# *DRAINAGE REPORT*

**Wellington Hills County Park**

**December 17, 2013**

***Snohomish County Parks Department***

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# Drainage Information Summary Form

## Summary Table

| Drainage Basin Information | Individual Basin Information | | |
|---|---|---|---|
| | TDA A | TDA B | TDA C |
| | Fields, Parking, Trails, and Landscaping | | |
| Ex. On-Site Basin Area (Acres)[3] | 14.52 | 16.43 | 20.11 |
| Prop. On-Site Basin Area (Acres)[3,4] | 13.69 | 14.09 | 23.75 |
| Types of Storage Proposed | Pond (1), Pipe (3) | Vaults (2), Pipe (1) | Pond (1), Vault (2) |
| Total Storage Volume (cu. ft.) | 69,392 | 94,800 | 206,339 |
| Soil Type(s)[2] | Till | Till | Till |
| **Predeveloped Runoff Rates[1]** | | | |
| Q(cfs.) 2 yr. | 0.37 | 0.43 | 0.51 |
| 10 yr. | 0.80 | 0.93 | 1.11 |
| 100 yr. | 1.34 | 1.55 | 1.85 |
| **Postdeveloped Runoff Rates[1]** | | | |
| Q(cfs.) 2 yr. | 0.30 | 0.45 | 0.35 |
| 10 yr. | 0.61 | 0.94 | 0.80 |
| 100 yr. | 1.20 | 1.30 | 1.77 |
| **Offsite Upstream Area** | | | |
| Number of Acres | N/A | N/A | N/A |
| | | | |
| **Offsite Downstream Flow** | | | |
| Q(cfs.) 100 yr. | N/A | N/A | N/A |

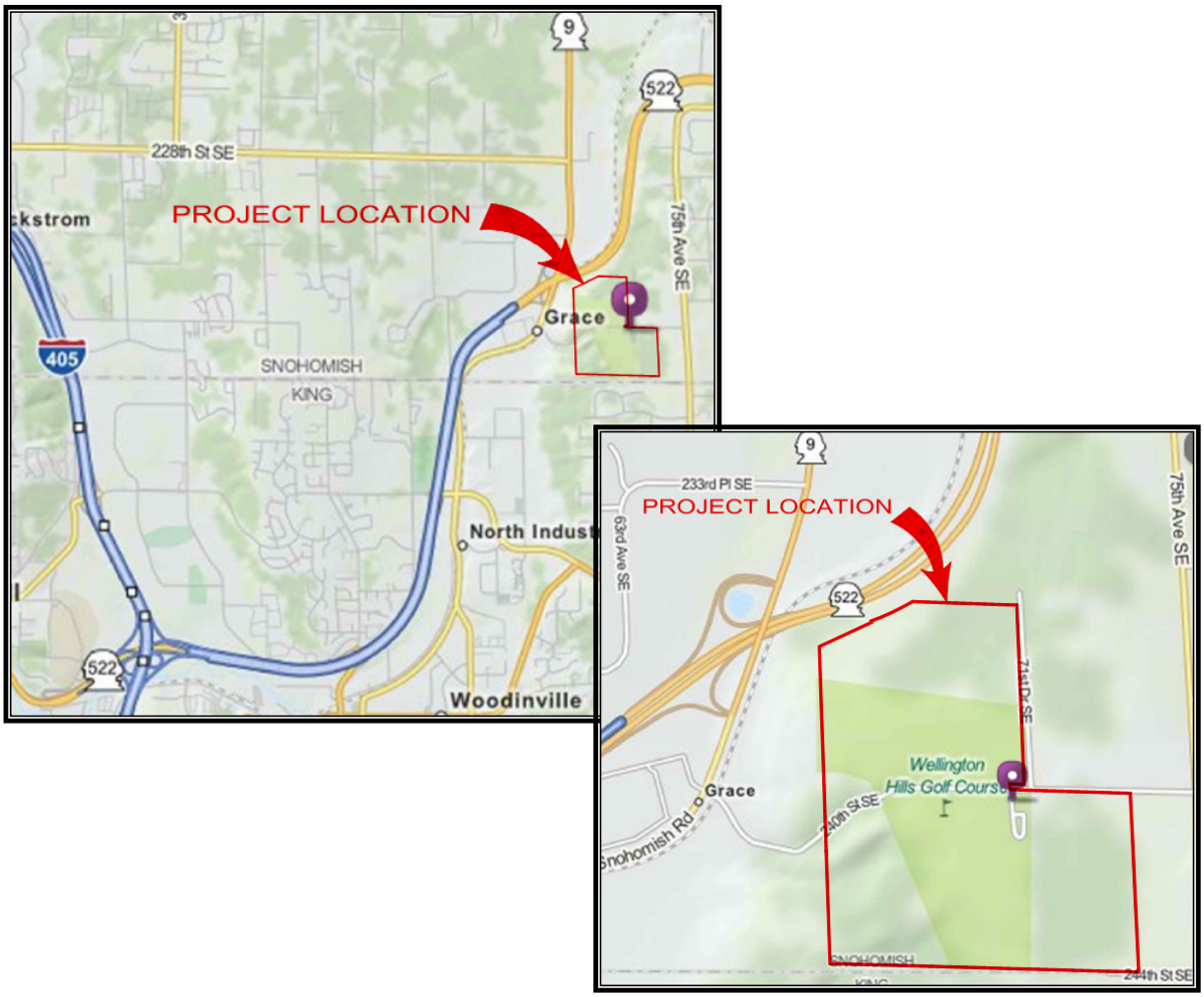
1. See Appendix B for Runoff Rate Calculations.
2. Per 1983 Soil Survey of Snohomish County Area Washington, prepared by the U.S. Department of Agriculture, NRCS soils are Alderwood Gravelly Sandy Loam which is considered till.
3. See Appendix A for drainage basin maps. Areas reflect developed limits of project.
4. TDA B includes 17,500 sq. ft. impervious surface from the 240th Street SE project.

## Project Overview and Executive Summary

Snohomish County Parks Department (Parks) proposes improvements to the acquired parks land which previously was a private golf and country club. Wellington Hills County Park land is 104 acres in size and was acquired with Brightwater mitigation funds in 2011. The site will be modified to construct ball fields, walking paths, a picnic area, an off-leash area for dogs, and parking. The project will preserve nearly 75 percent of the land as natural area and open space.

The project is located in the southwest quarter of Section 35, Township 27N, Range 5E of Snohomish County, bordering the northern limits of the City of Woodinville.

**Vicinity Map**



The proposed improvements include:

- Roundabout for the reconstructed 240th Street Southeast Project at the intersection with the park accesses.
- Four synthetic grass ball fields.
- Three natural grass ball fields.
- 181,642 square feet of porous concrete walkways.
- 279,536 square feet of pavement for parking lots and driveways to access the north and south halves of the park.
- Utilities include water mains for domestic and fire supply and septic lines to accommodate future improvements.
- Stormwater detention and water quality treatment as required per the Snohomish County Drainage Manual includes two detention ponds, four detention vaults, four pipe galleries, and seven bioswales.

Snohomish County Public Works is concurrently designing the 240th Street Southeast Improvements Project whose limits will overlap with the park boundary. The designs have been coordinated to tie the roundabout design to the roadway alignment. The stormwater design of the park will provide compensatory flow control on-site for the Public Works project.

This Drainage Report has evaluated the existing drainage patterns, defined the project's Threshold Discharge Areas (TDAs), basin boundaries, and land cover conditions. Hydrologic modeling has been performed to determine the detention volumes and comparison of flows for the existing condition and proposed condition. The impacts of daylighting groundwater to surface flows during construction, as well as potential long term impacts, have been considered and evaluated in this report.

The project site has three TDAs. The applicable design standards by which stormwater design is compliant for this project include:

- 2010 Snohomish County Drainage Manual (SCDM)
- Snohomish County Engineering Design and Development Standards (EDDS), 2012 Edition

## Existing Site Conditions Summary

### *Land Use and Areas*

The park site contains natural wooded areas over 55 of its 104 acres. The site plan has been designed to preserve the natural areas and minimize impacts to wetlands. Sewall Wetland Consulting, Inc. conducted an on-site investigation and identified three streams and nine wetlands within the limits of the Parks property. Vintage Creek is located in the southwest corner of the park, an unnamed creek in the west, and Parson Creek in the northern portion.

*Soil Types*

NRCS Soils Survey Maps indicate the site is comprised entirely of Alderwood gravelly sandy loam, 2 to 8 percent and 8 to 15 percent.

A geotechnical investigation has been performed by Snohomish County and the findings presented in the *Geologic Investigation and Geotechnical Engineering Report* (Geotechnical Report). Its findings include identification of the surficial geology as glacial till. Test pits were excavated at seventy-four locations throughout the site. Site stratigraphy has been described as a uniform layer of topsoil underlain by silty sand with gravel of variable thickness.

The project site is not located within a designated sole source aquifer, the nearest being the Cross Valley Sole Source Aquifer located over a quarter mile north and east of the project site.

Groundwater had been observed during the site investigations throughout the site at varying depths which supports the basal flows of the local drainages and wetlands. Based on the soils and groundwater presence, infiltration as a means of addressing stormwater is not deemed feasible as the primary method for the site. It is acceptable to assume infiltration for the porous walking paths and sidewalks. Due to the low infiltration potential of the glacial till soil, porous concrete was modeled using an infiltration rate of 0.25 inches per hour.

The geotechnical recommendations are based on the assumption that a temporary deep groundwater cutoff trench be installed along the upper limits of the project site. The purpose of this trench is to draw down the groundwater and reduce moisture content of the soils to improve workability of the moisture-sensitive soils. The estimated flow rate from this trench is 0.25 gallons per hour for every 15 feet of length. The temporary erosion control plan addresses this surface water discharge during construction and controls flow rates. The cutoff trench, if left in place after construction, will continue to direct groundwater to the surface. The existing hydrologic regime functions in a similar manner with groundwater supplying the basal flows to the creeks.

*Drainage Patterns and Features*

The project site is located on a plateau characterized by a gently rolling landscape. Steep slopes are located near the north and west slopes where the terrain leads to the Little Bear Creek Valley. Local drainages include three streams. Vintage Creek is located in the southwest corner of the site, Parson Creek in the north, and an unnamed creek in the west.

Basin delineations have been made for the project site. Within the park limits, three TDAs were identified (refer to basin figures in Appendix A). TDAs are defined as the limits where one or more natural discharge locations from the project site converge within a quarter mile downstream of the project limits. See the Off-Site Analysis below for descriptions of the TDAs and downstream features.

## Off-Site Analysis

*Upstream Analysis*

An analysis was completed to identify offsite areas that contribute to the project site. Based on site visits and review of available topographic information, it is anticipated that there is nominal off-site contribution from the south of the park boundary and from the east. These flows are expected to be relatively small. The project improvements will manage the off-site runoff that enters the site and maintain the existing flow patterns.

*Downstream Analysis*

Runoff from the park site drains toward Little Bear Creek which flows to the southwest before converging with Howell Creek, flowing into the Sammamish River, then Lake Washington, eventually to Lake Union and the Puget Sound.

Downstream conditions for the site's TDAs are described below. See Appendix B for figures showing aerial photos with descriptions of each TDA's downstream conditions.

**TDA A**

See Appendix A for a figure showing an aerial photo with descriptions of the TDA A downstream conditions and accompanying photos.

TDA A consists of the area in the southern portion of the site and contains a single basin that is tributary to Vintage Creek. Bounded to the east by 75th Avenue Southeast, the upper limits of the TDA are within a relatively flat plateau that is heavily wooded. The topographic relief falls to the west, creating a heavily forested ravine containing Vintage Creek. The creek exits the park boundary, which is also the County line. The drainage enters the city of Woodinville, where it continues to flow in a southwesterly direction through a wooded area (Photo A.1). The creek eventually enters an enclosed conveyance system north of Northeast 203rd Street and passes beneath the parking lot of Universal Land Construction Company (Photo A.2 and Photo A.3).

The City of Woodinville's *Comprehensive Stormwater Management Plan* (December 2010) indicates that this enclosed conveyance system flows west approximately 300 feet, then turns north in 144th Avenue Northeast and returns into the County limits. The storm drain pipe beneath the parking lot and where it continues north in 144th Avenue Northeast have been identified in this study as capacity-constrained systems. Refer to the Flow Control Requirements section for discussion on affects to the system due to the project.

This TDA is tributary to Little Bear Creek, which is located west of SR 522 and 3/4 miles downstream.

**TDA B**

See Appendix A for a figure showing an aerial photo with descriptions of the TDA C downstream conditions and accompanying photos.

TDA B is situated to the north of TDA A and has three locations where stormwater exits the park boundary. The drainage from the south end of TDA B exits to the west and enters a heavily wooded ravine forming an unnamed creek (Photo B.1, Photo B.3, and Photo B.4). There is evidence of exposed soils along the stream bank as well as a culvert comprised of large voids used to bypass a former trail embankment (Photo B.2). The ravine drains beyond the park boundary to a driveway embankment. Drainage then enters a culvert and exits the other side of the embankment into an enclosed conveyance system and passes beneath the parking lot of JEV Recycling, Inc.

Drainage from the north end of TDA B drains off site (Photo B.5) to a steep slope that is currently experiencing erosion (Photo B.6). The drainage flows down the slope and is collected by a retaining wall situated on the east side of the University Swaging parking lot. It seeps through the wall and is then diverted into a closed conveyance system and flows underneath the parking lot. It is likely that a perforated pipe drainage system behind the wall also collects the runoff and conveys it via pipes to the conveyance system in the parking lot.

Roadway drainage and vegetated areas along 240th Street Southeast right-of-way flow to roadside ditches, traveling through a series of ditches and culverts alongside the road and down the hill. Water on the north side of the roadway enters the enclosed conveyance system 300 feet west of the park boundary along 240th Street Southeast, near the Wellington Hills Business Park improvements. Drainage on the south side of the roadway travels 200 feet west of the developer improvements prior to entering enclosed conveyance.

Roadway drainage and drainage from the south end of TDA B converge approximately 500 feet west of the park boundary. Drainage from the north end of TDA B joins at the railroad tracks just east of SR 522. These combined flows travel west under the railroad tracks via a culvert crossing to a catch basin in an existing sidewalk. The flow then enters a westerly pipe system traveling through the Woodinville Costco parking lot. These pipe system outlets via a submerged 12-inch pipe on the east side of SR 522 before flowing to a meandering ditch to a 24-inch culvert, crossing under SR 522 into Little Bear Creek.

**TDA C**

See Appendix A for a figure showing an aerial photo with descriptions of the TDA C downstream conditions and accompanying photos.

TDA C consists of two sub-basins. The first basin is a small area located in the northwest corner of the park (Photo C.10). Runoff from this basin flows to the northwest down wooded slopes to the base of the hill, located on the south side of SR 522. A retaining wall running along the shoulder of the highway collects the runoff (Photo C.6). The runoff is conveyed along the top side of the retaining wall to the west and seeps through the face of the retaining wall (Photo C.7) and runs along the shoulder to catch basins located beneath the Woodinville Snohomish Road overpass (Photo C.8). From there, piped conveyance systems take the runoff to Little Bear Creek. It is likely that a perforated pipe drainage system behind the wall also collects the runoff and conveys it via pipes to the catch basins along the highway shoulder.

The second sub-basin is a much larger basin which begins in the upper plateau described in the other TDAs (Photo C.1). TDA C includes runoff from 240th Street Southeast, draining west in roadside ditches and passing through a culvert located beneath 240th Street Southeast. The topography falls to the north and west, conveying stormwater via a series of drainages through the steeper wooded slopes in the northern 500 feet of the park site to Parson Creek (Photo C.2), which flows from east to west along the north side of the site.

While no erosion due to stream flows was observed in Parson Creek, sloughing was observed due to saturated banks and springs along the creek (Photo C.3). This sloughing is attributed to groundwater, as discussed in the Geotechnical Report.

Stormwater leaves the site along the northern boundary as Parson Creek draining into the SR 522 right-of-way where it passes through a culvert to the northwest (Photos C.4 and C.5). The creek passes another culvert under railroad tracks before entering a stretch of daylighted and improved stream bed along the Brightwater Treatment Plant site. From there the creek passes under Woodinville Snohomish Road via a culvert and discharges to Little Bear Creek.

## Water Pollution Source Control for New Development

No pollution generating activities or uses, as described on Volume IV, Chapters 3 and 4 of the SCDM, are planned for the site during or following construction.

## Preservation of Natural Drainage Systems and Outfalls

See the Drainage Information Summary Form at the beginning of this report for a summary of changes to TDA areas and their respective flows. Existing flow patterns were maintained to the highest extent possible in accordance with Snohomish County Code (SCC). To the extent possible, the proposed grading maintains area balance between basin areas; however, development of the site will result in changes to the basin boundaries within the site. To mitigate for this, the stormwater runoff from each TDA will match those of the pre-developed conditions (till forest) from the existing TDA boundaries. The project will provide flow control and water quality treatment consistent with the SCC and will not impact downstream streams, conveyances, or properties.

## On-Site Stormwater Management

Stormwater management Best Management Practices (BMPs) will be utilized to the maximum extent feasible in order to infiltrate, retain, and provide stormwater runoff treatment for the site in accordance with SCC. A variety of BMPs will be used throughout the site, including ponds, vaults, pip galleries, porous concrete, dispersion trenches, and bio-swales.

Conveyance piping for the project was sized based on the 100-year storm using the Rational Method. Conveyance calculations based on standard WSDOT calculation spreadsheets are included in Appendix D.

## Runoff Treatment Requirements

Per the SCDM, stormwater treatment is required for pollution generating surfaces with the design intent of removing 80-percent of total suspended solids (TSS). There are no downstream sensitive water bodies requiring the need for phosphorous treatment at the site.

Bioswales are proposed at conveyance system outfalls for detained and undetained flows. All bioswales have 3:1 side slopes and depths of 2 feet. See the table below for a summary of the proposed bioswales and Appendix E for bioswale calculations.

**Proposed Bioswales**

| BIO-SWALE | DESCRIPTION | DESIGN FLOWS [CFS] | | | | BASE WIDTH | LENGTH | LONG. SLOPE |
|---|---|---|---|---|---|---|---|---|
| | | QWQ | 2-YR RELEASE | Q100 15 | Q10 15 | [FT] | [FT] | |
| A-1 | DOWNSTREAM OF TDA A PARKING LOT DETENTION | - | 0.012 | 0.05 | 0.03 | 2 | 100 | 1.5% |
| B-1 | DOWNSTREAM OF TDA B SOUTH PARKING LOT VAULT | - | 0.016 | 0.06 | 0.04 | 3 | 100 | 3.0% |
| B-2 | DOWNSTREAM OF TDA B CENTRAL PARKING LOT VAULT; INCLUDES ADDITIONAL UNDETAINED FLOWS | 0.01 | 0.008 | 0.33 | 0.16 | 2 | 170 | 5.0% |
| C-1 | TREATS PORTION OF TDA C PARKING LOTS SOUTH OF 240TH | 0.21 | - | 3.95 | 1.82 | 2 | 300 | 3.4% |
| C-2 | TREATS PORTION OF TDA C PARKING LOTS SOUTH OF 240TH | 0.20 | - | 2.00 | 0.98 | 5 | 150 | 1.5% |
| C-3 | DOWNSTREAM OF TDA C NE PARKING LOT VAULT | - | 0.182 | 0.99 | 0.42 | 2 | 210 | 2.0% |
| C-4 | DOWNSTREAM OF TDA C NW PARKING LOT VAULT | - | 0.011 | 0.03 | 0.02 | 2 | 100 | 2.0% |

## Flow Control Requirements

Snohomish County (County) has adopted the "2010 Snohomish County Drainage Manual" (SCDM). In accordance with the SCDM, the hydrologic modeling of the project has been modeled using MGS Flood Version 4.31, an approved equivalent HSPF-based continuous modeling program to the Department of Ecology's Western Washington Hydrology Model (WWHM). Each TDA was modeled to meet the flow duration requirements of the SCDM.

Flow control will be required for the project per the SCDM to maintain peak flows for stormwater runoff from the proposed project area. Stormwater discharges shall be controlled to match developed discharge flow durations to pre-developed durations between 50 percent of the 2-year peak flow and up to the full 50-year peak flow. The pre-developed condition to be matched shall be a forested land cover over till soil.

Each TDA as defined above will provide flow control within its limits to meet the SCDM standard.

**TDA A**

TDA A contains the drainage basin identified on the Basin Delineation Figures in Appendix A. Improvements in TDA A primarily include clearing of trees and grading to construct four ball fields. A portion of an impervious asphalt parking lot will be built at the west side of TDA A. Porous concrete walkways will connect the ball fields and parking lot.

The impacted project area within the existing TDA A is 14.52 acres. The project's proposed grading concept will divert approximately 0.83 acre from TDA A to TDA B, resulting in a remaining 13.69 acres of project area in TDA A. The storm drainage system downstream of TDA A is capacity-constrained and will benefit from the reduction in tributary area, as discussed later in this report. The diversion of tributary area to TDA B will not result in an increase in TDA B runoff compared to existing conditions.

Proposed land cover within TDA A was characterized based on the proposed site plan. The table below shows the total area of each proposed land cover type within the project limits that drain to each of the proposed flow control facilities, as well as that portion of the developed area that will remain undetained.

**Proposed Land Cover in TDA A**

| BASIN | PGIS | | NPGIS | | POROUS CONC | | GRASS AND TURF | | FOREST | | TOTAL IMPERV | TOTAL AREA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | [SF] | [AC] | [SF] | [AC] | [SF] | [AC] | [SF] | [AC] | [SF] | [AC] | [AC] | [AC] |
| E LOT GAL | 17914 | 0.411 | 481 | 0.011 | 2911 | 0.067 | 1891 | 0.043 | 120 | 0.003 | 0.422 | 0.535 |
| FIELD 5 GAL | 0 | 0.000 | 7392 | 0.170 | 38211 | 0.877 | 259541 | 5.958 | 0 | 0.000 | 0.170 | 7.005 |
| S DET POND | 0 | 0.000 | 14426 | 0.331 | 7083 | 0.163 | 127462 | 2.926 | 20556 | 0.472 | 0.331 | 3.892 |
| UNDETAINED | 0 | 0.000 | 4387 | 0.101 | 740 | 0.017 | 80496 | 1.848 | 0 | 0.000 | 0.101 | 1.966 |
| W LOT GAL | 9057 | 0.208 | 224 | 0.005 | 1370 | 0.031 | 2257 | 0.052 | 0 | 0.000 | 0.213 | 0.296 |
| **TOTAL TDA** | **26971** | **0.619** | **26911** | **0.618** | **50315** | **1.155** | **471647** | **10.828** | **20676** | **0.475** | **1.237** | **13.694** |

The TDA was modeled using a continuous hydrologic model to meet the flow duration requirements of the SCDM. Hydrologic modeling summaries are provided in Appendix B. To meet flow control requirements, four detention facilities will be constructed in TDA A with a combined volume of 69,392 cubic feet as shown in the table below.

**Detention Facilities in TDA A**

| Facility | Type | Volume | Tributary Areas |
|---|---|---|---|
| East Parking Lot Detention Gallery | Pipes | 9,000 CF | Parking areas at west side of TDA |
| Field 5 Detention Gallery | Pipes | 27,000 CF | Fields 3, 4, & 5 |
| South Detention Pond | Pond | 28,892CF | Field 6 and outflow from Field 5 Gallery |
| West Parking Lot Detention Gallery | Pipes | 4,500 CF | Parking areas at west side of TDA |

As discussed earlier in this report, there is a conveyance system downstream of TDA A that the City of Woodinville has identified as capacity-constrained. The project will decrease flows to Vintage Creek and the constrained system. Currently, 14.52 acres of the project site are located in TDA A. The project's proposed grading concept will divert approximately 0.83 acre from TDA A to TDA B. Runoff from the remaining 13.69 acres of project site within TDA A will be detained to match pre-developed conditions of forest over till soil. Existing and proposed runoff from TDA A to Vintage Creek is shown in the table below. Conditions in the existing downstream conveyance will be improved as compared to current.

**Peak Flows to Vintage Creek – Existing and Post-Construction**

| Condition | TDA A Area Tributary to Vintage Creek [AC] | Peak Flow | | |
|---|---|---|---|---|
| | | 2-year [CFS] | 10-year [CFS] | 100-year [CFS] |
| Existing* | 14.52 | 0.48 | 1.06 | 2.10 |
| Proposed | 13.69 | 0.30 | 0.61 | 1.20 |

*Existing conditions modeled as 75% till pasture and 25% till forest.

**TDA B**

TDA B contains the drainage basin identified on the Basin Delineation Figures in Appendix A. Improvements within these limits include clearing of trees to install a synthetic ball field, a natural grass field, a parking lot, and walking paths.

The proposed grading concept will divert runoff between TDAs A, B, and C, but flows will be matched to pre-developed conditions (till forest) for the existing TDA boundaries. The impacted project area within the existing TDA B is 16.42 acres. The project's proposed grading concept will divert approximately 0.83 acre from TDA A to TDA B and 3.62 acres from TDA B to TDA C, resulting in a net decrease of 2.79 acres away from TDA B.

The Southeast 240th Street Improvement Project is within TDA B. Compensatory flow control for the roadway project will be provided as part of the park development. The detention provided on the park site has been designed for an additional 17,500 square feet of new impervious area that will be created by the Public Works project. The point of compliance is the storm drain at the intersection of Southeast 240th Street and Snohomish-Woodinville Road which is the point where all flows combine from TDA B and the Southeast 240th Street Improvements.

Proposed land cover within TDA B was characterized based on the proposed site plan. The table below shows the total area of each proposed land cover type within the project limits that drain to each of the proposed flow control facilities, as well as that portion of the developed area that will remain undetained. Impervious surface runoff from 26,000 square feet of the future Community Activity Center Building was included in the characterization.

**Proposed Land Cover in TDA B**

| BASIN | PGIS | | NPGIS | | POROUS CONC | | GRASS AND TURF | | FOREST | | TOTAL IMPERV | TOTAL AREA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | [SF] | [AC] | [SF] | [AC] | [SF] | [AC] | [SF] | [AC] | [SF] | [AC] | [AC] | [AC] |
| S LOT VAULT | 36825 | 0.845 | 1636 | 0.038 | 8033 | 0.184 | 16247 | 0.373 | 813 | 0.019 | 0.883 | 1.459 |
| C LOT VAULT | 20568 | 0.472 | 768 | 0.018 | 921 | 0.021 | 12163 | 0.279 | 476 | 0.011 | 0.490 | 0.801 |
| FIELD 7 GAL* | 0 | 0.000 | 26553 | 0.610 | 29307 | 0.673 | 286102 | 6.568 | 7526 | 0.173 | 0.610 | 8.023 |
| 240th | 17500 | 0.402 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0.402 | 0.402 |
| UNDET A2 | 0 | 0.000 | 1075 | 0.025 | 3524 | 0.081 | 55804 | 1.281 | 603 | 0.014 | 0.025 | 1.401 |
| UNDET A3 | 2546 | 0.058 | 313 | 0.007 | 4409 | 0.101 | 48219 | 1.107 | 0 | 0.000 | 0.066 | 1.274 |
| UNDET A4 | 0 | 0.000 | 4103 | 0.094 | 0 | 0.000 | 27702 | 0.636 | 0 | 0.000 | 0.094 | 0.730 |
| **TOTAL TDA** | **77439** | **1.778** | **29391** | **0.675** | **46194** | **1.060** | **446238** | **10.244** | **9417** | **0.216** | **2.569** | **14.089** |

* FIELD 7 GAL INCLUDES 26,000 SF NPGIS FOR FUTURE COMMUNITY ACTIVITY CENTER BUILDING.

Hydrologic modeling summaries are provided in Appendix B. To meet flow control requirements, four detention facilities will be constructed in TDA B with a combined volume of 94,800 cubic feet as shown in the table below.

**Detention Facilities in TDA B**

| Facility | Type | Volume | Tributary Areas |
|---|---|---|---|
| South Parking Lot Detention Vault | Vault | 28,800 CF | Parking areas at southwest side of TDA |
| Central Parking Lot Detention Vault | Vault | 18,000 CF | Parking areas near center of site |
| Field 7 Detention Gallery | Pipes | 48,000 CF | Field 7 & southern halves of Fields 1 & 2 |

## TDA C

TDA C contains the drainage basin identified on the Basin Delineation Figures in Appendix A. Improvements within these limits include limited clearing of trees to install a parking lot and driveway, walking paths, and an off-leash dog park. A portion of a synthetic ball field near the eastern limits of the park also falls within this TDA.

The impacted project area within the existing TDA C is 20.11 acres. The project's proposed grading concept will divert approximately 3.62 acres from TDA B to TDA C. Flow control systems will match flows from the larger developed TDA to the pre-developed conditions (till forest) for the existing TDA boundary.

Flow control will be provided by a detention pond and a detention vault. Runoff from synthetic ball fields, parking lots, driveways, walkways, lawn, and other sites areas south of 240th Street Southeast will be collected and conveyed north under 240th Street Southeast to the detention pond. Runoff from lawn and walkways immediate adjacent to the pond will drain to the pond.

The pond will be designed as a combined public space and flow control facility with gentle slopes for walking. In the dry season it will be an open grassed area for public use, but will store stormwater during the wet season.

Runoff from parking lots, driveways, walkways, lawn, and other sites areas both north and south of 240th Street Southeast will be collected and conveyed to the TDA C detention vault.

Proposed land cover within TDA C was characterized based on the proposed site plan. The table below shows the total area of each proposed land cover type within the project limits that drain to each of the proposed flow control facilities, as well as that portion of the developed area that will remain undetained. Impervious surface runoff from 16,000 square feet of the future Community Activity Center Building was included in the characterization.

**Proposed Land Cover in TDA C**

| BASIN | PGIS | | NPGIS | | POROUS CONC | | GRASS AND TURF | | FOREST | | TOTAL IMPERV | TOTAL AREA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | [SF] | [AC] | [SF] | [AC] | [SF] | [AC] | [SF] | [AC] | [SF] | [AC] | [AC] | [AC] |
| N DET POND* | 83306 | 1.912 | 52081 | 1.196 | 42336 | 0.972 | 303428 | 6.966 | 2615 | 0.060 | 3.232 | 11.229 |
| NE LOT VAULT | 70001 | 1.607 | 6443 | 0.148 | 26109 | 0.599 | 176548 | 4.053 | 133568 | 3.066 | 1.755 | 9.474 |
| N W LOT VAULT | 21819 | 0.501 | 640 | 0.015 | 6818 | 0.157 | 26954 | 0.619 | 348 | 0.008 | 0.516 | 1.299 |
| UNDETAINED | 0 | 0.000 | 0 | 0.000 | 9870 | 0.227 | 53269 | 1.223 | 13171 | 0.302 | 0.000 | 1.752 |
| **TOTAL TDA** | **175126** | **4.020** | **57825** | **1.327** | **85133** | **1.954** | **560199** | **12.860** | **149702** | **3.437** | **5.502** | **23.754** |

* N DET POND INCLUDES 16,000 SF NPGIS FOR FUTURE COMMUNITY ACTIVITY CENTER BUILDING.

Hydrologic modeling summaries are provided in Appendix B. To meet flow control requirements, four detention facilities will be constructed in TDA C with a combined volume of 206,339 cubic feet as shown in the table below.

**Detention Facilities in TDA C**

| Facility | Type | Volume | Tributary Areas |
|---|---|---|---|
| North Detention Pond | Pond | 131,459 CF | Northern halves of Fields 1 & 2 and parking areas near center of site |
| NE Parking Lot Detention Vault | Vault | 46,080 CF | Site driveways, parking areas at north side of TDA |
| NW Parking Lot Detention Vault | Vault | 28,800 CF | Parking areas at northwest side of TDA |

## Summary of Land Cover and Hydrologic Modeling

Proposed land cover characterization and modeling discussions are presented in the "Flow Control Requirements" section above.

## SWPPP Erosion Control Best Management Practices (BMPs)

A Stormwater Pollution Prevention Plan (SWPPP) has been prepared for the Project as part of the NPDES construction permit with the Washington State Department of Ecology. The SWPPP outlines the proposed Erosion Control BMPs that will be implemented during

construction to prevent the transport of sediment and other impacts that increase runoff during land disturbing activities such as clearing and grading. Erosion and sedimentation control best management practices that will be used for this project include the following:

*Preserving Natural Vegetation*
Prior to any clearing or grading activities, clearing limits shown on the plans will be visibly delineated in the field.

*Soil Stabilization Measures*
Cleared areas to remain undisturbed for an extended period will be seeded, or otherwise stabilized in some fashion. Temporary ground cover such as temporary seeding or mulch will be applied to disturbed areas. Due to the nature of the moisture-sensitive soils of the site, construction should not be performed during periods of wet weather without contingencies to address disturbed soils and dewatering of excavations.

*Perimeter Protections*
Silt fence, wattles, or other protection will be used along edges of the project area where existing contours show the possibility for sediment-laden runoff to leave the site during construction.

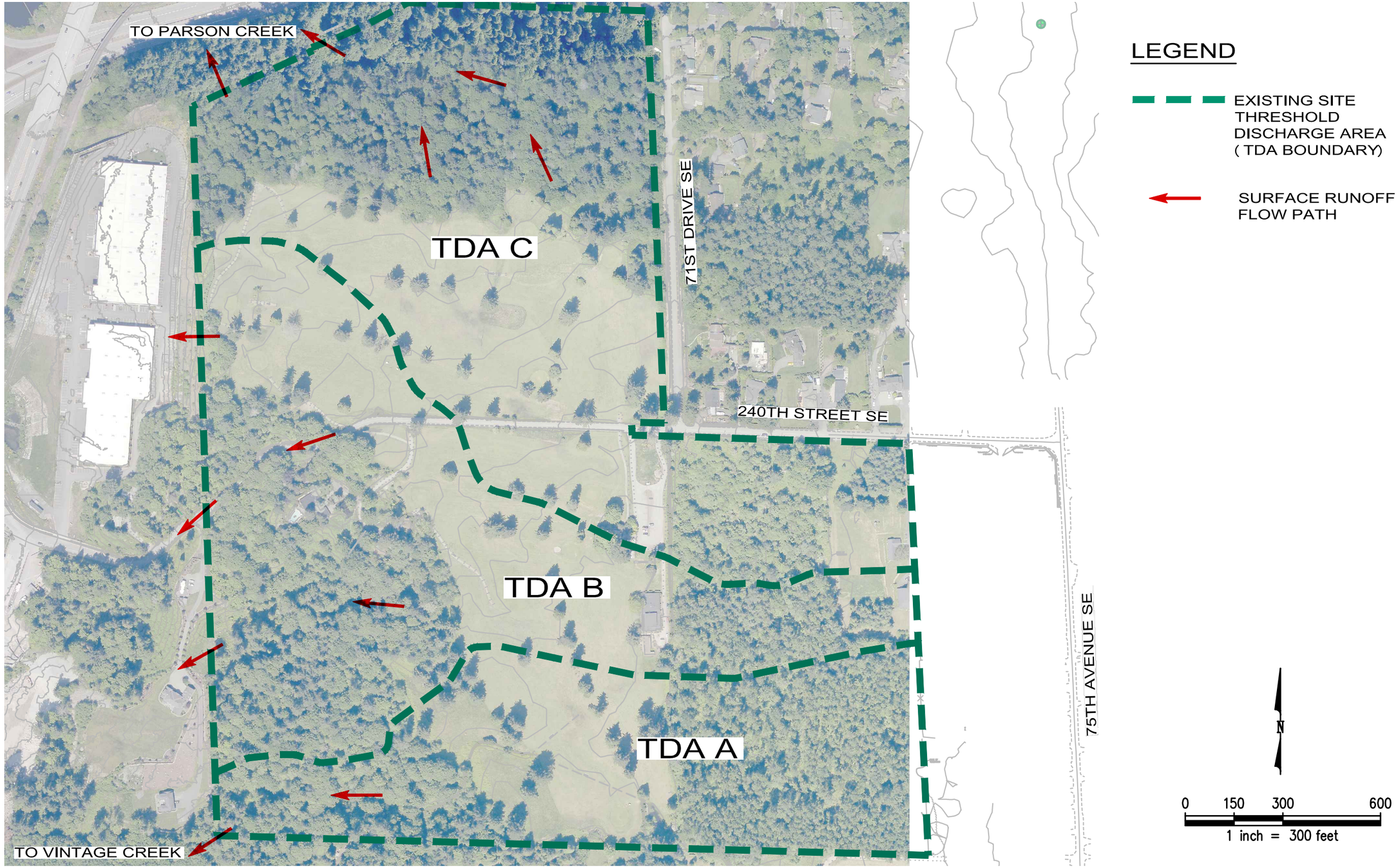
*Sediment Pond*
Surface water collected from disturbed areas of the project will be routed to temporary sediment ponds or portable tanks to allow suspended solids to settle out prior to discharge from the site. Sedimentation facilities will be sized in accordance with the SCDM.

*Traffic Area Stabilization*
One or more stabilized construction entrances and wheel washes will be installed to minimize tracking dirt off the site from construction vehicles.

*Dust Control*
Water trucks will be used to control dust during construction, as needed. Permanent erosion and sedimentation control measures will consist of establishing vegetation in landscape areas and installing pavement.

# Appendix A

# Basin Figures

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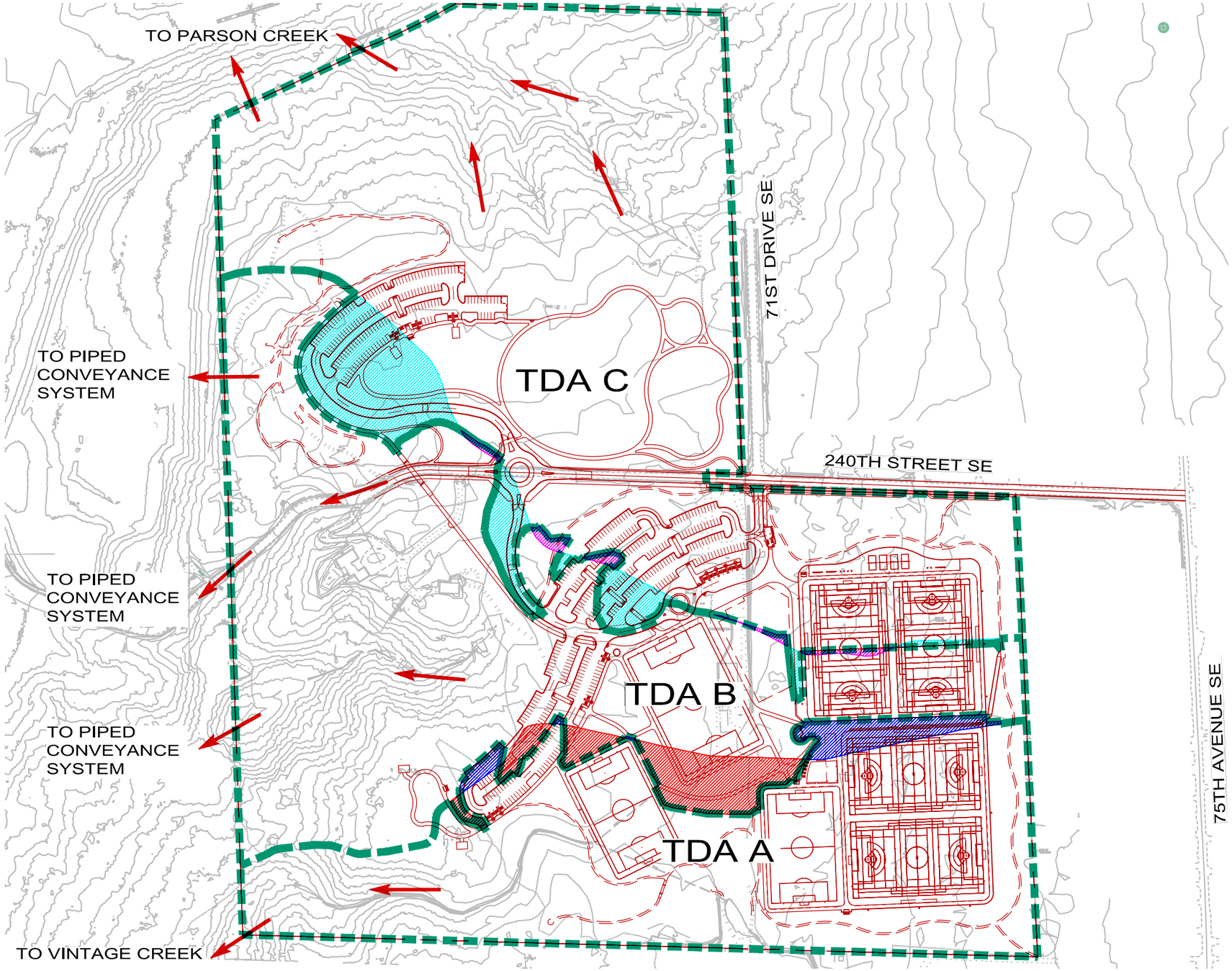
SNOHOMISH COUNTY PARKS AND RECREATION
WELLINGTON HILLS COUNTY PARK

EXISTING STORM DRAINAGE BASIN DELINEATION
FIGURE 1




## LEGEND

PROPOSED SITE THRESHOLD DISCHARGE AREA ( TDA BOUNDARY)

TDA A TO TDA B
1.79 AC

TDA B TO TDA A
0.96 AC

TDA B TO TDA C
3.90 AC

TDA C TO TDA B
0.28 AC

TDA A NET CHANGE
-1.79 + 0.96 = -0.83 AC

TDA B NET CHANGE
+1.79 - 0.96 - 3.90 + 0.28 = -2.79 AC

TDA C NET CHANGE
+3.90 - 0.28 = +3.62 AC

SURFACE RUNOFF FLOW PATH

N

0 150 300 600
1 inch = 300 feet

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SNOHOMISH COUNTY PARKS AND RECREATION
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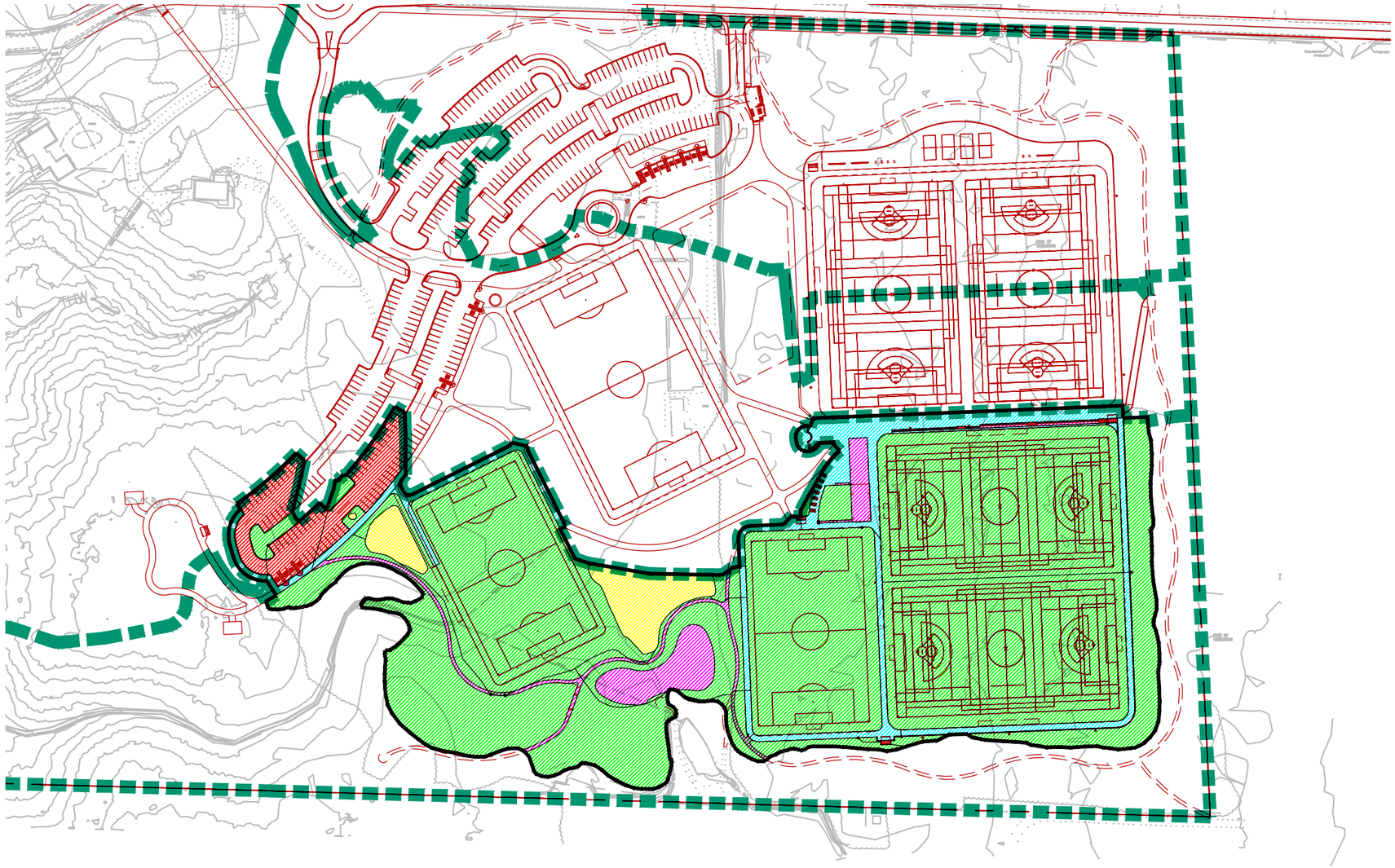
PROPOSED STORM DRAINAGE BASIN DELINEATION
FIGURE 2



## LEGEND

- PROPOSED SITE THRESHOLD DISCHARGE AREA ( TDA BOUNDARY)
- LIMIT OF DISTURBANCE
- PGIS
- NPGIS
- POROUS CONC
- GRASS AND TURF
- FOREST AND UNDISTURBED

N

0 100 200 400

1 inch = 200 feet

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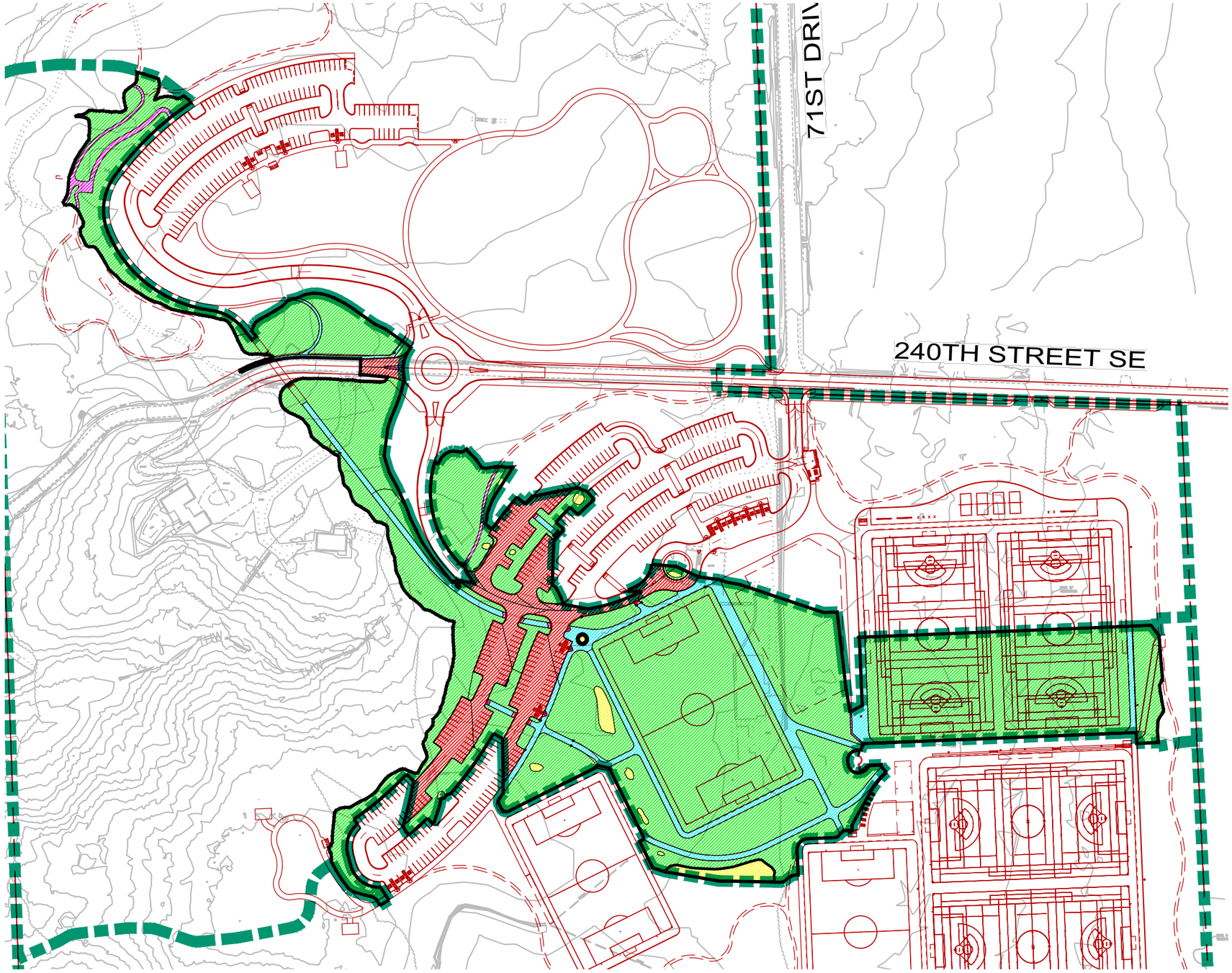
**SNOHOMISH COUNTY PARKS AND RECREATION**
**WELLINGTON HILLS COUNTY PARK**

STORM DRAINAGE BASIN CHARACTERIZATION
FIGURE 3A – TDA A




## LEGEND

- PROPOSED SITE THRESHOLD DISCHARGE AREA ( TDA BOUNDARY)
- LIMIT OF DISTURBANCE
- PGIS
- NPGIS
- POROUS CONC
- GRASS AND TURF
- FOREST AND UNDISTURBED

N

0 100 200 400

1 inch = 200 feet

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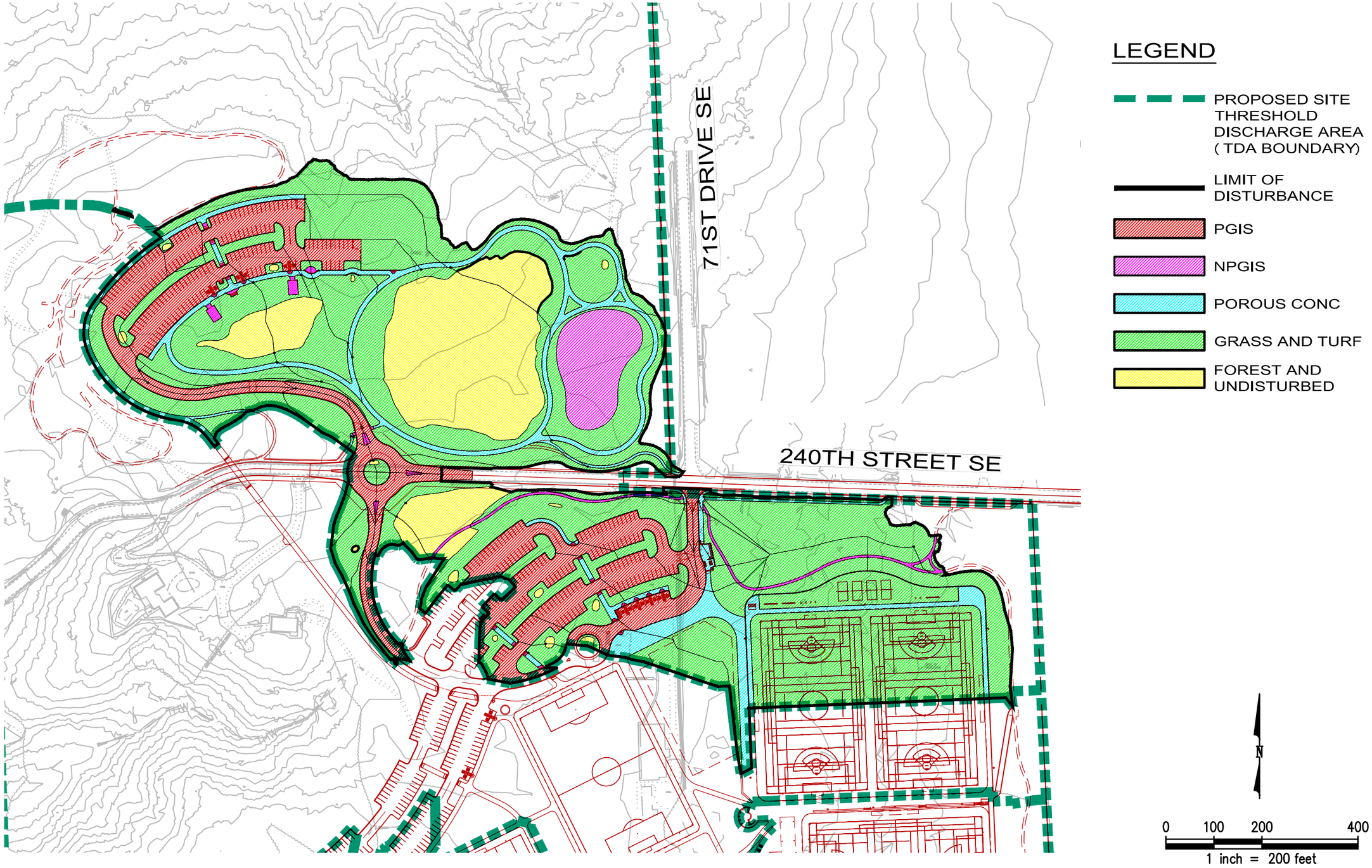
**SNOHOMISH COUNTY PARKS AND RECREATION**
**WELLINGTON HILLS COUNTY PARK**

STORM DRAINAGE BASIN CHARACTERIZATION
FIGURE 3B – TDA B

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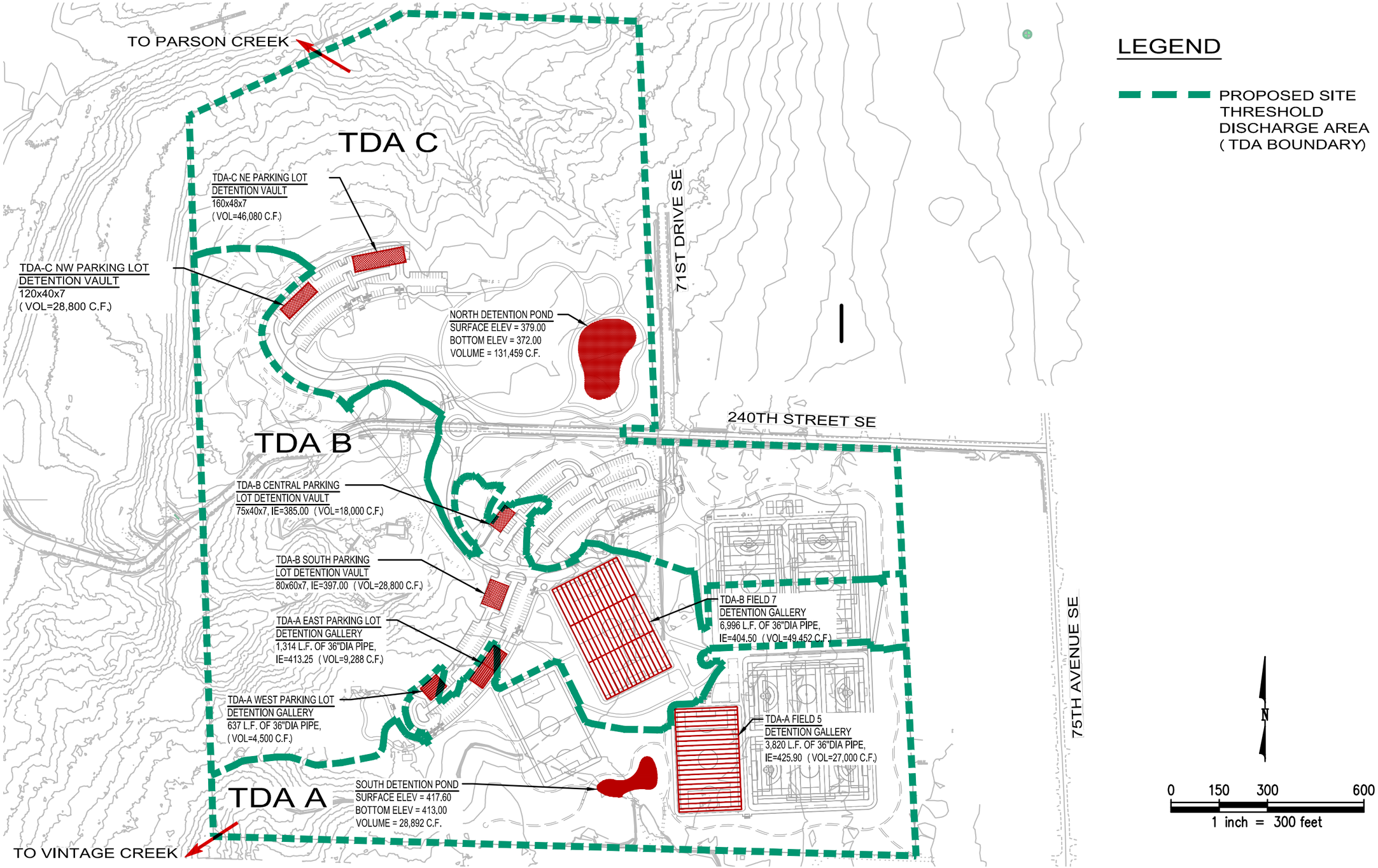
**SNOHOMISH COUNTY PARKS AND RECREATION**
**WELLINGTON HILLS COUNTY PARK**

STORM DRAINAGE BASIN CHARACTERIZATION
FIGURE 3C – TDA C

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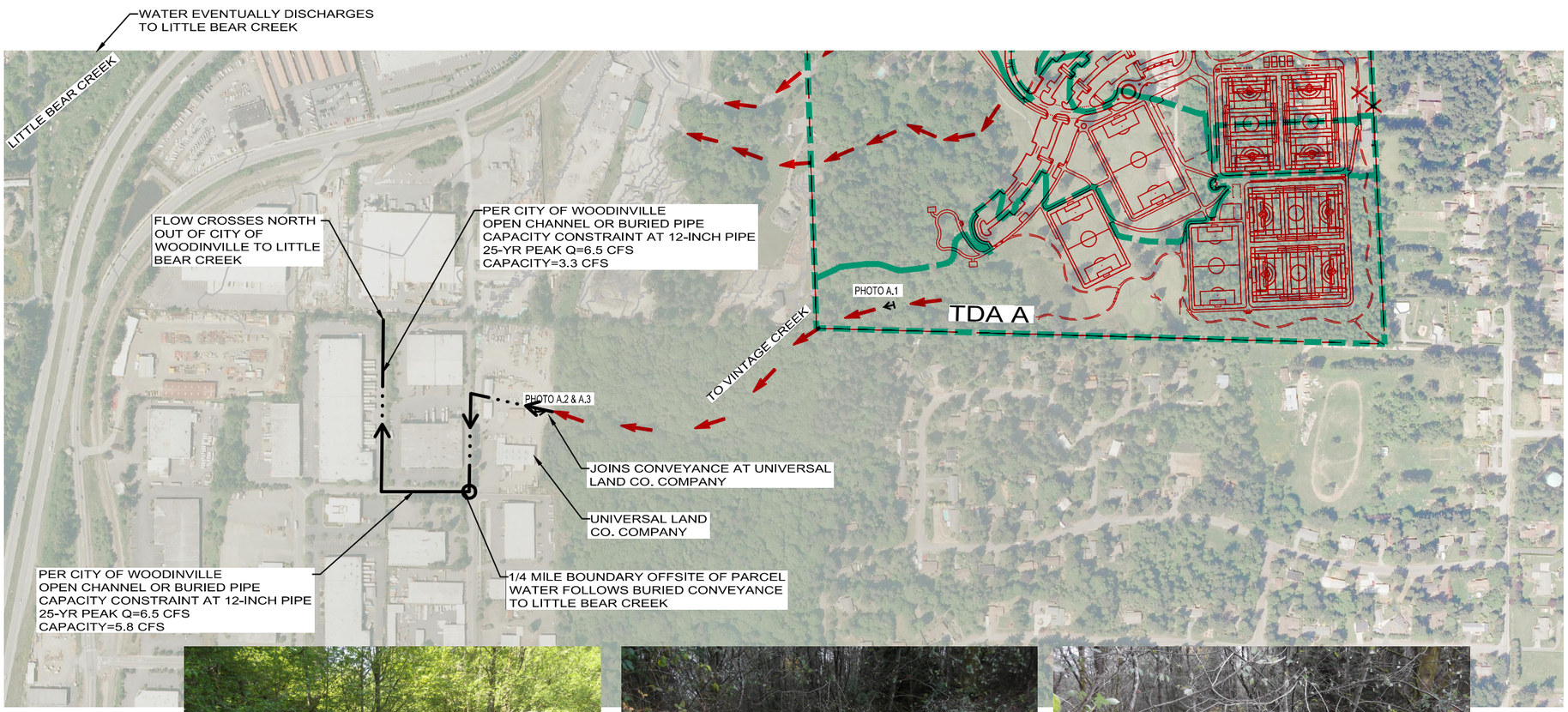
**SNOHOMISH COUNTY PARKS AND RECREATION**
**WELLINGTON HILLS COUNTY PARK**

**PROPOSED STORM DRAINAGE DETENTION**
**FIGURE 4**

# Appendix B

# Downstream Analysis Figures and Photos




## LEGEND

- PROPOSED SITE THRESHOLD DISCHARGE AREA ( TDA BOUNDARY)
- FLOW DIRECTION
- PHOTO LOCATION ( ARROW POINTS IN DIRECTION OF PHOTO)
- CLOSED CONVEYANCE SYSTEM

PHOTO A.1

PHOTO A.2

PHOTO A.3

N

0 250 500 1000

1 inch = 500 feet

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SNOHOMISH COUNTY PARKS AND RECREATION
WELLINGTON HILLS COUNTY PARK

TDA A DOWNSTREAM ANALYSIS
FIGURE 5A

PHOTO B.1

PHOTO B.2

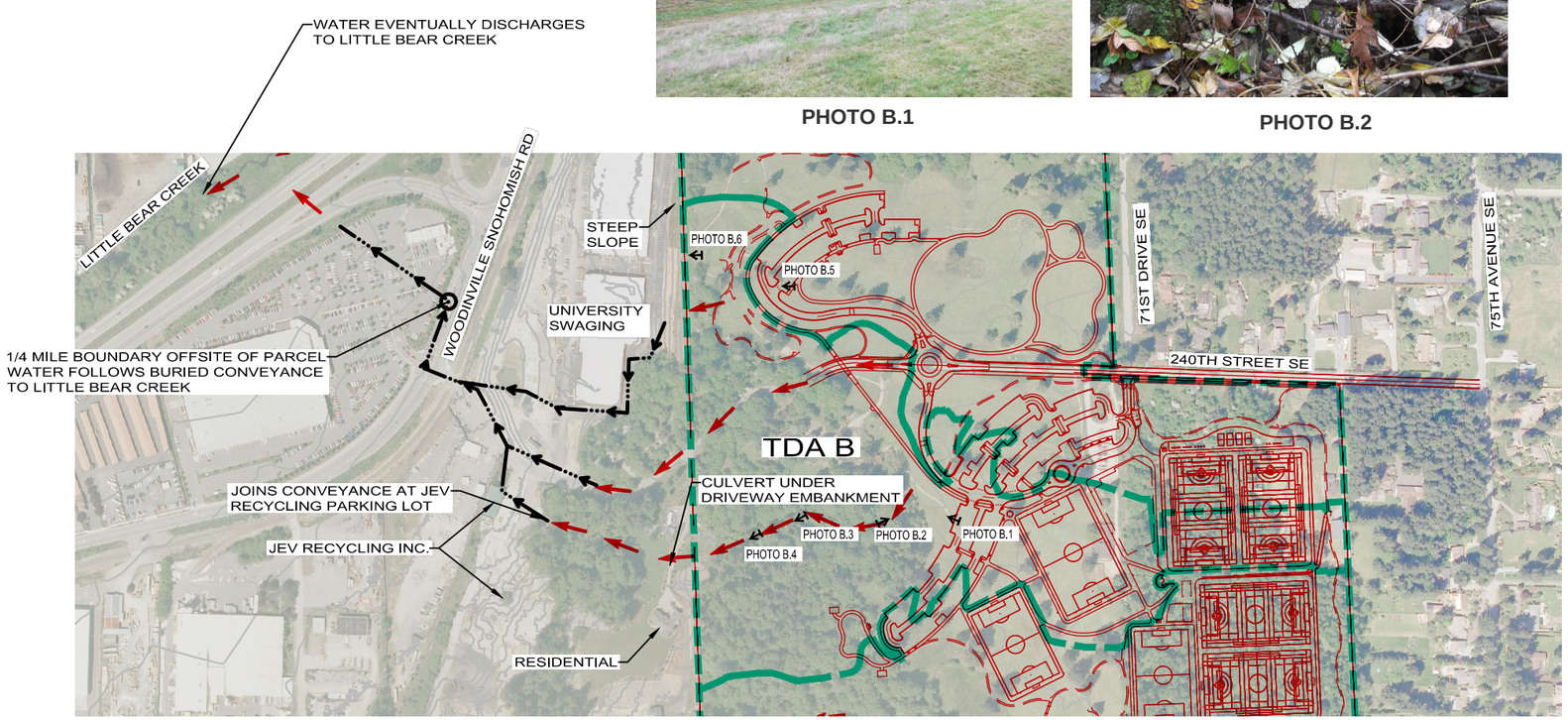

PHOTO B.3

PHOTO B.4

PHOTO B.5

PHOTO B.6

## LEGEND

- PROPOSED SITE THRESHOLD DISCHARGE AREA ( TDA BOUNDARY)
- FLOW DIRECTION
- PHOTO LOCATION ( ARROW POINTS IN DIRECTION OF PHOTO)
- CLOSED CONVEYANCE SYSTEM

N

0 250 500 1000

1 inch = 500 feet

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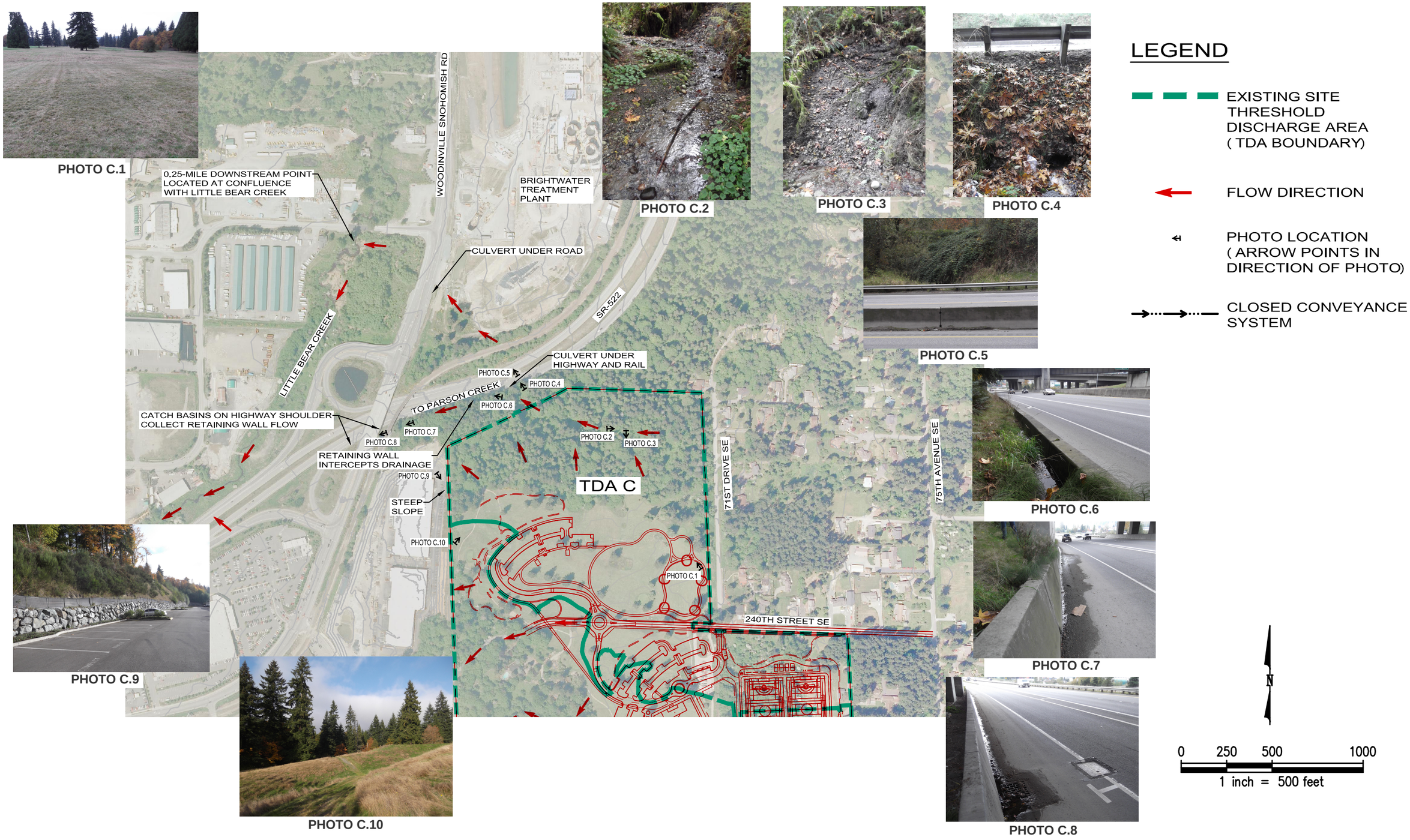
SNOHOMISH COUNTY PARKS AND RECREATION
WELLINGTON HILLS COUNTY PARK

TDA B DOWNSTREAM ANALYSIS
FIGURE 5B

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SNOHOMISH COUNTY PARKS AND RECREATION
WELLINGTON HILLS COUNTY PARK

TDA C DOWNSTREAM ANALYSIS
FIGURE 5C

# Appendix C

# Hydrologic Calculations

# MGS FLOOD
# PROJECT REPORT

**Program Version: MGSFlood 4.31**
**Program License Number: 200410007**
**Run Date: 11/15/2013 11:10 AM**

Input File Name: Wellington Runoff Calcs - TDA A.fld
Project Name: Wellington Hills County Park - TDA A
Analysis Title: Stormwater Runoff Calculations
Comments:

**——————————————— PRECIPITATION INPUT ———————————————**

Computational Time Step (Minutes): 60

Extended Precipitation Timeseries Selected
Climatic Region Number: 14

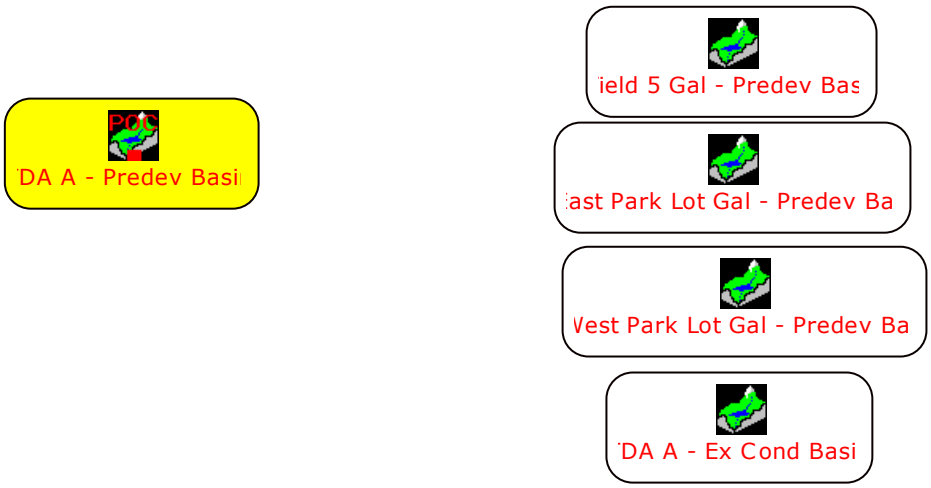
Full Period of Record Available used for Routing
Precipitation Station : 96004405 Puget East 44 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961044 Puget East 44 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********** Default HSPF Parameters Used (Not Modified by User) **********

**********  **WATERSHED DEFINITION**  **********

**----------SCENARIO: PREDEVELOPED**
Number of Subbasins: 5




---------- Subbasin : TDA A - Predev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 14.523 |
| Till Pasture | 0.000 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| Subbasin Total | 14.523 |

---------- Subbasin : East Park Lot Gal - Predev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.535 |
| Till Pasture | 0.000 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |

| | |
|---|---|
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| Subbasin Total | 0.535 |

---------- Subbasin : Field 5 Gal - Predev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 7.005 |
| Till Pasture | 0.000 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| Subbasin Total | 7.005 |

---------- Subbasin : TDA A - Ex Cond Basin ----------

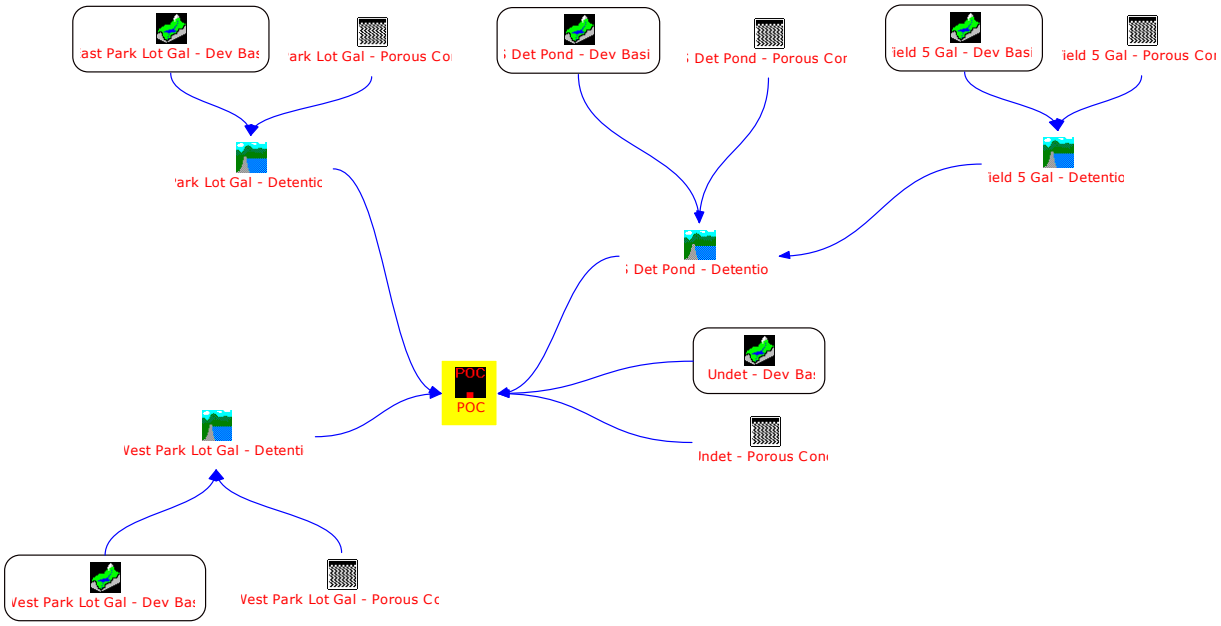
| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 3.631 |
| Till Pasture | 10.892 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| Subbasin Total | 14.523 |

---------- Subbasin : West Park Lot Gal - Predev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.296 |
| Till Pasture | 0.000 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| Subbasin Total | 0.296 |

**----------SCENARIO: POSTDEVELOPED**

Number of Subbasins: 5




---------- Subbasin : East Park Lot Gal - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.003 |
| Till Pasture | 0.000 |
| Till Grass | 0.043 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.422 |
| --- | --- |
| Subbasin Total | 0.468 |

---------- Subbasin : Field 5 Gal - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.000 |
| Till Pasture | 0.000 |
| Till Grass | 5.958 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.170 |
| --- | --- |
| Subbasin Total | 6.128 |

---------- Subbasin : S Det Pond - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.472 |
| Till Pasture | 0.000 |
| Till Grass | 2.926 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.331 |
| Subbasin Total | 3.729 |

---------- Subbasin : Undet - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.000 |
| Till Pasture | 0.000 |
| Till Grass | 1.848 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.101 |
| Subbasin Total | 1.949 |

---------- Subbasin : West Park Lot Gal - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.000 |
| Till Pasture | 0.000 |
| Till Grass | 0.052 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.213 |
| Subbasin Total | 0.265 |

********** **LINK DATA** **********

----------SCENARIO: PREDEVELOPED
Number of Links: 0

********** **LINK DATA** **********

----------SCENARIO: POSTDEVELOPED
Number of Links: 10

**----------**
**Link Name: Field 5 Gal - Detention**
Link Type: Structure
Downstream Link Name: S Det Pond - Detention

Prismatic Pond Option Used
Pond Floor Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 103.00
Max Pond Elevation (ft) : 103.50
Storage Depth (ft) : 3.00
Pond Bottom Length (ft) : 120.0
Pond Bottom Width (ft) : 75.0
Pond Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 9000.
Area at Riser Crest El (sq-ft) : 9,000.
(acres) : 0.207
Volume at Riser Crest (cu-ft) : 27,000.
(ac-ft) : 0.620
Area at Max Elevation (sq-ft) : 9000.
(acres) : 0.207
Vol at Max Elevation (cu-ft) : 32,400.
(ac-ft) : 0.744

Massmann Infiltration Option Used
Hydraulic Conductivity (in/hr) : 0.00
Depth to Water Table (ft) : 100.00
Bio-Fouling Potential : Low
Maintenance : Average or Better

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 18.00
Common Length (ft) : 0.000
Riser Crest Elevation : 103.00 ft

Hydraulic Structure Geometry

Number of Devices: 4

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 100.00
Diameter (in) : 1.25
Orientation : Horizontal
Elbow : No

---Device Number 2 ---
Device Type : Circular Orifice
Control Elevation (ft) : 102.00
Diameter (in) : 1.75

Orientation : Vertical
Elbow : Yes

---Device Number 3 ---
Device Type : Circular Orifice
Control Elevation (ft) : 102.30
Diameter (in) : 2.50
Orientation : Vertical
Elbow : Yes

---Device Number 4 ---
Device Type : Circular Orifice
Control Elevation (ft) : 102.60
Diameter (in) : 2.50
Orientation : Horizontal
Elbow : Yes

**----------**
**Link Name: Park Lot Gal - Porous Conc**
Link Type: Porous Pavement Structure
Downstream Link Name: Park Lot Gal - Detention

Pavement Length (ft) : 291.10
Pavement Width (ft) : 10.00
Pavement Slope (ft/ft) : 0.020
Pavement Infiltration Rate (in/hr) : 20.000
Number of Infiltration Cells : 6
Trench Cell Length (ft) : 48.52
Trench Cell Width (ft) : 10.00
Trench Cell Depth (ft) : 1.50
Trench Gravel Porosity (%) : 30.00
Trench Bed Slope (ft/ft) : 0.005
Native Soil Infiltration Rate (in/hr) : 0.250

**----------**
**Link Name: S Det Pond - Porous Conc**
Link Type: Porous Pavement Structure
Downstream Link Name: S Det Pond - Detention

Pavement Length (ft) : 708.30
Pavement Width (ft) : 10.00
Pavement Slope (ft/ft) : 0.020
Pavement Infiltration Rate (in/hr) : 0.250
Number of Infiltration Cells : 14
Trench Cell Length (ft) : 50.59
Trench Cell Width (ft) : 10.00
Trench Cell Depth (ft) : 1.50
Trench Gravel Porosity (%) : 30.00
Trench Bed Slope (ft/ft) : 0.005
Native Soil Infiltration Rate (in/hr) : 0.250

**----------**
**Link Name: Field 5 Gal - Porous Conc**

Link Type: Porous Pavement Structure
Downstream Link Name: Field 5 Gal - Detention

| | |
|---|---|
| Pavement Length (ft) | : 3821.10 |
| Pavement Width (ft) | : 10.00 |
| Pavement Slope (ft/ft) | : 0.020 |
| Pavement Infiltration Rate (in/hr) | : 20.000 |
| Number of Infiltration Cells | : 76 |
| Trench Cell Length (ft) | : 50.28 |
| Trench Cell Width (ft) | : 10.00 |
| Trench Cell Depth (ft) | : 1.50 |
| Trench Gravel Porosity (%) | : 30.00 |
| Trench Bed Slope (ft/ft) | : 0.005 |
| Native Soil Infiltration Rate (in/hr) | : 0.250 |

**----------**
**Link Name: Undet - Porous Conc**
Link Type: Porous Pavement Structure
Downstream Link Name: POC

| | |
|---|---|
| Pavement Length (ft) | : 609.30 |
| Pavement Width (ft) | : 10.00 |
| Pavement Slope (ft/ft) | : 0.020 |
| Pavement Infiltration Rate (in/hr) | : 20.000 |
| Number of Infiltration Cells | : 12 |
| Trench Cell Length (ft) | : 50.78 |
| Trench Cell Width (ft) | : 10.00 |
| Trench Cell Depth (ft) | : 1.50 |
| Trench Gravel Porosity (%) | : 30.00 |
| Trench Bed Slope (ft/ft) | : 0.005 |
| Native Soil Infiltration Rate (in/hr) | : 0.250 |

**----------**
**Link Name: S Det Pond - Detention**
Link Type: Structure
Downstream Link Name: POC

User Specified Elevation Volume Table Used

| Elevation (ft) | Pond Volume (cu-ft) |
|---|---|
| 413.50 | 0. |
| 414.00 | 1827. |
| 415.00 | 6466. |
| 416.00 | 12436. |
| 417.00 | 19806. |
| 417.10 | 20622. |
| 417.60 | 24924. |
| 418.10 | 29602. |

Massmann Infiltration Option Used

| | |
|---|---|
| Hydraulic Conductivity (in/hr) | : 0.00 |
| Depth to Water Table (ft) | : 100.00 |
| Bio-Fouling Potential | : Low |
| Maintenance | : Average or Better |

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 18.00
Common Length (ft) : 0.000
Riser Crest Elevation : 417.60 ft

Hydraulic Structure Geometry

Number of Devices: 4

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 413.50
Diameter (in) : 0.50
Orientation : Horizontal
Elbow : No

---Device Number 2 ---
Device Type : Circular Orifice
Control Elevation (ft) : 415.00
Diameter (in) : 2.50
Orientation : Vertical
Elbow : Yes

---Device Number 3 ---
Device Type : Circular Orifice
Control Elevation (ft) : 416.00
Diameter (in) : 3.00
Orientation : Vertical
Elbow : Yes

---Device Number 4 ---
Device Type : Circular Orifice
Control Elevation (ft) : 417.00
Diameter (in) : 3.00
Orientation : Vertical
Elbow : Yes

**----------**
**Link Name: Park Lot Gal - Detention**
Link Type: Structure
Downstream Link Name: POC

Prismatic Pond Option Used
Pond Floor Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 103.00
Max Pond Elevation (ft) : 103.50
Storage Depth (ft) : 3.00
Pond Bottom Length (ft) : 75.0
Pond Bottom Width (ft) : 40.0
Pond Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 3000.
Area at Riser Crest El (sq-ft) : 3,000.
(acres) : 0.069
Volume at Riser Crest (cu-ft) : 9,000.

| | | | |
|---|---|---|---|
| | (ac-ft) | : | 0.207 |
| Area at Max Elevation | (sq-ft) | : | 3000. |
| | (acres) | : | 0.069 |
| Vol at Max Elevation | (cu-ft) | : | 10,800. |
| | (ac-ft) | : | 0.248 |

Massmann Infiltration Option Used
Hydraulic Conductivity (in/hr) : 0.00
Depth to Water Table (ft) : 100.00
Bio-Fouling Potential : Low
Maintenance : Average or Better

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 18.00
Common Length (ft) : 0.000
Riser Crest Elevation : 103.00 ft

Hydraulic Structure Geometry

Number of Devices: 3

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 100.00
Diameter (in) : 0.44
Orientation : Horizontal
Elbow : No

---Device Number 2 ---
Device Type : Circular Orifice
Control Elevation (ft) : 102.00
Diameter (in) : 0.50
Orientation : Vertical
Elbow : Yes

---Device Number 3 ---
Device Type : Circular Orifice
Control Elevation (ft) : 102.40
Diameter (in) : 1.00
Orientation : Horizontal
Elbow : Yes

**----------**
**Link Name: POC**
Link Type: Copy
Downstream Link: None

**----------**
**Link Name: West Park Lot Gal - Porous Conc**
Link Type: Porous Pavement Structure
Downstream Link Name: West Park Lot Gal - Detention

Pavement Length (ft) : 137.00

Pavement Width (ft) : 10.00
Pavement Slope (ft/ft) : 0.020
Pavement Infiltration Rate (in/hr) : 20.000
Number of Infiltration Cells : 3
Trench Cell Length (ft) : 45.67
Trench Cell Width (ft) : 10.00
Trench Cell Depth (ft) : 1.50
Trench Gravel Porosity (%) : 30.00
Trench Bed Slope (ft/ft) : 0.005
Native Soil Infiltration Rate (in/hr) : 0.250

**----------**
**Link Name: West Park Lot Gal - Detention**
Link Type: Structure
Downstream Link Name: POC

Prismatic Pond Option Used
Pond Floor Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 103.00
Max Pond Elevation (ft) : 103.50
Storage Depth (ft) : 3.00
Pond Bottom Length (ft) : 60.0
Pond Bottom Width (ft) : 25.0
Pond Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 1500.
Area at Riser Crest El (sq-ft) : 1,500.
(acres) : 0.034
Volume at Riser Crest (cu-ft) : 4,500.
(ac-ft) : 0.103
Area at Max Elevation (sq-ft) : 1500.
(acres) : 0.034
Vol at Max Elevation (cu-ft) : 5,400.
(ac-ft) : 0.124

Massmann Infiltration Option Used
Hydraulic Conductivity (in/hr) : 0.00
Depth to Water Table (ft) : 100.00
Bio-Fouling Potential : Low
Maintenance : Average or Better

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 18.00
Common Length (ft) : 0.000
Riser Crest Elevation : 103.00 ft

Hydraulic Structure Geometry

Number of Devices: 4

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 100.00
Diameter (in) : 0.44
Orientation : Horizontal

Elbow : No

---Device Number 2 ---
Device Type : Circular Orifice
Control Elevation (ft) : 102.00
Diameter (in) : 0.50
Orientation : Vertical
Elbow : Yes

---Device Number 3 ---
Device Type : Circular Orifice
Control Elevation (ft) : 102.30
Diameter (in) : 0.50
Orientation : Vertical
Elbow : Yes

---Device Number 4 ---
Device Type : Circular Orifice
Control Elevation (ft) : 102.60
Diameter (in) : 0.50
Orientation : Vertical
Elbow : Yes

**********FLOOD FREQUENCY AND DURATION STATISTICS**********

**----------SCENARIO: PREDEVELOPED**
Number of Subbasins: 5
Number of Links: 0

**----------SCENARIO: POSTDEVELOPED**
Number of Subbasins: 5
Number of Links: 10

*************Groundwater Recharge Summary ***************
Recharge is computed as input to Perlnd Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation

| Model Element | Recharge Amount (ac-ft) |
|---|---|
| Subbasin: TDA A - Predev Basin | 2776.196 |
| Subbasin: East Park Lot Gal - | 102.270 |
| Subbasin: Field 5 Gal - Predev | 1339.066 |
| Subbasin: TDA A - Ex Cond Basi | 2754.429 |
| Subbasin: West Park Lot Gal - | 56.583 |
| Total: | 7028.543 |

Total Post Developed Recharge During Simulation

| Model Element | Recharge Amount (ac-ft) |
|---|---|
| Subbasin: East Park Lot Gal - | 6.143 |
| Subbasin: Field 5 Gal - Dev Ba | 771.700 |
| Subbasin: S Det Pond - Dev Bas | 469.212 |

| | | |
|---|---|---|
| Subbasin: | Undet - Dev Basin | 239.359 |
| Subbasin: | West Park Lot Gal - | 6.735 |
| Link: | Field 5 Gal - Detent | Not Computed |
| Link: | Park Lot Gal - Porou | Not Computed |
| Link: | S Det Pond - Porous | Not Computed |
| Link: | Field 5 Gal - Porous | Not Computed |
| Link: | Undet - Porous Conc | Not Computed |
| Link: | S Det Pond - Detenti | Not Computed |
| Link: | Park Lot Gal - Deten | Not Computed |
| Link: | POC | Not Applicable |
| Link: | West Park Lot Gal - | Not Computed |
| Link: | West Park Lot Gal - | Not Computed |
| Total: | | 1493.150 |

**Total Predevelopment Recharge is Greater than Post Developed**
**Average Recharge Per Year, (Number of Years= 158)**
**Predeveloped: 44.484 ac-ft/year, Post Developed: 9.450 ac-ft/year**

**********Water Quality Facility Data **********

**----------SCENARIO: PREDEVELOPED**

Number of Links: 0

**----------SCENARIO: POSTDEVELOPED**

Number of Links: 10

**********Compliance Point Results **********

Scenario Predeveloped Compliance Subbasin: TDA A - Predev Basin

Scenario Postdeveloped Compliance Link: POC

***** Point of Compliance Flow Frequency Data *****
Recurrence Interval Computed Using Gringorten Plotting Position

| Predevelopment Runoff | | Postdevelopment Runoff | |
|---|---|---|---|
| Tr (Years) | Discharge (cfs) | Tr (Years) | Discharge (cfs) |
| 2-Year | 0.367 | 2-Year | 0.295 |
| 5-Year | 0.600 | 5-Year | 0.476 |
| 10-Year | 0.800 | 10-Year | 0.608 |
| 25-Year | 0.998 | 25-Year | 0.861 |
| 50-Year | 1.191 | 50-Year | 1.027 |
| 100-Year | 1.338 | 100-Year | 1.197 |
| 200-Year | 1.995 | 200-Year | 1.731 |

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

****** Flow Duration Performance ******
Excursion at Predeveloped 50%Q2 (Must be Less Than 0%): -0.3% PASS

| | | | |
|---|---|---|---|
| Maximum Excursion from 50%Q2 to Q2 (Must be Less Than 0%): | | -0.3% | PASS |
| Maximum Excursion from Q2 to Q50 (Must be less than 10%): | -1.2% | PASS | |
| Percent Excursion from Q2 to Q50 (Must be less than 50%): | 0.0% | PASS | |

---

MEETS ALL FLOW DURATION DESIGN CRITERIA: PASS

---

# MGS FLOOD
# PROJECT REPORT

**Program Version: MGSFlood 4.31**
**Program License Number: 200410007**
**Run Date: 12/09/2013 12:49 PM**

Input File Name: Wellington Runoff Calcs - TDA B.fld
Project Name: Wellington Hills County Park - TDA B
Analysis Title: Stormwater Runoff Calculations
Comments:

**——————————————— PRECIPITATION INPUT ———————————————**

Computational Time Step (Minutes): 60

Extended Precipitation Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 96004405 Puget East 44 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961044 Puget East 44 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********** Default HSPF Parameters Used (Not Modified by User) **********

********** **WATERSHED DEFINITION** **********

**----------SCENARIO: PREDEVELOPED**
Number of Subbasins: 6

---------- Subbasin : S Lot Vault - Predev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 1.459 |
| Till Pasture | 0.000 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| Subbasin Total | 1.459 |

---------- Subbasin : C Lot Vault - Predev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.801 |
| Till Pasture | 0.000 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| Subbasin Total | 0.801 |

---------- Subbasin : Field 7 Gal - Predev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 8.023 |
| Till Pasture | 0.000 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| Subbasin Total | 8.023 |

---------- Subbasin : 240th - Predev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.402 |
| Till Pasture | 0.000 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| Subbasin Total | 0.402 |

---------- Subbasin : N Park Vault - Predev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 1.299 |
| Till Pasture | 0.000 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |

| | |
|---|---|
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| --- | --- |
| Subbasin Total | 1.299 |

---------- Subbasin : TDA B - Predev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 16.427 |
| Till Pasture | 0.000 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| --- | --- |
| Subbasin Total | 16.427 |

**----------SCENARIO: POSTDEVELOPED**

Number of Subbasins: 6

---------- Subbasin : S Park Lot Vault - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.019 |
| Till Pasture | 0.000 |
| Till Grass | 0.373 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.883 |
| --- | --- |
| Subbasin Total | 1.275 |

---------- Subbasin : C Park Lot Vault - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.011 |
| Till Pasture | 0.000 |
| Till Grass | 0.279 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |

| | |
|---|---|
| Impervious | 0.490 |
| Subbasin Total | 0.780 |

---------- Subbasin : Field 7 Gal - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.173 |
| Till Pasture | 0.000 |
| Till Grass | 6.568 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.610 |
| Subbasin Total | 7.351 |

---------- Subbasin : 240th - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.000 |
| Till Pasture | 0.000 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.402 |
| Subbasin Total | 0.402 |

---------- Subbasin : Undet A2 - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.014 |
| Till Pasture | 0.000 |
| Till Grass | 1.281 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.025 |
| Subbasin Total | 1.320 |

---------- Subbasin : Undet A3+A4 - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.000 |

| | |
|---|---|
| Till Pasture | 0.000 |
| Till Grass | 1.743 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.160 |
| --- | --- |
| Subbasin Total | 1.903 |

********** **LINK DATA** **********

----------SCENARIO: PREDEVELOPED
Number of Links: 1

**----------**
**Link Name: TDA B - Predev Discharge**
Link Type: Copy
Downstream Link: None

********** **LINK DATA** **********

----------SCENARIO: POSTDEVELOPED
Number of Links: 12

**----------**
**Link Name: S Park Lot Vault - Detention**
Link Type: Structure
Downstream Link Name: TDA B A2 - Dev Discharge

Prismatic Pond Option Used
Pond Floor Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 106.00
Max Pond Elevation (ft) : 106.50
Storage Depth (ft) : 6.00
Pond Bottom Length (ft) : 80.0
Pond Bottom Width (ft) : 60.0
Pond Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 4800.
Area at Riser Crest El (sq-ft) : 4,800.
(acres) : 0.110
Volume at Riser Crest (cu-ft) : 28,800.
(ac-ft) : 0.661
Area at Max Elevation (sq-ft) : 4800.
(acres) : 0.110
Vol at Max Elevation (cu-ft) : 31,680.
(ac-ft) : 0.727

Massmann Infiltration Option Used

Hydraulic Conductivity (in/hr) : 0.00
Depth to Water Table (ft) : 100.00
Bio-Fouling Potential : Low
Maintenance : Average or Better

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 18.00
Common Length (ft) : 0.000
Riser Crest Elevation : 106.00 ft

Hydraulic Structure Geometry

Number of Devices: 4

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 100.00
Diameter (in) : 0.50
Orientation : Horizontal
Elbow : No

---Device Number 2 ---
Device Type : Circular Orifice
Control Elevation (ft) : 102.80
Diameter (in) : 0.50
Orientation : Vertical
Elbow : No

---Device Number 3 ---
Device Type : Circular Orifice
Control Elevation (ft) : 103.40
Diameter (in) : 0.62
Orientation : Horizontal
Elbow : Yes

---Device Number 4 ---
Device Type : Circular Orifice
Control Elevation (ft) : 103.90
Diameter (in) : 0.75
Orientation : Horizontal
Elbow : Yes

**----------**
**Link Name: C Park Lot Vault - Detention**
Link Type: Structure
Downstream Link Name: TDA B A2 - Dev Discharge

Prismatic Pond Option Used
Pond Floor Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 106.00
Max Pond Elevation (ft) : 106.50
Storage Depth (ft) : 6.00
Pond Bottom Length (ft) : 75.0
Pond Bottom Width (ft) : 40.0

Pond Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 3000.
Area at Riser Crest El (sq-ft) : 3,000.
(acres) : 0.069
Volume at Riser Crest (cu-ft) : 18,000.
(ac-ft) : 0.413
Area at Max Elevation (sq-ft) : 3000.
(acres) : 0.069
Vol at Max Elevation (cu-ft) : 19,800.
(ac-ft) : 0.455

Massmann Infiltration Option Used
Hydraulic Conductivity (in/hr) : 0.00
Depth to Water Table (ft) : 100.00
Bio-Fouling Potential : Low
Maintenance : Average or Better

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 18.00
Common Length (ft) : 0.000
Riser Crest Elevation : 106.00 ft

Hydraulic Structure Geometry

Number of Devices: 4

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 100.00
Diameter (in) : 0.44
Orientation : Horizontal
Elbow : No

---Device Number 2 ---
Device Type : Circular Orifice
Control Elevation (ft) : 103.30
Diameter (in) : 0.75
Orientation : Vertical
Elbow : Yes

---Device Number 3 ---
Device Type : Circular Orifice
Control Elevation (ft) : 104.10
Diameter (in) : 1.25
Orientation : Vertical
Elbow : Yes

---Device Number 4 ---
Device Type : Circular Orifice
Control Elevation (ft) : 104.70
Diameter (in) : 1.50
Orientation : Vertical
Elbow : Yes

---
**Link Name: Field 7 Gal - Detention**
Link Type: Structure
Downstream Link Name: TDA B A2 - Dev Discharge

Prismatic Pond Option Used
Pond Floor Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 103.00
Max Pond Elevation (ft) : 103.50
Storage Depth (ft) : 3.00
Pond Bottom Length (ft) : 200.0
Pond Bottom Width (ft) : 80.0
Pond Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 16000.
Area at Riser Crest El (sq-ft) : 16,000.
(acres) : 0.367
Volume at Riser Crest (cu-ft) : 48,000.
(ac-ft) : 1.102
Area at Max Elevation (sq-ft) : 16000.
(acres) : 0.367
Vol at Max Elevation (cu-ft) : 57,600.
(ac-ft) : 1.322

Massmann Infiltration Option Used
Hydraulic Conductivity (in/hr) : 0.00
Depth to Water Table (ft) : 100.00
Bio-Fouling Potential : Low
Maintenance : Average or Better

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 18.00
Common Length (ft) : 0.000
Riser Crest Elevation : 103.00 ft

Hydraulic Structure Geometry

Number of Devices: 5

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 100.00
Diameter (in) : 2.25
Orientation : Horizontal
Elbow : No

---Device Number 2 ---
Device Type : Circular Orifice
Control Elevation (ft) : 101.10
Diameter (in) : 1.50
Orientation : Vertical
Elbow : Yes

---Device Number 3 ---
Device Type : Circular Orifice
Control Elevation (ft) : 101.40

Diameter (in) : 2.00
Orientation : Vertical
Elbow : Yes

---Device Number 4 ---
Device Type : Circular Orifice
Control Elevation (ft) : 101.60
Diameter (in) : 1.50
Orientation : Vertical
Elbow : Yes

---Device Number 5 ---
Device Type : Circular Orifice
Control Elevation (ft) : 102.00
Diameter (in) : 4.00
Orientation : Vertical
Elbow : Yes

---

**Link Name: TDA B A2 - Dev Discharge**
Link Type: Copy
Downstream Link Name: TDA B - Dev Discharge

---

**Link Name: S Park Lot Vault - Porous Conc**
Link Type: Porous Pavement Structure
Downstream Link Name: S Park Lot Vault - Detention

Pavement Length (ft) : 803.30
Pavement Width (ft) : 10.00
Pavement Slope (ft/ft) : 0.020
Pavement Infiltration Rate (in/hr) : 20.000
Number of Infiltration Cells : 16
Trench Cell Length (ft) : 50.21
Trench Cell Width (ft) : 10.00
Trench Cell Depth (ft) : 1.50
Trench Gravel Porosity (%) : 30.00
Trench Bed Slope (ft/ft) : 0.005
Native Soil Infiltration Rate (in/hr) : 0.250

---

**Link Name: C Park Lot Vault - Porous Conc**
Link Type: Porous Pavement Structure
Downstream Link Name: C Park Lot Vault - Detention

Pavement Length (ft) : 92.10
Pavement Width (ft) : 10.00
Pavement Slope (ft/ft) : 0.005
Pavement Infiltration Rate (in/hr) : 20.000
Number of Infiltration Cells : 2
Trench Cell Length (ft) : 46.05
Trench Cell Width (ft) : 10.00
Trench Cell Depth (ft) : 1.50

Trench Gravel Porosity (%) : 30.00
Trench Bed Slope (ft/ft) : 0.020
Native Soil Infiltration Rate (in/hr) : 0.250

---

**Link Name: Field 7 Gal - Porous Conc**
Link Type: Porous Pavement Structure
Downstream Link Name: Field 7 Gal - Detention

Pavement Length (ft) : 2930.70
Pavement Width (ft) : 10.00
Pavement Slope (ft/ft) : 0.005
Pavement Infiltration Rate (in/hr) : 20.000
Number of Infiltration Cells : 59
Trench Cell Length (ft) : 49.67
Trench Cell Width (ft) : 10.00
Trench Cell Depth (ft) : 1.50
Trench Gravel Porosity (%) : 30.00
Trench Bed Slope (ft/ft) : 0.020
Native Soil Infiltration Rate (in/hr) : 0.250

---

**Link Name: Undet A2 - Porous Conc**
Link Type: Porous Pavement Structure
Downstream Link Name: Undet A2 - Dev Discharge

Pavement Length (ft) : 352.40
Pavement Width (ft) : 10.00
Pavement Slope (ft/ft) : 0.005
Pavement Infiltration Rate (in/hr) : 20.000
Number of Infiltration Cells : 7
Trench Cell Length (ft) : 50.34
Trench Cell Width (ft) : 10.00
Trench Cell Depth (ft) : 1.50
Trench Gravel Porosity (%) : 30.00
Trench Bed Slope (ft/ft) : 0.020
Native Soil Infiltration Rate (in/hr) : 0.250

---

**Link Name: Undet A2 - Dev Discharge**
Link Type: Copy
Downstream Link Name: TDA B A2 - Dev Discharge

---

**Link Name: Undet A3+A4 - Porous Conc**
Link Type: Porous Pavement Structure
Downstream Link Name: TDA B A3+A4 - Dev Discharge

Pavement Length (ft) : 618.80
Pavement Width (ft) : 10.00
Pavement Slope (ft/ft) : 0.020
Pavement Infiltration Rate (in/hr) : 20.000

Number of Infiltration Cells : 12
Trench Cell Length (ft) : 51.57
Trench Cell Width (ft) : 10.00
Trench Cell Depth (ft) : 1.50
Trench Gravel Porosity (%) : 30.00
Trench Bed Slope (ft/ft) : 0.005
Native Soil Infiltration Rate (in/hr) : 0.250

**----------**
**Link Name: TDA B A3+A4 - Dev Discharge**
Link Type: Copy
Downstream Link Name: TDA B - Dev Discharge

**----------**
**Link Name: TDA B - Dev Discharge**
Link Type: Copy
Downstream Link: None

**************************FLOOD FREQUENCY AND DURATION STATISTICS**********************

**----------SCENARIO: PREDEVELOPED**
Number of Subbasins: 6
Number of Links: 1

**----------SCENARIO: POSTDEVELOPED**
Number of Subbasins: 6
Number of Links: 12

*************Groundwater Recharge Summary ***************
Recharge is computed as input to Perlnd Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation

| Model Element | Recharge Amount (ac-ft) |
|---|---|
| Subbasin: S Lot Vault - Predev | 278.900 |
| Subbasin: C Lot Vault - Predev | 153.118 |
| Subbasin: Field 7 Gal - Predev | 1533.665 |
| Subbasin: 240th - Predev Basin | 76.846 |
| Subbasin: N Park Vault - Prede | 248.315 |
| Subbasin: TDA B - Predev Basin | 3140.162 |
| Link: TDA B - Predev Disch | Not Applicable |
| Total: | 5431.006 |

Total Post Developed Recharge During Simulation

| Model Element | Recharge Amount (ac-ft) |
|---|---|
| Subbasin: S Park Lot Vault - D | 51.944 |
| Subbasin: C Park Lot Vault - D | 38.240 |
| Subbasin: Field 7 Gal - Dev Ba | 883.780 |
| Subbasin: 240th - Dev Basin | 0.000 |

Subbasin: Undet A2 - Dev Basin 168.596
Subbasin: Undet A3+A4 - Dev Ba 225.759
Link: S Park Lot Vault - D Not Computed
Link: C Park Lot Vault - D Not Computed
Link: Field 7 Gal - Detent Not Computed
Link: TDA B A2 - Dev Disch Not Applicable
Link: S Park Lot Vault - P Not Computed
Link: C Park Lot Vault - P Not Computed
Link: Field 7 Gal - Porous Not Computed
Link: Undet A2 - Porous Co Not Computed
Link: Undet A2 - Dev Disch Not Applicable
Link: Undet A3+A4 - Porous Not Computed
Link: TDA B A3+A4 - Dev Di Not Applicable
Link: TDA B - Dev Discharg Not Applicable

Total: 1368.318

**Total Predevelopment Recharge is Greater than Post Developed**
**Average Recharge Per Year, (Number of Years= 158)**
**Predeveloped: 34.373 ac-ft/year, Post Developed: 8.660 ac-ft/year**

*************Water Quality Facility Data ***************

**----------SCENARIO: PREDEVELOPED**

Number of Links: 1

**----------SCENARIO: POSTDEVELOPED**

Number of Links: 12

*************Compliance Point Results ***************

Scenario Predeveloped Compliance Link: TDA B - Predev Discharge
Scenario Postdeveloped Compliance Link: TDA B - Dev Discharge

***** Point of Compliance Flow Frequency Data *****
Recurrence Interval Computed Using Gringorten Plotting Position

| Predevelopment Runoff | | Postdevelopment Runoff | |
|---|---|---|---|
| Tr (Years) | Discharge (cfs) | Tr (Years) | Discharge (cfs) |
| 2-Year | 0.425 | 2-Year | 0.451 |
| 5-Year | 0.695 | 5-Year | 0.680 |
| 10-Year | 0.927 | 10-Year | 0.941 |
| 25-Year | 1.157 | 25-Year | 1.146 |
| 50-Year | 1.381 | 50-Year | 1.270 |
| 100-Year | 1.551 | 100-Year | 1.299 |
| 200-Year | 2.311 | 200-Year | 1.690 |

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

****** Flow Duration Performance ******

| | | | |
|---|---|---|---|
| Excursion at Predeveloped 50%Q2 (Must be Less Than 0%): | -1.8% | PASS | |
| Maximum Excursion from 50%Q2 to Q2 (Must be Less Than 0%): | | -1.8% | PASS |
| Maximum Excursion from Q2 to Q50 (Must be less than 10%): | 0.0% | PASS | |
| Percent Excursion from Q2 to Q50 (Must be less than 50%): | 0.0% | PASS | |

---

MEETS ALL FLOW DURATION DESIGN CRITERIA: PASS

---

# MGS FLOOD
# PROJECT REPORT

**Program Version: MGSFlood 4.31**
**Program License Number: 200410007**
**Run Date: 12/09/2013 12:50 PM**

Input File Name: TDA C.fld
Project Name: Wellington Hills County Park - TDA C
Analysis Title: Stormwater Runoff Calculations
Comments:

**——————————————— PRECIPITATION INPUT ———————————————**

Computational Time Step (Minutes): 60

Extended Precipitation Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 96004405 Puget East 44 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961044 Puget East 44 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********** Default HSPF Parameters Used (Not Modified by User) **********

********** **WATERSHED DEFINITION** **********

**----------SCENARIO: PREDEVELOPED**
Number of Subbasins: 3

---------- Subbasin : N Det Pond - Predev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 11.229 |
| Till Pasture | 0.000 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| Subbasin Total | 11.229 |

---------- Subbasin : N Park Lot Gal - Predev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 8.135 |
| Till Pasture | 0.000 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| Subbasin Total | 8.135 |

---------- Subbasin : TDA C - Predev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 20.110 |
| Till Pasture | 0.000 |
| Till Grass | 0.000 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| Subbasin Total | 20.110 |

**----------SCENARIO: POSTDEVELOPED**

Number of Subbasins: 4

---------- Subbasin : N Det Pond - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.060 |
| Till Pasture | 0.000 |
| Till Grass | 6.966 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 3.231 |
| Subbasin Total | 10.257 |

---------- Subbasin : Undet - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.302 |

| | |
|---|---|
| Till Pasture | 0.000 |
| Till Grass | 1.223 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.000 |
| Subbasin Total | 1.525 |

---------- Subbasin : NE Park Lot Vault - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 3.066 |
| Till Pasture | 0.000 |
| Till Grass | 4.053 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 1.755 |
| Subbasin Total | 8.874 |

---------- Subbasin : NW Park Lot Vault - Dev Basin ----------

| | -------Area(Acres) -------- |
|---|---|
| Till Forest | 0.008 |
| Till Pasture | 0.000 |
| Till Grass | 0.619 |
| Outwash Forest | 0.000 |
| Outwash Pasture | 0.000 |
| Outwash Grass | 0.000 |
| Wetland | 0.000 |
| Green Roof | 0.000 |
| User 2 | 0.000 |
| Impervious | 0.516 |
| Subbasin Total | 1.143 |

********** **LINK DATA** **********

----------SCENARIO: PREDEVELOPED
Number of Links: 0

********** **LINK DATA** **********

----------SCENARIO: POSTDEVELOPED
Number of Links: 8

---
**Link Name: N Det Pond - Porous Conc**
Link Type: Porous Pavement Structure
Downstream Link Name: N Det Pond - Detention

| | |
|---|---|
| Pavement Length (ft) | : 4233.60 |
| Pavement Width (ft) | : 10.00 |
| Pavement Slope (ft/ft) | : 0.020 |
| Pavement Infiltration Rate (in/hr) | : 20.000 |
| Number of Infiltration Cells | : 85 |
| Trench Cell Length (ft) | : 49.81 |
| Trench Cell Width (ft) | : 10.00 |
| Trench Cell Depth (ft) | : 1.50 |
| Trench Gravel Porosity (%) | : 30.00 |
| Trench Bed Slope (ft/ft) | : 0.005 |
| Native Soil Infiltration Rate (in/hr) | : 0.250 |

---
**Link Name: N Det Pond - Detention**
Link Type: Structure
Downstream Link Name: TDA C - Dev Discharge

User Specified Elevation Volume Table Used

| Elevation (ft) | Pond Volume (cu-ft) |
|---|---|
| 372.50 | 0. |
| 373.00 | 3006. |
| 374.00 | 12585. |
| 375.00 | 26508. |
| 376.00 | 44160. |
| 377.00 | 65270. |
| 378.00 | 90067. |
| 379.00 | 118775. |
| 379.50 | 134395. |

Massmann Infiltration Option Used
Hydraulic Conductivity (in/hr) : 0.00
Depth to Water Table (ft) : 100.00
Bio-Fouling Potential : Low
Maintenance : Average or Better

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 18.00
Common Length (ft) : 0.000
Riser Crest Elevation : 379.00 ft

Hydraulic Structure Geometry

Number of Devices: 4

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 372.50

Diameter (in) : 1.37
Orientation : Horizontal
Elbow : No

---Device Number 2 ---
Device Type : Circular Orifice
Control Elevation (ft) : 377.00
Diameter (in) : 1.25
Orientation : Vertical
Elbow : Yes

---Device Number 3 ---
Device Type : Circular Orifice
Control Elevation (ft) : 377.75
Diameter (in) : 2.75
Orientation : Vertical
Elbow : Yes

---Device Number 4 ---
Device Type : Circular Orifice
Control Elevation (ft) : 378.50
Diameter (in) : 2.25
Orientation : Horizontal
Elbow : Yes

---

**Link Name: TDA C - Dev Discharge**
Link Type: Copy
Downstream Link: None

---

**Link Name: Undet - Porous Conc**
Link Type: Porous Pavement Structure
Downstream Link Name: TDA C - Dev Discharge

Pavement Length (ft) : 987.00
Pavement Width (ft) : 10.00
Pavement Slope (ft/ft) : 0.020
Pavement Infiltration Rate (in/hr) : 20.000
Number of Infiltration Cells : 20
Trench Cell Length (ft) : 49.35
Trench Cell Width (ft) : 10.00
Trench Cell Depth (ft) : 1.50
Trench Gravel Porosity (%) : 30.00
Trench Bed Slope (ft/ft) : 0.005
Native Soil Infiltration Rate (in/hr) : 0.250

---

**Link Name: NE Park Lot Vault - Porous Conc**
Link Type: Porous Pavement Structure
Downstream Link Name: NE Park Lot Vault - Detention

Pavement Length (ft) : 2610.90

Pavement Width (ft) : 10.00
Pavement Slope (ft/ft) : 0.020
Pavement Infiltration Rate (in/hr) : 20.000
Number of Infiltration Cells : 52
Trench Cell Length (ft) : 50.20
Trench Cell Width (ft) : 10.00
Trench Cell Depth (ft) : 1.50
Trench Gravel Porosity (%) : 30.00
Trench Bed Slope (ft/ft) : 0.005
Native Soil Infiltration Rate (in/hr) : 0.250

**----------**
**Link Name: NE Park Lot Vault - Detention**
Link Type: Structure
Downstream Link Name: TDA C - Dev Discharge

Prismatic Pond Option Used
Pond Floor Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 106.00
Max Pond Elevation (ft) : 106.50
Storage Depth (ft) : 6.00
Pond Bottom Length (ft) : 160.0
Pond Bottom Width (ft) : 48.0
Pond Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 7680.
Area at Riser Crest El (sq-ft) : 7,680.
(acres) : 0.176
Volume at Riser Crest (cu-ft) : 46,080.
(ac-ft) : 1.058
Area at Max Elevation (sq-ft) : 7680.
(acres) : 0.176
Vol at Max Elevation (cu-ft) : 50,688.
(ac-ft) : 1.164

Massmann Infiltration Option Used
Hydraulic Conductivity (in/hr) : 0.00
Depth to Water Table (ft) : 100.00
Bio-Fouling Potential : Low
Maintenance : Average or Better

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 18.00
Common Length (ft) : 0.000
Riser Crest Elevation : 106.00 ft

Hydraulic Structure Geometry

Number of Devices: 4

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 100.00
Diameter (in) : 1.37
Orientation : Horizontal

Elbow : No

---Device Number 2 ---
Device Type : Circular Orifice
Control Elevation (ft) : 102.80
Diameter (in) : 1.00
Orientation : Vertical
Elbow : Yes

---Device Number 3 ---
Device Type : Circular Orifice
Control Elevation (ft) : 103.50
Diameter (in) : 2.25
Orientation : Vertical
Elbow : Yes

---Device Number 4 ---
Device Type : Circular Orifice
Control Elevation (ft) : 104.20
Diameter (in) : 2.25
Orientation : Vertical
Elbow : Yes

---

**Link Name: NW Park Lot Vault - Porous Conc**
Link Type: Porous Pavement Structure
Downstream Link Name: NW Park Lot Vault - Detention

Pavement Length (ft) : 618.80
Pavement Width (ft) : 10.00
Pavement Slope (ft/ft) : 0.020
Pavement Infiltration Rate (in/hr) : 20.000
Number of Infiltration Cells : 12
Trench Cell Length (ft) : 51.57
Trench Cell Width (ft) : 10.00
Trench Cell Depth (ft) : 1.50
Trench Gravel Porosity (%) : 30.00
Trench Bed Slope (ft/ft) : 0.005
Native Soil Infiltration Rate (in/hr) : 0.250

---

**Link Name: NW Park Lot Vault - Detention**
Link Type: Structure
Downstream Link Name: TDA C - Dev Discharge

Prismatic Pond Option Used
Pond Floor Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 106.00
Max Pond Elevation (ft) : 106.50
Storage Depth (ft) : 6.00
Pond Bottom Length (ft) : 120.0
Pond Bottom Width (ft) : 40.0
Pond Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 4800.

Area at Riser Crest El (sq-ft) : 4,800.
(acres) : 0.110
Volume at Riser Crest (cu-ft) : 28,800.
(ac-ft) : 0.661
Area at Max Elevation (sq-ft) : 4800.
(acres) : 0.110
Vol at Max Elevation (cu-ft) : 31,680.
(ac-ft) : 0.727

Massmann Infiltration Option Used
Hydraulic Conductivity (in/hr) : 0.00
Depth to Water Table (ft) : 100.00
Bio-Fouling Potential : Low
Maintenance : Average or Better

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 18.00
Common Length (ft) : 0.000
Riser Crest Elevation : 106.00 ft

Hydraulic Structure Geometry

Number of Devices: 4

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 100.00
Diameter (in) : 0.50
Orientation : Horizontal
Elbow : No

---Device Number 2 ---
Device Type : Circular Orifice
Control Elevation (ft) : 102.70
Diameter (in) : 0.50
Orientation : Vertical
Elbow : Yes

---Device Number 3 ---
Device Type : Circular Orifice
Control Elevation (ft) : 103.70
Diameter (in) : 0.62
Orientation : Vertical
Elbow : Yes

---Device Number 4 ---
Device Type : Circular Orifice
Control Elevation (ft) : 104.70
Diameter (in) : 0.62
Orientation : Vertical
Elbow : Yes

**********FLOOD FREQUENCY AND DURATION STATISTICS**********

**----------SCENARIO: PREDEVELOPED**
Number of Subbasins: 3
Number of Links: 0

**----------SCENARIO: POSTDEVELOPED**
Number of Subbasins: 4
Number of Links: 8

*************Groundwater Recharge Summary ***************
Recharge is computed as input to Perlnd Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation

| Model Element | Recharge Amount (ac-ft) |
|---|---|
| Subbasin: N Det Pond - Predev | 2146.520 |
| Subbasin: N Park Lot Gal - Pre | 1555.075 |
| Subbasin: TDA C - Predev Basin | 3844.199 |
| Total: | 7545.793 |

Total Post Developed Recharge During Simulation

| Model Element | Recharge Amount (ac-ft) |
|---|---|
| Subbasin: N Det Pond - Dev Bas | 913.729 |
| Subbasin: Undet - Dev Basin | 216.137 |
| Subbasin: NE Park Lot Vault - | 1111.050 |
| Subbasin: NW Park Lot Vault - | 81.704 |
| Link: N Det Pond - Porous | Not Computed |
| Link: N Det Pond - Detenti | Not Computed |
| Link: TDA C - Dev Discharg | Not Applicable |
| Link: Undet - Porous Conc | Not Computed |
| Link: NE Park Lot Vault - | Not Computed |
| Link: NE Park Lot Vault - | Not Computed |
| Link: NW Park Lot Vault - | Not Computed |
| Link: NW Park Lot Vault - | Not Computed |
| Total: | 2322.621 |

**Total Predevelopment Recharge is Greater than Post Developed**
**Average Recharge Per Year, (Number of Years= 158)**
**Predeveloped: 47.758 ac-ft/year, Post Developed: 14.700 ac-ft/year**

*************Water Quality Facility Data ***************

**----------SCENARIO: PREDEVELOPED**

Number of Links: 0

**----------SCENARIO: POSTDEVELOPED**

Number of Links: 8

**********Compliance Point Results **********

Scenario Predeveloped Compliance Subbasin: TDA C - Predev Basin

Scenario Postdeveloped Compliance Link: TDA C - Dev Discharge

***** Point of Compliance Flow Frequency Data *****

Recurrence Interval Computed Using Gringorten Plotting Position

| Predevelopment Runoff | | Postdevelopment Runoff | |
|---|---|---|---|
| Tr (Years) | Discharge (cfs) | Tr (Years) | Discharge (cfs) |
| 2-Year | 0.508 | 2-Year | 0.353 |
| 5-Year | 0.831 | 5-Year | 0.563 |
| 10-Year | 1.108 | 10-Year | 0.795 |
| 25-Year | 1.382 | 25-Year | 1.049 |
| 50-Year | 1.650 | 50-Year | 1.460 |
| 100-Year | 1.853 | 100-Year | 1.768 |
| 200-Year | 2.762 | 200-Year | 1.869 |

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

****** Flow Duration Performance ******

| | | | |
|---|---|---|---|
| Excursion at Predeveloped 50%Q2 (Must be Less Than 0%): | -5.7% | PASS | |
| Maximum Excursion from 50%Q2 to Q2 (Must be Less Than 0%): | | -5.7% | PASS |
| Maximum Excursion from Q2 to Q50 (Must be less than 10%): | 2.9% | PASS | |
| Percent Excursion from Q2 to Q50 (Must be less than 50%): | 5.6% | PASS | |

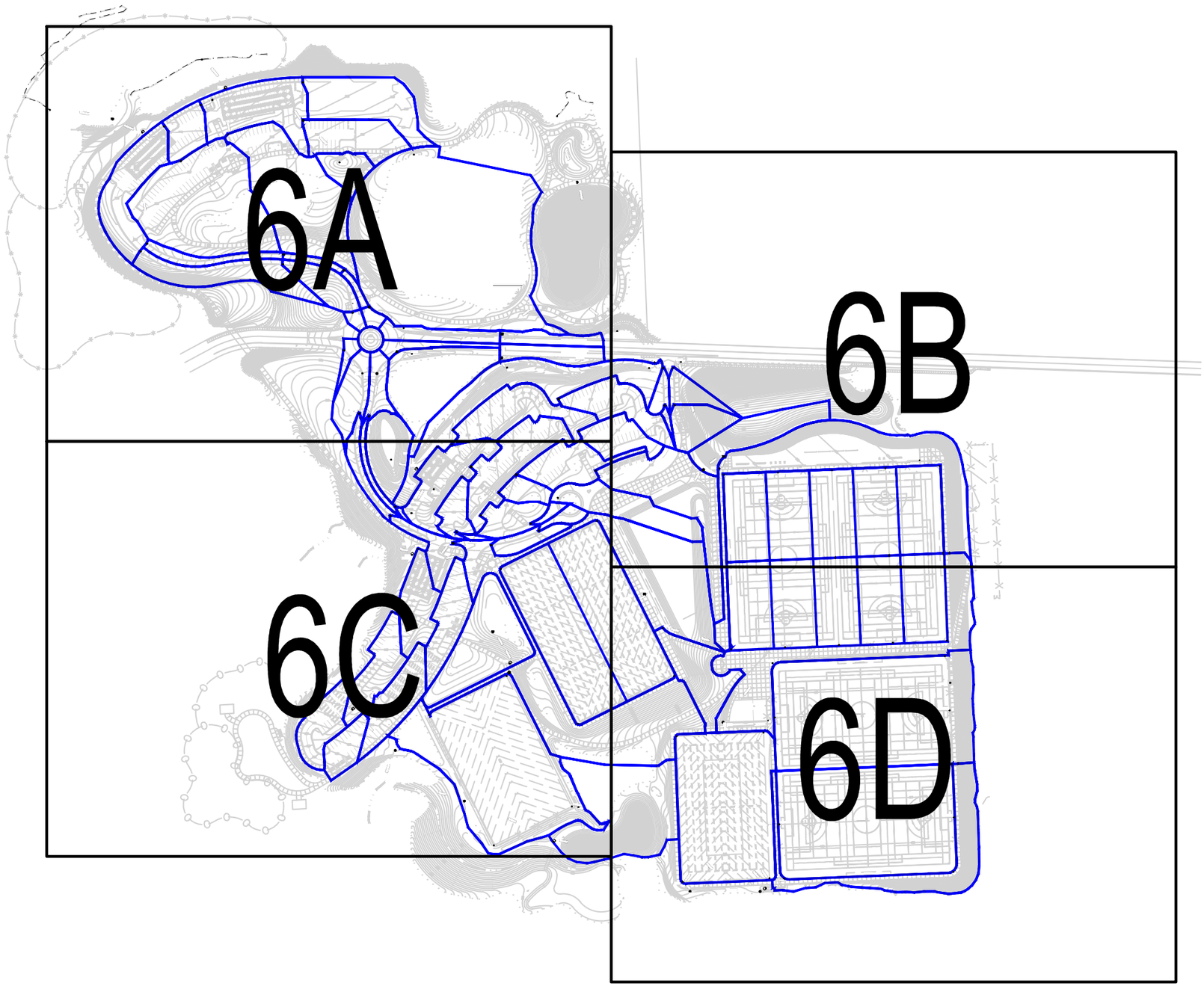
---

MEETS ALL FLOW DURATION DESIGN CRITERIA: PASS

---

# Appendix D

# Conveyance Calculations




LEGEND

DRAINAGE BASIN BOUNDARY

N

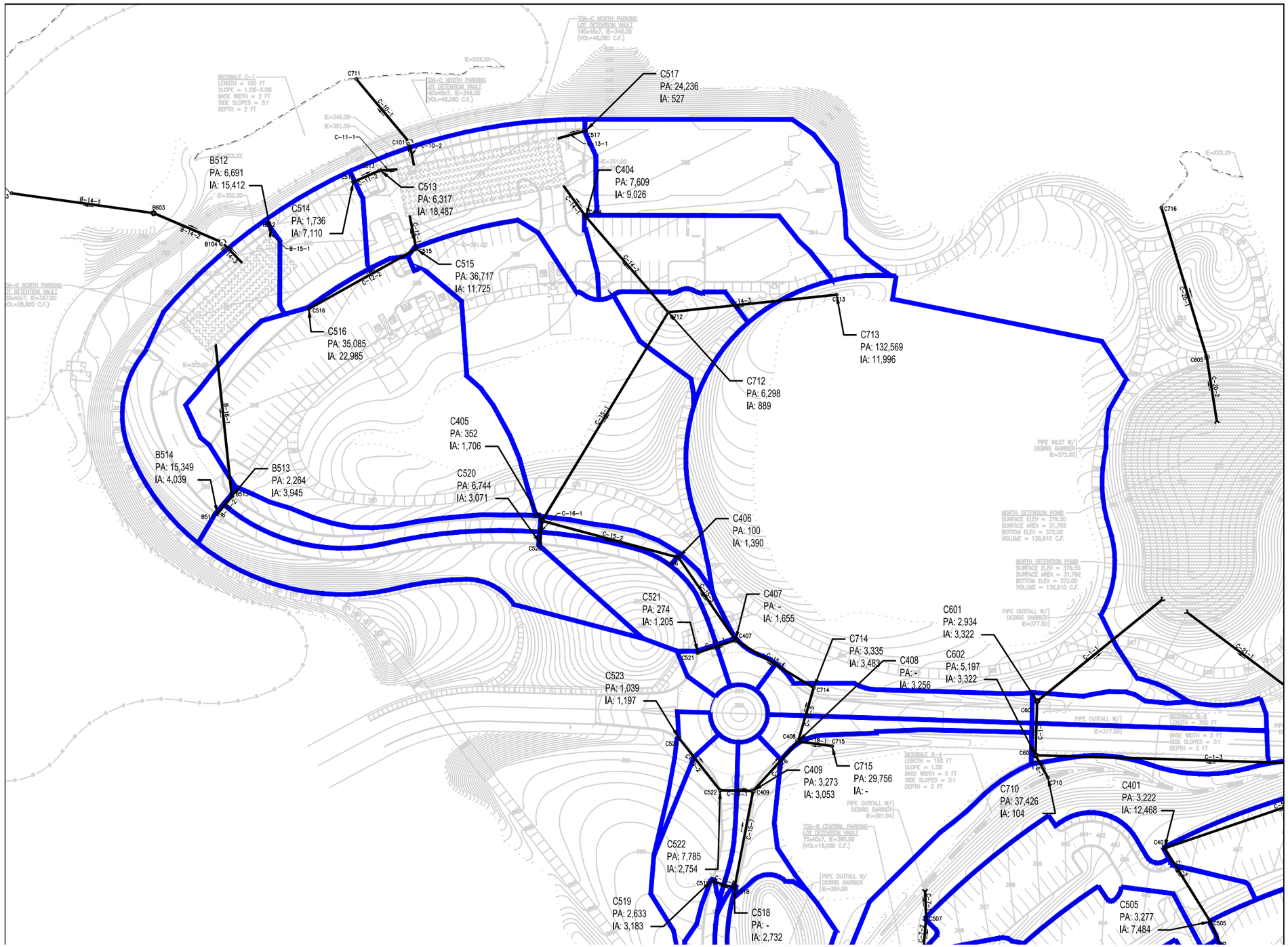
0 250 500 1000

1 inch =250 feet

kpff Consulting Engineers
1601 Fifth Avenue, Suite 1600
Seattle, Washington 98101-3665
(206) 622-5822 Fax (206) 622-8130

SNOHOMISH COUNTY PARKS AND RECREATION
WELLINGTON HILLS COUNTY PARK

CONVEYANCE TRIBUTARY AREAS
FIGURE 6



KEY MAP

## LEGEND

DRAINAGE BASIN BOUNDARY

STORM DRAINAGE CONVEYANCE

N

0 100 200 400

1 inch =100 feet

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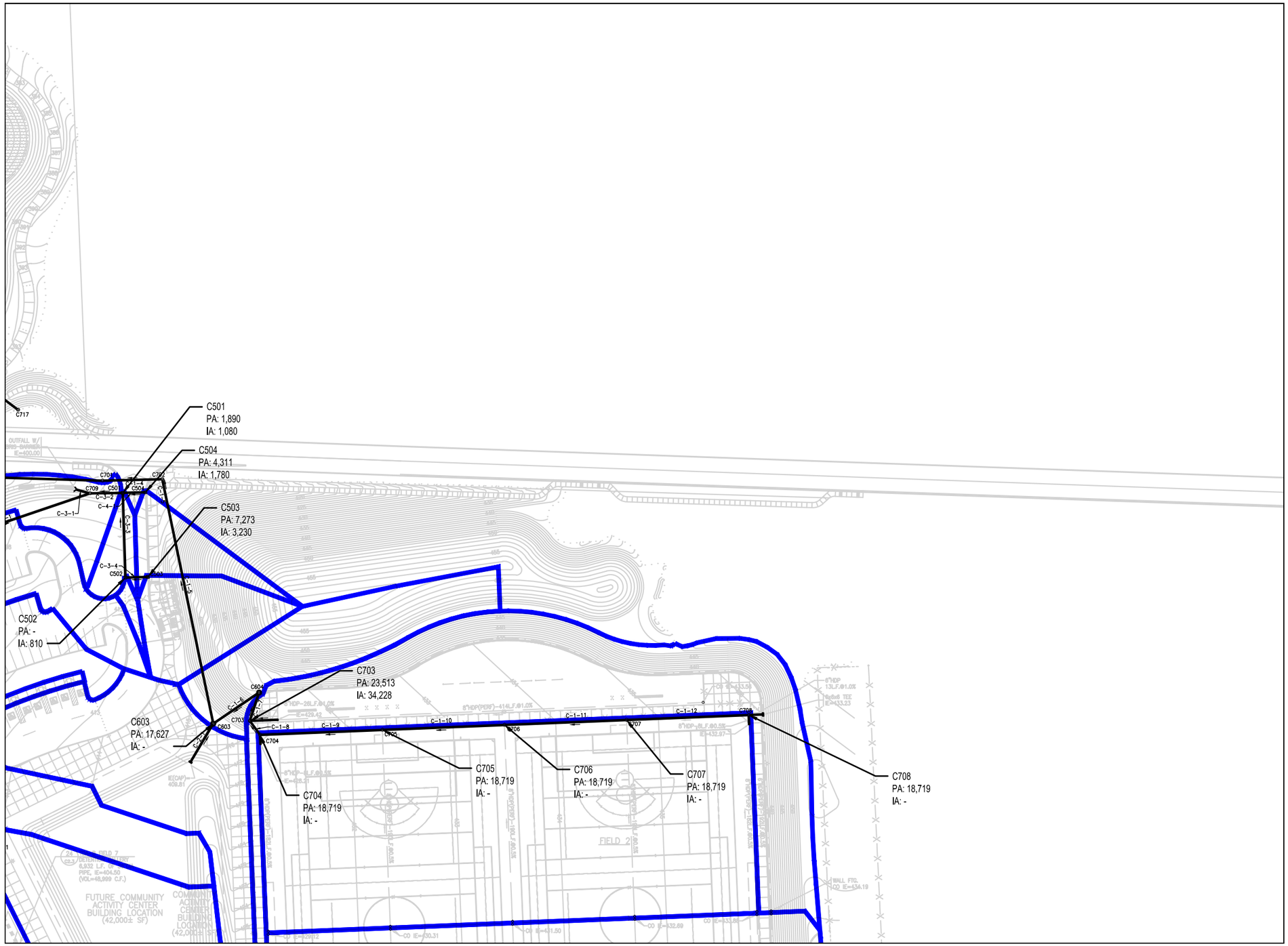
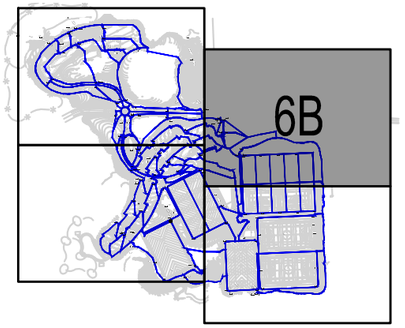
SNOHOMISH COUNTY PARKS AND RECREATION
WELLINGTON HILLS COUNTY PARK

CONVEYANCE TRIBUTARY AREAS
FIGURE 6A




KEY MAP

## LEGEND

DRAINAGE BASIN BOUNDARY

STORM DRAINAGE CONVEYANCE

N

0 100 200 400

1 inch =100 feet

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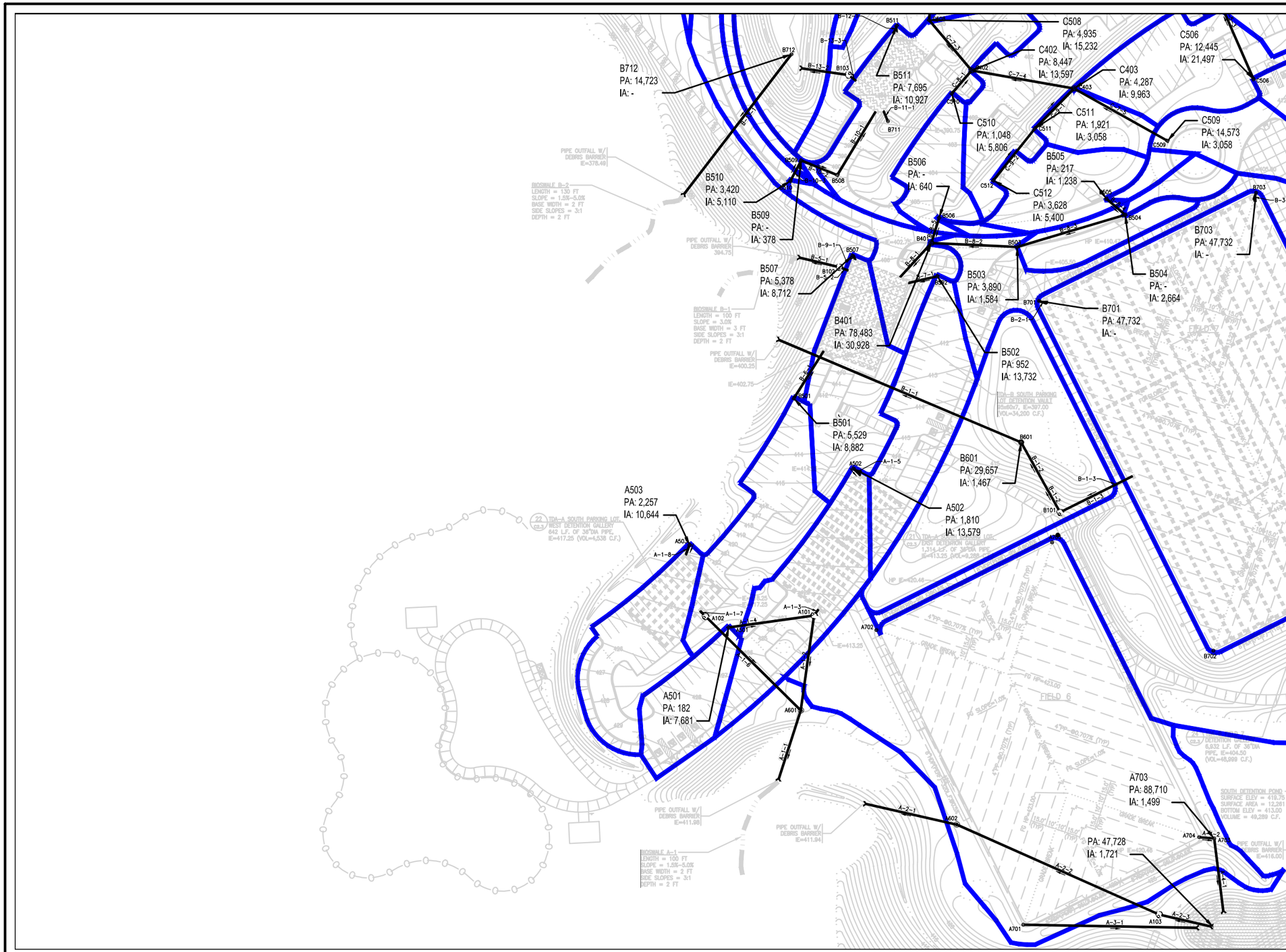
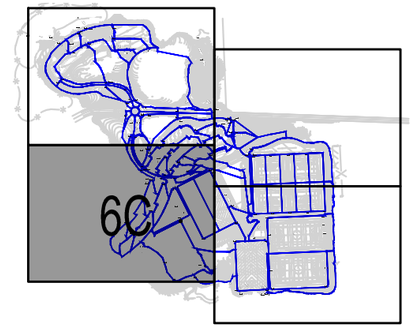
SNOHOMISH COUNTY PARKS AND RECREATION
WELLINGTON HILLS COUNTY PARK

CONVEYANCE TRIBUTARY AREAS
FIGURE 6B




KEY MAP

## LEGEND

DRAINAGE BASIN BOUNDARY

STORM DRAINAGE CONVEYANCE

N

0 100 200 400

1 inch =100 feet

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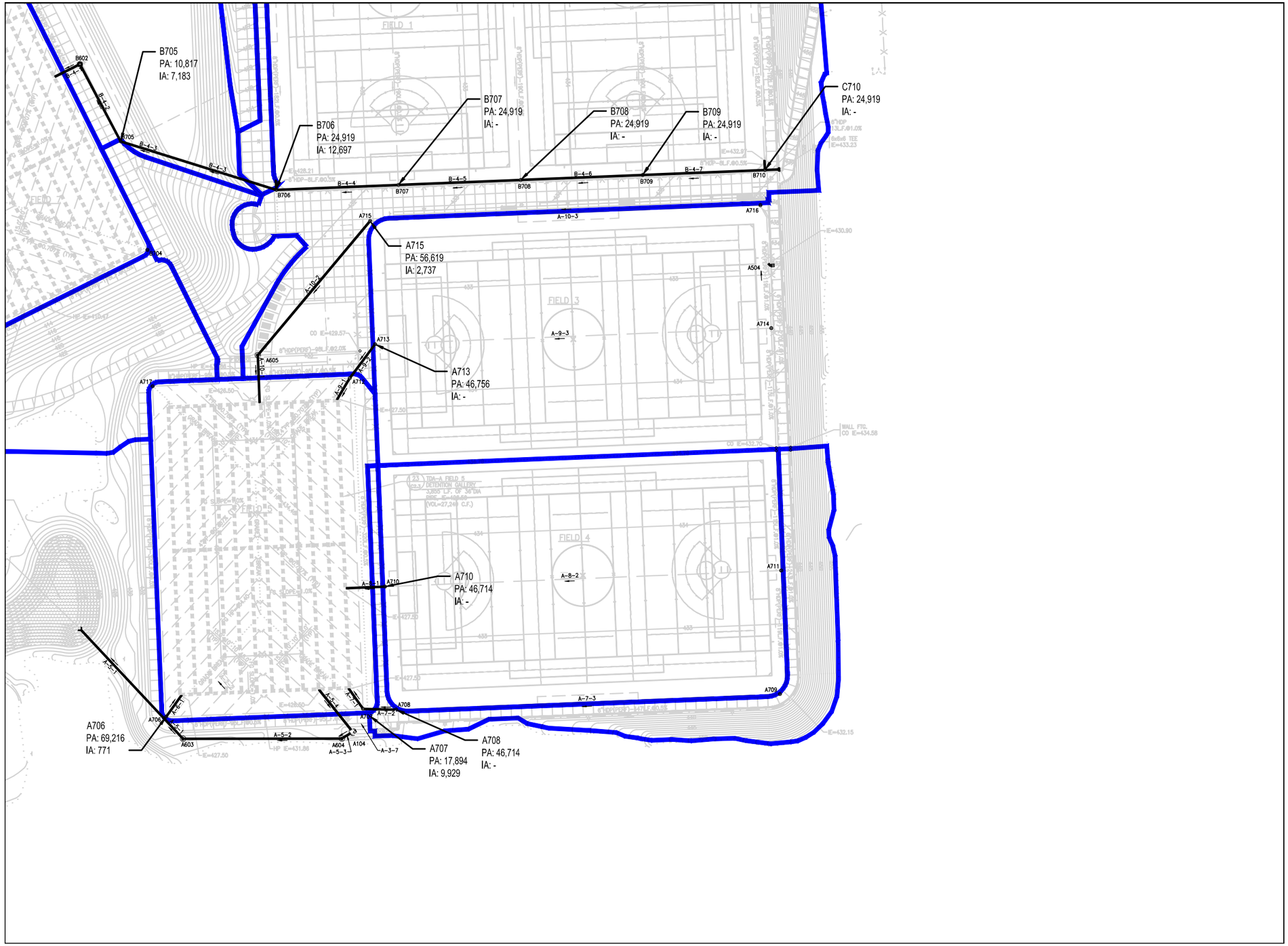
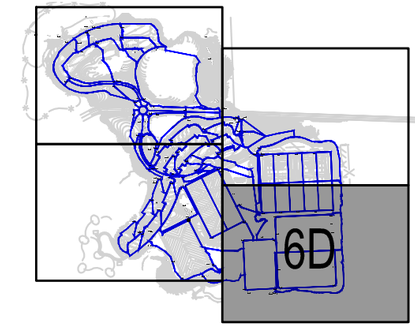
SNOHOMISH COUNTY PARKS AND RECREATION
WELLINGTON HILLS COUNTY PARK

CONVEYANCE TRIBUTARY AREAS
FIGURE 6C




KEY MAP

## LEGEND

DRAINAGE BASIN BOUNDARY

STORM DRAINAGE CONVEYANCE

N

0 100 200 400

1 inch =100 feet

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SNOHOMISH COUNTY PARKS AND RECREATION
WELLINGTON HILLS COUNTY PARK

CONVEYANCE TRIBUTARY AREAS
FIGURE 6D

# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 | n = 0.586 | Design Storm Event = 100 | Pavement thickness (ft) = 1.5 | Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| A-1-8 | A503 | DETENTION | | 0.30 | 0.79 | 0.23 | 0.23 | 5.0 | 5.0 | 3.92 | 0.91 | | 0.91 | 12 | 0.012 | 0.0056 | 3.66 | 2.87 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 9 | 0.05 | 418.30 | 418.25 | 421.67 | 422.20 | 0.75 | 1.32 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| A-1-7 | DETENTION | A102 | | 0.00 | 0.00 | 0.00 | 0.23 | 5.0 | 5.0 | 3.90 | 0.91 | | 0.91 | 12 | 0.012 | 0.0100 | 4.91 | 3.86 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 4 | 0.04 | 417.25 | 417.21 | 423.90 | 424.12 | 4.02 | 4.29 | More than 2 ft of cover | More than 2 ft of cover | |
| A-1-6 | A102 | A601 | | 0.00 | 0.00 | 0.00 | 0.23 | 5.0 | 5.1 | 3.90 | 0.91 | | 0.91 | 12 | 0.012 | 0.0388 | 9.68 | 7.60 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 126 | 4.89 | 417.21 | 412.32 | 424.12 | 426.15 | 4.29 | 11.21 | More than 2 ft of cover | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
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The conservative assumption is that the flow enters the storm sewer run at the upstream end of the run being analyzed.

For pipe cover calculation, Pipe cover = (Ground or Rim Elevation - Pipe invert elevation) - (pavement thickness) - (top of pipe thickness) - (pipe diameter).
The pipe thickness is based on the pipe diameter per WSDOT Manual Concrete for Shallow Pipe Cover Installations Fill Height Table 8-11.2
Please specify the largest pipe thickness of the storm sewer run being analyzed.

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WARNING: START YOUR STORMSEWER RUN ON ROW 12. DO NOT SKIP ANY ROWS IN BETWEEN. USE ONE SHEET PER STORMSEWER RUN

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# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 | n = 0.586 | Design Storm Event = 100 | Pavement thickness (ft) = 1.5 | Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| A-1-4 | A501 | A101 | | 0.18 | 0.89 | 0.16 | 0.16 | 5.0 | 5.0 | 3.92 | 0.63 | | 0.63 | 12 | 0.012 | 0.0411 | 9.96 | 7.82 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 80 | 3.29 | 416.50 | 413.21 | 425.25 | 422.73 | 6.13 | 6.90 | More than 2 ft of cover | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
Column 12 represents inflow from a storm sewer line, branch, an offsite source that flows into the trunk line being analyzed.
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For pipe cover calculation, Pipe cover = (Ground or Rim Elevation - Pipe invert elevation) - (pavement thickness) - (top of pipe thickness) - (pipe diameter).
The pipe thickness is based on the pipe diameter per WSDOT Manual Concrete for Shallow Pipe Cover Installations Fill Height Table 8-11.2
Please specify the largest pipe thickness of the storm sewer run being analyzed.

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# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| A-1-5 | A502 | DETENTION | | 0.33 | 0.65 | 0.22 | 0.22 | 5.0 | 5.0 | 3.92 | 0.84 | | 0.84 | 12 | 0.012 | 0.0411 | 9.96 | 7.82 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 9 | 0.37 | 414.62 | 414.25 | 418.50 | 417.90 | 1.26 | 1.02 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| A-1-3 | DETENTION | A101 | | 0.00 | 0.00 | 0.00 | 0.22 | 5.0 | 5.0 | 3.91 | 0.84 | | 0.84 | 12 | 0.012 | 0.0100 | 4.91 | 3.86 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 4 | 0.04 | 413.25 | 413.21 | 422.70 | 422.73 | 6.82 | 6.90 | More than 2 ft of cover | More than 2 ft of cover | |
| A-1-2 | A101 | A601 | | 0.00 | 0.00 | 0.00 | 0.22 | 5.0 | 5.0 | 3.91 | 0.84 | 0.63 | 1.47 | 12 | 0.012 | 0.0100 | 4.91 | 3.86 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 89 | 0.89 | 413.21 | 412.32 | 422.73 | 426.15 | 6.90 | 11.21 | More than 2 ft of cover | More than 2 ft of cover | |
| A-1-1 | A601 | BIOSWALE | | 0.00 | 0.00 | 0.00 | 0.22 | 5.0 | 5.3 | 3.78 | 0.84 | 0.91 | 2.38 | 12 | 0.012 | 0.0050 | 3.47 | 2.73 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 68 | 0.34 | 412.32 | 411.98 | 426.15 | 413.98 | 11.21 | -0.63 | More than 2 ft of cover | Not Enough Cover - Need to Revise Pipe Elevations | |

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**Notes:**
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For pipe cover calculation, Pipe cover = (Ground or Rim Elevation - Pipe invert elevation) - (pavement thickness) - (top of pipe thickness) - (pipe diameter).
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# STORM SEWER DESIGN (English Units)

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Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| A-2-3 | DETENTION | A103 | | 1.14 | 0.27 | 0.31 | 0.31 | 5.0 | 5.0 | 3.92 | 1.21 | 10.21 | 11.43 | 24 | 0.012 | 0.0031 | 4.32 | 13.55 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 49 | 0.15 | 413.00 | 412.85 | 416.00 | 425.50 | -0.63 | 9.02 | Not Enough Cover - Need to Revise Pipe Elevations | More than 2 ft of cover | |
| A-2-2 | A103 | A602 | | 0.00 | 0.00 | 0.00 | 0.31 | 5.0 | 5.2 | 3.84 | 1.21 | | 11.43 | 24 | 0.012 | 0.0030 | 4.29 | 13.45 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 212 | 0.64 | 412.85 | 412.21 | 425.50 | 420.50 | 9.02 | 4.67 | More than 2 ft of cover | More than 2 ft of cover | |
| A-2-1 | A602 | OUTFALL | | 0.00 | 0.00 | 0.00 | 0.31 | 5.0 | 6.0 | 3.52 | 1.21 | | 11.43 | 24 | 0.012 | 0.0030 | 4.30 | 13.48 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 89 | 0.27 | 412.21 | 411.94 | 420.50 | 414.94 | 4.67 | -0.63 | More than 2 ft of cover | Not Enough Cover - Need to Revise Pipe Elevations | |

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**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length**** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| A-3-1 | A701 | DETENTION | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.0 | 3.92 | 0.00 | | 0.00 | 12 | 0.012 | 0.0123 | 5.44 | 4.27 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 168 | 2.06 | 418.06 | 416.00 | 422.04 | 419.00 | 1.36 | 0.38 | Low Cover - See Notes at Bottom | Not Enough Cover - Need to Revise Pipe Elevations | |

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**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| A-4-2 | A704 | A703 | | 2.07 | 0.26 | 0.54 | 0.54 | 5.0 | 5.0 | 3.92 | 2.12 | | 2.12 | 12 | 0.012 | 0.0408 | 9.92 | 7.78 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 13 | 0.53 | 417.90 | 417.37 | 422.04 | 420.50 | 1.52 | 0.50 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| A-4-1 | A703 | DETENTION | | 0.00 | 0.00 | 0.00 | 0.54 | 5.0 | 5.0 | 3.91 | 2.12 | | 2.12 | 12 | 0.012 | 0.0196 | 6.87 | 5.39 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 70 | 1.37 | 417.37 | 416.00 | 420.50 | 419.00 | 0.50 | 0.38 | Low Cover - See Notes at Bottom | Not Enough Cover - Need to Revise Pipe Elevations | |

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**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| A-5-4 | DETENTION | A104 | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.0 | 3.92 | 0.00 | 8.10 | 8.10 | 18 | 0.012 | 0.0100 | 6.44 | 11.37 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 49 | 0.49 | 426.50 | 426.01 | 433.50 | 435.25 | 3.88 | 6.12 | More than 2 ft of cover | More than 2 ft of cover | |
| A-5-3 | A104 | A604 | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.1 | 3.92 | 0.00 | | 8.10 | 18 | 0.012 | 0.0237 | 9.92 | 17.52 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 8 | 0.19 | 423.25 | 423.06 | 435.25 | 433.50 | 8.88 | 7.32 | More than 2 ft of cover | More than 2 ft of cover | |
| A-5-2 | A604 | A603 | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.1 | 3.92 | 0.00 | | 8.10 | 18 | 0.012 | 0.0241 | 9.99 | 17.63 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 150 | 3.61 | 423.06 | 419.45 | 433.50 | 431.50 | 7.32 | 8.93 | More than 2 ft of cover | More than 2 ft of cover | |
| A-5-1 | A603 | DETENTION | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.4 | 3.92 | 0.00 | | 8.10 | 18 | 0.012 | 0.0241 | 10.00 | 17.66 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 143 | 3.45 | 419.45 | 416.00 | 431.50 | 419.00 | 8.93 | -0.13 | More than 2 ft of cover | Not Enough Cover - Need to Revise Pipe Elevations | |

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Please report any problems to the WSDOT HQ Hydraulics Office.

# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| A-6-1 | A706 | DETENTION | | 1.61 | 0.26 | 0.41 | 0.41 | 5.0 | 5.0 | 3.92 | 1.62 | | 1.62 | 12 | 0.012 | 0.0400 | 9.83 | 7.71 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 25 | 1.00 | 428.50 | 427.50 | 433.44 | 433.50 | 2.32 | 3.38 | More than 2 ft of cover | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
Column 12 represents inflow from a storm sewer line, branch, an offsite source that flows into the trunk line being analyzed.
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# STORM SEWER DESIGN (English Units)

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**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| A-7-2 | A708 | A707 | | 1.07 | 0.25 | 0.27 | 0.27 | 5.0 | 5.0 | 3.92 | 1.05 | | 1.05 | 12 | 0.012 | 0.0100 | 4.91 | 3.86 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 30 | 0.30 | 428.15 | 427.85 | 432.32 | 433.44 | 1.55 | 2.96 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |
| A-7-1 | A707 | DETENTION | | 0.64 | 0.48 | 0.31 | 0.58 | 5.0 | 5.0 | 3.92 | 2.26 | | 2.26 | 12 | 0.012 | 0.0152 | 6.06 | 4.76 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 23 | 0.35 | 427.85 | 427.50 | 433.44 | 433.50 | 2.96 | 3.38 | More than 2 ft of cover | More than 2 ft of cover | |

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**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| A-8-1 | A710 | DETENTION | | 1.07 | 0.25 | 0.27 | 0.27 | 5.0 | 5.0 | 3.92 | 1.05 | | 1.05 | 12 | 0.012 | 0.0414 | 9.99 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 37 | 1.53 | 429.03 | 427.50 | 433.52 | 433.50 | 1.87 | 3.38 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |

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**Notes:**
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Please specify the largest pipe thickness of the storm sewer run being analyzed.

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# STORM SEWER DESIGN (English Units)

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**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| A-9-2 | A713 | A712 | | 1.70 | 0.25 | 0.43 | 0.43 | 5.0 | 5.0 | 3.92 | 1.67 | | 1.67 | 12 | 0.012 | 0.0210 | 7.12 | 5.59 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 40 | 0.84 | 429.29 | 428.45 | 433.52 | 433.44 | 1.60 | 2.37 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |
| A-9-1 | A712 | DETENTION | | 0.00 | 0.00 | 0.00 | 0.43 | 5.0 | 5.1 | 3.88 | 1.67 | | 1.67 | 12 | 0.012 | 0.0413 | 9.98 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 23 | 0.95 | 428.45 | 427.50 | 433.44 | 433.50 | 2.37 | 3.38 | More than 2 ft of cover | More than 2 ft of cover | |

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**Notes:**
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**Designed By:** JRG
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m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| A-10-2 | A715 | A605 | | 1.36 | 0.28 | 0.38 | 0.38 | 5.0 | 5.0 | 3.92 | 1.50 | | 1.50 | 12 | 0.012 | 0.0050 | 3.47 | 2.73 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 168 | 0.84 | 428.12 | 427.28 | 432.32 | 432.98 | 1.57 | 3.08 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |
| A-10-1 | A605 | DETENTION | | 0.00 | 0.00 | 0.00 | 0.38 | 5.0 | 5.8 | 3.59 | 1.50 | | 1.50 | 12 | 0.012 | 0.0177 | 6.54 | 5.13 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 44 | 0.78 | 427.28 | 426.50 | 432.98 | 433.50 | 3.08 | 4.38 | More than 2 ft of cover | More than 2 ft of cover | |

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m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-1-3 | DETENTION | B101 | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.0 | 3.92 | 0.00 | | 6.20 | 18 | 0.012 | 0.0050 | 4.55 | 8.04 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 76 | 0.38 | 404.50 | 404.12 | 412.00 | 419.80 | 4.38 | 12.56 | More than 2 ft of cover | More than 2 ft of cover | |
| B-1-2 | B101 | B601 | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.3 | 3.92 | 0.00 | 6.20 | 6.20 | 18 | 0.012 | 0.0051 | 4.58 | 8.09 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 73 | 0.37 | 404.12 | 403.75 | 419.80 | 410.50 | 12.56 | 3.63 | More than 2 ft of cover | More than 2 ft of cover | |
| B-1-1 | B601 | OUTFALL | | 0.71 | 0.28 | 0.20 | 0.20 | 5.0 | 5.0 | 3.92 | 0.79 | | 6.99 | 18 | 0.012 | 0.0137 | 7.54 | 13.32 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 255 | 3.50 | 403.75 | 400.25 | 410.50 | 403.25 | 3.63 | -0.13 | More than 2 ft of cover | Not Enough Cover - Need to Revise Pipe Elevations | |

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| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-2-1 | B701 | DETENTION | | 1.10 | 0.25 | 0.27 | 0.27 | 5.0 | 5.0 | 3.92 | 1.07 | | 1.07 | 12 | 0.012 | 0.0400 | 9.83 | 7.71 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 6 | 0.24 | 405.74 | 405.50 | 412.04 | 412.00 | 3.68 | 3.88 | More than 2 ft of cover | More than 2 ft of cover | |

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**Project Office:** KPFF Seattle

m = 10.07 | n = 0.586 | Design Storm Event = 100 | Pavement thickness (ft) = 1.5 | Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-3-1 | B703 | DETENTION | | 1.10 | 0.25 | 0.27 | 0.27 | 5.0 | 5.0 | 3.92 | 1.07 | | 1.07 | 12 | 0.012 | 0.0400 | 9.83 | 7.71 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 6 | 0.24 | 405.74 | 405.50 | 412.04 | 412.00 | 3.68 | 3.88 | More than 2 ft of cover | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
Column 12 represents inflow from a storm sewer line, branch, an offsite source that flows into the trunk line being analyzed.
The conservative assumption is that the flow enters the storm sewer run at the upstream end of the run being analyzed.

For pipe cover calculation, Pipe cover = (Ground or Rim Elevation - Pipe invert elevation) - (pavement thickness) - (top of pipe thickness) - (pipe diameter).
The pipe thickness is based on the pipe diameter per WSDOT Manual Concrete for Shallow Pipe Cover Installations Fill Height Table 8-11.2
Please specify the largest pipe thickness of the storm sewer run being analyzed.

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WARNING: START YOUR STORMSEWER RUN ON ROW 12. DO NOT SKIP ANY ROWS IN BETWEEN. USE ONE SHEET PER STORMSEWER RUN

Please report any problems to the WSDOT HQ Hydraulics Office.

# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

**m =** 10.07 **n =** 0.586 **Design Storm Event =** 100 **Pavement thickness (ft) =** 1.5 **Pipe Thickness (inches) =** 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *8a* | *9* | *10* | *11* | *12* | *13* | *14* | *14a* | *15* | *16* | *17* | *17a* | *17b* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *24* |
| B-4-7 | B710 | B709 | | 0.57 | 0.25 | 0.14 | 0.14 | 5.0 | 5.0 | 3.92 | 0.56 | | 0.56 | 12 | 0.012 | 0.0101 | 4.93 | 3.87 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 118 | 1.19 | 432.60 | 431.41 | 435.88 | 434.69 | 0.65 | 0.65 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| B-4-6 | B709 | B708 | | 0.57 | 0.25 | 0.14 | 0.29 | 5.0 | 5.0 | 3.92 | 1.12 | | 1.12 | 12 | 0.012 | 0.0101 | 4.93 | 3.87 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 118 | 1.19 | 431.41 | 430.22 | 434.69 | 433.50 | 0.65 | 0.65 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| B-4-5 | B708 | B707 | | 0.57 | 0.25 | 0.14 | 0.43 | 5.0 | 5.4 | 3.75 | 1.61 | | 1.61 | 12 | 0.012 | 0.0101 | 4.93 | 3.87 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 118 | 1.19 | 430.22 | 429.03 | 433.50 | 432.31 | 0.65 | 0.66 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| B-4-4 | B707 | B706 | | 0.57 | 0.25 | 0.14 | 0.57 | 5.0 | 5.8 | 3.60 | 2.06 | | 2.06 | 12 | 0.012 | 0.0101 | 4.93 | 3.87 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 118 | 1.19 | 429.03 | 427.84 | 432.31 | 431.12 | 0.66 | 0.66 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| B-4-3 | B706 | B705 | | 0.86 | 0.47 | 0.41 | 0.98 | 5.0 | 6.2 | 3.46 | 3.38 | | 3.38 | 12 | 0.012 | 0.1231 | 17.24 | 13.53 | TRY TO REDUCE VELOCITY | ADEQUATE PIPE CAPACITY | 156 | 19.20 | 427.84 | 408.64 | 431.12 | 412.40 | 0.66 | 1.13 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| B-4-2 | B705 | B602 | | 0.41 | 0.51 | 0.21 | 1.19 | 5.0 | 6.3 | 3.41 | 4.05 | | 4.05 | 12 | 0.012 | 0.0413 | 9.99 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 82 | 3.39 | 408.64 | 405.25 | 412.40 | 412.35 | 1.13 | 4.48 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |
| B-4-1 | B602 | DETENTION | | 0.00 | 0.00 | 0.00 | 1.19 | 5.0 | 6.5 | 3.37 | 4.05 | | 4.05 | 12 | 0.012 | 0.0300 | 8.51 | 6.68 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 25 | 0.75 | 405.25 | 404.50 | 412.35 | 412.00 | 4.48 | 4.88 | More than 2 ft of cover | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
Column 12 represents inflow from a storm sewer line, branch, an offsite source that flows into the trunk line being analyzed.
The conservative assumption is that the flow enters the storm sewer run at the upstream end of the run being analyzed.

For pipe cover calculation, Pipe cover = (Ground or Rim Elevation - Pipe invert elevation) - (pavement thickness) - (top of pipe thickness) - (pipe diameter).
The pipe thickness is based on the pipe diameter per WSDOT Manual Concrete for Shallow Pipe Cover Installations Fill Height Table 8-11.2
Please specify the largest pipe thickness of the storm sewer run being analyzed.

The spreadsheet will only calculate one storm sewer line at a time. Please copy the "Blank Template" and use this for calculating new storm sewer lines.
If analyzing complicated stormsewer system with multiple lateral lines to the trunk line, it is recommended that Stormshed be used to
model the conveyance system. Please contact your region Hydraulic Contact.

WARNING: START YOUR STORMSEWER RUN ON ROW 12. DO NOT SKIP ANY ROWS IN BETWEEN. USE ONE SHEET PER STORMSEWER RUN

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# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-5-2 | DETENTION | B102 | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.0 | 3.92 | 0.00 | | 0.00 | 12 | 0.012 | 0.0400 | 9.83 | 7.71 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 6 | 0.24 | 401.00 | 400.76 | 406.10 | 406.50 | 2.48 | 3.12 | More than 2 ft of cover | More than 2 ft of cover | |
| B-5-1 | B102 | BIOSWALE | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.0 | 3.92 | 0.00 | 7.67 | 7.67 | 12 | 0.012 | 0.1856 | 21.16 | 16.61 | TRY TO REDUCE VELOCITY | ADEQUATE PIPE CAPACITY | 36 | 6.68 | 400.76 | 394.08 | 406.50 | 397.08 | 3.12 | 0.38 | More than 2 ft of cover | Not Enough Cover - Need to Revise Pipe Elevations | |

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**Notes:**
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# STORM SEWER DESIGN (English Units)

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Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 | n = 0.586 | Design Storm Event = 100 | Pavement thickness (ft) = 1.5 | Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-6-1 | B501 | DETENTION | | 0.33 | 0.65 | 0.22 | 0.22 | 5.0 | 5.0 | 3.92 | 0.84 | | 0.84 | 12 | 0.012 | 0.0413 | 9.99 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 53 | 2.19 | 403.19 | 401.00 | 411.93 | 408.90 | 6.12 | 5.27 | More than 2 ft of cover | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
Column 12 represents inflow from a storm sewer line, branch, an offsite source that flows into the trunk line being analyzed.
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# STORM SEWER DESIGN (English Units)

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Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-7-1 | B502 | DETENTION | | 0.34 | 0.86 | 0.29 | 0.29 | 5.0 | 5.0 | 3.92 | 1.13 | | 1.13 | 12 | 0.012 | 0.0414 | 10.00 | 7.85 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 28 | 1.16 | 402.16 | 401.00 | 409.64 | 407.00 | 4.85 | 3.38 | More than 2 ft of cover | More than 2 ft of cover | |

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**Notes:**
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# STORM SEWER DESIGN (English Units)

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Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 | n = 0.586 | Design Storm Event = 100 | Pavement thickness (ft) = 1.5 | Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-8-5 | B506 | B401 | | 0.01 | 0.90 | 0.01 | 0.01 | 5.0 | 5.0 | 3.92 | 0.05 | | 0.05 | 12 | 0.012 | 0.0365 | 9.39 | 7.37 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 23 | 0.84 | 403.62 | 402.78 | 406.75 | 406.75 | 0.50 | 1.35 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |

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Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-8-4 | B505 | B504 | | 0.03 | 0.80 | 0.03 | 0.03 | 5.0 | 5.0 | 3.92 | 0.11 | | 0.11 | 12 | 0.012 | 0.0041 | 3.14 | 2.47 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 22 | 0.09 | 407.19 | 407.10 | 410.32 | 410.52 | 0.50 | 0.79 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| B-8-3 | B504 | B503 | | 0.06 | 0.90 | 0.06 | 0.08 | 5.0 | 5.0 | 3.92 | 0.32 | | 0.32 | 12 | 0.012 | 0.0090 | 4.66 | 3.65 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 108 | 0.97 | 407.10 | 406.13 | 410.52 | 409.38 | 0.79 | 0.63 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| B-8-2 | B503 | B401 | | 0.13 | 0.44 | 0.06 | 0.14 | 5.0 | 5.4 | 3.75 | 0.51 | | 0.51 | 12 | 0.012 | 0.0414 | 9.99 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 81 | 3.35 | 406.13 | 402.78 | 409.38 | 406.75 | 0.63 | 1.35 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| B-8-1 | B401 | DETENTION | | 2.51 | 0.43 | 1.09 | 1.23 | 5.0 | 5.0 | 3.92 | 4.81 | 0.05 | 4.86 | 12 | 0.012 | 0.0414 | 10.00 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 43 | 1.78 | 402.78 | 401.00 | 406.75 | 406.80 | 1.35 | 3.18 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
Column 12 represents inflow from a storm sewer line, branch, an offsite source that flows into the trunk line being analyzed.
The conservative assumption is that the flow enters the storm sewer run at the upstream end of the run being analyzed.

For pipe cover calculation, Pipe cover = (Ground or Rim Elevation - Pipe invert elevation) - (pavement thickness) - (top of pipe thickness) - (pipe diameter).
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WARNING: START YOUR STORMSEWER RUN ON ROW 12. DO NOT SKIP ANY ROWS IN BETWEEN. USE ONE SHEET PER STORMSEWER RUN

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# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-9-1 | B507 | DETENTION | | 0.32 | 0.65 | 0.21 | 0.21 | 5.0 | 5.0 | 3.92 | 0.83 | | 0.83 | 12 | 0.012 | 0.0400 | 9.83 | 7.71 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 3 | 0.12 | 401.12 | 401.00 | 405.60 | 406.00 | 1.86 | 2.38 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
Column 12 represents inflow from a storm sewer line, branch, an offsite source that flows into the trunk line being analyzed.
The conservative assumption is that the flow enters the storm sewer run at the upstream end of the run being analyzed.

For pipe cover calculation, Pipe cover = (Ground or Rim Elevation - Pipe invert elevation) - (pavement thickness) - (top of pipe thickness) - (pipe diameter).
The pipe thickness is based on the pipe diameter per WSDOT Manual Concrete for Shallow Pipe Cover Installations Fill Height Table 8-11.2
Please specify the largest pipe thickness of the storm sewer run being analyzed.

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WARNING: START YOUR STORMSEWER RUN ON ROW 12. DO NOT SKIP ANY ROWS IN BETWEEN. USE ONE SHEET PER STORMSEWER RUN

Please report any problems to the WSDOT HQ Hydraulics Office.

# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-10-3 | B510 | B509 | | 0.20 | 0.64 | 0.13 | 0.13 | 5.0 | 5.0 | 3.92 | 0.49 | | 0.49 | 12 | 0.012 | 0.0410 | 9.95 | 7.81 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 20 | 0.82 | 394.25 | 393.43 | 399.75 | 399.55 | 2.88 | 3.50 | More than 2 ft of cover | More than 2 ft of cover | |
| B-10-2 | B509 | B508 | | 0.01 | 0.90 | 0.01 | 0.13 | 5.0 | 5.0 | 3.91 | 0.52 | | 0.52 | 12 | 0.012 | 0.0414 | 10.00 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 36 | 1.49 | 393.43 | 391.94 | 399.55 | 400.75 | 3.50 | 6.19 | More than 2 ft of cover | More than 2 ft of cover | |
| B-10-1 | B508 | DETENTION | | 0.00 | 0.00 | 0.00 | 0.13 | 5.0 | 5.1 | 3.88 | 0.52 | | 0.52 | 12 | 0.012 | 0.0414 | 10.00 | 7.85 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 71 | 2.94 | 391.94 | 389.00 | 400.75 | 396.80 | 6.19 | 5.18 | More than 2 ft of cover | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
Column 12 represents inflow from a storm sewer line, branch, an offsite source that flows into the trunk line being analyzed.
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For pipe cover calculation, Pipe cover = (Ground or Rim Elevation - Pipe invert elevation) - (pavement thickness) - (top of pipe thickness) - (pipe diameter).
The pipe thickness is based on the pipe diameter per WSDOT Manual Concrete for Shallow Pipe Cover Installations Fill Height Table 8-11.2
Please specify the largest pipe thickness of the storm sewer run being analyzed.

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# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *8a* | *9* | *10* | *11* | *12* | *13* | *14* | *14a* | *15* | *16* | *17* | *17a* | *17b* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *24* |
| B-11-1 | B711 | DETENTION | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.0 | 3.92 | 0.00 | | 0.00 | 12 | 0.012 | 0.0411 | 9.96 | 7.82 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 9 | 0.37 | 389.37 | 389.00 | 395.25 | 397.90 | 3.26 | 6.27 | More than 2 ft of cover | More than 2 ft of cover | |

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**Notes:**
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WARNING: START YOUR STORMSEWER RUN ON ROW 12. DO NOT SKIP ANY ROWS IN BETWEEN. USE ONE SHEET PER STORMSEWER RUN

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# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-12-1 | B511 | DETENTION | | 0.43 | 0.63 | 0.27 | 0.27 | 5.0 | 5.0 | 3.92 | 1.06 | | 1.06 | 12 | 0.012 | 0.0400 | 9.83 | 7.71 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 4 | 0.16 | 389.16 | 389.00 | 393.51 | 394.00 | 1.72 | 2.38 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |

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**Notes:**
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# STORM SEWER DESIGN (English Units)

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Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-13-3 | DETENTION | B103 | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.0 | 3.92 | 0.00 | 1.58 | 1.58 | 12 | 0.012 | 0.0083 | 4.48 | 3.52 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 6 | 0.05 | 382.50 | 382.45 | 395.90 | 395.50 | 10.78 | 10.43 | More than 2 ft of cover | More than 2 ft of cover | |
| B-13-2 | B103 | OUTFALL | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.0 | 3.92 | 0.00 | | 1.58 | 12 | 0.012 | 0.0060 | 3.82 | 3.00 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 43 | 0.26 | 382.45 | 382.19 | 395.50 | 386.19 | 10.43 | 1.38 | More than 2 ft of cover | Low Cover - See Notes at Bottom | |
| B-13-1 | B712 | BIOSWALE | | 0.34 | 0.25 | 0.08 | 0.08 | 5.0 | 5.0 | 3.92 | 0.33 | | 1.91 | 12 | 0.012 | 0.0042 | 3.20 | 2.51 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 172 | 0.73 | 379.22 | 378.49 | 382.35 | 381.49 | 0.50 | 0.38 | Low Cover - See Notes at Bottom | Not Enough Cover - Need to Revise Pipe Elevations | |

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# STORM SEWER DESIGN (English Units)

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**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-14-3 | DETENTION | B104 | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.0 | 3.92 | 0.00 | 2.43 | 2.43 | 12 | 0.012 | 0.0413 | 9.98 | 7.83 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 24 | 0.99 | 347.00 | 346.01 | 356.10 | 356.50 | 6.48 | 7.87 | More than 2 ft of cover | More than 2 ft of cover | |
| B-14-2 | B104 | B603 | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.0 | 3.92 | 0.00 | | 2.43 | 12 | 0.012 | 0.0884 | 14.61 | 11.46 | TRY TO REDUCE VELOCITY | ADEQUATE PIPE CAPACITY | 68 | 6.01 | 346.01 | 340.00 | 356.50 | 343.50 | 7.87 | 0.88 | More than 2 ft of cover | Low Cover - See Notes at Bottom | |
| B-14-1 | B603 | B713 | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.1 | 3.92 | 0.00 | | 2.43 | 12 | 0.012 | 0.1642 | 19.91 | 15.63 | TRY TO REDUCE VELOCITY | ADEQUATE PIPE CAPACITY | 137 | 22.50 | 340.00 | 317.50 | 343.50 | 321.00 | 0.88 | 0.88 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |

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**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 | n = 0.586 | Design Storm Event = 100 | Pavement thickness (ft) = 1.5 | Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-15-1 | B512 | DETENTION | | 0.51 | 0.70 | 0.36 | 0.36 | 5.0 | 5.0 | 3.92 | 1.40 | | 1.40 | 12 | 0.012 | 0.0400 | 9.83 | 7.71 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 5 | 0.20 | 351.20 | 351.00 | 355.58 | 356.00 | 1.76 | 2.38 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
Column 12 represents inflow from a storm sewer line, branch, an offsite source that flows into the trunk line being analyzed.
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# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| B-16-2 | B514 | B513 | | 0.45 | 0.39 | 0.17 | 0.17 | 5.0 | 5.0 | 3.92 | 0.67 | | 0.67 | 12 | 0.012 | 0.0040 | 3.11 | 2.44 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 20 | 0.08 | 356.12 | 356.04 | 359.25 | 359.25 | 0.50 | 0.58 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| B-16-1 | B513 | DETENTION | | 0.14 | 0.66 | 0.09 | 0.27 | 5.0 | 5.1 | 3.87 | 1.03 | | 1.03 | 12 | 0.012 | 0.0343 | 9.10 | 7.14 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 147 | 5.04 | 356.04 | 351.00 | 359.25 | 355.70 | 0.58 | 2.07 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |

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**Designed By:** JRG
**Project Office:** KPFF Seattle

**m =** 10.07 **n =** 0.586 **Design Storm Event =** 100 **Pavement thickness (ft) =** 1.5 **Pipe Thickness (inches) =** 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *8a* | *9* | *10* | *11* | *12* | *13* | *14* | *14a* | *15* | *16* | *17* | *17a* | *17b* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *24* |
| C-1-12 | C708 | C707 | | 0.43 | 0.25 | 0.11 | 0.11 | 5.0 | 5.0 | 3.92 | 0.42 | | 0.42 | 12 | 0.012 | 0.0101 | 4.93 | 3.87 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 118 | 1.19 | 432.60 | 431.41 | 435.88 | 434.69 | 0.65 | 0.65 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| C-1-11 | C707 | C706 | | 0.43 | 0.25 | 0.11 | 0.21 | 5.0 | 5.0 | 3.92 | 0.84 | | 0.84 | 12 | 0.012 | 0.0101 | 4.93 | 3.87 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 118 | 1.19 | 431.41 | 430.22 | 434.69 | 433.50 | 0.65 | 0.65 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| C-1-10 | C706 | C705 | | 0.43 | 0.25 | 0.11 | 0.32 | 5.0 | 5.4 | 3.75 | 1.21 | | 1.21 | 12 | 0.012 | 0.0101 | 4.93 | 3.87 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 118 | 1.19 | 430.22 | 429.03 | 433.50 | 432.31 | 0.65 | 0.66 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| C-1-9 | C705 | C704 | | 0.43 | 0.25 | 0.11 | 0.43 | 5.0 | 5.8 | 3.60 | 1.55 | | 1.55 | 12 | 0.012 | 0.0101 | 4.93 | 3.87 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 118 | 1.19 | 429.03 | 427.84 | 432.31 | 431.12 | 0.66 | 0.66 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| C-1-8 | C704 | C703 | | 0.43 | 0.25 | 0.11 | 0.54 | 5.0 | 6.2 | 3.46 | 1.86 | | 1.86 | 12 | 0.012 | 0.0180 | 6.59 | 5.17 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 15 | 0.27 | 427.84 | 427.57 | 431.12 | 431.20 | 0.66 | 1.01 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| C-1-7 | C703 | C604 | | 1.33 | 0.64 | 0.84 | 1.38 | 5.0 | 6.0 | 3.92 | 5.41 | | 5.41 | 18 | 0.012 | 0.0056 | 4.80 | 8.47 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 27 | 0.15 | 427.57 | 427.42 | 431.20 | 433.50 | 0.50 | 2.95 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |
| C-1-6 | C604 | C603 | | 0.00 | 0.00 | 0.00 | 1.38 | 5.0 | 5.1 | 3.88 | 5.41 | | 5.41 | 18 | 0.012 | 0.4070 | 41.07 | 72.52 | TRY TO REDUCE VELOCITY | ADEQUATE PIPE CAPACITY | 50 | 20.35 | 427.42 | 407.07 | 433.50 | 415.10 | 2.95 | 4.91 | More than 2 ft of cover | More than 2 ft of cover | |
| C-1-5 | C603 | C702 | | 0.40 | 0.25 | 0.10 | 1.48 | 5.0 | 5.1 | 3.87 | 5.72 | | 5.72 | 18 | 0.010 | 0.0175 | 10.22 | 18.05 | TRY TO REDUCE VELOCITY | ADEQUATE PIPE CAPACITY | 240 | 4.20 | 407.07 | 402.87 | 415.10 | 406.50 | 4.91 | 0.50 | More than 2 ft of cover | Low Cover - See Notes at Bottom | |
| C-1-4 | C702 | C701 | | 0.00 | 0.00 | 0.00 | 1.48 | 5.0 | 5.5 | 3.71 | 5.72 | | 5.72 | 18 | 0.012 | 0.0209 | 9.31 | 16.43 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 56 | 1.17 | 402.87 | 401.70 | 406.50 | 405.49 | 0.50 | 0.67 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| C-1-3 | C701 | C602 | | 0.00 | 0.00 | 0.00 | 1.48 | 5.0 | 5.6 | 3.67 | 5.72 | | 5.72 | 18 | 0.012 | 0.0515 | 14.61 | 25.80 | TRY TO REDUCE VELOCITY | ADEQUATE PIPE CAPACITY | 334 | 17.21 | 401.70 | 384.49 | 405.49 | 389.50 | 0.67 | 1.88 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| C-1-2 | C602 | C601 | | 0.20 | 0.50 | 0.10 | 1.58 | 5.0 | 6.0 | 3.53 | 5.56 | 10.62 | 16.19 | 24 | 0.012 | 0.0100 | 7.80 | 24.48 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 49 | 0.49 | 384.49 | 384.00 | 389.50 | 389.50 | 1.38 | 1.88 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| C-1-1 | C601 | DETENTION | | 0.14 | 0.60 | 0.09 | 1.66 | 5.0 | 6.1 | 3.49 | 5.81 | | 16.43 | 24 | 0.012 | 0.0188 | 10.70 | 33.60 | TRY TO REDUCE VELOCITY | ADEQUATE PIPE CAPACITY | 154 | 2.90 | 380.40 | 377.50 | 389.50 | 380.50 | 5.48 | -0.63 | More than 2 ft of cover | Not Enough Cover - Need to Revise Pipe Elevations | |

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# STORM SEWER DESIGN (English Units)

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Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| C-3-4 | C503 | C502 | | 0.24 | 0.45 | 0.11 | 0.11 | 5.0 | 5.0 | 3.92 | 0.43 | | 0.43 | 12 | 0.012 | 0.0410 | 9.95 | 7.81 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 20 | 0.82 | 405.49 | 404.67 | 410.80 | 410.80 | 2.69 | 3.51 | More than 2 ft of cover | More than 2 ft of cover | |
| C-3-3 | C502 | C501 | | 0.02 | 0.90 | 0.02 | 0.13 | 5.0 | 5.0 | 3.91 | 0.49 | | 0.49 | 12 | 0.012 | 0.0414 | 9.99 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 80 | 3.31 | 404.67 | 401.36 | 410.80 | 406.67 | 3.51 | 2.69 | More than 2 ft of cover | More than 2 ft of cover | |
| C-3-2 | C501 | C709 | | 0.07 | 0.49 | 0.03 | 0.16 | 5.0 | 5.2 | 3.85 | 0.61 | 0.24 | 0.85 | 12 | 0.012 | 0.0413 | 9.99 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 30 | 1.24 | 401.36 | 400.12 | 406.67 | 404.62 | 2.69 | 1.88 | More than 2 ft of cover | Low Cover - See Notes at Bottom | |
| C-3-1 | C709 | BIOSWALE | | 0.00 | 0.00 | 0.00 | 0.16 | 5.0 | 5.2 | 3.82 | 0.61 | 3.63 | 4.48 | 12 | 0.012 | 0.0142 | 5.85 | 4.59 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 12 | 0.17 | 400.12 | 399.95 | 404.62 | 403.00 | 1.88 | 0.43 | Low Cover - See Notes at Bottom | Not Enough Cover - Need to Revise Pipe Elevations | |

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**Designed By:** JRG
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m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| C-4-1 | C504 | C501 | | 0.14 | 0.44 | 0.06 | 0.06 | 5.0 | 5.0 | 3.92 | 0.24 | | 0.24 | 12 | 0.012 | 0.0410 | 9.95 | 7.81 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 20 | 0.82 | 402.18 | 401.36 | 406.67 | 406.67 | 1.87 | 2.69 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |

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**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| C-5-3 | C506 | C505 | | 0.78 | 0.66 | 0.52 | 0.52 | 5.0 | 5.0 | 3.92 | 2.02 | | 2.02 | 12 | 0.012 | 0.0195 | 6.85 | 5.38 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 93 | 1.81 | 408.07 | 406.26 | 411.20 | 409.73 | 0.50 | 0.85 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| C-5-2 | C505 | C401 | | 0.25 | 0.70 | 0.17 | 0.69 | 5.0 | 5.2 | 3.82 | 2.63 | | 2.63 | 12 | 0.012 | 0.0414 | 9.99 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 81 | 3.35 | 405.47 | 402.12 | 409.73 | 405.25 | 1.63 | 0.50 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| C-5-1 | C401 | C709 | | 0.36 | 0.77 | 0.28 | 0.97 | 5.0 | 5.4 | 3.76 | 3.63 | | 3.63 | 12 | 0.012 | 0.0096 | 4.82 | 3.78 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 208 | 2.00 | 402.12 | 400.12 | 405.25 | 404.62 | 0.50 | 1.88 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
Column 12 represents inflow from a storm sewer line, branch, an offsite source that flows into the trunk line being analyzed.
The conservative assumption is that the flow enters the storm sewer run at the upstream end of the run being analyzed.

For pipe cover calculation, Pipe cover = (Ground or Rim Elevation - Pipe invert elevation) - (pavement thickness) - (top of pipe thickness) - (pipe diameter).
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Please specify the largest pipe thickness of the storm sewer run being analyzed.

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WARNING: START YOUR STORMSEWER RUN ON ROW 12. DO NOT SKIP ANY ROWS IN BETWEEN. USE ONE SHEET PER STORMSEWER RUN

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# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *8a* | *9* | *10* | *11* | *12* | *13* | *14* | *14a* | *15* | *16* | *17* | *17a* | *17b* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *24* |
| C-6-1 | C710 | C602 | | 0.86 | 0.25 | 0.22 | 0.22 | 5.0 | 5.0 | 3.92 | 0.85 | 9.77 | 10.62 | 18 | 0.012 | 0.0100 | 6.44 | 11.37 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 22 | 0.22 | 384.71 | 384.49 | 389.75 | 389.50 | 1.92 | 1.88 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
Column 12 represents inflow from a storm sewer line, branch, an offsite source that flows into the trunk line being analyzed.
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WARNING: START YOUR STORMSEWER RUN ON ROW 12. DO NOT SKIP ANY ROWS IN BETWEEN. USE ONE SHEET PER STORMSEWER RUN

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# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *8a* | *9* | *10* | *11* | *12* | *13* | *14* | *14a* | *15* | *16* | *17* | *17a* | *17b* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *24* |
| C-7-5 | C509 | C403 | | 0.40 | 0.36 | 0.15 | 0.15 | 5.0 | 5.0 | 3.92 | 0.58 | | 0.58 | 12 | 0.012 | 0.0414 | 9.99 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 102 | 4.22 | 402.35 | 398.13 | 410.35 | 407.98 | 5.38 | 7.23 | More than 2 ft of cover | More than 2 ft of cover | |
| C-7-4 | C403 | C402 | | 0.33 | 0.70 | 0.23 | 0.38 | 5.0 | 5.0 | 3.92 | 1.48 | 0.80 | 2.28 | 12 | 0.012 | 0.0414 | 10.00 | 7.85 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 98 | 4.06 | 398.13 | 394.07 | 407.98 | 400.55 | 7.23 | 3.86 | More than 2 ft of cover | More than 2 ft of cover | |
| C-7-3 | C402 | C508 | | 0.51 | 0.65 | 0.33 | 0.71 | 5.0 | 5.2 | 3.85 | 2.72 | 0.49 | 4.01 | 12 | 0.012 | 0.0413 | 9.98 | 7.83 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 62 | 2.56 | 394.07 | 391.51 | 400.55 | 394.59 | 3.86 | 0.45 | More than 2 ft of cover | Not Enough Cover - Need to Revise Pipe Elevations | |
| C-7-2 | C508 | C507 | | 0.46 | 0.74 | 0.34 | 1.05 | 5.0 | 5.3 | 3.80 | 3.99 | | 5.29 | 18 | 0.012 | 0.0137 | 7.53 | 13.29 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 30 | 0.41 | 391.51 | 391.10 | 394.59 | 394.90 | -0.05 | 0.67 | Not Enough Cover - Need to Revise Pipe Elevations | Low Cover - See Notes at Bottom | |
| C-7-1 | C507 | BIOSWALE | | 0.00 | 0.00 | 0.00 | 1.05 | 5.0 | 5.3 | 3.78 | 3.99 | | 5.29 | 18 | 0.012 | 0.0024 | 3.15 | 5.57 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 25 | 0.06 | 391.10 | 391.04 | 394.90 | 394.04 | 0.67 | -0.13 | Low Cover - See Notes at Bottom | Not Enough Cover - Need to Revise Pipe Elevations | |

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**Notes:**

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# STORM SEWER DESIGN (English Units)

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Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| C-8-1 | C510 | C402 | | 0.16 | 0.80 | 0.13 | 0.13 | 5.0 | 5.0 | 3.92 | 0.49 | | 0.49 | 12 | 0.012 | 0.0411 | 9.96 | 7.82 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 27 | 1.11 | 395.18 | 394.07 | 401.19 | 400.55 | 3.38 | 3.86 | More than 2 ft of cover | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
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Please specify the largest pipe thickness of the storm sewer run being analyzed.

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model the conveyance system. Please contact your region Hydraulic Contact.

WARNING: START YOUR STORMSEWER RUN ON ROW 12. DO NOT SKIP ANY ROWS IN BETWEEN. USE ONE SHEET PER STORMSEWER RUN

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# STORM SEWER DESIGN (English Units)

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**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| C-9-2 | C512 | C511 | | 0.21 | 0.64 | 0.13 | 0.13 | 5.0 | 5.0 | 3.92 | 0.52 | | 0.52 | 12 | 0.012 | 0.0414 | 10.00 | 7.85 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 63 | 2.61 | 402.89 | 400.28 | 406.83 | 407.45 | 1.32 | 4.55 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |
| C-9-1 | C511 | C403 | | 0.11 | 0.65 | 0.07 | 0.21 | 5.0 | 5.1 | 3.87 | 0.80 | | 0.80 | 12 | 0.012 | 0.0413 | 9.99 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 52 | 2.15 | 400.28 | 398.13 | 407.45 | 407.98 | 4.55 | 7.23 | More than 2 ft of cover | More than 2 ft of cover | |

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**Designed By:** JRG
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m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| C-10-2 | DETENTION | C101 | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.0 | 3.92 | 0.00 | | 0.00 | 12 | 0.012 | 0.0410 | 9.95 | 7.81 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 20 | 0.82 | 344.71 | 343.89 | 355.00 | 355.50 | 7.67 | 8.99 | More than 2 ft of cover | More than 2 ft of cover | |
| C-10-1 | C101 | C711 | | 0.00 | 0.00 | 0.00 | 0.00 | 5.0 | 0.0 | 3.92 | 0.00 | | 0.00 | 12 | 0.012 | 0.0413 | 9.99 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 76 | 3.14 | 343.89 | 340.75 | 355.50 | 344.25 | 8.99 | 0.88 | More than 2 ft of cover | Low Cover - See Notes at Bottom | |

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**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 | n = 0.586 | Design Storm Event = 100 | Pavement thickness (ft) = 1.5 | Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| C-11-2 | C514 | C513 | | 0.20 | 0.77 | 0.16 | 0.16 | 5.0 | 5.0 | 3.92 | 0.62 | | 0.62 | 12 | 0.012 | 0.0344 | 9.12 | 7.16 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 27 | 0.93 | 351.55 | 350.62 | 354.68 | 354.45 | 0.50 | 1.20 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| C-11-1 | C513 | DETENTION | | 0.57 | 0.73 | 0.42 | 0.58 | 5.0 | 5.0 | 3.92 | 2.26 | | 2.26 | 12 | 0.012 | 0.0413 | 9.99 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 15 | 0.62 | 350.62 | 350.00 | 354.45 | 355.00 | 1.20 | 2.38 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |

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m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| C-12-2 | C516 | C515 | | 1.33 | 0.51 | 0.68 | 0.68 | 5.0 | 5.0 | 3.92 | 2.65 | | 2.65 | 12 | 0.012 | 0.0162 | 6.25 | 4.91 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 118 | 1.91 | 353.23 | 351.32 | 356.36 | 357.47 | 0.50 | 3.53 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |
| C-12-1 | C515 | DETENTION | | 1.11 | 0.41 | 0.45 | 1.13 | 5.0 | 5.3 | 3.78 | 4.27 | | 4.27 | 12 | 0.012 | 0.0412 | 9.98 | 7.83 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 32 | 1.32 | 351.32 | 350.00 | 357.47 | 355.80 | 3.53 | 3.18 | More than 2 ft of cover | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
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# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| C-13-1 | C517 | DETENTION | | 0.57 | 0.26 | 0.15 | 0.15 | 5.0 | 5.0 | 3.92 | 0.59 | | 0.59 | 12 | 0.012 | 0.0411 | 9.96 | 7.82 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 27 | 1.11 | 351.11 | 350.00 | 356.39 | 356.30 | 2.65 | 3.68 | More than 2 ft of cover | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
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# STORM SEWER DESIGN (English Units)

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**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| C-14-3 | C713 | C712 | | 3.32 | 0.30 | 1.01 | 1.01 | 5.0 | 5.0 | 3.92 | 3.95 | | 3.95 | 12 | 0.012 | 0.0147 | 5.95 | 4.67 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 163 | 2.39 | 356.37 | 353.98 | 359.50 | 357.50 | 0.50 | 0.89 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| C-14-2 | C712 | C404 | | 0.17 | 0.33 | 0.05 | 1.06 | 5.0 | 5.5 | 3.73 | 3.96 | | 3.96 | 12 | 0.012 | 0.0253 | 7.81 | 6.13 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 120 | 3.03 | 353.98 | 350.95 | 357.50 | 359.55 | 0.89 | 5.98 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |
| C-14-1 | C404 | DETENTION | | 0.38 | 0.60 | 0.23 | 1.29 | 5.0 | 5.7 | 3.63 | 4.69 | | 4.69 | 12 | 0.012 | 0.0414 | 10.00 | 7.85 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 35 | 1.45 | 350.95 | 349.50 | 359.55 | 357.70 | 5.98 | 5.57 | More than 2 ft of cover | More than 2 ft of cover | |

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**Notes:**
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# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

**m =** 10.07 **n =** 0.586 **Design Storm Event =** 100 **Pavement thickness (ft) =** 1.5 **Pipe Thickness (inches) =** 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *8a* | *9* | *10* | *11* | *12* | *13* | *14* | *14a* | *15* | *16* | *17* | *17a* | *17b* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *24* |
| C-15-8 | C519 | C518 | | 0.13 | 0.61 | 0.08 | 0.08 | 5.0 | 5.0 | 3.92 | 0.32 | | 0.32 | 12 | 0.012 | 0.0100 | 4.91 | 3.86 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 20 | 0.20 | 382.27 | 382.07 | 388.45 | 388.45 | 3.56 | 3.76 | More than 2 ft of cover | More than 2 ft of cover | |
| C-15-7 | C518 | C409 | | 0.06 | 0.90 | 0.06 | 0.14 | 5.0 | 5.1 | 3.89 | 0.53 | | 0.53 | 12 | 0.012 | 0.0400 | 9.83 | 7.71 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 93 | 3.72 | 382.07 | 378.35 | 388.45 | 384.00 | 3.76 | 3.02 | More than 2 ft of cover | More than 2 ft of cover | |
| C-15-6 | C409 | C408 | | 0.15 | 0.56 | 0.08 | 0.22 | 5.0 | 5.2 | 3.82 | 0.84 | 0.52 | 1.36 | 12 | 0.012 | 0.0051 | 3.50 | 2.75 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 63 | 0.32 | 378.35 | 378.03 | 384.00 | 383.94 | 3.02 | 3.29 | More than 2 ft of cover | More than 2 ft of cover | |
| C-15-5 | C408 | C714 | | 0.07 | 0.90 | 0.07 | 0.29 | 5.0 | 5.5 | 3.70 | 1.06 | 0.67 | 2.25 | 12 | 0.012 | 0.0051 | 3.51 | 2.75 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 51 | 0.26 | 378.03 | 377.77 | 383.94 | 383.04 | 3.29 | 2.65 | More than 2 ft of cover | More than 2 ft of cover | |
| C-15-4 | C714 | C407 | | 0.16 | 0.58 | 0.09 | 0.38 | 5.0 | 5.8 | 3.61 | 1.36 | | 2.55 | 12 | 0.012 | 0.0080 | 4.40 | 3.45 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 86 | 0.69 | 377.77 | 377.08 | 383.04 | 383.65 | 2.65 | 3.94 | More than 2 ft of cover | More than 2 ft of cover | |
| C-15-3 | C407 | C406 | | 0.04 | 0.90 | 0.03 | 0.41 | 5.0 | 6.1 | 3.49 | 1.44 | 0.16 | 2.78 | 12 | 0.012 | 0.0100 | 4.91 | 3.86 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 94 | 0.94 | 377.08 | 376.14 | 383.65 | 380.50 | 3.94 | 1.74 | More than 2 ft of cover | Low Cover - See Notes at Bottom | |
| C-15-2 | C406 | C405 | | 0.03 | 0.86 | 0.03 | 0.44 | 5.0 | 6.4 | 3.39 | 1.49 | | 2.84 | 12 | 0.012 | 0.0386 | 9.65 | 7.57 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 134 | 5.17 | 376.14 | 370.97 | 380.50 | 374.18 | 1.74 | 0.58 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |
| C-15-1 | C405 | C712 | | 0.05 | 0.79 | 0.04 | 0.48 | 5.0 | 6.6 | 3.32 | 1.59 | 0.40 | 3.33 | 12 | 0.012 | 0.0726 | 13.24 | 10.39 | TRY TO REDUCE VELOCITY | ADEQUATE PIPE CAPACITY | 234 | 16.99 | 370.97 | 353.98 | 374.18 | 357.50 | 0.58 | 0.89 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |

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**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| C-16-1 | C520 | C405 | | 0.23 | 0.45 | 0.10 | 0.10 | 5.0 | 5.0 | 3.92 | 0.40 | | 0.40 | 12 | 0.012 | 0.0040 | 3.11 | 2.44 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 20 | 0.08 | 371.05 | 370.97 | 374.18 | 374.18 | 0.50 | 0.58 | Low Cover - See Notes at Bottom | Low Cover - See Notes at Bottom | |

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**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 | n = 0.586 | Design Storm Event = 100 | Pavement thickness (ft) = 1.5 | Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| C-17-1 | C521 | C407 | | 0.09 | 0.46 | 0.04 | 0.04 | 5.0 | 5.0 | 3.92 | 0.16 | | 0.16 | 12 | 0.012 | 0.0414 | 10.00 | 7.84 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 36 | 1.49 | 378.57 | 377.08 | 383.15 | 383.65 | 1.95 | 3.94 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |

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**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| C-18-1 | C715 | C408 | | 0.68 | 0.25 | 0.17 | 0.17 | 5.0 | 5.0 | 3.92 | 0.67 | | 0.67 | 12 | 0.012 | 0.0363 | 9.36 | 7.35 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 30 | 1.09 | 379.12 | 378.03 | 382.25 | 383.94 | 0.50 | 3.29 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**

Column 12 represents inflow from a storm sewer line, branch, an offsite source that flows into the trunk line being analyzed.
The conservative assumption is that the flow enters the storm sewer run at the upstream end of the run being analyzed.

For pipe cover calculation, Pipe cover = (Ground or Rim Elevation - Pipe invert elevation) - (pavement thickness) - (top of pipe thickness) - (pipe diameter).
The pipe thickness is based on the pipe diameter per WSDOT Manual Concrete for Shallow Pipe Cover Installations Fill Height Table 8-11.2
Please specify the largest pipe thickness of the storm sewer run being analyzed.

The spreadsheet will only calculate one storm sewer line at a time. Please copy the "Blank Template" and use this for calculating new storm sewer lines.
If analyzing complicated stormsewer system with multiple lateral lines to the trunk line, it is recommended that Stormshed be used to
model the conveyance system. Please contact your region Hydraulic Contact.

WARNING: START YOUR STORMSEWER RUN ON ROW 12. DO NOT SKIP ANY ROWS IN BETWEEN. USE ONE SHEET PER STORMSEWER RUN

Please report any problems to the WSDOT HQ Hydraulics Office.

# STORM SEWER DESIGN (English Units)

This spreadsheet accomplishes a storm sewer design using the rational method. Enter the data in the non-shaded areas only.
Please use one spreadsheet per stormsewer run.

**Project Name:** Wellington Hills Conveyance Calculations

**Designed By:** JRG
**Project Office:** KPFF Seattle

m = 10.07 n = 0.586 Design Storm Event = 100 Pavement thickness (ft) = 1.5 Pipe Thickness (inches) = 1.5

| Location | | | | | | | | | | | | | | Discharge | Drain Design | | | | | | Drain Profile | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drain Located On | From Sta. | To Sta. | Source of Drainage | Drainage Area A (acre) | Runoff Coeff. C | CA (acre) | Sum CA (acre) | $T_c$ Across Area (minutes) | Total Tc = Col. 8a + Tc across pipe length (minutes) | Rainfall Intensity (in/hr) | Runoff (cfs) | Contrib. Inflow (cfs) | Total Flow (cfs) | Pipe Dia. (in) | Manning roughness coefficient "n" | Pipe Slope (ft/ft) | Velocity Of Flow (ft/s) | Pipe Capacity (cfs) | Pipe Velocity Check (Desirable Minimum 3 ft/sec; Desirable Maximum 10 ft/sec for Column 16) | Pipe Capacity Check (Column 13 vs. Column 17) | Pipe Length*** (ft) | Elevation Change (ft) | Upstr. Invert Elev. (ft) | Downstr. Invert Elev. (ft) | Upstr. Ground Elev. (ft) | Downstr. Ground Elev. (ft) | Upstr. Pipe Cover (ft) | Downstr. Pipe Cover (ft) | Upstr. Pipe Cover Check (ft) | Downstr. Pipe Cover Check (ft) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8a | 9 | 10 | 11 | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 17a | 17b | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 24 |
| C-19-2 | C523 | C522 | | 0.05 | 0.60 | 0.03 | 0.03 | 5.0 | 5.0 | 3.92 | 0.12 | | 0.12 | 12 | 0.012 | 0.0233 | 7.50 | 5.89 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 63 | 1.47 | 379.97 | 378.50 | 383.10 | 384.00 | 0.50 | 2.88 | Low Cover - See Notes at Bottom | More than 2 ft of cover | |
| C-19-1 | C522 | C409 | | 0.24 | 0.42 | 0.10 | 0.13 | 5.0 | 5.0 | 3.92 | 0.52 | | 0.52 | 12 | 0.012 | 0.0052 | 3.53 | 2.77 | VELOCITY OK | ADEQUATE PIPE CAPACITY | 29 | 0.15 | 378.50 | 378.35 | 384.00 | 384.00 | 2.88 | 3.02 | More than 2 ft of cover | More than 2 ft of cover | |

**See WSDOT Hydraulic Manual 6-5 for explanation of columns. http://www.wsdot.wa.gov/eesc/design/hydraulics/**

**Notes:**
Column 12 represents inflow from a storm sewer line, branch, an offsite source that flows into the trunk line being analyzed.
The conservative assumption is that the flow enters the storm sewer run at the upstream end of the run being analyzed.

For pipe cover calculation, Pipe cover = (Ground or Rim Elevation - Pipe invert elevation) - (pavement thickness) - (top of pipe thickness) - (pipe diameter).
The pipe thickness is based on the pipe diameter per WSDOT Manual Concrete for Shallow Pipe Cover Installations Fill Height Table 8-11.2
Please specify the largest pipe thickness of the storm sewer run being analyzed.

The spreadsheet will only calculate one storm sewer line at a time. Please copy the "Blank Template" and use this for calculating new storm sewer lines.
If analyzing complicated stormsewer system with multiple lateral lines to the trunk line, it is recommended that Stormshed be used to
model the conveyance system. Please contact your region Hydraulic Contact.

WARNING: START YOUR STORMSEWER RUN ON ROW 12. DO NOT SKIP ANY ROWS IN BETWEEN. USE ONE SHEET PER STORMSEWER RUN

Please report any problems to the WSDOT HQ Hydraulics Office.

# Appendix E

# Water Quality Calculations

# Trapezoidal Bioswale

## BIOSWALE A-1

Design Steps (HRM RT.04)

| | | | | |
|---|---|---|---|---|
| | Bioswale Type = | Point flow | | |
| P-1 | $Q_{WQ}$ = | 0.012 | CFS | |
| P-2 | 2-yr 24-hr precip | 1.75 | IN | |
| | Configuration | Online | | |
| | k = | 1.72 | | |
| | $Q_{BIOFIL}$ = | 0.02 | CFS | |
| P-3 | Longit. Slope = | 1.50% | | |
| P-4 | Soil and Cover | Grass-legume mix on lightly compacted, compost-amended soil (CABS) | | |
| | n = | 0.22 | | |
| D-1 | Design Flow Depth = | 4.00 | IN | |
| | Actual Flow Depth = | 0.85 | IN | Solved Successfully |
| D-2 | Cross-sectional Shape = | Trapezoidal | | |
| D-3 | Side slope = | 3 | H:1V | |
| | Manual Override Width = | 2.00 | FT | |
| | Actual Width = | 2.00 | FT | OK, Width >= 2' |
| D-4 | $A_{BIOFILL}$ = | 0.16 | SF | Calculated using actual flow depth |
| D-5 | $V_{BIOFILL}$ = | 0.13 | FPS | OK, V < 1.0 FPS |
| D-6 | Required Residence Time = | 9.00 | MIN | |
| | Actual Residence Time = | 12.63 | MIN | OK, Residence Time >= 9 min |
| | Required Length = | 71 | FT | |
| | Manual Override Length = | | FT | |
| | Design Length = | 100 | FT | Swale length OK |
| FC-1 | $Q_{15min,\ 100YR}$ = | 0.05 | CFS | |
| | $Q_{15min,\ 10YR}$ = | 0.03 | CFS | |
| FC-2 | $n_{100YR}$ = | 0.03 | | |
| FC-3 | 100-year Flow Depth = | 0.43 | IN | Solved Successfully |
| | 10-year Flow Depth = | 1.11 | IN | Solved Successfully |
| FC-4 | Pavement Depth = | 0.00 | IN | |
| | Subgrade Depth = | 0.00 | IN | |
| | Minimum Swale Depth = | 2.00 | FT | Measured from top of pavement to bottom of swale including freeboard to pavement (2' min depth, 6" min to bottom of subgrade) |

# Trapezoidal Bioswale

## BIOSWALE B-1

Design Steps (HRM RT.04)

| | | | | |
|---|---|---|---|---|
| | Bioswale Type = | Point flow | | |
| P-1 | $Q_{WQ}$ = | 0.016 | CFS | |
| P-2 | 2-yr 24-hr precip | 1.75 | IN | |
| | Configuration | Online | | |
| | k = | 1.72 | | |
| | $Q_{BIOFIL}$ = | 0.03 | CFS | |
| P-3 | Longit. Slope = | 3.00% | | |
| P-4 | Soil and Cover | Grass-legume mix on lightly compacted, compost-amended soil (CABS) | | |
| | n = | 0.22 | | |
| D-1 | Design Flow Depth = | 4.00 | IN | |
| | Actual Flow Depth = | 0.66 | IN | Solved Successfully |
| D-2 | Cross-sectional Shape = | Trapezoidal | | |
| D-3 | Side slope = | 3 | H:1V | |
| | Manual Override Width = | 3.00 | FT | |
| | Actual Width = | 3.00 | FT | OK, Width >= 2' |
| D-4 | $A_{BIOFILL}$ = | 0.17 | SF | Calculated using actual flow depth |
| D-5 | $V_{BIOFILL}$ = | 0.16 | FPS | OK, V < 1.0 FPS |
| D-6 | Required Residence Time = | 9.00 | MIN | |
| | Actual Residence Time = | 10.30 | MIN | OK, Residence Time >= 9 min |
| | Required Length = | 87 | FT | |
| | Manual Override Length = | | FT | |
| | Design Length = | 100 | FT | Swale length OK |
| FC-1 | $Q_{15min,\ 100YR}$ = | 0.06 | CFS | |
| | $Q_{15min,\ 10YR}$ = | 0.04 | CFS | |
| FC-2 | $n_{100YR}$ = | 0.03 | | |
| FC-3 | 100-year Flow Depth = | 0.31 | IN | Solved Successfully |
| | 10-year Flow Depth = | 0.86 | IN | Solved Successfully |
| FC-4 | Pavement Depth = | 0.00 | IN | |
| | Subgrade Depth = | 0.00 | IN | |
| | Minimum Swale Depth = | 2.00 | FT | Measured from top of pavement to bottom of swale including freeboard to pavement (2' min depth, 6" min to bottom of subgrade) |

# Trapezoidal Bioswale

## BIOSWALE B-2 - DOWNSTREAM OF DETENTION

Design Steps (HRM RT.04)

| | | | | |
|---|---|---|---|---|
| | Bioswale Type = | Point flow | | |
| P-1 | $Q_{WQ}$ = | 0.010 | CFS | |
| P-2 | 2-yr 24-hr precip | 1.75 | IN | |
| | Configuration | Online | | |
| | k = | 1.72 | | |
| | $Q_{BIOFIL}$ = | 0.02 | CFS | |
| P-3 | Longit. Slope = | 5.00% | | |
| P-4 | Soil and Cover | Grass-legume mix on lightly compacted, compost-amended soil (CABS) | | |
| | n = | 0.22 | | |
| D-1 | Design Flow Depth = | 4.00 | IN | |
| | Actual Flow Depth = | 0.42 | IN | Solved Successfully |
| D-2 | Cross-sectional Shape = | Trapezoidal | | |
| D-3 | Side slope = | 3 | H:1V | |
| | Manual Override Width = | 3.00 | FT | |
| | Actual Width = | 3.00 | FT | OK, Width >= 2' |
| D-4 | $A_{BIOFILL}$ = | 0.11 | SF | Calculated using actual flow depth |
| D-5 | $V_{BIOFILL}$ = | 0.16 | FPS | OK, V < 1.0 FPS |
| D-6 | Required Residence Time = | 9.00 | MIN | |
| | Actual Residence Time = | 10.60 | MIN | OK, Residence Time >= 9 min |
| | Required Length = | 85 | FT | |
| | Manual Override Length = | | FT | |
| | Design Length = | 100 | FT | Swale length OK |
| FC-1 | $Q_{15min,\ 100YR}$ = | 0.28 | CFS | |
| | $Q_{15min,\ 10YR}$ = | 0.13 | CFS | |
| FC-2 | $n_{100YR}$ = | 0.03 | | |
| FC-3 | 100-year Flow Depth = | 0.68 | IN | Solved Successfully |
| | 10-year Flow Depth = | 1.39 | IN | Solved Successfully |
| FC-4 | Pavement Depth = | 0.00 | IN | |
| | Subgrade Depth = | 0.00 | IN | |
| | Minimum Swale Depth = | 2.00 | FT | Measured from top of pavement to bottom of swale including freeboard to pavement (2' min depth, 6" min to bottom of subgrade) |

# Trapezoidal Bioswale

## BIOSWALE B-2 - DOWNSTREAM OF DETENTION

Design Steps (HRM RT.04)

| | | | | |
|---|---|---|---|---|
| | Bioswale Type = | Point flow | | |
| P-1 | $Q_{WQ}$ = | 0.008 | CFS | |
| P-2 | 2-yr 24-hr precip | 1.75 | IN | |
| | Configuration | Online | | |
| | k = | 1.72 | | |
| | $Q_{BIOFIL}$ = | 0.01 | CFS | |
| P-3 | Longit. Slope = | 5.00% | | |
| P-4 | Soil and Cover | Grass-legume mix on lightly compacted, compost-amended soil (CABS) | | |
| | n = | 0.22 | | |
| D-1 | Design Flow Depth = | 4.00 | IN | |
| | Actual Flow Depth = | 0.38 | IN | Solved Successfully |
| D-2 | Cross-sectional Shape = | Trapezoidal | | |
| D-3 | Side slope = | 3 | H:1V | |
| | Manual Override Width = | 3.00 | FT | |
| | Actual Width = | 3.00 | FT | OK, Width >= 2' |
| D-4 | $A_{BIOFILL}$ = | 0.10 | SF | Calculated using actual flow depth |
| D-5 | $V_{BIOFILL}$ = | 0.15 | FPS | OK, V < 1.0 FPS |
| D-6 | Required Residence Time = | 9.00 | MIN | |
| | Actual Residence Time = | 11.34 | MIN | OK, Residence Time >= 9 min |
| | Required Length = | 79 | FT | |
| | Manual Override Length = | | FT | |
| | Design Length = | 100 | FT | Swale length OK |
| FC-1 | $Q_{15min,\ 100YR}$ = | 0.05 | CFS | |
| | $Q_{15min,\ 10YR}$ = | 0.03 | CFS | |
| FC-2 | $n_{100YR}$ = | 0.03 | | |
| FC-3 | 100-year Flow Depth = | 0.25 | IN | Solved Successfully |
| | 10-year Flow Depth = | 0.55 | IN | Solved Successfully |
| FC-4 | Pavement Depth = | 0.00 | IN | |
| | Subgrade Depth = | 0.00 | IN | |
| | Minimum Swale Depth = | 2.00 | FT | Measured from top of pavement to bottom of swale including freeboard to pavement (2' min depth, 6" min to bottom of subgrade) |

# Trapezoidal Bioswale

## BIOSWALE C-1

Design Steps (HRM RT.04)

| | | | | |
|---|---|---|---|---|
| | Bioswale Type = | Point flow | | |
| P-1 | $Q_{WQ}$ = | 0.210 | CFS | |
| P-2 | 2-yr 24-hr precip | 1.75 | IN | |
| | Configuration | Online | | |
| | k = | 1.72 | | |
| | $Q_{BIOFIL}$ = | 0.36 | CFS | |
| P-3 | Longit. Slope = | 3.42% | | |
| P-4 | Soil and Cover | Grass-legume mix on lightly compacted, compost-amended soil (CABS) | | |
| | n = | 0.22 | | |
| D-1 | Design Flow Depth = | 4.00 | IN | |
| | Actual Flow Depth = | 3.42 | IN | Solved Successfully |
| D-2 | Cross-sectional Shape = | Trapezoidal | | |
| D-3 | Side slope = | 3 | H:1V | |
| | Manual Override Width = | 2.00 | FT | |
| | Actual Width = | 2.00 | FT | OK, Width >= 2' |
| D-4 | $A_{BIOFILL}$ = | 0.81 | SF | Calculated using actual flow depth |
| D-5 | $V_{BIOFILL}$ = | 0.45 | FPS | OK, V < 1.0 FPS |
| D-6 | Required Residence Time = | 9.00 | MIN | |
| | Actual Residence Time = | 9.00 | MIN | OK, Residence Time >= 9 min |
| | Required Length = | 241 | FT | |
| | Manual Override Length = | | FT | |
| | Design Length = | 241 | FT | Swale length OK |
| FC-1 | $Q_{15min,\ 100YR}$ = | 3.95 | CFS | |
| | $Q_{15min,\ 10YR}$ = | 1.82 | CFS | |
| FC-2 | $n_{100YR}$ = | 0.03 | | |
| FC-3 | 100-year Flow Depth = | 4.22 | IN | Solved Successfully |
| | 10-year Flow Depth = | 7.84 | IN | Solved Successfully |
| FC-4 | Pavement Depth = | 0.00 | IN | |
| | Subgrade Depth = | 0.00 | IN | |
| | Minimum Swale Depth = | 2.00 | FT | Measured from top of pavement to bottom of swale including freeboard to pavement (2' min depth, 6" min to bottom of subgrade) |

# Trapezoidal Bioswale

## BIOSWALE C-2

Design Steps (HRM RT.04)

| | | | | |
|---|---|---|---|---|
| | Bioswale Type = | Point flow | | |
| P-1 | $Q_{WQ}$ = | 0.200 | CFS | |
| P-2 | 2-yr 24-hr precip | 1.75 | IN | |
| | Configuration | Online | | |
| | k = | 1.72 | | |
| | $Q_{BIOFIL}$ = | 0.34 | CFS | |
| P-3 | Longit. Slope = | 1.50% | | |
| P-4 | Soil and Cover | Grass-legume mix on lightly compacted, compost-amended soil (CABS) | | |
| | n = | 0.22 | | |
| D-1 | Design Flow Depth = | 4.00 | IN | |
| | Actual Flow Depth = | 2.64 | IN | Solved Successfully |
| D-2 | Cross-sectional Shape = | Trapezoidal | | |
| D-3 | Side slope = | 3 | H:1V | |
| | Manual Override Width = | 5.00 | FT | |
| | Actual Width = | 5.00 | FT | OK, Width >= 2' |
| D-4 | $A_{BIOFILL}$ = | 1.24 | SF | Calculated using actual flow depth |
| D-5 | $V_{BIOFILL}$ = | 0.28 | FPS | OK, V < 1.0 FPS |
| D-6 | Required Residence Time = | 9.00 | MIN | |
| | Actual Residence Time = | 9.00 | MIN | OK, Residence Time >= 9 min |
| | Required Length = | 150 | FT | |
| | Manual Override Length = | | FT | |
| | Design Length = | 150 | FT | Swale length OK |
| FC-1 | $Q_{15min,\ 100YR}$ = | 2.00 | CFS | |
| | $Q_{15min,\ 10YR}$ = | 0.98 | CFS | |
| FC-2 | $n_{100YR}$ = | 0.03 | | |
| FC-3 | 100-year Flow Depth = | 2.30 | IN | Solved Successfully |
| | 10-year Flow Depth = | 4.81 | IN | Solved Successfully |
| FC-4 | Pavement Depth = | 0.00 | IN | |
| | Subgrade Depth = | 0.00 | IN | |
| | Minimum Swale Depth = | 2.00 | FT | Measured from top of pavement to bottom of swale including freeboard to pavement (2' min depth, 6" min to bottom of subgrade) |

# Trapezoidal Bioswale

## BIOSWALE C-3

Design Steps (HRM RT.04)

| | | | | |
|---|---|---|---|---|
| | Bioswale Type = | Point flow | | |
| P-1 | $Q_{WQ}$ = | 0.182 | CFS | |
| P-2 | 2-yr 24-hr precip | 1.75 | IN | |
| | Configuration | Online | | |
| | k = | 1.72 | | |
| | $Q_{BIOFIL}$ = | 0.31 | CFS | |
| P-3 | Longit. Slope = | 2.00% | | |
| P-4 | Soil and Cover | Grass-legume mix on lightly compacted, compost-amended soil (CABS) | | |
| | n = | 0.22 | | |
| D-1 | Design Flow Depth = | 4.00 | IN | |
| | Actual Flow Depth = | 3.66 | IN | Solved Successfully |
| D-2 | Cross-sectional Shape = | Trapezoidal | | |
| D-3 | Side slope = | 3 | H:1V | |
| | Manual Override Width = | | FT | |
| | Actual Width = | 2.00 | FT | OK, Width >= 2' |
| D-4 | $A_{BIOFILL}$ = | 0.89 | SF | Calculated using actual flow depth |
| D-5 | $V_{BIOFILL}$ = | 0.35 | FPS | OK, V < 1.0 FPS |
| D-6 | Required Residence Time = | 9.00 | MIN | |
| | Actual Residence Time = | 9.00 | MIN | OK, Residence Time >= 9 min |
| | Required Length = | 191 | FT | |
| | Manual Override Length = | | FT | |
| | Design Length = | 191 | FT | Swale length OK |
| FC-1 | $Q_{15min,\ 100YR}$ = | 0.99 | CFS | |
| | $Q_{15min,\ 10YR}$ = | 0.42 | CFS | |
| FC-2 | $n_{100YR}$ = | 0.03 | | |
| FC-3 | 100-year Flow Depth = | 2.30 | IN | Solved Successfully |
| | 10-year Flow Depth = | 4.27 | IN | Solved Successfully |
| FC-4 | Pavement Depth = | 0.00 | IN | |
| | Subgrade Depth = | 0.00 | IN | |
| | Minimum Swale Depth = | 2.00 | FT | Measured from top of pavement to bottom of swale including freeboard to pavement (2' min depth, 6" min to bottom of subgrade) |

# Trapezoidal Bioswale

## BIOSWALE C-4

Design Steps (HRM RT.04)

| | | | | |
|---|---|---|---|---|
| | Bioswale Type = | Point flow | | |
| P-1 | $Q_{WQ}$ = | 0.011 | CFS | |
| P-2 | 2-yr 24-hr precip | 1.75 | IN | |
| | Configuration | Online | | |
| | k = | 1.72 | | |
| | $Q_{BIOFIL}$ = | 0.02 | CFS | |
| P-3 | Longit. Slope = | 2.00% | | |
| P-4 | Soil and Cover | Grass-legume mix on lightly compacted, compost-amended soil (CABS) | | |
| | n = | 0.22 | | |
| D-1 | Design Flow Depth = | 4.00 | IN | |
| | Actual Flow Depth = | 0.73 | IN | Solved Successfully |
| D-2 | Cross-sectional Shape = | Trapezoidal | | |
| D-3 | Side slope = | 3 | H:1V | |
| | Manual Override Width = | | FT | |
| | Actual Width = | 2.00 | FT | OK, Width >= 2' |
| D-4 | $A_{BIOFILL}$ = | 0.13 | SF | Calculated using actual flow depth |
| D-5 | $V_{BIOFILL}$ = | 0.14 | FPS | OK, V < 1.0 FPS |
| D-6 | Required Residence Time = | 9.00 | MIN | |
| | Actual Residence Time = | 12.08 | MIN | OK, Residence Time >= 9 min |
| | Required Length = | 75 | FT | |
| | Manual Override Length = | | FT | |
| | Design Length = | 100 | FT | Swale length OK |
| FC-1 | $Q_{15min,\ 100YR}$ = | 0.03 | CFS | |
| | $Q_{15min,\ 10YR}$ = | 0.02 | CFS | |
| FC-2 | $n_{100YR}$ = | 0.03 | | |
| FC-3 | 100-year Flow Depth = | 0.31 | IN | Solved Successfully |
| | 10-year Flow Depth = | 0.85 | IN | Solved Successfully |
| FC-4 | Pavement Depth = | 0.00 | IN | |
| | Subgrade Depth = | 0.00 | IN | |
| | Minimum Swale Depth = | 2.00 | FT | Measured from top of pavement to bottom of swale including freeboard to pavement (2' min depth, 6" min to bottom of subgrade) |

# Appendix F

# Stormwater Modification Request

Snohomish County
Planning and Development Services
Date: 12-17-2013

**Use this form for projects vested on or after September 30, 2010**

# Stormwater Modification or Waiver Request

**PRINT**

**A. Applicability:**
This application is to be used for requests for modifications or waivers from stormwater management regulations pursuant to SCC 30.63A.170 and modifications requested pursuant to SCC 30.63C.060.

**B. Instructions:**
(1) Complete the blanks below. (2) Provide sufficient information to evaluate the request. (3) Contact (425) 388-3311 x2790 to schedule an appointment to submit this request. Supporting documents and fees must be submitted at the appointment.

Request is for: ✔ Modification or Waiver of the following stormwater management regulations and standards:

| Check applicable SCC Chapter | List specific code provision |
|---|---|
| ☒ Drainage Chapter 30.63A SCC | 30.63A.520 |
| ☐ Land Disturbing Activity Chapter 30.63B SCC | |
| ☐ Low Impact Development (LID) Chapter 30.63C SCC | |
| ☐ Drainage Manual | |
| ☐ EDDS Chapter 5 (Drainage) | |

**C. Project Information:**
PFN: _____ Project Name: Wellington Hills County Park

Project Vesting Date: _____ PDS Project Manager: _____

Applicant or Representative and Firm: KPFF Consulting Engineers, Contact: Pat Sloan, PE

Applicant Signature: _____ Phone: (206) 622-5822

Address: 1601 5th Ave, Suite 1600, Seattle, WA 98101 Email: pat.sloan@kpff.com

**D. Criteria:**
1. Describe the modification or waiver request, including reasons for the request and site-specific details. (SCC 30.63A.830(5)(c) or 30.63A.840(4)(c))

Request to modify sizes of Threshold Discharge Areas (TDAs) between existing and proposed for the three TDAs within the impacted project limits. Requested modifications: 1) TDA A: 14.52 acres to 13.69 acres 2) TDA B: 16.43 acres to 14.09 acres 3) TDA C: 20.11 acres to 23.75 acres.

2. Describe how the intent of the stormwater management regulations and standards will be achieved if the modification or waiver is granted. ((SCC 30.63A.830(5)(b) or 30.63A.840(4)(b), EDDS #1)

Per SCC, runoff from the developed site must match predeveloped conditions of forest over till soil. Using flow control design, the runoff from the site's proposed TDA boundaries will match predeveloped flows from the site's existing TDA boundaries, meeting the requirements of the SCC.

3. (Modification only): Describe how the modification or waiver will provide substantially equivalent environmental protection as the adopted stormwater management regulations and standards. (SCC 30.63A.830(6)(a), EDDS #3)

Per SCC, natural drainage patterns must be maintained. Using flow control design, the runoff from the site's proposed TDA boundaries will match predeveloped flows from the site's existing TDA boundaries.

4. (Modification only): Describe how the modification or waiver is based upon sound engineering practices which will meet design objectives addressing safety, function, environmental protection and facility maintenance. (SCC 30.63A.830(6)(b))

Stormwater flow control is required with this project. The flow control systems were designed to meet the predeveloped flow conditions from the existing TDA boundaries. Flow control systems were designed by a licensed professional engineer in accordance with the SCC.

5. (Modification only): Describe how the modification does not adversely impact off-site properties. (SCC 30.63A.830(5)(c))

Flows to City of Woodinville capacity-constrained piped stormwater systems downstream of the site will be decreased with the project. Flows to steep, erodible slopes along the west boundary of the site will be decreased.

6. Describe how the modification or waiver results in the least possible change that could be granted that still meets the intent of chapters 30.63A and 30.63B SCC, the Drainage Manual and chapter 5 of the EDDS. (SCC 30.63A.830(6)(d) or 30.63A.840(5)(c))

Per SCC, runoff from the developed site must match predeveloped conditions of forest over till soil. Using flow control design, the runoff from the site's proposed TDA boundaries will match predeveloped flows from the site's existing TDA boundary.

7. (Waiver only): Describe how application of the stormwater management regulation or standard for which the waiver is requested will deny the applicant all economically viable use of the property. (SCC 30.63A.840(5)(a))

N/A

8. (Waiver only): Describe how the waiver will not: (a) increase risk to the public health and welfare; (b) be injurious to other properties in the vicinity or upstream or downstream; and (c) affect the quality of waters of the state. (SCC 30.63A.840(5)(b))

N/A

(The questions on this page apply to LID Projects only)

9. (Modification pursuant to Chapter 30.63C SCC only): Identify the applicable SCC chapter and specific provision(s) for which the modification is requested. (SCC 30.63C.060(1)(a))

(a) Chapter 30.23 SCC; N/A
(b) Chapter 30.24 SCC; N/A
(c) Chapter 30.25 SCC; N/A
(d) Chapter 30.26 SCC; N/A
(e) Chapter 30.42B SCC; N/A
(f) Chapter 30.5 SCC. N/A

10. (Modification pursuant to Chapter 30.63C only): Describe why the modification is necessary to implement a LID BMP identified in SCC 30.63C.030(1). (SCC 30.63C.060(1)(b))

N/A

11. (Modification pursuant to Chapter 30.63C only): Describe how the modification is consistent with and furthers the purposes of the stormwater regulations set forth in SCC 30.63A.100. (SCC 30.63C.080(2)(a))

N/A

12. (Modification pursuant to Chapter 30.63C only): Describe how the modification does not result in significant adverse environmental impacts. (SCC 30.63C.080(2)(b))

N/A

13. (Modification pursuant to Chapter 30.63C only): Describe how the modification does not adversely impact the public health, safety, and welfare. (SCC 30.63C.080(2)(c))

N/A

14. (Modification pursuant to Chapter 30.63C only): Describe how the modification is consistent with generally accepted engineering and design criteria. (SCC 30.63C.080(2)(d))

N/A

15. (Modification pursuant to Chapter 30.63C only): Describe how the modification will result in one or more of the following: (SCC 30.63C.080(2)(e))

___ (i) Innovative site design;
(ii) Increased on-site stormwater retention using a variety of vegetation and landscape conditions;
(iii) Retention or re-creation of original natural habitat conditions over a significant portion of the site;
(iv) Improved on-site water quality beyond that required by current applicable regulations; or
(v) Retention or re-creation of pre-development and/or natural hydrologic conditions, and retention or re-creation of forested watershed conditions.

N/A

(This page to be completed by Planning and Development Services Staff)

**A. Analysis of Justification for Modification:**

___ Conformance to existing standard
___ Adverse Topography
___ Comparable to or exceeds standards
___ Aesthetics
___ Improved safety
___ Maintainability
___ Public cost savings
___ Other

_____

_____

_____

_____

Director's Findings of Fact:

_____

_____

_____

_____

Staff Recommendations:

___ Approve
___ Conditional Approval
___ Deny
___ Denial without Prejudice

Basis:

_____

_____

_____

_____

Additional Review Received (certain projects may require review by other parties as applicable):

___ Fire Marshal
___ Biologist
___ Traffic
___ Right of Way

Final PDS Administrative Decision:

___ Approved
___ Approved with conditions
___ Denied
___ Denied without Prejudice

Conditions, if applicable:

_____

_____

_____

_____

_____

_____

Signature: _____ Date: _____