanno subcatchments with RDII rates greater than 8000 gpad that were located within the City of Portland.

Alternative 3 Results

This alternative reduces the peak flow to Fanno Pump Station but does not eliminate the need for additional pumping capacity in order to avoid discharging to Clean Water Services. The major driver for work in this basin is the MAO that requires BES to eliminate discharges to the Clean Water Services Collection System by 2011. Since this alternative does not eliminate the need without additional pumping this alternative was not considered further.

Alternatives Comparison and Discussion

Table 5 **Components**		
	Local I/I Reduction and Local Conveyance	**Conveyance**
New Pump Station Capacity	16 cfs	28 cfs
Dual 30-inch Pressure Lines	16,000 feet X 2	16,000 feet X 2
Burlingame Trunk SW 31st to SW 21st, 48-inch Gravity Sewer	2,700 feet	2,400 feet
Burlingame Trunk Improvements Between SW 21st and I-5	CIPP Liner; 2,100 feet	CIPP Liner; 1,150 feet 36-inch Bore/Jack; 1,200 feet
Burlingame Trunk upstream of SWPI, 36-inch	900 feet	900 feet
Modifications to 36-inch section of SWPI	800 feet	800 feet
Other gravity pipe, 18-inch and less	7,700 feet	28,900 feet
Other gravity pipe, 21- to 36-inch	None	10,300 feet
Other gravity pipe, 42- and 48-inch	None	5,500 feet
Phase 1 I/I Reduction, # Properties	2,011	N/A
Phase 2 I/I Reduction, # Properties	1,770	N/A

Table 6 Likelihood of Failure (1 Low 5 High)		
Level of Service Requirement	**I/I Reduction and Conveyance**	**Conveyance**
Meet 2012 MAO requirement	1.5	1
Comply with State of Oregon standards regarding sewer releases to receiving waters	1	1
No sewage releases to the street, ground surface, or basements up to the 5-year storm (Fanno)	3 difficult area limited experience	1
No sewage releases to the street, ground surface, or basements up to the 5-year storm (Burlingame)	2 difficult area limited experience	2 Recently upgraded sections of Burlingame Trunk will be at capacity

Challenges Associated with I/I program in the Fanno Basin

Private Property Access Required: Inspection of interior plumbing may be required to determine if foundation drains or sump pumps are connected to the sanitary sewer.

Stormwater System Improvements Likely: Improvements to the Stormwater collection system will be necessary to provide a discharge location for some disconnections.

Unimproved Streets: The City is not responsible for private drainage systems beyond the public right of way unless they are identified in Environmental Services records as City Owned facilities.

Next Steps – Modelers Notes

Check head loss in detail between diversion structure and pump station when running under surcharged conditions.

Survey trunk upstream of pump station to verify rim and inverts.