FINAL STORMWATER DESIGN REPORT (TIR)
Parklands at Camas Meadows Subdivision
SUB15-03

Parcels #175948-000 986031-650
and Parklands Archery Business Park
and Camas Meadows Drive

(TIR also includes Conveyance Capacity Quantity Only for
and Village at Camas Meadows
and Larkspur Drive South Subarea)

IN THE CITY OF CAMAS



12-29-2016

CERTIFICATION OF FEASIBILITY-
The stormwater plan designed for the Parklands Residential Subdivision and Parklands Business Park is FEASIBLE and has been designed in accordance with Camas Municipal Code (CMC) 14.02 and Camas Stormwater Design Standards Manual (CSDSM) and has the ability to meet or exceed the applicable code requirements.

PREPARED BY
Kessi Consulting – James Kessi P.E.
6400 NE Hwy 99# G169
Vancouver, WA 98665
james.kessi@gmail.com
360-991-9300

December 29, 2016

TABLE OF CONTENTS

SECTION A – PROJECT OVERVIEW 4
SECTION B – MINIMUM REQUIREMENTS 5
SECTION C –SOILS EVALUATION 6
SECTION D – SOURCE CONTROL 6,7
SECTION E – ON-SITE STORMWATER MANAGEMENT BMPs 8
SECTION F – RUNOFF TREATMENT ANALYSIS AND DESIGN 8,9
SECTION G – FLOW CONTROL ANALYSIS AND DESIGN 10
SECTION H – WETLANDS PROTECTION 10
SECTION I – OTHER PERMITS..... 11
SECTION J – CONVEYANCE SYTEMS ANALYSIS AND DESIGNS..... 12-13
SECTION K –OFF-SITE ANALYSIS 14
SECTION L – APPROVAL CONDITIONS SUMMARY..... 15-16
SECTION M – SPECIAL REPORTS AND STUDIESMENT BMPs 16
SECTION N – MAINTENANCE AND OPERATIONS MANUAL 16

APPENDICES A-H

Appendix A files

A-1 Location and Other Maps
A-2 FIRM Map
A-3 Basin Maps
1) **Fig. 1A Historic Basin Map**
2) **Fig 1B Historic Basin Map – add projects**
3) **Fig 3 Post Subbasin Map**

A-4 Selected Soils Data and Soils Map
A-5 Isopluvial Maps

Appendix B files

B-1 Minimum Requirements #1 -#9 – Responses for Section B, TIR
B-2 MR #8 Wetlands Protection Evaluation
B-2a Support files for Hydroperiod Evaluation
B-2b MR #8 Annual WLF Comparison
B-2c MR #8 Monthly WLF Comparison
B-3 MR #7 Flow Control

Appendix C Runoff Treatment

C-1 Water Quality Flow Rates
C-2 Perk Filter Sizing Summary
C-3 Phosphorus Reduction

Appendix D Conveyance System

D-1 Storm System Pipe Capacity and Velocity Check -10-yr (Reach Info and HGL)
Reach Analysis

HCAD for Line A and B – 10-yr
HCAD for Line C – 10-yr
HCAD for Line E – 10-yr
HCAD for Line D, E, and F – 10-yr
HCAD for Line G
HCAD Thru Wetlands – 10-yr
HGL analysis
HCAD for Line A and B – 10-yr
HCAD for Line C – 10-yr
HCAD for Line D, E, and F – 10-yr
HCAD for Line G

D-2 Conveyance Design Comments

D-3 Dynamic Analysis Water Surface Summary for 100-yr Surcharged Condition

HCAD for Line A, B, and C – 100-yr
HCAD for Line E
HCAD for Line D and F – 100-yr
HCAD for Line G
HCAD Thru Wetlands – 100-yr

D-4 Rear Yard Sytems

HCAD for Rear Yard Systems – see also App. C-4 WQ for Single Lot

Appendix E Appurtenances

E-1 Pipe Capacity and Velocity Calcs.
E-2 Catch Basin Design Comments
E-3 Energy Dissipator Manhole Design
E-4 Flow Dispersion System – Line A and Line C

Appendix F Offsite Analysis

F-1 Offsite Analysis

Appendix G Other Reports

G-1 Geotech Report
G-2 Wetlands Evaluation - Wetlands Protection

Appendix H Maintenance

H-1 Maintenance and Operations Manual

Parklands at Camas Meadows Residential Subdivision and Parklands (aka the Archery) Business Park and Camas Meadows Drive

Section A – Project Overview

The "**Parklands at Camas Meadows Residential Subdivision and Parklands (aka the Archery) Business Park**" proposal is to subdivide two existing parcels of land into business and residential development, totaling approximately 36.4 acres grading with approximately 23.5 acres of land disturbing activity. The Property, tax parcel numbers 986031650 and 175948000, are located in a portion of the SW and SE ¼ Section 28, Township 2 North, Range 3 East of the Willamette Meridian, Clark County, Washington into up to 42 single family residences within the R-15 Zone and 6 commercial buildings. The TIR also covers the conveyance and water quality for the full width of Camas Meadows Drive along the site frontage.

This TIR also includes Conveyance Capacity Quantity Only for the Village at Camas Meadows and Larkspur Drive South basin areas. When each of these areas develops in the future, the conveyance and quantity control capacity are provided for with this TIR, but each of these projects will still need to provide water quality at the time of development.

The Property is currently undeveloped. The site topography slopes from the south, northeasterly towards the north boundary, more specifically towards the wetlands that extends southeasterly across the site (north ⅓) leaving a portion of upland area at the northeast corner that is fairly flat. The majority of the natural runoff is overland flowing from the south, northeasterly, toward the wetland areas. The site is currently covered with trees and brush.

There are several culverts located onsite, apparently to convey surface runoff across paths or trails or former field roads. These culverts will be removed. There are four specific culverts at areas that separate the three onsite wetland areas. These culverts will be retained.

Construction of the "**Parklands at Camas Meadows Residential Subdivision and Parklands (Archery) Business Park**" will consist of construction of private streets, sidewalks, single family residential lots, underground utilities, and stormwater mitigation facilities (quality control). Parking areas and loading docks will be constructed with the business park portion including utilities and stormwater mitigation facilities (quality control - including treatment for phosphorus).

Due to soil properties in this area, stormwater management by standard infiltration BMPs and LID BMP's are not generally applicable for this site. The geotechnical report also indicates that:

> *Weathered and competent conglomerate bedrock was encountered in all test pits at various depths… The bedrock consisted of angular to sub-rounded clasts of various sizes cemented in a matrix of sand, silt, and clay. The bedrock was very dense and*

excavator refusal was noted at various depths as indicated in Table 1 in Section 5.7, Excavation.

The design of the proposed stormwater system was influenced by the suitability of the existing site topography. Typically, this type of setting would lend itself to stormwater management within the wetland buffer(s). However, the buffers along these wetlands are heavily treed in most areas and tree preservation has been taken into consideration. There is also a requirement for phosphorous control. Presently, DOE has only certified a few treatment technologies through the TAPE program that meet criteria for phosphorous removal. The Filterra® System was originally proposed for the Preliminary TIR but has been replaced with the Perk Filter. The final water quality treatment design (including phosphorus control) is based on one of these TAPE approved/certified products - **PerkFilter™**, which provides both standard Water Quality Treatment and Phosphorus Control.

Further discussion is provided in **Section F – Runoff Treatment Analysis and Design**

Section B – Minimum Requirements

The "**Parklands Residential Subdivision and Parklands Business Park**" proposal contains only one threshold discharge area (TDA) and is subject to consideration of minimum requirements 1 – 10. However, only requirements 1-6, 9 and 10 are applicable. See Appendix B-1, B-2, and B-3.

Table B -1 - Summary of Land Disturbing Activities

The defined site area is 36.4 acres.

1. Amount of Existing Impervious surface	None
2. Amount of New Impervious surface*	16.5 ac.
3.Amount of Replaced Impervious surface	None
4. Amount of Native Vegetation converted to lawn or landscaping	12.03
5. Amount of Native Vegetation converted to pasture	None
6. Amount of Native Vegetation converted to pervious access area	None
7. Total amount of land-disturbing activity	23.46 acres

* Roofs and drives at individual lots assumed at 6,500 sq ft per lot on this project and driveways at a minimum of 1,000 sf.

This project includes a design for management of runoff from offsite areas located upslope from this project and which presently drain overland to and through this site. The defined **drainage area** is 70.2 acres

- Includes The Village at Camas Meadows, Camas Meadows Drive from Payne Road to Larkspur, and an area between Larkspur and The Village at Camas Meadows.

1. Amount of Existing Impervious surface	None
2. Amount of New Impervious surface*	23.61 ac.
3.Amount of Replaced Impervious surface	None
4. Amount of Native Vegetation converted to lawn or landscaping	20.73
5. Amount of Native Vegetation converted to pasture	None
6. Amount of Native Vegetation converted to pervious access area	None
7. Total amount of land-disturbing activity	47.34acres

* Roofs and drives at individual lots assumed at 4,500 sq ft per lot on this project

Table B-2 - TDA Minimum Requirement Summary

TDA Number	Req'd to meet runoff control (treatment) requirements listed in Min. Requirement 6	Req'd to meet flow control requirements listed in Min. Requirement 7	Req'd to meet wetlands protection requirements listed in Min. Requirement 8
TDA # 1	Yes	N/A – large water body	Yes

The effective impervious area for the street ROW portion is 11.43 acres. This includes the driveway entrance portion area for each lot.

Section C – Soils Evaluation

The "Soil Survey of Clark County, Washington" indicates the soil at this site consist of the following:

> (HcB) Hesson clay loam, 0 to 8 percent slopes, (HcD) Hesson clay loam, 8 to 20 percent slopes.

Clark County GIS indicates that the site soils are designated as Soil Group 3, Moderately Drained Soils for use with the Western Washington Hydrology Model (WWHM2012). The SCS or NRCS designation is HSG C.

> (CvA) Cove silty clay loam, 0 to 3 percent slopes

Clark County GIS indicates that the site soils are designated as Soil Group 4, Poorly Drained Soils for use with the Western Washington Hydrology Model (WWHM2012). The SCS or NRCS designation is HSG D.

> (LgB) Lauren gravelly loam, 0 to 8 percent slopes

Clark County has further segregated this soil group as a Group 1 soil (SG-1) Excessively drained soils (hydrologic soil groups A & B) for use with the Western Washington Hydrology Model (WWHM2012). The SCS or NRCS designation is HSG B. However, at this site the water table is high in some locations and this soil was modeled as SG-3.

See the soils map in Appendix A for additional information

According to the NRCS web soil survey,
Excerpt from Geotechnical Report:

The Web Soil Survey (United States Department of Agriculture, Natural Resource Conservation Service [USDA NRCS], 2013 Website) indicates the site is underlain by three soil types. Hesson clay loam soils are mapped on the majority of the site from the northwest corner to the southwest corner of the property, while Cove silty clay loam and Lauren gravelly loam soils are mapped in the north and northeastern portions of the property respectively. Soils resembling the Lauren series were not encountered during subsurface excavations.

Although actual on-site soils may vary from the broad USDA descriptions, Lauren soils are generally coarse-textured, well drained soils with rapid permeability. Cove soils are generally fine-textured, poorly drained soils with very slow permeability and high shrink-swell potential. Hesson soils are fine-textured, well drained soils with moderately slow permeability and moderate shrink-swell potential.

Subsurface infiltration testing was not performed. See report in Appendix F.

Section D – Source Control

There are not any prohibited discharges planned for this site. A SWPPP has been developed for the Final TIR that identifies and lists BMPs for Source Control and includes BMPS to prohibit sediment laden runoff from leaving the site and impacting any local or State waters. In addition, BMPs will be implemented as necessary to prevent pollutants from coming in contact with stormwater runoff.

The proposed site is being developed with activities that are pollution generating. The following BMP categories have some degree of applicability, in particular, BMPs for Landscaping and Lawn/ Vegetation Management and Maintenance of Stormwater Drainage and Treatment Systems.

Public Right of Way

All source control BMPs in the public right-of-way of Camas Meadows Drive and other ROW will be the responsibility of Camas City forces per their established maintenance procedures, or by a Business Park Owners' Association (BPOA) for the commercial portion - or a combination of each of the entities may be tasked for selected responsibilities. The stormwater facilities will be publicly owned and maintained in a manner consistent with the Stormwater Facility Maintenance Manual and BMPs for Landscaping and Lawn/Vegetation Management.

Private Right of Way

The stormwater facilities will be privately owned and maintained by the HOA in a manner consistent with the Stormwater Facility Maintenance Manual and BMPs for Landscaping and Lawn/Vegetation Management. This will be the responsibility of the Home Owners Association.

Business Park Owners' Association (BPOA) for Commercial Areas

The stormwater facilities will be privately owned and maintained by the BPOA in a manner consistent with the Stormwater Facility Maintenance Manual and BMPs for Landscaping and Lawn/Vegetation Management. This will be the responsibility of a BPOA representing the businesses within the development.

Individual Residential Subdivision Lot Owners

In addition to the subdivision storm system being designed to accommodate runoff from the entire site, individual lot owners will also be voluntarily responsible for source control BMPs related to installing and maintaining landscaping and roof downspout systems on their respective lots. This additional responsibility includes promotion of the voluntary prevention of introduction of pollutants into their system(s) and will be further implemented by the use of zero phosphorus yard products to assist in the reduction of phosphorus. Even if this is not fully voluntarily complied with by all future lot owners, the overall required total reduction in phosphorus for the entire site (including all residential lots draining to buffers rather than to streets) meets the required standards for the overall site. Application of appropriate maintenance measures will also provide additional source control beyond the minimum standards.

Additional Reference: SMMWW, Volume IV, Chapter 2 - Selection of Operational and Structural Source Control BMPs; 2.2 Pollutant Source-Specific BMPs

BMPs for Dust Control at Disturbed Land Areas and Unpaved Roadways and Parking Lots

BMPs for Landscaping and Lawn/ Vegetation Management

BMPs for Maintenance of Stormwater Drainage and Treatment Systems

BMPs for Urban Streets

Section E – Onsite Stormwater Management BMPs

An Erosion Control Plan has been developed for implementation of BMPs to manage stormwater during grading activities and are shown on the erosion control plan.

Individual lot owners will be responsible for installing and maintaining roof downspout systems on their respective lots. Those lots with Downspout Dispersion Systems (BMP T5.10B) Volume III, Chapter 3.1.2 of the SMMWW (2012) will comply with the requirements of this reference.

Section F – Runoff Water Quality Treatment Analysis and Design including Phosphorus Removal (Requirement = 50% minimum for the Entire Site)

1) Basic stormwater treatment is required for the private streets in this project.
2) Enhanced stormwater treatment is required for the business portion of this project.
3) Phosphorous removal of 50% of the phosphorous load is also required for the total developed site. See Appendix C for WQ treatment rates required for street and business park systems.

See Section L – Approval Conditions Summary on page 17 regarding (Condition of Approval #17) for discussion related to Water Quality Treatment and Achieved Effective **Site Phosphorus Treatment Standards and Analysis** with further reference to Appendix C, C-3a and C-3b for Individual Lots adjacent to Wetland Buffer.

The runoff from surfaces requiring water quality and phosphorus treatment will be routed to specific Perk Filter ™ Systems. The systems are approved as off-line in nature and are sized to treat the off-line flow rate determined from WWHM2012 analysis.

F.1 The required phosphorus standard is removal of 50% of the total phosphorus that is leaving the entire site and discharging into the wetlands. To account for the lots that are adjacent to the buffers and are not able to be routed to the street systems for phosphorus removal, the overall net phosphorus removal from the site has been calculated by allotting a different removal value for these areas and determining an overall removal percentage.

F.2 In short, for a majority 84% or 23.9 acres of the entire site which drains to the street system and PerkFilters, a phosphorus removal of 62.4% is allotted per TAPE standards documentation.

F.3 For a small 16% or 4.5 acres portion of the site for the rear yards that are adjacent and drain to the wetland buffers, a conservative phosphorus removal of 40% is achieved through natural processes and overland flow through the vegetated buffers.

F.4 So, in summary, for the entire 28.4 acres of developed site the total phosphorus removal conservatively averages out to be 52%, which exceeds the minimum standard of 50% removal.

F.5 Phosphorus Removal of more than 50% is achieved for the overall site: The majority of the individual lots lawn yard and landscaped areas are being directed to the street and then to PerkFilters. Treatment for this co-mingled flow achieves both adequate water quality treatment for phosphorus removal with a TAPE approved system element (PerkFilters) for water quality and phosphorus removal treatment with the PerkFilters.

F.6 Thus, phosphorus removal standards for the entire site is met and Condition of Approval #17 is satisfied (the minimum removal standard is 50%). Phosphorus removal from the entire site is also demonstrated in detail in Appendix C, C-3a and C-3b.

> *Condition of Approval #17 Stormwater runoff from the proposed lots and landscaped areas of the site shall be directed into the streets and/or into a stormwater treatment system that will provide adequate phosphorus removal from the yard and landscaped areas of the site prior to release into the wetlands.*

F.7 As an additional voluntary measure to reduce the most likely phosphorus sources, all commercial pads and residential lots will be required by the HOA CC&R's to use only fertilizers that have a zero phosphorous designation. These restrictions will be recorded on

all lots within the final approved CCR's for the site. Even without these measures, the overall site will still comply with the phosphorus removal standards.

Business Park and Commercial Site

The runoff from the Business Park parking and landscape areas that drain onto parking pavement will receive treatment in **PerkFilter Systems** - which includes both Water Quality and Phosphorus Treatment. The runoff from the roof areas will be directly conveyed to the respective storm system and not treated.

Private Individual Lot Stormwater Management

- Lots adjacent to a wetland buffer or with discharge to a wetland separate from the main storm systems

  a) Roof and drive runoff will be re-introduced as sheet flow (dispersion) to the specific lot source. However, some of the lots along the north leg of NE Longbow Lane will drain 3,000 sf of front yard lawn area and driveway to the street system. For some lots, the roof runoff may be piped to a small conveyance system with discharge released as sheet flow to the wetland buffer.

  b) More specifically, some of the individual lots will disperse roof runoff onto the specific lot for runoff directly overland to the wetland buffer. Some lots may direct the roof downspout into a pipe tied directly to a conveyance to the associated wetland and be dispersed through the wetland buffer. A few lots that do not border the wetland will direct runoff to rear yard or side yard inline systems for release to the associated wetland for dispersal. For Phosphorus treatment considerations, see sections F.1 – F.6 above.

  c) Lots that do not border the wetland buffer areas will collect runoff from the pervious and impervious areas (not including roof areas) in one or more inlets on the lots or direct runoff directly to the street. This runoff will then receive phosphorous treatment at the respective PerkFilter. For Phosphorus treatment considerations, see sections F.1 – F.6 above.

Private Street Right of Way Stormwater Management

NW Pittock Place *formerly ~~10th Fairway Drive~~*

The runoff will be collected at a single low point catch basin and conveyed (Storm Line A) to a PerkFilter located at the north end of the cul-de-sac.

NW McMaster Dr. *formerly ~~Golf Drive~~*

Most of the lots along this street will receive direct runoff from the lawn areas and driveway areas and will receive treatment with the street R/W runoff. The roof areas will be connected directly to the storm system in the street R/W. There are several lots on the north side of this street that slope toward Wetland B and C. The runoff from these lots will be flow directly to the wetland buffers for these two wetlands. For Phosphorus treatment considerations, see sections F.1 – F.6 above

Provision has also been made to intercept potential overflow from existing detention facilities located directly south of the project. A rear yard inline system for the bordering lots will convey potential overflow to the proposed system (Line E) in McMaster Dr.

The outfall for this conveyance system will be the existing south culvert that crosses from Wetland B to Wetland A. The outfall from this connection point on the existing 12 inch culvert will be increased in size from 12 inches to 24 inches.

NW Longbow Ln. *formerly ~~17th Green Drive and NW Parklands Trail~~*

Each side will drain to PerkFilter Systems which will route (Storm Line G) the outflow to the existing north culvert that crosses from Wetland B to Wetland A. The outlet portion of the culvert will be increased from 12 inches to 24 inches.

Upbasin & Offsite:

a) Larkspur and a future development west of Larkspur (future) – a storm line is extended to receive direct flow in Storm Line 'C' for release to Wetland A – assumed that this (these) area(s) will be treated (future) prior to entering the system in Camas Meadows Drive.
b) Camas Meadows Drive and landscape areas – paved areas, sidewalk, and landscape areas treated in PerkFilter Systems.
c) The Village site storm system lines for conveyance are collected in storm Line 'B' and 'C' for continued conveyance to Wetland A.

To reduce the stormwater runoff quantity impact to the wetlands, this project is proposing that the final grading of lots will have the most suitable portions of the existing on-site top soils collected and stockpiled at the beginning of grading, and then later carefully placed back on the future front and rear yard areas of the lots. This design aspect will allow some rainfall and runoff water to continue to re-supply the interflow feature back to the soil profile – which is important for hydrating the wetlands. This approach also reduces direct surface runoff volumes from the site.

The management of flows above the WQ flow rates will be directed to the particular storm line system for controlled release to Wetland A. The existing site release is from Wetland B to Wetland A which will then flow overland north into Lacamas Lake. A small portion of the offsite and onsite drainage basin area flows to Wetland C which flows west to Wetland B through two existing culverts. For Phosphorus treatment considerations, see sections F.1 – F.6 above.

Initial installation cost and the expenses associated with long-term maintenance are expected to be typical of projects with similar street sections at these slopes and runoff from most of the interior lots. There are no pollution-generating pervious surfaces (PGPS) on this project.

The amount of pollution-generating impervious surfaces (PGIS) is:

Parklands = 11.43 acres.
Camas Meadows Drive = 1.32 acres
The Village = 6.00 acres
Larkspur = 0.46 acres
The total is 19.21 acres pollution-generating impervious surfaces (PGIS)

Section G – Flow Control Analysis and Design

Flow control facilities are not required for this project since the discharge is to an exempt water body – Lacamas Lake*. There are several design features proposed that will 'reduce' peak flow rate and volume.

- Replacement of existing on-site soils to replicate on-site soil characteristics.

See appendix B-2 and B-3.

* The discharge from the site is mostly overland to the north with a direct connection to the mouth of Lacamas Creek or the upper end of Lacamas Lake since Lacamas Lake is a man-made impoundment. The release point is into the water level established by the water level at the lake. This is an area within the backwater condition for Lacamas Creek as it enters the Lake and is subjected to the lake level – (especially for times of significant flow).

Flow Control System Plan

This project is exempt as discussed in Section G. See Appendix B-3.

Section H – Wetlands Protection

Camas Stormwater Design Standards Manual – Submittal Requirements

For projects with stormwater discharges to a wetland, either directly or indirectly through a conveyance system, the preliminary TIR shall describe wetland protection measures to be implemented in accordance with Minimum Requirement 8. The narrative shall describe the measures that will maintain the hydrologic conditions, hydrophytic vegetation, and substrate characteristics necessary to support existing and designated uses.

Historically, the area with runoff to this portion of the wetlands was larger than the present condition. Development along the west has diverted flow to an area west of the project and an area in the southeast has been developed as several subdivisions with separate stormwater facilities. The watershed area to this portion of the wetland complex has been reduced from about 94 acres to about 71 acres (almost 25% reduction). However, two existing developments just south of the SE corner of the site were 'incorrectly' designed to divert additional acreage and an increased 'allowable' release rate to this site. See App. A, A-3 Basin Maps.

See Appendix B, B-2 for the evaluation that determines wetland protection is provided.

Presently, stormwater runoff enters the three wetland segments as overland flow or as direct rainfall. The expected area for stormwater runoff is:

Source Area	Acres
Parklands Residential Subdivision and Parklands Business Park	26.17
The Village at Camas Meadows	17.31
Camas Meadows Drive	2.40
Offsite – east of The Village at Camas Meadows and west of Larkspur Dr.	14.4
Wetland A (including buffer)	7.97
Wetland B (including buffer)	2.71
Wetland C (including buffer)	0.27
Total	71.22

Source Area	Acres
Lacamas Estates Subdivision – routed through Storm Facility – and 3 lots with direct discharge	7.31
Larkspur Subdivision – routed through Storm Facility	7.50
Total	14.81*

* Areas per As-built files from City

- Therefore, model upstream contributing basin total is about 86 acres.

One of the design elements is to maintain the overland flow aspect – all lots directly bordering the wetland buffers will maintain direct overland runoff. Runoff from the remaining lots not bordering the wetland buffers of this development will be collected and routed to several discharge points outside of the wetland buffers.

Section I – Other Permits

Construction of roads and stormwater facilities may require additional permits from other agencies. These permits may contain requirements that affect the design of the stormwater system. This section lists the titles of other possible required permits, the agencies that require the permits, and the permit requirements, if known, that affect the final stormwater plan. Approved permits that are critical to the feasibility of the stormwater facility design shall be included in this section.

1. Underground injection control (UIC) well registration: DOE. Any proposed public UIC wells shall receive Washington State Department of Ecology UIC Program rule authorization prior to civil plan approval. Provide a copy of the authorization during the plan review process. A copy of the registration application will be accepted if rule authorization notification has not been received from Ecology within 60 days of application for well registration.

Response: There are no proposed UICs for this site. However, a Construction General Permit is required and a SWPPP has been prepared for submittal as a separate attachment to the City.

Section J – Conveyance Systems Analysis and Design

1. *Reference the conceptual drainage design proposed in the preliminary stormwater plan.*

Response: The conveyance system layout follows the same pattern as proposed in the Preliminary submittal. See 2.

2. *Identify revisions to the conceptual drainage design contained in the preliminary stormwater plan.*

Response: The proposed storm system layout is essentially the same. The significant difference is that the conceptual plan provided for a 'clean' and 'dirty' line for conveyance. The requirement for phosphorous treatment for lawn runoff to the streets has resulted in the McMaster Drive system in particular being a one line system. A number of Perk Filter™ have been added along the street to provide the treatment for this lot runoff.

3. *Identify the criteria used to complete the analyses and their sources.*

Response: Standard conveyance system design as presented in Camas Stormwater Design Standards Manual (CSDSM) was applied. The analysis was performed with HydroCAD software ® applying the Santa Barbara Urban Hydrograph (SBUH) method for runoff and routing analysis. A specific additional feature was applied to route flow an account for downstream affects such as tail water (TW) or backwater conditions. This feature provides a dynamic routing analysis – selected as calculation setting – Dyn-Stor-Ind for reach routing and Dyn-Stor-Ind for pond routing. This feature allows the model to access and account for downstream flow elevations on a dynamic basis. For this analysis, this was important in evaluation the proposed storm connections into the two existing cross culverts from wetland B to wetland A. The design determined that the outlet portion from the connection points required a pipe size change for each from 12 inch to 24 inch diameters. The modeling also determined that the proper balancing of wetland surfaces required an additional 24 inch pipe was required to connect the two existing culverts at this new manhole connection points.

4. *Identify and discuss initial conditions, including stream base flows, beginning water surface elevations, hydraulic or energy grade lines, beginning storage elevations, and other data or assumptions used to complete the analyses of initial conditions. Reference the sources of information.*

Response: This is not applicable in general, however, wetland A was assumed to have a specific water level. Cross sections were determined near the north property line of the site and several more for the remaining area from the site to Lacamas

Lake. The hydrology/hydraulics analysis routed the flow based on these added modeling features.

5. *Describe any assumptions used to complete the analyses.*

Response: Additional direct rainfall and other sources of inflow were not accounted for in the analysis beyond the north property line – would be the same for both the pre and post analysis - so it was assumed that the modeled results would only change by the same amount.

6. *Complete a detailed hydraulic analysis of all proposed collection and conveyance system elements and existing collection and conveyance elements, including outfall structures and outlet protection, that influence the design or are affected by the proposal, in accordance with Chapter 7 (Conveyance Systems) of this manual. Compute and tabulate the following:*

    a. *Identify design flows and velocities and conveyance element capacities for all conveyance elements within the development.*

        Response: See Appendix D.

    b. *Identify the 10 year recurrence interval stage for detention facility outfalls (See Chapter 7). Provide stage-frequency documentation from the continuous runoff model.*

        Response: Not Applicable as Flow Control was determined as not required.

    c. *Compute existing 100-year floodplain elevations and lateral limits for all channels, and verify no net loss of conveyance or storage capacity from development.*

        Response: The 100-yr flood plain does extend into the site generally in the wetland area. However, this is not a channelized condition where a rise in water level would occur or lateral limits would be affected. The flood plain is related to a large water body-Lacamas Lake, and this flooded area is all a backwater affect that proceeds and exceeds relative to the water level in the lake. A 100-yr runoff event from the site would not be occurring at in the same time frame of a 100-yr flood event in the Lacamas Creek/Lake system. Since the water surface in the lake at the 100-yr flood event is so large, the runoff that might be occurring from the site would have no net rise in the water surface and no net loss in any related conveyance.

    d. *Reference conveyance system elements to labeled points shown on the site location map or development plan.*

        Response: Each structure (junction point) and the branch system are referenced with structure IDs.

    e. *Verify the capacity of each conveyance system element to convey design*

flow and discharge at non-erosive velocities. Verify the capacity of the onsite conveyance system to convey design flows that result from ultimate build-out of upstream areas.

Response: See Appendix D. The design flow requirement is a 10-yr, 24-hr event. However, a 25-yr event summary was evaluated and presented for review. All main lines (except 2) are capable of conveying the 100-yr event in open channel conditions. The offsite upstream are was accounted for in an ultimate build-out condition, even though a few of the existing larger lot residences may remain and not be further divided.

f. Include and reference all hydraulic computations, equations, pipe flow tables, flow profile computations, charts, nomographs, detail drawings, and other tabular or graphic aids used to design and confirm the performance of conveyance systems.

Response: See Appendix D.

g. Summarize the results of system analyses, and describe how the proposed design meets the requirements of this chapter.

Response: The conveyance system design complies with CSDSM with a few noted exceptions-see Appendix D, D-2 in particular.

Basically, several lateral sizes of 6 and 8 inches at PerkFilter™ systems that have elevation constraints for making connection to the main storm line.

Section K – Off-site Analysis

If applicable, provide the results of an offsite analysis prepared in accordance with Chapter 9 (Offsite Analysis and Mitigation) of this manual. (See exemptions in Chapter 9.)

Response: See Appendix F.

Section L – Approval Conditions Summary

List each preliminary approval condition related to stormwater control, wetlands, floodplains, and other water-related issues, and explain how the final design addresses or conforms to each condition.

Explanation of how the Project meets the City Conditions of Approval Relating to Stormwater from NOTICE of DECISION - Parklands at Camas Meadows (file# SUB15-03) Effective Date of Decision: July 13th, 2016

#15 Prior to final engineering approval of any phase, the applicant shall demonstrate to the satisfaction of the city that the proposed direct release meets the criteria of 2.5.7 of the 2012 SMMWW, or provide an acceptable alternative regional stormwater treatment and flow control system as allowed in CMC 17.19.040 (C, 3a) that will serve both this project and the Village at Camas Meadows development south of the site, or provide a separate on-site stormwater treatment and flow control system to serve only the subject property.

Response: The applicant has worked with the City and Ecology to provide sufficient information demonstrating that the proposed direct release meets the criteria of 2.5.7 of the 2012 SMMWW. See the Final Storm TIR, Appendix B for more details and information on direct release and how criteria are met.

#16 If direct release of stormwater flows into Lacamas Lake is approved, prior to final plat approval of any phase the applicant shall ensure that an adequate and acceptable perpetual stormwater easement across the Camas Meadows Golf Course is in place and recorded with Clark County.

Response: The final design has no stormwater pipes or facilities crossing the Golf Course so a stormwater easement is not applicable. All stormwater from the site is released on the site into the wetland and leaves the site as shallow flow into the off-site contiguous wetland as currently occurs and has historically been conveyed.

#17 Stormwater runoff from the proposed lots and landscaped areas of the site shall be directed into the streets and/or into a stormwater treatment system that will provide adequate phosphorus removal from the yard and landscaped areas of the site prior to release into the wetlands.

Response: The majority or 84% of the site, which the individual lot lawn and landscaped areas, are being directed to the street and then to Perkilters. Treatment for this co-mingled flow achieves both adequate water quality treatment for phosphorus with 52% removal (minimum 50% removal), with a TAPE approved system element (PerkFilter) for water quality and phosphorus removal treatment. The PerkFiler system is rated by TAPE for 62.4% phosphorous load reduction.

As an additional voluntary measure to reduce the most likely phosphorus sources, all commercial pads and residential lots will be required by the HOA CC&R's to use only fertilizers that have a zero phosphorous designation. These restrictions will be recorded on all lots within the final approved CCR's for the site. These voluntary measures, if followed, will additionally reduce the amount of phosphorus leaving the site. However, phosphorus removal requirements for the entire site are met, even without this voluntary measure.

See Appendix C Water Quality, C-3a and C-3b for more detailed phosphorus removal calculations and analysis.

A Pollutant Loading Analysis (using two different approaches) has been provided that conservatively demonstrate 52% of the total phosphorus leaving the total site is removed, which satisfies the DOE requirement of 50% net phosphorus removal standard. Thus, the phosphorus reduction standard has been met when evaluating total phosphorus removed from the entire site.

#18 Stormwater lines serving the site not located within the public right-of-way will shall be placed within private stormwater easements and shall be maintained by the homeowners association.

Response: Private stormwater easements have been provided for all Stormwater lines on the site (not located within the public right-of-way). All private stormwater facilities shall be maintained by the property owners association or as otherwise agreed to by the City.

Section M – Special Reports and Studies

Where site-specific characteristics, such as steep slopes, wetlands, and sites located in wellhead protection areas, present difficult drainage and water quality design problems, the Director may require additional information or the preparation of special reports and studies that further address the specific site characteristics, the potential for impacts associated with the development, and the measures that would be implemented to mitigate impacts. Special reports shall be prepared by professionals with expertise in the particular area of analysis, who shall date, sign, stamp, and otherwise certify the report. Subjects of special reports may include, but are not be limited to:

1. *Geotechnical* – See Appendix G
2. *Wetlands* – See Appendix G
3. *Floodplains and Floodways* – A floodplain does extend into the site in a backwater condition. See comments in Section J, 6c.
4. *Groundwater* – Infiltration BMPs are not proposed.
5. *Structural Design – Design for wall sections is applicable –provided as separate document(s)*
6. *Fluvial Geomorphology (erosion and deposition)* - Not applicable.

All special reports and studies shall be included in the technical appendix.

Section N – Maintenance and Operations Manual

The project engineer shall prepare maintenance and operations manual for each stormwater control or treatment facility to be privately maintained, and for those that constitute an experimental system to be maintained by the City. The manual shall be written in an orderly and concise format that clearly describes the design and operation of the facility. The manual shall also provide an outline of required maintenance tasks; with the

recommended frequencies each task should be performed. The manual shall contain or reference procedures from the Stormwater Manual.

Response: A Maintenance and Operations Manual has been prepared for the Parklands Subdivision and the Archery Business Park. See Appendix H and Section L, responses to 3 and 4.

APPENDIX A

A-1 GIS Development Packet

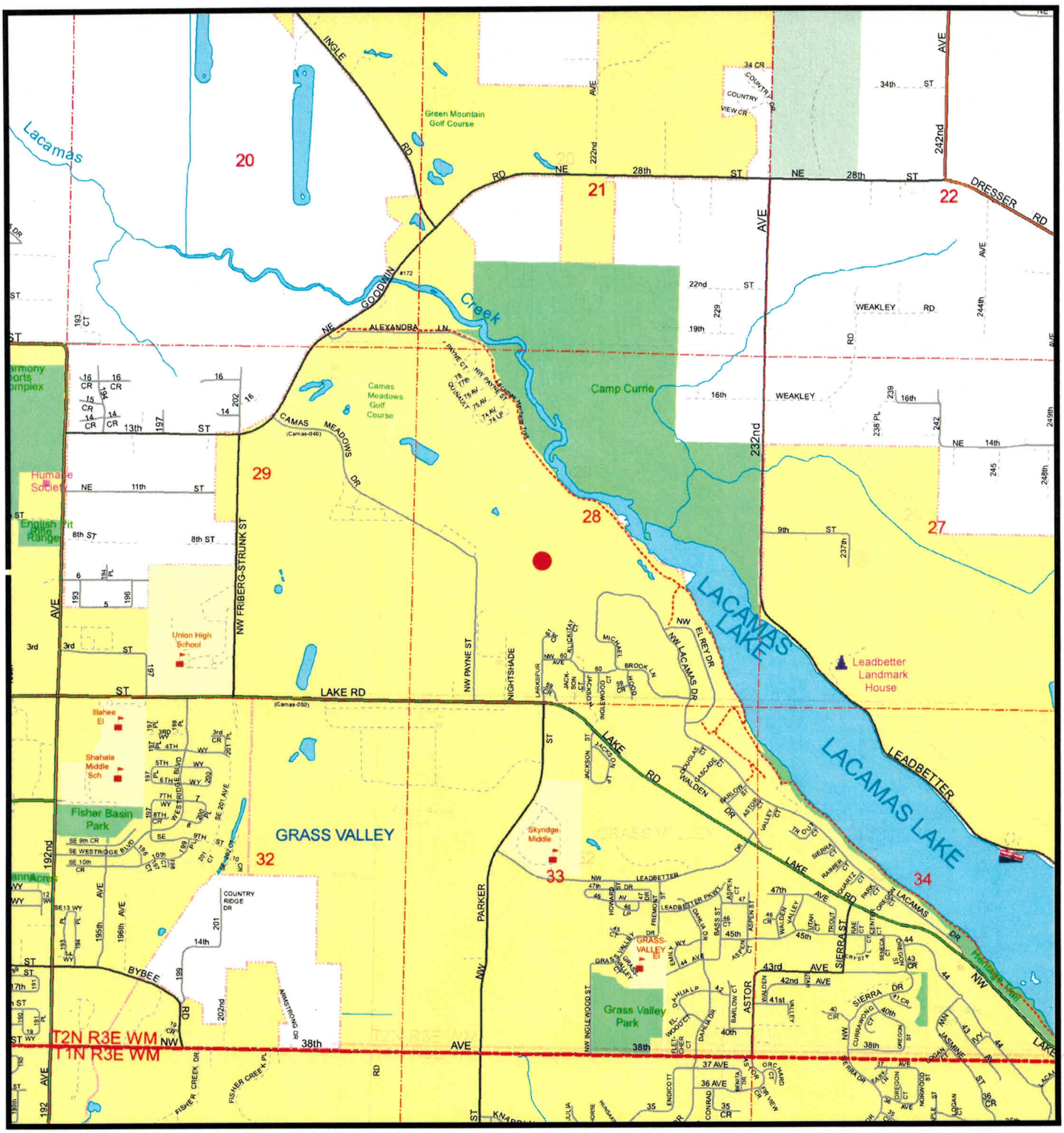
A-2 FIRM Map

A-3 Historic Basin Maps

1) **Fig. 1A Historic Basin Map**
2) **Fig 1B Historic Basin Map – add projects**
3) **Fig 2A Project Areas**
4) **Fig 2B Soils Map**
5) **Fig 3 Post Subbasin Map**

A-4 Selected Soils Data

A-5 Isopluvial Maps



CLARK COUNTY, WASHINGTON
Geographic Information System

1:24,000

0 0.1 0.2 0.3 0.4 0.5 Miles

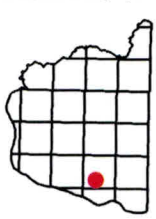
N

General Location Map

Account No: 175948000, 986031650
Owner: CHINOOK LAND OWNERS GROUP LLC
Address: 1400 NW 63RD ST
C/S/Z: VANCOUVER, WA 98663

● Subject Property Location

Printed on: February 04, 2015



Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.

Property Information Fact Sheet

Mailing Information:
Account No.: 175948000, 986031650
Owner: CHINOOK LAND OWNERS GROUP LLC
Address: 1400 NW 63RD ST
C/S/Z: VANCOUVER, WA 98663
Assessed Parcel Size: 36.43 Ac
Property Type: UNUSED LAND TIMBERED.

PARCEL LOCATION FINDINGS:

Quarter Section(s): SE 1/4,S28,T2N,R3E,
SW 1/4,S28,T2N,R3E
Municipal Jurisdiction: Camas
Urban Growth Area: Camas
Zoning: BP, R-15
Zoning Overlay: PlannedIndustrialDevelopmentOverlay
Comprehensive Plan Designation: IND,
SFL
Columbia River Gorge NSA: No Mapping Indicators
Building Moratorium: No Mapping Indicators

Late-Comer Area: No Mapping Indicators
Trans. Impact Fee Area: Camas
Park Impact Fee District: No Mapping Indicators
Neighborhood Association: No Mapping Indicators
School District: Camas
Elementary School: Grass Valley
Junior High School: Skyridge Middle
Senior High School: Camas
Fire District: Camas Washougal FD
Sewer District: Camas
Water District: None
Wildland: No Mapping Indicators
Historic Sites: No Mapping Indicators

ENVIRONMENTAL CONSTRAINTS:

Soil Type(s): CvA, 21.3% of parcel
HcB, 2.1%
HcD, 67.0%
HcE, 0.4%
LeB, 9.2%
Hydric Soils: Hydric, 21.3% of parcel
Non-Hydric, 78.7%
Flood Zone Designation: 500 Year Flood Area,
Floodway Fringe,
Outside Flood Area
CARA: Category 2 Recharge Areas
Liquefaction Susceptibility: Very Low
NEHRP: C
Slope: 0 - 5 percent, 56.2% of parcel
10 - 15 percent, 12.5%
15 - 25 percent, 2.9%
5 - 10 percent, 28.4%
Landslide Hazards: Slopes > 15%
Slope Stability: No Mapping Indicators
Priority Habitat and Species Areas: Riparian Habitat Conservation Area,
Species
Priority Species Area Buffer: WDFW Priority Species Buffer
Priority Habitat Area Buffer: No Mapping Indicators
Archeological Predictive: High, 85.2% of parcel
Moderate-High, 14.8%
Archeological Site Buffers: Mapping Indicators Found

NOTE
This data is compiled from many sources and scales. Clark county makes this information available as a service, and accepts no responsibility for any inaccuracy, actual or implied.



CLARK COUNTY, WASHINGTON
Geographic Information System

N

1:3,600

0 150 300 450 Feet

2014 Aerial Photography with Contours

Account No: 175948000, 986031650
Owner: CHINOOK LAND OWNERS GROUP LLC
Address: 1400 NW 63RD ST
C/S/Z: VANCOUVER, WA 98663

Proposed Development Area
2' Elevation Contours

Printed on: February 04, 2015

23120	23121	23122
23129	23128	23127
23132	23133	23134

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.

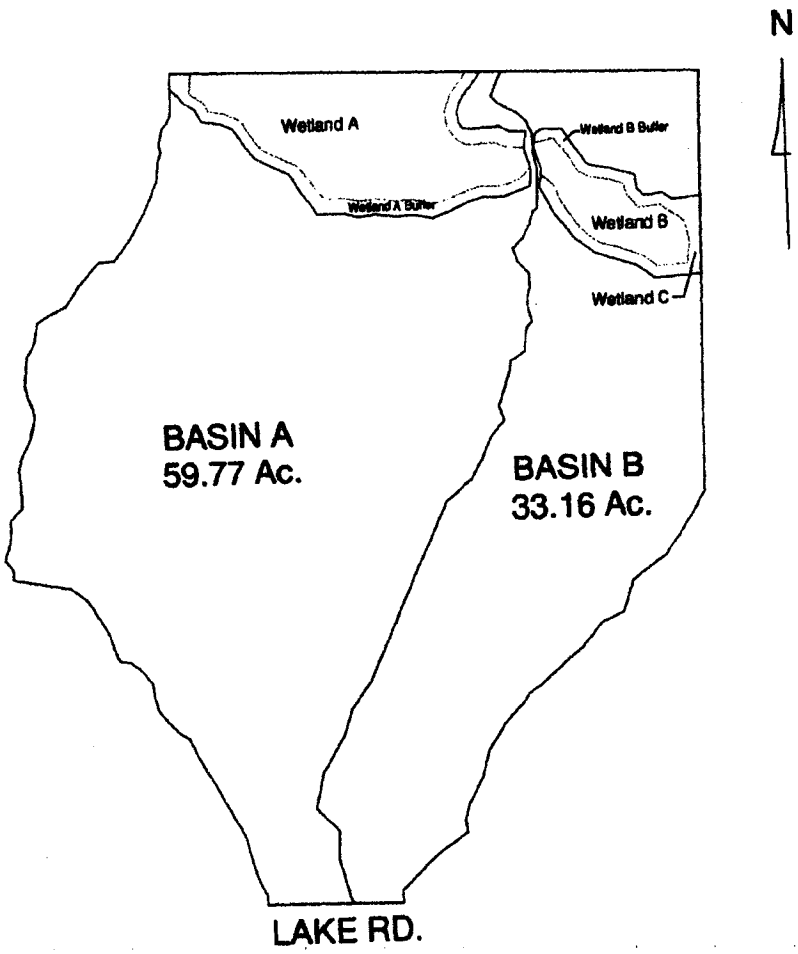


FIG. 1A HISTORIC BASIN MAP

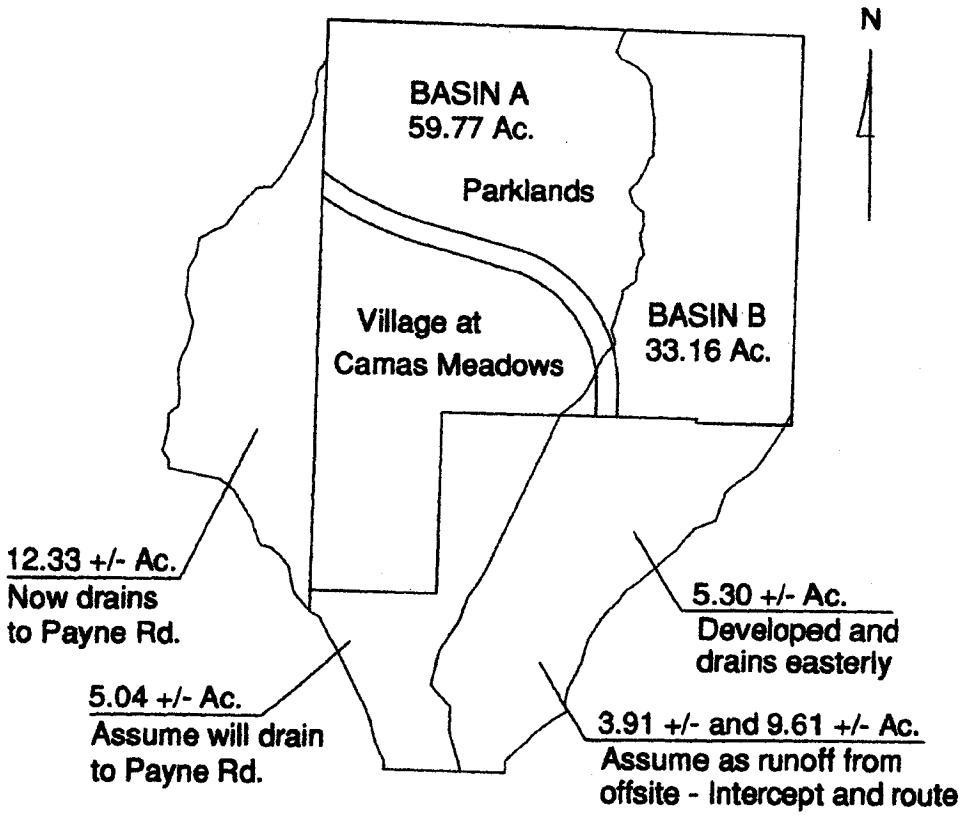


FIG. 1B HISTORIC BASIN MAP

- add PROJECTS

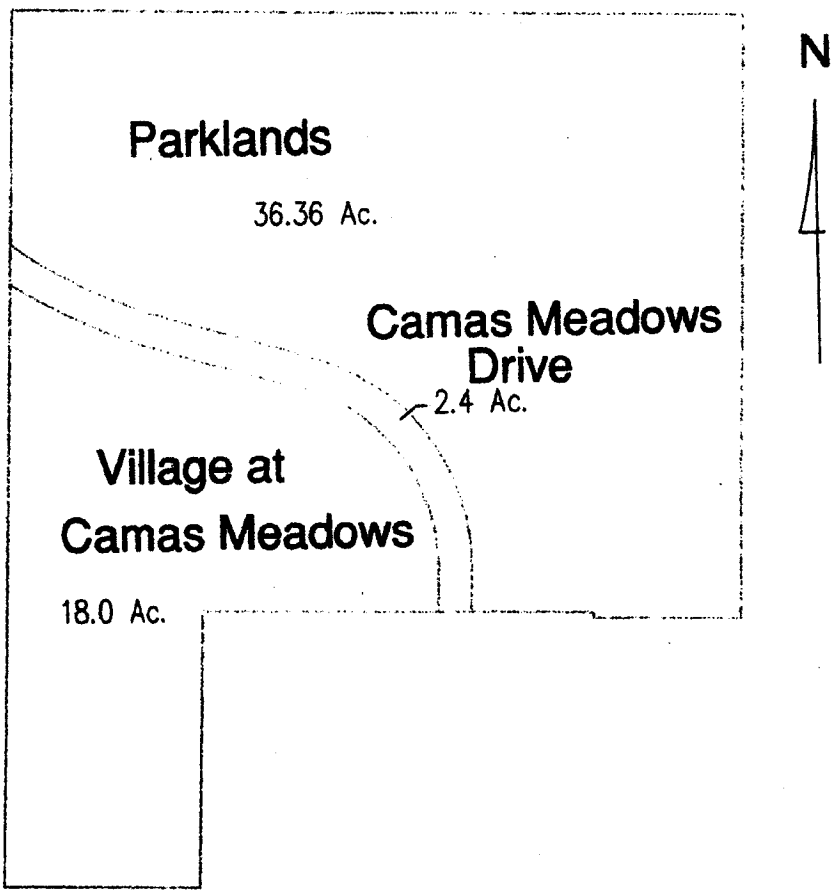


FIG. 2A PROJECT AREAS

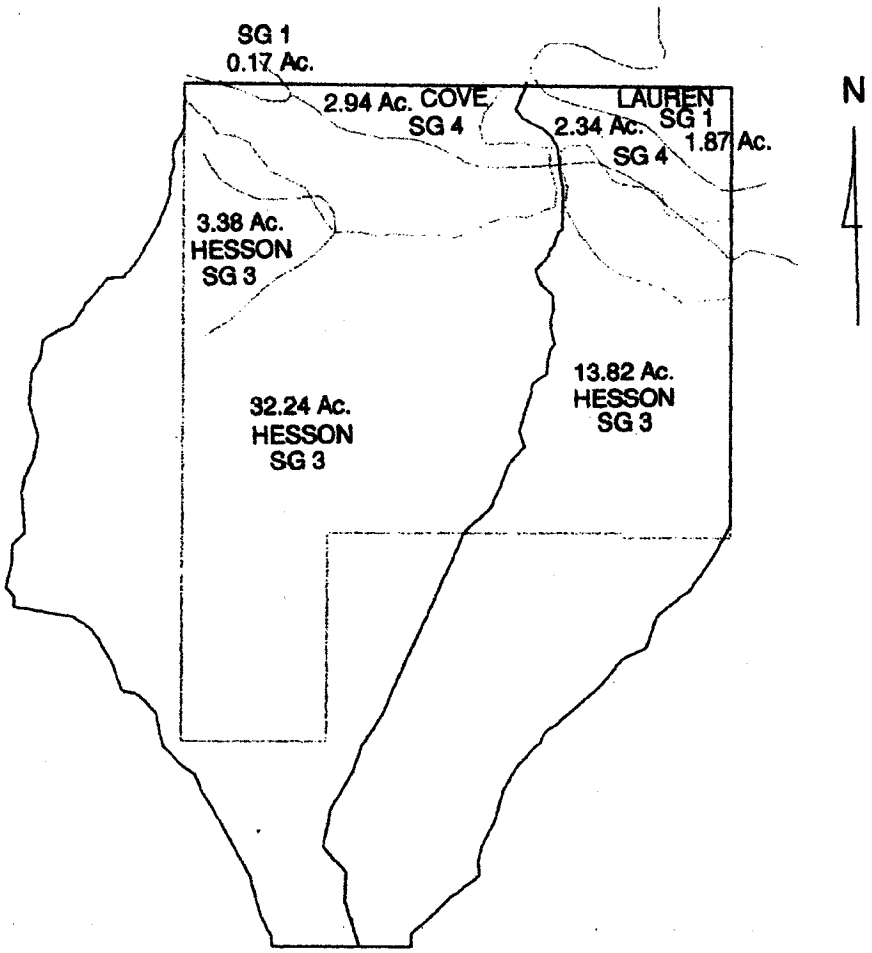


FIG. 2B SOILS MAP

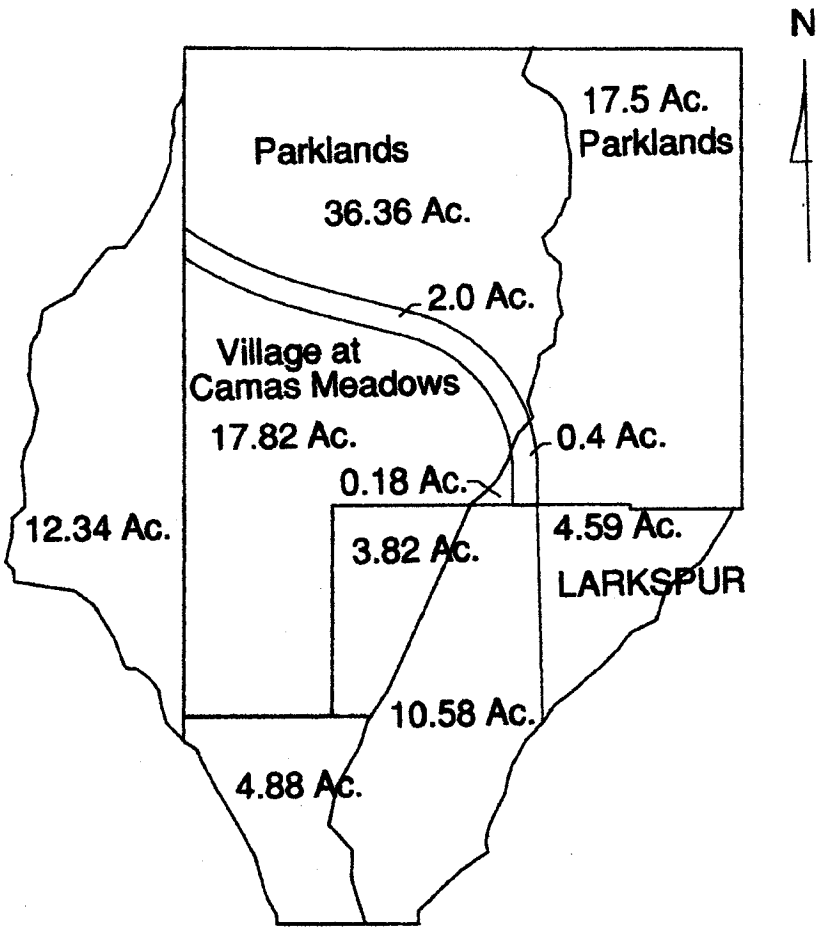


FIG. 1C HISTORIC BASIN MAP
- add PROJECTS

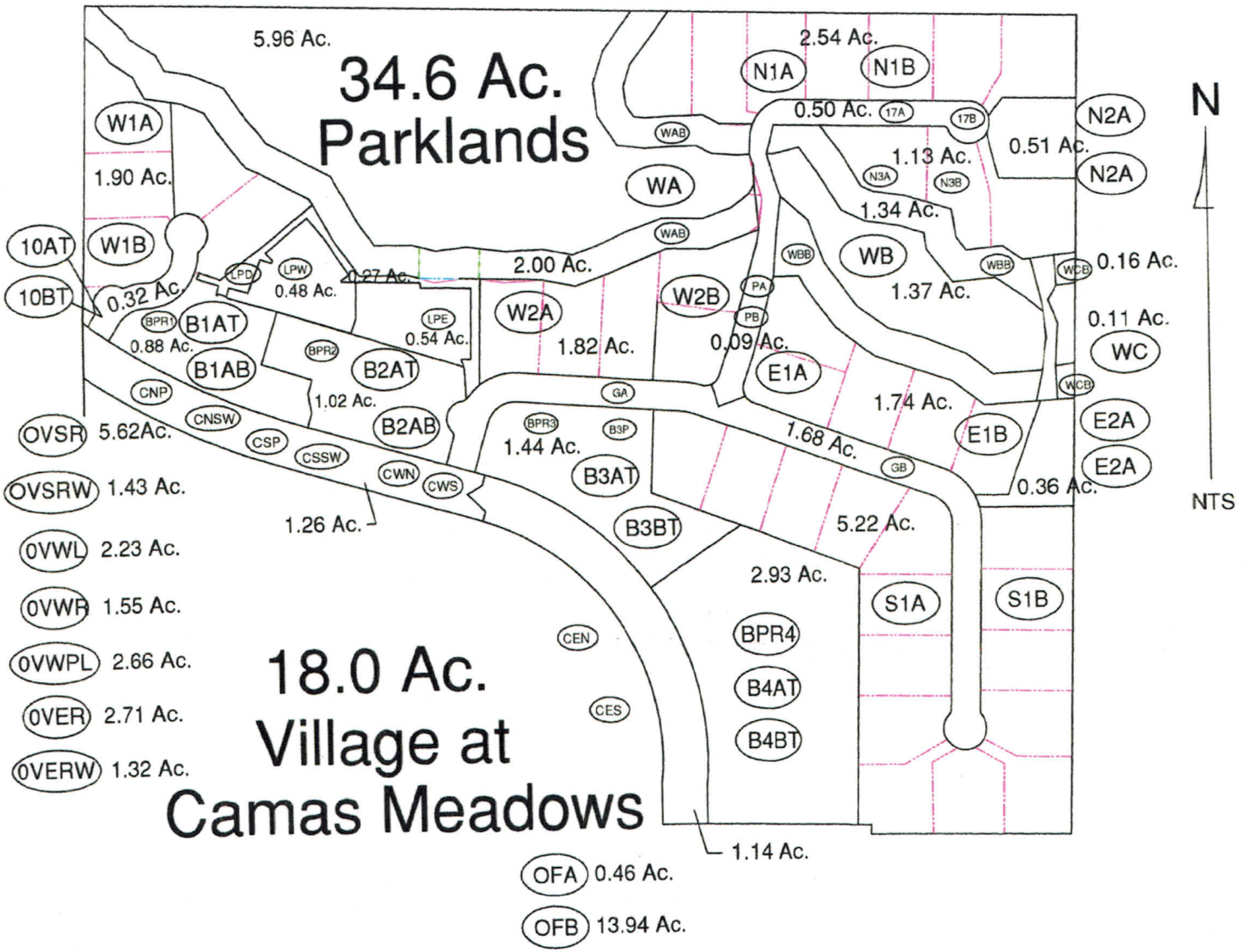


FIG. 3 - POST SUBBASIN AREAS

Exhibit 16 SP26-1005

SOIL INFORMATION

– selected text from USDA Soil Survey report of Clark County, Washington issued November 1972

See Geotech Report, Appendix E

- See page 10 for table with depth to bedrock information.

Cove Series

– selected text from USDA Soil Survey report of Clark County, Washington issued November 1972.

The Cove series consists of deep, very poorly drained, mostly nearly level soils (fig. 3). These soils have a clayey subsoil. They formed in water-laid deposits in old lakes and ponds. The native vegetation is deciduous trees, sedges, reeds, and water-tolerant shrubs and grasses.

Cove soils are used primarily for pasture.

Cove silty clay loam, 0 to 3 percent slopes (CvA).—This soil is in concave drainageways and in large, flat, old lakebeds. The slope is generally less than 1 percent.

In a typical profile the surface layer is very dark gray silty clay about 4 inches thick. Below this is firm clay about 32 inches thick. It is black in the upper part and very dark gray and mottled in the lower part. The underlying material, to a depth of 54 inches, is mottled, light olive-gray gravelly silty clay loam.

Included in mapping were small areas where the surface layer is gravelly silt loam, silty clay, or clay. Also included were areas where the subsoil is gravelly clay.

This soil is very poorly drained and very slowly permeable. Tillage is difficult. The available water capacity and fertility are low. The effective rooting depth averages less than 15 inches. Surface runoff is very slow, and ponding is common in winter unless drainage is provided. There is no hazard of erosion.

Water-tolerant grasses and legumes are well suited, but these plants must also resist drought because this soil is droughty in summer. Tall fescue, meadow foxtail, birdsfoot trefoil, and white Dutch clover are suited grasses and legumes

Hesson Series

– selected text from USDA Soil Survey report of Clark County, Washington issued November 1972.

The Hesson series consists of deep, well-drained soils that are mostly level to gently rolling. Some areas are hilly and very steep. These are moderately fine textured soils that have a fine textured subsoil. The parent material is deeply weathered, mixed old alluvium that contains varying amounts of gravel. The original vegetation is a heavy growth of Douglas-fir and a scattering of western redcedar and grand fir. The understory consists principally of vine maple, salal, Oregongrape, ferns, and red huckleberry.

All the acreage has been logged. Areas not in cultivation are in second-growth timber. The understory is similar in composition to that of the native stands. Red alder is dominant in some areas. The annual precipitation ranges from 50 inches to more than 60 inches.

Hesson clay loam, 0 to 8 percent slopes (HcB).-This is the dominant soil of the high terraces along the mountain foot slopes in the county. In most places the slope is 2 to 5 percent. The relief is undulating. Slopes are generally short to moderate in length.

SOIL INFORMATION

– selected text from USDA Soil Survey report of Clark County, Washington issued November 1972

In a typical profile the surface layer is dark reddish brown clay loam about 8 inches thick. The subsurface layer is dark reddish-brown clay loam about 4 inches thick. Below this layer is friable, dark reddish-brown clay loam about 10 inches thick. The next layer, to a depth of about 91 inches, is reddish-brown clay. In sequence from the top, the uppermost 18 inches is friable, the next 39 inches is firm, and the lower 12 inches is very firm.

Included in mapping were some areas that are nearly level or are slightly depressional and have a slightly mottled layer at a depth of 30 to 40 inches. This indicates reduced permeability and a temporary perched water table during rainy periods.

This soil is well drained and has moderately slow permeability. The available water capacity is high, and fertility is moderate. Problems arise in the proper scouring of tillage equipment when the soil is worked at about field capacity. Tillage is difficult when the surface layer is nearly dry. Surface runoff is slow, and the erosion hazard is slight.

Hesson clay loam, 8 to 20 percent slopes (HcD).-This soil is similar to Hesson clay loam, 0 to 8 percent slopes, except that the surface layer generally is 1 to 2 inches thinner. In places where erosion has been active, the surface layer is 2 to 4 inches thinner. The slopes are generally single and are moderate in length.
Most areas of this soil are cleared and in cultivation, but use is less intensive than on Hesson clay loam, 0 to 8
percent slopes. Runoff is medium, and the erosion hazard is moderate where the surface is left bare in winter.

Lauren Series
– selected text from USDA Soil Survey report of Clark County, Washington issued November 1972.

The Lauren series consists of deep, somewhat excessively drained, nearly level to gently sloping soils on terraces 50 to 300 feet above the Columbia River. In a few places, on terrace fronts, the soils are steep to very steep. These are very gravelly soils that formed in mixed Columbia River alluvium that contained some volcanic ash. Lauren soils are in the southwestern part of the county, in the vicinity of Mill Plain, Orchards, and Fourth Plain. The original vegetation was Douglas-fir, grand fir, bigleaf maple, vine maple, salal, and ferns. The average annual precipitation is about 48 inches.

Nearly all the acreage is cleared and in cultivation or suburban development. There are a few stands of second growth Douglas-fir in farm woodlots.

Lauren gravelly loam, 0 to 8 percent slopes (LgB).-This soil occurs on terraces. The slopes are generally less than 4 percent and approach 8 percent only along the terrace breaks.
In a typical profile the surface layer is very dark brown gravelly and very gravelly loam about 20 inches thick. Below the surface layer is friable, dark-brown very gravelly loam about 13 inches thick. The next layer is dark-brown very gravelly coarse sandy loam about 11 inches thick. The underlying material, to a depth of 70 inches, is dark-brown very gravelly loamy coarse sand.

Included in mapping were a few small areas where very gravelly loamy coarse sand is within 30 inches of the surface.This soil is somewhat excessively drained and easily tilled. Permeability generally is

SOIL INFORMATION

– selected text from USDA Soil Survey report of Clark County, Washington issued November 1972

moderately rapid, but it is rapid in the substratum. The available water capacity is moderate. Fertility is moderate. Surface runoff is slow, and the erosion hazard is slight.

Note: This geotech report by Columbia West Engineering, Inc. reports the following.

> *The Web Soil Survey (United States Department of Agriculture, Natural Resource Conservation Service [USDA NRCS], 2013 Website) indicates the site is underlain by three soil types. Hesson clay loam soils are mapped on the majority of the site from the northwest corner to the southwest corner of the property, while Cove silty clay loam and Lauren gravelly loam soils are mapped in the northern and northwestern portions of the property, respectively. Soils resembling the Lauren series were not encountered during subsurface excavation.* *
>
> *Although actual on-site soils may vary from the broad USDA descriptions, Lauren soils are generally coarse-textured, well drained soils with rapid permeability. Cove soils are generally fine-textured, poorly drained soils with very slow permeability and high shrinkswell potential. Hesson soils are fine-textured, well drained soils with moderately slow permeability and moderate shrink-swell potential.*
>
> * Review of the report reveals that TP1 and TP 2 were explored in this area of the site. Poorly graded GRAVEL with silt and sand was observed. Refusal was within 2.5 to 3 feet of the surface.

Permeability: Cove soils are at the wetland and listed at less than 0.06 in/hr in the 0-36 inch depth. Hesson soils located south of the wetlands and listed at less than 0.63 to 2.0 in/hr in the 0-22 inch depth.

This indicates that some infiltration will occur at the proposed biorention facilities even though the majority will be collected in underdrain systems and conveyed in the storm system piping.
Also, some infiltration may occur at the proposed systems in the wetland buffers – not significant.

Cove: CvA.	0–36	Clay	CH	A–7		100	70–80	<0. 06	0. 14–0. 16	5. 6–7. 3
	36–54	Gravelly silty clay loam.	CL	A–7	65–75	60–70	50–60	0. 06–0. 20	0. 15–0. 17	5. 6–7. 3
Cove, thin solum: CwA.	0–14	Silty clay loam	CL	A–7		100	85–95	0. 06–0. 20	0. 19–0. 21	4. 5–6. 0
	14–21	Clay	CH	A–7		100	70–80	<0. 06	0. 14–0. 16	5. 6–7. 3
	21–60	Silt loam	ML or CL	A–4 or A–6.		100	65–75	0. 06–0. 20	0. 19–0. 21	6. 6–7. 3
Dollar: DoB.	0–32	Loam	ML	A–4	100	90–95	60–70	0. 63–2. 0	0. 16–0. 18	4. 5–6. 0
	32–60	Loam (fragipan)	ML or CL	A–4	100	95–100	60–70	<0. 06	0. 06–0. 08	4. 5–6. 0
Fill land: Fn.	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Gee: GeB, GeD, GeE, GeF.	0–22	Silt loam	ML or CL	A–6		100	70–85	0. 63–2. 0	0. 19–0. 21	5. 1–6. 0
	22–72	Silty clay loam	CL	A–6		100	70–80	<0. 06	0. 06–0. 08	5. 1–6. 0
Gumboot: GuB.	0–12	Silt loam	OL	A–7	90–95	85–95	75–85	0. 63–2. 0	0. 19–0. 21	4. 5–7. 3
	12–50	Gravelly silty clay loam, clay loam.	CL	A–6	90–100	85–95	65–75	0. 06–0. 2	0. 19–0. 21	6. 1–7. 3
	50–60	Very gravelly silty clay.	GC	A–7	40–50	35–50	25–35	<0. 06	0. 06–0. 08	6. 1–7. 3
Hesson: HcB, HcD, HcE, HcF.	0–22	Clay loam	CL	A–7	85–95	85–95	65–75	0. 63–2. 0	0. 19–0. 21	4. 5–6. 0
	22–91	Clay	CH	A–7	85–90	85–90	75–85	0. 2–0. 63	0. 14–0. 16	4. 5–6. 0
HgB, HgD, HhE.	0–22	Gravelly clay loam.	SC	A–6	75–85	70–80	40–50	0. 63–2. 0	0. 14–0. 16	4. 5–6. 0
	22–91	Gravelly clay	CH	A–7	75–85	70–80	60–70	0. 2–0. 63	0. 11–0. 13	4. 5–6. 0

Figure A-2: 2-Year, 24-Hour Clark County Isopluvial Map

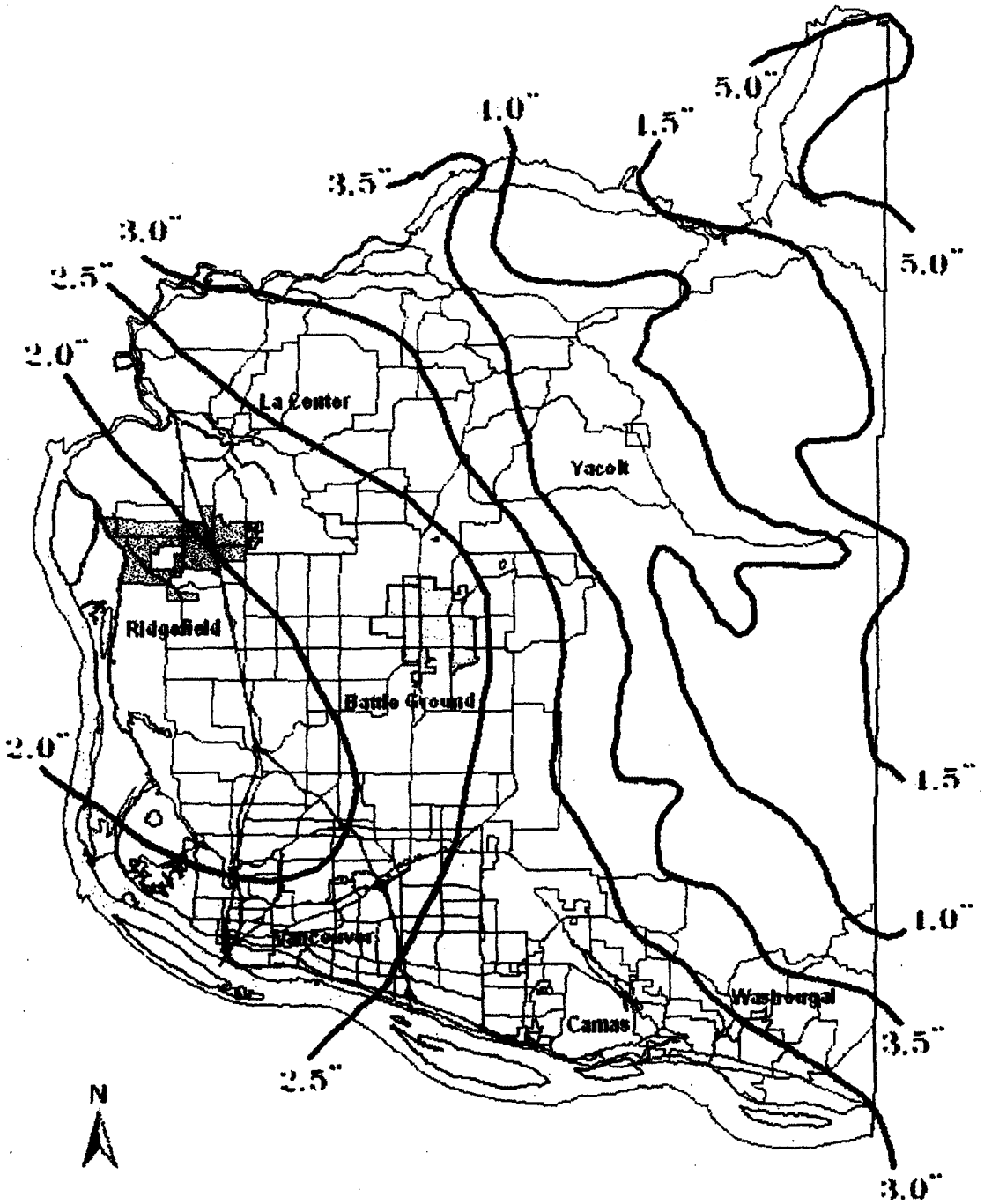


Figure A-3: 10-Year, 24-Hour Clark County Isopluvial Map

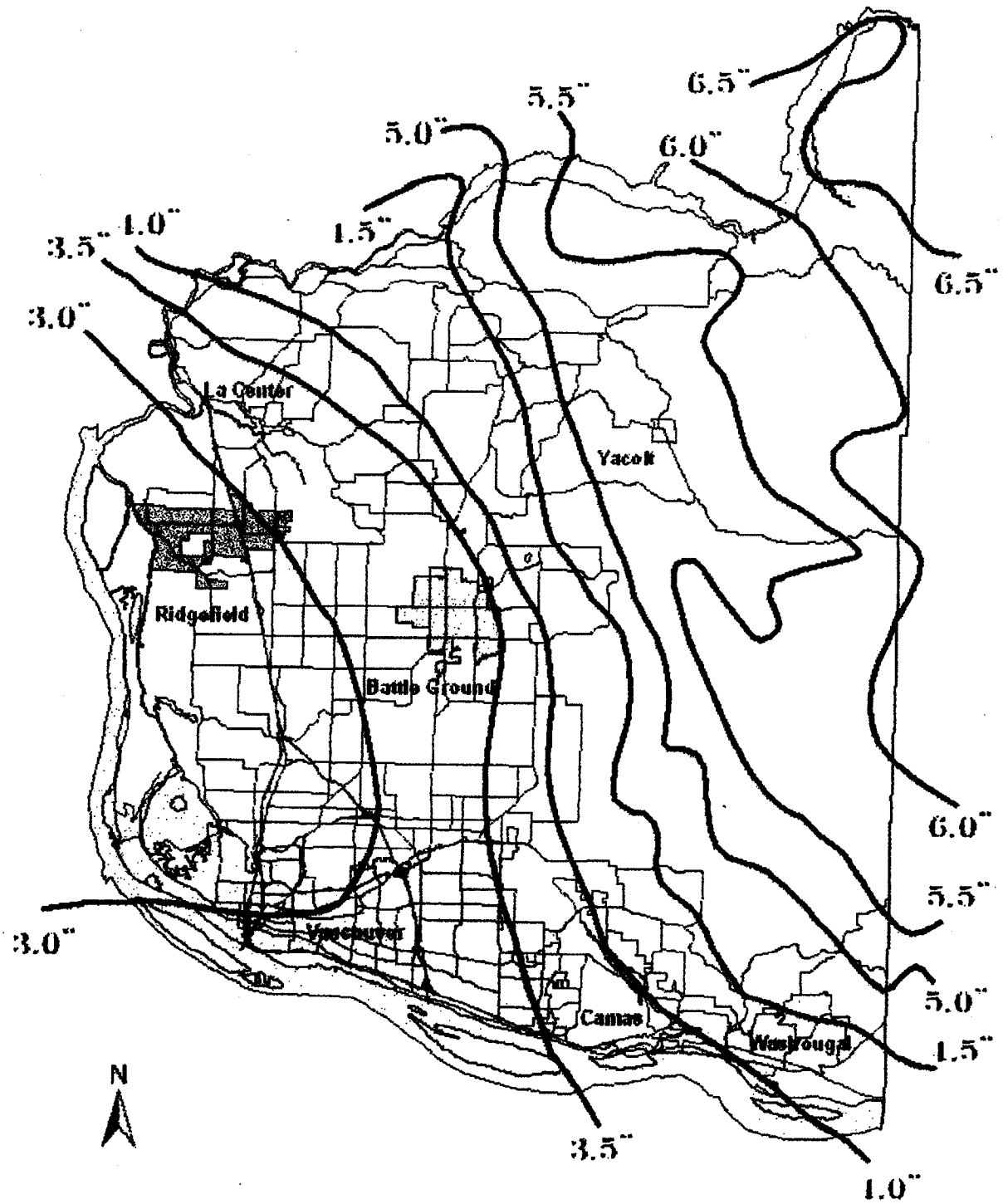


Figure A-4: 25-Year, 24-Hour Clark County Isopluvial Map

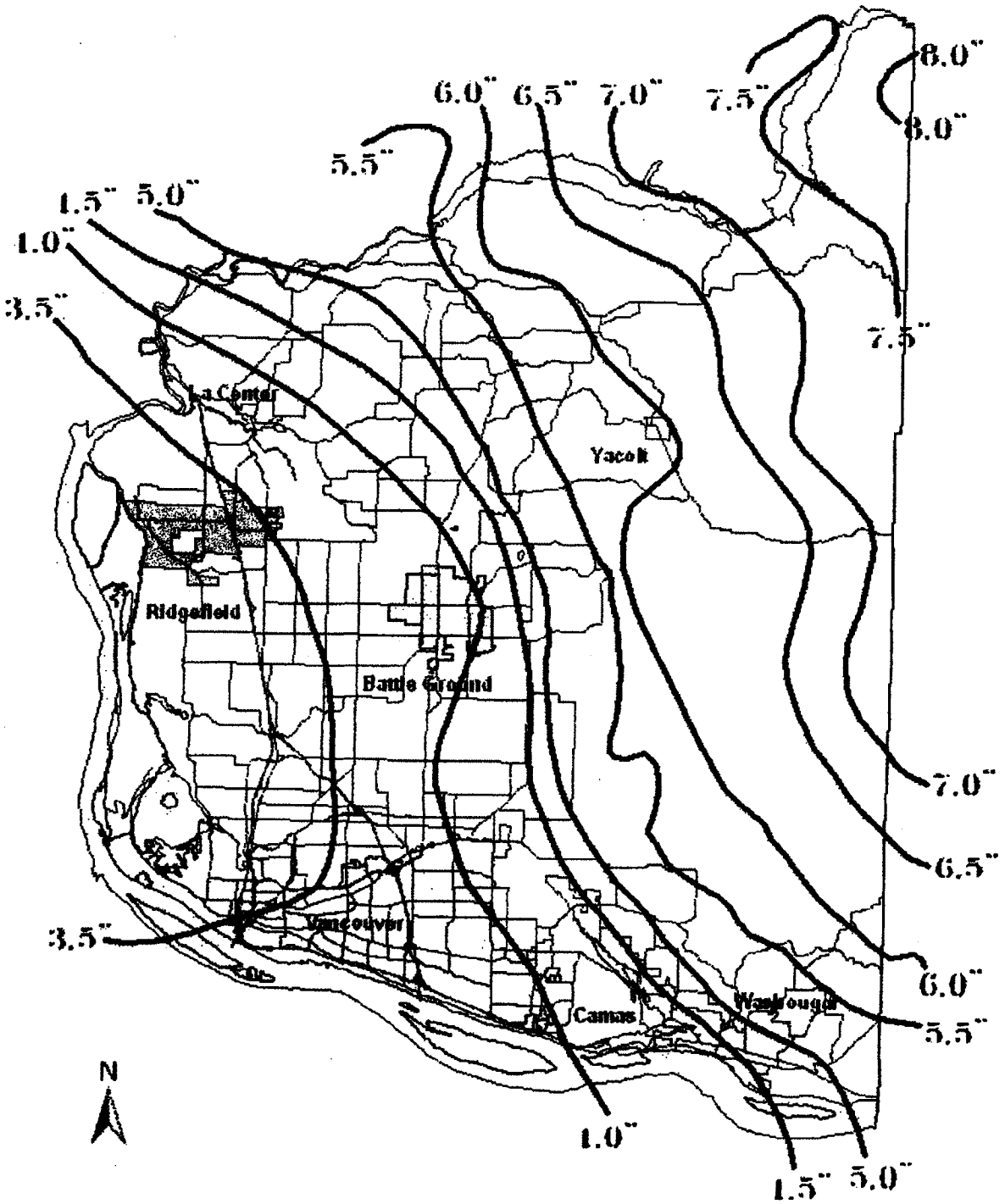
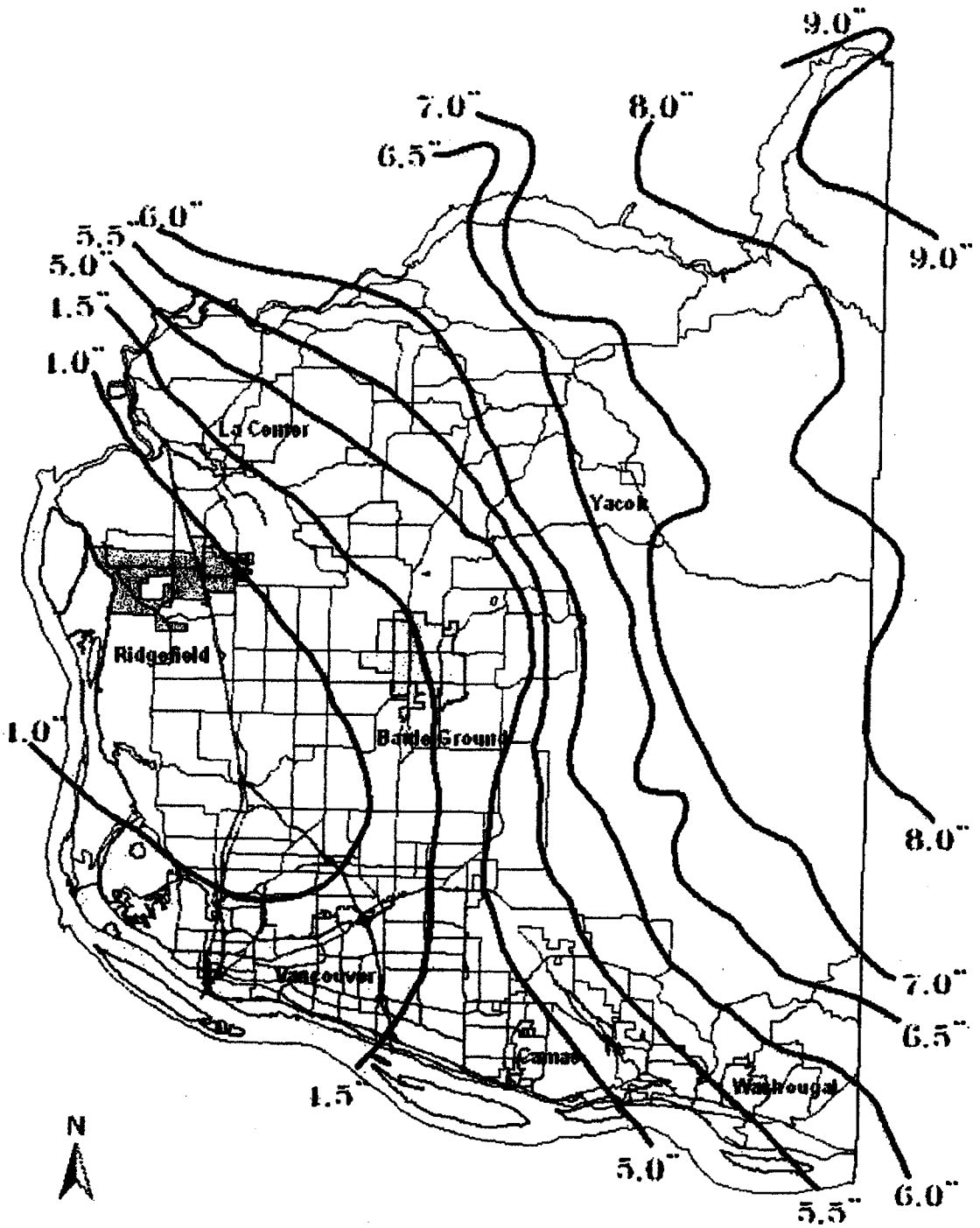


Figure A-5: 100-Year, 24-Hour Clark County Isopluvial Map



APPENDIX B

B-1 Minimum Requirements #1 -#9 Responses

B-2 MR #8 Wetlands Protection Evaluation

- **B-2a Support files for Hydroperiod Evaluation**
- **B-2b MR #8 Annual WLF Comparison**
- **B-2c MR #8 Monthly WLF Comparison**

B-3 MR #7 Flow Control

APPENDIX B-1

Section B (REPORT) - MINIMUM REQUIREMENTS #1-#9 - RESPONSES

Section B – Minimum Requirements

The "**Parklands Executive Residential Subdivision and Parklands Business Park**" proposal contains three threshold discharge areas (TDAs) which are subject to minimum requirements 1 – 10.

1. **Preparation of Stormwater Site Plans**

   Finalized.

2. **Construction Stormwater Pollution Prevention**

   A SWPP will be prepared for implementation. An erosion control plan will be part of the construction plan set.

3. **Source Control of Pollution**

   See Final TIR, Section D – Source Control

4. **Preservation of Natural Drainage Systems and Outfalls**

   There are no existing onsite drainage systems of significance for the overland flow to the wetland areas. See continued discussion under next Minimum Requirement.

5. **Onsite Stormwater Management**

   See Final TIR, Section E – Onsite Stormwater Management BMPs

6. **Runoff Treatment**

   See Final TIR, Section F – Runoff Treatment and Design

7. **Flow Control**
   See Final TIR, Section G – Flow Control Analysis and Design

8. **Wetlands Protection**

   See Final TIR, Section I – Wetlands Protction

Basin/Watershed Planning

Not applicable per Camas Stormwater Manual.

APPENDIX B-1

Section B (REPORT) - MINIMUM REQUIREMENTS #1-#9 - RESPONSES

9. Operation and Maintenance

An Operation and Maintenance procedure document has been developed to include City of Camas procedures and processes. The Clark County Stormwater Facility Maintenance Manual and DOE references are also be referred to for additional or appropriate procedures.

APPENDIX B-2 MINIMUM REQUIREMENT # 8 WETLAND PROTECTION EVALUATION FOR COMPLIANCE

Our evaluations for Minimum Requirement #8 Wetland Protection is based on the following reference and the applicable section.

Appendix 1-D Wetlands and Stormwater Management Guidelines

Guide Sheet 2B: Guidelines for Protection from Adverse Impacts of Modified Runoff Quantity Discharged to Wetlands

Per our conference call with DOE, several City staff, and their consultant, we understand that since this wetland is not classified as category 1 or 2, the provision for wetland protection is subject to whether or not the City determines protection is required and to what extent. We are proposing to meet water quality protection, implement erosion control practices, and provide the required wetland buffers.

We have already provided extensive analysis related to protection of elements related to hydroperiod. Our approach has been made relative to determining the hypothetical differences between a continuous model based on existing conditions and one based on future full build conditions for the watershed with runoff to this portion of the wetland – the portion receiving inflow from our site. This analysis is described in the above reference as follows:

> "*This analysis hypothesizes a fluctuating water stage over time before development that could fluctuate more, both higher and lower after development; these greater fluctuations are termed* ***stage excursions****. The guidelines set limits on the frequency and duration of excursions, as well as on overall water level fluctuation, after development."*

There are two descriptions presented for determining existing hydroperiod data. The first or preferred process is not fully practical, as it is based on

> *"the model being calibrated with at least one year of data taken using a continuously recording level gage under existing conditions and should be run for the historical rainfall period."*

This analysis would be limited to a one year evaluation as the post full build model would need to be based on the same temperature, rainfall data, etc. for the comparison. The second description is more representative of the approach that has been applied to date for this analysis. Although the first portion is still proposing data gathering for a period of time, the evaluation of the data is more in line with the approach undertaken in our analysis.

APPENDIX B-2 MINIMUM REQUIREMENT # 8 WETLAND PROTECTION EVALUATION FOR COMPLIANCE

The following information seems to be the most applicable criteria for evaluating the hydroperiod responses for this sloped wetland.

2. The following hydroperiod limits characterize wetlands with relatively high vegetation species richness and apply to all zones within all wetlands over the entire year. If these limits are exceeded, then species richness is likely to decline. If the analysis described above forecasts exceedences, one or more of the management strategies listed in step 5 should be employed to attempt to stay within the limits.

   - Mean annual Water Level Fluctuations (WLF) (and mean monthly WLF for every month of the year) does not exceed 20 cm (8 inches or 0.66 ft). Vegetation species richness decrease is likely with: (1) a mean annual (and mean monthly) WLF increase of more than 5 cm (2 inches or 0.16 ft) if pre- development mean annual (and mean monthly) WLF is greater than 15 cm, or (2) a mean annual (and mean monthly) WLF increase to 20 cm or more if pre-development mean annual (and mean monthly) WLF is 15 cm (6 inches or 0.5 ft) or less.

Finding: The evaluation for the mean annual WLF and mean monthly WLF for every month of the year has been completed for the 60-yr span from 1948 through 2008. The results have also been arranged from highest WFL to lowest WLF for these two evaluations.

- **The largest mean annual WLF is 0.10 inches or 0.008 ft (significantly less than the allowed 8 in or 0.66 ft) and the largest mean monthly WLF is 0.43 inches or 0.036 ft (significantly less than the allowed 6 inches or 0.5 ft).**

See separate files:

MR#8-01 Annual Mean Average Values – compare Water Level Fluctuations (WLF)
MR#8-02 Monthly Mean Average Values – compare Water Level Fluctuations (WLF)

   - The frequency of stage excursions of 15 cm above or below pre- development stage does not exceed an annual average of six.
     Note: A short-term lagging or advancement of the continuous record of water levels is acceptable. The 15 cm limit applies to the temporary increase in maximum water surface elevations (hydrograph peaks) after storm events and the maximum

APPENDIX B-2 MINIMUM REQUIREMENT # 8 WETLAND PROTECTION EVALUATION FOR COMPLIANCE

decrease in water surface elevations (hydrograph valley bottoms) between events and during the dry season.

Finding: There are no stage excursions of 15 cm (6 inches or 0.5 ft) above or below pre - development stage based on site modeling results.

The duration of stage excursions of 15 cm above or below pre- development stage does not exceed 72 hours per excursion. Note: A short-term lagging or advancement of the continuous record of water levels is acceptable. However, the 15 cm limit applies throughout the entire hydrograph, not just the peaks and valleys.

- The total dry period (when pools dry down to the soil surface everywhere in the wetland) does not increase or decrease by more than two weeks in any year.
- Alterations to watershed and wetland hydrology that may cause perennial wetlands to become **vernal** are avoided.

Finding: There is no duration of stage excursions of 15 cm (6 inches or 0.5 ft) above or below pre- development stage based on site modeling results.

Other files (separate document) used to develop the input for modeling:

1. **Site Background Info**
2. **May 11, 2016 Field Observations**
3. **Cross section locations – outflow route**
4. **HCAD – Control Cross Section for Wetland – WWHM input to SDD Table**
5. **HCAD Single Event Hydrograph Plot**

Summary:

- **The modeled largest mean annual WLF and the largest mean monthly WLF are both significantly less than the allowed limits.**
- **Modeling results of the site for both stage excursions, and duration of stage excursions, all fall well within the allowed limits above or below pre-development stage.**
- **Based on these results, the site can or does meet the requirements of Minimum Requirement #8 – Wetland Protection Evaluation for Compliance.**

APPENDIX b-2a SUPPORT FILES FOR HYDROPERIOD EVALUATION

1. Site Background Info – The Parklands in Camas, WA

There are 42 proposed residential lots of 15,000 sf minimum and the remainder as a business park. The offsite area from the south is a mix of residential and multi-unit housing. The road section between the two projects is about 2.4 acres.

There are three wetland portions for the onsite wetland designated as wetland A, Wetland B, and wetland C. Wetland A and B are separated by a road crossing with two 12 inch culverts and wetland B and C are separated by a road crossing with two 12 inch culverts.

Wetland A: 5.97 acres
Wetland B: 1.37 acres
Wetland C: 0.11 acres
7.44 acres total

The wetland buffer is 50 ft wide and includes another 3.5 acres. The remaining site area is 25.42. Another project (approx. 18 acres) is under review and an area to the west of about 14 acres has been accounted for as future development.

Note: The existing condition areas and post-development full build contributing areas are listed in file MR#8-01 Annual Mean Average Values – compare Water Level Fluctuations (WLF). The project basin maps represent the delineation of these contributing areas.

The site is underlain with sandstone and refusal varied from 3 ft to 6.5 ft at seven locations. The wetland continues (as a contiguous wetland) north for approximately another 600 feet to Lacamas Lake. The offsite portion is about 900 ft wide and is mostly reed canary grass and some wooded area before entering the Lake.

APPENDIX b-2a SUPPORT FILES FOR HYDROPERIOD EVALUATION

2. May 11, 2016 Field Observations



Looking north from site – large rockery wall at right side of flow path (along edge of golf green)



Looking back at site – rockery wall now on left side of flow path – view from cart path crossing

APPENDIX b-2a SUPPORT FILES FOR HYDROPERIOD EVALUATION



Looking north toward lake from cart path crossing – rockery wall again along golf course with flow path at left



Closer view of rockery and flow path at rockery

APPENDIX b-2a SUPPORT FILES FOR HYDROPERIOD EVALUATION



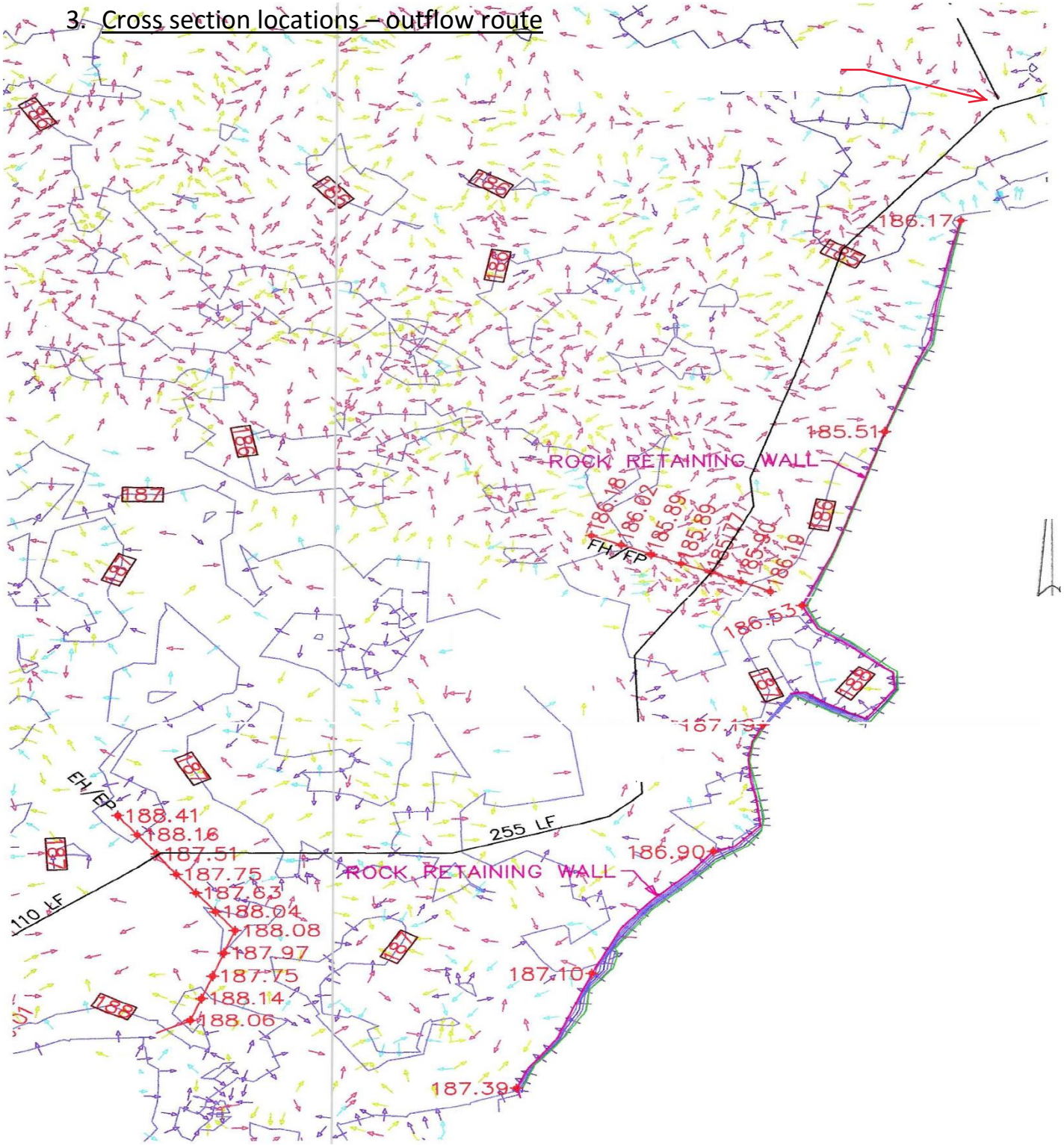
Same area along rockery wall



Outlet to Lacamas Lake – later determined there are two outfall locations – the other is 190 ft to the east.

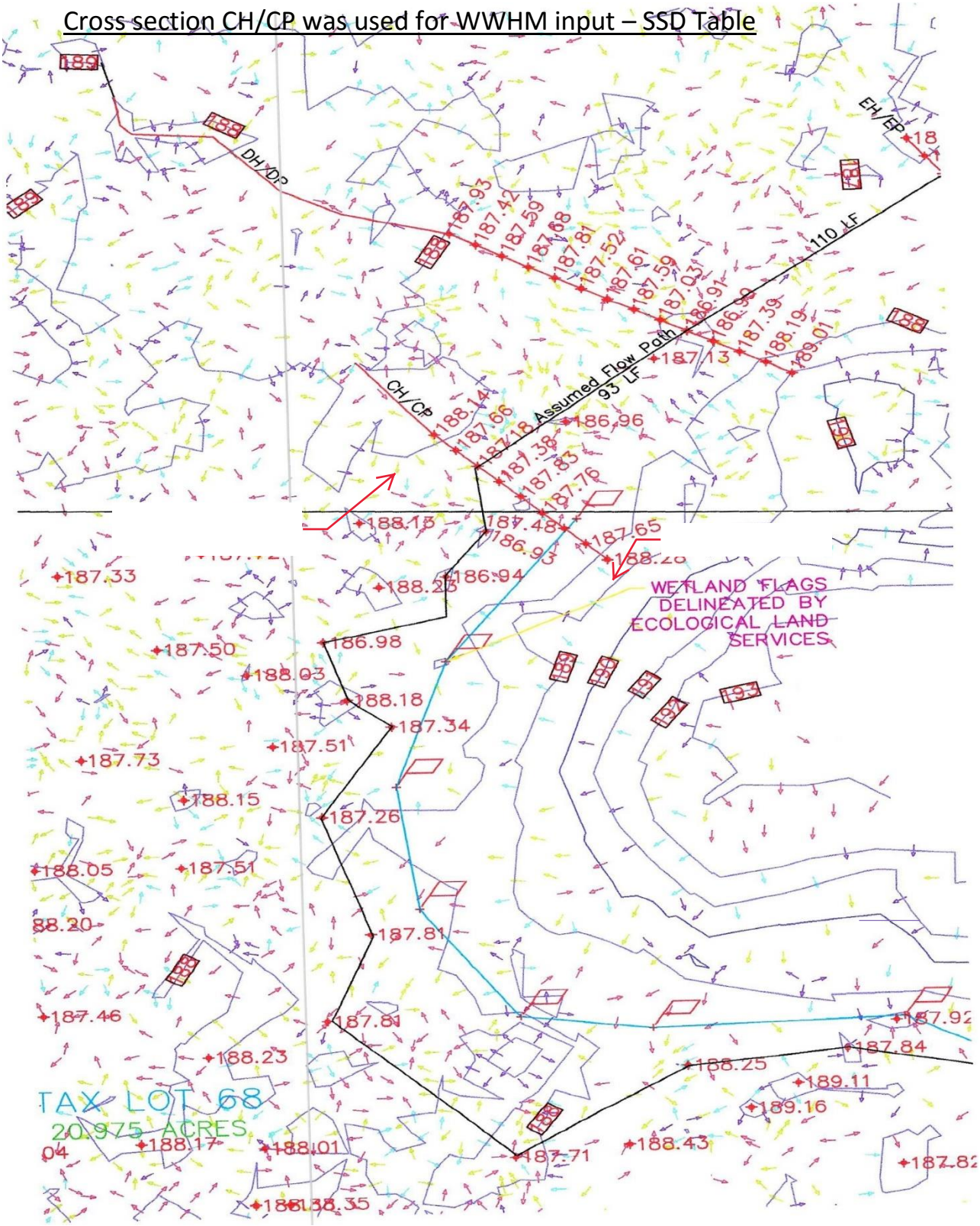
APPENDIX b-2a SUPPORT FILES FOR HYDROPERIOD EVALUATION

3. Cross section locations – outflow route



APPENDIX b-2a SUPPORT FILES FOR HYDROPERIOD EVALUATION

Cross section CH/CP was used for WWHM input – SSD Table



APPENDIX b-2a SUPPORT FILES FOR HYDROPERIOD EVALUATION

4. HCAD – Control Cross Section for Wetland – WWHM input to SDD Table

Parklands - per Survey *Type IA 24-hr 100-yr Rainfall=5.30"*
Prepared by Hewlett-Packard Company Printed 7/21/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

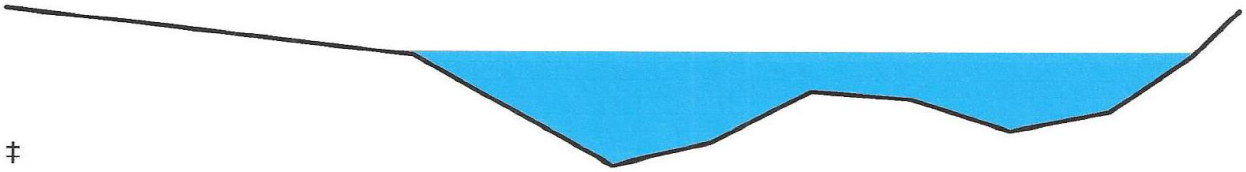
Summary for Reach CH: outflow from site

Inflow Area = 92.930 ac, 0.00% Impervious, Inflow Depth = 3.05" for 100-yr event
Inflow = 27.77 cfs @ 11.07 hrs, Volume= 23.638 af
Outflow = 27.76 cfs @ 11.15 hrs, Volume= 23.638 af, Atten= 0%, Lag= 4.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs / 3
Max. Velocity= 0.65 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 0.30 fps, Avg. Travel Time= 5.2 min

Peak Storage= 3,992 cf @ 11.11 hrs
Average Depth at Peak Storage= 1.00'
Bank-Full Depth= 1.35' Flow Area= 79.4 sf, Capacity= 59.05 cfs

Custom cross-section, Length= 93.0' Slope= 0.0029 '/' (101 Elevation Intervals)
Constant n= 0.080 Earth, long dense weeds
Inlet Invert= 187.18', Outlet Invert= 186.91'



‡

Offset (feet)	Elevation (feet)	Chan.Depth (feet)
-41.00	188.53	0.00
0.00	188.14	0.39
10.00	187.66	0.87
20.00	187.18	1.35
30.00	187.38	1.15
40.00	187.83	0.70
50.00	187.76	0.77
60.00	187.48	1.05
70.00	187.65	0.88
78.30	188.14	0.39
83.00	188.53	0.00

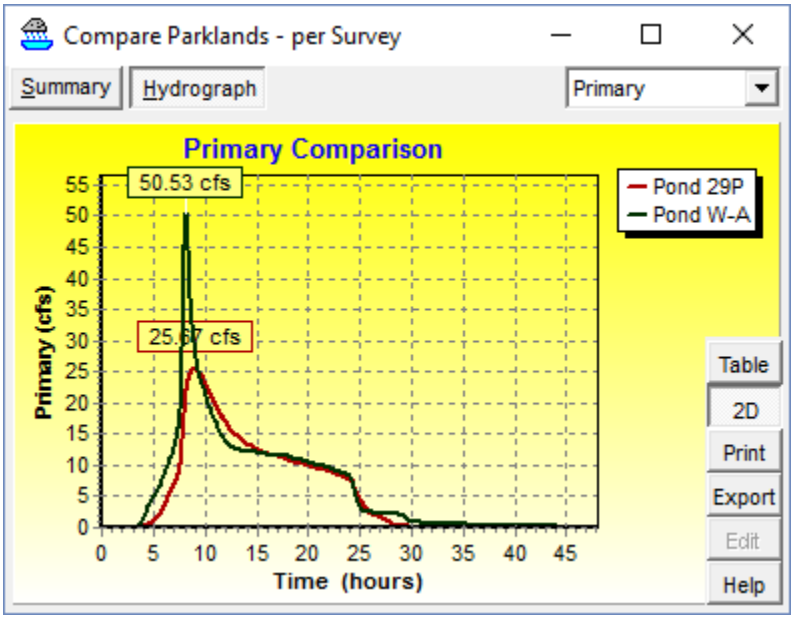
Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.20	1.4	14.2	132	0.31
0.30	3.0	18.5	284	0.91
0.47	8.2	41.9	761	2.76
0.48	8.6	42.8	800	2.95
0.58	13.4	52.4	1,243	5.37
0.65	17.5	66.6	1,630	7.22
0.96	40.0	78.4	3,719	25.53
1.35	79.4	124.1	7,387	59.05

APPENDIX b-2a SUPPORT FILES FOR HYDROPERIOD EVALUATION

5. HCAD Single Event Hydrograph Plot

FIG. 1 COMPARE HISTORIC FLOW AND POST FULL- BUILD FLOW

- 100-yr, 24-hr, single event – Flow at Cross-section at north property line
- No Flow Control per Min. Requirement #7



- Red is Historic and green is Post-Full Build

Even though post flow is nearly twice the historic, it is 'quickly' attenuated and the falling limb soon matches the historic (would also match existing condition).

A rough estimate of the volume during the peak is about 68,000 cu ft in about a 1.75 hour period of time.

The 100-yr,24-hr event Historic volume is 21.126 ac-ft and the Full-Build volume is 24.707 ac-ft or a 17% increase.

Historic:

The maximum velocity at the control section is 0.64 fps and the average for the event is 0.30 fps.

Post Full Build:

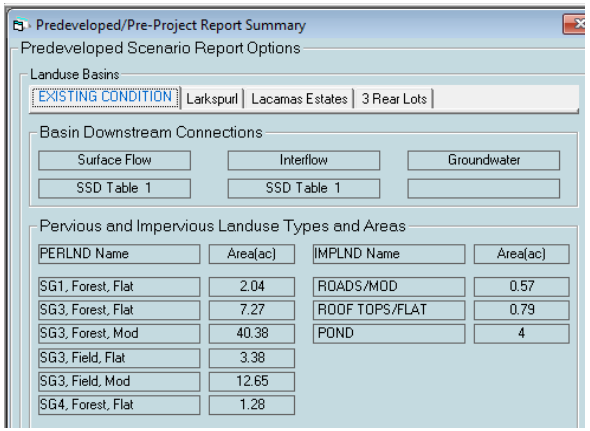
The maximum velocity at the control section is 0.72 fps and the average for the event is 0.36 fps.

- **These are not erosive velocities as the typical erosive velocity would be above 3 fps.**

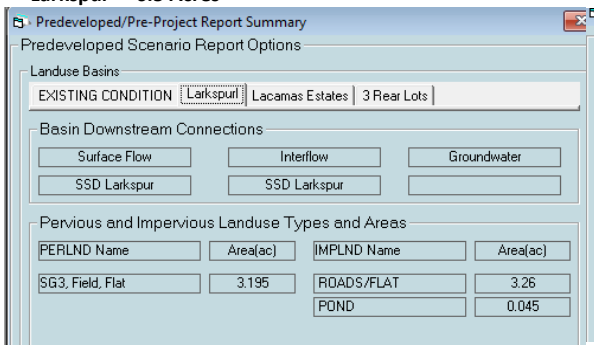
APPENDIX B WETLAND PROTECTION
B-2b MR #8 ANNUAL WLF COMPARISON

WWHM Input Values

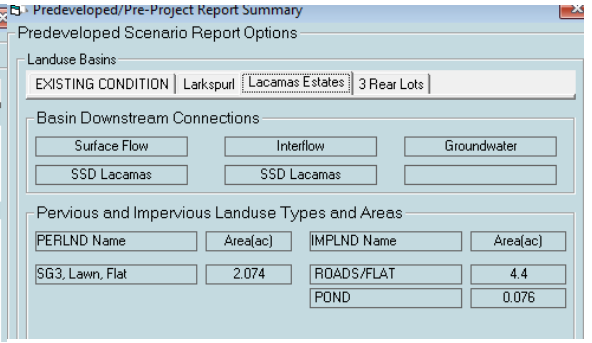
72.36 Acres and add other three areas = 86.13 Acres



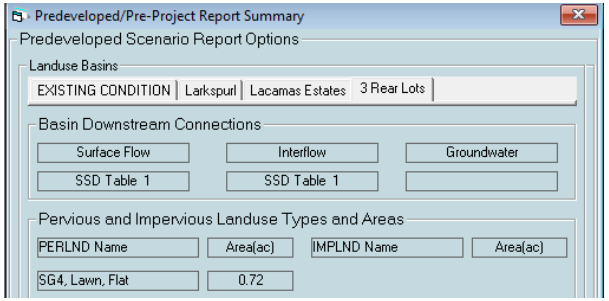
Larkspur = 6.5 Acres



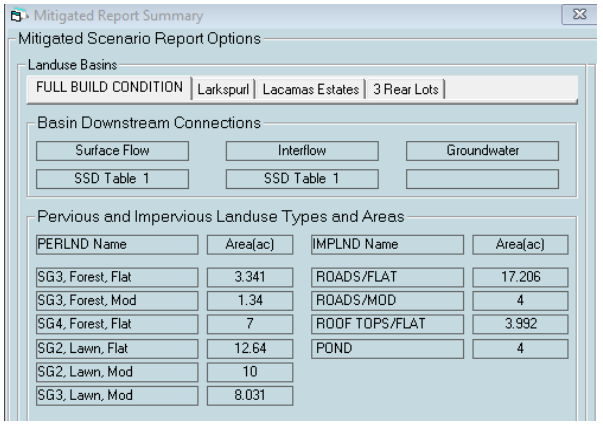
Lacamas Estates = 6.55 Acres



3 Lots = 0.72 Acres - input as HSG D (composite with roofs)



Full Development = 71.55 Acres. The add other three areas 85.32 Acres in model

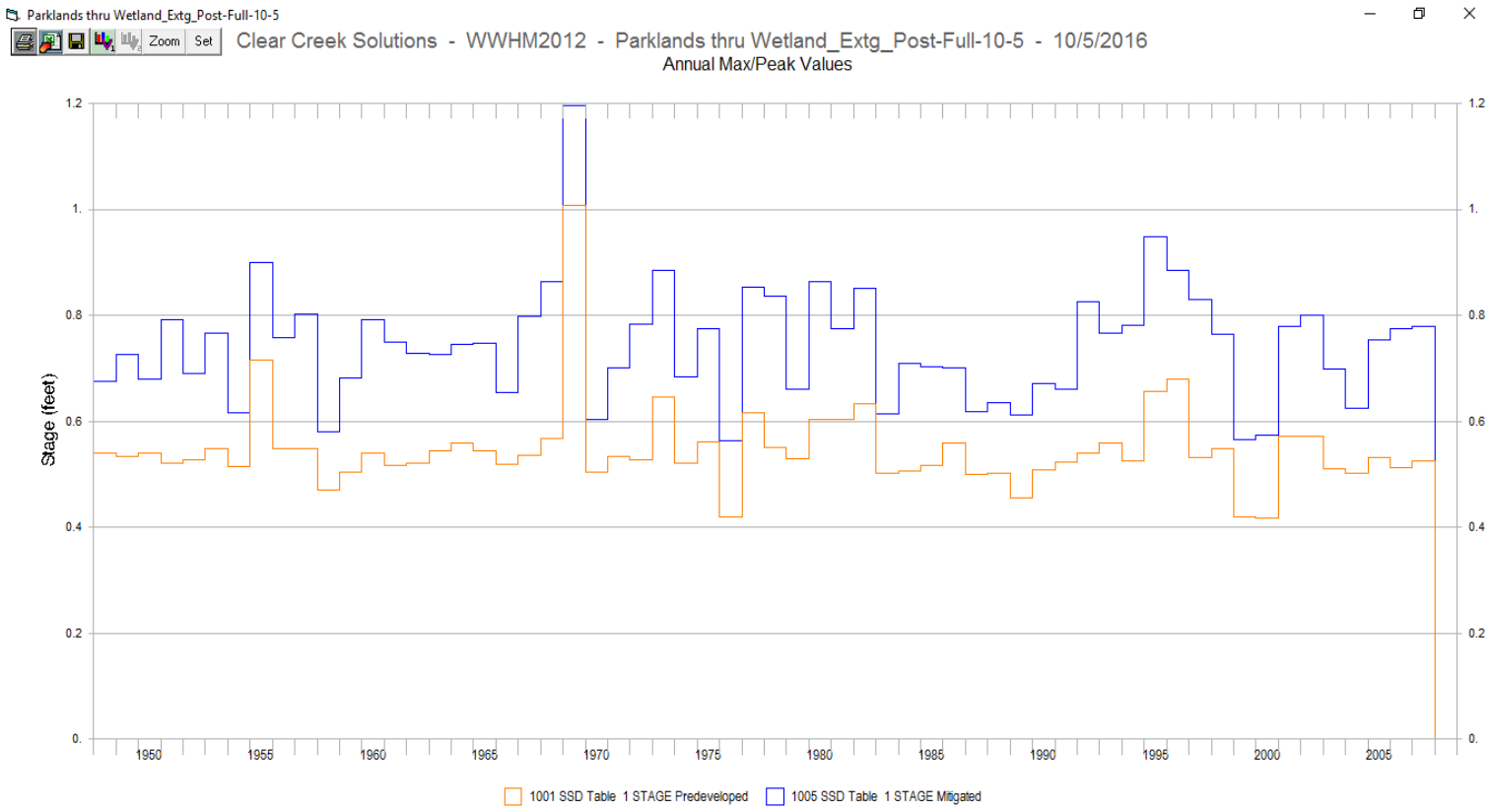


Notes:

1. Both models apply surface runoff and interflow conditions but not groundwater. Assumed sandstone close to surface at site and to south of site is restrictive.
2. Both models are based on the same SSD Table input and based on the same control section forflow release.
3. Both model apply precipitaion and evaporation to the wetland ponding surface. Actually this area was already accounted for as 4 acres in runoff area summaries. it was

• Since it was applied in the same manner to both, it doesn't skew the revative difference in WLFs.

APPENDIX B WETLAND PROTECTION
B-2b MR #8 ANNUAL WLF COMPARISON



APPENDIX B WETLAND PROTECTION
B-2b MR #8 ANNUAL WLF COMPARISON

Chronologic Order (Part 1)

Yearly Start in October Annual Basis	1000 SSD Table 1 Stage Existing	1003 SSD Table 1 Stage Post-full	WFL Stage Diff. (ft)
10/1/1948	0.5395406	0.6758	0.136
10/1/1949	0.5338328	0.725099	0.191
10/1/1950	0.5396591	0.679822	0.140
10/1/1951	0.5205137	0.791648	0.271
10/1/1952	0.5279581	0.690198	0.162
10/1/1953	0.5484218	0.76568	0.217
10/1/1954	0.5154371	0.615881	0.100
10/1/1955	0.7146549	0.900133	0.185
10/1/1956	0.5493676	0.757547	0.208
10/1/1957	0.5488995	0.802242	0.253
10/1/1958	0.47091	0.581094	0.110
10/1/1959	0.5047801	0.681179	0.176
10/1/1960	0.5394353	0.791504	0.252
10/1/1961	0.5176865	0.750177	0.232
10/1/1962	0.520259	0.727708	0.207
10/1/1963	0.5450631	0.725677	0.181
10/1/1964	0.5596859	0.744215	0.185
10/1/1965	0.5438498	0.746706	0.203
10/1/1966	0.5186027	0.654297	0.136
10/1/1967	0.5356779	0.798385	0.263
10/1/1968	0.5683826	0.862985	0.295
10/1/1969	1.006669	1.195714	0.189
10/1/1970	0.5031672	0.603265	0.100
10/1/1971	0.5335248	0.700894	0.167
10/1/1972	0.5283074	0.782503	0.254
10/1/1973	0.6455432	0.883976	0.238
10/1/1974	0.5202874	0.684284	0.164
10/1/1975	0.5612866	0.774875	0.214
10/1/1976	0.4195426	0.562605	0.143
10/1/1977	0.6157556	0.853217	0.237
10/1/1978	0.5504337	0.835704	0.285

Chronologic Order (Part 2)

Yearly Start in October Annual Basis	1000 SSD Table 1 Stage Existing	1003 SSD Table 1 Stage Post-full	WFL Stage Diff. (ft)
10/1/1979	0.530083	0.661415	0.131
10/1/1980	0.602645	0.863093	0.260
10/1/1981	0.603908	0.77411	0.170
10/1/1982	0.633952	0.851683	0.218
10/1/1983	0.502442	0.613586	0.111
10/1/1984	0.506779	0.709827	0.203
10/1/1985	0.516684	0.703085	0.186
10/1/1986	0.5589	0.701622	0.143
10/1/1987	0.500365	0.61721	0.117
10/1/1988	0.501101	0.635145	0.134
10/1/1989	0.454764	0.611058	0.156
10/1/1990	0.507534	0.671266	0.164
10/1/1991	0.52322	0.661414	0.138
10/1/1992	0.53982	0.826355	0.287
10/1/1993	0.559034	0.767289	0.208
10/1/1994	0.524672	0.781118	0.256
10/1/1995	0.656995	0.947417	0.290
10/1/1996	0.679676	0.885464	0.206
10/1/1997	0.53199	0.829502	0.298
10/1/1998	0.549406	0.763878	0.214
10/1/1999	0.418597	0.56493	0.146
10/1/2000	0.418002	0.57303	0.155
10/1/2001	0.571142	0.778123	0.207
10/1/2002	0.57146	0.799171	0.228
10/1/2003	0.509367	0.69792	0.189
10/1/2004	0.501092	0.625087	0.124
10/1/2005	0.532091	0.754634	0.223
10/1/2006	0.512854	0.77507	0.262
10/1/2007	0.525068	0.779752	0.255
10/1/2008	0	0	0.000

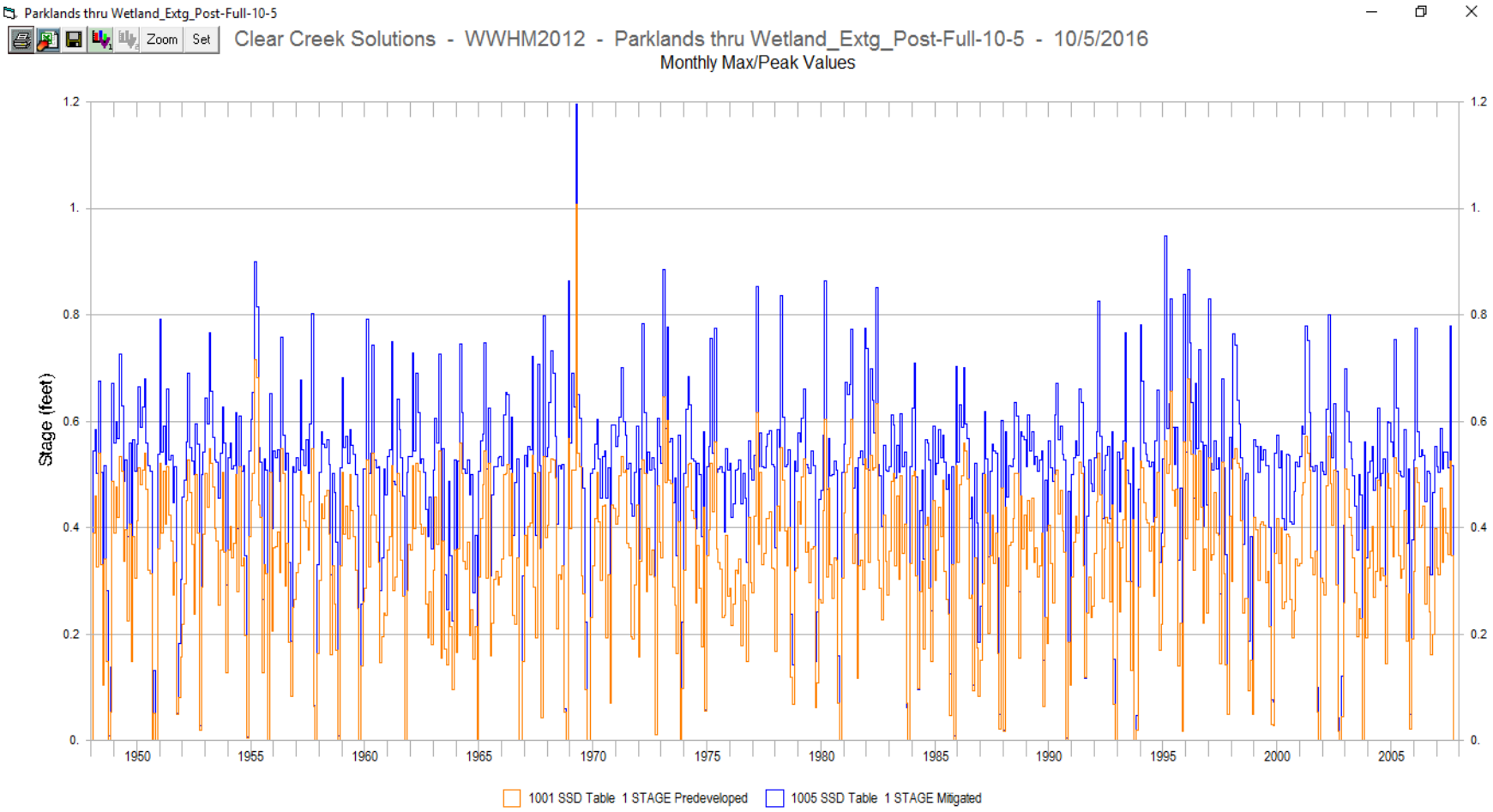
WFL - Highest to Lowest (Part 1)

Yearly Start in October Annual Basis	1000 SSD Table 1 Stage Existing	1003 SSD Table 1 Stage Post-full	WFL Stage Diff. (ft)
10/1/1997	0.53199	0.829502	0.298
10/1/1968	0.568383	0.862985	0.295
10/1/1995	0.656995	0.947417	0.290
10/1/1992	0.53982	0.826355	0.287
10/1/1978	0.550434	0.835704	0.285
10/1/1951	0.520514	0.791648	0.271
10/1/1967	0.535678	0.798385	0.263
10/1/2006	0.512854	0.77507	0.262
10/1/1980	0.602645	0.863093	0.260
10/1/1994	0.524672	0.781118	0.256
10/1/2007	0.525068	0.779752	0.255
10/1/1972	0.528307	0.782503	0.254
10/1/1957	0.5489	0.802242	0.253
10/1/1960	0.539435	0.791504	0.252
10/1/1973	0.645543	0.883976	0.238
10/1/1977	0.615756	0.853217	0.237
10/1/1961	0.517687	0.750177	0.232
10/1/2002	0.57146	0.799171	0.228
10/1/2005	0.532091	0.754634	0.223
10/1/1982	0.633952	0.851683	0.218
10/1/1953	0.548422	0.76568	0.217
10/1/1998	0.549406	0.763878	0.214
10/1/1975	0.561287	0.774875	0.214
10/1/1993	0.559034	0.767289	0.208
10/1/1956	0.549368	0.757547	0.208
10/1/1962	0.520259	0.727708	0.207
10/1/2001	0.571142	0.778123	0.207
10/1/1996	0.679676	0.885464	0.206
10/1/1984	0.506779	0.709827	0.203
10/1/1965	0.54385	0.746706	0.203
10/1/1949	0.533833	0.725099	0.191

WFL - Highest to Lowest (Part 2)

Yearly Start in October Annual Basis	1000 SSD Table 1 Stage Existing	1003 SSD Table 1 Stage Post-full	WFL Stage Diff. (ft)
10/1/1969	1.006669	1.195714	0.189
10/1/2003	0.509367	0.69792	0.189
10/1/1985	0.516684	0.703085	0.186
10/1/1955	0.714655	0.900133	0.185
10/1/1964	0.559686	0.744215	0.185
10/1/1963	0.545063	0.725677	0.181
10/1/1959	0.50478	0.681179	0.176
10/1/1981	0.603908	0.77411	0.170
10/1/1971	0.533525	0.700894	0.167
10/1/1974	0.520287	0.684284	0.164
10/1/1990	0.507534	0.671266	0.164
10/1/1952	0.527958	0.690198	0.162
10/1/1989	0.454764	0.611058	0.156
10/1/2000	0.418002	0.57303	0.155
10/1/1999	0.418597	0.56493	0.146
10/1/1976	0.419543	0.562605	0.143
10/1/1986	0.5589	0.701622	0.143
10/1/1950	0.539659	0.679822	0.140
10/1/1991	0.52322	0.661414	0.138
10/1/1948	0.539541	0.6758	0.136
10/1/1966	0.518603	0.654297	0.136
10/1/1988	0.501101	0.635145	0.134
10/1/1979	0.530083	0.661415	0.131
10/1/2004	0.501092	0.625087	0.124
10/1/1987	0.500365	0.61721	0.117
10/1/1983	0.502442	0.613586	0.111
10/1/1958	0.47091	0.581094	0.110
10/1/1954	0.515437	0.615881	0.100
10/1/1970	0.503167	0.603265	0.100
10/1/2008	0	0	0.000

APPENDIX B WETLAND PROTECTION
B-2c MR #8 - MONTHLY MEAN AVERAGE VALUES
COMPARE WATER LEVEL FLUCTUTAIONS (WLF)



APPENDIX B WETLAND PROTECTION
B-2c MR #8 - MONTHLY MEAN AVERAGE VALUES
COMPARE WATER LEVEL FLUCTUTAIONS (WLF)

Chronologic Order (Part 1)

Month/Yr Monthly Basis	1000 SSD Table 1 Stage Existing	1003 SSD Table 1 Stage Post-full	WFL Stage Diff. (ft)
########	0	0	0.000
########	0.3889198	0.543298	0.154
########	0.4606003	0.585275	0.125
1/1/1949	0.3254456	0.501706	0.176
2/1/1949	0.5395406	0.6758	0.136
3/1/1949	0.330761	0.504087	0.173
4/1/1949	0.1031704	0.274826	0.172
5/1/1949	0.3408766	0.517458	0.177
6/1/1949	0.1494969	0.282105	0.133
7/1/1949	0.00045924	0.009925	0.009
8/1/1949	0.05268456	0.138584	0.086
9/1/1949	0.4860552	0.67181	0.186
########	0.3906267	0.559442	0.169
########	0.4756182	0.599147	0.124
########	0.4195786	0.567196	0.148
1/1/1950	0.5338328	0.725099	0.191
2/1/1950	0.5055011	0.628924	0.123
3/1/1950	0.3372491	0.487871	0.151
4/1/1950	0.3958348	0.527487	0.132
5/1/1950	0.224558	0.383682	0.159
6/1/1950	0.4059314	0.558609	0.153
7/1/1950	0.1475885	0.333041	0.185
8/1/1950	0.3826286	0.564423	0.182
9/1/1950	0.3049622	0.505195	0.200
########	0.4125287	0.556421	0.144
########	0.51243	0.664537	0.152
########	0.4802838	0.588201	0.108
1/1/1951	0.5088556	0.627017	0.118
2/1/1951	0.5396591	0.679822	0.140
3/1/1951	0.472095	0.559095	0.087
4/1/1951	0.3198473	0.515922	0.196
5/1/1951	0.3128576	0.505526	0.193
6/1/1951	0.00023113	0.000231	0.000
7/1/1951	0.0503138	0.131306	0.081
8/1/1951	0	0	0.000

Chronologic Order (Part 2)

Month/Yr Monthly Basis	1000 SSD Table 1 Stage Existing	1003 SSD Table 1 Stage Post-full	WFL Stage Diff. (ft)
########	0.166803	0.362183	0.195
########	0.441239	0.584979	0.144
########	0.39488	0.549545	0.155
1/1/1979	0.550434	0.835704	0.285
2/1/1979	0.488521	0.607168	0.119
3/1/1979	0.394872	0.514431	0.120
4/1/1979	0.327586	0.51943	0.192
5/1/1979	0.400831	0.545511	0.145
6/1/1979	0.119676	0.237475	0.118
7/1/1979	0.067903	0.142752	0.075
8/1/1979	0.318179	0.524283	0.206
9/1/1979	0.323774	0.505163	0.181
########	0.449814	0.577126	0.127
########	0.405746	0.560517	0.155
########	0.494515	0.605085	0.111
1/1/1980	0.530083	0.661415	0.131
2/1/1980	0.354799	0.517937	0.163
3/1/1980	0.373881	0.511603	0.138
4/1/1980	0.29717	0.50102	0.204
5/1/1980	0.360286	0.544243	0.184
6/1/1980	0.363487	0.51674	0.153
7/1/1980	0.060983	0.148867	0.088
8/1/1980	0.108186	0.242158	0.134
9/1/1980	0.264043	0.454237	0.190
########	0.259436	0.470209	0.211
########	0.431197	0.573349	0.142
########	0.602645	0.863093	0.260
1/1/1981	0.306919	0.472511	0.166
2/1/1981	0.47432	0.56693	0.093
3/1/1981	0.330382	0.497999	0.168
4/1/1981	0.266339	0.500202	0.234
5/1/1981	0.342268	0.525553	0.183
6/1/1981	0.338973	0.508084	0.169
7/1/1981	0.070363	0.159847	0.089
8/1/1981	0	0	0.000

WFL - Highest to Lowest (Part 1)

Month/Yr Monthly Basis	1000 SSD Table 1 Stage Existing	1003 SSD Table 1 Stage Post-full	WFL Stage Diff. (ft)
########	0.563138	0.947417	0.384
########	0.53199	0.829502	0.298
9/1/1969	0.568383	0.862985	0.295
########	0.53982	0.826355	0.287
1/1/1979	0.550434	0.835704	0.285
8/1/1991	0.185368	0.469012	0.284
9/1/1996	0.561034	0.839125	0.278
6/1/1976	0.231176	0.502951	0.272
9/1/1970	0.230611	0.502043	0.271
########	0.520514	0.791648	0.271
8/1/1961	0.240464	0.509617	0.269
8/1/2007	0.199857	0.466889	0.267
4/1/1977	0.17848	0.44532	0.267
5/1/1967	0.219018	0.483982	0.265
########	0.526968	0.791504	0.265
8/1/1968	0.533937	0.798385	0.264
5/1/1965	0.197376	0.461594	0.264
8/1/1957	0.250746	0.514679	0.264
5/1/1986	0.238195	0.500769	0.263
########	0.512854	0.77507	0.262
5/1/1971	0.193056	0.455205	0.262
6/1/2007	0.241062	0.502665	0.262
4/1/1953	0.23747	0.498787	0.261
########	0.602645	0.863093	0.260
8/1/1990	0.231592	0.490059	0.258
########	0.524672	0.781118	0.256
7/1/1996	0.219554	0.474331	0.255
5/1/2008	0.525068	0.779752	0.255
6/1/1965	0.246128	0.500558	0.254
########	0.528307	0.782503	0.254
5/1/2004	0.247051	0.500798	0.254
6/1/1958	0.5489	0.802242	0.253
8/1/1992	0.230806	0.482565	0.252
9/1/1960	0.260047	0.510475	0.250
6/1/1972	0.194785	0.444239	0.249

WFL - Highest to Lowest (Part 2)

Month/Yr Monthly Basis	1000 SSD Table 1 Stage Exsting	1003 SSD Table 1 Stage Post-full	WFL Stage Diff. (ft)
6/1/1978	0.417998	0.575578	0.158
########	0.402059	0.559504	0.157
########	0.437768	0.595015	0.157
########	0.396115	0.552658	0.157
########	0.396876	0.553362	0.156
3/1/1953	0.368135	0.524598	0.156
6/1/1968	0.360376	0.516788	0.156
6/1/1993	0.259979	0.416308	0.156
7/1/1976	0.235702	0.391706	0.156
2/1/2004	0.342844	0.498492	0.156
5/1/1998	0.523073	0.678701	0.156
9/1/1953	0.38668	0.542289	0.156
4/1/1960	0.382963	0.538037	0.155
########	0.418002	0.57303	0.155
7/1/1995	0.503073	0.657916	0.155
2/1/1971	0.300296	0.455104	0.155
########	0.405746	0.560517	0.155
########	0.39488	0.549545	0.155
5/1/1975	0.36599	0.520507	0.155
########	0.38892	0.543298	0.154
9/1/2007	0.398558	0.552779	0.154
3/1/2008	0.388711	0.542767	0.154
4/1/1965	0.373016	0.526946	0.154
########	0.392705	0.546159	0.153
########	0.500958	0.654297	0.153
6/1/1980	0.363487	0.51674	0.153
4/1/2001	0.382573	0.535698	0.153
6/1/1990	0.390205	0.543224	0.153
9/1/1968	0.381087	0.534058	0.153
########	0.451621	0.604413	0.153
6/1/1950	0.405931	0.558609	0.153
########	0.390034	0.542547	0.153
7/1/1978	0.429746	0.582213	0.152
########	0.51243	0.664537	0.152
2/1/1985	0.279276	0.431279	0.152

APPENDIX B WETLAND PROTECTION
B-2c MR #8 - MONTHLY MEAN AVERAGE VALUES
COMPARE WATER LEVEL FLUCTUTAIONS (WLF)

9/1/1951	0.3597596	0.537375	0.178
########	0.5205137	0.791648	0.271
########	0.390034	0.542547	0.153
########	0.5056912	0.591647	0.086
1/1/1952	0.4072077	0.518023	0.111
2/1/1952	0.5138198	0.659805	0.146
3/1/1952	0.4228382	0.528187	0.105
4/1/1952	0.3759083	0.535493	0.160
5/1/1952	0.272432	0.44642	0.174
6/1/1952	0.3345274	0.514334	0.180
7/1/1952	0.0498891	0.050844	0.001
8/1/1952	0.08067256	0.183104	0.102
9/1/1952	0.1573422	0.303738	0.146
########	0.2188435	0.457513	0.239
########	0.2949103	0.489492	0.195
########	0.4503163	0.561079	0.111
1/1/1953	0.5279581	0.690198	0.162
2/1/1953	0.4666425	0.549654	0.083
3/1/1953	0.3681347	0.524598	0.156
4/1/1953	0.2374703	0.498787	0.261
5/1/1953	0.5001945	0.594626	0.094
6/1/1953	0.3895462	0.557334	0.168
7/1/1953	0.0199872	0.02735	0.007
8/1/1953	0.2884206	0.500758	0.212
9/1/1953	0.3866798	0.542289	0.156
########	0.5021553	0.643405	0.141
########	0.4377676	0.595015	0.157
########	0.5484218	0.76568	0.217
1/1/1954	0.521135	0.65598	0.135
2/1/1954	0.4768988	0.569711	0.093
3/1/1954	0.3981145	0.527167	0.129
4/1/1954	0.3744024	0.522489	0.148
5/1/1954	0.2533177	0.454638	0.201
6/1/1954	0.3588542	0.540816	0.182
7/1/1954	0.5040935	0.627581	0.123
8/1/1954	0.3531407	0.559841	0.207
9/1/1954	0.1278746	0.292209	0.164
########	0.3586135	0.531605	0.173
########	0.4020585	0.559504	0.157
########	0.3427964	0.510794	0.168

9/1/1981	0.305862	0.504333	0.198
########	0.427888	0.555822	0.128
########	0.502993	0.673766	0.171
########	0.519025	0.649697	0.131
1/1/1982	0.530537	0.669641	0.139
2/1/1982	0.603908	0.773104	0.169
3/1/1982	0.333464	0.475001	0.142
4/1/1982	0.38781	0.512722	0.125
5/1/1982	0.117833	0.240711	0.123
6/1/1982	0.328429	0.530437	0.202
7/1/1982	0.338312	0.544263	0.206
8/1/1982	0.284137	0.518153	0.234
9/1/1982	0.529147	0.77411	0.245
########	0.511362	0.736522	0.225
########	0.334363	0.508833	0.174
########	0.535897	0.697778	0.162
1/1/1983	0.507311	0.6393	0.132
2/1/1983	0.511905	0.577698	0.066
3/1/1983	0.633952	0.851683	0.218
4/1/1983	0.339766	0.519029	0.179
5/1/1983	0.286185	0.49846	0.212
6/1/1983	0.227498	0.403467	0.176
7/1/1983	0.423036	0.554501	0.131
8/1/1983	0.335909	0.508517	0.173
9/1/1983	0.272339	0.506609	0.234
########	0.35609	0.515401	0.159
########	0.486413	0.61249	0.126
########	0.502442	0.593752	0.091
1/1/1984	0.328511	0.493526	0.165
2/1/1984	0.459677	0.55406	0.094
3/1/1984	0.303145	0.504365	0.201
4/1/1984	0.498471	0.613586	0.115
5/1/1984	0.352255	0.514767	0.163
6/1/1984	0.406791	0.541025	0.134
7/1/1984	0.070569	0.062683	-0.008
8/1/1984	0	0	0.000
9/1/1984	0.332154	0.514455	0.182
########	0.497872	0.623537	0.126
########	0.506779	0.709827	0.203
########	0.310168	0.495458	0.185

9/1/1982	0.529147	0.77411	0.245
6/1/1964	0.241806	0.486152	0.244
8/1/1966	0.291671	0.532153	0.240
5/1/1966	0.220905	0.461161	0.240
7/1/1985	0.287119	0.52645	0.239
9/1/1957	0.265416	0.504585	0.239
########	0.218844	0.457513	0.239
########	0.645543	0.883976	0.238
5/1/1974	0.25445	0.492647	0.238
########	0.615756	0.853217	0.237
9/1/1976	0.271159	0.507367	0.236
7/1/2006	0.275086	0.511151	0.236
8/1/1987	0.17359	0.409293	0.236
########	0.287019	0.521825	0.235
########	0.521224	0.75575	0.235
6/1/1999	0.26754	0.501831	0.234
9/1/1983	0.272339	0.506609	0.234
########	0.529819	0.763878	0.234
8/1/1982	0.284137	0.518153	0.234
4/1/1981	0.266339	0.500202	0.234
8/1/1999	0.151186	0.383915	0.233
########	0.517687	0.750177	0.232
6/1/2004	0.229509	0.460968	0.231
7/1/1972	0.191	0.421284	0.230
########	0.272538	0.500758	0.228
########	0.259068	0.487066	0.228
1/1/2003	0.57146	0.799171	0.228
9/1/1966	0.30654	0.533136	0.227
9/1/1961	0.236344	0.462148	0.226
########	0.511362	0.736522	0.225
########	0.285678	0.510307	0.225
8/1/1962	0.281712	0.504489	0.223
5/1/1999	0.266622	0.489229	0.223
########	0.532091	0.754634	0.223
7/1/2001	0.244773	0.467067	0.222
2/1/1973	0.279645	0.501825	0.222
6/1/2005	0.308598	0.529738	0.221
7/1/1992	0.307709	0.527333	0.220
4/1/2000	0.297484	0.516468	0.219
9/1/2002	0.304964	0.523087	0.218

########	0.479899	0.63145	0.152
5/1/2006	0.432456	0.583916	0.151
6/1/1988	0.389394	0.540693	0.151
4/1/1959	0.161124	0.312298	0.151
########	0.502201	0.653192	0.151
7/1/2007	0.160731	0.311678	0.151
3/1/2001	0.387393	0.538325	0.151
2/1/1993	0.266611	0.417462	0.151
7/1/1955	0.196985	0.347789	0.151
4/1/1987	0.26704	0.417823	0.151
3/1/1950	0.337249	0.487871	0.151
########	0.422029	0.572444	0.150
########	0.402039	0.552364	0.150
1/1/1989	0.365722	0.515969	0.150
########	0.393451	0.543649	0.150
8/1/1971	0.442506	0.59257	0.150
6/1/1957	0.184604	0.334334	0.150
4/1/1966	0.159834	0.309548	0.150
9/1/2004	0.193775	0.343482	0.150
4/1/1967	0.235758	0.3852	0.149
########	0.403231	0.552425	0.149
########	0.4568	0.605991	0.149
9/1/1972	0.441968	0.591106	0.149
1/1/1986	0.382761	0.531428	0.149
########	0.386548	0.53495	0.148
9/1/1998	0.421188	0.569553	0.148
4/1/1954	0.374402	0.522489	0.148
3/1/1993	0.359802	0.507816	0.148
8/1/1956	0.504863	0.652626	0.148
7/1/1961	0.195966	0.343601	0.148
########	0.419579	0.567196	0.148
5/1/1958	0.448316	0.595473	0.147
1/1/1994	0.415236	0.562374	0.147
5/1/2001	0.264024	0.4106	0.147
1/1/1955	0.370708	0.517189	0.146
9/1/1952	0.157342	0.303738	0.146
7/1/2005	0.143566	0.289951	0.146
########	0.404788	0.551149	0.146
########	0.418597	0.56493	0.146
1/1/2000	0.405936	0.552009	0.146

APPENDIX B WETLAND PROTECTION
B-2c MR #8 - MONTHLY MEAN AVERAGE VALUES
COMPARE WATER LEVEL FLUCTUTAIONS (WLF)

1/1/1955	0.3707077	0.517189	0.146
2/1/1955	0.5001177	0.615881	0.116
3/1/1955	0.2803654	0.398497	0.118
4/1/1955	0.5154371	0.610317	0.095
5/1/1955	0.3278739	0.507082	0.179
6/1/1955	0.3433141	0.517679	0.174
7/1/1955	0.1969851	0.347789	0.151
8/1/1955	0.00569801	0.006212	0.001
9/1/1955	0.3830648	0.544102	0.161
########	0.4516213	0.604413	0.153
########	0.5022007	0.653192	0.151
########	0.7146549	0.900133	0.185
1/1/1956	0.6827379	0.815251	0.133
2/1/1956	0.4418734	0.550884	0.109
3/1/1956	0.4185046	0.522275	0.104
4/1/1956	0.1283704	0.263982	0.136
5/1/1956	0.3299178	0.529543	0.200
6/1/1956	0.3145488	0.508795	0.194
7/1/1956	0.00021448	1.68E-05	0.000
8/1/1956	0.5048633	0.652626	0.148
9/1/1956	0.2052681	0.397339	0.192
########	0.3632559	0.543617	0.180
########	0.3635143	0.531416	0.168
########	0.3927048	0.546159	0.153
1/1/1957	0.3161193	0.486254	0.170
2/1/1957	0.5493676	0.757547	0.208
3/1/1957	0.5017435	0.572922	0.071
4/1/1957	0.2911503	0.508914	0.218
5/1/1957	0.3702774	0.539989	0.170
6/1/1957	0.1846044	0.334334	0.150
7/1/1957	0.08236788	0.187128	0.105
8/1/1957	0.2507455	0.514679	0.264
9/1/1957	0.2654164	0.504585	0.239
########	0.3155639	0.532475	0.217
########	0.3336456	0.508054	0.174
########	0.505983	0.678046	0.172
1/1/1958	0.4615452	0.547115	0.086
2/1/1958	0.4119957	0.516356	0.104
3/1/1958	0.4002277	0.565264	0.165
4/1/1958	0.357785	0.502868	0.145

1/1/1985	0.097239	0.095204	-0.002
2/1/1985	0.279276	0.431279	0.152
3/1/1985	0.337694	0.508571	0.171
4/1/1985	0.170901	0.340388	0.169
5/1/1985	0.404237	0.565385	0.161
6/1/1985	0.42027	0.558413	0.138
7/1/1985	0.287119	0.52645	0.239
8/1/1985	0.147923	0.244825	0.097
9/1/1985	0.450956	0.590015	0.139
########	0.300923	0.499036	0.198
########	0.357033	0.520606	0.164
########	0.438626	0.584196	0.146
1/1/1986	0.382761	0.531428	0.149
2/1/1986	0.48883	0.574097	0.085
3/1/1986	0.316883	0.522462	0.206
4/1/1986	0.264349	0.472029	0.208
5/1/1986	0.238195	0.500769	0.263
6/1/1986	0.047449	0.124744	0.077
7/1/1986	0.330599	0.515565	0.185
8/1/1986	0.001417	0.009005	0.008
9/1/1986	0.516684	0.703085	0.186
########	0.334556	0.522102	0.188
########	0.479899	0.63145	0.152
########	0.497743	0.588999	0.091
1/1/1987	0.5589	0.701622	0.143
2/1/1987	0.545164	0.59479	0.050
3/1/1987	0.492109	0.56777	0.076
4/1/1987	0.26704	0.417823	0.151
5/1/1987	0.272686	0.457857	0.185
6/1/1987	0.093248	0.103408	0.010
7/1/1987	0.342427	0.52041	0.178
8/1/1987	0.17359	0.409293	0.236
9/1/1987	0.082511	0.183683	0.101
########	0.150717	0.252756	0.102
########	0.294482	0.502713	0.208
########	0.500365	0.61721	0.117
1/1/1988	0.428761	0.528936	0.100
2/1/1988	0.202348	0.34505	0.143
3/1/1988	0.347806	0.506684	0.159
4/1/1988	0.422778	0.557089	0.134

4/1/1957	0.29115	0.508914	0.218
3/1/1983	0.633952	0.851683	0.218
########	0.548422	0.76568	0.217
########	0.315564	0.532475	0.217
9/1/1992	0.252068	0.467783	0.216
2/1/1976	0.561287	0.774875	0.214
3/1/1968	0.288416	0.501781	0.213
9/1/1977	0.296218	0.509571	0.213
6/1/1975	0.286525	0.499835	0.213
6/1/2001	0.193485	0.406703	0.213
8/1/1972	0.291864	0.505004	0.213
2/1/2002	0.53911	0.752218	0.213
9/1/1990	0.182079	0.394478	0.212
5/1/2003	0.293047	0.505397	0.212
8/1/1953	0.288421	0.500758	0.212
5/1/1983	0.286185	0.49846	0.212
5/1/1988	0.333032	0.544816	0.212
########	0.298129	0.509528	0.211
5/1/1977	0.291476	0.50259	0.211
########	0.278473	0.489449	0.211
########	0.259436	0.470209	0.211
8/1/1989	0.360252	0.571023	0.211
########	0.31781	0.528298	0.210
6/1/1966	0.303588	0.514074	0.210
########	0.296641	0.50699	0.210
########	0.517413	0.727708	0.210
3/1/1994	0.29926	0.508607	0.209
6/1/1959	0.256818	0.465414	0.209
2/1/1994	0.559034	0.767289	0.208
########	0.294482	0.502713	0.208
2/1/1957	0.549368	0.757547	0.208
4/1/1986	0.264349	0.472029	0.208
7/1/1998	0.142244	0.349518	0.207
7/1/1975	0.176719	0.383713	0.207
1/1/2002	0.571142	0.778123	0.207
2/1/1966	0.304224	0.511075	0.207
8/1/1954	0.353141	0.559841	0.207
5/1/1969	0.303122	0.509397	0.206
8/1/1979	0.318179	0.524283	0.206
7/1/1982	0.338312	0.544263	0.206

2/1/1952	0.51382	0.659805	0.146
3/1/1998	0.385441	0.531136	0.146
9/1/2003	0.259288	0.40486	0.146
########	0.438626	0.584196	0.146
1/1/1992	0.390797	0.536309	0.146
########	0.398629	0.544115	0.145
########	0.417145	0.562598	0.145
########	0.47744	0.622801	0.145
4/1/1958	0.357785	0.502868	0.145
1/1/1978	0.368909	0.513806	0.145
5/1/1979	0.400831	0.545511	0.145
########	0.407659	0.552331	0.145
########	0.473067	0.617664	0.145
########	0.399463	0.543649	0.144
3/1/1973	0.39765	0.541825	0.144
1/1/2004	0.385591	0.52967	0.144
3/1/1976	0.360479	0.504425	0.144
########	0.412529	0.556421	0.144
5/1/1993	0.409426	0.553172	0.144
########	0.441239	0.584979	0.144
########	0.477887	0.621612	0.144
5/1/1991	0.393609	0.536791	0.143
6/1/1995	0.419548	0.562638	0.143
8/1/1977	0.419543	0.562605	0.143
1/1/1987	0.5589	0.701622	0.143
2/1/1988	0.202348	0.34505	0.143
########	0.43866	0.581001	0.142
########	0.431197	0.573349	0.142
########	0.42006	0.561842	0.142
########	0.422408	0.563992	0.142
2/1/1989	0.372082	0.513634	0.142
3/1/1982	0.333464	0.475001	0.142
9/1/1989	0.422822	0.564292	0.141
1/1/1960	0.379191	0.520655	0.141
2/1/2007	0.405047	0.546327	0.141
########	0.502155	0.643405	0.141
8/1/1975	0.438304	0.579526	0.141
3/1/2000	0.405483	0.546656	0.141
4/1/1963	0.387767	0.528326	0.141
3/1/1962	0.501403	0.64162	0.140

APPENDIX B WETLAND PROTECTION
B-2c MR #8 - MONTHLY MEAN AVERAGE VALUES
COMPARE WATER LEVEL FLUCTUTAIONS (WLF)

5/1/1958	0.4483157	0.595473	0.147
6/1/1958	0.5488995	0.802242	0.253
7/1/1958	0.06420413	0.066783	0.003
8/1/1958	0	0	0.000
9/1/1958	0.1635196	0.331235	0.168
########	0.3007539	0.504617	0.204
########	0.4448939	0.581094	0.136
########	0.4170913	0.556057	0.139
1/1/1959	0.4602026	0.550168	0.090
2/1/1959	0.47091	0.565815	0.095
3/1/1959	0.3869302	0.517795	0.131
4/1/1959	0.1611241	0.312298	0.151
5/1/1959	0.3281681	0.502046	0.174
6/1/1959	0.2568181	0.465414	0.209
7/1/1959	0.1698624	0.372427	0.203
8/1/1959	0.00107722	0.008022	0.007
9/1/1959	0.3278721	0.513048	0.185
########	0.5047801	0.681179	0.176
########	0.3880038	0.550107	0.162
########	0.4412169	0.571395	0.130
1/1/1960	0.3791908	0.520655	0.141
2/1/1960	0.5003392	0.584431	0.084
3/1/1960	0.4323756	0.553908	0.122
4/1/1960	0.3829628	0.538037	0.155
5/1/1960	0.3209791	0.500669	0.180
6/1/1960	0.2484951	0.439901	0.191
7/1/1960	0	0	0.000
8/1/1960	0.1399809	0.256648	0.117
9/1/1960	0.2600469	0.510475	0.250
########	0.2856778	0.510307	0.225
########	0.526968	0.791504	0.265
########	0.3260732	0.500857	0.175
1/1/1961	0.4228096	0.539141	0.116
2/1/1961	0.5394353	0.743453	0.204
3/1/1961	0.4234891	0.527512	0.104
4/1/1961	0.3738431	0.512951	0.139
5/1/1961	0.3355848	0.515144	0.180
6/1/1961	0.1454726	0.281598	0.136
7/1/1961	0.1959661	0.343601	0.148
8/1/1961	0.2404642	0.509617	0.269

5/1/1988	0.333032	0.544816	0.212
6/1/1988	0.389394	0.540693	0.151
7/1/1988	0.162661	0.342274	0.180
8/1/1988	0.020797	0.048901	0.028
9/1/1988	0.473801	0.600887	0.127
########	0.017542	0.019137	0.002
########	0.43866	0.581001	0.142
########	0.290827	0.457412	0.167
1/1/1989	0.365722	0.515969	0.150
2/1/1989	0.372082	0.513634	0.142
3/1/1989	0.41762	0.528829	0.111
4/1/1989	0.501101	0.635145	0.134
5/1/1989	0.500993	0.609325	0.108
6/1/1989	0.15593	0.280598	0.125
7/1/1989	0.459371	0.580591	0.121
8/1/1989	0.360252	0.571023	0.211
9/1/1989	0.422822	0.564292	0.141
########	0.321935	0.51405	0.192
########	0.452008	0.611058	0.159
########	0.393451	0.543649	0.150
1/1/1990	0.454764	0.580884	0.126
2/1/1990	0.335091	0.519552	0.184
3/1/1990	0.362046	0.534111	0.172
4/1/1990	0.307866	0.506969	0.199
5/1/1990	0.327621	0.527623	0.200
6/1/1990	0.390205	0.543224	0.153
7/1/1990	0.063467	0.151279	0.088
8/1/1990	0.231592	0.490059	0.258
9/1/1990	0.182079	0.394478	0.212
########	0.403799	0.563731	0.160
########	0.332825	0.512168	0.179
########	0.259068	0.487066	0.228
1/1/1991	0.500035	0.611202	0.111
2/1/1991	0.507534	0.671266	0.164
3/1/1991	0.424997	0.564637	0.140
4/1/1991	0.469617	0.590639	0.121
5/1/1991	0.393609	0.536791	0.143
6/1/1991	0.352999	0.528091	0.175
7/1/1991	2.61E-06	0.0044	0.004
8/1/1991	0.185368	0.469012	0.284

########	0.679676	0.885464	0.206
4/1/1969	0.311205	0.516916	0.206
3/1/1986	0.316883	0.522462	0.206
1/1/1962	0.282559	0.487539	0.205
9/1/1997	0.238523	0.442856	0.204
2/1/1961	0.539435	0.743453	0.204
########	0.300754	0.504617	0.204
4/1/1980	0.29717	0.50102	0.204
########	0.215408	0.419241	0.204
4/1/1970	0.309311	0.513118	0.204
########	0.506779	0.709827	0.203
1/1/1966	0.54385	0.746706	0.203
########	0.530124	0.732773	0.203
7/1/1959	0.169862	0.372427	0.203
########	0.30173	0.504217	0.202
6/1/1973	0.307867	0.510115	0.202
6/1/1982	0.328429	0.530437	0.202
5/1/1954	0.253318	0.454638	0.201
3/1/1984	0.303145	0.504365	0.201
5/1/1968	0.505036	0.706194	0.201
6/1/1971	0.310901	0.51195	0.201
########	0.332637	0.533281	0.201
6/1/1998	0.312774	0.513288	0.201
9/1/1950	0.304962	0.505195	0.200
5/1/1990	0.327621	0.527623	0.200
1/1/2005	0.269248	0.469234	0.200
5/1/1956	0.329918	0.529543	0.200
4/1/1990	0.307866	0.506969	0.199
########	0.30794	0.506924	0.199
5/1/1970	0.274632	0.473607	0.199
6/1/1996	0.140088	0.338916	0.199
9/1/1981	0.305862	0.504333	0.198
########	0.300923	0.499036	0.198
5/1/2000	0.318442	0.516315	0.198
7/1/1966	0.317647	0.514369	0.197
3/1/1969	0.210636	0.40691	0.196
4/1/1951	0.319847	0.515922	0.196
4/1/1973	0.311685	0.507688	0.196
8/1/1978	0.323662	0.519624	0.196
########	0.166803	0.362183	0.195

2/1/1951	0.539659	0.679822	0.140
3/1/1991	0.424997	0.564637	0.140
########	0.41666	0.556245	0.140
5/1/1995	0.271936	0.411185	0.139
4/1/1961	0.373843	0.512951	0.139
1/1/1982	0.530537	0.669641	0.139
9/1/1985	0.450956	0.590015	0.139
4/1/1964	0.17166	0.310658	0.139
4/1/1975	0.258413	0.397411	0.139
1/1/1968	0.407897	0.546873	0.139
########	0.417091	0.556057	0.139
4/1/1972	0.371057	0.509676	0.139
2/1/1992	0.52322	0.661414	0.138
6/1/1985	0.42027	0.558413	0.138
3/1/1980	0.373881	0.511603	0.138
7/1/1993	0.443121	0.57996	0.137
3/1/2005	0.488324	0.625087	0.137
6/1/1994	0.414539	0.550908	0.136
2/1/1949	0.539541	0.6758	0.136
########	0.444894	0.581094	0.136
6/1/1961	0.145473	0.281598	0.136
3/1/1997	0.53503	0.670963	0.136
2/1/2001	0.260038	0.395708	0.136
4/1/1956	0.12837	0.263982	0.136
1/1/1954	0.521135	0.65598	0.135
2/1/1997	0.320161	0.454974	0.135
5/1/1978	0.417982	0.552474	0.134
4/1/1988	0.422778	0.557089	0.134
6/1/1984	0.406791	0.541025	0.134
1/1/2007	0.400413	0.534463	0.134
4/1/1989	0.501101	0.635145	0.134
8/1/1980	0.108186	0.242158	0.134
4/1/1997	0.41549	0.549213	0.134
3/1/1992	0.502284	0.634985	0.133
6/1/1949	0.149497	0.282105	0.133
########	0.503128	0.635656	0.133
1/1/1956	0.682738	0.815251	0.133
1/1/1983	0.507311	0.6393	0.132
4/1/1998	0.143574	0.275369	0.132
4/1/1950	0.395835	0.527487	0.132

APPENDIX B WETLAND PROTECTION
B-2c MR #8 - MONTHLY MEAN AVERAGE VALUES
COMPARE WATER LEVEL FLUCTUTAIONS (WLF)

9/1/1961	0.2363438	0.462148	0.226
########	0.3589633	0.532604	0.174
########	0.3833846	0.545252	0.162
########	0.5176865	0.750177	0.232
1/1/1962	0.2825586	0.487539	0.205
2/1/1962	0.3064744	0.481429	0.175
3/1/1962	0.5014033	0.64162	0.140
4/1/1962	0.4682464	0.584347	0.116
5/1/1962	0.3394983	0.532296	0.193
6/1/1962	0.2716797	0.459218	0.188
7/1/1962	0	0	0.000
8/1/1962	0.2817124	0.504489	0.223
9/1/1962	0.3694544	0.534595	0.165
########	0.3588333	0.532631	0.174
########	0.5174126	0.727708	0.210
########	0.398629	0.544115	0.145
1/1/1963	0.520259	0.689718	0.169
2/1/1963	0.5063238	0.615288	0.109
3/1/1963	0.4072756	0.520571	0.113
4/1/1963	0.3877669	0.528326	0.141
5/1/1963	0.4012063	0.503848	0.103
6/1/1963	0.2566267	0.434282	0.178
7/1/1963	0.1940033	0.383681	0.190
8/1/1963	0.2800491	0.457018	0.177
9/1/1963	0.1803878	0.361074	0.181
########	0.320277	0.507614	0.187
########	0.4567997	0.605991	0.149
########	0.368816	0.559763	0.191
1/1/1964	0.5450631	0.725677	0.181
2/1/1964	0.1538684	0.345099	0.191
3/1/1964	0.375635	0.549163	0.174
4/1/1964	0.1716604	0.310658	0.139
5/1/1964	0.1431328	0.245747	0.103
6/1/1964	0.2418061	0.486152	0.244
7/1/1964	0.214811	0.346414	0.132
8/1/1964	0.09648819	0.225636	0.129
9/1/1964	0.357805	0.52765	0.170
########	0.165463	0.33267	0.167
########	0.3591588	0.525124	0.166
########	0.5596859	0.744215	0.185

9/1/1991	0.103445	0.141577	0.038
########	0.306862	0.500758	0.194
########	0.373453	0.532443	0.159
########	0.422408	0.563992	0.142
1/1/1992	0.390797	0.536309	0.146
2/1/1992	0.52322	0.661414	0.138
3/1/1992	0.502284	0.634985	0.133
4/1/1992	0.328308	0.51453	0.186
5/1/1992	0.118637	0.11751	-0.001
6/1/1992	0.239019	0.422357	0.183
7/1/1992	0.307709	0.527333	0.220
8/1/1992	0.230806	0.482565	0.252
9/1/1992	0.252068	0.467783	0.216
########	0.350694	0.53125	0.181
########	0.448449	0.57941	0.131
########	0.53982	0.826355	0.287
1/1/1993	0.461626	0.571135	0.110
2/1/1993	0.266611	0.417462	0.151
3/1/1993	0.359802	0.507816	0.148
4/1/1993	0.420272	0.535622	0.115
5/1/1993	0.409426	0.553172	0.144
6/1/1993	0.259979	0.416308	0.156
7/1/1993	0.443121	0.57996	0.137
8/1/1993	0.068489	0.152957	0.084
9/1/1993	4.41E-07	4.37E-07	0.000
########	0.372704	0.543108	0.170
########	0.242403	0.430383	0.188
########	0.361555	0.530241	0.169
1/1/1994	0.415236	0.562374	0.147
2/1/1994	0.559034	0.767289	0.208
3/1/1994	0.29926	0.508607	0.209
4/1/1994	0.298748	0.48197	0.183
5/1/1994	0.130606	0.297901	0.167
6/1/1994	0.414539	0.550908	0.136
7/1/1994	0	0	0.000
8/1/1994	0.019013	0.046788	0.028
9/1/1994	0.287636	0.473173	0.186
########	0.524672	0.781118	0.256
########	0.512107	0.675697	0.164
########	0.446604	0.558499	0.112

2/1/1977	0.314612	0.509467	0.195
8/1/1997	0.360771	0.555445	0.195
########	0.29491	0.489492	0.195
6/1/1956	0.314549	0.508795	0.194
########	0.549406	0.74361	0.194
########	0.306862	0.500758	0.194
3/1/2006	0.304348	0.498117	0.194
5/1/2002	0.311587	0.505279	0.194
6/1/1977	0.261891	0.455098	0.193
5/1/1962	0.339498	0.532296	0.193
5/1/1951	0.312858	0.505526	0.193
4/1/2007	0.257287	0.449583	0.192
########	0.321935	0.51405	0.192
9/1/1956	0.205268	0.397339	0.192
4/1/1979	0.327586	0.51943	0.192
4/1/1968	0.193072	0.384885	0.192
########	0.311565	0.503283	0.192
6/1/1960	0.248495	0.439901	0.191
9/1/1978	0.322374	0.51369	0.191
1/1/1950	0.533833	0.725099	0.191
2/1/1964	0.153868	0.345099	0.191
5/1/1976	0.322445	0.513645	0.191
6/1/1969	0.327844	0.519025	0.191
########	0.368816	0.559763	0.191
########	0.324908	0.515609	0.191
9/1/1980	0.264043	0.454237	0.190
5/1/1997	0.543405	0.733569	0.190
7/1/1963	0.194003	0.383681	0.190
1/1/1970	1.006669	1.195714	0.189
########	0.345352	0.534362	0.189
########	0.509367	0.69792	0.189
########	0.242403	0.430383	0.188
1/1/1977	0.319862	0.507573	0.188
########	0.334556	0.522102	0.188
6/1/1962	0.27168	0.459218	0.188
########	0.320277	0.507614	0.187
7/1/1977	0.148077	0.335409	0.187
9/1/2001	0.328591	0.515399	0.187
9/1/2000	0.352347	0.53913	0.187
########	0.257393	0.444037	0.187

7/1/1964	0.214811	0.346414	0.132
7/1/1983	0.423036	0.554501	0.131
1/1/1980	0.530083	0.661415	0.131
########	0.448449	0.57941	0.131
3/1/1959	0.38693	0.517795	0.131
1/1/1967	0.518603	0.649328	0.131
########	0.519025	0.649697	0.131
########	0.441217	0.571395	0.130
########	0.461883	0.59156	0.130
4/1/1999	0.239412	0.368705	0.129
8/1/1964	0.096488	0.225636	0.129
3/1/1954	0.398115	0.527167	0.129
########	0.427888	0.555822	0.128
3/1/2003	0.403544	0.531216	0.128
########	0.449814	0.577126	0.127
9/1/1988	0.473801	0.600887	0.127
8/1/1973	0.479345	0.606023	0.127
6/1/1970	0.096188	0.22231	0.126
1/1/1990	0.454764	0.580884	0.126
########	0.486413	0.61249	0.126
7/1/1965	0.152636	0.27842	0.126
########	0.497872	0.623537	0.126
4/1/1982	0.38781	0.512722	0.125
########	0.4606	0.585275	0.125
6/1/1989	0.15593	0.280598	0.125
4/1/2003	0.507747	0.632071	0.124
9/1/1974	0.097437	0.221584	0.124
1/1/1995	0.414117	0.538089	0.124
########	0.475618	0.599147	0.124
7/1/1954	0.504094	0.627581	0.123
6/1/1997	0.437609	0.561062	0.123
2/1/1950	0.505501	0.628924	0.123
5/1/1982	0.117833	0.240711	0.123
9/1/2005	0.474815	0.596484	0.122
3/1/1960	0.432376	0.553908	0.122
1/1/2006	0.502693	0.624	0.121
7/1/1989	0.459371	0.580591	0.121
4/1/1991	0.469617	0.590639	0.121
4/1/1995	0.402599	0.523205	0.121
2/1/1998	0.390756	0.511113	0.120

APPENDIX B WETLAND PROTECTION
B-2c MR #8 - MONTHLY MEAN AVERAGE VALUES
COMPARE WATER LEVEL FLUCTUTAIONS (WLF)

1/1/1965	0.5017329	0.615102	0.113
2/1/1965	0.337066	0.511117	0.174
3/1/1965	0.3224925	0.501214	0.179
4/1/1965	0.3730156	0.526946	0.154
5/1/1965	0.1973757	0.461594	0.264
6/1/1965	0.2461276	0.500558	0.254
7/1/1965	0.1526357	0.27842	0.126
8/1/1965	0.2151665	0.384719	0.170
9/1/1965	6.1984E-08	6.2E-08	0.000
########	0.3079403	0.506924	0.199
########	0.4171445	0.562598	0.145
########	0.4813267	0.575313	0.094
1/1/1966	0.5438498	0.746706	0.203
2/1/1966	0.3042236	0.511075	0.207
3/1/1966	0.5199056	0.625046	0.105
4/1/1966	0.1598341	0.309548	0.150
5/1/1966	0.2209045	0.461161	0.240
6/1/1966	0.3035882	0.514074	0.210
7/1/1966	0.3176472	0.514369	0.197
8/1/1966	0.291671	0.532153	0.240
9/1/1966	0.3065397	0.533136	0.227
########	0.3403167	0.515792	0.175
########	0.5000244	0.612847	0.113
########	0.5009583	0.654297	0.153
1/1/1967	0.5186027	0.649328	0.131
2/1/1967	0.3468609	0.509326	0.162
3/1/1967	0.5012392	0.607795	0.107
4/1/1967	0.2357583	0.3852	0.149
5/1/1967	0.2190176	0.483982	0.265
6/1/1967	0.3436111	0.530022	0.186
7/1/1967	2.1718E-06	2.19E-06	0.000
8/1/1967	0	0	0.000
9/1/1967	0.1493572	0.308521	0.159
########	0.3865481	0.53495	0.148
########	0.3281421	0.514267	0.186
########	0.4020385	0.552364	0.150
1/1/1968	0.4078966	0.546873	0.139
2/1/1968	0.5356779	0.72112	0.185
3/1/1968	0.2884161	0.501781	0.213
4/1/1968	0.1930715	0.384885	0.192

1/1/1995	0.414117	0.538089	0.124
2/1/1995	0.409772	0.526091	0.116
3/1/1995	0.355976	0.514696	0.159
4/1/1995	0.402599	0.523205	0.121
5/1/1995	0.271936	0.411185	0.139
6/1/1995	0.419548	0.562638	0.143
7/1/1995	0.503073	0.657916	0.155
8/1/1995	0.170427	0.335087	0.165
9/1/1995	0.218729	0.389618	0.171
########	0.363573	0.528774	0.165
########	0.563138	0.947417	0.384
########	0.500954	0.586585	0.086
1/1/1996	0.519759	0.632093	0.112
2/1/1996	0.656995	0.830074	0.173
3/1/1996	0.469523	0.588615	0.119
4/1/1996	0.4413	0.518348	0.077
5/1/1996	0.472681	0.588193	0.116
6/1/1996	0.140088	0.338916	0.199
7/1/1996	0.219554	0.474331	0.255
8/1/1996	0.018091	0.042174	0.024
9/1/1996	0.561034	0.839125	0.278
########	0.379743	0.542514	0.163
########	0.679676	0.885464	0.206
########	0.562927	0.747193	0.184
1/1/1997	0.538162	0.634113	0.096
2/1/1997	0.320161	0.454974	0.135
3/1/1997	0.53503	0.670963	0.136
4/1/1997	0.41549	0.549213	0.134
5/1/1997	0.543405	0.733569	0.190
6/1/1997	0.437609	0.561062	0.123
7/1/1997	0.220923	0.402526	0.182
8/1/1997	0.360771	0.555445	0.195
9/1/1997	0.238523	0.442856	0.204
########	0.53199	0.829502	0.298
########	0.338046	0.521592	0.184
########	0.35045	0.508684	0.158
1/1/1998	0.465125	0.56255	0.097
2/1/1998	0.390756	0.511113	0.120
3/1/1998	0.385441	0.531136	0.146
4/1/1998	0.143574	0.275369	0.132

6/1/1967	0.343611	0.530022	0.186
9/1/1986	0.516684	0.703085	0.186
3/1/1977	0.341737	0.528111	0.186
4/1/1992	0.328308	0.51453	0.186
########	0.328142	0.514267	0.186
6/1/2000	0.21482	0.400765	0.186
9/1/1949	0.486055	0.67181	0.186
9/1/1994	0.287636	0.473173	0.186
########	0.714655	0.900133	0.185
7/1/1950	0.147589	0.333041	0.185
2/1/1968	0.535678	0.72112	0.185
########	0.310168	0.495458	0.185
9/1/1959	0.327872	0.513048	0.185
5/1/1987	0.272686	0.457857	0.185
7/1/1986	0.330599	0.515565	0.185
9/1/2006	0.191262	0.376084	0.185
########	0.559686	0.744215	0.185
2/1/1990	0.335091	0.519552	0.184
########	0.562927	0.747193	0.184
5/1/1980	0.360286	0.544243	0.184
6/1/1974	0.162857	0.346671	0.184
########	0.157664	0.341408	0.184
########	0.338046	0.521592	0.184
6/1/1992	0.239019	0.422357	0.183
########	0.327755	0.51106	0.183
5/1/1981	0.342268	0.525553	0.183
4/1/1994	0.298748	0.48197	0.183
3/1/1978	0.331128	0.513991	0.183
9/1/1984	0.332154	0.514455	0.182
########	0.507209	0.689443	0.182
6/1/2006	0.187633	0.369792	0.182
########	0.319186	0.501204	0.182
6/1/1954	0.358854	0.540816	0.182
8/1/1950	0.382629	0.564423	0.182
7/1/1997	0.220923	0.402526	0.182
9/1/1973	0.37179	0.553361	0.182
9/1/1979	0.323774	0.505163	0.181
9/1/1963	0.180388	0.361074	0.181
1/1/1964	0.545063	0.725677	0.181
########	0.350694	0.53125	0.181

3/1/1979	0.394872	0.514431	0.120
3/1/1996	0.469523	0.588615	0.119
2/1/1979	0.488521	0.607168	0.119
########	0.508976	0.627359	0.118
3/1/1999	0.412322	0.530494	0.118
1/1/1951	0.508856	0.627017	0.118
3/1/1955	0.280365	0.398497	0.118
6/1/1979	0.119676	0.237475	0.118
########	0.500365	0.61721	0.117
1/1/1999	0.521927	0.638771	0.117
1/1/1971	0.411644	0.528485	0.117
8/1/1960	0.139981	0.256648	0.117
2/1/2000	0.411606	0.528126	0.117
1/1/1961	0.42281	0.539141	0.116
2/1/1995	0.409772	0.526091	0.116
4/1/1962	0.468246	0.584347	0.116
2/1/1955	0.500118	0.615881	0.116
1/1/1973	0.501084	0.61667	0.116
5/1/1996	0.472681	0.588193	0.116
4/1/1993	0.420272	0.535622	0.115
4/1/1984	0.498471	0.613586	0.115
########	0.421142	0.535618	0.114
1/1/1965	0.501733	0.615102	0.113
3/1/1963	0.407276	0.520571	0.113
########	0.500024	0.612847	0.113
1/1/1996	0.519759	0.632093	0.112
########	0.475063	0.587082	0.112
########	0.446604	0.558499	0.112
3/1/1989	0.41762	0.528829	0.111
1/1/1991	0.500035	0.611202	0.111
1/1/1975	0.520287	0.631448	0.111
1/1/1952	0.407208	0.518023	0.111
########	0.450316	0.561079	0.111
########	0.494515	0.605085	0.111
1/1/1976	0.430649	0.540963	0.110
2/1/1970	0.539046	0.649278	0.110
########	0.498454	0.608416	0.110
1/1/1993	0.461626	0.571135	0.110
2/1/1956	0.441873	0.550884	0.109
2/1/1963	0.506324	0.615288	0.109

APPENDIX B WETLAND PROTECTION
B-2c MR #8 - MONTHLY MEAN AVERAGE VALUES
COMPARE WATER LEVEL FLUCTUTAIONS (WLF)

5/1/1968	0.5050358	0.706194	0.201
6/1/1968	0.3603759	0.516788	0.156
7/1/1968	0.04228926	0.043232	0.001
8/1/1968	0.5339366	0.798385	0.264
9/1/1968	0.3810868	0.534058	0.153
########	0.4047884	0.551149	0.146
########	0.5031281	0.635656	0.133
########	0.5301238	0.732773	0.203
1/1/1969	0.5275877	0.690567	0.163
2/1/1969	0.4937429	0.572258	0.079
3/1/1969	0.2106355	0.40691	0.196
4/1/1969	0.3112054	0.516916	0.206
5/1/1969	0.3031215	0.509397	0.206
6/1/1969	0.3278443	0.519025	0.191
7/1/1969	0.05262675	0.058867	0.006
8/1/1969	0	0	0.000
9/1/1969	0.5683826	0.862985	0.295
########	0.3985417	0.55809	0.160
########	0.5072087	0.689443	0.182
########	0.5089761	0.627359	0.118
1/1/1970	1.006669	1.195714	0.189
2/1/1970	0.5390461	0.649278	0.110
3/1/1970	0.5148591	0.605849	0.091
4/1/1970	0.3093105	0.513118	0.204
5/1/1970	0.2746316	0.473607	0.199
6/1/1970	0.09618833	0.22231	0.126
7/1/1970	1.9731E-05	0.000499	0.000
8/1/1970	0	0	0.000
9/1/1970	0.2306105	0.502043	0.271
########	0.3277546	0.51106	0.183
########	0.4166598	0.556245	0.140
########	0.5031672	0.603265	0.100
1/1/1971	0.4116441	0.528485	0.117
2/1/1971	0.3002957	0.455104	0.155
3/1/1971	0.440459	0.532695	0.092
4/1/1971	0.4429955	0.543836	0.101
5/1/1971	0.1930556	0.455205	0.262
6/1/1971	0.3109006	0.51195	0.201
7/1/1971	0.07048396	0.165127	0.095
8/1/1971	0.4425063	0.59257	0.150

5/1/1998	0.523073	0.678701	0.156
6/1/1998	0.312774	0.513288	0.201
7/1/1998	0.142244	0.349518	0.207
8/1/1998	0.048728	0.049873	0.001
9/1/1998	0.421188	0.569553	0.148
########	0.298129	0.509528	0.211
########	0.529819	0.763878	0.234
########	0.549406	0.74361	0.194
1/1/1999	0.521927	0.638771	0.117
2/1/1999	0.512674	0.595341	0.083
3/1/1999	0.412322	0.530494	0.118
4/1/1999	0.239412	0.368705	0.129
5/1/1999	0.266622	0.489229	0.223
6/1/1999	0.26754	0.501831	0.234
7/1/1999	0.093235	0.185681	0.092
8/1/1999	0.151186	0.383915	0.233
9/1/1999	0.04997	0.064105	0.014
########	0.418597	0.56493	0.146
########	0.396115	0.552658	0.157
########	0.30173	0.504217	0.202
1/1/2000	0.405936	0.552009	0.146
2/1/2000	0.411606	0.528126	0.117
3/1/2000	0.405483	0.546656	0.141
4/1/2000	0.297484	0.516468	0.219
5/1/2000	0.318442	0.516315	0.198
6/1/2000	0.21482	0.400765	0.186
7/1/2000	0.029606	0.0756	0.046
8/1/2000	0.028403	0.071657	0.043
9/1/2000	0.352347	0.53913	0.187
########	0.418002	0.57303	0.155
########	0.331853	0.511468	0.180
########	0.399463	0.543649	0.144
1/1/2001	0.248988	0.418176	0.169
2/1/2001	0.260038	0.395708	0.136
3/1/2001	0.387393	0.538325	0.151
4/1/2001	0.382573	0.535698	0.153
5/1/2001	0.264024	0.4106	0.147
6/1/2001	0.193485	0.406703	0.213
7/1/2001	0.244773	0.467067	0.222
8/1/2001	0.341924	0.522128	0.180

5/1/2007	0.325527	0.505925	0.180
########	0.363256	0.543617	0.180
8/1/2001	0.341924	0.522128	0.180
6/1/1952	0.334527	0.514334	0.180
5/1/1960	0.320979	0.500669	0.180
########	0.331853	0.511468	0.180
7/1/1988	0.162661	0.342274	0.180
5/1/1961	0.335585	0.515144	0.180
########	0.324339	0.5037	0.179
########	0.332825	0.512168	0.179
4/1/1983	0.339766	0.519029	0.179
5/1/1955	0.327874	0.507082	0.179
3/1/1965	0.322493	0.501214	0.179
4/1/2005	0.299881	0.478075	0.178
########	0.343392	0.521561	0.178
5/1/2005	0.323526	0.501618	0.178
7/1/1987	0.342427	0.52041	0.178
6/1/1963	0.256627	0.434282	0.178
9/1/1951	0.35976	0.537375	0.178
1/1/2008	0.333796	0.511191	0.177
8/1/1963	0.280049	0.457018	0.177
5/1/1949	0.340877	0.517458	0.177
4/1/1976	0.334824	0.511348	0.177
########	0.50478	0.681179	0.176
1/1/1949	0.325446	0.501706	0.176
6/1/1983	0.227498	0.403467	0.176
########	0.340317	0.515792	0.175
6/1/1991	0.352999	0.528091	0.175
1/1/1974	0.601967	0.77698	0.175
2/1/1962	0.306474	0.481429	0.175
########	0.326073	0.500857	0.175
2/1/2005	0.318036	0.492511	0.174
########	0.334363	0.508833	0.174
########	0.333646	0.508054	0.174
6/1/1955	0.343314	0.517679	0.174
4/1/2006	0.321213	0.495557	0.174
2/1/1965	0.337066	0.511117	0.174
5/1/1952	0.272432	0.44642	0.174
5/1/1959	0.328168	0.502046	0.174
########	0.358833	0.532631	0.174

5/1/1989	0.500993	0.609325	0.108
########	0.480284	0.588201	0.108
3/1/1975	0.417621	0.525491	0.108
3/1/2002	0.507754	0.615246	0.107
3/1/1967	0.501239	0.607795	0.107
3/1/1952	0.422838	0.528187	0.105
3/1/1966	0.519906	0.625046	0.105
7/1/1957	0.082368	0.187128	0.105
2/1/1958	0.411996	0.516356	0.104
3/1/1961	0.423489	0.527512	0.104
3/1/1956	0.418505	0.522275	0.104
2/1/2008	0.437292	0.541061	0.104
5/1/1963	0.401206	0.503848	0.103
5/1/1964	0.143133	0.245747	0.103
8/1/1952	0.080673	0.183104	0.102
########	0.150717	0.252756	0.102
########	0.484316	0.586186	0.102
9/1/1987	0.082511	0.183683	0.101
4/1/1971	0.442996	0.543836	0.101
1/1/1988	0.428761	0.528936	0.100
########	0.503167	0.603265	0.100
8/1/2005	0.501092	0.599224	0.098
2/1/1975	0.431062	0.529011	0.098
1/1/1998	0.465125	0.56255	0.097
8/1/1985	0.147923	0.244825	0.097
2/1/2003	0.482379	0.578831	0.096
1/1/1997	0.538162	0.634113	0.096
3/1/2007	0.440535	0.535748	0.095
2/1/1959	0.47091	0.565815	0.095
4/1/1955	0.515437	0.610317	0.095
########	0.485552	0.580298	0.095
7/1/1971	0.070484	0.165127	0.095
5/1/1953	0.500195	0.594626	0.094
2/1/1984	0.459677	0.55406	0.094
########	0.481327	0.575313	0.094
2/1/1972	0.504456	0.59828	0.094
2/1/1954	0.476899	0.569711	0.093
2/1/1981	0.47432	0.56693	0.093
7/1/1999	0.093235	0.185681	0.092
3/1/1971	0.440459	0.532695	0.092

APPENDIX B WETLAND PROTECTION
B-2c MR #8 - MONTHLY MEAN AVERAGE VALUES
COMPARE WATER LEVEL FLUCTUTAIONS (WLF)

9/1/1971	0.4353317	0.593206	0.158
########	0.4076585	0.552331	0.145
########	0.4220294	0.572444	0.150
########	0.4984536	0.608416	0.110
1/1/1972	0.5335248	0.700894	0.167
2/1/1972	0.504456	0.59828	0.094
3/1/1972	0.507489	0.574548	0.067
4/1/1972	0.371057	0.509676	0.139
5/1/1972	0.3622417	0.521799	0.160
6/1/1972	0.1947846	0.444239	0.249
7/1/1972	0.1909996	0.421284	0.230
8/1/1972	0.2918636	0.505004	0.213
9/1/1972	0.4419676	0.591106	0.149
########	0.1576644	0.341408	0.184
########	0.3361697	0.50991	0.174
########	0.5283074	0.782503	0.254
1/1/1973	0.5010837	0.61667	0.116
2/1/1973	0.2796453	0.501825	0.222
3/1/1973	0.39765	0.541825	0.144
4/1/1973	0.3116845	0.507688	0.196
5/1/1973	0.3586574	0.531904	0.173
6/1/1973	0.3078667	0.510115	0.202
7/1/1973	0.01096808	0.011535	0.001
8/1/1973	0.4793449	0.606023	0.127
9/1/1973	0.3717899	0.553361	0.182
########	0.3433923	0.521561	0.178
########	0.6455432	0.883976	0.238
########	0.484316	0.586186	0.102
1/1/1974	0.6019672	0.77698	0.175
2/1/1974	0.4892811	0.562019	0.073
3/1/1974	0.4824662	0.568259	0.086
4/1/1974	0.2878227	0.44649	0.159
5/1/1974	0.25445	0.492647	0.238
6/1/1974	0.1628572	0.346671	0.184
7/1/1974	0.4100024	0.574663	0.165
8/1/1974	0	0	0.000
9/1/1974	0.09743669	0.221584	0.124
########	0.3191864	0.501204	0.182
########	0.4774396	0.622801	0.145
########	0.5186542	0.684284	0.166

9/1/2001	0.328591	0.515399	0.187
########	0.332637	0.533281	0.201
########	0.461883	0.59156	0.130
########	0.485808	0.575604	0.090
1/1/2002	0.571142	0.778123	0.207
2/1/2002	0.53911	0.752218	0.213
3/1/2002	0.507754	0.615246	0.107
4/1/2002	0.342302	0.514418	0.172
5/1/2002	0.311587	0.505279	0.194
6/1/2002	0.356805	0.517002	0.160
7/1/2002	0.052602	0.100169	0.048
8/1/2002	0	0	0.000
9/1/2002	0.304964	0.523087	0.218
########	0.296641	0.50699	0.210
########	0.272538	0.500758	0.228
########	0.477887	0.621612	0.144
1/1/2003	0.57146	0.799171	0.228
2/1/2003	0.482379	0.578831	0.096
3/1/2003	0.403544	0.531216	0.128
4/1/2003	0.507747	0.632071	0.124
5/1/2003	0.293047	0.505397	0.212
6/1/2003	0.017831	0.04367	0.026
7/1/2003	4.01E-08	4.01E-08	0.000
8/1/2003	0.045397	0.121294	0.076
9/1/2003	0.259288	0.40486	0.146
########	0.509367	0.69792	0.189
########	0.473067	0.617664	0.145
########	0.42006	0.561842	0.142
1/1/2004	0.385591	0.52967	0.144
2/1/2004	0.342844	0.498492	0.156
3/1/2004	0.276752	0.439826	0.163
4/1/2004	0.195486	0.358765	0.163
5/1/2004	0.247051	0.500798	0.254
6/1/2004	0.229509	0.460968	0.231
7/1/2004	0	0	0.000
8/1/2004	0.395047	0.561166	0.166
9/1/2004	0.193775	0.343482	0.150
########	0.324339	0.5037	0.179
########	0.355033	0.524198	0.169
########	0.403231	0.552425	0.149

########	0.33617	0.50991	0.174
########	0.358963	0.532604	0.174
3/1/1964	0.375635	0.549163	0.174
3/1/1949	0.330761	0.504087	0.173
5/1/1973	0.358657	0.531904	0.173
2/1/1996	0.656995	0.830074	0.173
########	0.358614	0.531605	0.173
8/1/1983	0.335909	0.508517	0.173
4/1/2002	0.342302	0.514418	0.172
3/1/1990	0.362046	0.534111	0.172
########	0.505983	0.678046	0.172
4/1/1949	0.10317	0.274826	0.172
9/1/1995	0.218729	0.389618	0.171
3/1/1985	0.337694	0.508571	0.171
########	0.502993	0.673766	0.171
########	0.372704	0.543108	0.170
6/1/2008	0.347324	0.517526	0.170
1/1/1957	0.316119	0.486254	0.170
9/1/1964	0.357805	0.52765	0.170
5/1/1957	0.370277	0.539989	0.170
8/1/1965	0.215167	0.384719	0.170
4/1/1985	0.170901	0.340388	0.169
1/1/1963	0.520259	0.689718	0.169
2/1/1982	0.603908	0.773104	0.169
1/1/2001	0.248988	0.418176	0.169
########	0.355033	0.524198	0.169
6/1/1981	0.338973	0.508084	0.169
########	0.390627	0.559442	0.169
########	0.361555	0.530241	0.169
########	0.346622	0.515098	0.168
########	0.342796	0.510794	0.168
########	0.363514	0.531416	0.168
6/1/1953	0.389546	0.557334	0.168
9/1/1958	0.16352	0.331235	0.168
3/1/1981	0.330382	0.497999	0.168
1/1/1972	0.533525	0.700894	0.167
5/1/1994	0.130606	0.297901	0.167
########	0.165463	0.33267	0.167
########	0.290827	0.457412	0.167
8/1/2004	0.395047	0.561166	0.166

########	0.502442	0.593752	0.091
########	0.497743	0.588999	0.091
3/1/1970	0.514859	0.605849	0.091
1/1/1959	0.460203	0.550168	0.090
########	0.485808	0.575604	0.090
7/1/1981	0.070363	0.159847	0.089
7/1/1980	0.060983	0.148867	0.088
7/1/1990	0.063467	0.151279	0.088
3/1/1951	0.472095	0.559095	0.087
########	0.505691	0.591647	0.086
8/1/1949	0.052685	0.138584	0.086
3/1/1974	0.482466	0.568259	0.086
########	0.500954	0.586585	0.086
1/1/1958	0.461545	0.547115	0.086
2/1/1986	0.48883	0.574097	0.085
8/1/1993	0.068489	0.152957	0.084
2/1/1960	0.500339	0.584431	0.084
2/1/1953	0.466643	0.549654	0.083
2/1/1999	0.512674	0.595341	0.083
7/1/1951	0.050314	0.131306	0.081
2/1/1969	0.493743	0.572258	0.079
6/1/1986	0.047449	0.124744	0.077
4/1/1996	0.4413	0.518348	0.077
8/1/2003	0.045397	0.121294	0.076
3/1/1987	0.492109	0.56777	0.076
2/1/1978	0.503442	0.578822	0.075
7/1/1979	0.067903	0.142752	0.075
2/1/1974	0.489281	0.562019	0.073
3/1/1957	0.501744	0.572922	0.071
3/1/1972	0.507489	0.574548	0.067
2/1/1983	0.511905	0.577698	0.066
2/1/1987	0.545164	0.59479	0.050
7/1/2002	0.052602	0.100169	0.048
7/1/2000	0.029606	0.0756	0.046
8/1/2000	0.028403	0.071657	0.043
9/1/1991	0.103445	0.141577	0.038
8/1/2006	0.02121	0.049982	0.029
8/1/1988	0.020797	0.048901	0.028
8/1/1994	0.019013	0.046788	0.028
6/1/2003	0.017831	0.04367	0.026

APPENDIX B WETLAND PROTECTION
B-2c MR #8 - MONTHLY MEAN AVERAGE VALUES
COMPARE WATER LEVEL FLUCTUTAIONS (WLF)

1/1/1975	0.5202874	0.631448	0.111
2/1/1975	0.4310621	0.529011	0.098
3/1/1975	0.4176209	0.525491	0.108
4/1/1975	0.2584133	0.397411	0.139
5/1/1975	0.3659904	0.520507	0.155
6/1/1975	0.2865245	0.499835	0.213
7/1/1975	0.1767193	0.383713	0.207
8/1/1975	0.4383042	0.579526	0.141
9/1/1975	0.05466184	0.057239	0.003
########	0.3466215	0.515098	0.168
########	0.3968755	0.553362	0.156
########	0.5212243	0.75575	0.235
1/1/1976	0.4306487	0.540963	0.110
2/1/1976	0.5612866	0.774875	0.214
3/1/1976	0.3604791	0.504425	0.144
4/1/1976	0.3348237	0.511348	0.177
5/1/1976	0.3224447	0.513645	0.191
6/1/1976	0.2311757	0.502951	0.272
7/1/1976	0.2357015	0.391706	0.156
8/1/1976	0.3855548	0.54864	0.163
9/1/1976	0.2711586	0.507367	0.236
########	0.2870193	0.521825	0.235
########	0.2154084	0.419241	0.204
########	0.2573929	0.444037	0.187
1/1/1977	0.3198615	0.507573	0.188
2/1/1977	0.3146117	0.509467	0.195
3/1/1977	0.3417374	0.528111	0.186
4/1/1977	0.1784804	0.44532	0.267
5/1/1977	0.2914756	0.50259	0.211
6/1/1977	0.2618913	0.455098	0.193
7/1/1977	0.1480765	0.335409	0.187
8/1/1977	0.4195426	0.562605	0.143
9/1/1977	0.2962181	0.509571	0.213
########	0.2784725	0.489449	0.211
########	0.4211417	0.535618	0.114
########	0.6157556	0.853217	0.237
1/1/1978	0.3689091	0.513806	0.145
2/1/1978	0.5034424	0.578822	0.075
3/1/1978	0.331128	0.513991	0.183
4/1/1978	0.3514734	0.511473	0.160
5/1/1978	0.4179821	0.552474	0.134
6/1/1978	0.4179975	0.575578	0.158
7/1/1978	0.4297459	0.582213	0.152
8/1/1978	0.3236624	0.519624	0.196
9/1/1978	0.3223737	0.51369	0.191

1/1/2005	0.269248	0.469234	0.200
2/1/2005	0.318036	0.492511	0.174
3/1/2005	0.488324	0.625087	0.137
4/1/2005	0.299881	0.478075	0.178
5/1/2005	0.323526	0.501618	0.178
6/1/2005	0.308598	0.529738	0.221
7/1/2005	0.143566	0.289951	0.146
8/1/2005	0.501092	0.599224	0.098
9/1/2005	0.474815	0.596484	0.122
########	0.40221	0.560463	0.158
########	0.345352	0.534362	0.189
########	0.532091	0.754634	0.223
1/1/2006	0.502693	0.624	0.121
2/1/2006	0.348146	0.505818	0.158
3/1/2006	0.304348	0.498117	0.194
4/1/2006	0.321213	0.495557	0.174
5/1/2006	0.432456	0.583916	0.151
6/1/2006	0.187633	0.369792	0.182
7/1/2006	0.275086	0.511151	0.236
8/1/2006	0.02121	0.049982	0.029
9/1/2006	0.191262	0.376084	0.185
########	0.31781	0.528298	0.210
########	0.512854	0.77507	0.262
########	0.485552	0.580298	0.095
1/1/2007	0.400413	0.534463	0.134
2/1/2007	0.405047	0.546327	0.141
3/1/2007	0.440535	0.535748	0.095
4/1/2007	0.257287	0.449583	0.192
5/1/2007	0.325527	0.505925	0.180
6/1/2007	0.241062	0.502665	0.262
7/1/2007	0.160731	0.311678	0.151
8/1/2007	0.199857	0.466889	0.267
9/1/2007	0.398558	0.552779	0.154
########	0.324908	0.515609	0.191
########	0.311565	0.503283	0.192
########	0.475063	0.587082	0.112
1/1/2008	0.333796	0.511191	0.177
2/1/2008	0.437292	0.541061	0.104
3/1/2008	0.388711	0.542767	0.154
4/1/2008	0.349322	0.512462	0.163
5/1/2008	0.525068	0.779752	0.255
6/1/2008	0.347324	0.517526	0.170
7/1/2008	0	0	0.000
8/1/2008	0	0	0.000
9/1/2008	0	0	0.000

########	0.359159	0.525124	0.166
########	0.518654	0.684284	0.166
1/1/1981	0.306919	0.472511	0.166
########	0.363573	0.528774	0.165
9/1/1962	0.369454	0.534595	0.165
3/1/1958	0.400228	0.565264	0.165
1/1/1984	0.328511	0.493526	0.165
7/1/1974	0.410002	0.574663	0.165
8/1/1995	0.170427	0.335087	0.165
9/1/1954	0.127875	0.292209	0.164
2/1/1991	0.507534	0.671266	0.164
########	0.512107	0.675697	0.164
########	0.357033	0.520606	0.164
4/1/2004	0.195486	0.358765	0.163
4/1/2008	0.349322	0.512462	0.163
2/1/1980	0.354799	0.517937	0.163
8/1/1976	0.385555	0.54864	0.163
3/1/2004	0.276752	0.439826	0.163
1/1/1969	0.527588	0.690567	0.163
########	0.379743	0.542514	0.163
5/1/1984	0.352255	0.514767	0.163
2/1/1967	0.346861	0.509326	0.162
1/1/1953	0.527958	0.690198	0.162
########	0.388004	0.550107	0.162
########	0.535897	0.697778	0.162
########	0.383385	0.545252	0.162
5/1/1985	0.404237	0.565385	0.161
9/1/1955	0.383065	0.544102	0.161
6/1/2002	0.356805	0.517002	0.160
4/1/1978	0.351473	0.511473	0.160
########	0.403799	0.563731	0.160
4/1/1952	0.375908	0.535493	0.160
5/1/1972	0.362242	0.521799	0.160
########	0.398542	0.55809	0.160
########	0.35609	0.515401	0.159
9/1/1967	0.149357	0.308521	0.159
5/1/1950	0.224558	0.383682	0.159
########	0.452008	0.611058	0.159
########	0.373453	0.532443	0.159
3/1/1988	0.347806	0.506684	0.159
3/1/1995	0.355976	0.514696	0.159
4/1/1974	0.287823	0.44649	0.159
########	0.40221	0.560463	0.158
########	0.35045	0.508684	0.158
9/1/1971	0.435332	0.593206	0.158

8/1/1996	0.018091	0.042174	0.024
9/1/1999	0.04997	0.064105	0.014
6/1/1987	0.093248	0.103408	0.010
7/1/1949	0.000459	0.009925	0.009
8/1/1986	0.001417	0.009005	0.008
7/1/1953	0.019987	0.02735	0.007
8/1/1959	0.001077	0.008022	0.007
7/1/1969	0.052627	0.058867	0.006
7/1/1991	2.61E-06	0.0044	0.004
7/1/1958	0.064204	0.066783	0.003
9/1/1975	0.054662	0.057239	0.003
########	0.017542	0.019137	0.002
8/1/1998	0.048728	0.049873	0.001
7/1/1952	0.049889	0.050844	0.001
7/1/1968	0.042289	0.043232	0.001
7/1/1973	0.010968	0.011535	0.001
8/1/1955	0.005698	0.006212	0.001
7/1/1970	1.97E-05	0.000499	0.000
7/1/1967	2.17E-06	2.19E-06	0.000
########	0	0	0.000
6/1/1951	0.000231	0.000231	0.000
8/1/1951	0	0	0.000
8/1/1958	0	0	0.000
7/1/1960	0	0	0.000
7/1/1962	0	0	0.000
9/1/1965	6.2E-08	6.2E-08	0.000
8/1/1967	0	0	0.000
8/1/1969	0	0	0.000
8/1/1970	0	0	0.000
8/1/1974	0	0	0.000
8/1/1981	0	0	0.000
8/1/1984	0	0	0.000
7/1/1994	0	0	0.000
8/1/2002	0	0	0.000
7/1/2003	4.01E-08	4.01E-08	0.000
7/1/2004	0	0	0.000
7/1/2008	0	0	0.000
8/1/2008	0	0	0.000
9/1/2008	0	0	0.000
9/1/1993	4.41E-07	4.37E-07	0.000
7/1/1956	0.000214	1.68E-05	0.000
5/1/1992	0.118637	0.11751	-0.001
1/1/1985	0.097239	0.095204	-0.002
7/1/1984	0.070569	0.062683	-0.008

APPENDIX B-3 Parklands Executive Residential and Parklands Business Park at Camas Meadows Golf Course – MR#7 Flow Control

This project discharges to a Flow Control - exempt receiving water – Lacamas Lake. Responses are included for this section on flow control, but section *2.5.8 Minimum Requirement #8: Wetlands Protection seems more applicable. The wetlands are within the 100 yr flood plain.*

- A hydroperiod analysis has been prepared to satisfy MR#8 without providing flow control.
- This modeling determined that provisions for Flow Control (without infiltration) provided no significant difference for inflow volume to the wetland. When modeled for flow control with infiltration, the hydroperiod results were quite negative for some summer months. This was of concern since the actual infiltration rate might differ from that modeled. A higher field rate than modeled would have greater negative impact on the wetland.

Conclusion: MR #7 Flow Control is not applicable for this project.

2.5.7 Minimum Requirement #7: FlowControl

Applicability

Projects must provide flow control to reduce the impacts of stormwater runoff from impervious surfaces and land cover conversions. The requirement below applies to projects that discharge stormwater directly, or indirectly through a conveyance system, into a fresh water - except for projects that discharge to a water in Appendix I-E – Flow Control-Exempt Receiving Waters in accordance with the following restrictions:

• *Direct discharge to the exempt receiving water does not result in the diversion of drainage from any perennial stream classified as Types 1, 2, 3, or 4 in the State of Washington Interim Water Typing System, or Types "S", "F", or "Np" in the Permanent Water Typing System, or from any category I, II, or III wetland; and*

- **The stormwater runoff from this development does not result in the diversion of drainage from any perennial stream .. or from any category I, II, or III wetland;**

• *Flow splitting devices or drainage BMP's are applied to route natural runoff volumes from the project site to any downstream Type 5 stream or category IV wetland:*

- **Flow splitting devices or drainage BMPs are not proposed to route natural runoff volumes from the project site to any downstream Type 5 stream or category IV wetland.**

APPENDIX B-3 Parklands Executive Residential and Parklands Business Park at Camas Meadows Golf Course – MR#7 Flow Control

• *Design of flow splitting devices or drainage BMP's will be based on continuous hydrologic modeling analysis. The design will assure that flows delivered to Type 5 stream reaches will approximate, but in no case exceed, durations ranging from 50% of the 2-year to the 50-year peak flow.*

- **Flow splitting devices or drainage BMPs are not proposed for flows to be delivered to Type 5 stream reaches.**

• *Flow splitting devices or drainage BMP's that deliver flow to category IV wetlands will also be designed using continuous hydrologic modeling to preserve pre-project wetland hydrologic conditions unless specifically waived or exempted by regulatory agencies with permitting jurisdiction; and*

- **An evaluation of runoff flow to the onsite category III wetland was performed with continuous hydrologic modeling that demonstrated that pre-project wetland hydrologic conditions would be preserved with the proposed design.**

• *The project site must be drained by a conveyance system that is comprised entirely of manmade conveyance elements (e.g., pipes, ditches, outfall protection, etc.) and extends to the ordinary high water line of the exempt receiving water; and*

- **Our conference call with DOE indicated that this requirement is related to conveyance that discharges to a smaller stream that has fish spawning habitat (salmon spawning in particular).**
- **The conveyance for this site continues through the wetland complex along a shallow, low gradient section to the ordinary high water line of the exempt receiving water, so, this site does not have that situation.**

• *The conveyance system between the project site and the exempt receiving water shall have sufficient hydraulic capacity to convey discharges from future build-out conditions (under current zoning) of the site, and the existing condition from non-project areas from which runoff is or will be collected*
; and

- **The conveyance system between the project site and the exempt receiving water <u>has</u> sufficient hydraulic capacity for this project and upstream projects in a fully developed built out condition. Based on hydraulic capacity modeling analysis of the 100-yr, 24-hr release flows through five cross sections along the conveyance to the lake, the maximum increases ranged from 0.10 ft to a maximum of 0.27 ft and no significant increase in**

APPENDIX B-3 Parklands Executive Residential and Parklands Business Park at Camas Meadows Golf Course – MR#7 Flow Control

velocity. These analysis results confirm that there are no site specific hydraulic capacity concerns.

• *Any erodible elements of the manmade conveyance system must be adequately stabilized to prevent erosion under the conditions noted above.*

If the discharge is to a stream that leads to a wetland, or to a wetland that has an outflow to a stream, both this requirement and Minimum Requirement #8 apply.

- **There are no elements in the proposed stormwater management design that will introduce erodible elements onsite or to the wetland complex and outfall conveyance as a whole. The modeled peak flow velocity within the wetland is a maximum of 0.7 fps (which is much less than the threshold for erosive concerns at 3 fps) and confirms there are no erosive concerns as proposed.**

Local governments may petition Ecology to exempt projects in additional areas. A petition must justify the proposed exemption based upon a hydrologic analysis that demonstrates that the potential stormwater runoff from the exempted area will not significantly increase the erosion forces on the stream channel nor have near field impacts.

Summary:

- **There are no elements in the proposed stormwater management design that will introduce erodible elements onsite or to the wetland complex and outfall conveyance as a whole.**
- **Our conference call with DOE indicated that this requirement is related to conveyance that discharges to a smaller stream that has fish spawning habitat (salmon spawning in particular). The conveyance for this site continues through the wetland complex along a shallow, low gradient section to the ordinary high water line of the exempt receiving water, so, this site does not have that situation.**
- **The conveyance system between the project site and the exempt receiving water <u>has</u> sufficient hydraulic capacity for this project and upstream projects in a fully developed built out condition. There are no elements in the proposed stormwater management design that will introduce erodible elements onsite or to the wetland complex and outfall conveyance as a whole.**
- **Based on these results and findings, the requirements of Minimum Requirement #7 – Flow Control are not applicable to the site.**

APPENDIX B-3 Parklands Executive Residential and Parklands Business Park at Camas Meadows Golf Course – MR#7 Flow Control

APPENDIX C

Appendix C Runoff Treatment

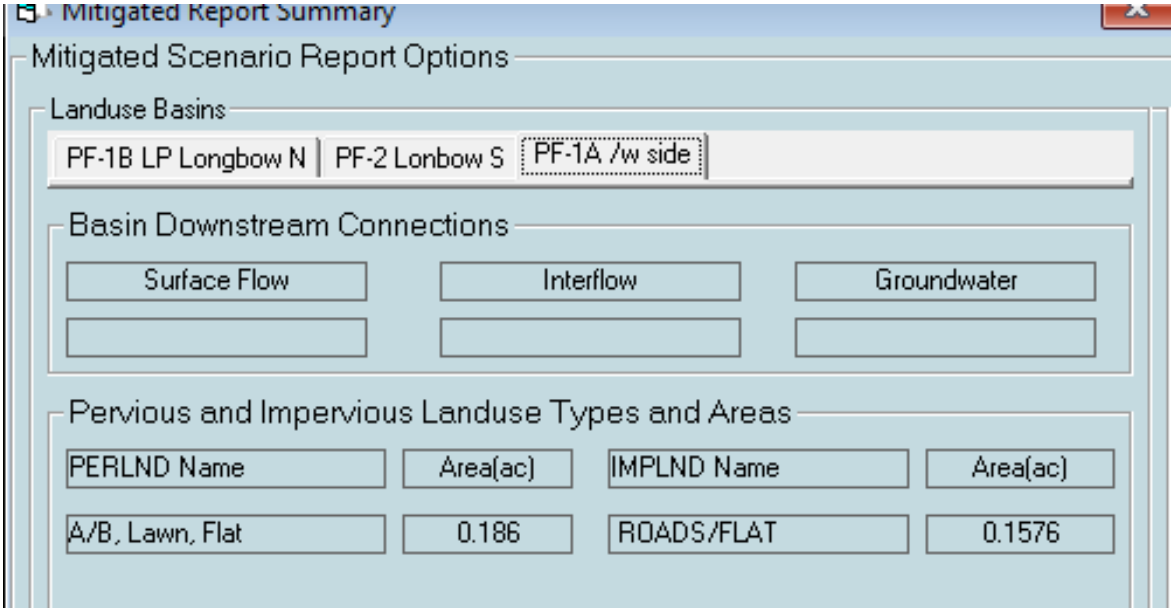
C-1 Water Quality Flow Rates

C-2 Perk Filter System Summary

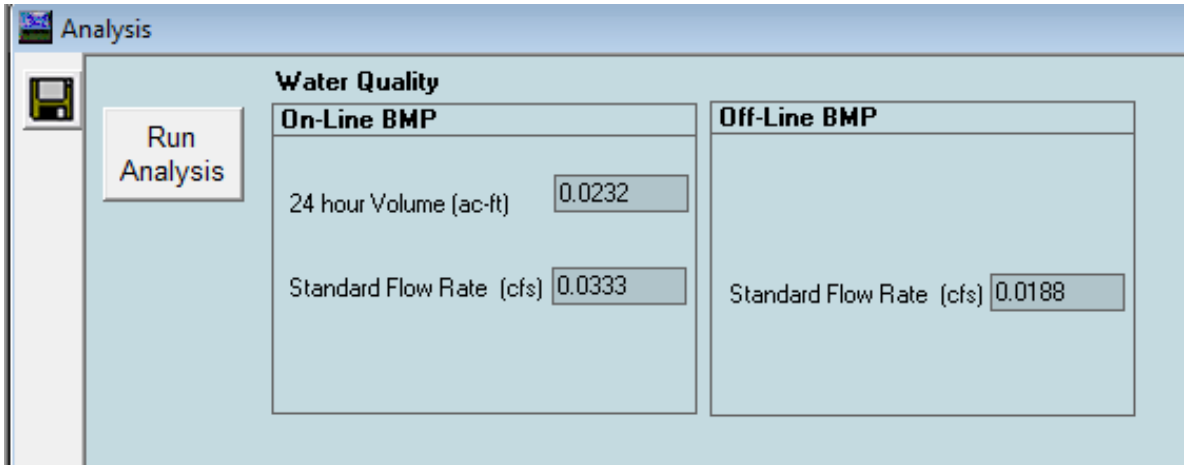
C-3 Phosphorus Reduction

APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

PF-1A Longbow Ln. (west side)

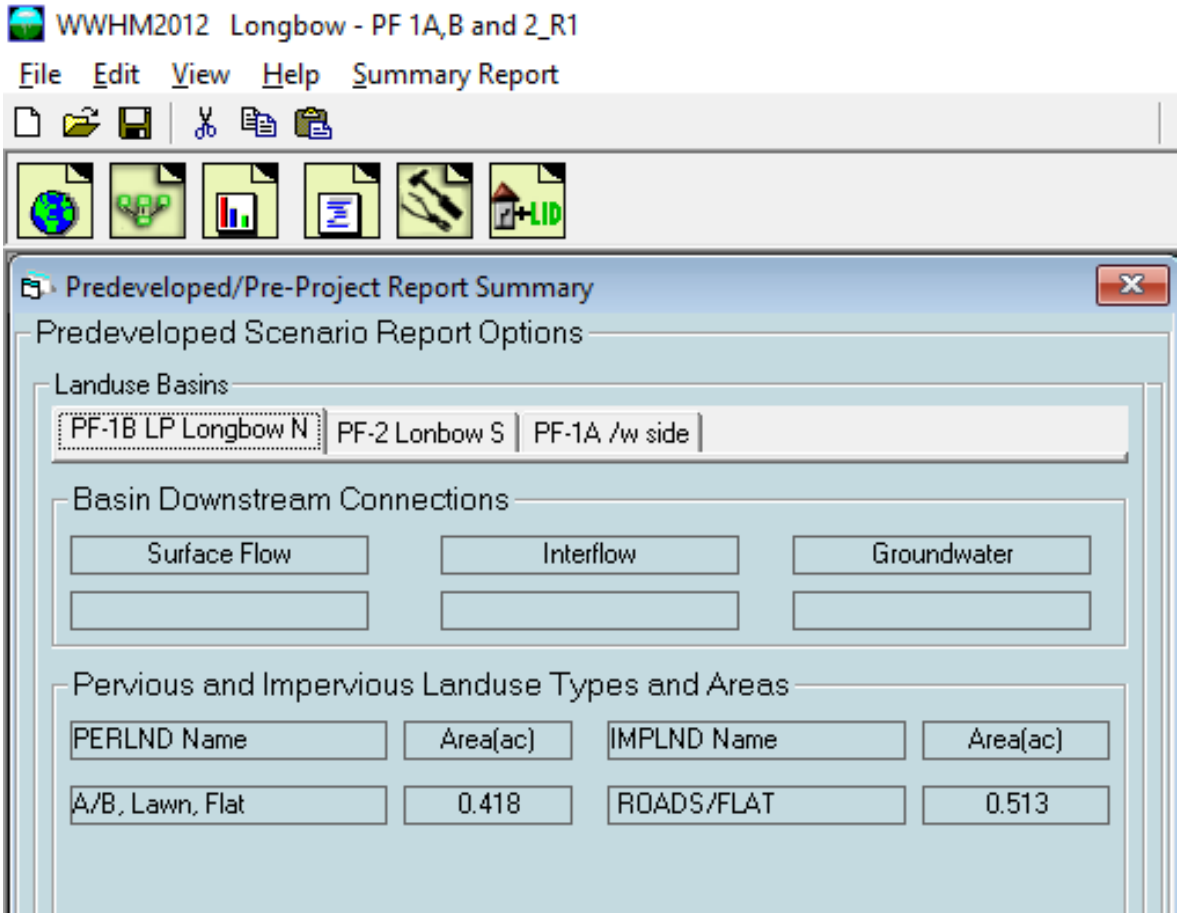


PF-1A Longbow Ln. (west side)

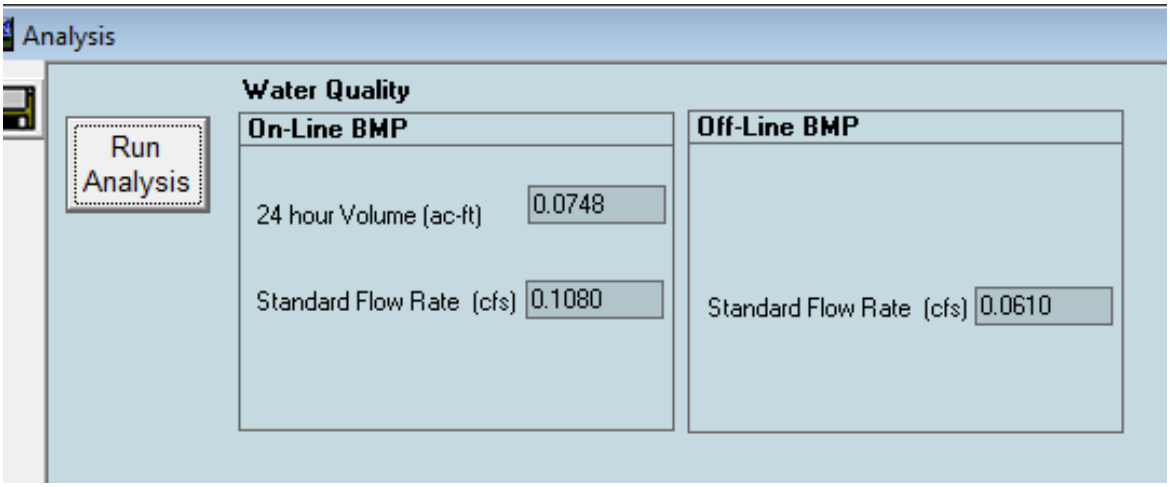


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

PF-1B Longbow Ln. (north low point)

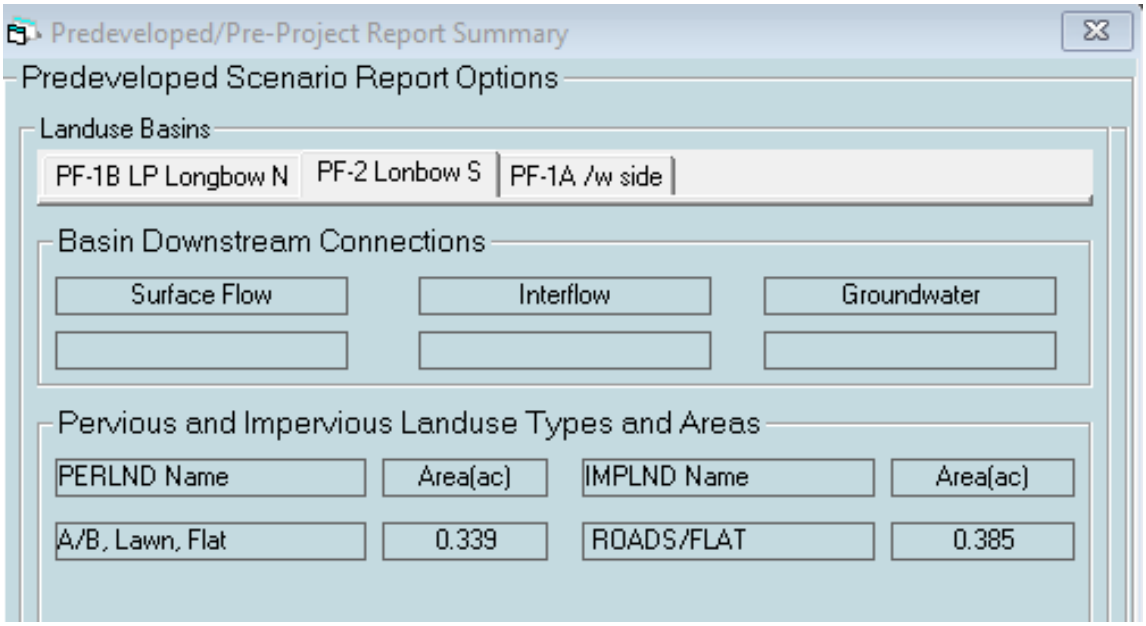


PF-1B Longbow Ln. (north low point)

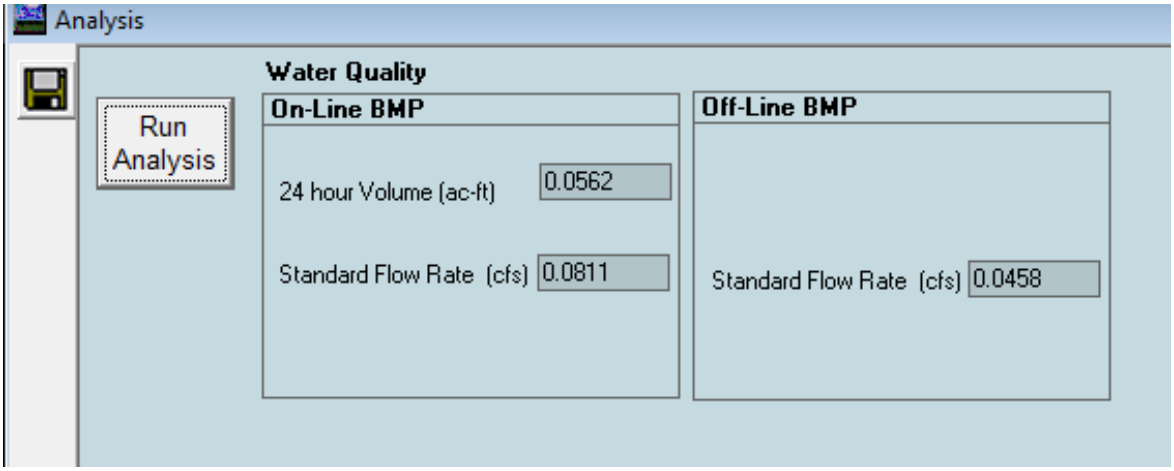


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

PF-2 Longbow Ln. (south low point)

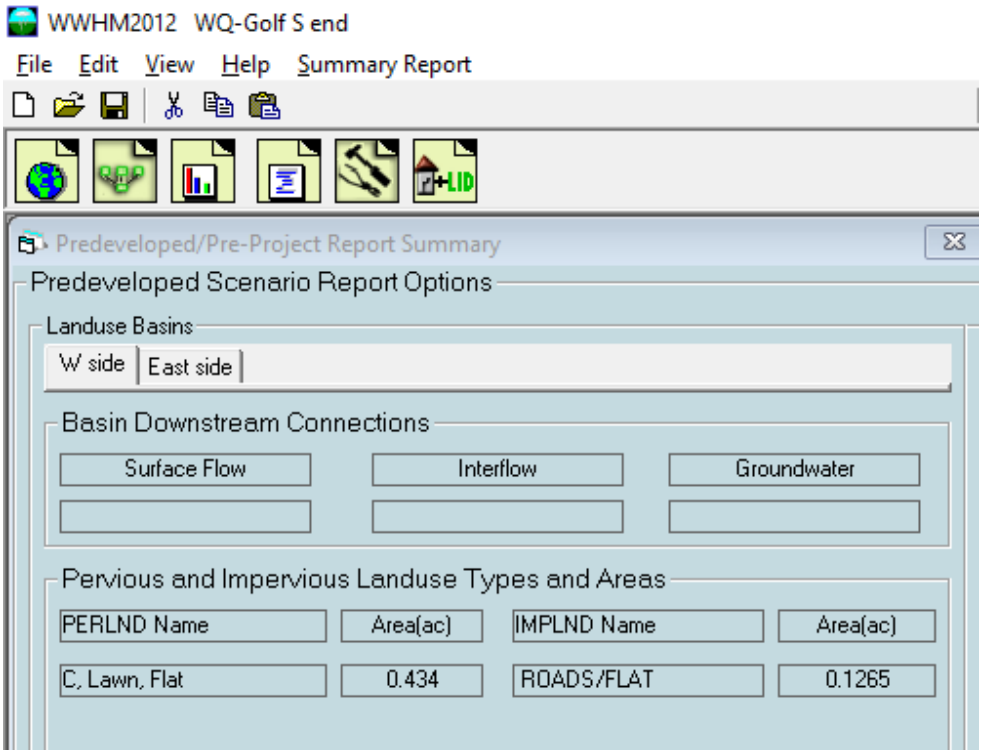


PF-2 Longbow Ln. (south low point)

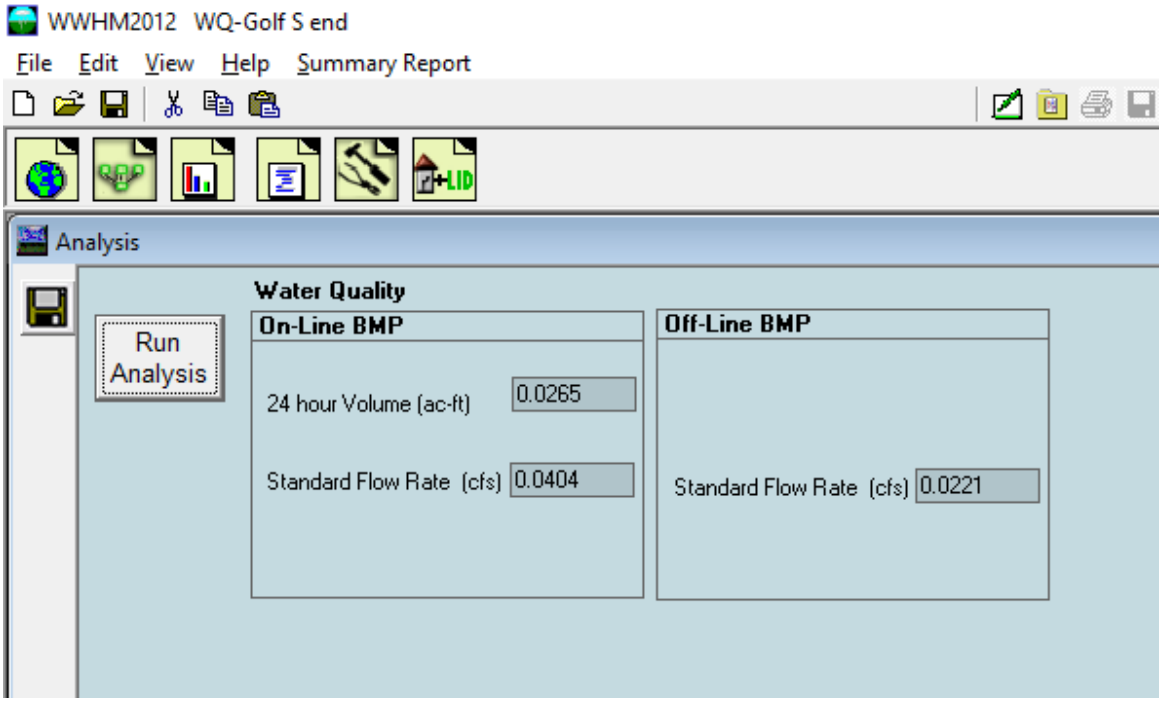


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

McMaster Dr. (PF-8 and PF-9) Same area input

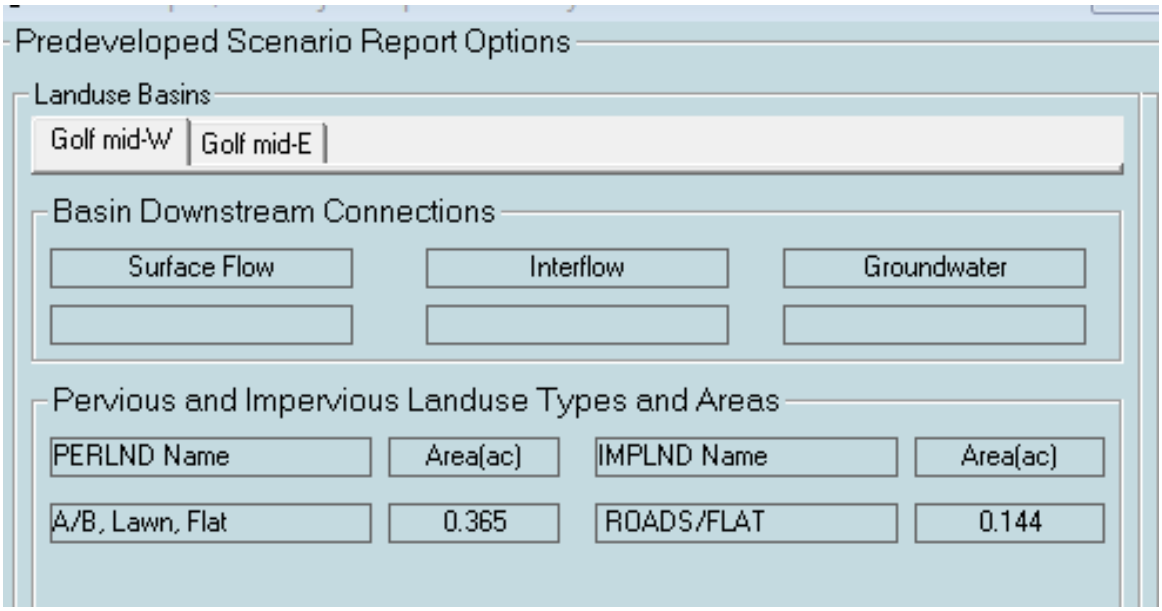


McMaster Dr. (PF-8 and PF-9) Same rate

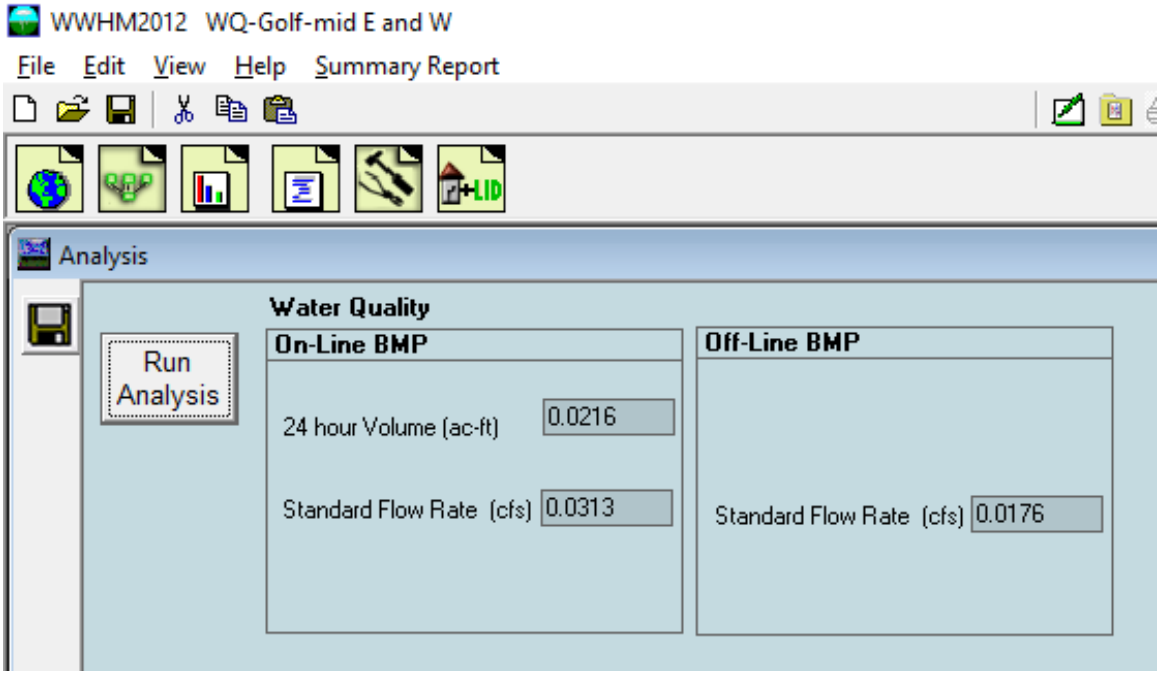


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

McMaster Dr. (PF 6 and PF-7) Same area input

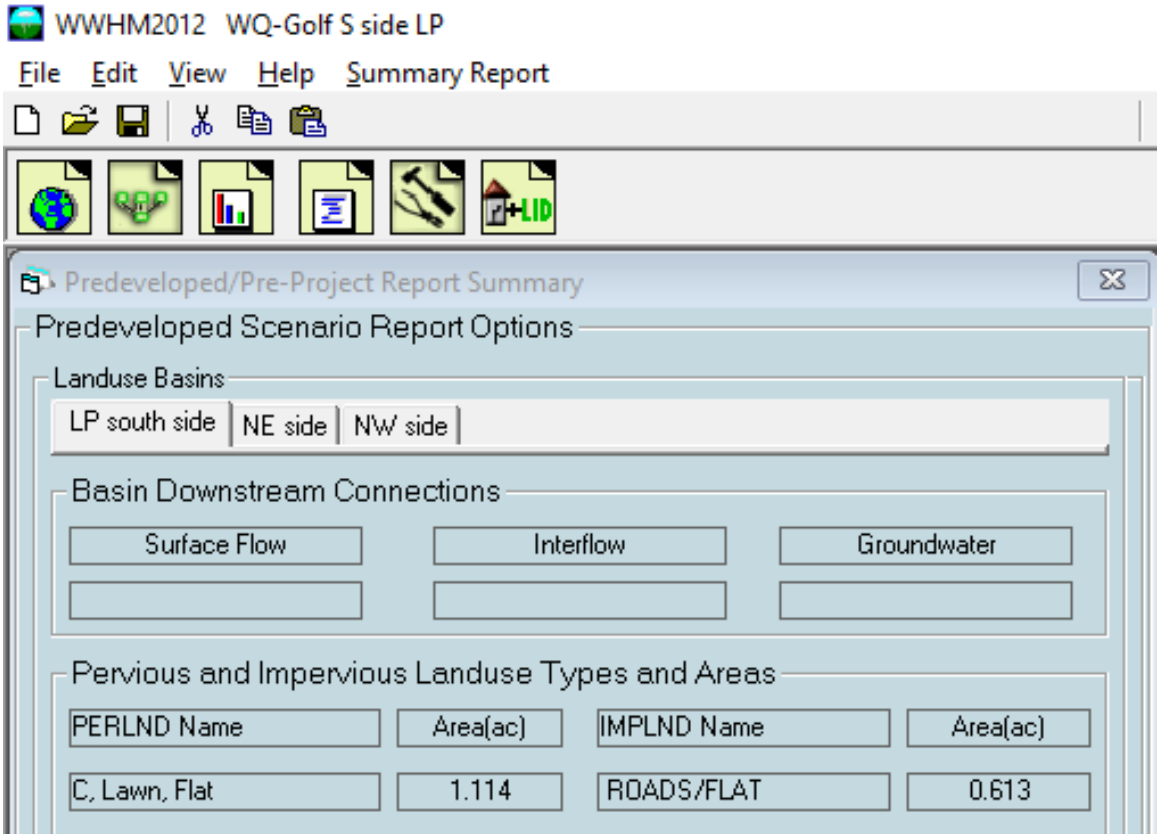


PF-6 and PF-7 (same area, same WQ rate)

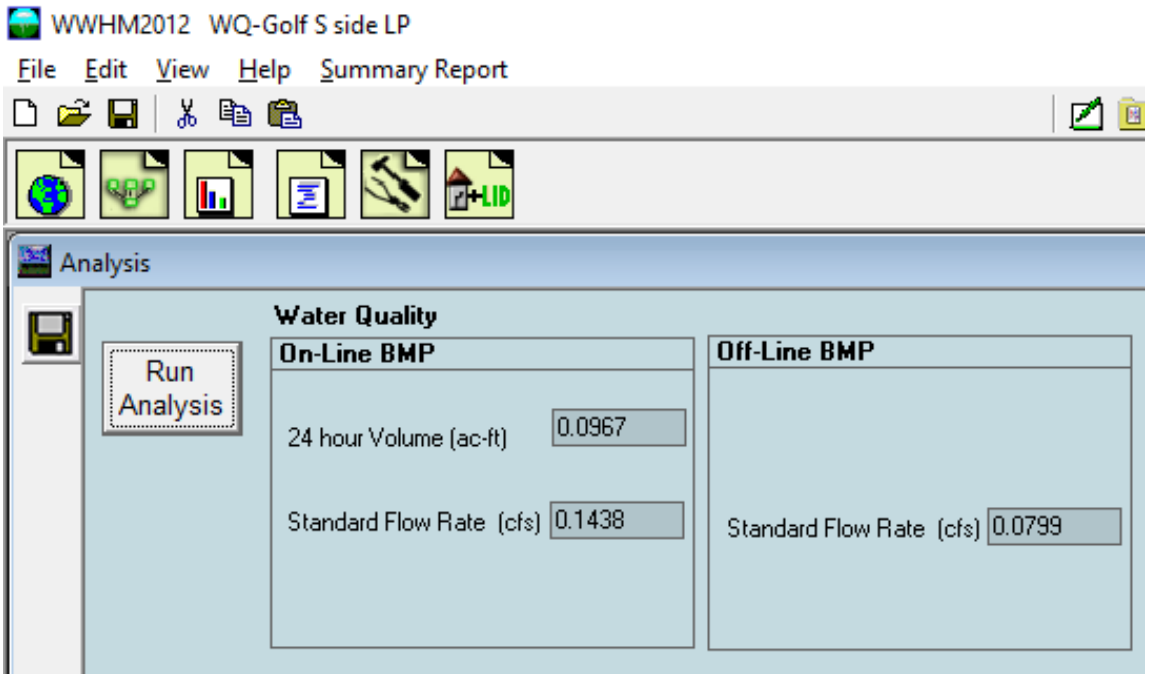


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

McMaster Dr. (PF-5)

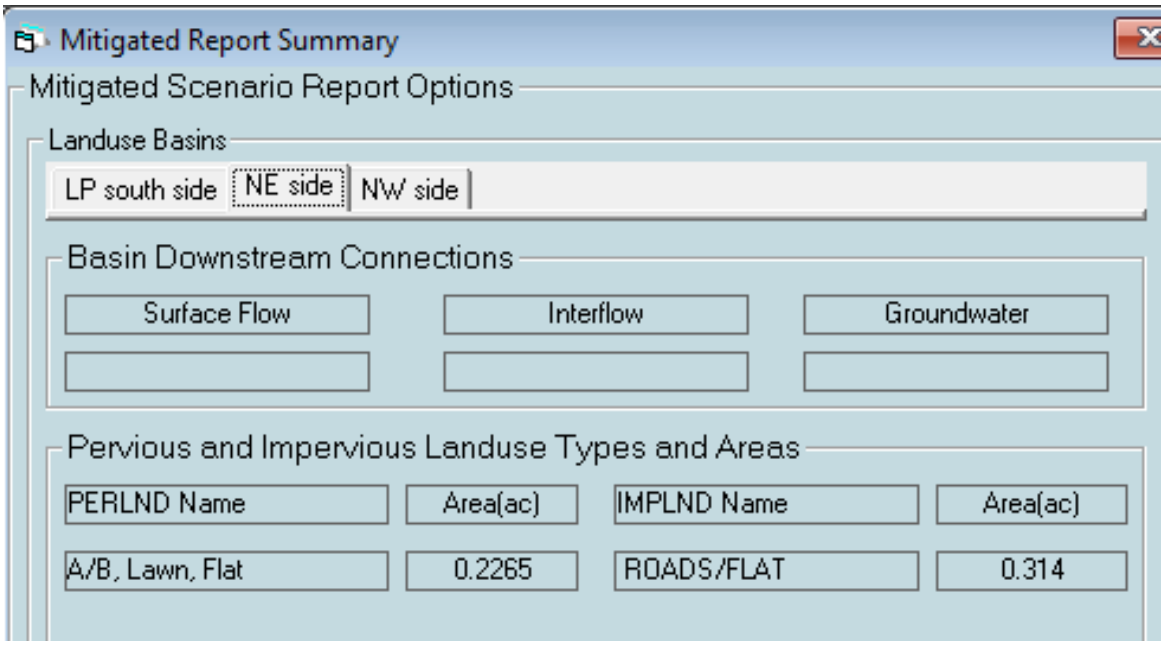


McMaster Dr. (PF-5)

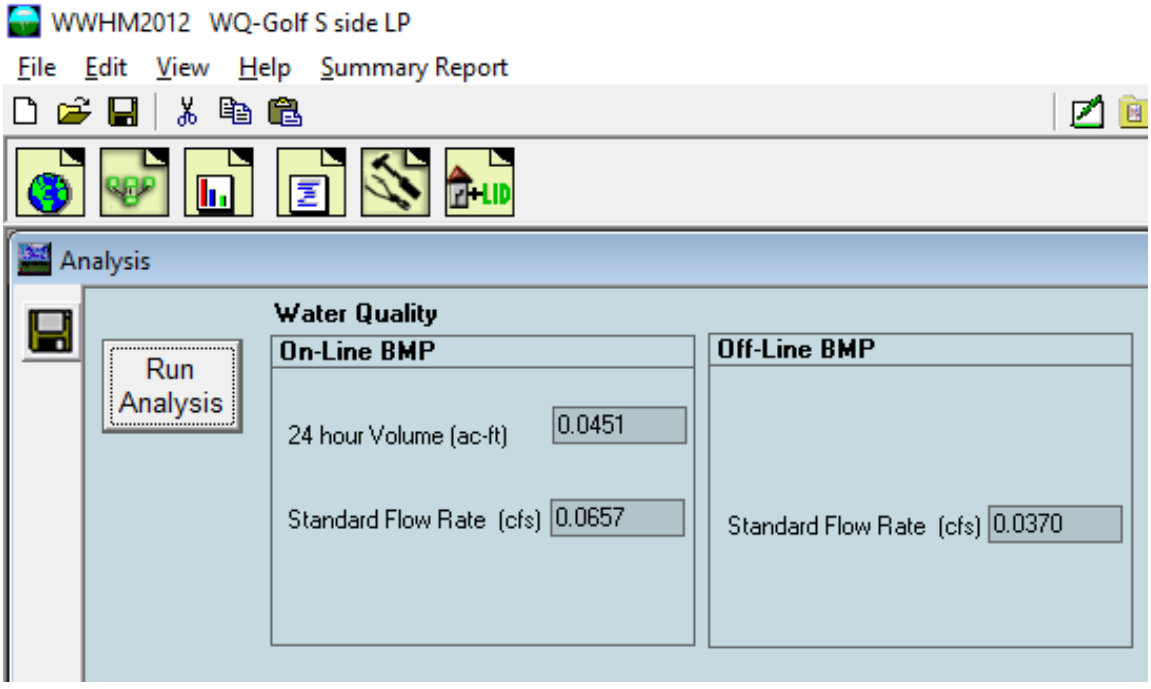


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

McMaster Dr. (NE corner with Longbow Ln. (PF-4)

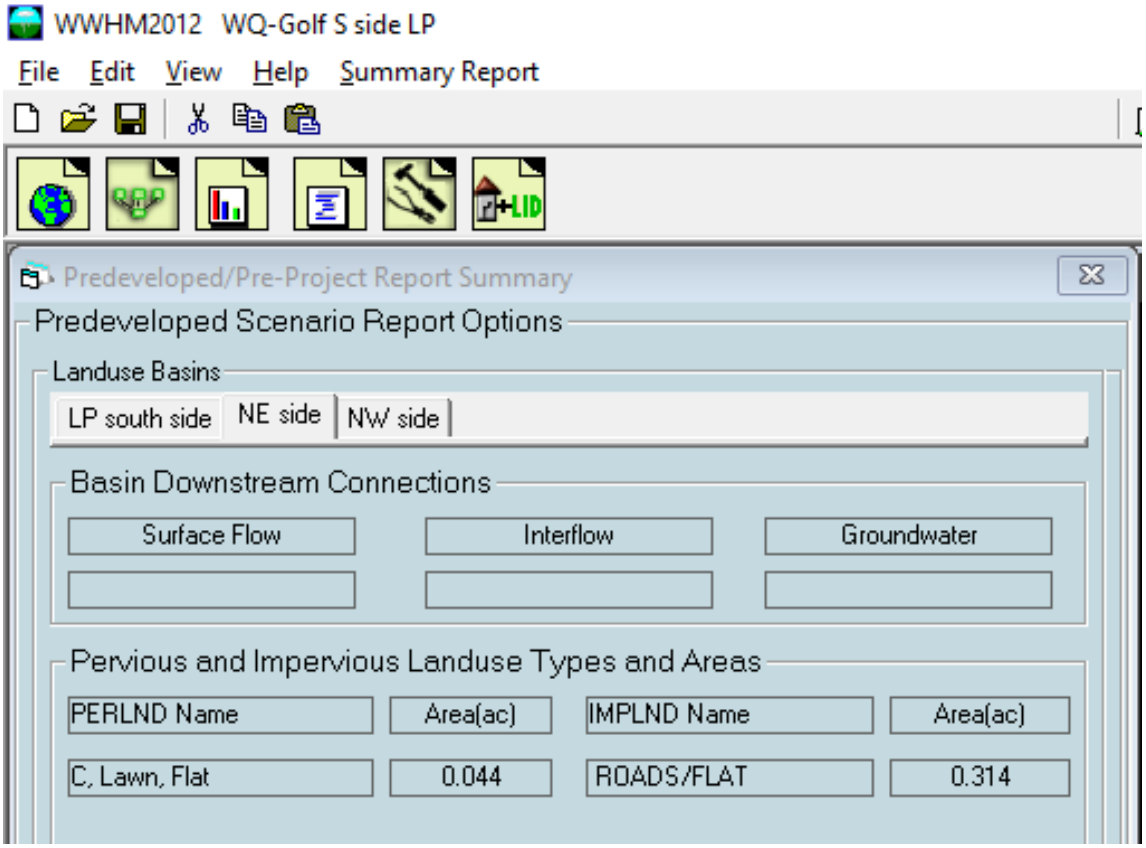


McMaster Dr. (NE corner with Longbow Ln. (PF-4)

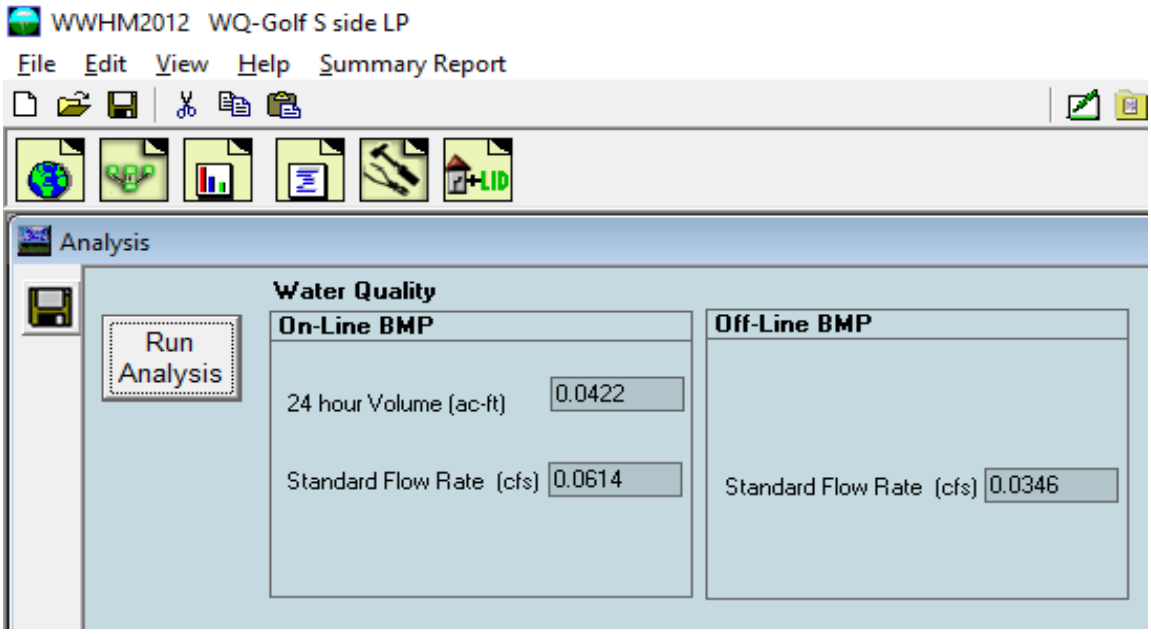


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

McMaster Dr. (NW corner with Longbow Ln. (PF-3)

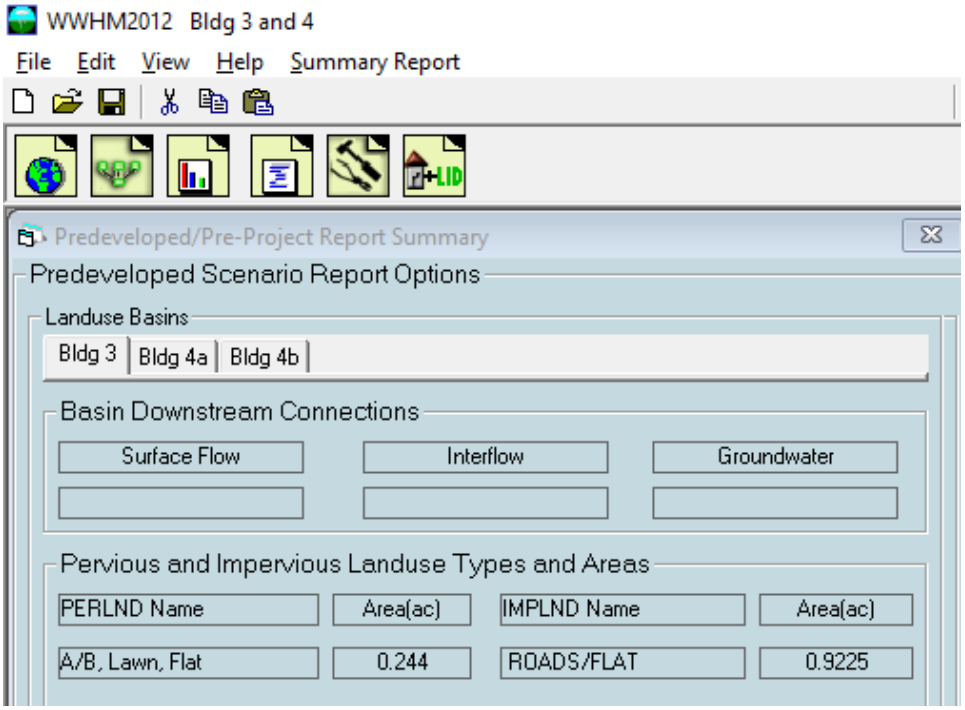


McMaster Dr. (NW corner with Longbow Ln. (PF-3)

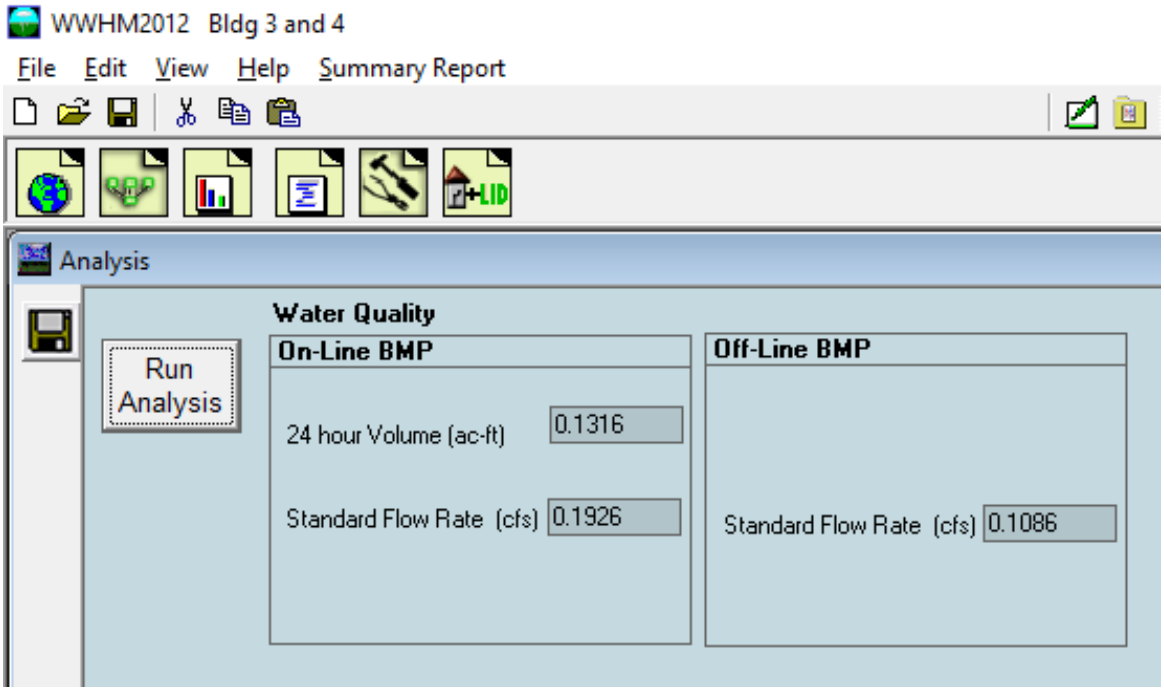


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

BLDG 3 (PF-12)

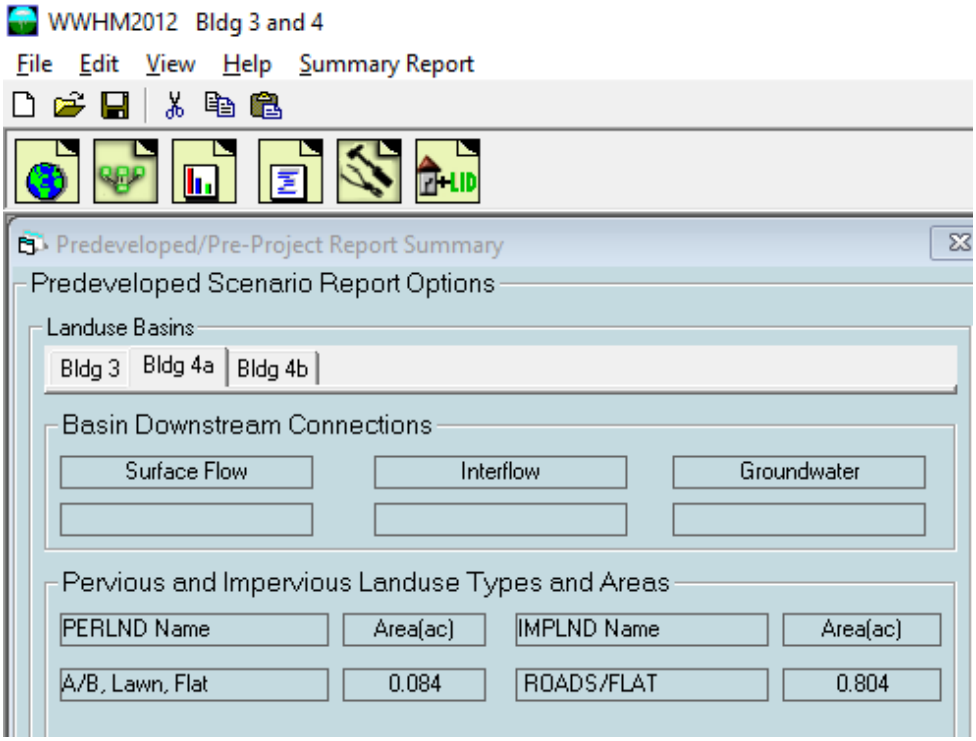


BLDG 3

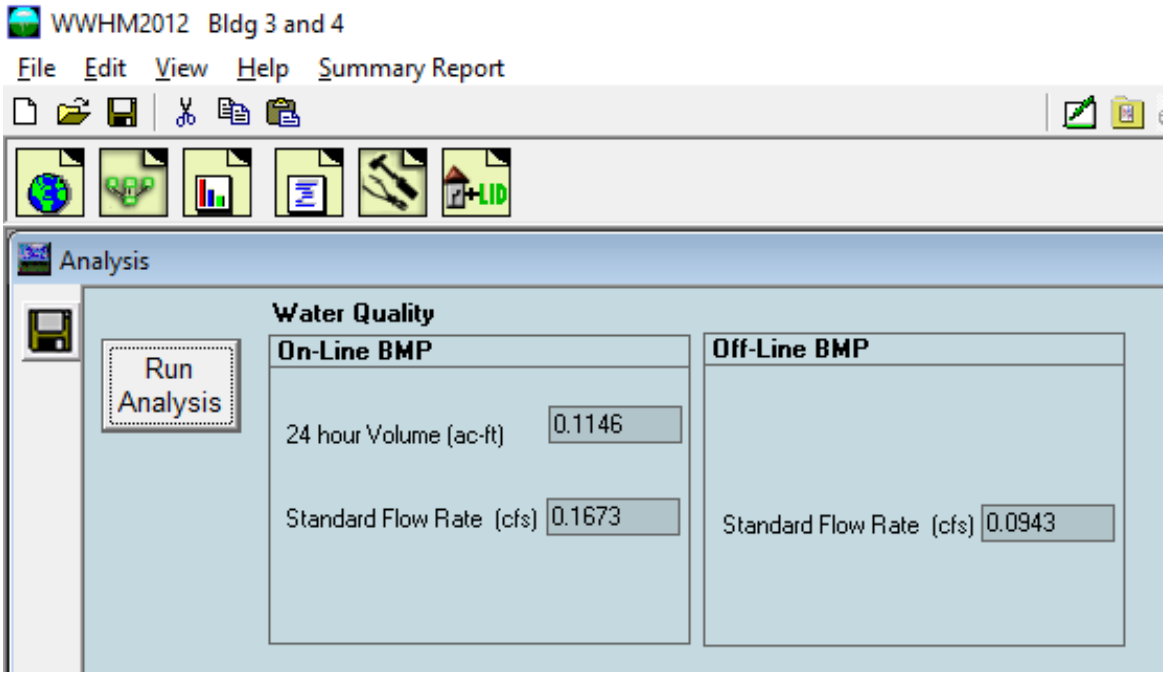


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

BLDG 4a (PF-11)

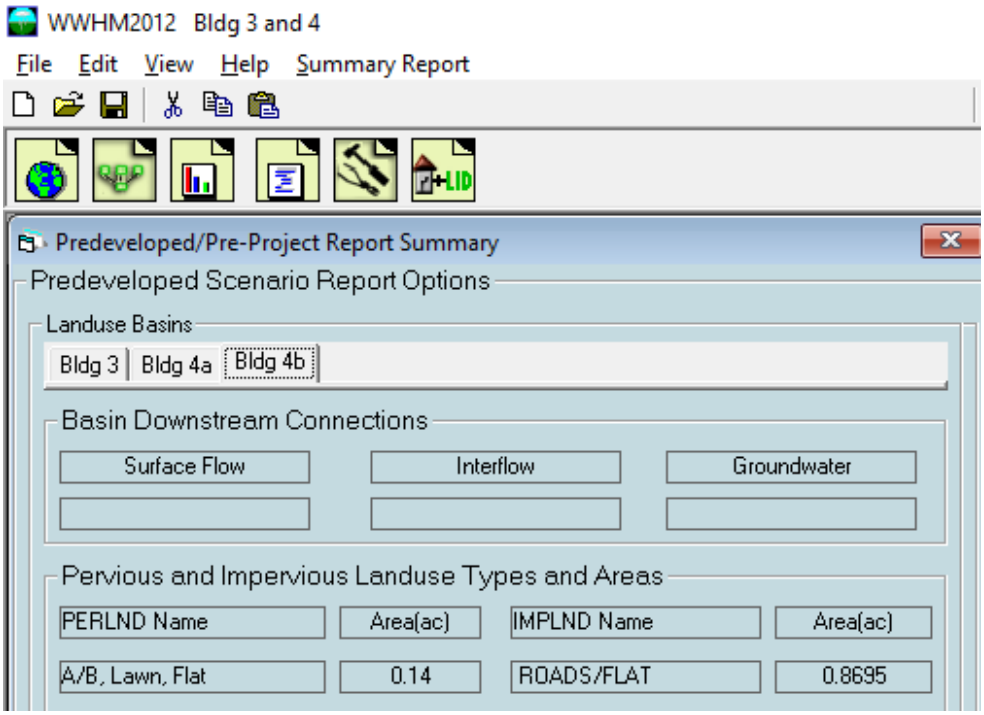


BLDG 4a

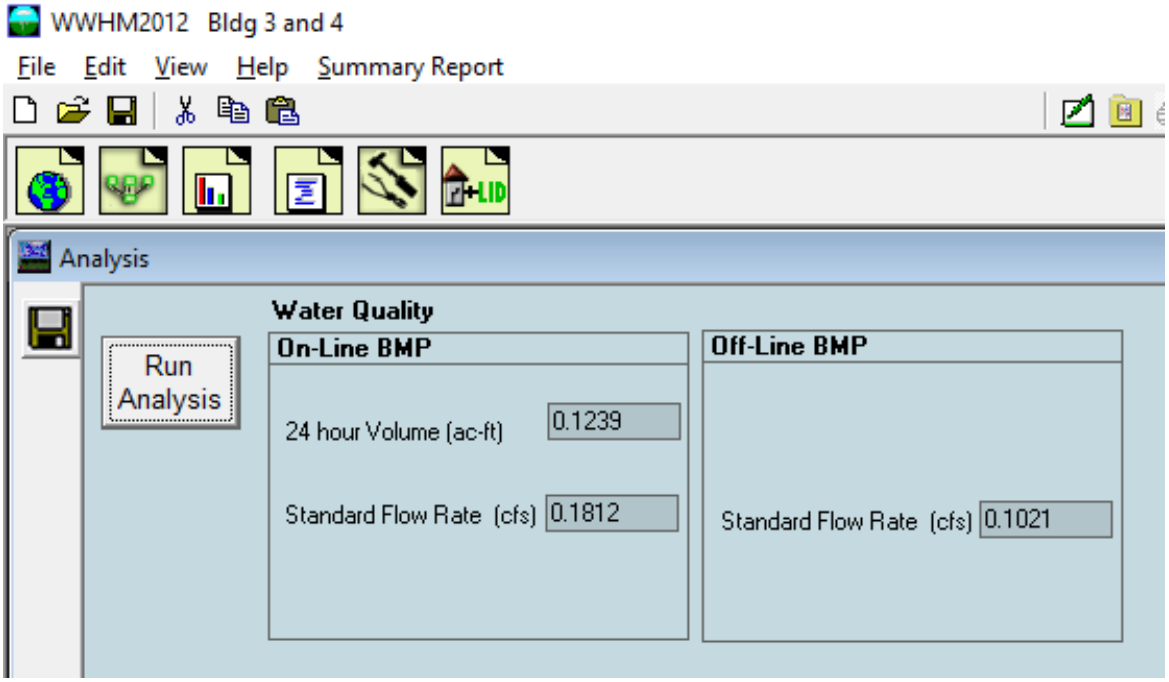


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

BLDG 4b (PF-10)

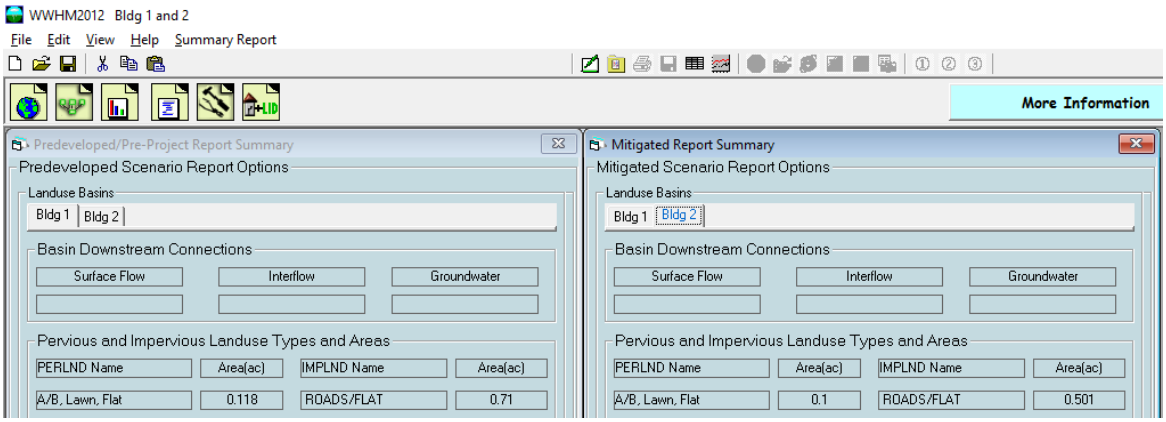


BLDG 4b

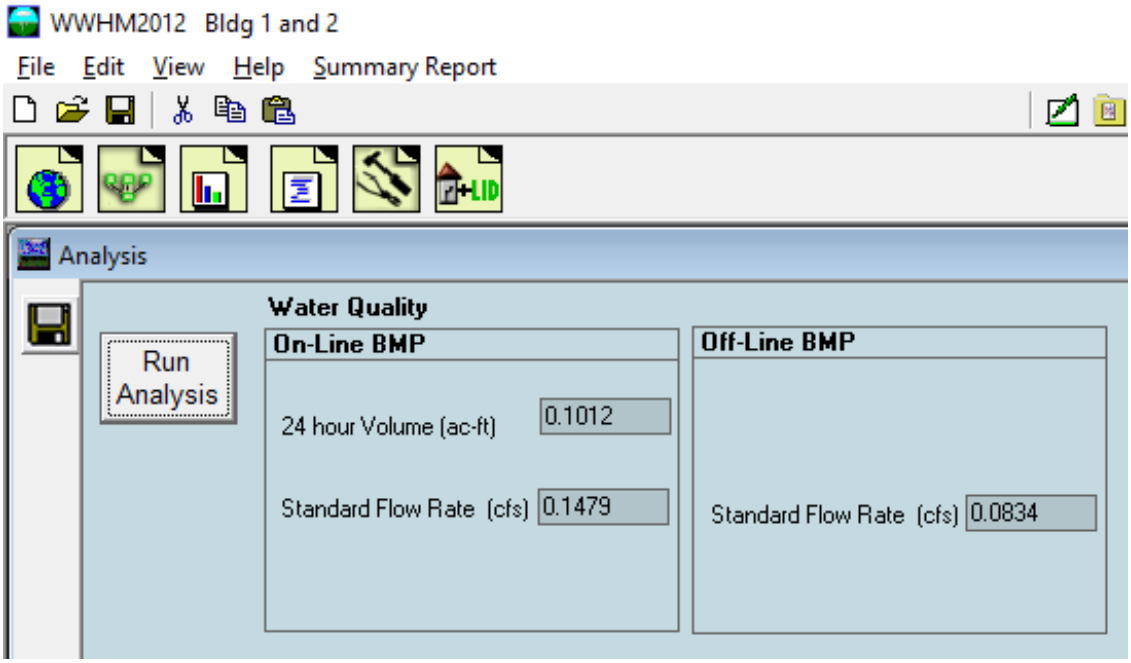


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

BLDG 1 and 2 (PF-14 and PF-13)

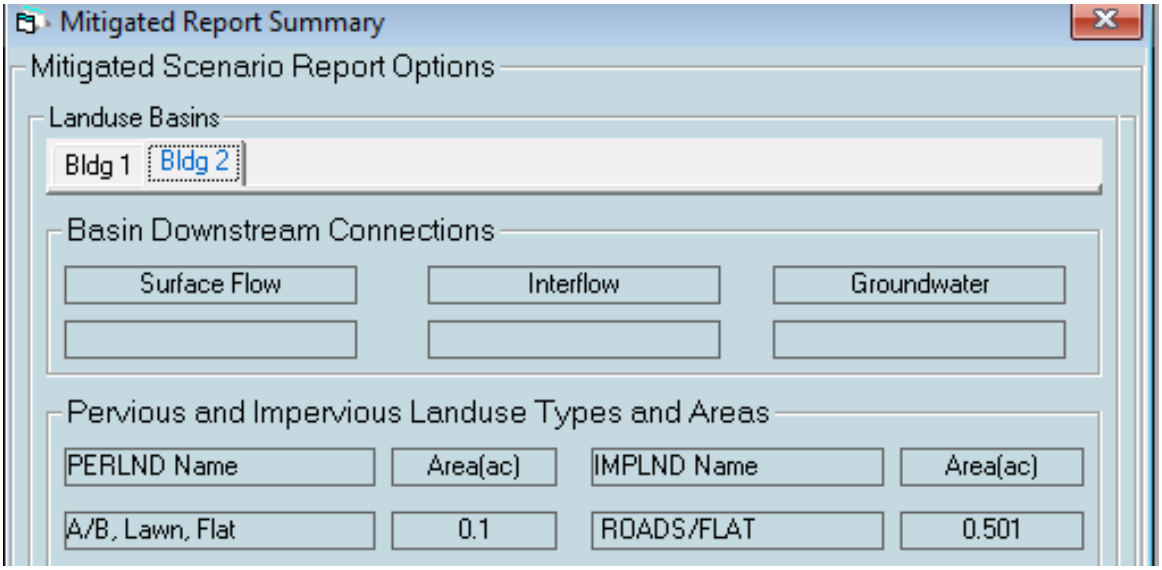


BLDG 1 (PF-14)

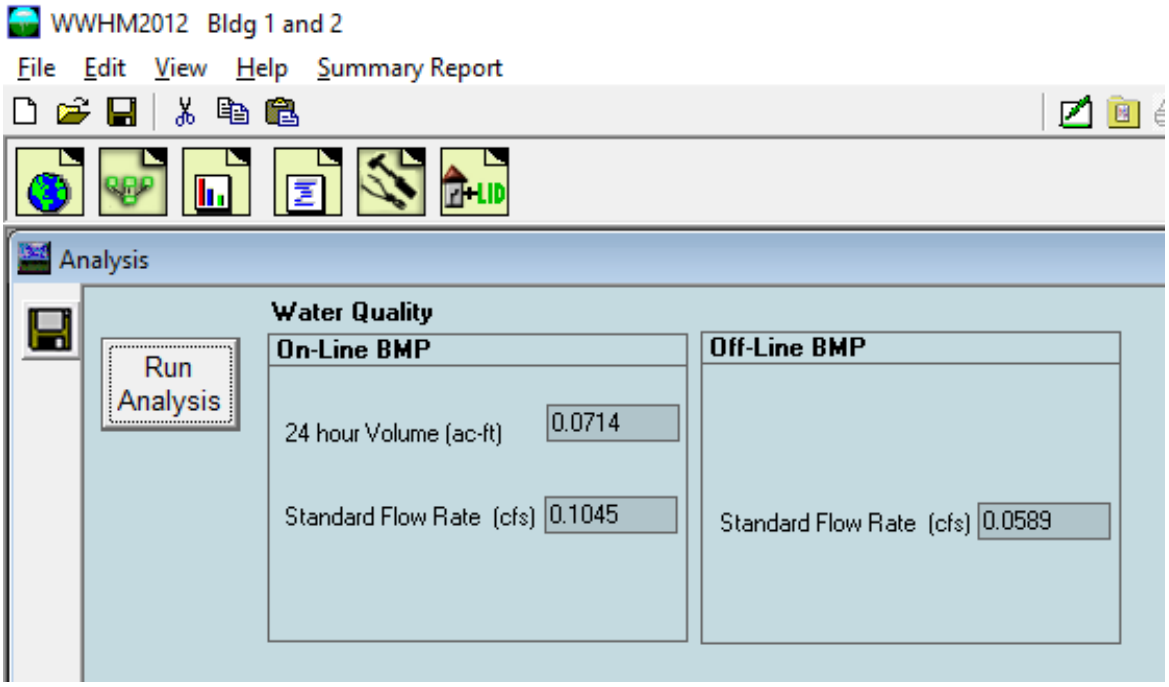


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

BLDG 2 (PF-13)

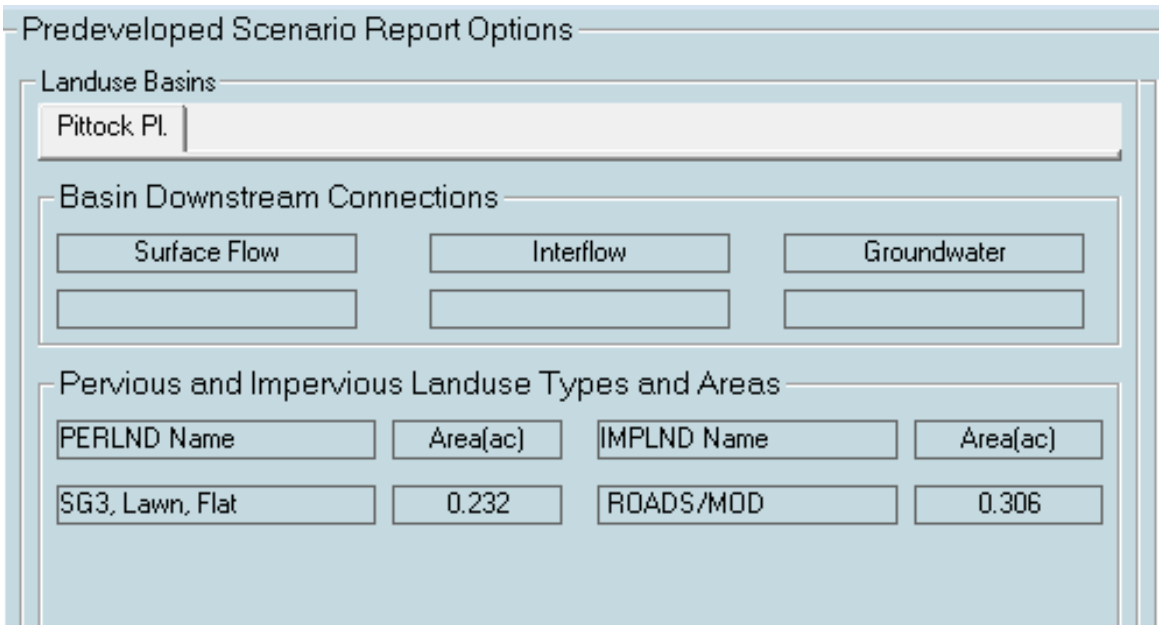


BLDG 2 (PF-13)

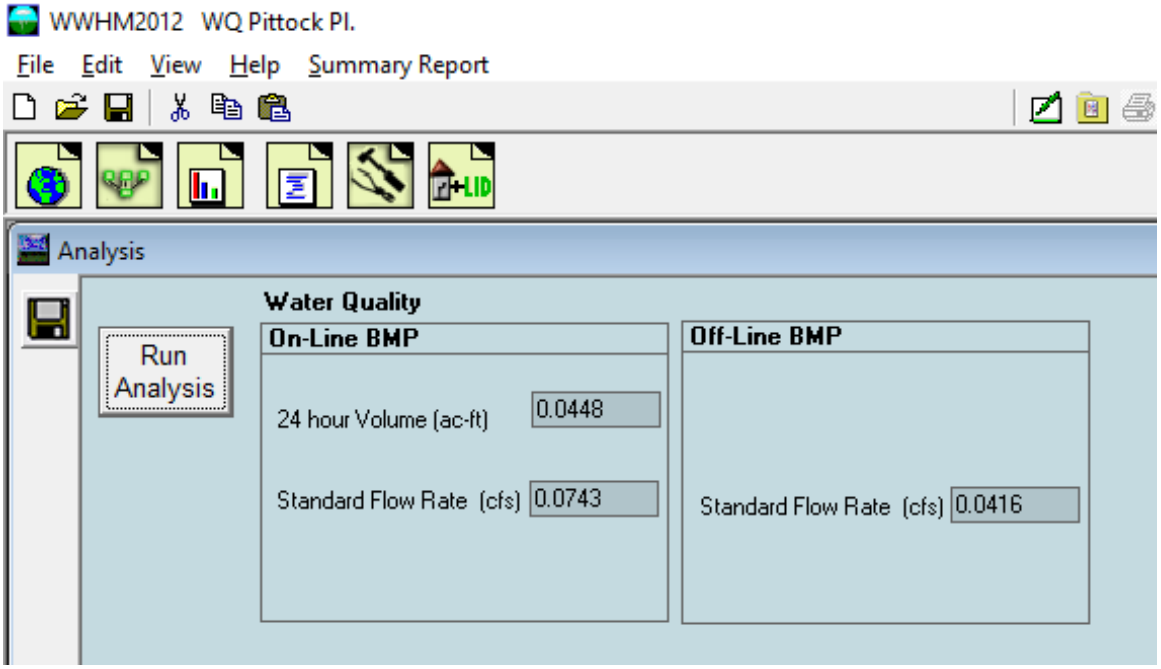


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

PF-15 Pittock Place Areas

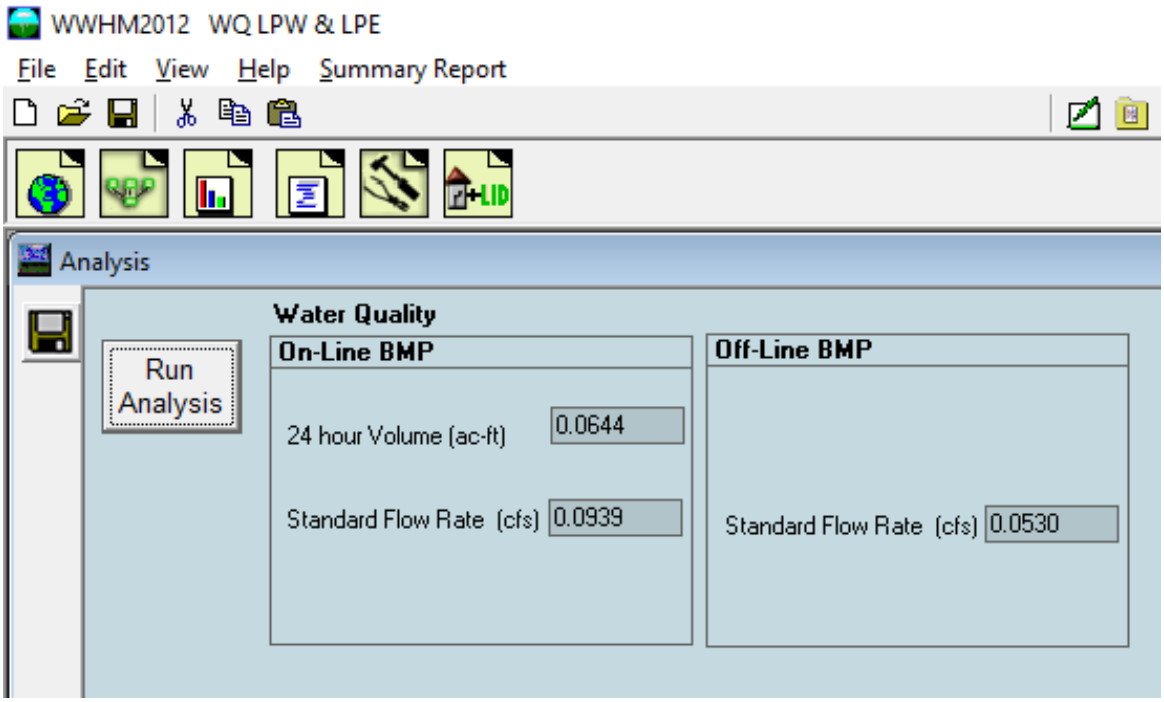


PF-15 Pittock Place

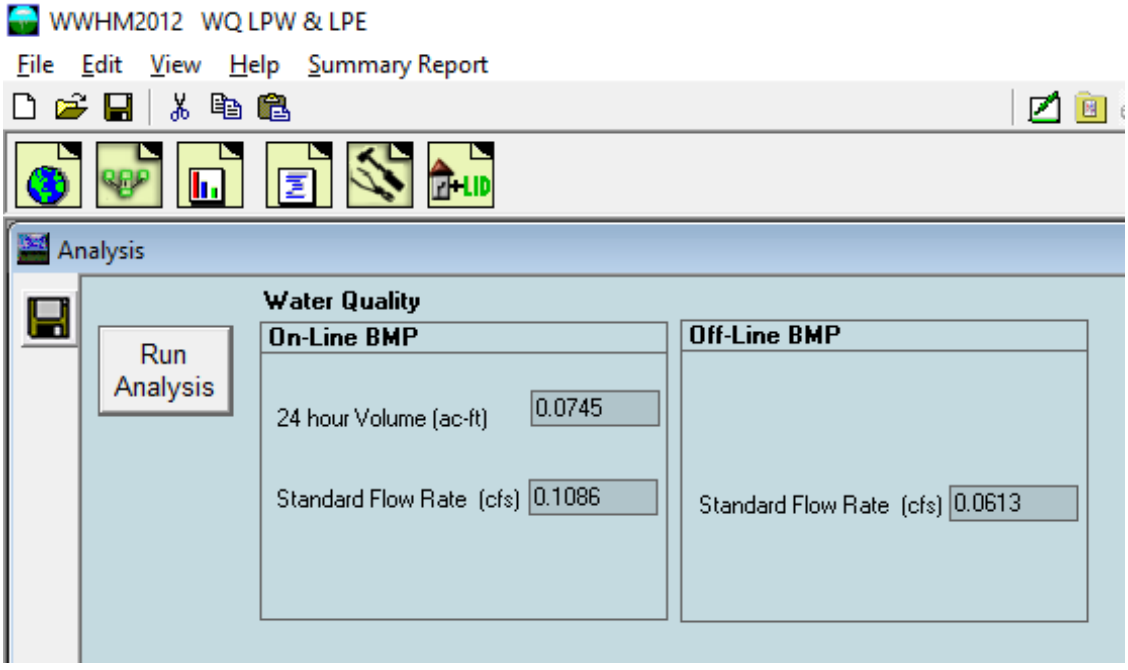


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

LPW (PF-16) Lower Parking Area - west side

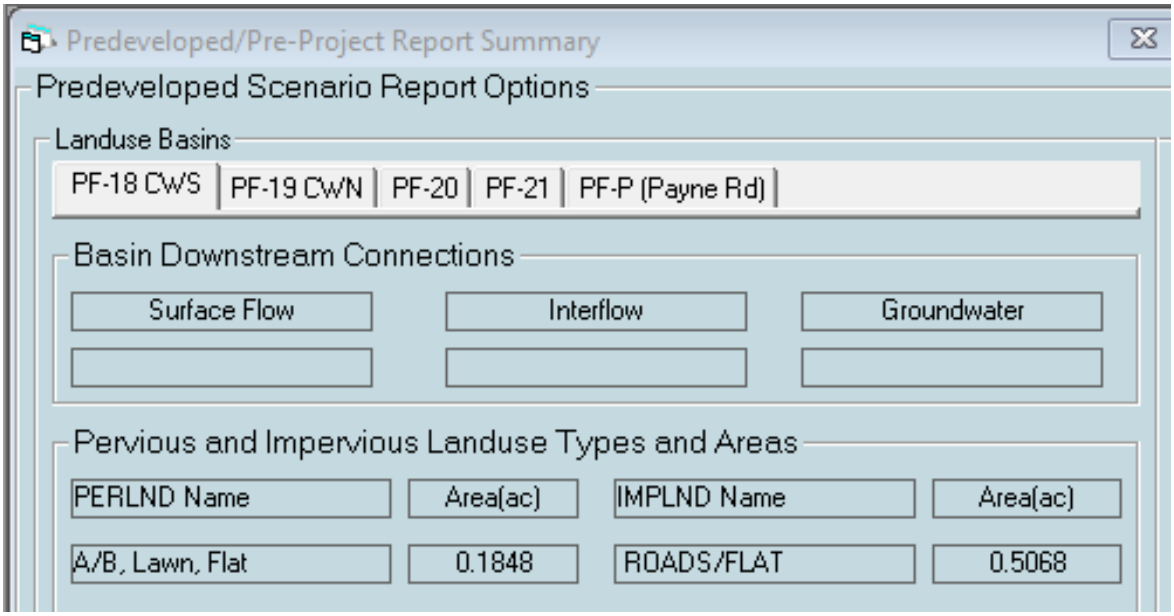


LPE (PF-17) Lower Parking Area – east side

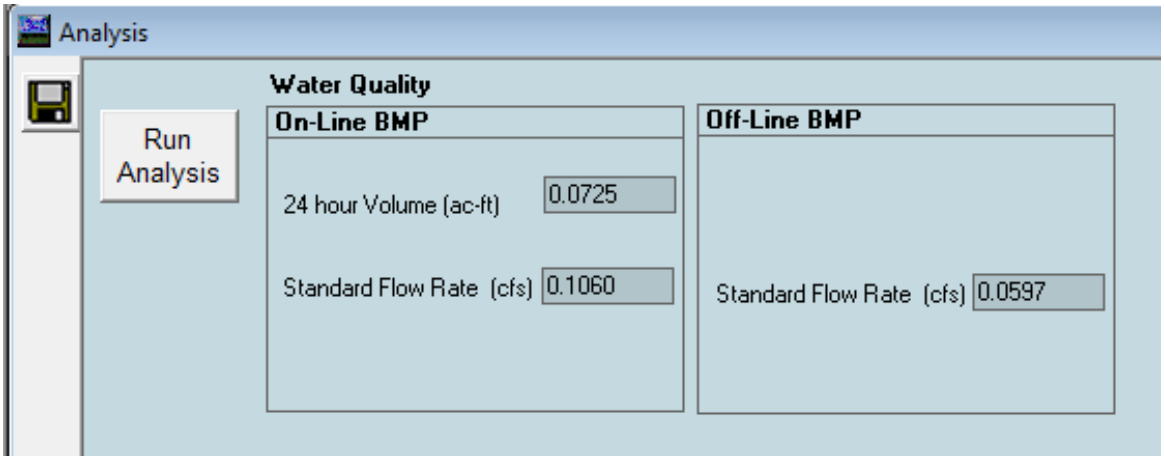


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

PF-18 Area (Camas Meadows Dr.)

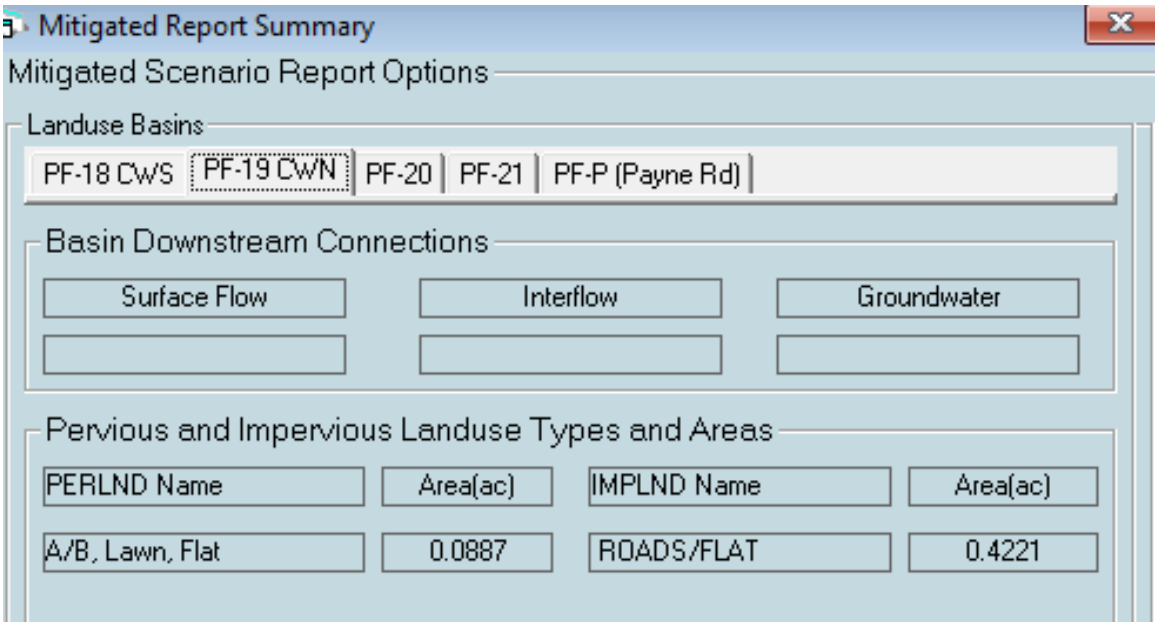


PF-18 WQ FLOW RATE

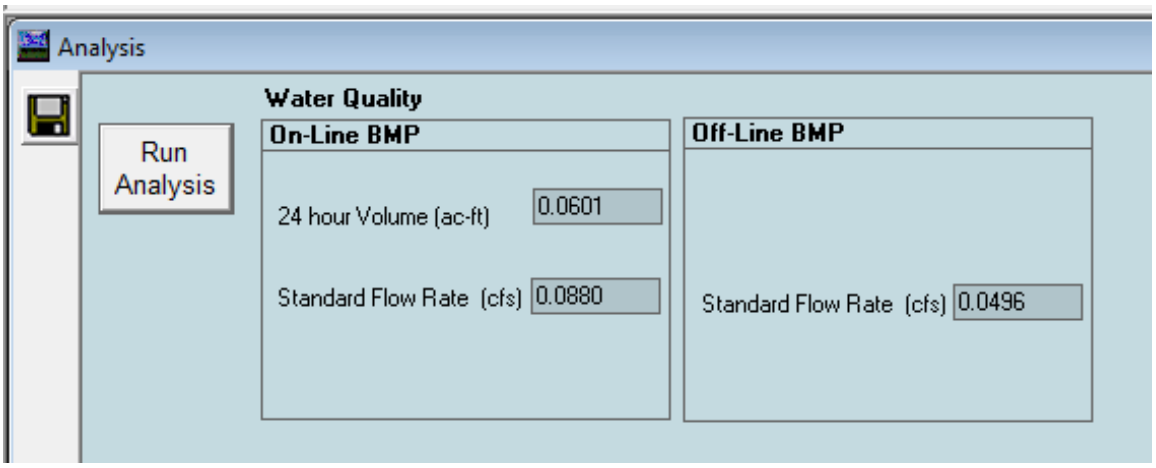


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

PF-19 Area (Camas Meadows Dr.)

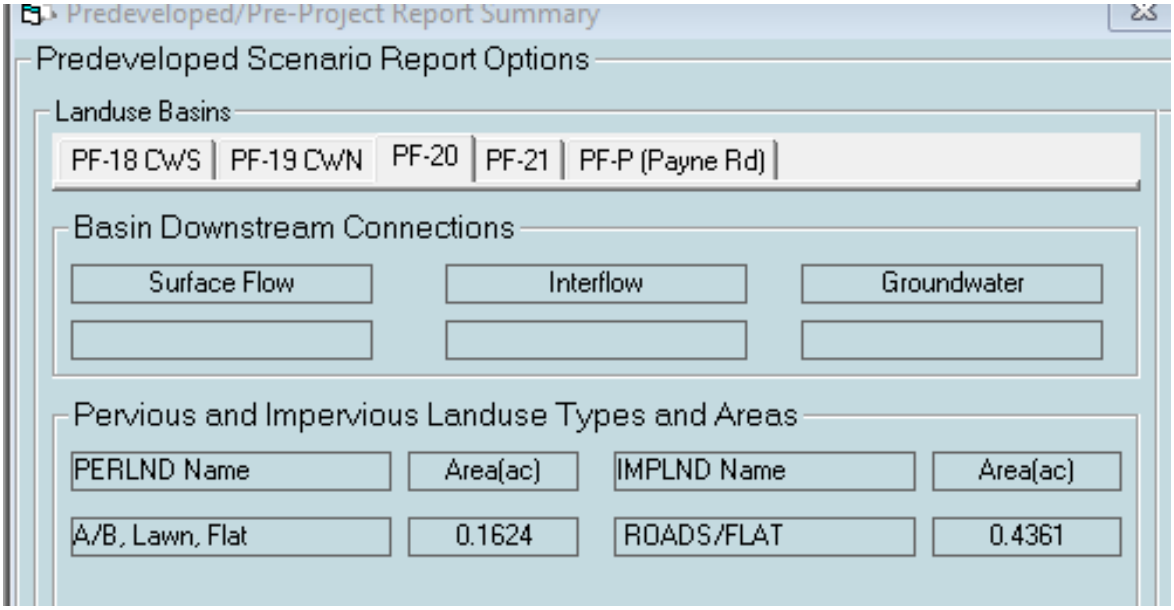


PF-19 WQ FLOW RATE

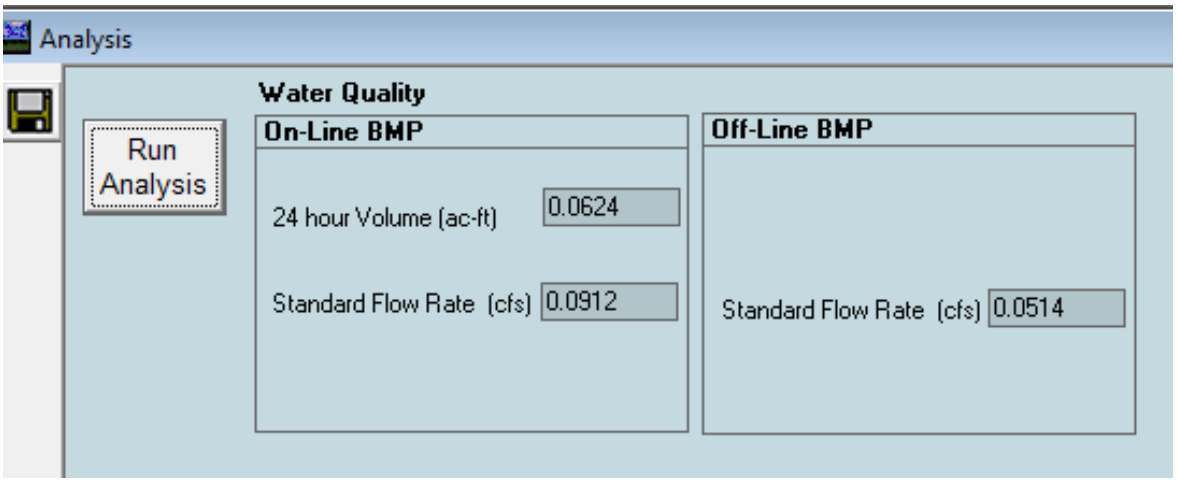


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

PF-20 AREA (Camas Meadows Dr.)

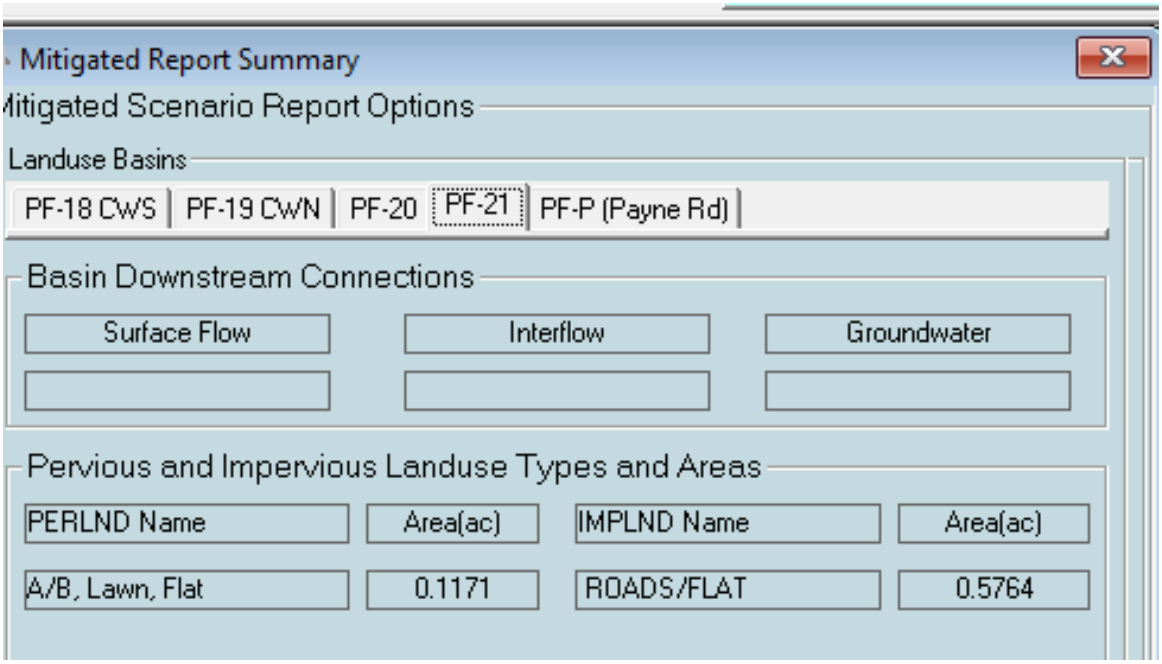


PF-20 WQ FLOW RATE

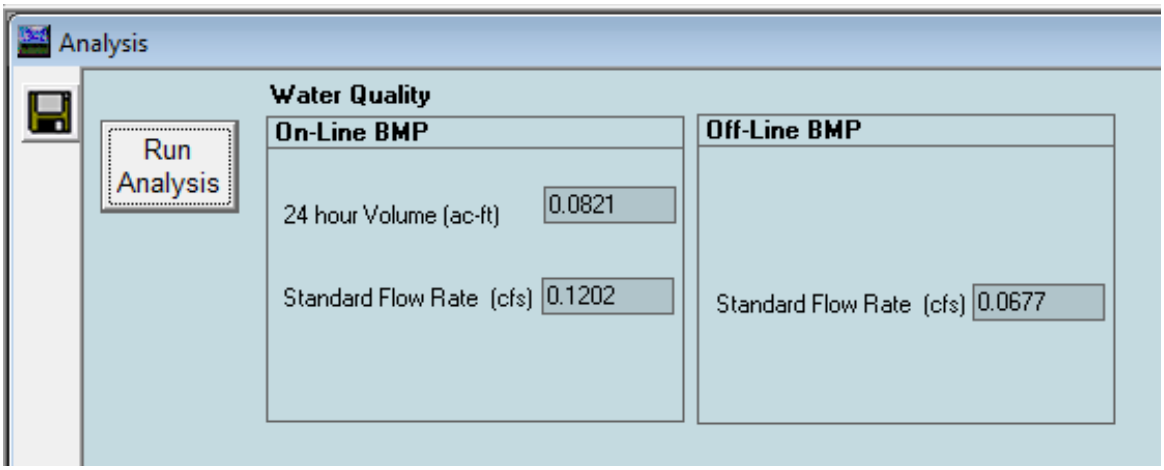


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

PF-21 AREA (Camas Meadows Dr.)

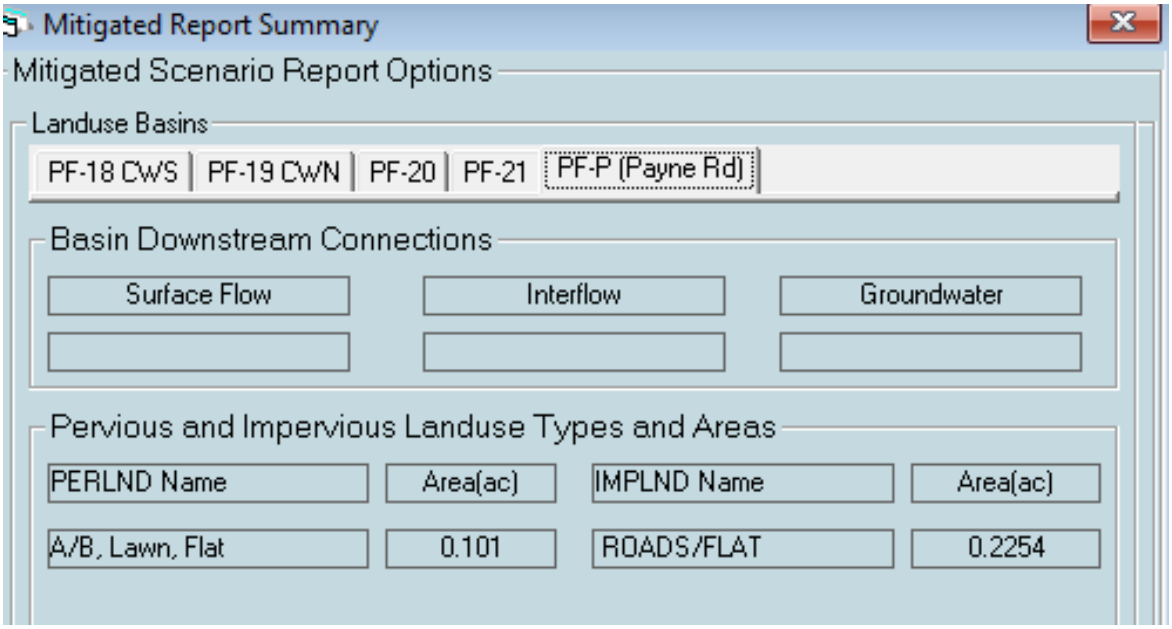


PF-21 WQ FLOW RATE

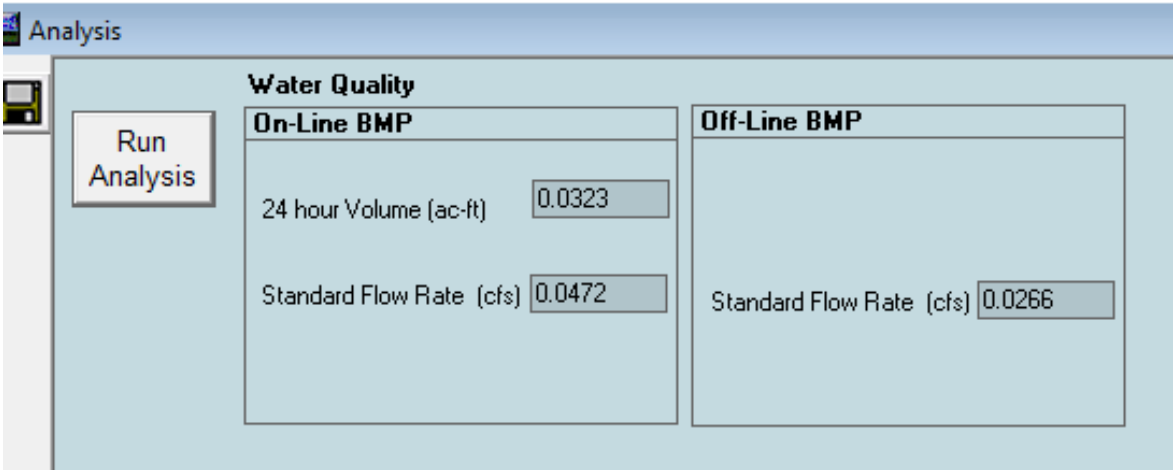


APPENDIX C-1 - WQ FLOW RATES FOR PERK FILTER SYSTEMS

PF-P AREA (Payne Rd)



PF-P WQ FLOW RATE (Payne Rd)



APPENDIX C-2 PERK FILTER SIZING SUMMARY
BASED ON WWHM WQ OFFLINE RATES

Perk Filter	ALLOWABLE CAPACITY - OFFLINE RATING			
Cartridge Size Height (in)	1 Unit Allowable Rate (cfs)	2 Unit Allowable Rate (cfs)	3 Unit Allowable Rate (cfs)	4 Unit Allowable Rate (cfs)
12"	0.015	0.030	0.045	0.061
18"	0.023	0.045	0.068	0.091
12" + 12"	0.030	0.061	0.091	0.121
18" + 12"	0.038	0.076	0.114	0.152

Parklands - System Requirements

Location	Perk Filter ID	Inflow Area Pervious (ac)	Inflow Area Impervious (ac)	Off-line Rate (cfs)	# Cartridge Bays	System	# Cartridges
Longbow - N	PF-1B	0.418	0.513	0.0610	4 Bi-lateral	12"	4-12"
Longbow - S	PF-2	0.339	0.385	0.0458	3 Bi-lateral	12"	3-12"
Longbow - W	PF-1A	0.186	0.1576	0.0188	1	18"	1-18"
Mc- NW	PF-3	0.044	0.314	0.0346	1	18" + 12"	1 - 18" and 1-12"
Mc - NE	PF-4	0.226	0.314	0.0370	3	12"	3-12"
Mc - S (LP)	PF-5	1.114	0.613	0.0799	3 Bi-lateral	12" + 12"	6-12"
Mc - mid- W	PF-6	0.365	0.144	0.0176	1	18"	1-18"
Mc - mid- E	PF-7	0.365	0.144	0.0176	1	18"	1-18"
Mc - S end-W	PF-8	0.434	0.1265	0.0221	1	18"	1-18"
Mc - S end-E	PF-9	0.434	0.1265	0.0221	1	18"	1-18"
Pittock	PF-15	0.232	0.455	0.0416	2	18"	2-18"

Camas Meadows Drive - System Requirements

Location	Perk Filter ID	Inflow Area Pervious (ac)	Inflow Area Impervious (ac)	Off-line Rate (cfs)	# Cartridge Bays	System	# Cartridges
E on N side CMD	PF-21	0.1171	0.5764	0.0677	3	18"	3-18"
E on S side CMD	PF-20	0.1624	0.4361	0.0514	2	12" + 12"	4-12"
W on S side CMD	PF-18	0.1848	0.5068	0.0597	2	12" + 12"	4-12"
W on N side CMD	PF-19	0.0887	0.4221	0.0496	2	12" + 12"	4-12"
Payne Rd.	PF-P	0.1010	0.2254	0.0266	1	12" + 12"	2-12"

Business Park - System Requirements

Location	Perk Filter ID	Inflow Area Pervious (ac)	Inflow Area Impervious (ac)	Off-line Rate (cfs)	# Cartridge Bays	System	# Cartridges
Bldg #1	PF-14	0.118	0.710	0.0834	3	12" + 12"	6-12"
Bldg #2	PF-13	0.100	0.510	0.0589	2	12" + 12"	4-12"
Bldg #3	PF-12	0.244	0.9225	0.1086	3 Bi-lateral	18" + 12"	3-12" & 3-18"
Bldg #4	PF-11	0.112	0.8355	0.0982	3	18" + 12"	3-12" & 3-18"
Bldg #4	PF-10	0.112	0.8355	0.0982	3	18" + 12"	3-12" & 3-18"

LPW	PF-16	0.031	0.452	0.0530	2	12" + 12"	4-12"
LPE	PF-17	0.017	0.523	0.0613	2	12" + 12"	4-12"

APPENDIX C3 WATER QUALITY
C-3a PHOSPHORUS LOADING ANALYSIS
DETERMINE PERCENT PHOSPHORUS REMOVAL BASED ON AREAS

SUMMARY OF CONTRIBUTING AREAS - SEE APPENDIX D SUBBASIN AREAS				
Contributing Area Description	**Treatment Condition**	**Area (ac)**	**Area/Total Area (ratio)**	**Percent**
Lawn and drives to buffer	No Perk Filter	4.527	0.1592	15.92%
Roofs to storm	No Perk Filter	3.753	0.1320	13.20%
Roofs to buffer	No Perk Filter	4.277	0.1504	15.04%
Treated Area	to Perk Filter	15.881	0.5584	55.84%
	Total for Site*	28.438		100.0%

*includes Camas Meadows Dr. and portion of Payne Rd.

Assume buffers/wetlands will remove 40% Phosphorous Pollutant Load - Evalaute 3 Scenarios

Scenario #1: Determine Percent Removal For Site Runoff - portion to Perk Filters and to buffer

Perk Filter	15.881	62.4% per TAPE		15.881*.624	9.91
No Perk Filter	4.527	**Lawn and drives to buffer**	assume average 40%	4.760*.40	1.81
Area of concern	20.408	All Roofs assumed "clean"			11.72
			percent removal	11.72/20.408	57.4%
					exceeds 50%

Scenario #2: Determine Percent Removal For Site Runoff - portion to Perk Filters and to buffer

Perk Filter	15.881	62.4% per TAPE		15.881*.624	9.91
No Perk Filter	8.804	**Lawn,drives, roofs to buffer**	assume average 40%	8.804*.40	3.52
	24.685	Roofs to storm assumed "clean" at 3.753 ac.			13.43
			percent removal	13.43/24.685	54.4%
					exceeds 50%

Scenario #3: Determine Percent Removal For Site Runoff - portion to Perk Filters and to buffer

Perk Filter	15.881	62.4% per TAPE		16.543*.624	9.91
No Perk Filter	12.557	**Lawn, roofs, and roofs to storm**	assume average 40%	11.027*.40	5.02
	28.438	include all areas			14.93
			percent removal	14.93/28.438	52.5%
					exceeds 50%

APPENDIX C3 WATER QUALITY
C-3a PHOSPHORUS LOADING ANALYSIS
DETERMINE PERCENT PHOSPHORUS REMOVAL BASED ON AREAS

SUMMARY OF CONTRIBUTING AREAS - SEE APPENDIX D SUBBASIN AREAS				
Contributing Area Description	**Treatment Condition**	**Area (ac)**	**Area/Total Area (ratio)**	**Percent**
Lawn and drives to buffer	No Perk Filter	4.527	0.1592	15.92%
Roofs to storm	No Perk Filter	3.753	0.1320	13.20%
Roofs to buffer	No Perk Filter	4.277	0.1504	15.04%
Treated Area	to Perk Filter	15.881	0.5584	55.84%
	Total for Site*	28.438		100.0%

*includes Camas Meadows Dr. and portion of Payne Rd.

Determine Minimum Percent Removal For Buffer to Satisfy 50% removal					
	Find for 50% removal - Scenario #1		by trial and error	10.204/20.408	50.0%
	4.527 + 15.881 = 20.408				
No Perk Filter	**4.527**	**Lawn and drives to buffer**	**6.5%**	4.527*0.065	0.294
and	15.881 + 4.277 + 3.753 = 23.911 acres considered "clean"			62.4 % portion	9.91
	All Roofs assumed "clean"				10.204
	Find for 50% removal - Scenario #2		by trial and error	12.3425/24.685	50.0%
	4.527 + 4.277 + 15.881 = 24.685		lowest level removal		
No Perk Filter	**8.804**		**27.63%**	8.804*.2763	2.4325
and	15.881 + 3.753 = 19.634 acres considered "clean"			62.4 % portion	9.91
	Roofs to storm assumed "clean", Roofs to buffers not assumed 'clean'				12.3422
	Find for 50% removal - Scenario #3		by trial and error	14.219/28.438	50.0%
	4.527 + 4.277 + 3.753 + 15.881 = 28.438		lowest level removal		
No Perk Filter	**12.557**		**34.3%**	12.557*.343	4.309
and	only 15.881 acres considered "clean"			62.4 % portion	9.91
					14.219

Notes:

1. The roof portion that goes directly to the storm system and not to the buffer is 2.835 Acres (McMaster, Longbow, and Pittock) and the roof portion from the south building (business) at 0.71 acres. This total of 3.55 acres is released at the two culverts betv Wetland A and B. This amount of runoff is assumed to be treated in the natural wetland ponding area - about 3.37 acre surface area. The most direct flow path through the onsite wetland is about 550 LF and then passes over another 600 LF in a shallow flo path through mostly reed canary grass. Reed canary grass is considered an excellent treatment medium.

2. The roof areas from the other three business portions (1.03 acres) will be released to the storm system and then released fror the dissipation system to the buffer (304 ft spread for sheet flow).

APPENDIX C WATER QUALITY
C-3b PHOSPHORUS LOADING CALCULATIONS

Reference : Pennsylvania Stormwater Best Management Practices Manaual
Chapter 8, Worksheet 12 (attached)

PREDEVELOPMENT AREA AND POLLUTANT LOADING				
Pre	28.437	0.30	2.7	**23.03**

Note: 0.3 is factor for HSG C soil (silt loam, clay loam or silty clay loam)

Developed - Untreated Portion to Buffer or to Wetlands				
Source	**Surface Area (ac)**	**TP EMC (mg/l)**	**Unit Conversion Factor**	**Pollutant Load**
Lots 2-10 - roofs	1.045	0.13	2.7	0.367 LBS
Lots 11-15 - roofs	0.597	0.13	2.7	0.210 LBS
Lot 16 - roof	0.149	0.13	2.7	0.052 LBS
Lots 32-38 - roofs	1.067	0.13	2.7	0.375 LBS
Lots 39-40 - roofs	0.298	0.13	2.7	0.105 LBS
Lots 41-42 - roofs	0.298	0.13	2.7	0.105 LBS
Business - roofs	4.575	0.13	2.7	1.606 LBS
Lots 2-10 - lawn/drive	0.989	0.40	2.7	1.068 LBS
Lots 11-15 - lawn/drive	1.795	0.40	2.7	1.939 LBS
Lot 16 - lawn/drive	0.213	0.40	2.7	0.230 LBS
Lots 32-38 - lawn/drive	0.731	0.40	2.7	0.789 LBS
Lots 39-40 - lawn/drive	0.311	0.40	2.7	0.336 LBS
Lots 41-42 - lawn/drive	0.218	0.40	2.7	0.235 LBS
north of parking lot	0.27	0.40	2.7	0.292 LBS
	12.556			**7.707 LBS**

Source	**Surface Area (ac)**	**TP EMC (mg/l)**	**Unit Conversion Factor**	**Pollutant Load**	
CMD	2.763	0.33	2.7	2.462 LBS	treated
Pittock	0.585	0.36	2.7	0.569 LBS	treated
Business -east	2.832	0.39	2.7	2.982 LBS	treated
Business -west	2.890	0.39	2.7	3.043 LBS	treated
Lawn to streeet	3.652	0.40	2.7	3.944 LBS	treated
Streets - R/W	3.159	0.36	2.7	3.071 LBS	treated
	15.881			**16.070 LBS**	
				7.707 LBS	
Total Post-Development Load				**23.778 LBS**	

Total Area 28.437

APPENDIX C WATER QUALITY
C-3b PHOSPHORUS LOADING CALCULATIONS

DETERMINE POLLUTANT LOADING WITH TREATMENT ACCOUNTED FOR		
16.07 lbs treated at 62.4% = 9.91 lbs removed	6.160 lbs remain	
6.495 lbs treated at 45%* = 2.923 lbs removed	3.572 lbs remain	
Pollutant Load	9.73 LBS	OK
compare Pre loading	23.03 LBS	

Note that even witout treatment credit at buffer, 6.16 + 6.495 = 12.655 LBS
which is a 45% reduction from Pre loading. So buffere only needs to provide 5% redu

*Assume wetland buffer will treat 45% of phosphorus pollutant load
1. Literature search varies on removal percentages.
However, natural buffers are considered effective even for wastewater conditions.
2. Buffer widths for 0% to 8% slopes are generally listed n the 70 to 100 LF range.
The buffer width for this site is 50 LF. However, during the WQ event, the distance to ponded water in the wetland is more than 50 feet. See attachment with contour 188 for reference.

Exhibit 16 SP26-1005

WORKSHEET 13. POLLUTANT REDUCTION THROUGH BMP APPLICATIONS*

** FILL THIS WORKSHEET OUT FOR EACH BMP TYPE WITH DIFFERENT POLLUTANT REMOVAL EFFICIENCIES. SUM POLLUTANT REDUCTION ACHIEVED FOR ALL BMP TYPES ON FINAL SHEET.*

BMP TYPE: _____

DISTURBED AREA CONTROLLED BY THIS BMP TYPE (AC)	

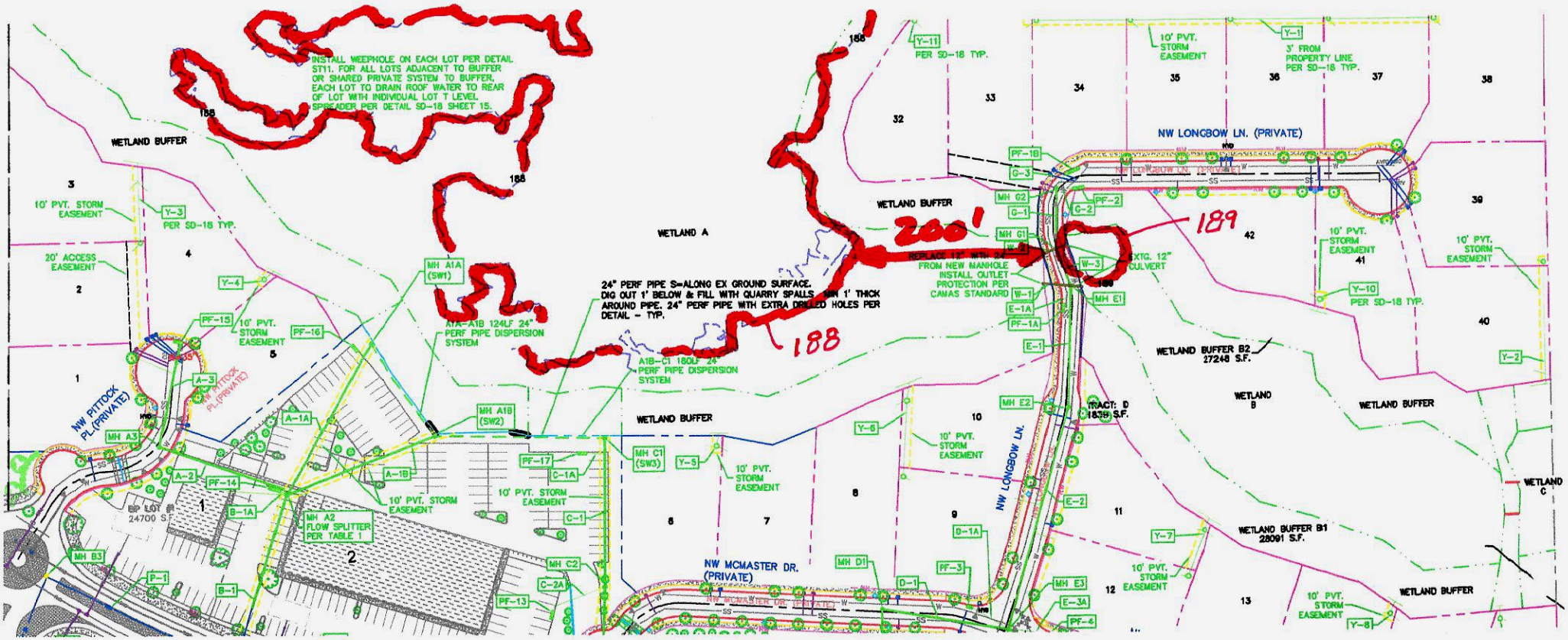
DISTURBED AREAS CONTROLLED BY THIS BMP TYPE:

		POLLUTANT					POLLUTANT LOAD**		
	LAND COVER CLASSIFICATION	TSS EMC *(mg/l)*	TP EMC *(mg/l)*	Nitrate-Nitrite EMC *(mg/l as N)*	COVER (Acres)	RUNOFF VOLUME (AF)	TSS*** (LBS)	TP*** (LBS)	NO_3 (LBS)
Pervious Surfaces	Forest	39	0.15	0.17					
	Meadow	47	0.19	0.3					
	Fertilized Planting Area	55	1.34	0.73					
	Native Planting Area	55	0.40	0.33					
	Lawn, Low-Input	180	0.40	0.44					
	Lawn, High-Input	180	2.22	1.46					
	Golf Course Fairway/Green	305	1.07	1.84					
	Grassed Athletic Field	200	1.07	1.01					
Impervious Surfaces	Rooftop	21	0.13	0.32					
	High Traffic Street / Highway	261	0.40	0.83					
	Medium Traffic Street	113	0.33	0.58					
	Low Traffic / Residential Street	86	0.36	0.47					
	Res. Driveway, Play Courts, etc.	60	0.46	0.47					
	High Traffic Parking Lot	120	0.39	0.60					
	Low Traffic Parking Lot	58	0.15	0.39					
						TOTAL LOAD TO THIS BMP TYPE			
						POLLUTANT REMOVAL EFFICIENCIES FROM TABLE 9-3 (%)			
						POLLUTANT REDUCTION ACHIEVED BY THIS BMP TYPE (LBS)			

POLLUTANT REDUCTION ACHIEVED BY ALL BMP TYPES (LBS)			
REQUIRED REDUCTION FROM WS12 (LBS)			

** Pollutant Load = [EMC, mg/l] X [Volume, AF] X [2.7, Unit Conversion]

*** TSS and TP calculations only required for projects not meeting CG1/CG2 or not controlling less than 90% of the disturbed area



Release at Longbow Ln.
The flow will travel about 200 LF prior to reaching the ponded water area with a flow path that continues to the north property line and enters dense reed canary grass.

Wetland A
The flow path for phosphorus treatment is the 50 LF buffer width plus flow to the 188 contour (actually to about 187.7)

Wetland B
The flow path for phosphorus treatment is the 50 LF buffer width plus flow to the 189 contour near the culvert.

APPENDIX D

Storm System Elements Discussion - Brief

The main piping has been entered into the model as Storm Line A, B, C, D, E, F, and G. The majority of the effort has been to make sure that the subbasin areas have been accounted for and directed to the appropriate storm system. The subbasin areas have been tabulated with respect to pervious and impervious area.

The plan shows the location of the Perk Filter system units and the outfall for Storm Line B and C in particular. These two outfalls will utilize stilling well structures to dissipate the energy from for flow from nearly 20 acres for each system. The Line A system is actually providing two stilling well structures. This second structure is mainly for better distribution of the flow volume to the perforated pipe dissipation system. See Appendix E-3 and E-4.

Appendix D Conveyance System

D-1 Storm System Pipe Capacity and Velocity Check -10-yr (Reach Info and HGL)

Reach Analysis
HCAD for Line A and B – 10-yr
HCAD for Line C – 10-yr
HCAD for Line E – 10-yr
HCAD for Line D, E, and F – 10-yr
HCAD for Line G
HCAD Thru Wetlands – 10-yr
HGL analysis
HCAD for Line A and B – 10-yr
HCAD for Line C – 10-yr
HCAD for Line D, E, and F – 10-yr
HCAD for Line G

D-2 Conveyance Design Comments

D-3 Dynamic Analysis Water Surface Summary for 100-yr Surcharged Condition

HCAD for Line A, B, and C – 100-yr
HCAD for Line E
HCAD for Line D and F – 100-yr
HCAD for Line G
HCAD Thru Wetlands – 100-yr

D-4 Rear Yard Sytems

HCAD for Rear Yard Systems – see also App. C-4 WQ for Single Lot

APPENDIX D
D-1 SUBBASIN AREAS-SITE AND CAMAS MEADOWS DRIVE

SUMMARY OF DRAINAGE AREAS

AREAS TREATED WITH PERK FILTERS FOR PHOSPHORUS

MCMASTER DR. AND LONGBOW LN TO WETLAND A - SOUTH CULVERT*

Subcat ID	Drive Area (sf)	Lawn Area (sf)	Street Area (sf)	Sidewalk Area (sf)	Grass Area (sf)	Total Area (sf)	Total Area (ac)
PF1A	1,000	7,576	3,978	1,884	529	14,967	0.344
PF3	---	---	9,509	3,282	1,856	14,647	0.336
PF4	2,000	7,966	8,740	2,939	1,901	23,546	0.541
PF5	5,000	44,399	15,809	5,894	4,136	75,238	1.727
PF6	2,360	15,391	2,900	1,000	540	22,191	0.509
PF7	2,360	15,329	2,900	1,000	540	22,129	0.508
PF8	3,000	18,452	1,923	586	176	24,137	0.554
PF9	3,000	18,452	1,923	586	176	24,137	0.554
	18,720	127,565	47,682	17,171	9,854	220,992	**5.073**
	0.430 Ac.	**2.928 Ac.**	1.095 Ac.	0.394 Ac.	0.226 Ac.		

LONGBOW LN TO WETLAND A - NORTH CULVERT*

Subcat ID	Drive Area (sf)	Lawn Area (sf)	Street Area (sf)	Sidewalk Area (sf)	Grass Area (sf)	Total Area (sf)	Total Area (ac)
PF1B	6,500	18,000	10,791	5,080	3,227	43,598	1.001
PF2	5,000	13,500	11,731	545	1,285	32,061	0.736
	11,500.00	31,500.00	22,522.00	5,625.00	4,512.00	75,659	**1.737**
	0.264 Ac.	**0.723 Ac.**	0.517 Ac.	0.129 Ac.	0.104 Ac.		

* North and South Culverts are now Interconnected

SUMMARY FOR TREATED AREAS -MCMASTER AND LONGBOW SYSTEM

Drive Area (sf)	Lawn Area (sf)	Street Area (sf)	Sidewalk Area (sf)	Grass Area (sf)	Total Area (sf)	Total Area (ac)
30,220	159,065	70,204	22,796	14,366	296,651	**6.810**
0.694 Ac.	3.652 Ac.	1.612 Ac.	0.523 Ac.	0.330 Ac.		

SUMMARY FOR TREATED AREAS - BUSINESS PK -EAST

Subcat ID	Parking Area (sf)	Landscape Area (sf)	Total Area (sf)	Total Area (ac)
PF10	37,875	6,109	43,984	1.010
PF11	35,023	3,662	38,685	0.888
PF12	30,681	9,998	40,679	0.934
	103,579	19,769	123,348	**2.832**
	2.378 Ac.	0.454 Ac.		

APPENDIX D
D-1 SUBBASIN AREAS-SITE AND CAMAS MEADOWS DRIVE

SUMMARY FOR TREATED AREAS - BUSINESS PK -WEST				
Subcat ID	**Parking Area (sf)**	**Landscape Area (sf)**	**Total Area (sf)**	**Total Area (ac)**
PF13	21,016	4,369	25,385	0.583
PF14	33,428	5,160	38,588	0.886
PF16	19,881	1,364	21,245	0.488
PF17	30,681	9,998	40,679	0.934
	105,006	20,891	125,897	**2.890**
	2.411 Ac.	0.480 Ac.		

PITTOCK PLACE							
Subcat ID	**Drive Area (sf)**	**Lawn Area (sf)**	**Street Area (sf)**	**Sidewalk Area (sf)**	**Grass Area (sf)**	**Total Area (sf)**	**Total Area (ac)**
PF15	1,000	9,010	13,447	1,350	683	25,490	**0.585**

Camas Meadows Drive and Payne Rd (portion)

Subcat ID	**Street Area (sf)**	**Sidewalk Area (sf)**	**Grass Area (sf)**	**Total Area (sf)**	**Total Area (ac)**
PFP	7,418	2,400	4,400	14,218	0.326
PF18	17,676	4,400	8,052	30,128	0.692
PF19	13,067	5,420	3,864	22,351	0.513
PF20	15,139	3,858	7,073	26,070	0.598
PF21	15,214	7,280	5,100	27,594	0.633
	68,514	23,358	28,489	120,361	**2.763**

SUMMARY FOR TREATED AREAS	
McMaster and Longbow Ln	6.810
Business Park-East	2.832
Business Park-West	2.890
Pittock Place	0.585
Camas Meadows Drive	2.763
	15.880

Treated

APPENDIX D
D-1 SUBBASIN AREAS-SITE AND CAMAS MEADOWS DRIVE

UNTREATED - DRAINS TO AND THROUGH BUFFER

South of Wetland A			W1A and W1B		
Lot #	**Lot Area (sf)**	**Roof (sf)**	**Drive (sf)**	**Lawn (sf)**	
2	16,255	6,500	1,000	8,755	Note: Lot # 1 drains to Pittock Place
3	18,071	6,500	1,000	10,571	
4	16,016	6,500	1,000	8,516	
5	15,864	---	1,000	8,364	Lot #5 roof drains to Pittock Place
6	16,213	6,500	1,000	8,713	
7	15,463	6,500	1,000	7,963	
8	17,274	6,500	1,000	9,774	
9	---	---	---	---	Note: Lot # 9 drains to Longbow Ln. -See PF1A
10	15,043	6,500	1,000	7,543	
	130,199	45,500	8,000	70,199	
	2.989 Ac.	1.045 Ac.	0.184 Ac.	1.612 Ac.	

Imperv.	Perv.	Total
1.228 Ac.	1.612 Ac.	2.840 Ac.

Lawn/Drive
1.795 Ac.

Subcat ID		Lawn (sf)
LPD	North of parking area	11,678

0.27 Ac.

Lots South of Wetland B					
Lot #	**Lot Area (sf)**	**Roof (sf)**	**Drive (sf)**	**Lawn (sf)**	
11	15,008	6,500	1,000	7,508	
12	15,090	---	1,000	7,590	Note: Lot #12 roof to drains to Longbow Ln. - See PF2
13	15,073	6,500	1,000	7,573	
14	15,016	6,500	1,000	7,516	
15	15,413	6,500	1,000	7,913	
	75,600	26,000	5,000	38,100	
	1.736 Ac.	0.597 Ac.	0.115 Ac.	0.875 Ac.	

Imperv.	Perv.	Total
0.712 Ac.	0.875 Ac.	1.586 Ac.

Lawn/Drive
0.989 Ac.

E1A	E1B
0.689	0.875

Lots South of Wetland C					
Lot #	**Lot Area (sf)**	**Roof (sf)**	**Drive (sf)**	**Lawn (sf)**	
16	15,798	6,500	1,000	8,298	
	0.363 Ac.	0.149 Ac.	0.023 Ac.	0.190 Ac.	

Imperv.	Perv.	Total
0.172 Ac.	0.190 Ac.	0.363 Ac.

Lawn/Drive
0.213 Ac.

E2A	E2B

APPENDIX D
D-1 SUBBASIN AREAS-SITE AND CAMAS MEADOWS DRIVE

Lot #	Lot Area (sf)	Roof (sf)	Lawn (sf)
32	15,328	7,500	7,828
33	16,516	6,500	6,016
34	15,112	6,500	4,612
35	15,103	6,500	4,603
36	15,096	6,500	4,596
37	15,473	6,500	4,973
38	18,044	6,500	7,044
	110,672	46,500	39,672
	2.541 Ac.	1.067 Ac.	0.731 Ac.

Imperv.	Perv.	Total
1.067 Ac.	0.731 Ac.	1.799 Ac.
N1A	**N1B**	

Lots North of Wetland B Portion Draining to Rear			
Lot #	**Lot Area (sf)**	**Roof (sf)**	**Lawn (sf)**
39	18,235	6,500	6,235
40	18,329	6,500	7,329
	36,564	13,000	13,564
	0.839 Ac.	**0.298 Ac.**	**0.311**
		N2A	**N2B**

Lots North of Wetland B Portion Draining to Longbow Ln.			
Lot #	**Lot Area (sf)**	**Drives (sf)**	**Lawn (sf)**
39	18,235	1,000	7,500
40	18,329	1,500	3,000
	36,564	2,500	10,500
	0.839 Ac.	0.057 Ac.	0.241 Ac.
			Drains to PF2

Lots North of Wetland B Portion Draining to Rear			
Lot #	**Lot Area (sf)**	**Roof (sf)**	**Lawn (sf)**
42	15,385	6,500	4,885
41	15,115	6,500	4,615
	30,500	13,000	9,500
	0.700 Ac.	**0.298 Ac.**	**0.218**
		N3A	**N3B**

Lots North of Wetland B Portion Draining toLongbow Ln.			
Lot #	**Lot Area (sf)**	**Drives (sf)**	**Lawn (sf)**
42	15,385	1,000	3,000
41	15,115	1,000	3,000
	30,500	2,000	6,000
	0.700 Ac.	0.046 Ac.	0.138 Ac.
			Drains to PF2

Roof Areas Released at Longbow Ln. - Untreated

System - Untreated

Roof Areas to McMaster Dr. and Longbow Ln - Line E			
Subcat ID	**# Roofs**	**Roof Area (sf)**	**Total Area (ac)**
RE2	2	13,000	0.298
RE3A	1	6,500	0.149
RE3B	2	13,000	0.298
RE4	1	6,500	0.149
RE5	1	6,500	0.149
RE6	4	26,000	0.597
RE7	2	13,000	0.298
RE8	2	13,000	0.298
RE9	1	6,500	0.149
	16	104,000	**2.388**

Roof Areas to Pittock Place.			
Subcat ID	**# Roofs**	**Roof Area (sf)**	**Total Area (ac)**
RP1	2	13,000	0.298

Business Park Roof Areas to Dissipation System			
Subcat ID	**# Roofs**	**Roof Area (sf)**	**Total Area (ac)**
BPR1	Business	3,000	0.069
BPR2	Business	19857	0.456
			0.525

Total roof area not treated	**0.823**
Total line D, E, & F	**3.753**

APPENDIX D
D-1 SUBBASIN AREAS-SITE AND CAMAS MEADOWS DRIVE

Roof Areas to McMaster Dr. - Line D and F			
Subcat ID	**# Roofs**	**Roof Area (sf)**	**Total Area (ac)**
RD1	1	6,500	0.149
		6,500	**0.149**

Roof Areas to McMaster Dr. - Line D and F			
Subcat ID	**# Roofs**	**Roof Area (sf)**	**Total Area (ac)**
BPR3	Business	21950	0.504
BPR4	Business	31,000	0.712
			1.216

Total roof area not treated **3.7530** roofs to storm and Wetland A

Sum Total - not treated	**4.576**
Lots 2-10	1.045
Lots 11-15	0.597
Lot 16	0.149
Lots 32-38	1.067
Lots 39-40	0.298
Lots 41-42	0.298
	3.454
to dissipation system and buffer	0.823
	4.277

Impervious Area (ac)	**Pervious Area (ac)**		
1.228	1.612		
	0.27		
0.689 Ac.	0.875 Ac.		
0.172	0.19		
1.067	0.731		
0.298	0.311		
0.298	0.218		
3.752	4.207	7.959	Untreated (Imperv. and Perv.)
		4.575	Untreated - roofs
		15.881	Treated
	Total	########	

compare 28.14 Ac. in HCAD

SUMMARY FOR POLLUTANT ANALYSIS		
Contributing Area Description	**Treatment Condition**	**Area (ac)**
Lawn and drives to buffer	No Perk Filter	4.527
Roofs to storm	No Perk Filter	3.753
Roofs to buffer	No Perk Filter	4.277
Treated Area	to Perk Filter	15.881
	Total for Site*	28.438

*includes Camas Meadows Dr. and portion of Payne Rd.

Note: slight descrepancies in area summaries - insignificant

APPENDIX D CONVEYANCE SYSTEM
D-1 STORM SYSTEM PIPE CAPACITY
AND VELOCITY CHECK - 10-YR EVENT

Notes:

1. The storm systems are sized for open channel flow - 10-yr event. However, velocity head losses create a backwater condition -see remark column.
2. In the 10-yr max. velocity column, the open channel flow velocity is noted first and then the velocity due to the backwater condition where applicable.

STORM LINE A & B

Upstream Structure ID	Downstream Structure ID	Pipe Length ID	Pipe Length cntr to cntr (ft)	Pipe Size (in)	US Rim Elev.	US Invert (ft)	DS Invert (ft)	Pipe Slope cntr to cntr (ft/ft)	10-YR Peak Rate (cfs)	Pipe Full Capacity (cfs)	Max. Velocity at 10-yr Flow (fps)*	Max. WSEL (ft)	Depth at Structure (ft)	Pipe Dia. (ft)	Remark on Hydraulic Condition
PF-P1	MH P1	PFP1	9.0	10	230.28	229.07	229.02	0.0056	0.27	1.63	2.21/1.97	229.40	0.33	0.83	OK
MH P1	MH B3	P-2	116.7	12	230.46	229.02	222.58	0.0552	0.27	8.40	4.86/1.71	229.27	0.25	1.00	OK
MH B3	MH B1	P-1	222.6	12	230.25	222.38	214.85	0.0338	0.27	6.56	4.09/1.71	222.63	0.25	1.00	OK
PF-18	MH B2	PF18	30.0	10	221.73	216.64	215.69	0.0317	0.50	4.04	5.04/2.69	217.05	0.41	0.83	OK
PF-19	MH B2	PF19	30.0	10	221.73	216.64	215.69	0.0317	0.39	4.04	4.69/2.43	217.01	0.37	0.83	OK
MH B2	MH B1	B-2	67.9	12	222.11	215.49	214.85	0.0094	0.89	3.48	3.71/1.03	216.72	1.23	1.00	submerged
MH B4	MH B1	B-4	61.5	18	229.98	215.67	214.85	0.0133	3.19	12.13	5.79/2.80	216.94	1.27	1.50	submerged
MH B1	MH A2	B-1	190.0	18	222.45	214.65	211.10	0.0187	9.53	14.4	8.71/5.40	216.66	2.01	1.50	submerged
PF-15	MH A3	A-3	112.6	10	205.36	201.36	200.80	0.0050	0.72	1.55	2.78/2.65	201.91	0.55	0.83	OK
MH A3	MH A2	A-2	253.0	10	218.14	200.73	199.47	0.0050	0.72	1.94	3.30/2.11	201.26	0.53	0.83	submerged
MH A2	MH A1A	A-1A	184.0	15	218.95	199.37	188.00	0.0618	5.71	16.06	13.09/4.65	200.83	1.46	1.25	submerged
MH A2	MHA1B	A-1B	170.0	15	218.95	199.37	188.50	0.0639	5.71	16.33	13.31/4.65	200.83	1.46	1.25	submerged
MH A1B	MH C1	A1B-C1	180.0	24	200.70	191.50	192.00	-0.0028	28.77	11.97	---/3.81	192.53	1.03	2.00	OK
MH A1A	MH A1B	AIA-A1B	124.0	24	200.00	191.00	191.50	-0.0040	28.77	14.31	---/4.55	192.53	1.53	2.00	OK
PF-14	MH A2	B-1A	10.0	8	217.63	212.80	212.72	0.0080	0.73	1.08	3.33/2.8	213.42	0.62	0.67	OK
PF-16	MH A1A	A-1C	9.5	8	200.56	195.73	189.67	0.6379	0.42	9.65	13.86/2.09	196.11	0.38	0.67	OK

Storm System Line C

Upstream Structure ID	Downstream Structure ID	Pipe Length ID	Pipe Length cntr to cntr (ft)	Pipe Size (in)	US Rim Elev.	US Invert (ft)	DS Invert (ft)	Pipe Slope cntr to cntr (ft/ft)	10-YR Peak Rate (cfs)	Pipe Full Capacity (cfs)	Max. Velocity at 10-yr Flow (fps)	Max. WSEL (ft)	Depth at Structure (ft)	Pipe Dia. (ft)	Remark on Hydraulic Condition
D1-1	Tee into C-10	C-11	13.0	15	243.08+/-	240.13	238.23	0.1462	no flow	24.7	---	no flow	---	---	---
Extg MH C11	MH C10	C-10	163.4	18	242.62	238.72	237.68	0.0064	2.46	8.38	4.12/3.3	239.68	0.96	1.50	OK
MH C10	MH C9	C-9	121.7	18	242.00	237.68	237.25	0.0035	2.46	6.24	3.32/2.45	239.13	1.45	1.50	OK
MH C9	MH C8	C-8	200.0	24	245.34	237.25	228.79	0.0423	13.2	46.53	12.75/4.51	239.01	1.76	2.00	OK
MH C8	MH C7	C-7	166.3	24	236.46	228.59	224.72	0.0233	13.19	34.51	10.25/4.51	230.35	1.76	2.00	OK
MH C7	MH C6	C-6	149.8	30	231.84	224.52	221.94	0.0172	13.19	53.83	9.06/4.89	226.28	1.76	2.50	OK
PF-20	MH C6	C6-B	21.0	8	230.19	225.19	223.57	0.0771	0.43	5.10	5.68/2.89	225.56	0.37	0.67	OK

APPENDIX D CONVEYANCE SYSTEM
D-1 STORM SYSTEM PIPE CAPACITY
AND VELOCITY CHECK - 10-YR EVENT

PF-21	MH C6	C-6A	21.0	8	230.19	225.19	223.57	0.0771	0.48	6.69	7.10/2.06	226.09	0.9	0.67	submerged
MH C6	MH C5	C-5	118.1	30	230.60	221.74	221.10	0.0054	14.11	30.19	6.04/2.51	225.31	3.57	2.50	submerged
MH C5	MH C4	C-4	96.4	30	231.17	220.90	220.41	0.0051	14.11	29.24	5.90/2.60	224.99	4.09	2.50	submerged
MH C4	MH C3	C-3	55.6	30	231.61	220.21	220.08	0.0023	16.08	19.83	4.5/3.13	224.66	4.45	2.50	submerged
MH C3	MH C2	C-2	134.0	18	228.35	219.88	201.00	0.1409	16.08	39.43	21.17/9.09	224.04	4.16	1.50	submerged
PF-13	MH C2	C-2A	63.5	8	216.70	211.87	206.00	0.0924	0.47	3.67	7.24/2.15	212.27	0.40	0.67	OK
MH C2	MH C1	C-1	158.5	18	210.80	200.80	189.00	0.0744	16.53	28.66	16.79/9.35	205.17	4.37	1.50	submerged
PF-17	MHC1	C-1A	16.4	8	203.88	199.05	190.22	0.5384	0.42	8.87	13.05/2.09	199.43	0.38	0.67	OK

Storm System Line D, E, & F

Upstream Structure ID	Downstream Structure ID	Pipe Length ID	Pipe Length cntr to cntr (ft)	Pipe Size (in)	US Rim Elev.	US Invert (ft)	DS Invert (ft)	Pipe Slope cntr to cntr (ft/ft)	10-YR Peak Rate (cfs)	Pipe Full Capacity (cfs)	Max. Velocity at 10-yr Flow (fps)	Max. WSEL (ft)	Depth at Structure (ft)	Pipe Dia. (ft)	Remark on Hydraulic Condition
DI-2	Extg MH	E-12	15.0	15	224.78+/-	221.83	218.62	0.2140	no flow	29.88	---	no flow	---	1.25	no flow
Extg MH	AD4	E-11	14.0	12	221.88	218.62	217.00	0.1157	2.94	12.12	12.72/4.13	219.86	1.24	1.00	submerged
AD4	AD1	E-10	25.0	15	219.00	216.00	215.85	0.0060	2.94	7.37	5.66/3.73	217.11	1.11	1.25	OK
AD3	AD2	E-14	94.8	12	228.00	226.00	216.00	0.1055	GW flow ?	11.57	---	226.00	Min. Flow	1.00	OK
AD2	AD1	E-13	124.0	12	218.00	216.00	215.50	0.0040	0.13	2.26	1.58/0.57	216.46	0.46	1.00	OK
AD1	MH E9	E-9	115.3	15	218.00	215.50	214.00	0.0130	3.31	7.37	5.84/3.32	216.45	0.95	1.25	OK
MH E9	MH E8	E-8	76.5	15	219.24	214.00	213.00	0.0131	3.46	7.39	5.92/4.44	215.01	1.01	1.25	OK
MH E8	MH E7	E-7	84.3	15	217.50	213.00	212.35	0.0077	3.46	5.67	4.85/4.11	214.09	1.09	1.25	OK
PF-8	MH E7	E-7A	12.0	6	216.05	212.22	212.15	0.0058	0.32	0.85	2.27/0.73	213.33	1.11	0.50	submerged
PF-9	MH E7	E-7B	10.0	6	216.05	212.22	212.15	0.0070	0.32	0.94	2.43/0.73	213.33	1.11	0.50	submerged
MH E7	MH E6	E-6	196.3	15	216.29	212.15	210.35	0.0092	4.28	6.19	5.44/3.64	213.29	1.14	1.25	OK
PF-6	MH E6	PF5	12.0	6	214.04	210.79	210.15	0.0533	0.30	2.24	0.85/0.75	211.34	0.55	0.50	submerged
PF-7	MH E6	PF7	10.0	6	214.04	210.79	210.15	0.0640	0.30	2.39	0.94/0.75	211.34	0.55	0.50	submerged
MH E6	MH E5B	E-5B	93.4	18	214.32	210.15	209.00	0.0123	5.36	10.59	6.01/3.67	211.31	1.16	1.50	OK
MH E5B	MH E5A	E-5A	55.9	18	213.36	208.80	208.10	0.0125	5.48	27.39	12.10/4.94	210.00	1.20	1.50	OK
MH E5A	MH E4	E-4	173.9	18	212.78	207.90	205.20	0.0155	5.6	20.63	9.93/3.73	209.09	1.19	1.50	OK
PF-10	MH F1	F-2R	85.6	10	226.48	220.90	215.55	0.0625	0.84	5.48	7.27/2.42	221.41	0.51	0.83	OK

APPENDIX D CONVEYANCE SYSTEM
D-1 STORM SYSTEM PIPE CAPACITY
AND VELOCITY CHECK - 10-YR EVENT

PF-11	MH F1	F-2L	125.6	10	226.26	220.68	215.55	0.0408	0.76	4.43	6.06/2.35	221.16	0.48	0.83	OK
MH F1	MH E4	F-1	180.7	12	219.53	215.45	205.29	0.0562	2.48	8.45	9.34/3.27	216.37	0.92	1.00	OK
MH E4	MH E3	E-3	213.4	18	209.38	205.00	198.29	0.0314	8.13	18.63	10.18/4.62	206.66	1.66	1.50	submerged
PF-3	MH E3	D-1A	17.0	8	203.47	200.05	198.84	0.0712	0.28	0.83	2.14	200.66	0.61	0.67	OK
PF-4	MH E3	E-3A	10.0	8	203.56	200.14	199.71	0.0430	0.38	0.85	2.37/0.33	200.68	0.54	0.67	OK
PF-5	MH E3	D-1B	13.0	8	203.20	198.41	198.29	0.0092	1.05	1.16	3.77/3.04	201.02	2.61	0.67	submerged
PF-12	MH D2	D-2	138.0	10	215.79	215.79	200.64	0.1098	1.31	7.26	10.08/2.78	216.46	0.67	0.83	
MH D2	MH E3	D-1	135.8	12	204.67	200.00	198.29	0.0126	1.31	4.00	4.55/2.14	200.96	0.96	1.00	OK
MH E3	MH E2	E-2	244.9	18	203.49	198.09	190.20	0.0322	11.33	18.85	11.15/6.45	200.61	2.52	1.50	submerged
MH E2	MH E1	E-1	129.1	18	193.30	190.00	187.98	0.0156	11.33	13.14	8.36/6.45	192.54	2.54	1.50	submerged
PF-1A	MH E1	E-1A	26.0	8	191.94	188.52	187.47	0.0404	0.23	2.43	4.36/1.00	189.04	0.52	0.67	OK
MH E1	OUTLET	W-1	30.0	24	190.86	187.47	187.47	0.0000	6.72	---	---/3.65	188.99	1.52	2.00	OK
MH E1	MH G1	W-3	43.0	24	190.86	187.98	186.07	0.0444	4.85	47.67	15.17/4.45	189.99	2.01	2.00	submerged

Storm System Line G

Upstream Structure ID	Downstream Structure ID	Pipe Length ID	Pipe Length cntr to cntr (ft)	Pipe Size (in)	US Rim Elev.	US Invert (ft)	DS Invert (ft)	Pipe Slope cntr to cntr (ft/ft)	10-YR Peak Rate (cfs)	Pipe Full Capacity (cfs)	Max. Velocity at 10-yr Flow (fps)	Max. WSEL (ft)	Depth at Structure (ft)	Pipe Dia. (ft)	Remark on Hydraulic Condition
PF-1B	MH G2	G-3	19.0	6	189.75	186.5	186.34	0.0084	0.68	0.51	2.62/3.37	188.92	2.42	0.50	submerged
PF-2	MH G2	G-2	18.0	6	189.66	186.41	186.34	0.0039	0.51	0.35	1.79/2.48	188.68	2.27	0.50	submerged
MH G2	MH G1	G-1	63.8	12	189.88	186.34	186.07	0.0042	1.18	2.32	2.76/1.34	188.40	2.06	1.00	submerged
MH G1	OUTLET	W-2	14.7	24	190.37	186.07	186.06	0.0007	7.84	5.99	1.91/2.45	188.32	2.25	2.00	submerged

APPENDIX D-1
PIPE CAPACITY CALCS

Note: Pipes modeled with Pond symbol in HCAD do not provide pipe capacity - but do provide pipe

Job Name: **Parklands**
Job Number:
Date: 10/18/16 1:37 PM
Reach: MH A2 to MH A1A or Line A-1A

Design Values
Results

Pipe Capacity (Full Flow)

By Manning's Equation

$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2} \quad \text{and,} \quad Q = KS^{1/2}$$

Pipe diameter = 15 in. = or 1.25 feet

Pipe slope = 0.0618 ft. per foot

Manning's n = 0.013

Pipe cross-section area $A = \pi r^2$ = 1.227 sq. ft.

Pipe hydraulic radius R = D/4 = 0.3125

$K = 1.486/n((AR^{2/3})$ K 64.595

Then Q = 16.059 cfs 7207.68 gpm
V = 13.086 fps

Job Name: **Parklands**
Job Number:
Date: 10/18/16 1:37 PM
Reach: MH A2 to MH A1B (A-1B)

Design Values
Results

Pipe Capacity (Full Flow)

By Manning's Equation

$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2} \quad \text{and,} \quad Q = KS^{1/2}$$

Pipe diameter = 15 in. = or 1.25 feet

Pipe slope = 0.0639 ft. per foot

Manning's n = 0.013

Pipe cross-section area $A = \pi r^2$ = 1.227 sq. ft.

Pipe hydraulic radius R = D/4 = 0.3125

$K = 1.486/n((AR^{2/3})$ K 64.595

Then Q = 16.329 cfs 7329.12 gpm
V = 13.306 fps

APPENDIX D-1
PIPE CAPACITY CALCS

Job Name: **Parklands**
Job Number:
Date: 10/18/16 1:37 PM
Reach: Stub to MH C9from south

Design Values
Results

Pipe Capacity (Full Flow)

By Manning's Equation

$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2} \quad \text{and,} \quad Q = KS^{1/2}$$

Pipe diameter =	24	in. = or	2 feet
Pipe slope =	0.0423	ft. per foot	
Manning's n =	0.013		
Pipe cross-section area	A = π r^2 =	3.142 sq. ft.	
Pipe hydraulic radius	R = D/4 =	0.5000	
K = 1.486/n((AR$^{2/3}$)	K	226.219	
Then	Q =	46.527 cfs	20882.94 gpm
	V =	14.810 fps	

Job Name: **Parklands**
Job Number:
Date: 10/18/16 1:37 PM
Reach: MH C4 to MH C3 (Line C-3)

Design Values
Results

Pipe Capacity (Full Flow)

By Manning's Equation

$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2} \quad \text{and,} \quad Q = KS^{1/2}$$

Pipe diameter =	30	in. = or	2.5 feet
Pipe slope =	0.0023	ft. per foot	
Manning's n =	0.013		
Pipe cross-section area	A = π r^2 =	4.909 sq. ft.	
Pipe hydraulic radius	R = D/4 =	0.6250	
K = 1.486/n((AR$^{2/3}$)	K	410.165	
Then	Q =	19.671 cfs	8829.01 gpm
	V =	4.007 fps	

APPENDIX D-1
PIPE CAPACITY CALCS

Job Name: **Parklands**
Job Number:
Date: 10/18/16 1:37 PM
Reach: MH E4 to MH E3 Line E-3)

Design Values
Results

Pipe Capacity (Full Flow)

By Manning's Equation

$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2} \quad \text{and,} \quad Q = KS^{1/2}$$

Pipe diameter =	18	in. = or	1.5 feet
Pipe slope =	0.0314	ft. per foot	
Manning's n =	0.013		
Pipe cross-section area	A = π r^2 =	1.767 sq. ft.	
Pipe hydraulic radius	R = D/4 =	0.3750	
K = 1.486/n((AR$^{2/3}$)	K	105.040	
Then	Q =	18.614 cfs	8354.42 gpm
	V =	10.533 fps	

Job Name: **Parklands**
Job Number:
Date: 10/18/16 1:37 PM
Reach: PF-5 to MH E3

Design Values
Results

Pipe Capacity (Full Flow)

By Manning's Equation

$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2} \quad \text{and,} \quad Q = KS^{1/2}$$

Pipe diameter =	8	in. = or	0.666667 feet
Pipe slope =	0.0092	ft. per foot	
Manning's n =	0.013		
Pipe cross-section area	A = π r^2 =	0.349 sq. ft.	
Pipe hydraulic radius	R = D/4 =	0.1667	
K = 1.486/n((AR$^{2/3}$)	K	12.083	
Then	Q =	1.159 cfs	520.23 gpm
	V =	3.320 fps	

APPENDIX D-1
PIPE CAPACITY CALCS

Job Name: **Parklands**
Job Number:
Date: 10/18/16 1:37 PM
Reach: PF-1B to MH G1

Design Values
Results

Pipe Capacity (Full Flow)

By Manning's Equation

$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2} \quad \text{and,} \quad Q = KS^{1/2}$$

Pipe diameter =	6	in. = or	0.5 feet
Pipe slope =	0.0084	ft. per foot	
Manning's n =	0.013		
Pipe cross-section area	A = π r^2 =	0.196 sq. ft.	
Pipe hydraulic radius	R = D/4 =	0.1250	
K = 1.486/n((AR$^{2/3}$)	K	5.611	
Then	Q =	0.514 cfs	230.82 gpm
	V =	2.619 fps	

Job Name: **Parklands**
Job Number:
Date: 10/18/16 1:37 PM
Reach: PF-2 to MH G1

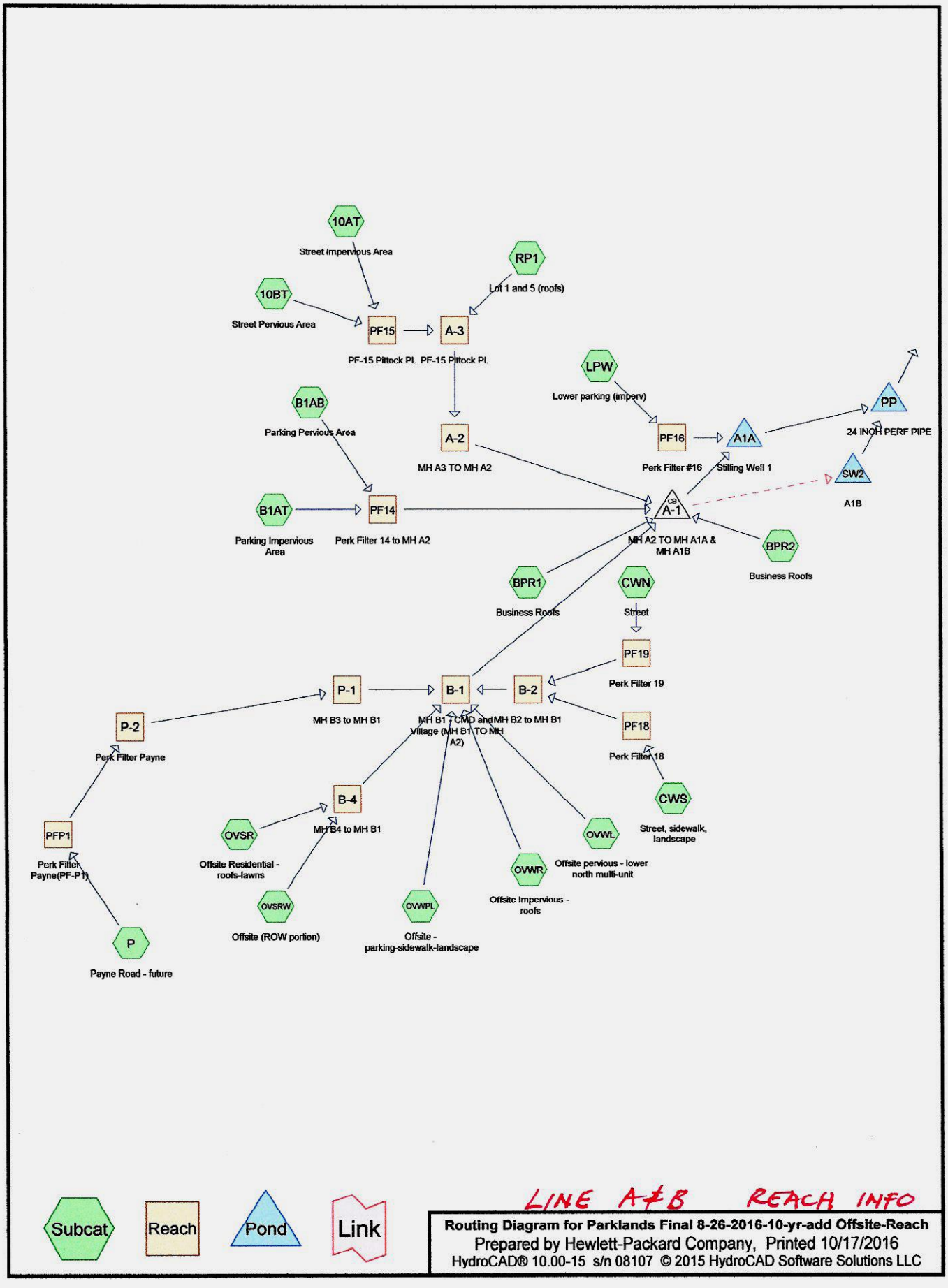
Design Values
Results

Pipe Capacity (Full Flow)

By Manning's Equation

$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2} \quad \text{and,} \quad Q = KS^{1/2}$$

Pipe diameter =	6	in. = or	0.5 feet
Pipe slope =	0.0039	ft. per foot	
Manning's n =	0.013		
Pipe cross-section area	A = π r^2 =	0.196 sq. ft.	
Pipe hydraulic radius	R = D/4 =	0.1250	
K = 1.486/n((AR$^{2/3}$)	K	5.611	
Then	Q =	0.350 cfs	157.28 gpm
	V =	1.785 fps	


10AT
Street Impervious Area
RP1
Lot 1 and 5 (roofs)
10BT
Street Pervious Area
PF15
A-3
PF-15 Pittock Pl.
PF-15 Pittock Pl.
LPW
Lower parking (imperv)
B1AB
Parking Pervious Area
A-2
MH A3 TO MH A2
PF16
A1A
PP
24 INCH PERF PIPE
Perk Filter #16
Stilling Well 1
SW2
A1B
B1AT
PF14
CB
A-1
Parking Impervious Area
Perk Filter 14 to MH A2
MH A2 TO MH A1A & MH A1B
BPR2
Business Roofs
BPR1
Business Roofs
CWN
Street
PF19
Perk Filter 19
P-1
B-1
B-2
MH B3 to MH B1
MH B1 TCMD and MH B2 to MH B1 Village (MH B1 TO MH A2)
P-2
PF18
Perk Filter Payne
Perk Filter 18
CWS
Street, sidewalk, landscape
B-4
MH B4 to MH B1
PFP1
OVSR
OVWL
Perk Filter Payne(PF-P1)
Offsite Residential - roofs-lawns
Offsite pervious - lower north multi-unit
OVWR
OVSRW
OVWPL
Offsite Impervious - roofs
Offsite (ROW portion)
Offsite - parking-sidewalk-landscape
P
Payne Road - future
Subcat
Reach
Pond
Link
LINE A≠B REACH INFO
Routing Diagram for Parklands Final 8-26-2016-10-yr-add Offsite-Reach
Prepared by Hewlett-Packard Company, Printed 10/17/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Parklands Final 8-26-2016-10-yr-add Offsite-Reach

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	A-2	200.60	199.47	143.6	0.0079	0.013	10.0	0.0	0.0
2	A-3	201.36	200.80	112.6	0.0050	0.013	10.0	0.0	0.0
3	B-1	214.65	211.10	188.8	0.0188	0.013	18.0	0.0	0.0
4	B-2	215.49	214.85	67.0	0.0096	0.013	12.0	0.0	0.0
5	B-4	215.67	214.85	61.5	0.0133	0.013	18.0	0.0	0.0
6	P-1	222.38	214.85	222.0	0.0339	0.013	12.0	0.0	0.0
7	P-2	229.07	222.58	116.7	0.0556	0.013	12.0	0.0	0.0
8	PF14	212.80	212.72	10.0	0.0080	0.013	8.0	0.0	0.0
9	PF15	201.36	201.35	2.0	0.0050	0.013	10.0	0.0	0.0
10	PF16	195.73	189.67	9.5	0.6379	0.013	8.0	0.0	0.0
11	PF18	216.64	215.69	28.0	0.0339	0.013	10.0	0.0	0.0
12	PF19	216.64	215.69	28.0	0.0339	0.013	10.0	0.0	0.0
13	PFP1	229.07	229.02	9.0	0.0056	0.013	10.0	0.0	0.0
14	A-1	199.27	188.00	183.6	0.0614	0.013	15.0	0.0	0.0
15	A-1	199.27	188.50	170.6	0.0631	0.013	15.0	0.0	0.0
16	A1A	191.50	191.50	2.0	0.0000	0.013	24.0	0.0	0.0
17	SW2	191.00	191.00	2.0	0.0000	0.013	24.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Reach A-2: MH A3 TO MH A2 Avg. Flow Depth=0.35' Max Vel=3.30 fps Inflow=0.72 cfs 0.240 af
10.0" Round Pipe n=0.013 L=143.6' S=0.0079 '/' Capacity=1.94 cfs Outflow=0.72 cfs 0.240 af

Reach A-3: PF-15 Pittock Pl. Avg. Flow Depth=0.40' Max Vel=2.78 fps Inflow=0.72 cfs 0.240 af
10.0" Round Pipe n=0.013 L=112.6' S=0.0050 '/' Capacity=1.55 cfs Outflow=0.72 cfs 0.240 af

Reach B-1: MH B1 - CMD and Village Avg. Flow Depth=0.89' Max Vel=8.71 fps Inflow=9.53 cfs 3.668 af
18.0" Round Pipe n=0.013 L=188.8' S=0.0188 '/' Capacity=14.40 cfs Outflow=9.53 cfs 3.668 af

Reach B-2: MH B2 to MH B1 Avg. Flow Depth=0.35' Max Vel=3.71 fps Inflow=0.89 cfs 0.321 af
12.0" Round Pipe n=0.013 L=67.0' S=0.0096 '/' Capacity=3.48 cfs Outflow=0.89 cfs 0.321 af

Reach B-4: MH B4 to MH B1 Avg. Flow Depth=0.53' Max Vel=5.79 fps Inflow=3.19 cfs 1.372 af
18.0" Round Pipe n=0.013 L=61.5' S=0.0133 '/' Capacity=12.13 cfs Outflow=3.19 cfs 1.372 af

Reach P-1: MH B3 to MH B1 Avg. Flow Depth=0.14' Max Vel=4.09 fps Inflow=0.27 cfs 0.087 af
12.0" Round Pipe n=0.013 L=222.0' S=0.0339 '/' Capacity=6.56 cfs Outflow=0.27 cfs 0.087 af

Reach P-2: Perk Filter Payne Avg. Flow Depth=0.12' Max Vel=4.86 fps Inflow=0.27 cfs 0.087 af
12.0" Round Pipe n=0.013 L=116.7' S=0.0556 '/' Capacity=8.40 cfs Outflow=0.27 cfs 0.087 af

Reach PF14: Perk Filter 14 to MH A2 Avg. Flow Depth=0.40' Max Vel=3.33 fps Inflow=0.73 cfs 0.247 af
8.0" Round Pipe n=0.013 L=10.0' S=0.0080 '/' Capacity=1.08 cfs Outflow=0.73 cfs 0.247 af

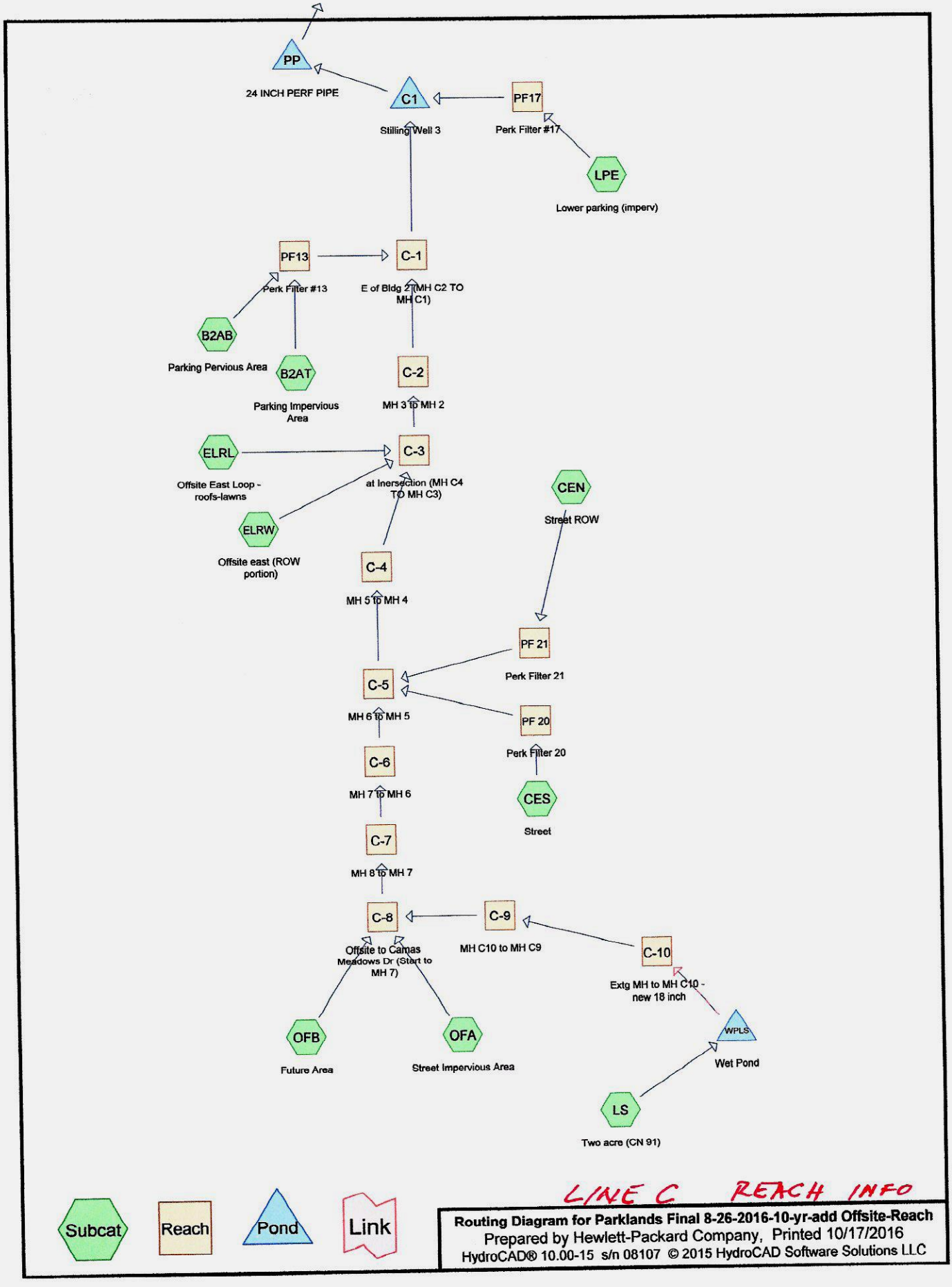
Reach PF15: PF-15 Pittock Pl. Avg. Flow Depth=0.31' Max Vel=2.47 fps Inflow=0.45 cfs 0.152 af
10.0" Round Pipe n=0.013 L=2.0' S=0.0050 '/' Capacity=1.55 cfs Outflow=0.45 cfs 0.152 af

Reach PF16: Perk Filter #16 Avg. Flow Depth=0.10' Max Vel=13.86 fps Inflow=0.42 cfs 0.141 af
8.0" Round Pipe n=0.013 L=9.5' S=0.6379 '/' Capacity=9.65 cfs Outflow=0.42 cfs 0.141 af

Reach PF18: Perk Filter 18 Avg. Flow Depth=0.20' Max Vel=5.04 fps Inflow=0.50 cfs 0.181 af
10.0" Round Pipe n=0.013 L=28.0' S=0.0339 '/' Capacity=4.04 cfs Outflow=0.50 cfs 0.181 af

Reach PF19: Perk Filter 19 Avg. Flow Depth=0.18' Max Vel=4.69 fps Inflow=0.39 cfs 0.140 af
10.0" Round Pipe n=0.013 L=28.0' S=0.0339 '/' Capacity=4.04 cfs Outflow=0.39 cfs 0.140 af

Reach PFP1: Perk Filter Payne(PF-P1) Avg. Flow Depth=0.23' Max Vel=2.21 fps Inflow=0.27 cfs 0.087 af
10.0" Round Pipe n=0.013 L=9.0' S=0.0056 '/' Capacity=1.63 cfs Outflow=0.27 cfs 0.087 af


PP
24 INCH PERF PIPE
C1
Stilling Well 3
PF17
Perk Filter #17
LPE
Lower parking (imperv)
PF13
Perk Filter #13
C-1
E of Bldg 2 (MH C2 TO MH C1)
B2AB
Parking Pervious Area
B2AT
Parking Impervious Area
C-2
MH 3 to MH 2
ELRL
Offsite East Loop - roofs-lawns
C-3
at Inersection (MH C4 TO MH C3)
CEN
Street ROW
ELRW
Offsite east (ROW portion)
C-4
MH 5 to MH 4
PF 21
Perk Filter 21
C-5
MH 6 to MH 5
PF 20
Perk Filter 20
C-6
MH 7 to MH 6
CES
Street
C-7
MH 8 to MH 7
C-8
C-9
MH C10 to MH C9
C-10
Extg MH to MH C10 - new 18 inch
Offsite to Camas Meadows Dr (Start to MH 7)
OFB
Future Area
OFA
Street Impervious Area
WPLS
Wet Pond
LS
Two acre (CN 91)
Subcat
Reach
Pond
Link
LINE C REACH INFO
Routing Diagram for Parklands Final 8-26-2016-10-yr-add Offsite-Reach
Prepared by Hewlett-Packard Company, Printed 10/17/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Parklands Final 8-26-2016-10-yr-add Offsite-Reach
Prepared by Hewlett-Packard Company

HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	C-1	200.80	189.00	158.5	0.0744	0.013	18.0	0.0	0.0
2	C-10	238.72	237.68	163.4	0.0064	0.013	18.0	0.0	0.0
3	C-2	219.88	201.00	134.0	0.1409	0.013	18.0	0.0	0.0
4	C-3	220.21	220.08	55.6	0.0023	0.013	30.0	0.0	0.0
5	C-4	220.90	220.21	96.4	0.0072	0.013	30.0	0.0	0.0
6	C-5	221.74	221.10	118.1	0.0054	0.013	30.0	0.0	0.0
7	C-6	224.52	221.94	149.8	0.0172	0.013	30.0	0.0	0.0
8	C-7	228.59	224.72	166.3	0.0233	0.013	24.0	0.0	0.0
9	C-8	237.25	228.79	200.0	0.0423	0.013	24.0	0.0	0.0
10	C-9	237.68	237.25	121.7	0.0035	0.013	18.0	0.0	0.0
11	PF 20	225.19	224.01	21.8	0.0541	0.013	10.0	0.0	0.0
12	PF 21	226.02	223.99	21.8	0.0931	0.013	10.0	0.0	0.0
13	PF13	211.87	206.00	63.5	0.0924	0.013	8.0	0.0	0.0
14	PF17	199.05	190.22	16.4	0.5384	0.013	8.0	0.0	0.0
15	C1	192.00	192.00	2.0	0.0000	0.013	24.0	0.0	0.0
16	WPLS	239.08	238.92	112.6	0.0014	0.013	12.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Reach C-1: E of Bldg 2 (MH C2 TO MH Avg. Flow Depth=0.82' Max Vel=16.78 fps Inflow=16.50 cfs 6.783 af
18.0" Round Pipe n=0.013 L=158.5' S=0.0744 '/' Capacity=28.66 cfs Outflow=16.50 cfs 6.783 af

Reach C-10: Extg MH to MH C10 - new Avg. Flow Depth=0.56' Max Vel=4.12 fps Inflow=2.46 cfs 1.701 af
18.0" Round Pipe n=0.013 L=163.4' S=0.0064 '/' Capacity=8.38 cfs Outflow=2.46 cfs 1.701 af

Reach C-2: MH 3 to MH 2 Avg. Flow Depth=0.67' Max Vel=21.16 fps Inflow=16.04 cfs 6.624 af
18.0" Round Pipe n=0.013 L=134.0' S=0.1409 '/' Capacity=39.43 cfs Outflow=16.04 cfs 6.624 af

Reach C-3: at Inersection (MH C4 TO Avg. Flow Depth=1.71' Max Vel=4.50 fps Inflow=16.04 cfs 6.624 af
30.0" Round Pipe n=0.013 L=55.6' S=0.0023 '/' Capacity=19.83 cfs Outflow=16.04 cfs 6.624 af

Reach C-4: MH 5 to MH 4 Avg. Flow Depth=1.11' Max Vel=6.70 fps Inflow=14.05 cfs 5.804 af
30.0" Round Pipe n=0.013 L=96.4' S=0.0072 '/' Capacity=34.70 cfs Outflow=14.07 cfs 5.804 af

Reach C-5: MH 6 to MH 5 Avg. Flow Depth=1.20' Max Vel=6.04 fps Inflow=14.05 cfs 5.804 af
30.0" Round Pipe n=0.013 L=118.1' S=0.0054 '/' Capacity=30.19 cfs Outflow=14.05 cfs 5.804 af

Reach C-6: MH 7 to MH 6 Avg. Flow Depth=0.84' Max Vel=9.06 fps Inflow=13.15 cfs 5.477 af
30.0" Round Pipe n=0.013 L=149.8' S=0.0172 '/' Capacity=53.83 cfs Outflow=13.14 cfs 5.477 af

Reach C-7: MH 8 to MH 7 Avg. Flow Depth=0.86' Max Vel=10.24 fps Inflow=13.15 cfs 5.477 af
24.0" Round Pipe n=0.013 L=166.3' S=0.0233 '/' Capacity=34.51 cfs Outflow=13.15 cfs 5.477 af

Reach C-8: Offsite to Camas Avg. Flow Depth=0.73' Max Vel=12.74 fps Inflow=13.16 cfs 5.477 af
24.0" Round Pipe n=0.013 L=200.0' S=0.0423 '/' Capacity=46.53 cfs Outflow=13.15 cfs 5.477 af

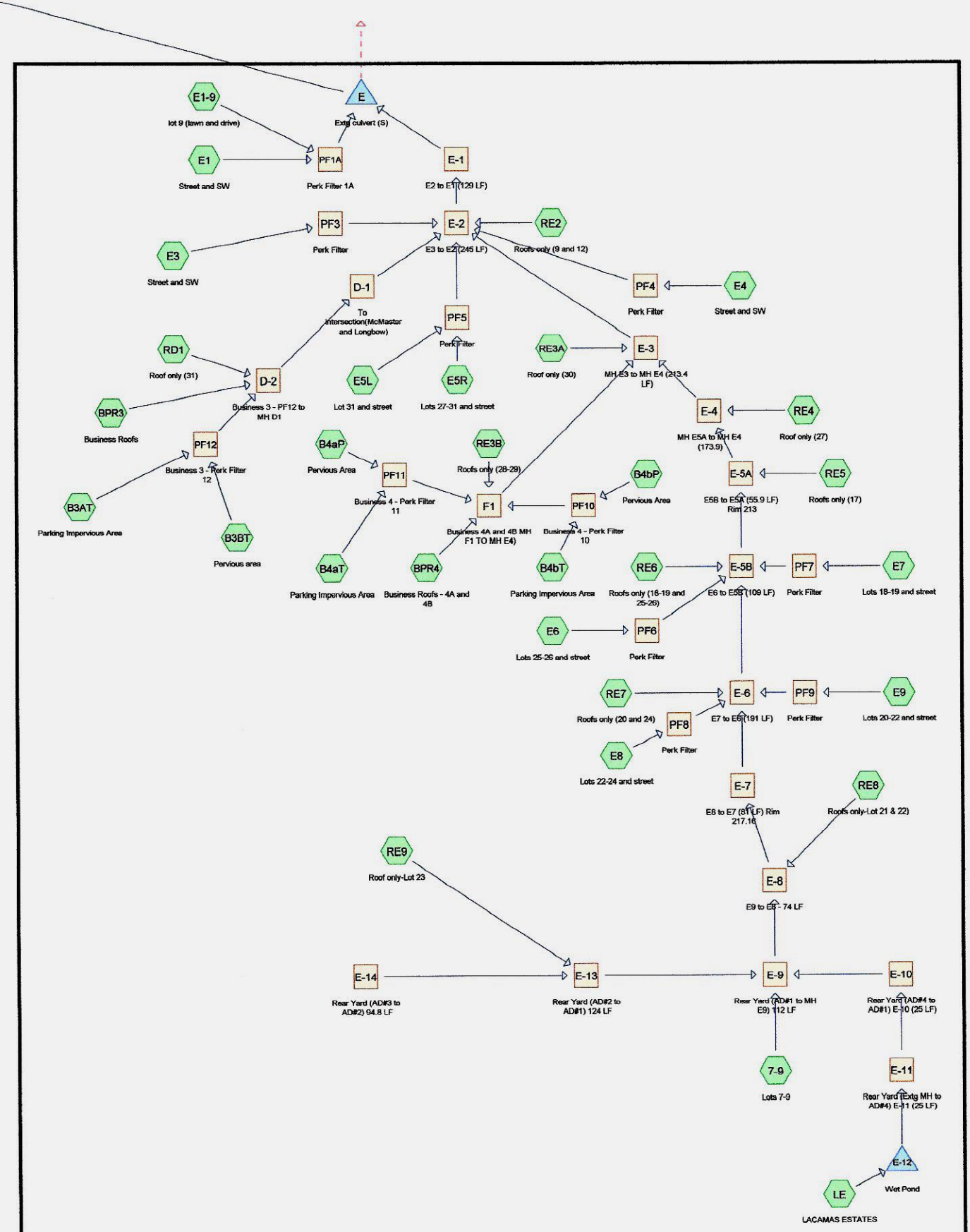
Reach C-9: MH C10 to MH C9 Avg. Flow Depth=0.65' Max Vel=3.32 fps Inflow=2.46 cfs 1.701 af
18.0" Round Pipe n=0.013 L=121.7' S=0.0035 '/' Capacity=6.24 cfs Outflow=2.46 cfs 1.701 af

Reach PF 20: Perk Filter 20 Avg. Flow Depth=0.16' Max Vel=5.68 fps Inflow=0.43 cfs 0.155 af
10.0" Round Pipe n=0.013 L=21.8' S=0.0541 '/' Capacity=5.10 cfs Outflow=0.43 cfs 0.155 af

Reach PF 21: Perk Filter 21 Avg. Flow Depth=0.15' Max Vel=7.10 fps Inflow=0.48 cfs 0.172 af
10.0" Round Pipe n=0.013 L=21.8' S=0.0931 '/' Capacity=6.69 cfs Outflow=0.48 cfs 0.172 af

Reach PF13: Perk Filter #13 Avg. Flow Depth=0.16' Max Vel=7.24 fps Inflow=0.47 cfs 0.160 af
8.0" Round Pipe n=0.013 L=63.5' S=0.0924 '/' Capacity=3.67 cfs Outflow=0.47 cfs 0.160 af

Reach PF17: Perk Filter #17 Avg. Flow Depth=0.10' Max Vel=13.05 fps Inflow=0.42 cfs 0.141 af
8.0" Round Pipe n=0.013 L=16.4' S=0.5384 '/' Capacity=8.87 cfs Outflow=0.42 cfs 0.141 af


E
E1-9
lot 9 (lawn and drive)
Exist culvert (S)
E1
Street and SW
PF1A
Perk Filter 1A
E-1
E2 to E1 (129 LF)
PF3
Perk Filter
E-2
E3 to E2 (245 LF)
RE2
Roofs only (9 and 12)
E3
Street and SW
D-1
To intersection(McMaster and Longbow)
PF4
Perk Filter
E4
Street and SW
PF5
Perk Filter
RD1
Roof only (31)
D-2
Business 3 - PF12 to MH D1
E5L
Lot 31 and street
E5R
Lots 27-31 and street
RE3A
Roof only (30)
E-3
MH E3 to MH E4 (213.4 LF)
BPR3
Business Roofs
E-4
MH E5A to MH E4 (173.9)
RE4
Roof only (27)
PF12
Business 3 - Perk Filter 12
B4aP
Pervious Area
PF11
Business 4 - Perk Filter 11
RE3B
Roofs only (28-29)
B4bP
Pervious Area
E-5A
E5B to E5A (55.9 LF) Rim 213
RE5
Roofs only (17)
B3AT
Parking Impervious Area
B3BT
Pervious area
F1
Business 4A and 4B MH F1 TO MH E4)
PF10
Business 4 - Perk Filter 10
B4aT
Parking Impervious Area
BPR4
Business Roofs - 4A and 4B
B4bT
Parking Impervious Area
RE6
Roofs only (18-19 and 25-26)
E-5B
E6 to E5B (109 LF)
PF7
Perk Filter
E7
Lots 18-19 and street
E6
Lots 25-26 and street
PF6
Perk Filter
RE7
Roofs only (20 and 24)
E-6
E7 to E6 (191 LF)
PF9
Perk Filter
E9
Lots 20-22 and street
PF8
Perk Filter
E8
Lots 22-24 and street
E-7
E8 to E7 (81 LF) Rim 217.16
RE8
Roofs only-Lot 21 & 22)
RE9
Roof only-Lot 23
E-8
E9 to E8 - 74 LF
E-14
Rear Yard (AD#3 to AD#2) 94.8 LF
E-13
Rear Yard (AD#2 to AD#1) 124 LF
E-9
Rear Yard (AD#1 to MH E9) 112 LF
E-10
Rear Yard (AD#4 to AD#1) E-10 (25 LF)
7-9
Lots 7-9
E-11
Rear Yard (Exig MH to AD#4) E-11 (25 LF)
E-12
Wet Pond
LE
LACAMAS ESTATES
Subcat
Reach
Pond
Link
LINE D, E, & F REACH INFO
Routing Diagram for Parklands Final 8-26-2016-10-yr-add Offsite-Reach
Prepared by Hewlett-Packard Company, Printed 10/17/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Parklands Final 8-26-2016-10-yr-add Offsite-Reach
Prepared by Hewlett-Packard Company

HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	D-1	200.00	198.29	135.8	0.0126	0.013	12.0	0.0	0.0
2	D-2	215.79	200.64	138.0	0.1098	0.013	10.0	0.0	0.0
3	E-1	190.00	187.98	129.1	0.0156	0.013	18.0	0.0	0.0
4	E-10	215.50	214.00	115.3	0.0130	0.013	15.0	0.0	0.0
5	E-11	218.62	217.00	14.0	0.1157	0.013	12.0	0.0	0.0
6	E-13	216.00	215.50	124.0	0.0040	0.013	12.0	0.0	0.0
7	E-14	226.00	216.00	94.8	0.1055	0.013	12.0	0.0	0.0
8	E-2	198.09	190.20	244.9	0.0322	0.013	18.0	0.0	0.0
9	E-3	205.00	198.29	213.4	0.0314	0.013	18.0	0.0	0.0
10	E-4	205.00	198.29	173.9	0.0386	0.013	18.0	0.0	0.0
11	E-5A	209.00	205.20	55.9	0.0680	0.013	18.0	0.0	0.0
12	E-5B	210.15	209.20	93.4	0.0102	0.013	18.0	0.0	0.0
13	E-6	212.15	210.35	196.3	0.0092	0.013	15.0	0.0	0.0
14	E-7	213.00	212.35	84.3	0.0077	0.013	15.0	0.0	0.0
15	E-8	214.00	213.00	76.5	0.0131	0.013	15.0	0.0	0.0
16	E-9	215.50	214.00	115.3	0.0130	0.013	15.0	0.0	0.0
17	F1	215.45	205.29	180.7	0.0562	0.013	12.0	0.0	0.0
18	PF10	220.90	215.55	85.6	0.0625	0.013	10.0	0.0	0.0
19	PF11	220.68	215.55	125.6	0.0408	0.013	10.0	0.0	0.0
20	PF12	215.79	215.78	1.0	0.0100	0.013	10.0	0.0	0.0
21	PF1A	188.52	187.47	26.0	0.0404	0.013	8.0	0.0	0.0
22	PF3	199.47	199.40	15.0	0.0047	0.013	8.0	0.0	0.0
23	PF4	198.38	198.33	10.0	0.0050	0.013	8.0	0.0	0.0
24	PF5	198.41	198.29	13.0	0.0092	0.013	8.0	0.0	0.0
25	PF6	210.21	210.15	12.0	0.0050	0.013	8.0	0.0	0.0
26	PF7	210.21	210.15	10.0	0.0060	0.013	8.0	0.0	0.0
27	PF8	212.21	212.15	12.0	0.0050	0.013	8.0	0.0	0.0
28	PF9	212.21	212.15	10.0	0.0060	0.013	8.0	0.0	0.0
29	E	187.47	187.47	30.0	0.0000	0.013	24.0	0.0	0.0
30	E	187.98	186.06	43.0	0.0447	0.013	24.0	0.0	0.0
31	E-12	222.68	222.53	6.5	0.0231	0.013	12.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Reach D-1: To intersection(McMaster Avg. Flow Depth=0.39' Max Vel=4.55 fps Inflow=1.31 cfs 0.441 af
12.0" Round Pipe n=0.013 L=135.8' S=0.0126 '/' Capacity=4.00 cfs Outflow=1.31 cfs 0.441 af

Reach D-2: Business 3 - PF12 to MH D1 Avg. Flow Depth=0.24' Max Vel=10.08 fps Inflow=1.31 cfs 0.441 af
10.0" Round Pipe n=0.013 L=138.0' S=0.1098 '/' Capacity=7.26 cfs Outflow=1.31 cfs 0.441 af

Reach E-1: E2 to E1 (129 LF) Avg. Flow Depth=1.07' Max Vel=8.36 fps Inflow=11.32 cfs 4.892 af
18.0" Round Pipe n=0.013 L=129.1' S=0.0156 '/' Capacity=13.14 cfs Outflow=11.33 cfs 4.892 af

Reach E-10: Rear Yard (AD#4 to AD#1) Avg. Flow Depth=0.55' Max Vel=5.66 fps Inflow=2.94 cfs 1.741 af
15.0" Round Pipe n=0.013 L=115.3' S=0.0130 '/' Capacity=7.37 cfs Outflow=2.94 cfs 1.741 af

Reach E-11: Rear Yard (Extg MH to Avg. Flow Depth=0.34' Max Vel=12.72 fps Inflow=2.94 cfs 1.741 af
12.0" Round Pipe n=0.013 L=14.0' S=0.1157 '/' Capacity=12.12 cfs Outflow=2.94 cfs 1.741 af

Reach E-13: Rear Yard (AD#2 to AD#1) Avg. Flow Depth=0.16' Max Vel=1.58 fps Inflow=0.13 cfs 0.044 af
12.0" Round Pipe n=0.013 L=124.0' S=0.0040 '/' Capacity=2.26 cfs Outflow=0.13 cfs 0.044 af

Reach E-14: Rear Yard (AD#3 to AD#2) 94.8 LF Avg. Flow Depth=0.00' Max Vel=0.00 fps
12.0" Round Pipe n=0.013 L=94.8' S=0.1055 '/' Capacity=11.57 cfs Outflow=0.00 cfs 0.000 af

Reach E-2: E3 to E2 (245 LF) Avg. Flow Depth=0.84' Max Vel=11.15 fps Inflow=11.32 cfs 4.892 af
18.0" Round Pipe n=0.013 L=244.9' S=0.0322 '/' Capacity=18.85 cfs Outflow=11.32 cfs 4.892 af

Reach E-3: MH E3 to MH E4 (213.4 LF) Avg. Flow Depth=0.69' Max Vel=10.17 fps Inflow=8.11 cfs 3.742 af
18.0" Round Pipe n=0.013 L=213.4' S=0.0314 '/' Capacity=18.63 cfs Outflow=8.11 cfs 3.742 af

Reach E-4: MH E5A to MH E4 (173.9) Avg. Flow Depth=0.53' Max Vel=9.92 fps Inflow=5.60 cfs 2.864 af
18.0" Round Pipe n=0.013 L=173.9' S=0.0386 '/' Capacity=20.63 cfs Outflow=5.59 cfs 2.864 af

Reach E-5A: E5B to E5A (55.9 LF) Rim Avg. Flow Depth=0.45' Max Vel=12.09 fps Inflow=5.47 cfs 2.820 af
18.0" Round Pipe n=0.013 L=55.9' S=0.0680 '/' Capacity=27.39 cfs Outflow=5.47 cfs 2.820 af

Reach E-5B: E6 to E5B (109 LF) Avg. Flow Depth=0.75' Max Vel=6.01 fps Inflow=5.35 cfs 2.775 af
18.0" Round Pipe n=0.013 L=93.4' S=0.0102 '/' Capacity=10.59 cfs Outflow=5.35 cfs 2.775 af

Reach E-6: E7 to E6 (191 LF) Avg. Flow Depth=0.76' Max Vel=5.44 fps Inflow=4.27 cfs 2.370 af
15.0" Round Pipe n=0.013 L=196.3' S=0.0092 '/' Capacity=6.19 cfs Outflow=4.27 cfs 2.370 af

Reach E-7: E8 to E7 (81 LF) Rim 217.16 Avg. Flow Depth=0.70' Max Vel=4.85 fps Inflow=3.45 cfs 2.038 af
15.0" Round Pipe n=0.013 L=84.3' S=0.0077 '/' Capacity=5.67 cfs Outflow=3.45 cfs 2.038 af

Reach E-8: E9 to E8 - 74 LF Avg. Flow Depth=0.60' Max Vel=5.92 fps Inflow=3.45 cfs 2.038 af
15.0" Round Pipe n=0.013 L=76.5' S=0.0131 '/' Capacity=7.39 cfs Outflow=3.45 cfs 2.038 af

Reach E-9: Rear Yard (AD#1 to MH E9) Avg. Flow Depth=0.59' Max Vel=5.84 fps Inflow=3.31 cfs 1.949 af
15.0" Round Pipe n=0.013 L=115.3' S=0.0130 '/' Capacity=7.37 cfs Outflow=3.31 cfs 1.949 af

Reach F1: Business 4A and 4B MH F1 Avg. Flow Depth=0.37' Max Vel=9.34 fps Inflow=2.48 cfs 0.834 af
12.0" Round Pipe n=0.013 L=180.7' S=0.0562 '/' Capacity=8.45 cfs Outflow=2.48 cfs 0.834 af

Reach PF10: Business 4 - Perk Filter 10 Avg. Flow Depth=0.22' Max Vel=7.27 fps Inflow=0.84 cfs 0.281 af
10.0" Round Pipe n=0.013 L=85.6' S=0.0625 '/' Capacity=5.48 cfs Outflow=0.84 cfs 0.281 af

Reach PF11: Business 4 - Perk Filter 11 Avg. Flow Depth=0.23' Max Vel=6.06 fps Inflow=0.76 cfs 0.253 af
10.0" Round Pipe n=0.013 L=125.6' S=0.0408 '/' Capacity=4.43 cfs Outflow=0.76 cfs 0.253 af

Reach PF12: Business 3 - Perk Filter 12 Avg. Flow Depth=0.33' Max Vel=3.62 fps Inflow=0.73 cfs 0.247 af
10.0" Round Pipe n=0.013 L=1.0' S=0.0100 '/' Capacity=2.19 cfs Outflow=0.73 cfs 0.247 af

Reach PF1A: Perk Filter 1A Avg. Flow Depth=0.14' Max Vel=4.36 fps Inflow=0.23 cfs 0.079 af
8.0" Round Pipe n=0.013 L=26.0' S=0.0404 '/' Capacity=2.43 cfs Outflow=0.23 cfs 0.079 af

Reach PF3: Perk Filter Avg. Flow Depth=0.27' Max Vel=2.14 fps Inflow=0.28 cfs 0.094 af
8.0" Round Pipe n=0.013 L=15.0' S=0.0047 '/' Capacity=0.83 cfs Outflow=0.28 cfs 0.094 af

Reach PF4: Perk Filter Avg. Flow Depth=0.31' Max Vel=2.37 fps Inflow=0.38 cfs 0.129 af
8.0" Round Pipe n=0.013 L=10.0' S=0.0050 '/' Capacity=0.85 cfs Outflow=0.38 cfs 0.129 af

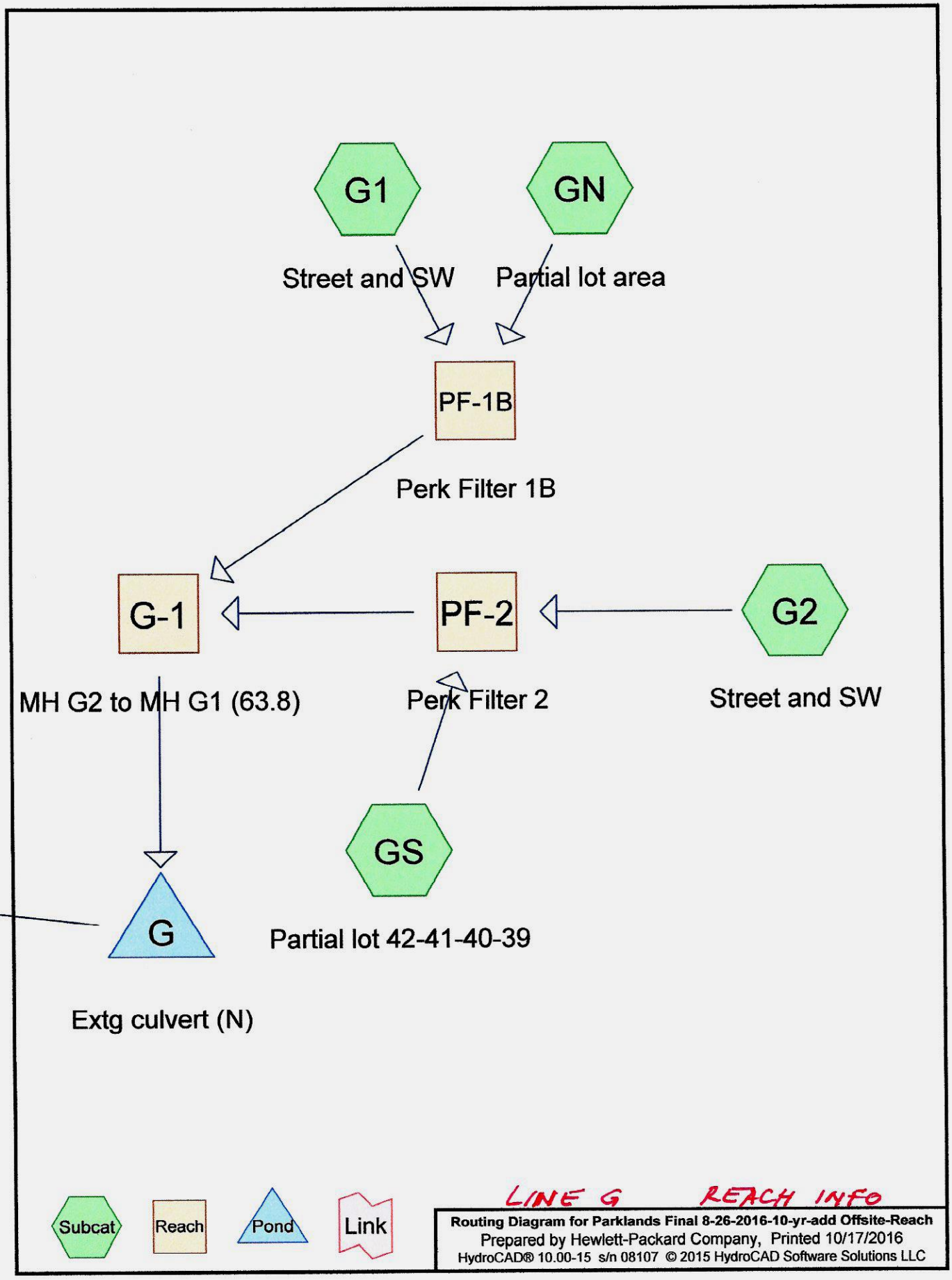
Reach PF5: Perk Filter Avg. Flow Depth=0.50' Max Vel=3.77 fps Inflow=1.05 cfs 0.398 af
8.0" Round Pipe n=0.013 L=13.0' S=0.0092 '/' Capacity=1.16 cfs Outflow=1.05 cfs 0.398 af

Reach PF6: Perk Filter Avg. Flow Depth=0.27' Max Vel=2.24 fps Inflow=0.30 cfs 0.114 af
8.0" Round Pipe n=0.013 L=12.0' S=0.0050 '/' Capacity=0.85 cfs Outflow=0.30 cfs 0.114 af

Reach PF7: Perk Filter Avg. Flow Depth=0.26' Max Vel=2.39 fps Inflow=0.30 cfs 0.114 af
8.0" Round Pipe n=0.013 L=10.0' S=0.0060 '/' Capacity=0.94 cfs Outflow=0.30 cfs 0.114 af

Reach PF8: Perk Filter Avg. Flow Depth=0.28' Max Vel=2.27 fps Inflow=0.32 cfs 0.122 af
8.0" Round Pipe n=0.013 L=12.0' S=0.0050 '/' Capacity=0.85 cfs Outflow=0.32 cfs 0.122 af

Reach PF9: Perk Filter Avg. Flow Depth=0.27' Max Vel=2.43 fps Inflow=0.32 cfs 0.122 af
8.0" Round Pipe n=0.013 L=10.0' S=0.0060 '/' Capacity=0.94 cfs Outflow=0.32 cfs 0.122 af


G1
GN
Street and SW
Partial lot area
PF-1B
Perk Filter 1B
G-1
PF-2
G2
MH G2 to MH G1 (63.8)
Perk Filter 2
Street and SW
GS
G
Partial lot 42-41-40-39
Extg culvert (N)
Subcat
Reach
Pond
Link
LINE G REACH INFO
Routing Diagram for Parklands Final 8-26-2016-10-yr-add Offsite-Reach
Prepared by Hewlett-Packard Company, Printed 10/17/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Parklands Final 8-26-2016-10-yr-add Offsite-Reach

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	G-1	186.34	186.07	63.8	0.0042	0.013	12.0	0.0	0.0
2	PF-1B	186.50	186.34	19.0	0.0084	0.013	6.0	0.0	0.0
3	PF-2	186.41	186.34	18.0	0.0039	0.013	6.0	0.0	0.0
4	G	186.06	186.06	15.0	0.0000	0.013	24.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment G1: Street and SW Runoff Area=19,098 sf 83.10% Impervious Runoff Depth=3.28"
Tc=5.0 min CN=80.0/98.0 Runoff=0.36 cfs 0.120 af

Subcatchment G2: Street and SW Runoff Area=13,561 sf 90.52% Impervious Runoff Depth=3.41"
Tc=5.0 min CN=80.0/98.0 Runoff=0.26 cfs 0.088 af

Subcatchment GN: Partial lot area Runoff Area=24,500 sf 26.53% Impervious Runoff Depth=2.50"
Tc=10.0 min CN=83.0/98.0 Runoff=0.33 cfs 0.117 af

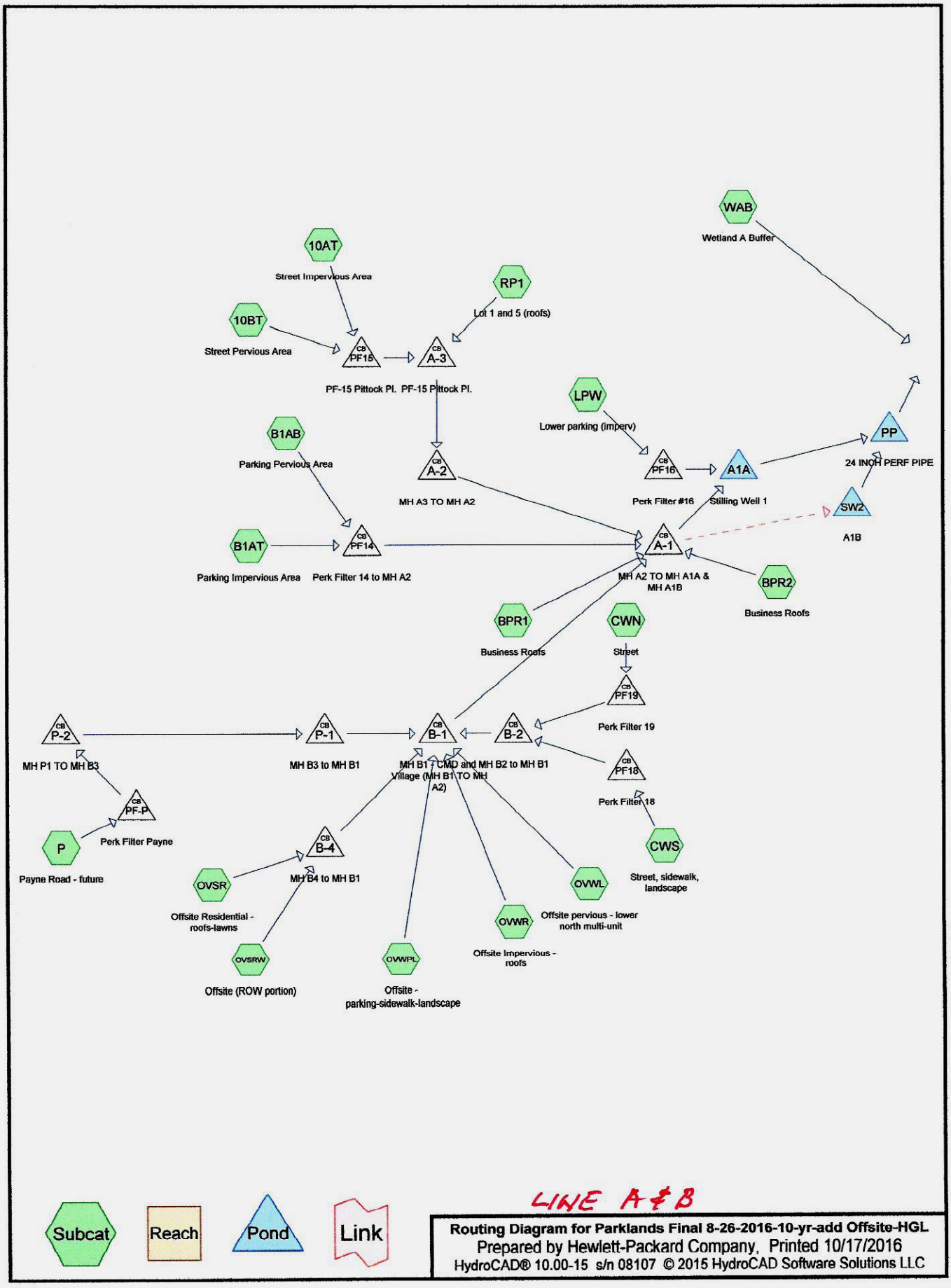
Subcatchment GS: Partial lot 42-41-40-39 Runoff Area=18,500 sf 27.03% Impervious Runoff Depth=2.51"
Tc=10.0 min CN=83.0/98.0 Runoff=0.25 cfs 0.089 af

Reach G-1: MH G2 to MH G1 (63.8) Avg. Flow Depth=0.43' Max Vel=2.76 fps Inflow=0.89 cfs 0.414 af
12.0" Round Pipe n=0.013 L=63.8' S=0.0042 '/' Capacity=2.32 cfs Outflow=0.89 cfs 0.414 af

Reach PF-1B: Perk Filter 1B Avg. Flow Depth=0.50' Max Vel=2.99 fps Inflow=0.68 cfs 0.237 af
6.0" Round Pipe n=0.013 L=19.0' S=0.0084 '/' Capacity=0.51 cfs Outflow=0.54 cfs 0.237 af

Reach PF-2: Perk Filter 2 Avg. Flow Depth=0.50' Max Vel=2.03 fps Inflow=0.51 cfs 0.177 af
6.0" Round Pipe n=0.013 L=18.0' S=0.0039 '/' Capacity=0.35 cfs Outflow=0.38 cfs 0.177 af

Pond G: Extg culvert (N) Peak Elev=188.31' Storage=42 cf Inflow=7.58 cfs 2.642 af
24.0" Round Culvert n=0.013 L=15.0' S=0.0000 '/' Outflow=7.58 cfs 2.641 af


WAB
Wetland A Buffer
10AT
Street Impervious Area
RP1
Lot 1 and 5 (roofs)
10BT
Street Pervious Area
CB PF15
CB A-3
PF-15 Pittock Pl.
PF-15 Pittock Pl.
LPW
Lower parking (imperv)
B1AB
Parking Pervious Area
CB A-2
MH A3 TO MH A2
CB PF16
A1A
PP
24 INCH PERF PIPE
Perk Filter #16
Stilling Well 1
SW2
A1B
B1AT
Parking Impervious Area
CB PF14
Perk Filter 14 to MH A2
CB A-1
MH A2 TO MH A1A & MH A1B
BPR2
Business Roofs
BPR1
Business Roofs
CWN
Street
CB PF19
Perk Filter 19
CB P-2
MH P1 TO MH B3
CB P-1
MH B3 to MH B1
CB B-1
MH B1 - CMD and MH B2 to MH B1 Village (MH B1 TO MH A2)
CB B-2
CB PF18
Perk Filter 18
CB PF-P
Perk Filter Payne
P
Payne Road - future
CB B-4
MH B4 to MH B1
CWS
Street, sidewalk, landscape
OVSR
Offsite Residential - roofs-lawns
OVWL
Offsite pervious - lower north multi-unit
OVWR
Offsite Impervious - roofs
OVSRW
Offsite (ROW portion)
OVWPL
Offsite - parking-sidewalk-landscape
Subcat
Reach
Pond
Link
LINE A & B
Routing Diagram for Parklands Final 8-26-2016-10-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company, Printed 10/17/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Parklands Final 8-26-2016-10-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company

HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	A-1	199.27	188.00	183.6	0.0614	0.013	15.0	0.0	0.0
2	A-1	199.27	188.50	170.6	0.0631	0.013	15.0	0.0	0.0
3	A-2	200.60	199.47	143.6	0.0079	0.013	10.0	0.0	0.0
4	A-3	201.36	200.80	112.6	0.0050	0.013	10.0	0.0	0.0
5	A1A	191.50	191.50	2.0	0.0000	0.013	24.0	0.0	0.0
6	B-1	214.65	211.10	188.8	0.0188	0.013	18.0	0.0	0.0
7	B-2	215.49	214.85	67.0	0.0096	0.013	12.0	0.0	0.0
8	B-4	215.67	214.85	61.5	0.0133	0.013	18.0	0.0	0.0
9	P-1	222.38	214.85	222.0	0.0339	0.013	12.0	0.0	0.0
10	P-2	229.02	222.58	116.7	0.0552	0.013	12.0	0.0	0.0
11	PF-P	229.07	229.02	9.0	0.0056	0.013	10.0	0.0	0.0
12	PF14	212.80	212.72	10.0	0.0080	0.013	8.0	0.0	0.0
13	PF15	201.36	201.31	1.0	0.0500	0.013	10.0	0.0	0.0
14	PF16	195.73	188.95	9.5	0.7137	0.013	8.0	0.0	0.0
15	PF18	216.64	215.69	28.0	0.0339	0.013	10.0	0.0	0.0
16	PF19	216.64	215.69	28.0	0.0339	0.013	10.0	0.0	0.0
17	SW2	191.00	191.00	2.0	0.0000	0.013	24.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10AT: Street Impervious Runoff Area=15,797 sf 100.00% Impervious Runoff Depth=3.57"
Tc=5.0 min CN=0.0/98.0 Runoff=0.32 cfs 0.108 af

Subcatchment 10BT: Street Pervious Area Runoff Area=9,720 sf 0.00% Impervious Runoff Depth=2.37"
Tc=5.0 min CN=86.0/0.0 Runoff=0.13 cfs 0.044 af

Subcatchment B1AB: Parking Pervious Area Runoff Area=5,160 sf 0.00% Impervious Runoff Depth=1.95"
Tc=10.0 min CN=81.0/0.0 Runoff=0.05 cfs 0.019 af

Subcatchment B1AT: Parking Impervious Runoff Area=33,428 sf 100.00% Impervious Runoff Depth=3.57"
Tc=5.0 min CN=0.0/98.0 Runoff=0.68 cfs 0.228 af

Subcatchment BPR1: Business Roofs Runoff Area=3,000 sf 100.00% Impervious Runoff Depth=3.57"
Tc=5.0 min CN=0.0/98.0 Runoff=0.06 cfs 0.020 af

Subcatchment BPR2: Business Roofs Runoff Area=19,857 sf 100.00% Impervious Runoff Depth=3.57"
Tc=5.0 min CN=0.0/98.0 Runoff=0.41 cfs 0.135 af

Subcatchment CWN: Street Runoff Area=22,251 sf 82.63% Impervious Runoff Depth=3.29"
Tc=11.0 min CN=81.0/98.0 Runoff=0.39 cfs 0.140 af

Subcatchment CWS: Street, sidewalk, Runoff Area=30,128 sf 73.27% Impervious Runoff Depth=3.14"
Tc=11.0 min CN=81.0/98.0 Runoff=0.50 cfs 0.181 af

Subcatchment LPW: Lower parking Runoff Area=21,245 sf 93.58% Impervious Runoff Depth=3.47"
Tc=5.0 min CN=83.0/98.0 Runoff=0.42 cfs 0.141 af

Subcatchment OVSR: Offsite Residential - Runoff Area=244,726 sf 0.00% Impervious Runoff Depth=2.11"
Tc=25.0 min CN=83.0/0.0 Runoff=2.14 cfs 0.990 af

Subcatchment OVSRW: Offsite (ROW Runoff Area=62,071 sf 79.42% Impervious Runoff Depth=3.22"
Tc=10.0 min CN=80.0/98.0 Runoff=1.08 cfs 0.382 af

Subcatchment OVWL: Offsite pervious - Runoff Area=97,317 sf 100.00% Impervious Runoff Depth=3.57"
Tc=15.0 min CN=0.0/98.0 Runoff=1.77 cfs 0.664 af

Subcatchment OVWPL: Offsite - Runoff Area=115,995 sf 92.63% Impervious Runoff Depth=3.44"
Tc=5.0 min CN=80.0/98.0 Runoff=2.28 cfs 0.764 af

Subcatchment OVWR: Offsite Impervious Runoff Area=67,651 sf 100.00% Impervious Runoff Depth=3.57"
Tc=15.0 min CN=0.0/98.0 Runoff=1.23 cfs 0.461 af

Subcatchment P: Payne Road - future Runoff Area=14,218 sf 69.05% Impervious Runoff Depth=3.19"
Tc=0.0 min CN=86.0/98.0 Runoff=0.27 cfs 0.087 af

Subcatchment RP1: Lot 1 and 5 (roofs) Runoff Area=13,000 sf 100.00% Impervious Runoff Depth=3.57"
Tc=5.0 min CN=0.0/98.0 Runoff=0.27 cfs 0.089 af

Subcatchment WAB: Wetland A Buffer Runoff Area=2.000 ac 0.00% Impervious Runoff Depth=1.95"
Tc=10.0 min CN=81.0/0.0 Runoff=0.87 cfs 0.326 af

Pond A-1: MH A2 TO MH A1A & MH A1B Peak Elev=200.83' Inflow=11.43 cfs 4.312 af
Primary=5.71 cfs 2.156 af Secondary=5.71 cfs 2.156 af Outflow=11.43 cfs 4.312 af

Pond A-2: MH A3 TO MH A2 Peak Elev=201.26' Inflow=0.72 cfs 0.240 af
10.0" Round Culvert n=0.013 L=143.6' S=0.0079 '/' Outflow=0.72 cfs 0.240 af

Pond A-3: PF-15 Pittock Pl. Peak Elev=201.91' Inflow=0.72 cfs 0.240 af
10.0" Round Culvert n=0.013 L=112.6' S=0.0050 '/' Outflow=0.72 cfs 0.240 af

Pond A1A: Stilling Well 1 Peak Elev=192.87' Storage=614 cf Inflow=6.13 cfs 2.297 af
24.0" Round Culvert n=0.013 L=2.0' S=0.0000 '/' Outflow=6.12 cfs 2.289 af

Pond B-1: MH B1 - CMD and Village (MH B1 TO MH A2) Peak Elev=216.66' Inflow=9.54 cfs 3.668 af
18.0" Round Culvert n=0.013 L=188.8' S=0.0188 '/' Outflow=9.54 cfs 3.668 af

Pond B-2: MH B2 to MH B1 Peak Elev=216.72' Inflow=0.89 cfs 0.321 af
12.0" Round Culvert n=0.013 L=67.0' S=0.0096 '/' Outflow=0.89 cfs 0.321 af

Pond B-4: MH B4 to MH B1 Peak Elev=216.94' Inflow=3.19 cfs 1.372 af
18.0" Round Culvert n=0.013 L=61.5' S=0.0133 '/' Outflow=3.19 cfs 1.372 af

Pond P-1: MH B3 to MH B1 Peak Elev=222.63' Inflow=0.27 cfs 0.087 af
12.0" Round Culvert n=0.013 L=222.0' S=0.0339 '/' Outflow=0.27 cfs 0.087 af

Pond P-2: MH P1 TO MH B3 Peak Elev=229.27' Inflow=0.27 cfs 0.087 af
12.0" Round Culvert n=0.013 L=116.7' S=0.0552 '/' Outflow=0.27 cfs 0.087 af

Pond PF-P: Perk Filter Payne Peak Elev=229.40' Inflow=0.27 cfs 0.087 af
10.0" Round Culvert n=0.013 L=9.0' S=0.0056 '/' Outflow=0.27 cfs 0.087 af

Pond PF14: Perk Filter 14 to MH A2 Peak Elev=213.42' Inflow=0.73 cfs 0.247 af
8.0" Round Culvert n=0.013 L=10.0' S=0.0080 '/' Outflow=0.73 cfs 0.247 af

Pond PF15: PF-15 Pittock Pl. Peak Elev=201.96' Inflow=0.45 cfs 0.152 af
10.0" Round Culvert n=0.013 L=1.0' S=0.0500 '/' Outflow=0.45 cfs 0.152 af

Pond PF16: Perk Filter #16 Peak Elev=196.11' Inflow=0.42 cfs 0.141 af
8.0" Round Culvert n=0.013 L=9.5' S=0.7137 '/' Outflow=0.42 cfs 0.141 af

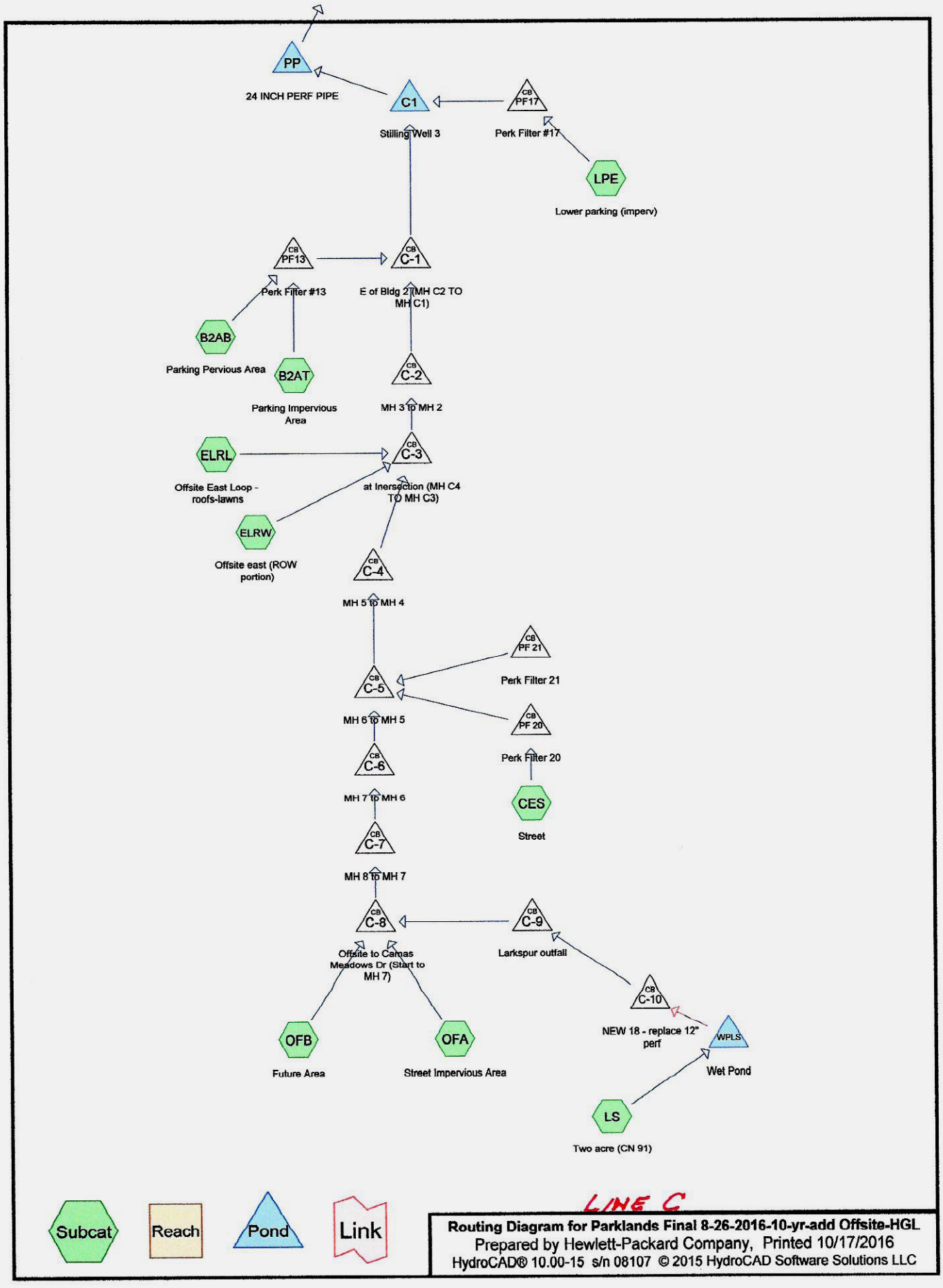
Pond PF18: Perk Filter 18 Peak Elev=217.05' Inflow=0.50 cfs 0.181 af
10.0" Round Culvert n=0.013 L=28.0' S=0.0339 '/' Outflow=0.50 cfs 0.181 af

Pond PF19: Perk Filter 19 Peak Elev=217.01' Inflow=0.39 cfs 0.140 af
10.0" Round Culvert n=0.013 L=28.0' S=0.0339 '/' Outflow=0.39 cfs 0.140 af

Pond PP: 24 INCH PERF PIPE Peak Elev=192.53' Storage=0.004 af Inflow=28.77 cfs 11.360 af
Outflow=28.76 cfs 11.360 af

Pond SW2: A1B

Peak Elev=192.70' Storage=218 cf Inflow=5.71 cfs 2.156 af
24.0" Round Culvert n=0.013 L=2.0' S=0.0000 '/' Outflow=5.71 cfs 2.152 af


PP
24 INCH PERF PIPE
C1
Stilling Well 3
CB PF17
Perk Filter #17
LPE
Lower parking (imperv)
CB PF13
Perk Filter #13
CB C-1
E of Bldg 2 (MH C2 TO MH C1)
B2AB
Parking Pervious Area
B2AT
Parking Impervious Area
CB C-2
MH 3 to MH 2
ELRL
Offsite East Loop - roofs-lawns
CB C-3
at Inersection (MH C4 TO MH C3)
ELRW
Offsite east (ROW portion)
CB C-4
MH 5 to MH 4
CB PF 21
Perk Filter 21
CB C-5
CB PF 20
Perk Filter 20
MH 6 to MH 5
CB C-6
CES
Street
MH 7 to MH 6
CB C-7
MH 8 to MH 7
CB C-8
CB C-9
Offsite to Camas Meadows Dr (Start to MH 7)
Larkspur outfall
CB C-10
NEW 18 - replace 12" perf
WPLS
Wet Pond
OFB
Future Area
OFA
Street Impervious Area
LS
Two acre (CN 91)
Subcat
Reach
Pond
Link
LINE C
Routing Diagram for Parklands Final 8-26-2016-10-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company, Printed 10/17/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Parklands Final 8-26-2016-10-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	C-1	200.80	189.00	158.5	0.0744	0.013	18.0	0.0	0.0
2	C-10	238.75	237.68	163.4	0.0065	0.013	18.0	0.0	0.0
3	C-2	219.88	201.00	134.0	0.1409	0.013	18.0	0.0	0.0
4	C-3	220.21	220.08	55.6	0.0023	0.013	30.0	0.0	0.0
5	C-4	220.90	220.41	96.4	0.0051	0.013	30.0	0.0	0.0
6	C-5	221.74	221.10	118.1	0.0054	0.013	30.0	0.0	0.0
7	C-6	224.52	221.94	149.8	0.0172	0.013	30.0	0.0	0.0
8	C-7	228.59	224.72	166.3	0.0233	0.013	24.0	0.0	0.0
9	C-8	237.25	228.79	200.0	0.0423	0.013	24.0	0.0	0.0
10	C-9	237.68	237.25	121.7	0.0035	0.013	18.0	0.0	0.0
11	C1	192.00	192.00	2.0	0.0000	0.013	24.0	0.0	0.0
12	PF 20	225.19	224.01	21.8	0.0541	0.013	10.0	0.0	0.0
13	PF 21	226.02	223.99	21.8	0.0931	0.013	10.0	0.0	0.0
14	PF13	211.87	206.00	63.5	0.0924	0.013	8.0	0.0	0.0
15	PF17	199.05	190.22	16.4	0.5384	0.013	8.0	0.0	0.0
16	WPLS	239.08	238.92	112.6	0.0014	0.013	12.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Pond C-1: E of Bldg 2 (MH C2 TO MH C1) Peak Elev=205.33' Inflow=16.54 cfs 6.783 af
18.0" Round Culvert n=0.013 L=158.5' S=0.0744 '/' Outflow=16.54 cfs 6.783 af

Pond C-10: NEW 18 - replace 12" perf Peak Elev=239.68' Inflow=2.46 cfs 1.701 af
18.0" Round Culvert n=0.013 L=163.4' S=0.0065 '/' Outflow=2.46 cfs 1.701 af

Pond C-2: MH 3 to MH 2 Peak Elev=224.20' Inflow=16.08 cfs 6.624 af
18.0" Round Culvert n=0.013 L=134.0' S=0.1409 '/' Outflow=16.08 cfs 6.624 af

Pond C-3: at Inersection (MH C4 TO MH C3) Peak Elev=224.66' Inflow=16.08 cfs 6.624 af
30.0" Round Culvert n=0.013 L=55.6' S=0.0023 '/' Outflow=16.08 cfs 6.624 af

Pond C-4: MH 5 to MH 4 Peak Elev=224.99' Inflow=14.11 cfs 5.804 af
30.0" Round Culvert n=0.013 L=96.4' S=0.0051 '/' Outflow=14.11 cfs 5.804 af

Pond C-5: MH 6 to MH 5 Peak Elev=225.31' Inflow=14.11 cfs 5.804 af
30.0" Round Culvert n=0.013 L=118.1' S=0.0054 '/' Outflow=14.11 cfs 5.804 af

Pond C-6: MH 7 to MH 6 Peak Elev=226.28' Inflow=13.20 cfs 5.477 af
30.0" Round Culvert n=0.013 L=149.8' S=0.0172 '/' Outflow=13.20 cfs 5.477 af

Pond C-7: MH 8 to MH 7 Peak Elev=230.35' Inflow=13.20 cfs 5.477 af
24.0" Round Culvert n=0.013 L=166.3' S=0.0233 '/' Outflow=13.20 cfs 5.477 af

Pond C-8: Offsite to Camas Meadows Dr (Start to MH 7) Peak Elev=239.01' Inflow=13.20 cfs 5.477 af
24.0" Round Culvert n=0.013 L=200.0' S=0.0423 '/' Outflow=13.20 cfs 5.477 af

Pond C-9: Larkspur outfall Peak Elev=239.13' Inflow=2.46 cfs 1.701 af
18.0" Round Culvert n=0.013 L=121.7' S=0.0035 '/' Outflow=2.46 cfs 1.701 af

Pond C1: Stilling Well 3 Peak Elev=193.64' Storage=0.006 af Inflow=16.95 cfs 6.924 af
24.0" Round Culvert x 2.00 n=0.013 L=2.0' S=0.0000 '/' Outflow=16.95 cfs 6.920 af

Pond PF 20: Perk Filter 20 Peak Elev=225.56' Inflow=0.43 cfs 0.155 af
10.0" Round Culvert n=0.013 L=21.8' S=0.0541 '/' Outflow=0.43 cfs 0.155 af

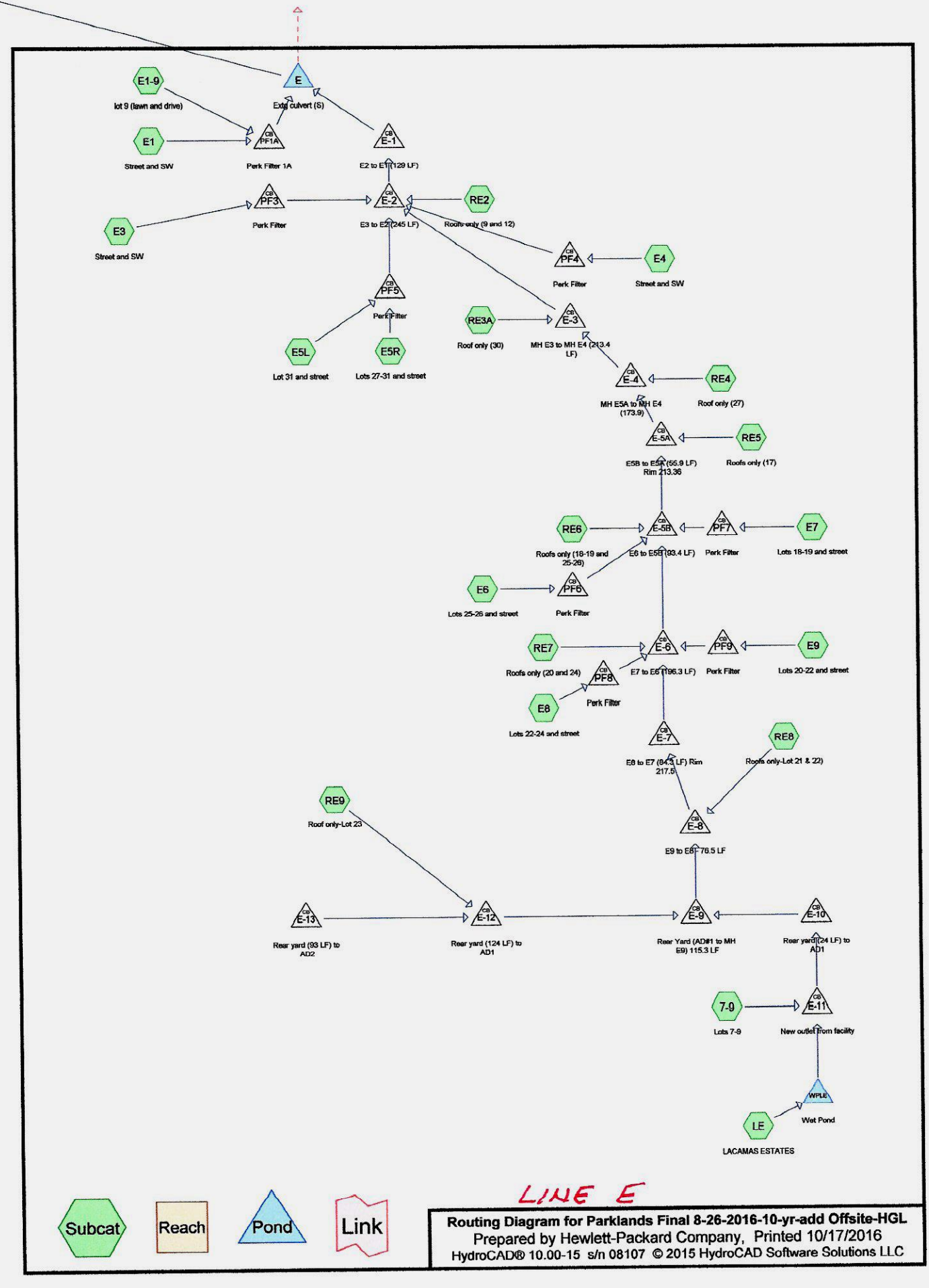
Pond PF 21: Perk Filter 21 Peak Elev=226.39' Inflow=0.48 cfs 0.172 af
10.0" Round Culvert n=0.013 L=21.8' S=0.0931 '/' Outflow=0.48 cfs 0.172 af

Pond PF13: Perk Filter #13 Peak Elev=212.27' Inflow=0.47 cfs 0.160 af
8.0" Round Culvert n=0.013 L=63.5' S=0.0924 '/' Outflow=0.47 cfs 0.160 af

Pond PF17: Perk Filter #17 Peak Elev=199.43' Inflow=0.42 cfs 0.141 af
8.0" Round Culvert n=0.013 L=16.4' S=0.5384 '/' Outflow=0.42 cfs 0.141 af

Pond PP: 24 INCH PERF PIPE Peak Elev=192.53' Storage=0.004 af Inflow=28.77 cfs 11.360 af
Outflow=28.76 cfs 11.360 af

Pond WPLS: Wet Pond Peak Elev=240.69' Storage=30,840 cf Inflow=4.26 cfs 1.607 af
Primary=2.46 cfs 1.701 af Secondary=0.00 cfs 0.000 af Outflow=2.46 cfs 1.701 af


E1-9
lot 9 (lawn and drive)
E
Exist culvert (S)
E1
Street and SW
PF1A
Perk Filter 1A
E-1
E2 to E1 (129 LF)
PF3
Perk Filter
E-2
RE2
Roofs only (9 and 12)
E3
Street and SW
E3 to E2 (245 LF)
PF4
Perk Filter
E4
Street and SW
PF5
Perk Filter
RE3A
Roof only (30)
E-3
MH E3 to MH E4 (213.4 LF)
E5L
Lot 31 and street
E5R
Lots 27-31 and street
E-4
RE4
Roof only (27)
MH E5A to MH E4 (173.9)
E-5A
RE5
Roofs only (17)
E5B to E5A (55.9 LF)
Rim 213.36
RE6
Roofs only (18-19 and 25-26)
E-5B
PF7
E7
Lots 18-19 and street
E6 to E5B (93.4 LF)
Perk Filter
E6
Lots 25-26 and street
PF6
Perk Filter
RE7
Roofs only (20 and 24)
E-6
PF9
E9
Lots 20-22 and street
E7 to E6 (196.3 LF)
Perk Filter
PF8
Perk Filter
E8
Lots 22-24 and street
E-7
RE8
Roofs only-Lot 21 & 22)
E8 to E7 (84.3 LF) Rim 217.5
RE9
Roof only-Lot 23
E-8
E9 to E8 76.5 LF
E-13
Rear yard (93 LF) to AD2
E-12
Rear yard (124 LF) to AD1
E-9
Rear Yard (AD#1 to MH E9) 115.3 LF
E-10
Rear yard (24 LF) to AD1
7-9
Lots 7-9
E-11
New outlet from facility
WPLE
Wet Pond
LE
LACAMAS ESTATES
Subcat
Reach
Pond
Link
LINE E
Routing Diagram for Parklands Final 8-26-2016-10-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company, Printed 10/17/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Parklands Final 8-26-2016-10-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company

HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	E	187.47	187.47	30.0	0.0000	0.013	24.0	0.0	0.0
2	E	187.98	186.06	43.0	0.0447	0.013	24.0	0.0	0.0
3	E-1	190.00	187.98	129.1	0.0156	0.013	18.0	0.0	0.0
4	E-10	216.00	215.85	25.0	0.0060	0.013	15.0	0.0	0.0
5	E-11	218.62	217.00	14.0	0.1157	0.013	12.0	0.0	0.0
6	E-12	216.00	215.50	124.0	0.0040	0.013	12.0	0.0	0.0
7	E-13	226.00	216.00	94.8	0.1055	0.013	12.0	0.0	0.0
8	E-2	198.09	190.20	244.9	0.0322	0.013	18.0	0.0	0.0
9	E-3	205.00	198.29	213.4	0.0314	0.013	18.0	0.0	0.0
10	E-4	207.90	205.20	173.9	0.0155	0.013	18.0	0.0	0.0
11	E-5A	208.80	208.10	55.9	0.0125	0.013	18.0	0.0	0.0
12	E-5B	210.15	209.00	93.4	0.0123	0.013	18.0	0.0	0.0
13	E-6	212.15	210.35	196.3	0.0092	0.013	15.0	0.0	0.0
14	E-7	213.00	212.35	84.3	0.0077	0.013	15.0	0.0	0.0
15	E-8	214.00	213.00	76.5	0.0131	0.013	15.0	0.0	0.0
16	E-9	215.50	214.00	115.3	0.0130	0.013	15.0	0.0	0.0
17	PF1A	188.52	187.47	26.0	0.0404	0.013	8.0	0.0	0.0
18	PF3	199.47	199.40	15.0	0.0047	0.013	8.0	0.0	0.0
19	PF4	198.38	198.33	10.0	0.0050	0.013	8.0	0.0	0.0
20	PF5	198.41	198.29	13.0	0.0092	0.013	8.0	0.0	0.0
21	PF6	210.21	210.15	12.0	0.0050	0.013	8.0	0.0	0.0
22	PF7	210.21	210.15	10.0	0.0060	0.013	8.0	0.0	0.0
23	PF8	212.21	212.15	12.0	0.0050	0.013	8.0	0.0	0.0
24	PF9	212.21	212.15	10.0	0.0060	0.013	8.0	0.0	0.0
25	WPLE	222.68	222.53	6.5	0.0231	0.013	12.0	0.0	0.0

Pond PF3: Perk Filter Peak Elev=200.66' Inflow=0.28 cfs 0.094 af
8.0" Round Culvert n=0.013 L=15.0' S=0.0047 '/' Outflow=0.28 cfs 0.094 af

Pond PF4: Perk Filter Peak Elev=200.68' Inflow=0.38 cfs 0.129 af
8.0" Round Culvert n=0.013 L=10.0' S=0.0050 '/' Outflow=0.38 cfs 0.129 af

Pond PF5: Perk Filter Peak Elev=201.02' Inflow=1.05 cfs 0.398 af
8.0" Round Culvert n=0.013 L=13.0' S=0.0092 '/' Outflow=1.05 cfs 0.398 af

Pond PF6: Perk Filter Peak Elev=211.34' Inflow=0.30 cfs 0.114 af
8.0" Round Culvert n=0.013 L=12.0' S=0.0050 '/' Outflow=0.30 cfs 0.114 af

Pond PF7: Perk Filter Peak Elev=211.34' Inflow=0.30 cfs 0.114 af
8.0" Round Culvert n=0.013 L=10.0' S=0.0060 '/' Outflow=0.30 cfs 0.114 af

Pond PF8: Perk Filter Peak Elev=213.33' Inflow=0.32 cfs 0.122 af
8.0" Round Culvert n=0.013 L=12.0' S=0.0050 '/' Outflow=0.32 cfs 0.122 af

Pond PF9: Perk Filter Peak Elev=213.33' Inflow=0.32 cfs 0.122 af
8.0" Round Culvert n=0.013 L=10.0' S=0.0060 '/' Outflow=0.32 cfs 0.122 af

Pond WPLE: Wet Pond Peak Elev=224.15' Storage=36,836 cf Inflow=4.63 cfs 1.743 af
12.0" Round Culvert n=0.013 L=6.5' S=0.0231 '/' Outflow=2.94 cfs 1.741 af

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Pond E: Extg culvert (S) Peak Elev=188.99' Storage=37 cf Inflow=11.62 cfs 4.971 af
Primary=6.74 cfs 3.816 af Secondary=4.89 cfs 1.155 af Outflow=11.62 cfs 4.971 af

Pond E-1: E2 to E1 (129 LF) Peak Elev=192.54' Inflow=11.40 cfs 4.892 af
18.0" Round Culvert n=0.013 L=129.1' S=0.0156 '/' Outflow=11.40 cfs 4.892 af

Pond E-10: Rear yard (24 LF) to AD1 Peak Elev=217.11' Inflow=3.24 cfs 1.905 af
15.0" Round Culvert n=0.013 L=25.0' S=0.0060 '/' Outflow=3.24 cfs 1.905 af

Pond E-11: New outlet from facility Peak Elev=219.86' Inflow=3.24 cfs 1.905 af
12.0" Round Culvert n=0.013 L=14.0' S=0.1157 '/' Outflow=3.24 cfs 1.905 af

Pond E-12: Rear yard (124 LF) to AD1 Peak Elev=216.46' Inflow=0.13 cfs 0.044 af
12.0" Round Culvert n=0.013 L=124.0' S=0.0040 '/' Outflow=0.13 cfs 0.044 af

Pond E-13: Rear yard (93 LF) to AD2 Peak Elev=0.00'
12.0" Round Culvert n=0.013 L=94.8' S=0.1055 '/' Primary=0.00 cfs 0.000 af

Pond E-2: E3 to E2 (245 LF) Peak Elev=200.63' Inflow=11.40 cfs 4.892 af
18.0" Round Culvert n=0.013 L=244.9' S=0.0322 '/' Outflow=11.40 cfs 4.892 af

Pond E-3: MH E3 to MH E4 (213.4 LF) Peak Elev=206.67' Inflow=8.17 cfs 3.742 af
18.0" Round Culvert n=0.013 L=213.4' S=0.0314 '/' Outflow=8.17 cfs 3.742 af

Pond E-4: MH E5A to MH E4 (173.9) Peak Elev=209.10' Inflow=5.64 cfs 2.864 af
18.0" Round Culvert n=0.013 L=173.9' S=0.0155 '/' Outflow=5.64 cfs 2.864 af

Pond E-5A: E5B to E5A (55.9 LF) Rim 213.36 Peak Elev=210.00' Inflow=5.52 cfs 2.820 af
18.0" Round Culvert n=0.013 L=55.9' S=0.0125 '/' Outflow=5.52 cfs 2.820 af

Pond E-5B: E6 to E5B (93.4 LF) Peak Elev=211.31' Inflow=5.39 cfs 2.775 af
18.0" Round Culvert n=0.013 L=93.4' S=0.0123 '/' Outflow=5.39 cfs 2.775 af

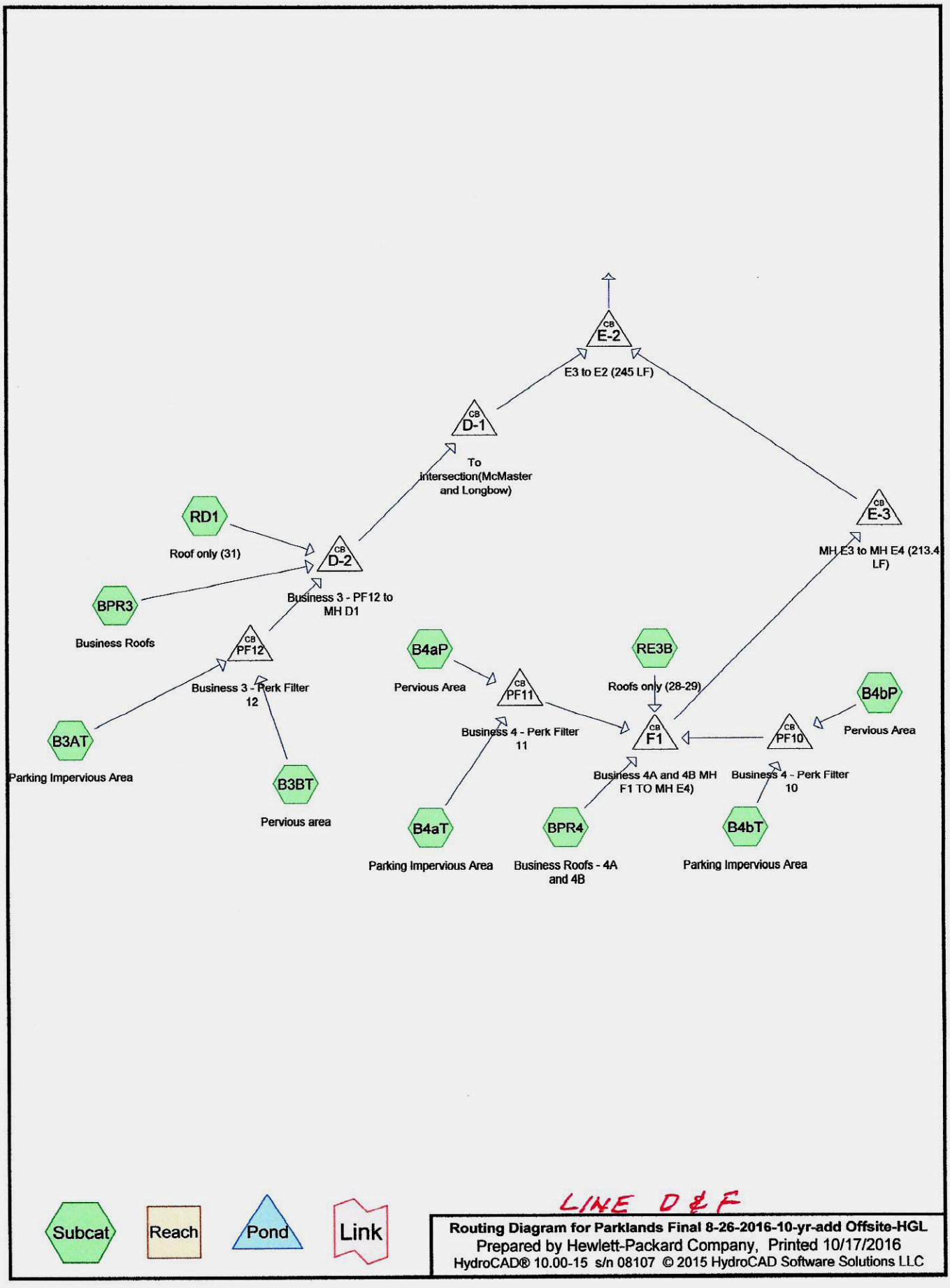
Pond E-6: E7 to E6 (196.3 LF) Peak Elev=213.29' Inflow=4.29 cfs 2.370 af
15.0" Round Culvert n=0.013 L=196.3' S=0.0092 '/' Outflow=4.29 cfs 2.370 af

Pond E-7: E8 to E7 (84.3 LF) Rim 217.5 Peak Elev=214.09' Inflow=3.46 cfs 2.038 af
15.0" Round Culvert n=0.013 L=84.3' S=0.0077 '/' Outflow=3.46 cfs 2.038 af

Pond E-8: E9 to E8 - 76.5 LF Peak Elev=215.01' Inflow=3.46 cfs 2.038 af
15.0" Round Culvert n=0.013 L=76.5' S=0.0131 '/' Outflow=3.46 cfs 2.038 af

Pond E-9: Rear Yard (AD#1 to MH E9) 115.3 LF Peak Elev=216.45' Inflow=3.31 cfs 1.949 af
15.0" Round Culvert n=0.013 L=115.3' S=0.0130 '/' Outflow=3.31 cfs 1.949 af

Pond PF1A: Perk Filter 1A Peak Elev=189.04' Inflow=0.23 cfs 0.079 af
8.0" Round Culvert n=0.013 L=26.0' S=0.0404 '/' Outflow=0.23 cfs 0.079 af


CB E-2
E3 to E2 (245 LF)
CB D-1
To intersection(McMaster and Longbow)
RD1
Roof only (31)
CB D-2
CB E-3
MH E3 to MH E4 (213.4 LF)
BPR3
Business Roofs
Business 3 - PF12 to MH D1
CB PF12
Business 3 - Perk Filter 12
B4aP
Pervious Area
CB PF11
RE3B
Roofs only (28-29)
B4bP
Pervious Area
B3AT
Parking Impervious Area
Business 4 - Perk Filter 11
CB F1
CB PF10
B3BT
Pervious area
Business 4A and 4B MH F1 TO MH E4)
Business 4 - Perk Filter 10
B4aT
Parking Impervious Area
BPR4
Business Roofs - 4A and 4B
B4bT
Parking Impervious Area
Subcat
Reach
Pond
Link
LINE D & F
Routing Diagram for Parklands Final 8-26-2016-10-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company, Printed 10/17/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Parklands Final 8-26-2016-10-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	D-1	200.00	198.29	135.8	0.0126	0.013	12.0	0.0	0.0
2	D-2	215.79	200.64	138.0	0.1098	0.013	10.0	0.0	0.0
3	E-2	198.09	190.20	244.9	0.0322	0.013	18.0	0.0	0.0
4	E-3	205.00	198.29	213.4	0.0314	0.013	18.0	0.0	0.0
5	F1	215.45	205.29	180.7	0.0562	0.013	12.0	0.0	0.0
6	PF10	220.90	215.55	85.6	0.0625	0.013	10.0	0.0	0.0
7	PF11	220.68	215.55	125.6	0.0408	0.013	10.0	0.0	0.0
8	PF12	215.79	215.78	1.0	0.0100	0.013	10.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Pond D-1: To intersection(McMaster and Longbow) Peak Elev=200.96' Inflow=1.31 cfs 0.441 af
12.0" Round Culvert n=0.013 L=135.8' S=0.0126 '/' Outflow=1.31 cfs 0.441 af

Pond D-2: Business 3 - PF12 to MH D1 Peak Elev=216.46' Inflow=1.31 cfs 0.441 af
10.0" Round Culvert n=0.013 L=138.0' S=0.1098 '/' Outflow=1.31 cfs 0.441 af

Pond E-2: E3 to E2 (245 LF) Peak Elev=200.63' Inflow=11.40 cfs 4.892 af
18.0" Round Culvert n=0.013 L=244.9' S=0.0322 '/' Outflow=11.40 cfs 4.892 af

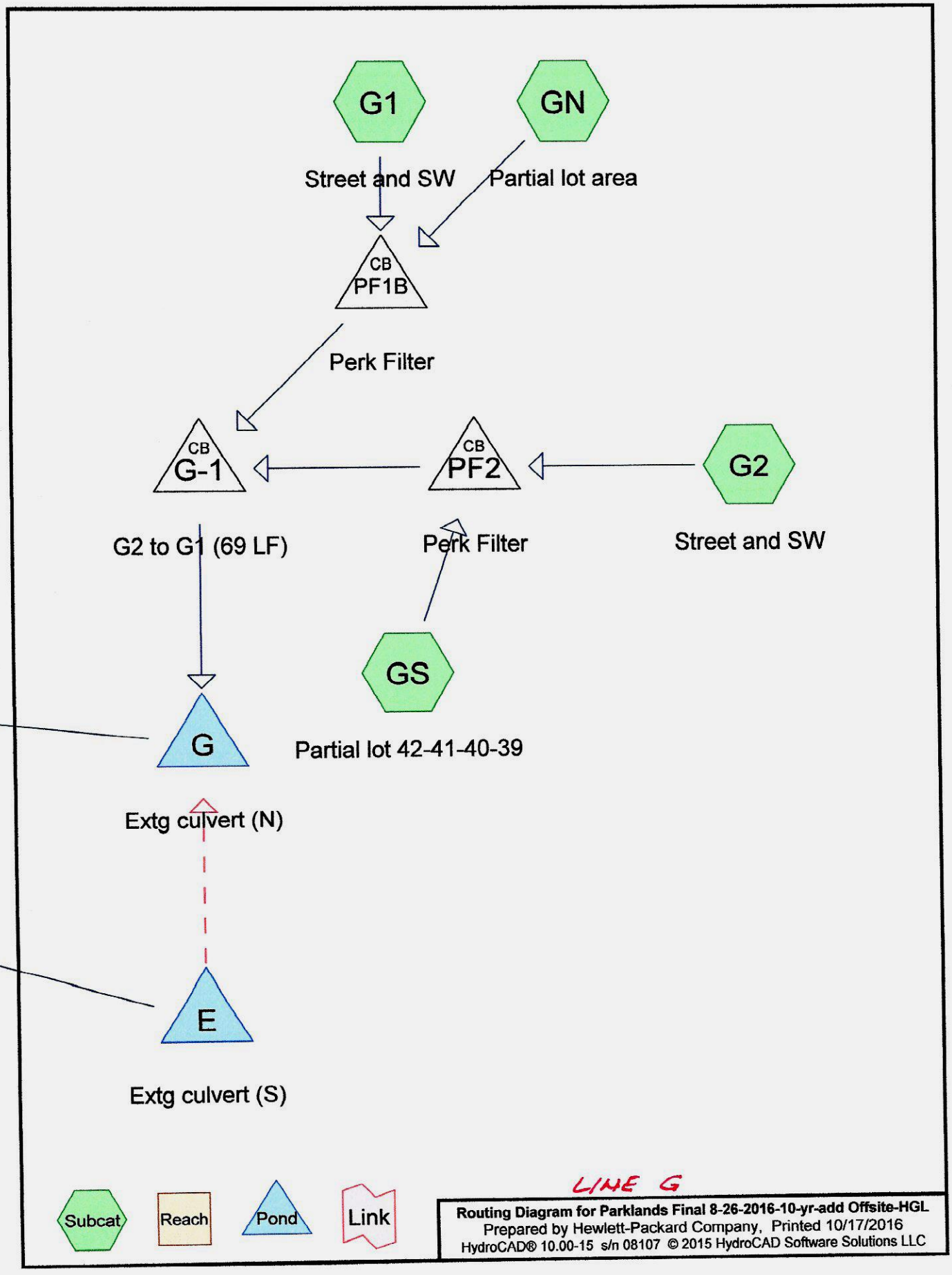
Pond E-3: MH E3 to MH E4 (213.4 LF) Peak Elev=206.67' Inflow=8.17 cfs 3.742 af
18.0" Round Culvert n=0.013 L=213.4' S=0.0314 '/' Outflow=8.17 cfs 3.742 af

Pond F1: Business 4A and 4B MH F1 TO MH E4) Peak Elev=216.37' Inflow=2.48 cfs 0.834 af
12.0" Round Culvert n=0.013 L=180.7' S=0.0562 '/' Outflow=2.48 cfs 0.834 af

Pond PF10: Business 4 - Perk Filter 10 Peak Elev=221.41' Inflow=0.84 cfs 0.281 af
10.0" Round Culvert n=0.013 L=85.6' S=0.0625 '/' Outflow=0.84 cfs 0.281 af

Pond PF11: Business 4 - Perk Filter 11 Peak Elev=221.16' Inflow=0.76 cfs 0.253 af
10.0" Round Culvert n=0.013 L=125.6' S=0.0408 '/' Outflow=0.76 cfs 0.253 af

Pond PF12: Business 3 - Perk Filter 12 Peak Elev=216.54' Inflow=0.73 cfs 0.247 af
10.0" Round Culvert n=0.013 L=1.0' S=0.0100 '/' Outflow=0.73 cfs 0.247 af


G1
GN
Street and SW
Partial lot area
CB
PF1B
Perk Filter
CB
G-1
CB
PF2
G2
G2 to G1 (69 LF)
Perk Filter
Street and SW
GS
G
Partial lot 42-41-40-39
Extg culvert (N)
E
Extg culvert (S)
Subcat
Reach
Pond
Link
LINE G
Routing Diagram for Parklands Final 8-26-2016-10-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company, Printed 10/17/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Parklands Final 8-26-2016-10-yr-add Offsite-HGL

HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	E	187.47	187.47	30.0	0.0000	0.013	24.0	0.0	0.0
2	E	187.98	186.06	43.0	0.0447	0.013	24.0	0.0	0.0
3	G	186.06	186.06	15.0	0.0000	0.013	24.0	0.0	0.0
4	G-1	186.34	186.07	63.8	0.0042	0.011	12.0	0.0	0.0
5	PF1B	186.50	186.34	19.0	0.0084	0.013	6.0	0.0	0.0
6	PF2	186.41	186.34	18.0	0.0039	0.013	6.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Pond E: Extg culvert (S) Peak Elev=188.99' Storage=37 cf Inflow=11.62 cfs 4.971 af
Primary=6.74 cfs 3.816 af Secondary=4.89 cfs 1.155 af Outflow=11.62 cfs 4.971 af

Pond G: Extg culvert (N) Peak Elev=188.32' Storage=42 cf Inflow=7.84 cfs 2.641 af
24.0" Round Culvert n=0.013 L=15.0' S=0.0000 '/' Outflow=7.84 cfs 2.640 af

Pond G-1: G2 to G1 (69 LF) Peak Elev=188.40' Inflow=1.18 cfs 0.414 af
12.0" Round Culvert n=0.011 L=63.8' S=0.0042 '/' Outflow=1.18 cfs 0.414 af

Pond PF1B: Perk Filter Peak Elev=188.93' Inflow=0.68 cfs 0.237 af
6.0" Round Culvert n=0.013 L=19.0' S=0.0084 '/' Outflow=0.68 cfs 0.237 af

Pond PF2: Perk Filter Peak Elev=188.68' Inflow=0.51 cfs 0.177 af
6.0" Round Culvert n=0.013 L=18.0' S=0.0039 '/' Outflow=0.51 cfs 0.177 af

APPENDIX D CONVEYANCE SYSTEM
APPENDIX D-2 CONVEYANCE DESIGN COMMENTS

7.1 Design and Construction Standards

Minimum Pipe Diameter (7.2)

- *Public mainline storm sewers shall be a minimum of twelve (12) inches inside diameter. Downstream pipe diameters shall not be reduced except when approved by the City.*
  - **Condition met on public and private streets. The exception is Longbow Ln where grade restrictions necessitate a smaller pipe size.**
- *Public storm sewer laterals shall be ten (10) inches inside diameter. Larger pipe diameter may be used with large capacity catch basins and when approved by the City.*

- **There are several 6 and 8 inch laterals from the Perk Filter systems. The inflow is small due to the closer spacing along the main pipe runs and there are elevation constraints. In particular along Longbow Ln.**

7.5 Hydraulic Methods

"Two hydraulic methods can be used for the design of pipelines. The first method is a gravity flow or open channel design, which is most commonly performed using Manning's equation. This method assumes that flow is steady (does not change with time) and uniform (the depth and velocity remain constant throughout the pipe for a given flow). Manning's equation can be found in standard hydraulic textbooks and in the WSDOT Hydraulics Manual (WSDOT 2007)."

- **Gravity flow or open channel design, using Manning's equation was applied in this design.**
- **However, the existing culverts from Wetland B to C required a dynamic flow analysis which is an option with HydroCAD. Pipe run input can be converted to the pond symbol and the analysis accounts for downstream (or tailwater elevations).**

"The second method is a pressure flow design, where the water surface elevation rises above the crown of the pipe. A backwater analysis is performed to determine the level of the water surface (the hydraulic grade line) for a pipeline system with a given diameter, slope, and flow rate. This method also assumes steady flow, but the flow is not necessarily uniform (the slope of the hydraulic grade line differs from the slope of the pipe).

New pipes shall be designed to operate in an open-channel regime during the design storm and shall be sized using open channel design methods. Under certain hydrologic and

APPENDIX D CONVEYANCE SYSTEM
APPENDIX D-2 CONVEYANCE DESIGN COMMENTS

hydraulic conditions, however, flow can rise above the pipe, creating a pressurized pipeline. For those situations, it is important to determine the hydraulic grade line to ensure that water does not overtop manholes and catch basins. A backwater analysis shall be calculated under any of the following conditions:"

- *Pipes with slopes less than 0.50 percent.*
  - **A 10-yr analysis was performed to check open channel flow conditions. See Appendix D-1.**
  - **However, the 100-yr analysis required a pressure flow analysis to account for losses due to high velocity conditions. Pipes were upsized accordingly.**
- *Pipes with velocities over 6.5 feet per second (fps) (for subcritical flow only).*
  - **There are several pipes with velocities above this rate – flow control manholes have been designed to account (suppress the energy) for downstream system impacts.**
- *Inlet and outlet pipes forming a sharp angle (45 degrees or greater) at junctions.*
  - **There are several laterals with this condition, but the main pipe system has capacity to account for these minor losses.**
- *Pipe inverts less than three (3) feet deep when entering and leaving junctions.*
  - **No situations where pipe invert depths are less than three (3) feet.**

"When using Manning's equation for the design, each pipe within the system shall be sized *and sloped such that its barrel capacity at normal full flow is equal to or greater than the required conveyance capacity for the peak runoff of the design storm. A Manning's "N" of 0.013 shall be used for all pipes in Table 7-1. Table 7-2 provides the allowable minimum pipe slope and associated design capacity."*

- **The design storm is for a 10-yr event. The capacity check was made for the 10-yr event in Appendix D-1. The main system is sized to convey the 10-yr in open channel conditions to the last pipe segments where flow energy reduction systems produce minor backwater situations.**

APPENDIX D CONVEYANCE SYSTEM
D-3 STORM SYSTEM PIPE CAPACITY
AND 100-YR HGL CHECK

Notes:

1. The storm systems are sized for open channel flow - 10-yr event. However, velocity head losses create a backwater condition which was tabulated for the 10-yr event.

2. This tabulation for the 100-yr event indicates the storm systems are adequate in managing the 100-yr event as well. See MH C6 which has 0.22 ft freeboard and represents the closed HGL to rim elevation relationship.

STORM LINE A & B														
Upstream Structure ID	Downstream Structure ID	Pipe Length ID	Pipe Length cntr to cntr (ft)	Pipe Size (in)	US Rim Elev.	US Invert (ft)	DS Invert (ft)	Pipe Slope cntr to cntr (ft/ft)	100-YR Peak Rate (cfs)	Pipe Full Capacity (cfs)	Max. WSEL (ft)	Depth at Structure (ft)	Pipe Dia. (ft)	Remark on Hydraulic Condition
PF-P1	MH P1	PFP1	9.0	10	230.28	229.07	229.02	0.0056	0.39	1.63	229.47	0.40	0.83	OK
MH P1	MH B3	P-2	116.7	12	230.46	229.02	222.58	0.0552	0.39	8.40	229.33	0.31	1.00	OK
MH B3	MH B1	P-1	222.6	12	230.25	222.38	214.85	0.0338	0.39	6.56	222.69	0.31	1.00	OK
PF-18	MH B2	PF18	30.0	10	221.73	216.64	215.69	0.0317	0.73	4.04	218.42	1.78	0.83	submerged
PF-19	MH B2	PF19	30.0	10	221.73	216.64	215.69	0.0317	0.56	4.04	218.39	1.75	0.83	submerged
MH B2	MH B1	B-2	67.9	12	222.11	215.49	214.85	0.0094	1.30	3.48	218.35	2.86	1.00	submerged
MH B4	MH B1	B-4	61.5	18	229.98	215.67	214.85	0.0133	5.23	12.13	218.57	2.90	1.50	submerged
MH B1	MH A2	B-1	190.0	18	222.45	214.65	211.10	0.0187	14.22	14.4	218.19	3.54	1.50	submerged
PF-15	MH A3	A-3	112.6	10	205.36	201.36	200.80	0.0050	0.67	1.55	202.69	1.33	0.83	submerged
MH A3	MH A2	A-2	253.0	10	218.14	200.73	199.47	0.0050	1.04	1.94	202.64	1.91	0.83	submerged
MH A2	MH A1A	A-1A	184.0	15	218.95	199.37	188.00	0.0618	8.46	16.06	201.95	2.58	1.25	submerged
MH A2	MHA1B	A-1B	170.0	15	218.95	199.37	188.50	0.0639	8.46	16.33	201.95	2.58	1.25	submerged
MH A1B	MH C1	A1B-C1	180.0	24	200.70	191.50	192.00	-0.0028	28.77	11.97	192.53	1.03	2.00	OK
MH A1A	MH A1B	AIA-A1B	124.0	24	200.00	191.00	191.50	-0.0040	28.77	14.31	192.53	1.53	2.00	OK
PF-14	MH A2	B-1A	10.0	8	217.63	212.80	212.72	0.0080	1.05	1.08	213.63	0.83	0.67	submerged
PF-16	MH A1A	A-1C	9.5	8	200.56	195.73	189.67	0.6379	0.60	9.65	196.19	0.46	0.67	OK

APPENDIX D CONVEYANCE SYSTEM
D-3 STORM SYSTEM PIPE CAPACITY
AND 100-YR HGL CHECK

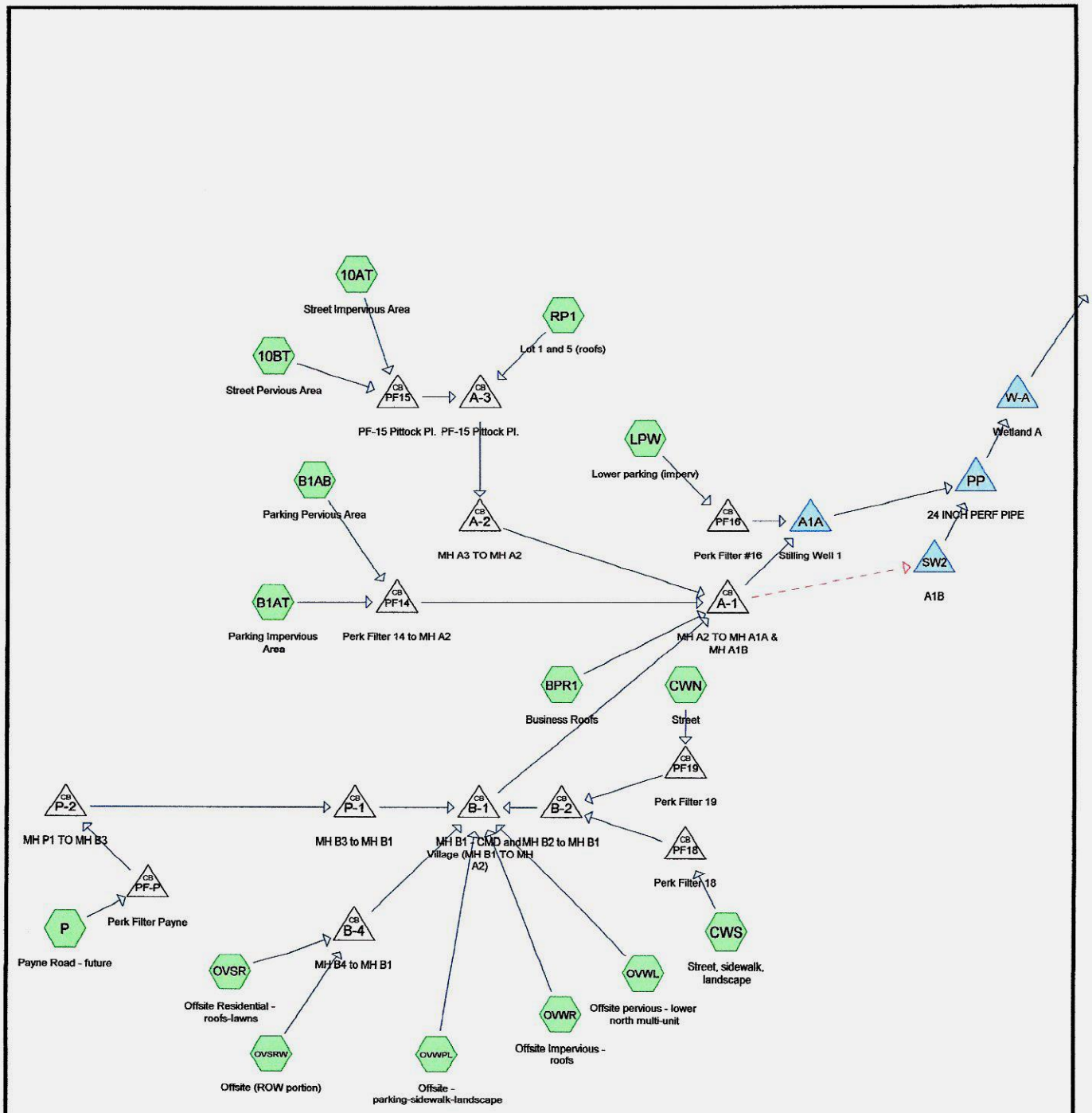
Storm System Line C														
Upstream Structure ID	Downstream Structure ID	Pipe Length ID	Pipe Length cntr to cntr (ft)	Pipe Size (in)	US Rim Elev.	US Invert (ft)	DS Invert (ft)	Pipe Slope cntr to cntr (ft/ft)	10-YR Peak Rate (cfs)	Pipe Full Capacity (cfs)	Max. WSEL (ft)	Depth at Structure (ft)	Pipe Dia. (ft)	Remark on Hydraulic Condition
D1-1	Tee into C-10	C-11	13.0	15	243.08+/-	240.13	238.23	0.1462	no flow	24.7	no flow	---	---	---
Extg MH C11	MH C10	C-10	163.4	18	242.62	238.72	237.68	0.0064	3.26	8.38	240.13	1.41	1.50	OK
MH C10	MH C9	C-9	121.7	18	242.00	237.68	237.25	0.0035	3.26	6.24	239.9	2.22	1.50	OK
MH C9	MH C8	C-8	200.0	24	245.34	237.25	228.79	0.0423	18.78	46.53	239.79	2.54	2.00	submerged
MH C8	MH C7	C-7	166.3	24	236.46	228.59	224.72	0.0233	18.78	34.51	232.64	4.05	2.00	submerged
MH C7	MH C6	C-6	149.8	30	231.84	224.52	221.94	0.0172	18.78	53.83	230.94	6.42	2.50	submerged
PF-20	MH C6	C6-B	21.0	8	230.19	225.19	223.57	0.0771	0.43	5.10	225.56	0.37	0.67	OK
PF-21	MH C6	C-6A	21.0	8	230.19	225.19	223.57	0.0771	0.48	6.69	226.09	0.90	0.67	submerged
MH C6	MH C5	C-5	118.1	30	230.60	221.74	221.10	0.0054	20.1	30.19	230.38	8.64	2.50	submerged
MH C5	MH C4	C-4	96.4	30	231.17	220.90	220.41	0.0051	20.1	29.24	229.74	8.84	2.50	submerged
MH C4	MH C3	C-3	55.6	30	231.61	220.21	220.08	0.0023	23.25	19.83	229.06	8.85	2.50	submerged
MH C3	MH C2	C-2	134.0	18	228.35	219.88	201.00	0.1409	23.25	39.43	228.10	8.22	1.50	submerged
PF-13	MH C2	C-2A	63.5	8	216.70	211.87	206.00	0.0924	0.47	3.67	212.27	0.40	0.67	OK
MH C2	MH C1	C-1	158.5	18	210.80	200.80	189.00	0.0744	23.92	28.66	209.45	8.65	1.50	submerged
PF-17	MHC1	C-1A	16.4	8	203.88	199.05	190.22	0.5384	0.42	8.87	199.43	0.38	0.67	OK

Storm System Line D, E, & F														
Upstream Structure ID	Downstream Structure ID	Pipe Length ID	Pipe Length cntr to cntr (ft)	Pipe Size (in)	US Rim Elev.	US Invert (ft)	DS Invert (ft)	Pipe Slope cntr to cntr (ft/ft)	10-YR Peak Rate (cfs)	Pipe Full Capacity (cfs)	Max. WSEL (ft)	Depth at Structure (ft)	Pipe Dia. (ft)	Remark on Hydraulic Condition
DI-2	Extg MH E10	E-12	15.0	15	224.78+/-	221.83	218.62	0.2140	no flow	29.88	no flow	---	1.25	no flow
Extg MH E10	AD4	E-11	14.0	12	221.88	218.62	217.00	0.1157	3.06	12.12	219.77	1.15	1.00	submerged
AD4	AD1	E-10	25.0	15	219.00	216.00	215.85	0.0060	3.06	7.37	217.07	1.07	1.25	OK
AD3	AD2	E-14	94.8	12	228.00	226.00	216.00	0.1055	GW flow ?	11.57	226.00	Min. Flow	1.00	OK
AD2	AD1	E-13	124.0	12	218.00	216.00	215.50	0.0040	0.20	2.26	216.48	0.48	1.00	OK
AD1	MH E9	E-9	115.3	15	218.00	215.50	214.00	0.0130	3.28	7.37	216.44	0.94	1.25	OK
MH E9	MH E8	E-8	76.5	15	219.24	214.00	213.00	0.0131	3.43	7.39	215.01	1.01	1.25	OK
MH E8	MH E7	E-7	84.3	15	217.50	213.00	212.35	0.0077	3.43	5.67	214.09	1.09	1.25	OK
PF-8	MH E7	E-7A	12.0	6	216.05	212.22	212.15	0.0058	0.32	0.85	213.34	1.12	0.50	submerged
PF-9	MH E7	E-7B	10.0	6	216.05	212.22	212.15	0.0070	0.32	0.94	213.34	1.12	0.50	submerged
MH E7	MH E6	E-6	196.3	15	216.29	212.15	210.35	0.0092	4.31	6.19	213.30	1.15	1.25	OK
PF-6	MH E6	PF5	12.0	6	214.04	210.79	210.15	0.0533	0.30	2.24	211.35	0.56	0.50	submerged
PF-7	MH E6	PF7	10.0	6	214.04	210.79	210.15	0.0640	0.30	2.39	211.35	0.56	0.50	submerged

APPENDIX D CONVEYANCE SYSTEM
D-3 STORM SYSTEM PIPE CAPACITY
AND 100-YR HGL CHECK

MH E6	MH E5B	E-5B	93.4	18	214.32	210.15	209.00	0.0123	5.42	10.59	211.32	1.17	1.50	OK	
MH E5B	MH E5A	E-5A	55.9	18	213.36	208.80	208.10	0.0125	5.55	27.39	210.01	1.21	1.50	OK	
MH E5A	MH E4	E-4	173.9	18	212.78	207.90	205.20	0.0155	5.67	20.63	209.10	1.20	1.50	OK	
PF-10	MH F1	F-2R	85.6	10	226.48	220.90	215.55	0.0625	0.84	5.48	221.41	0.51	0.83	OK	
PF-11	MH F1	F-2L	125.6	10	226.26	220.68	215.55	0.0408	0.76	4.43	221.16	0.48	0.83	OK	
MH F1	MH E4	F-1	180.7	12	219.53	215.45	205.29	0.0562	2.48	8.45	216.37	0.92	1.00	OK	
MH E4	MH E3	E-3	213.4	18	209.38	205.00	198.29	0.0314	8.2	18.63	206.68	1.68	1.50	submerged	
PF-3	MH E3	D-1A	17.0	8	203.47	200.05	198.84	0.0712	0.28	0.83	200.67	0.62	0.67	OK	
PF-4	MH E3	E-3A	10.0	8	203.56	200.14	199.71	0.0430	0.38	0.85	200.69	0.55	0.67	OK	
PF-5	MH E3	D-1B	13.0	8	203.20	198.41	198.29	0.0092	1.05	1.16	201.04	2.63	0.67	submerged	
PF-12	MH D2	D-2	138.0	10	215.79	215.79	200.64	0.1098	1.31	7.26	216.46	0.67	0.83	OK	
MH D2	MH E3	D-1	135.8	12	204.67	200.00	198.29	0.0126	1.31	4.00	200.97	0.97	1.00	OK	
MH E3	MH E2	E-2	244.9	18	203.49	198.09	190.20	0.0322	11.43	18.85	200.65	2.56	1.50	submerged	
MH E2	MH E1	E-1	129.1	18	193.30	190.00	187.98	0.0156	11.43	13.14	192.56	2.56	1.50	submerged	
PF-1A	MH E1	E-1A	26.0	8	191.94	188.52	187.47	0.0404	0.23	2.43	189.04	0.52	0.67	OK	
MH E1	OUTLET	W-1	30.0	24	190.86	187.47	187.47	0.0000	6.76	---	188.99	1.52	2.00	OK	6.75 fps
MH E1	MH G1	W-3	43.0	24	190.86	187.98	186.07	0.0444	4.91	47.67	189.99	2.01	2.00	submerged	4.46 fps

Storm System Line G															
Upstream Structure ID	**Downstream Structure ID**	**Pipe Length ID**	**Pipe Length cntr to cntr (ft)**	**Pipe Size (in)**	**US Rim Elev.**	**US Invert (ft)**	**DS Invert (ft)**	**Pipe Slope cntr to cntr (ft/ft)**	**10-YR Peak Rate (cfs)**	**Pipe Full Capacity (cfs)**	**Max. WSEL (ft)**	**Depth at Structure (ft)**	**Pipe Dia. (ft)**	**Remark on Hydraulic Condition**	
PF-1B	MH G2	G-3	19.0	6	189.75	186.5	186.34	0.0084	0.68	0.51	188.93	2.43	0.50	submerged	
PF-2	MH G2	G-2	18.0	6	189.66	186.41	186.34	0.0039	0.51	0.35	188.68	2.27	0.50	submerged	
MH G2	MH G1	G-1	63.8	12	189.88	186.34	186.07	0.0042	1.18	2.32	188.40	2.06	1.00	submerged	
MH G1	OUTLET	W-2	14.7	24	190.37	186.07	186.06	0.0007	7.86	5.99	188.33	2.26	2.00	submerged	2.46 cfs



Subcat | Reach | Pond | Link

LINE A1B

Routing Diagram for Parklands Final 8-26-2016-100-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company, Printed 10/13/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Parklands Final 8-26-2016-100-yr-add Offsite-HGL

HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	A-1	199.27	188.00	183.6	0.0614	0.013	15.0	0.0	0.0
2	A-1	199.27	188.50	170.6	0.0631	0.013	15.0	0.0	0.0
3	A-2	200.60	199.47	143.6	0.0079	0.013	10.0	0.0	0.0
4	A-3	201.36	200.80	112.6	0.0050	0.013	10.0	0.0	0.0
5	A1A	191.50	191.50	2.0	0.0000	0.013	24.0	0.0	0.0
6	B-1	214.65	211.10	188.8	0.0188	0.013	18.0	0.0	0.0
7	B-2	215.49	214.85	67.0	0.0096	0.013	12.0	0.0	0.0
8	B-4	215.67	214.85	61.5	0.0133	0.013	18.0	0.0	0.0
9	P-1	222.38	214.85	222.0	0.0339	0.013	12.0	0.0	0.0
10	P-2	229.02	222.58	116.7	0.0552	0.013	12.0	0.0	0.0
11	PF-P	229.07	229.02	9.0	0.0056	0.013	10.0	0.0	0.0
12	PF14	212.80	212.72	10.0	0.0080	0.013	8.0	0.0	0.0
13	PF15	201.36	201.31	1.0	0.0500	0.013	10.0	0.0	0.0
14	PF16	195.73	188.95	9.5	0.7137	0.013	8.0	0.0	0.0
15	PF18	216.64	215.69	28.0	0.0339	0.013	10.0	0.0	0.0
16	PF19	216.64	215.69	28.0	0.0339	0.013	10.0	0.0	0.0
17	SW2	191.00	191.00	2.0	0.0000	0.013	24.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10AT: Street Impervious Runoff Area=15,797 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.45 cfs 0.153 af

Subcatchment 10BT: Street Pervious Area Runoff Area=9,720 sf 0.00% Impervious Runoff Depth=3.75"
Tc=5.0 min CN=86.0/0.0 Runoff=0.21 cfs 0.070 af

Subcatchment B1AB: Parking Pervious Area Runoff Area=5,160 sf 0.00% Impervious Runoff Depth=3.25"
Tc=10.0 min CN=81.0/0.0 Runoff=0.09 cfs 0.032 af

Subcatchment B1AT: Parking Impervious Runoff Area=33,428 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.96 cfs 0.324 af

Subcatchment BPR1: Business Roofs Runoff Area=3,000 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.09 cfs 0.029 af

Subcatchment CWN: Street Runoff Area=22,251 sf 82.63% Impervious Runoff Depth=4.75"
Tc=11.0 min CN=81.0/98.0 Runoff=0.56 cfs 0.202 af

Subcatchment CWS: Street, sidewalk, Runoff Area=30,128 sf 73.27% Impervious Runoff Depth=4.58"
Tc=11.0 min CN=81.0/98.0 Runoff=0.73 cfs 0.264 af

Subcatchment LPW: Lower parking Runoff Area=21,245 sf 93.58% Impervious Runoff Depth=4.96"
Tc=5.0 min CN=83.0/98.0 Runoff=0.60 cfs 0.202 af

Subcatchment OVSR: Offsite Residential - Runoff Area=244,726 sf 0.00% Impervious Runoff Depth=3.45"
Tc=25.0 min CN=83.0/0.0 Runoff=3.69 cfs 1.614 af

Subcatchment OVSRW: Offsite (ROW Runoff Area=62,071 sf 79.42% Impervious Runoff Depth=4.67"
Tc=10.0 min CN=80.0/98.0 Runoff=1.56 cfs 0.555 af

Subcatchment OVWL: Offsite pervious - Runoff Area=97,317 sf 100.00% Impervious Runoff Depth=5.06"
Tc=15.0 min CN=0.0/98.0 Runoff=2.49 cfs 0.943 af

Subcatchment OVWPL: Offsite - Runoff Area=115,995 sf 92.63% Impervious Runoff Depth=4.92"
Tc=5.0 min CN=80.0/98.0 Runoff=3.24 cfs 1.092 af

Subcatchment OVWR: Offsite Impervious Runoff Area=67,651 sf 100.00% Impervious Runoff Depth=5.06"
Tc=15.0 min CN=0.0/98.0 Runoff=1.73 cfs 0.655 af

Subcatchment P: Payne Road - future Runoff Area=14,218 sf 69.05% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=86.0/98.0 Runoff=0.39 cfs 0.127 af

Subcatchment RP1: Lot 1 and 5 (roofs) Runoff Area=13,000 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.37 cfs 0.126 af

Pond A-1: MH A2 TO MH A1A & MH A1B Peak Elev=201.95' Inflow=16.93 cfs 6.377 af
Primary=8.46 cfs 3.188 af Secondary=8.46 cfs 3.188 af Outflow=16.93 cfs 6.377 af

Pond A-2: MH A3 TO MH A2 Peak Elev=202.33' Inflow=1.04 cfs 0.349 af
10.0" Round Culvert n=0.013 L=143.6' S=0.0079 '/' Outflow=1.04 cfs 0.349 af

Pond A-3: PF-15 Pittock Pl. Peak Elev=202.64' Inflow=1.04 cfs 0.349 af
10.0" Round Culvert n=0.013 L=112.6' S=0.0050 '/' Outflow=1.04 cfs 0.349 af

Pond A1A: Stilling Well 1 Peak Elev=193.36' Storage=711 cf Inflow=9.05 cfs 3.390 af
24.0" Round Culvert n=0.013 L=2.0' S=0.0000 '/' Outflow=9.03 cfs 3.382 af

Pond B-1: MH B1 - CMD and Village (MH B1 TO MH A2) Peak Elev=218.19' Inflow=14.22 cfs 5.451 af
18.0" Round Culvert n=0.013 L=188.8' S=0.0188 '/' Outflow=14.22 cfs 5.451 af

Pond B-2: MH B2 to MH B1 Peak Elev=218.35' Inflow=1.30 cfs 0.466 af
12.0" Round Culvert n=0.013 L=67.0' S=0.0096 '/' Outflow=1.30 cfs 0.466 af

Pond B-4: MH B4 to MH B1 Peak Elev=218.57' Inflow=5.23 cfs 2.168 af
18.0" Round Culvert n=0.013 L=61.5' S=0.0133 '/' Outflow=5.23 cfs 2.168 af

Pond P-1: MH B3 to MH B1 Peak Elev=222.69' Inflow=0.39 cfs 0.127 af
12.0" Round Culvert n=0.013 L=222.0' S=0.0339 '/' Outflow=0.39 cfs 0.127 af

Pond P-2: MH P1 TO MH B3 Peak Elev=229.33' Inflow=0.39 cfs 0.127 af
12.0" Round Culvert n=0.013 L=116.7' S=0.0552 '/' Outflow=0.39 cfs 0.127 af

Pond PF-P: Perk Filter Payne Peak Elev=229.47' Inflow=0.39 cfs 0.127 af
10.0" Round Culvert n=0.013 L=9.0' S=0.0056 '/' Outflow=0.39 cfs 0.127 af

Pond PF14: Perk Filter 14 to MH A2 Peak Elev=213.63' Inflow=1.05 cfs 0.356 af
8.0" Round Culvert n=0.013 L=10.0' S=0.0080 '/' Outflow=1.05 cfs 0.356 af

Pond PF15: PF-15 Pittock Pl. Peak Elev=202.69' Inflow=0.67 cfs 0.223 af
10.0" Round Culvert n=0.013 L=1.0' S=0.0500 '/' Outflow=0.67 cfs 0.223 af

Pond PF16: Perk Filter #16 Peak Elev=196.19' Inflow=0.60 cfs 0.202 af
8.0" Round Culvert n=0.013 L=9.5' S=0.7137 '/' Outflow=0.60 cfs 0.202 af

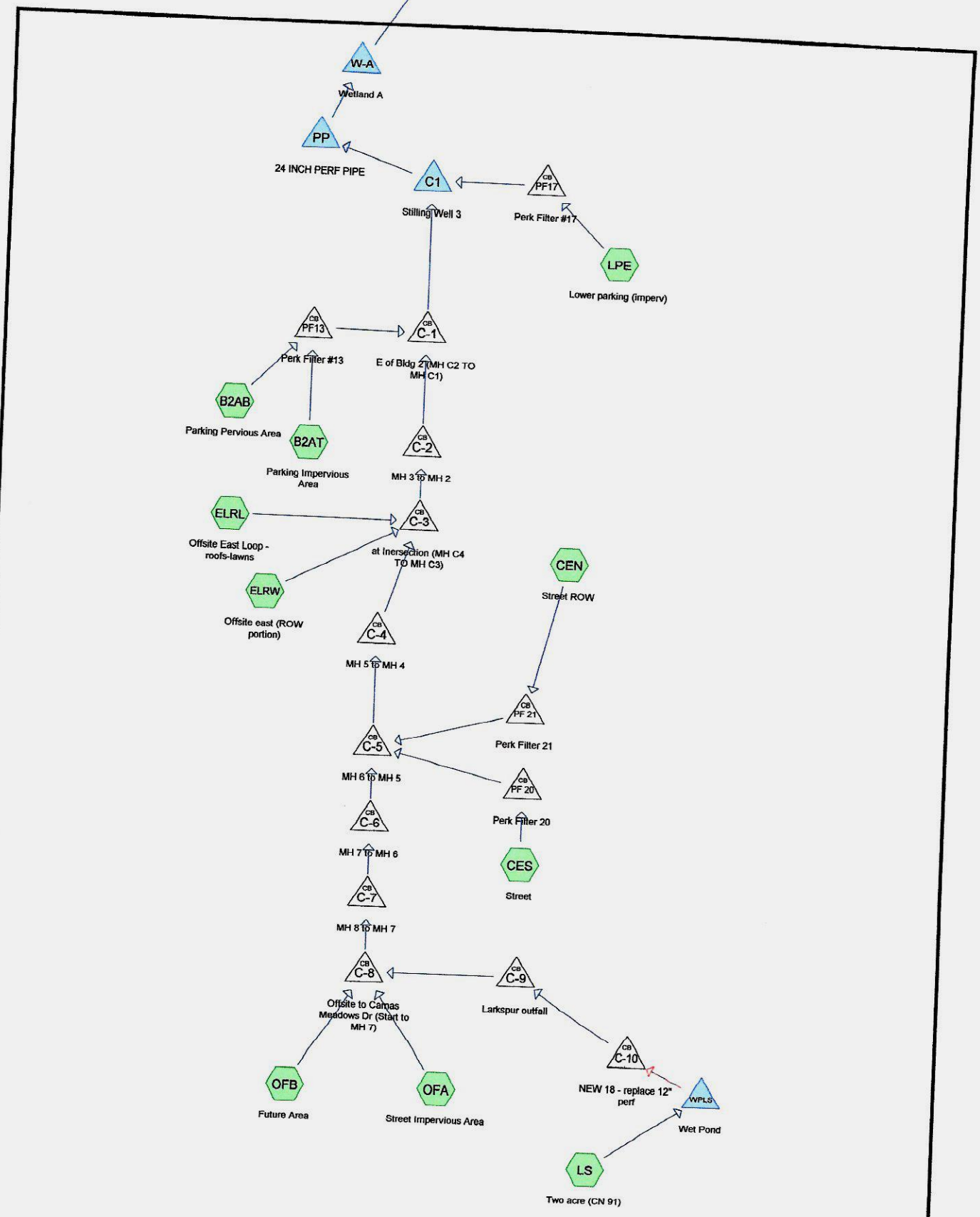
Pond PF18: Perk Filter 18 Peak Elev=218.42' Inflow=0.73 cfs 0.264 af
10.0" Round Culvert n=0.013 L=28.0' S=0.0339 '/' Outflow=0.73 cfs 0.264 af

Pond PF19: Perk Filter 19 Peak Elev=218.39' Inflow=0.56 cfs 0.202 af
10.0" Round Culvert n=0.013 L=28.0' S=0.0339 '/' Outflow=0.56 cfs 0.202 af

Pond PP: 24 INCH PERF PIPE Peak Elev=192.99' Storage=0.010 af Inflow=42.00 cfs 16.805 af
Outflow=41.97 cfs 16.805 af

Pond SW2: A1B Peak Elev=193.30' Storage=235 cf Inflow=8.46 cfs 3.188 af
24.0" Round Culvert n=0.013 L=2.0' S=0.0000 '/' Outflow=8.46 cfs 3.184 af

Pond W-A: Wetland A Peak Elev=188.18' Storage=1.500 af Inflow=72.99 cfs 30.244 af
Outflow=65.90 cfs 30.244 af


W-A
Wetland A
PP
24 INCH PERF PIPE
C1
Stilling Well 3
CB PF17
Perk Filter #17
LPE
Lower parking (imperv)
CB PF13
Perk Filter #13
CB C-1
E of Bldg 2 (MH C2 TO MH C1)
B2AB
Parking Pervious Area
B2AT
Parking Impervious Area
CB C-2
MH 3 to MH 2
ELRL
Offsite East Loop - roofs-lawns
CB C-3
at Inersection (MH C4 TO MH C3)
ELRW
Offsite east (ROW portion)
CB C-4
MH 5 to MH 4
CEN
Street ROW
CB PF 21
Perk Filter 21
CB C-5
MH 6 to MH 5
CB PF 20
Perk Filter 20
CB C-6
MH 7 to MH 6
CES
Street
CB C-7
MH 8 to MH 7
CB C-8
CB C-9
Offsite to Camas Meadows Dr (Start to MH 7)
Larkspur outfall
CB C-10
NEW 18 - replace 12" perf
WPLS
Wet Pond
OFB
Future Area
OFA
Street Impervious Area
LS
Two acre (CN 91)
Subcat
Reach
Pond
Link
LINE C
Routing Diagram for Parklands Final 8-26-2016-100-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company, Printed 10/13/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Parklands Final 8-26-2016-100-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	C-1	200.80	189.00	158.5	0.0744	0.013	18.0	0.0	0.0
2	C-10	238.75	237.68	163.4	0.0065	0.013	18.0	0.0	0.0
3	C-2	219.88	201.00	134.0	0.1409	0.013	18.0	0.0	0.0
4	C-3	220.21	220.08	55.6	0.0023	0.013	30.0	0.0	0.0
5	C-4	220.90	220.41	96.4	0.0051	0.013	30.0	0.0	0.0
6	C-5	221.74	221.10	118.1	0.0054	0.013	30.0	0.0	0.0
7	C-6	224.52	221.94	149.8	0.0172	0.013	30.0	0.0	0.0
8	C-7	228.59	224.72	166.3	0.0233	0.013	24.0	0.0	0.0
9	C-8	237.25	228.79	200.0	0.0423	0.013	24.0	0.0	0.0
10	C-9	237.68	237.25	121.7	0.0035	0.013	18.0	0.0	0.0
11	C1	192.00	192.00	2.0	0.0000	0.013	24.0	0.0	0.0
12	PF 20	225.19	224.01	21.8	0.0541	0.013	10.0	0.0	0.0
13	PF 21	226.02	223.99	21.8	0.0931	0.013	10.0	0.0	0.0
14	PF13	211.87	206.00	63.5	0.0924	0.013	8.0	0.0	0.0
15	PF17	199.05	190.22	16.4	0.5384	0.013	8.0	0.0	0.0
16	WPLS	239.08	238.92	112.6	0.0014	0.013	12.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment B2AB: Parking Pervious Area Runoff Area=4,369 sf 0.00% Impervious Runoff Depth=3.25"
Tc=10.0 min CN=81.0/0.0 Runoff=0.08 cfs 0.027 af

Subcatchment B2AT: Parking Impervious Runoff Area=21,016 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.60 cfs 0.204 af

Subcatchment CEN: Street ROW Runoff Area=27,594 sf 81.52% Impervious Runoff Depth=4.71"
Tc=11.0 min CN=80.0/98.0 Runoff=0.69 cfs 0.249 af

Subcatchment CES: Street Runoff Area=26,070 sf 72.87% Impervious Runoff Depth=4.55"
Tc=11.0 min CN=80.0/98.0 Runoff=0.63 cfs 0.227 af

Subcatchment ELRL: Offsite East Loop - Runoff Area=118,219 sf 0.00% Impervious Runoff Depth=3.45"
Tc=25.0 min CN=83.0/0.0 Runoff=1.78 cfs 0.780 af

Subcatchment ELRW: Offsite east (ROW Runoff Area=57,368 sf 73.29% Impervious Runoff Depth=4.55"
Tc=10.0 min CN=80.0/98.0 Runoff=1.41 cfs 0.500 af

Subcatchment LPE: Lower parking Runoff Area=20,949 sf 96.50% Impervious Runoff Depth=5.01"
Tc=5.0 min CN=83.0/98.0 Runoff=0.60 cfs 0.201 af

Subcatchment LS: Two acre (CN 91) Runoff Area=6.500 ac 50.15% Impervious Runoff Depth=4.41"
Tc=15.0 min CN=86.0/98.0 Runoff=6.38 cfs 2.387 af

Subcatchment OFA: Street Impervious Runoff Area=37,500 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=1.08 cfs 0.363 af

Subcatchment OFB: Future Area Runoff Area=602,064 sf 0.00% Impervious Runoff Depth=4.53"
Tc=10.0 min CN=93.3/0.0 Runoff=15.30 cfs 5.213 af

Pond C-1: E of Bldg 2 (MH C2 TO MH C1) Peak Elev=209.45' Inflow=23.92 cfs 10.043 af
18.0" Round Culvert n=0.013 L=158.5' S=0.0744 '/' Outflow=23.92 cfs 10.043 af

Pond C-10: NEW 18 - replace 12" perf Peak Elev=240.13' Inflow=3.26 cfs 2.481 af
18.0" Round Culvert n=0.013 L=163.4' S=0.0065 '/' Outflow=3.26 cfs 2.481 af

Pond C-2: MH 3 to MH 2 Peak Elev=228.10' Inflow=23.25 cfs 9.812 af
18.0" Round Culvert n=0.013 L=134.0' S=0.1409 '/' Outflow=23.25 cfs 9.812 af

Pond C-3: at Inersection (MH C4 TO MH C3) Peak Elev=229.06' Inflow=23.25 cfs 9.812 af
30.0" Round Culvert n=0.013 L=55.6' S=0.0023 '/' Outflow=23.25 cfs 9.812 af

Pond C-4: MH 5 to MH 4 Peak Elev=229.74' Inflow=20.10 cfs 8.533 af
30.0" Round Culvert n=0.013 L=96.4' S=0.0051 '/' Outflow=20.10 cfs 8.533 af

Pond C-5: MH 6 to MH 5 Peak Elev=230.38' Inflow=20.10 cfs 8.533 af
30.0" Round Culvert n=0.013 L=118.1' S=0.0054 '/' Outflow=20.10 cfs 8.533 af

Pond C-6: MH 7 to MH 6 Peak Elev=230.94' Inflow=18.78 cfs 8.057 af
30.0" Round Culvert n=0.013 L=149.8' S=0.0172 '/' Outflow=18.78 cfs 8.057 af

Pond C-7: MH 8 to MH 7 Peak Elev=232.64' Inflow=18.78 cfs 8.057 af
24.0" Round Culvert n=0.013 L=166.3' S=0.0233 '/' Outflow=18.78 cfs 8.057 af

Pond C-8: Offsite to Camas Meadows Dr (Start to MH 7) Peak Elev=239.79' Inflow=18.78 cfs 8.057 af
24.0" Round Culvert n=0.013 L=200.0' S=0.0423 '/' Outflow=18.78 cfs 8.057 af

Pond C-9: Larkspur outfall Peak Elev=239.90' Inflow=3.26 cfs 2.481 af
18.0" Round Culvert n=0.013 L=121.7' S=0.0035 '/' Outflow=3.26 cfs 2.481 af

Pond C1: Stilling Well 3 Peak Elev=194.07' Storage=0.006 af Inflow=24.51 cfs 10.243 af
24.0" Round Culvert x 2.00 n=0.013 L=2.0' S=0.0000 '/' Outflow=24.50 cfs 10.239 af

Pond PF 20: Perk Filter 20 Peak Elev=230.43' Inflow=0.63 cfs 0.227 af
10.0" Round Culvert n=0.013 L=21.8' S=0.0541 '/' Outflow=0.63 cfs 0.227 af

Pond PF 21: Perk Filter 21 Peak Elev=230.44' Inflow=0.69 cfs 0.249 af
10.0" Round Culvert n=0.013 L=21.8' S=0.0931 '/' Outflow=0.69 cfs 0.249 af

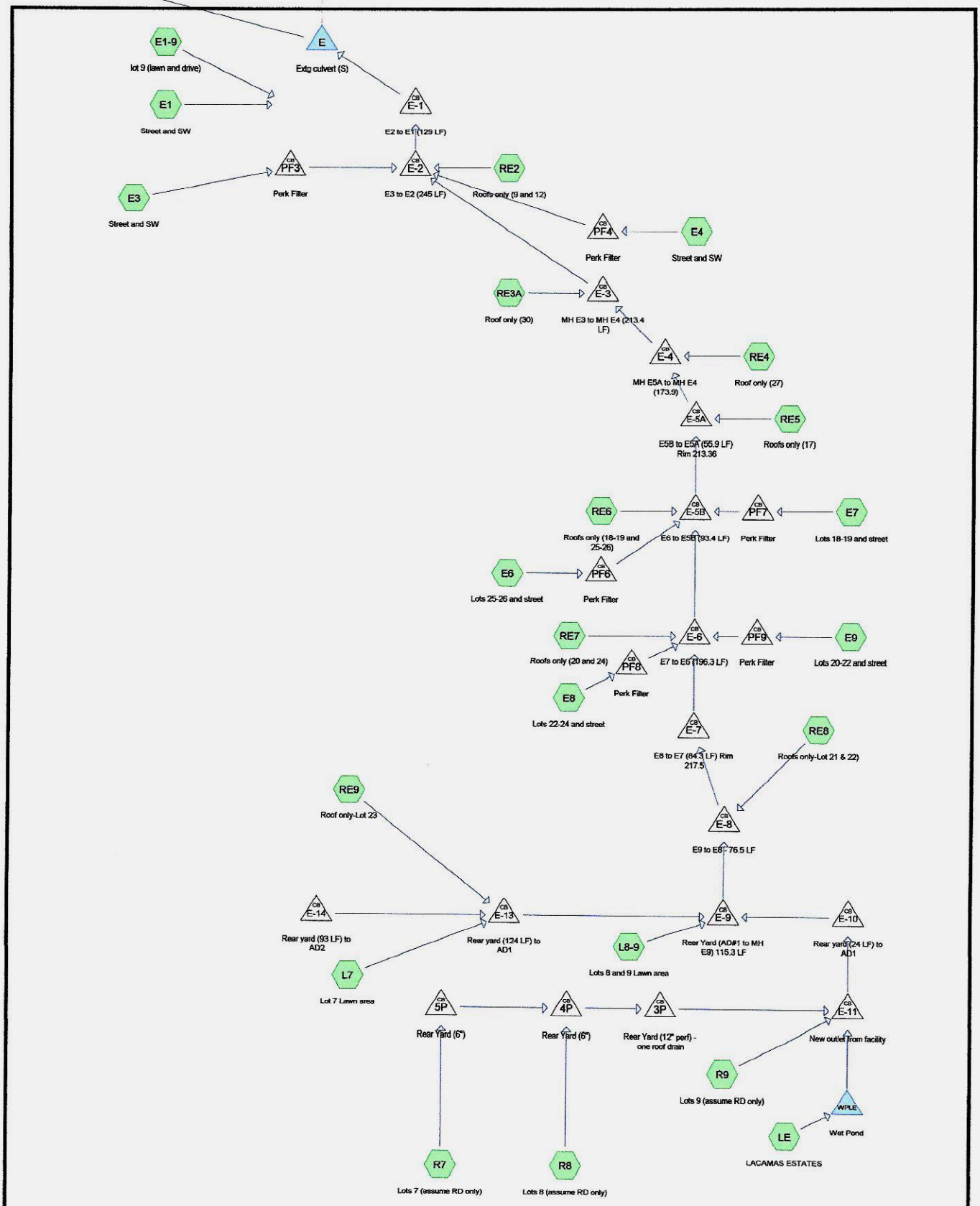
Pond PF13: Perk Filter #13 Peak Elev=212.37' Inflow=0.68 cfs 0.231 af
8.0" Round Culvert n=0.013 L=63.5' S=0.0924 '/' Outflow=0.68 cfs 0.231 af

Pond PF17: Perk Filter #17 Peak Elev=199.51' Inflow=0.60 cfs 0.201 af
8.0" Round Culvert n=0.013 L=16.4' S=0.5384 '/' Outflow=0.60 cfs 0.201 af

Pond PP: 24 INCH PERF PIPE Peak Elev=192.99' Storage=0.010 af Inflow=42.00 cfs 16.805 af
Outflow=41.97 cfs 16.805 af

Pond W-A: Wetland A Peak Elev=188.18' Storage=1.500 af Inflow=72.99 cfs 30.244 af
Outflow=65.90 cfs 30.244 af

Pond WPLS: Wet Pond Peak Elev=241.27' Storage=35,900 cf Inflow=6.38 cfs 2.387 af
Primary=3.26 cfs 2.481 af Secondary=0.00 cfs 0.000 af Outflow=3.26 cfs 2.481 af


E
E1-9
lot 9 (lawn and drive)
Extg culvert (S)
E1
Street and SW
E-1
E2 to E1 (129 LF)
PF3
Perk Filter
E-2
RE2
Roofs only (9 and 12)
E3
Street and SW
E3 to E2 (245 LF)
PF4
Perk Filter
E4
Street and SW
RE3A
Roof only (30)
E-3
MH E3 to MH E4 (213.4 LF)
E-4
RE4
Roof only (27)
MH E5A to MH E4 (173.9)
E-5A
RE5
Roofs only (17)
E5B to E5A (55.9 LF) Rim 213.36
RE6
Roofs only (18-19 and 25-26)
E-5B
PF7
E7
Lots 18-19 and street
E6 to E5B (93.4 LF)
Perk Filter
E6
Lots 25-26 and street
PF6
Perk Filter
RE7
Roofs only (20 and 24)
E-6
PF9
E9
Lots 20-22 and street
E7 to E6 (196.3 LF)
Perk Filter
PF8
Perk Filter
E8
Lots 22-24 and street
E-7
RE8
Roofs only-Lot 21 & 22)
E8 to E7 (84.3 LF) Rim 217.5
RE9
Roof only-Lot 23
E-8
E9 to E8 - 76.5 LF
E-14
E-13
E-9
E-10
Rear yard (93 LF) to AD2
Rear yard (124 LF) to AD1
L8-9
Lots 8 and 9 Lawn area
Rear Yard (AD#1 to MH E9) 115.3 LF
Rear yard (24 LF) to AD1
L7
Lot 7 Lawn area
5P
4P
3P
E-11
Rear Yard (6")
Rear Yard (6")
Rear Yard (12" perf) - one roof drain
New outlet from facility
R9
Lots 9 (assume RD only)
WPLE
Wet Pond
LE
LACAMAS ESTATES
R7
Lots 7 (assume RD only)
R8
Lots 8 (assume RD only)
Subcat
Reach
Pond
Link
LINE E
Routing Diagram for Parklands Final 8-26-2016-100-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company, Printed 10/13/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	3P	218.62	218.61	70.0	0.0001	0.013	12.0	0.0	0.0
2	4P	218.62	218.61	15.0	0.0007	0.013	6.0	0.0	0.0
3	5P	218.62	218.61	15.0	0.0007	0.013	6.0	0.0	0.0
4	E	187.47	187.47	30.0	0.0000	0.013	24.0	0.0	0.0
5	E	187.98	186.06	43.0	0.0447	0.013	24.0	0.0	0.0
6	E-1	190.00	187.98	129.1	0.0156	0.013	18.0	0.0	0.0
7	E-10	216.00	215.85	25.0	0.0060	0.013	15.0	0.0	0.0
8	E-11	218.62	217.00	14.0	0.1157	0.013	12.0	0.0	0.0
9	E-13	216.00	215.50	124.0	0.0040	0.013	12.0	0.0	0.0
10	E-14	226.00	216.00	94.8	0.1055	0.013	12.0	0.0	0.0
11	E-2	198.09	190.20	244.9	0.0322	0.013	18.0	0.0	0.0
12	E-3	205.00	198.29	213.4	0.0314	0.013	18.0	0.0	0.0
13	E-4	207.90	205.20	173.9	0.0155	0.013	18.0	0.0	0.0
14	E-5A	208.80	208.10	55.9	0.0125	0.013	18.0	0.0	0.0
15	E-5B	210.15	209.00	93.4	0.0123	0.013	18.0	0.0	0.0
16	E-6	212.15	210.35	196.3	0.0092	0.013	15.0	0.0	0.0
17	E-7	213.00	212.35	84.3	0.0077	0.013	15.0	0.0	0.0
18	E-8	214.00	213.00	76.5	0.0131	0.013	15.0	0.0	0.0
19	E-9	215.50	214.00	115.3	0.0130	0.013	15.0	0.0	0.0
20	PF3	199.47	199.40	15.0	0.0047	0.013	8.0	0.0	0.0
21	PF4	198.38	198.33	10.0	0.0050	0.013	8.0	0.0	0.0
22	PF6	210.21	210.15	12.0	0.0050	0.013	8.0	0.0	0.0
23	PF7	210.21	210.15	10.0	0.0060	0.013	8.0	0.0	0.0
24	PF8	212.21	212.15	12.0	0.0050	0.013	8.0	0.0	0.0
25	PF9	212.21	212.15	10.0	0.0060	0.013	8.0	0.0	0.0
26	WPLE	222.68	222.53	6.5	0.0231	0.013	12.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment E1: Street and SW Runoff Area=6,391 sf 91.72% Impervious Runoff Depth=4.90"
Tc=5.0 min CN=80.0/98.0 Runoff=0.18 cfs 0.060 af

Subcatchment E1-9: lot 9 (lawn and drive) Runoff Area=8,576 sf 11.66% Impervious Runoff Depth=3.64"
Tc=10.0 min CN=83.0/98.0 Runoff=0.17 cfs 0.060 af

Subcatchment E3: Street and SW Runoff Area=14,647 sf 87.33% Impervious Runoff Depth=4.82"
Tc=5.0 min CN=80.0/98.0 Runoff=0.40 cfs 0.135 af

Subcatchment E4: Street and SW Runoff Area=23,546 sf 58.09% Impervious Runoff Depth=4.26"
Tc=5.0 min CN=80.0/98.0 Runoff=0.57 cfs 0.192 af

Subcatchment E6: Lots 25-26 and street Runoff Area=22,191 sf 28.21% Impervious Runoff Depth=4.10"
Tc=15.0 min CN=85.8/98.0 Runoff=0.47 cfs 0.174 af

Subcatchment E7: Lots 18-19 and street Runoff Area=22,129 sf 28.29% Impervious Runoff Depth=4.11"
Tc=15.0 min CN=85.8/98.0 Runoff=0.47 cfs 0.174 af

Subcatchment E8: Lots 22-24 and street Runoff Area=24,137 sf 22.82% Impervious Runoff Depth=4.04"
Tc=15.0 min CN=85.9/98.0 Runoff=0.50 cfs 0.187 af

Subcatchment E9: Lots 20-22 and street Runoff Area=24,137 sf 22.82% Impervious Runoff Depth=4.04"
Tc=15.0 min CN=85.9/98.0 Runoff=0.50 cfs 0.187 af

Subcatchment L7: Lot 7 Lawn area Runoff Area=0.137 ac 0.00% Impervious Runoff Depth=3.75"
Tc=15.0 min CN=86.0/0.0 Runoff=0.12 cfs 0.043 af

Subcatchment L8-9: Lots 8 and 9 Lawn area Runoff Area=0.273 ac 0.00% Impervious Runoff Depth=3.75"
Tc=15.0 min CN=86.0/0.0 Runoff=0.23 cfs 0.085 af

Subcatchment LE: LACAMAS ESTATES Runoff Area=6.590 ac 67.37% Impervious Runoff Depth=4.63"
Tc=15.0 min CN=86.0/98.0 Runoff=6.77 cfs 2.545 af

Subcatchment R7: Lots 7 (assume RD Runoff Area=0.103 ac 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.13 cfs 0.043 af

Subcatchment R8: Lots 8 (assume RD Runoff Area=0.103 ac 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.13 cfs 0.043 af

Subcatchment R9: Lots 9 (assume RD Runoff Area=0.103 ac 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.13 cfs 0.043 af

Subcatchment RE2: Roofs only (9 and 12) Runoff Area=13,000 sf 100.00% Impervious Runoff Depth=5.06"
Tc=10.0 min CN=0.0/98.0 Runoff=0.35 cfs 0.126 af

Subcatchment RE3A: Roof only (30) Runoff Area=6,500 sf 100.00% Impervious Runoff Depth=5.06"
Tc=10.0 min CN=0.0/98.0 Runoff=0.18 cfs 0.063 af

Subcatchment RE4: Roof only (27) Runoff Area=6,500 sf 100.00% Impervious Runoff Depth=5.06"
Tc=10.0 min CN=0.0/98.0 Runoff=0.18 cfs 0.063 af

Subcatchment RE5: Roofs only (17) Runoff Area=6,500 sf 100.00% Impervious Runoff Depth=5.06"
Tc=10.0 min CN=0.0/98.0 Runoff=0.18 cfs 0.063 af

Subcatchment RE6: Roofs only (18-19 Runoff Area=26,000 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.75 cfs 0.252 af

Subcatchment RE7: Roofs only (20 and Runoff Area=13,000 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.37 cfs 0.126 af

Subcatchment RE8: Roofs only-Lot 21 & Runoff Area=13,000 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.37 cfs 0.126 af

Subcatchment RE9: Roof only-Lot 23 Runoff Area=6,500 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.19 cfs 0.063 af

Pond 3P: Rear Yard (12" perf) - one roof drain Peak Elev=220.26' Inflow=0.26 cfs 0.087 af
12.0" Round Culvert n=0.013 L=70.0' S=0.0001 '/' Outflow=0.26 cfs 0.087 af

Pond 4P: Rear Yard (6") Peak Elev=220.28' Inflow=0.26 cfs 0.087 af
6.0" Round Culvert n=0.013 L=15.0' S=0.0007 '/' Outflow=0.26 cfs 0.087 af

Pond 5P: Rear Yard (6") Peak Elev=220.28' Inflow=0.13 cfs 0.043 af
6.0" Round Culvert n=0.013 L=15.0' S=0.0007 '/' Outflow=0.13 cfs 0.043 af

Pond E: Extg culvert (S) Peak Elev=189.33' Storage=41 cf Inflow=16.68 cfs 7.325 af
Primary=9.56 cfs 5.204 af Secondary=7.13 cfs 2.121 af Outflow=16.67 cfs 7.325 af

Pond E-1: E2 to E1 (129 LF) Peak Elev=194.60' Inflow=16.33 cfs 7.160 af
18.0" Round Culvert n=0.013 L=129.1' S=0.0156 '/' Outflow=16.33 cfs 7.160 af

Pond E-10: Rear yard (24 LF) to AD1 Peak Elev=217.29' Inflow=4.04 cfs 2.673 af
15.0" Round Culvert n=0.013 L=25.0' S=0.0060 '/' Outflow=4.04 cfs 2.673 af

Pond E-11: New outlet from facility Peak Elev=220.26' Inflow=4.04 cfs 2.673 af
12.0" Round Culvert n=0.013 L=14.0' S=0.1157 '/' Outflow=4.04 cfs 2.673 af

Pond E-13: Rear yard (124 LF) to AD1 Peak Elev=216.68' Inflow=0.30 cfs 0.106 af
12.0" Round Culvert n=0.013 L=124.0' S=0.0040 '/' Outflow=0.30 cfs 0.106 af

Pond E-14: Rear yard (93 LF) to AD2 Peak Elev=0.00'
12.0" Round Culvert n=0.013 L=94.8' S=0.1055 '/' Primary=0.00 cfs 0.000 af

Pond E-2: E3 to E2 (245 LF) Peak Elev=202.52' Inflow=16.33 cfs 7.160 af
18.0" Round Culvert n=0.013 L=244.9' S=0.0322 '/' Outflow=16.33 cfs 7.160 af

Pond E-3: MH E3 to MH E4 (213.4 LF) Peak Elev=207.60' Inflow=11.57 cfs 5.471 af
18.0" Round Culvert n=0.013 L=213.4' S=0.0314 '/' Outflow=11.57 cfs 5.471 af

Pond E-4: MH E5A to MH E4 (173.9) Peak Elev=209.53' Inflow=7.97 cfs 4.215 af
18.0" Round Culvert n=0.013 L=173.9' S=0.0155 '/' Outflow=7.97 cfs 4.215 af

Pond E-5A: E5B to E5A (55.9 LF) Rim 213.36 Peak Elev=210.43' Inflow=7.79 cfs 4.152 af
18.0" Round Culvert n=0.013 L=55.9' S=0.0125 '/' Outflow=7.79 cfs 4.152 af

Pond E-5B: E6 to E5B (93.4 LF) Peak Elev=211.70' Inflow=7.61 cfs 4.089 af
18.0" Round Culvert n=0.013 L=93.4' S=0.0123 '/' Outflow=7.61 cfs 4.089 af

Pond E-6: E7 to E6 (196.3 LF) Peak Elev=213.79' Inflow=5.97 cfs 3.489 af
15.0" Round Culvert n=0.013 L=196.3' S=0.0092 '/' Outflow=5.97 cfs 3.489 af

Pond E-7: E8 to E7 (84.3 LF) Rim 217.5 Peak Elev=214.53' Inflow=4.62 cfs 2.990 af
15.0" Round Culvert n=0.013 L=84.3' S=0.0077 '/' Outflow=4.62 cfs 2.990 af

Pond E-8: E9 to E8 - 76.5 LF Peak Elev=215.35' Inflow=4.62 cfs 2.990 af
15.0" Round Culvert n=0.013 L=76.5' S=0.0131 '/' Outflow=4.62 cfs 2.990 af

Pond E-9: Rear Yard (AD#1 to MH E9) 115.3 LF Peak Elev=216.66' Inflow=4.37 cfs 2.864 af
15.0" Round Culvert n=0.013 L=115.3' S=0.0130 '/' Outflow=4.37 cfs 2.864 af

Pond PF3: Perk Filter Peak Elev=202.58' Inflow=0.40 cfs 0.135 af
8.0" Round Culvert n=0.013 L=15.0' S=0.0047 '/' Outflow=0.40 cfs 0.135 af

Pond PF4: Perk Filter Peak Elev=202.63' Inflow=0.57 cfs 0.192 af
8.0" Round Culvert n=0.013 L=10.0' S=0.0050 '/' Outflow=0.57 cfs 0.192 af

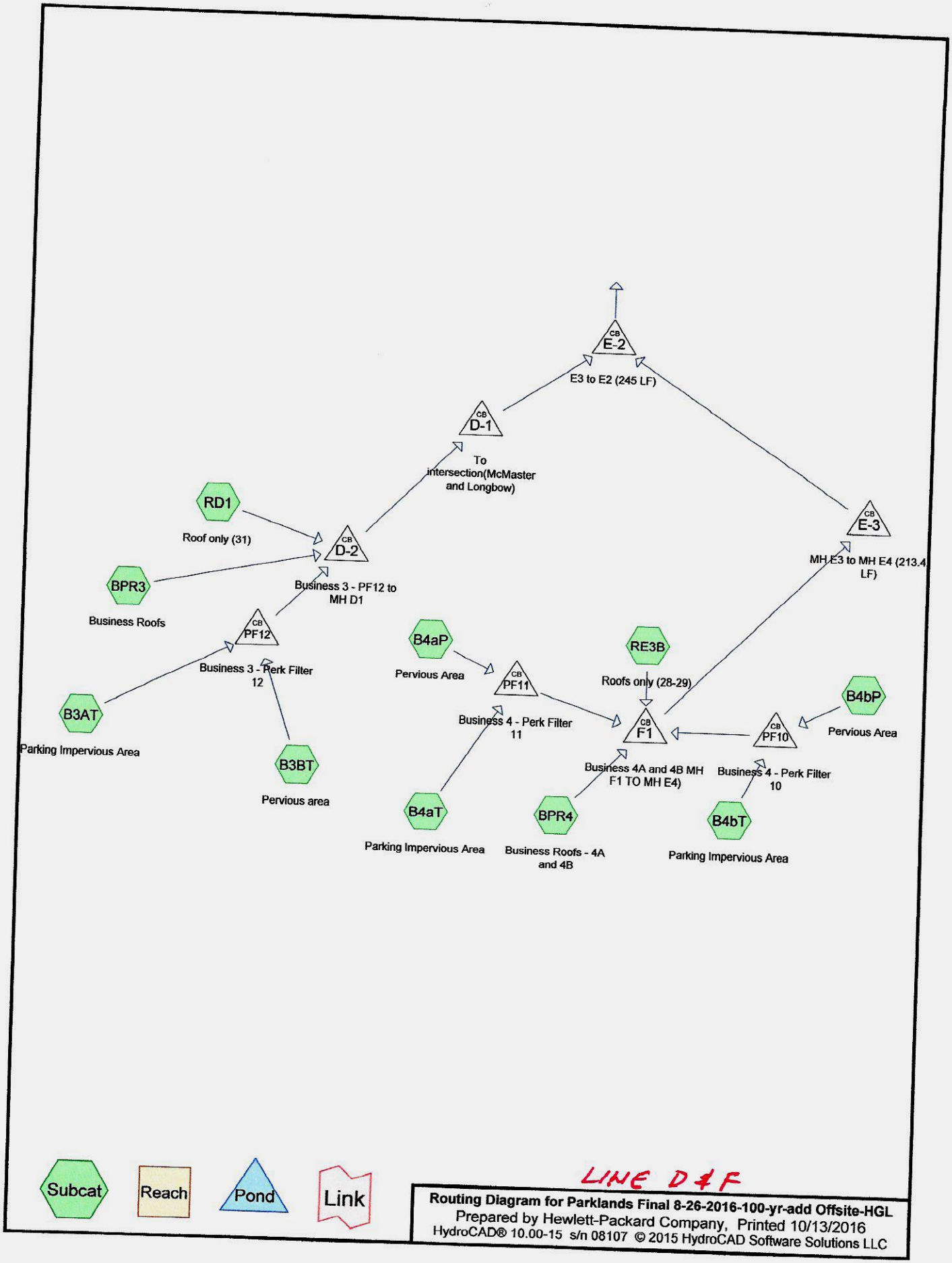
Pond PF6: Perk Filter Peak Elev=211.78' Inflow=0.47 cfs 0.174 af
8.0" Round Culvert n=0.013 L=12.0' S=0.0050 '/' Outflow=0.47 cfs 0.174 af

Pond PF7: Perk Filter Peak Elev=211.78' Inflow=0.47 cfs 0.174 af
8.0" Round Culvert n=0.013 L=10.0' S=0.0060 '/' Outflow=0.47 cfs 0.174 af

Pond PF8: Perk Filter Peak Elev=213.88' Inflow=0.50 cfs 0.187 af
8.0" Round Culvert n=0.013 L=12.0' S=0.0050 '/' Outflow=0.50 cfs 0.187 af

Pond PF9: Perk Filter Peak Elev=213.88' Inflow=0.50 cfs 0.187 af
8.0" Round Culvert n=0.013 L=10.0' S=0.0060 '/' Outflow=0.50 cfs 0.187 af

Pond WPLE: Wet Pond Peak Elev=224.88' Storage=41,208 cf Inflow=6.77 cfs 2.545 af
12.0" Round Culvert n=0.013 L=6.5' S=0.0231 '/' Outflow=3.89 cfs 2.543 af


CB E-2
E3 to E2 (245 LF)
CB D-1
To intersection(McMaster and Longbow)
RD1
Roof only (31)
CB D-2
CB E-3
MH E3 to MH E4 (213.4 LF)
BPR3
Business Roofs
Business 3 - PF12 to MH D1
CB PF12
Business 3 - Perk Filter 12
B3AT
Parking Impervious Area
B3BT
Pervious area
B4aP
Pervious Area
CB PF11
Business 4 - Perk Filter 11
RE3B
Roofs only (28-29)
CB F1
B4bP
Pervious Area
CB PF10
Business 4 - Perk Filter 10
Business 4A and 4B MH F1 TO MH E4)
B4aT
Parking Impervious Area
BPR4
Business Roofs - 4A and 4B
B4bT
Parking Impervious Area
Subcat
Reach
Pond
Link
LINE D & F
Routing Diagram for Parklands Final 8-26-2016-100-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company, Printed 10/13/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Parklands Final 8-26-2016-100-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	D-1	200.00	198.29	135.8	0.0126	0.013	12.0	0.0	0.0
2	D-2	215.79	200.64	138.0	0.1098	0.013	10.0	0.0	0.0
3	E-2	198.09	190.20	244.9	0.0322	0.013	18.0	0.0	0.0
4	E-3	205.00	198.29	213.4	0.0314	0.013	18.0	0.0	0.0
5	F1	215.45	205.29	180.7	0.0562	0.013	12.0	0.0	0.0
6	PF10	220.90	215.55	85.6	0.0625	0.013	10.0	0.0	0.0
7	PF11	220.68	215.55	125.6	0.0408	0.013	10.0	0.0	0.0
8	PF12	215.79	215.78	1.0	0.0100	0.013	10.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment B3AT: Parking Impervious Runoff Area=30,681 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.88 cfs 0.297 af

Subcatchment B3BT: Pervious area Runoff Area=9,998 sf 0.00% Impervious Runoff Depth=3.25"
Tc=5.0 min CN=81.0/0.0 Runoff=0.19 cfs 0.062 af

Subcatchment B4aP: Pervious Area Runoff Area=3,662 sf 0.00% Impervious Runoff Depth=3.25"
Tc=5.0 min CN=81.0/0.0 Runoff=0.07 cfs 0.023 af

Subcatchment B4aT: Parking Impervious Runoff Area=35,023 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=1.01 cfs 0.339 af

Subcatchment B4bP: Pervious Area Runoff Area=6,109 sf 0.00% Impervious Runoff Depth=3.25"
Tc=5.0 min CN=81.0/0.0 Runoff=0.11 cfs 0.038 af

Subcatchment B4bT: Parking Impervious Runoff Area=37,875 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=1.09 cfs 0.367 af

Subcatchment BPR3: Business Roofs Runoff Area=21,950 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.63 cfs 0.213 af

Subcatchment BPR4: Business Roofs - Runoff Area=31,000 sf 100.00% Impervious Runoff Depth=5.06"
Tc=5.0 min CN=0.0/98.0 Runoff=0.89 cfs 0.300 af

Subcatchment RD1: Roof only (31) Runoff Area=6,500 sf 100.00% Impervious Runoff Depth=5.06"
Tc=10.0 min CN=0.0/98.0 Runoff=0.18 cfs 0.063 af

Subcatchment RE3B: Roofs only (28-29) Runoff Area=13,000 sf 100.00% Impervious Runoff Depth=5.06"
Tc=10.0 min CN=0.0/98.0 Runoff=0.35 cfs 0.126 af

Pond D-1: To intersection(McMaster and Longbow) Peak Elev=203.00' Inflow=1.87 cfs 0.635 af
12.0" Round Culvert n=0.013 L=135.8' S=0.0126 '/' Outflow=1.87 cfs 0.635 af

Pond D-2: Business 3 - PF12 to MH D1 Peak Elev=216.72' Inflow=1.87 cfs 0.635 af
10.0" Round Culvert n=0.013 L=138.0' S=0.1098 '/' Outflow=1.87 cfs 0.635 af

Pond E-2: E3 to E2 (245 LF) Peak Elev=202.52' Inflow=16.33 cfs 7.160 af
18.0" Round Culvert n=0.013 L=244.9' S=0.0322 '/' Outflow=16.33 cfs 7.160 af

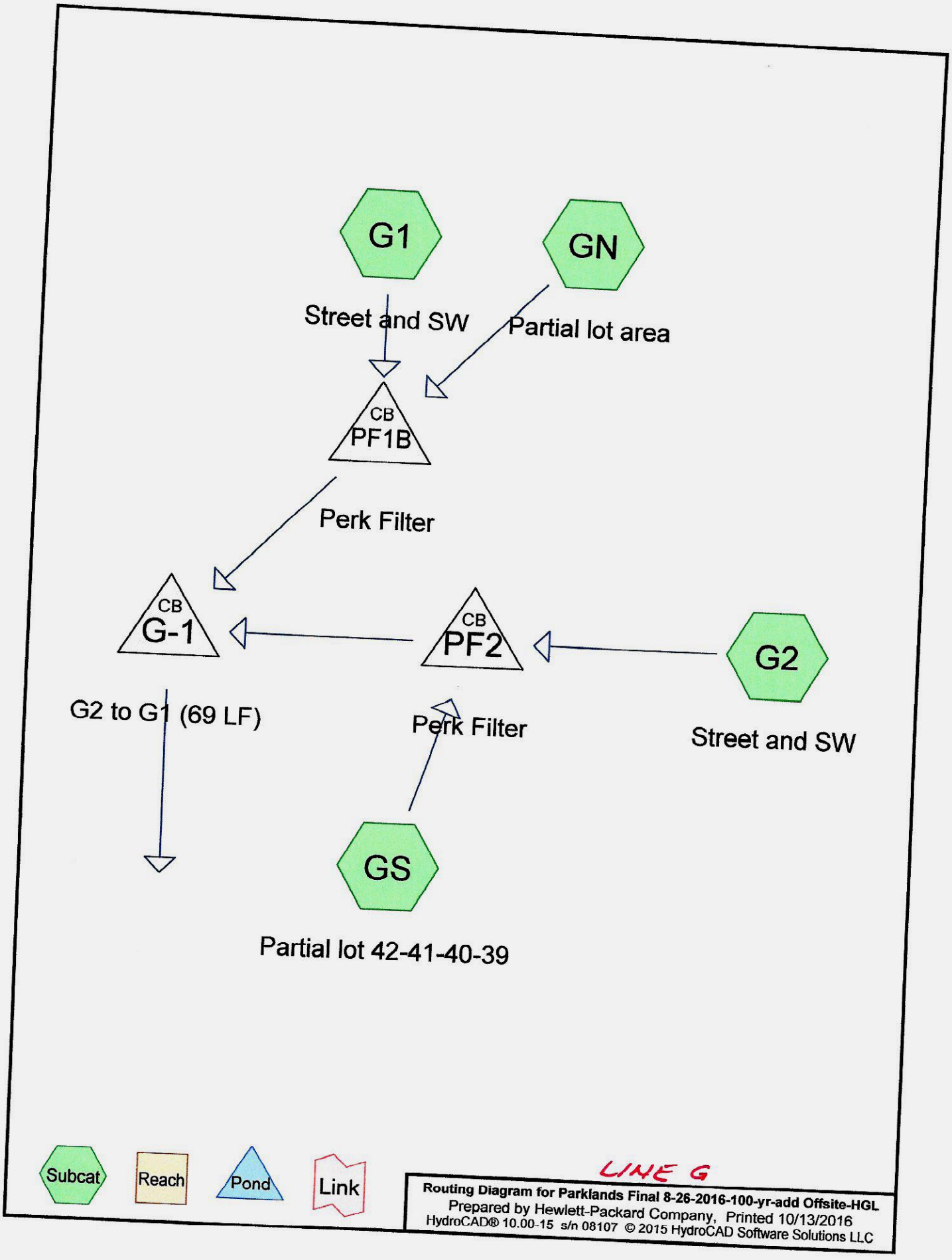
Pond E-3: MH E3 to MH E4 (213.4 LF) Peak Elev=207.60' Inflow=11.57 cfs 5.471 af
18.0" Round Culvert n=0.013 L=213.4' S=0.0314 '/' Outflow=11.57 cfs 5.471 af

Pond F1: Business 4A and 4B MH F1 TO MH E4) Peak Elev=216.82' Inflow=3.52 cfs 1.193 af
12.0" Round Culvert n=0.013 L=180.7' S=0.0562 '/' Outflow=3.52 cfs 1.193 af

Pond PF10: Business 4 - Perk Filter 10 Peak Elev=221.53' Inflow=1.20 cfs 0.405 af
10.0" Round Culvert n=0.013 L=85.6' S=0.0625 '/' Outflow=1.20 cfs 0.405 af

Pond PF11: Business 4 - Perk Filter 11 Peak Elev=221.27' Inflow=1.08 cfs 0.362 af
10.0" Round Culvert n=0.013 L=125.6' S=0.0408 '/' Outflow=1.08 cfs 0.362 af

Pond PF12: Business 3 - Perk Filter 12 Peak Elev=216.88' Inflow=1.07 cfs 0.359 af
10.0" Round Culvert n=0.013 L=1.0' S=0.0100 '/' Outflow=1.07 cfs 0.359 af


G1
GN
Street and SW
Partial lot area
CB
PF1B
Perk Filter
CB
G-1
CB
PF2
G2
G2 to G1 (69 LF)
Perk Filter
Street and SW
GS
Partial lot 42-41-40-39
Subcat
Reach
Pond
Link
LINE G
Routing Diagram for Parklands Final 8-26-2016-100-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company, Printed 10/13/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Parklands Final 8-26-2016-100-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	G-1	186.34	186.07	63.8	0.0042	0.011	12.0	0.0	0.0
2	PF1B	186.50	186.34	19.0	0.0084	0.013	6.0	0.0	0.0
3	PF2	186.41	186.34	18.0	0.0039	0.013	6.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment G1: Street and SW Runoff Area=19,098 sf 83.10% Impervious Runoff Depth=4.74"
Tc=5.0 min CN=80.0/98.0 Runoff=0.51 cfs 0.173 af

Subcatchment G2: Street and SW Runoff Area=13,561 sf 90.52% Impervious Runoff Depth=4.88"
Tc=5.0 min CN=80.0/98.0 Runoff=0.38 cfs 0.127 af

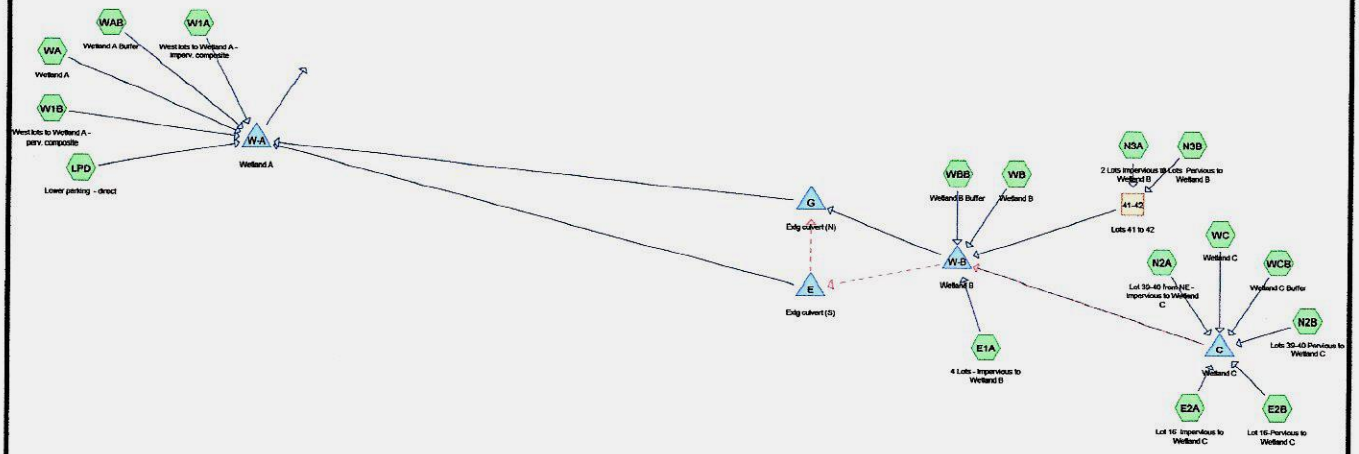
Subcatchment GN: Partial lot area Runoff Area=24,500 sf 26.53% Impervious Runoff Depth=3.88"
Tc=10.0 min CN=83.0/98.0 Runoff=0.52 cfs 0.182 af

Subcatchment GS: Partial lot 42-41-40-39 Runoff Area=18,500 sf 27.03% Impervious Runoff Depth=3.88"
Tc=10.0 min CN=83.0/98.0 Runoff=0.39 cfs 0.137 af

Pond G-1: G2 to G1 (69 LF) Peak Elev=188.91' Inflow=1.79 cfs 0.619 af
12.0" Round Culvert n=0.011 L=63.8' S=0.0042 '/' Outflow=1.79 cfs 0.619 af

Pond PF1B: Perk Filter Peak Elev=190.15' Inflow=1.02 cfs 0.355 af
6.0" Round Culvert n=0.013 L=19.0' S=0.0084 '/' Outflow=1.02 cfs 0.355 af

Pond PF2: Perk Filter Peak Elev=189.57' Inflow=0.76 cfs 0.264 af
6.0" Round Culvert n=0.013 L=18.0' S=0.0039 '/' Outflow=0.76 cfs 0.264 af



Subcat Reach Pond Link

THRU WETLANDS

Routing Diagram for Parklands Final 8-26-2016-100-yr-add Offsite-HGL
Prepared by Hewlett-Packard Company, Printed 10/13/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
10.950	81.0	Brush (WA, WAB, WB, WBB, WC, WCB)
0.046	83.0	Drives across lawns (2 lots) - ammended (W1A)
0.138	83.0	Drives across lawns (6 lots) - ammended (W1A)
0.149	83.0	Impervious (1 at 6500) - unconnected (E2A)
0.149	98.0	Impervious (39) roof area (N2A)
0.597	83.0	Impervious (4 at 6500) - unconnected (E1A)
0.149	98.0	Impervious (40) roof area (N2A)
0.149	98.0	Impervious (41) (N3A)
0.149	98.0	Impervious (42) (N3A)
0.444	83.0	Pervious (2 lots) - ammended (W1B)
0.143	83.0	Pervious (39) ammended soil (N2B)
0.168	83.0	Pervious (40) ammended soil (N2B)
0.106	83.0	Pervious (41) ammended soils (N3B)
0.112	83.0	Pervious (42) ammended soils (N3B)
1.317	83.0	Pervious (7 lots) - ammended (W1B)
0.190	83.0	Pervious composite for unconnected (E2B)
0.298	98.0	Roofs (2 lots) (W1A)
0.746	98.0	Roofs (5 lots) (W1A)
0.268	81.0	ammended (LPD)
0.023	83.0	drive - composite CN (E2A)
0.092	83.0	drives (4 at 1000) - composite CN (E1A)

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	C	190.64	190.18	14.3	0.0322	0.013	12.0	0.0	0.0
2	C	190.73	190.30	14.5	0.0297	0.013	12.0	0.0	0.0
3	E	187.47	187.47	30.0	0.0000	0.013	24.0	0.0	0.0
4	E	187.98	186.06	43.0	0.0447	0.013	24.0	0.0	0.0
5	G	186.06	186.06	15.0	0.0000	0.013	24.0	0.0	0.0
6	W-B	188.20	187.98	13.0	0.0169	0.013	12.0	0.0	0.0
7	W-B	186.06	186.06	20.0	0.0000	0.013	12.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment E1A: 4 Lots - Impervious to Runoff Area=30,000 sf 0.00% Impervious Runoff Depth=3.45"
Tc=20.0 min CN=83.0/0.0 Runoff=0.49 cfs 0.198 af

Subcatchment E2A: Lot 16 Impervious to Runoff Area=7,500 sf 0.00% Impervious Runoff Depth=3.45"
Tc=20.0 min CN=83.0/0.0 Runoff=0.12 cfs 0.049 af

Subcatchment E2B: Lot 16-Pervious to Runoff Area=8,298 sf 0.00% Impervious Runoff Depth=3.45"
Tc=20.0 min CN=83.0/0.0 Runoff=0.13 cfs 0.055 af

Subcatchment LPD: Lower parking - direct Runoff Area=11,678 sf 0.00% Impervious Runoff Depth=3.25"
Tc=15.0 min CN=81.0/0.0 Runoff=0.19 cfs 0.073 af

Subcatchment N2A: Lot 39-40 from NE - Runoff Area=13,000 sf 100.00% Impervious Runoff Depth=5.06"
Tc=20.0 min CN=0.0/98.0 Runoff=0.31 cfs 0.126 af

Subcatchment N2B: Lots 39-40 Pervious to Runoff Area=13,564 sf 0.00% Impervious Runoff Depth=3.45"
Tc=20.0 min CN=83.0/0.0 Runoff=0.22 cfs 0.089 af

Subcatchment N3A: 2 Lots Impervious to Runoff Area=13,000 sf 100.00% Impervious Runoff Depth=5.06"
Tc=20.0 min CN=0.0/98.0 Runoff=0.31 cfs 0.126 af

Subcatchment N3B: 2 Lots Pervious to Runoff Area=9,500 sf 0.00% Impervious Runoff Depth=3.45"
Tc=20.0 min CN=83.0/0.0 Runoff=0.15 cfs 0.063 af

Subcatchment W1A: West lots to Wetland Runoff Area=53,500 sf 85.05% Impervious Runoff Depth=4.82"
Tc=20.0 min CN=83.0/98.0 Runoff=1.22 cfs 0.493 af

Subcatchment W1B: West lots to Wetland A Runoff Area=76,699 sf 0.00% Impervious Runoff Depth=3.45"
Tc=20.0 min CN=83.0/0.0 Runoff=1.25 cfs 0.506 af

Subcatchment WA: Wetland A Runoff Area=5.970 ac 0.00% Impervious Runoff Depth=3.25"
Tc=10.0 min CN=81.0/0.0 Runoff=4.57 cfs 1.618 af

Subcatchment WAB: Wetland A Buffer Runoff Area=2.000 ac 0.00% Impervious Runoff Depth=3.25"
Tc=10.0 min CN=81.0/0.0 Runoff=1.53 cfs 0.542 af

Subcatchment WB: Wetland B Runoff Area=1.370 ac 0.00% Impervious Runoff Depth=3.25"
Tc=10.0 min CN=81.0/0.0 Runoff=1.05 cfs 0.371 af

Subcatchment WBB: Wetland B Buffer Runoff Area=55,339 sf 0.00% Impervious Runoff Depth=3.25"
Tc=10.0 min CN=81.0/0.0 Runoff=0.97 cfs 0.344 af

Subcatchment WC: Wetland C Runoff Area=5,218 sf 0.00% Impervious Runoff Depth=3.25"
Tc=10.0 min CN=81.0/0.0 Runoff=0.09 cfs 0.032 af

Subcatchment WCB: Wetland C Buffer Runoff Area=9,573 sf 0.00% Impervious Runoff Depth=3.25"
Tc=10.0 min CN=81.0/0.0 Runoff=0.17 cfs 0.060 af

Reach 41-42: Lots 41 to 42 Inflow=0.46 cfs 0.189 af
Outflow=0.46 cfs 0.189 af

Pond C: Wetland C Peak Elev=191.32' Storage=0 cf Inflow=1.05 cfs 0.412 af
Primary=0.58 cfs 0.230 af Secondary=0.46 cfs 0.182 af Outflow=1.05 cfs 0.412 af

Pond E: Extg culvert (S) Peak Elev=189.33' Storage=41 cf Inflow=16.68 cfs 7.325 af
Primary=9.56 cfs 5.204 af Secondary=7.13 cfs 2.121 af Outflow=16.67 cfs 7.325 af

Pond G: Extg culvert (N) Peak Elev=188.72' Storage=47 cf Inflow=11.37 cfs 4.439 af
24.0" Round Culvert n=0.013 L=15.0' S=0.0000 '/' Outflow=11.37 cfs 4.438 af

Pond W-A: Wetland A Peak Elev=188.18' Storage=1.500 af Inflow=72.99 cfs 30.244 af
Outflow=65.90 cfs 30.244 af

Pond W-B: Wetland B Peak Elev=189.26' Storage=0.143 af Inflow=4.63 cfs 1.765 af
Primary=3.13 cfs 1.698 af Secondary=1.27 cfs 0.045 af Outflow=4.40 cfs 1.744 af

APPENDIX C3 WATER QUALITY
C-3a PHOSPHORUS LOADING ANALYSIS
DETERMINE PERCENT PHOSPHORUS REMOVAL BASED ON AREAS

SUMMARY OF CONTRIBUTING AREAS - SEE APPENDIX D SUBBASIN AREAS				
Contributing Area Description	**Treatment Condition**	**Area (ac)**	**Area/Total Area (ratio)**	**Percent**
Lawn and drives to buffer	No Perk Filter	4.527	0.1592	15.92%
Roofs to storm	No Perk Filter	3.753	0.1320	13.20%
Roofs to buffer	No Perk Filter	4.277	0.1504	15.04%
Treated Area	to Perk Filter	15.881	0.5584	55.84%
	Total for Site*	28.438		100.0%

*includes Camas Meadows Dr. and portion of Payne Rd.

Assume buffers/wetlands will remove 40% Phosphorous Pollutant Load - Evalaute 3 Scenarios

Scenario #1: Determine Percent Removal For Site Runoff - portion to Perk Filters and to buffer

Perk Filter	15.881	62.4% per TAPE		15.881*.624	9.91
No Perk Filter	4.527	**Lawn and drives to buffer**	assume average 40%	4.760*.40	1.81
Area of concern	20.408	All Roofs assumed "clean"			11.72
			percent removal	11.72/20.408	57.4%
					exceeds 50%

Scenario #2: Determine Percent Removal For Site Runoff - portion to Perk Filters and to buffer

Perk Filter	15.881	62.4% per TAPE		15.881*.624	9.91
No Perk Filter	8.804	**Lawn,drives, roofs to buffer**	assume average 40%	8.804*.40	3.52
	24.685	Roofs to storm assumed "clean" at 3.753 ac.			13.43
			percent removal	13.43/24.685	54.4%
					exceeds 50%

Scenario #3: Determine Percent Removal For Site Runoff - portion to Perk Filters and to buffer

Perk Filter	15.881	62.4% per TAPE		16.543*.624	9.91
No Perk Filter	12.557	**Lawn, roofs, and roofs to storm**	assume average 40%	11.027*.40	5.02
	28.438	include all areas			14.93
			percent removal	14.93/28.438	52.5%
					exceeds 50%

APPENDIX C3 WATER QUALITY
C-3a PHOSPHORUS LOADING ANALYSIS
DETERMINE PERCENT PHOSPHORUS REMOVAL BASED ON AREAS

SUMMARY OF CONTRIBUTING AREAS - SEE APPENDIX D SUBBASIN AREAS				
Contributing Area Description	**Treatment Condition**	**Area (ac)**	**Area/Total Area (ratio)**	**Percent**
Lawn and drives to buffer	No Perk Filter	4.527	0.1592	15.92%
Roofs to storm	No Perk Filter	3.753	0.1320	13.20%
Roofs to buffer	No Perk Filter	4.277	0.1504	15.04%
Treated Area	to Perk Filter	15.881	0.5584	55.84%
	Total for Site*	28.438		100.0%

*includes Camas Meadows Dr. and portion of Payne Rd.

Determine Minimum Percent Removal For Buffer to Satisfy 50% removal					
	Find for 50% removal - Scenario #1		by trial and error	10.204/20.408	50.0%
	4.527 + 15.881 = 20.408				
No Perk Filter	**4.527**	**Lawn and drives to buffer**	**6.5%**	4.527*0.065	0.294
and	15.881 + 4.277 + 3.753 = 23.911 acres considered "clean"			62.4 % portion	9.91
	All Roofs assumed "clean"				10.204
	Find for 50% removal - Scenario #2		by trial and error	12.3425/24.685	50.0%
	4.527 + 4.277 + 15.881 = 24.685		lowest level removal		
No Perk Filter	**8.804**		**27.63%**	8.804*.2763	2.4325
and	15.881 + 3.753 = 19.634 acres considered "clean"			62.4 % portion	9.91
	Roofs to storm assumed "clean", Roofs to buffers not assumed 'clean'				12.3422
	Find for 50% removal - Scenario #3		by trial and error	14.219/28.438	50.0%
	4.527 + 4.277 + 3.753 + 15.881 = 28.438		lowest level removal		
No Perk Filter	**12.557**		**34.3%**	12.557*.343	4.309
and	only 15.881 acres considered "clean"			62.4 % portion	9.91
					14.219

Notes:

1. The roof portion that goes directly to the storm system and not to the buffer is 2.835 Acres (McMaster, Longbow, and Pittock and the roof portion from the south building (business) at 0.71 acres. This total of 3.55 acres is released at the two culverts betv Wetland A and B. This amount of runoff is assumed to be treated in the natural wetland ponding area - about 3.37 acre surface area. The most direct flow path through the onsite wetland is about 550 LF and then passes over another 600 LF in a shallow flo path through mostly reed canary grass. Reed canary grass is considered an excellent treatment medium.

2. The roof areas from the other three business portions (1.03 acres) will be released to the storm system and then released fro the dissipation system to the buffer (304 ft spread for sheet flow).

APPENDIX C WATER QUALITY
C-3b PHOSPHORUS LOADING CALCULATIONS

Reference : Pennsylvania Stormwater Best Management Practices Manaual
Chapter 8, Worksheet 12 (attached)

PREDEVELOPMENT AREA AND POLLUTANT LOADING				
Pre	28.437	0.30	2.7	**23.03**

Note: 0.3 is factor for HSG C soil (silt loam, clay loam or silty clay loam)

Developed - Untreated Portion to Buffer or to Wetlands				
Source	**Surface Area (ac)**	**TP EMC (mg/l)**	**Unit Conversion Factor**	**Pollutant Load**
Lots 2-10 - roofs	1.045	0.13	2.7	0.367 LBS
Lots 11-15 - roofs	0.597	0.13	2.7	0.210 LBS
Lot 16 - roof	0.149	0.13	2.7	0.052 LBS
Lots 32-38 - roofs	1.067	0.13	2.7	0.375 LBS
Lots 39-40 - roofs	0.298	0.13	2.7	0.105 LBS
Lots 41-42 - roofs	0.298	0.13	2.7	0.105 LBS
Business - roofs	4.575	0.13	2.7	1.606 LBS
Lots 2-10 - lawn/drive	0.989	0.40	2.7	1.068 LBS
Lots 11-15 - lawn/drive	1.795	0.40	2.7	1.939 LBS
Lot 16 - lawn/drive	0.213	0.40	2.7	0.230 LBS
Lots 32-38 - lawn/drive	0.731	0.40	2.7	0.789 LBS
Lots 39-40 - lawn/drive	0.311	0.40	2.7	0.336 LBS
Lots 41-42 - lawn/drive	0.218	0.40	2.7	0.235 LBS
north of parking lot	0.27	0.40	2.7	0.292 LBS
	12.556			**7.707 LBS**

Source	**Surface Area (ac)**	**TP EMC (mg/l)**	**Unit Conversion Factor**	**Pollutant Load**	
CMD	2.763	0.33	2.7	2.462 LBS	treated
Pittock	0.585	0.36	2.7	0.569 LBS	treated
Business -east	2.832	0.39	2.7	2.982 LBS	treated
Business -west	2.890	0.39	2.7	3.043 LBS	treated
Lawn to streeet	3.652	0.40	2.7	3.944 LBS	treated
Streets - R/W	3.159	0.36	2.7	3.071 LBS	treated
	15.881			**16.070 LBS**	
				7.707 LBS	
Total Post-Development Load				**23.778 LBS**	

Total Area 28.437

APPENDIX C WATER QUALITY
C-3b PHOSPHORUS LOADING CALCULATIONS

DETERMINE POLLUTANT LOADING WITH TREATMENT ACCOUNTED FOR		
16.07 lbs treated at 62.4% = 9.91 lbs removed	6.160 lbs remain	
6.495 lbs treated at 45%* = 2.923 lbs removed	3.572 lbs remain	
Pollutant Load	9.73 LBS	OK
compare Pre loading	23.03 LBS	

Note that even witout treatment credit at buffer, 6.16 + 6.495 = 12.655 LBS
which is a 45% reduction from Pre loading. So buffere only needs to provide 5% redu

*Assume wetland buffer will treat 45% of phosphorus pollutant load
1. Literature search varies on removal percentages.
However, natural buffers are considered effective even for wastewater conditions.
2. Buffer widths for 0% to 8% slopes are generally listed n the 70 to 100 LF range.
The buffer width for this site is 50 LF. However, during the WQ event, the distance to ponded water in the wetland is more than 50 feet. See attachment with contour 188 for reference.

APPENDIX D CONVEYANCE SYSTEM
D-4 REAR YARD SYSTEMS

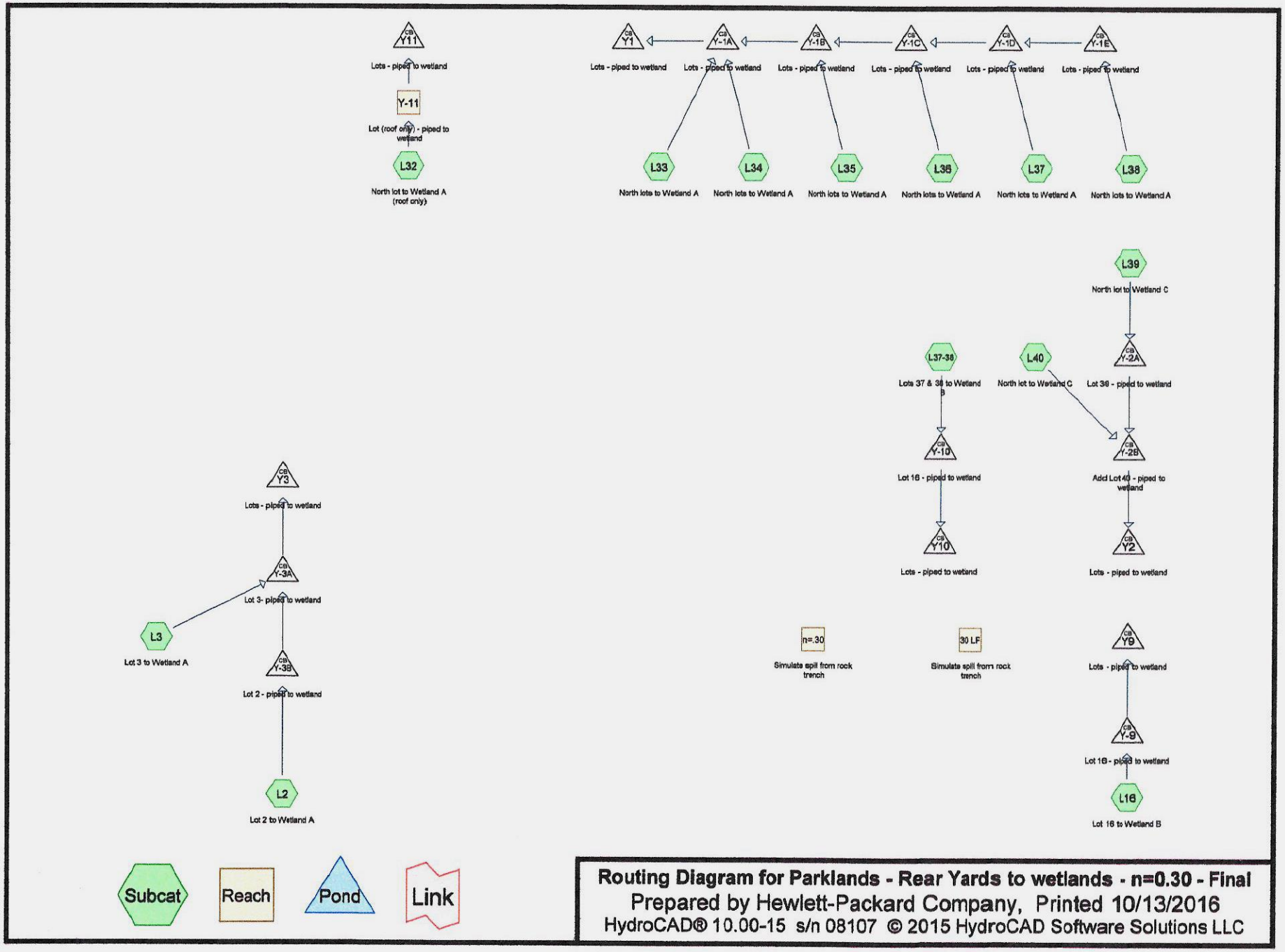
REAR YARD SYSTEMS

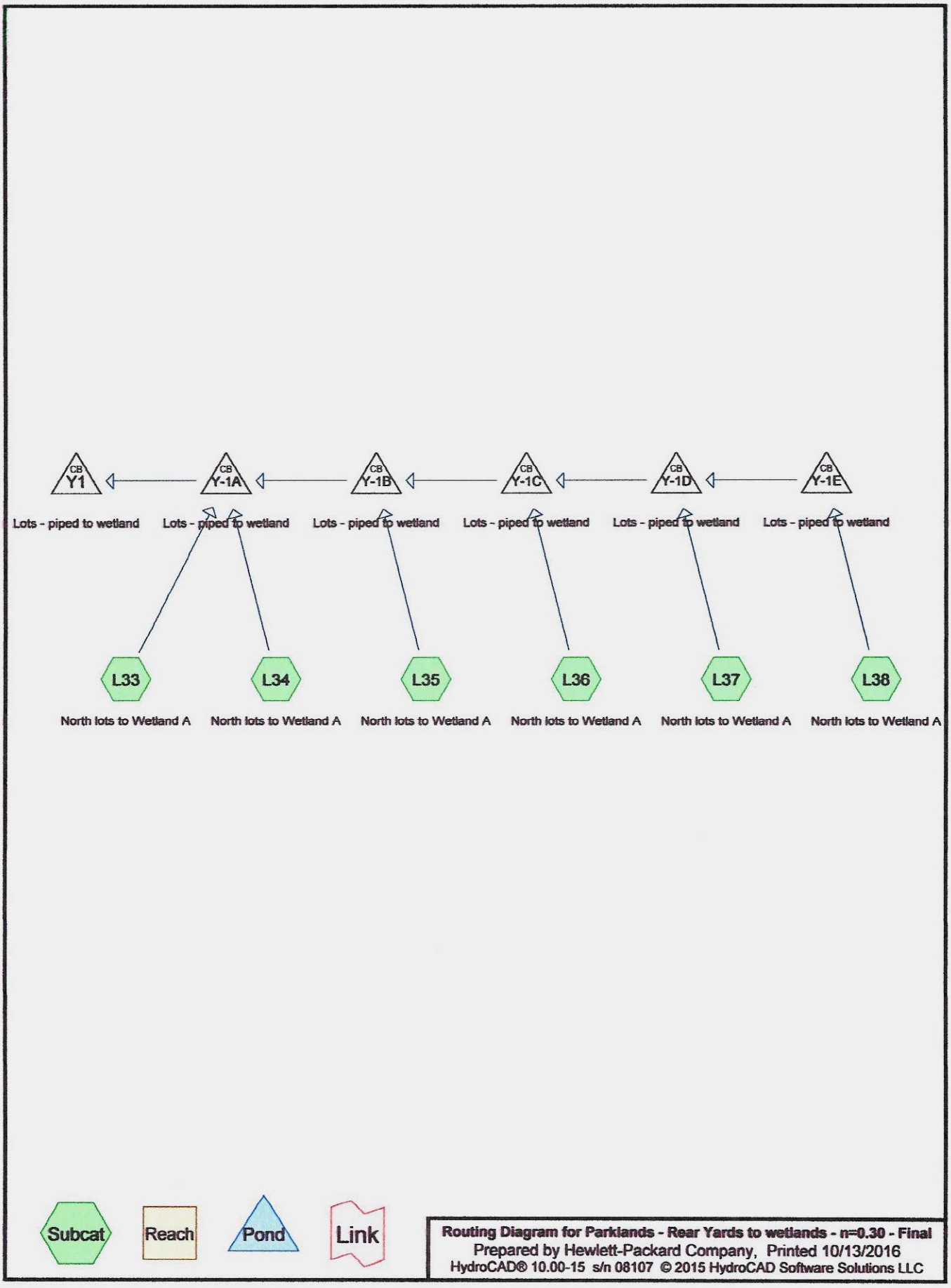
Upstream Structure ID	Downstream Structure & Perf LF ID	Pipe Length ID	Pipe Length cntr to cntr (ft)	Lot #	Pipe Size (in)	Area to System (sf)	US Rim Elev.	US Invert (ft)	DS Invert (ft)	Existing Ground Elev. (ft)	Pipe Slope cntr to cntr (ft/ft)
GR1E	GR1D	Y-1E	109	38	8	6,500/7,044	194.70	193.70	192.45	N/A	0.0115
GR1D	GR1C	Y-1D	102	37	8	6,500/4,973	193.50	192.45	191.27	N/A	0.0115
GR1C	GR1B	Y-1C	102	36	8	6,500/4,596	192.56	191.27	190.10	N/A	0.0115
GR1B	GR1A	Y-1B	95	35	8	6,500/4,603	191.75	190.10	189.01	N/A	0.0115
GR1A	Y1 (90 LF)	Perf	from GR1A	33 & 34	8	13,000/10,628	N/A	189.008	189.01	189+/-	0
GR2	Y2	Y-2A	116.0	39	6	6,500/1,000/6,235	194.00	192.00	191.55	193.00	0.0039
no inlet	Y2 (30 lf)	Y-2B	12.7	40	6	6,500	N/A	191.55	191.50	193.00	0.0039
GR3	Y3	Y-3A	63.0	3	6	6,500/1,000/8,754	200.00	198.00	191.40	---	0.1048
no inlet	Y3 (20 LF)	Y-3B	20.0	2	6	6,500	N/A	191.40	189.30	190.80	0.1050
GR4 (SOLID)	Y4 (10 LF)	Y-4	15.0	4	6	6,500	195.00	193.00	191.20	192.73	0.1200
GR5 (SOLID)	Y5 (20 LF)	Y-5	20.0	6 & 7	6	13,000	193.50	191.50	188.50	190.00	0.1500
GR6 (SOLID)	Y6 (20 LF)	Y-6	18.0	10	6	13,000	193.50	191.50	189.10	190.60	0.1333
GR7A (SOLID)	GR7B (SOLID)	Y-7A	48.0	12	6	6,500	204.00	202.00	194.13	---	0.1640
GR7B (SOLID)	Y7 (20 LF)	Y-7B	20.0	11	6	6,500	196.00	194.13	191.50	193.00	0.1315
GR8 (SOLID)	Y8 (20 LF)	Y-8	13.0	14 & 15	6	13,000	202.50	201.63	201.50	203.00	0.0100
GR9 (SOLID)	Y9 (10 LF)	Y-9	13.5	16	6	6,500	198.00	196.00	194.50	196.00	0.1111
GR10 (SOLID)	Y10 (20 LF)	Y-10	12.0	41 & 42	6	13,000	194.00	192.00	191.00	192.50	0.0833
GR11 (SOLID)	Y11 (10 LF)	Y-11	10.0	32	6	6,500	190.25	189.50	189.00	189.00	0.0500

REAR YARD RUNOFF SUMMARY DATA

Lot #	escription of how site runoff areas are manage	Lawn (sf)	Drive (sf)
2	lawn, drive, and roof to GR3	See Table - GR3	
3	lawn and drive as direct runoff	10,571	1,000
4	lawn and drive as direct runoff	8,516	1,000
5	lawn and drive as direct runoff	8,364	1,000
6	lawn and drive as direct runoff	8,713	1,000
7	lawnand drive as direct runoff	7,963	1,000
8	partial lawn as direct runoff	7,329	---
9	lawn, drive, and roof to street	---	---
10	lawn and drive as direct runoff - roof to GR6	7,543	1,000
11	lawn and drive as direct runoff - roof to GR7B	7,508	1,000
12	lawn and drive to GR7A - roof to street	See Table - GR7A	
13	lawn and drive as direct runoff - roof to GR7B	7,573	1,000
14	lawn and drive as direct runoff - roof to GR8	7,516	1,000
15	lawn and drive as direct runoff - roof to GR8	7,913	1,000
16	lawn and drive as direct runoff - roof to GR9	8,298	1,000
32	lawn and drive as direct runoff - roof to GR11	7,828	1,000
33 to 38	See Table	GR1E to GR1A	
39	roof and partial lawn to GR2	See Table - GR2	
40	partial lawn as direct runoff	7,329	---
41	partial lawn as direct runoff	4,615	---
42	partial lawn as direct runoff	4,885	---

Note: Not all the systems are modeled in HCAD since some with one or two roof areas are repetitive and would have the same output.


CB Y11
Lots - piped to wetland
Y-11
Lot (roof only) - piped to wetland
L32
North lot to Wetland A (roof only)
CB Y1
CB Y-1A
CB Y-1B
CB Y-1C
CB Y-1D
CB Y-1E
Lots - piped to wetland
L33
L34
L35
L36
L37
L38
North lots to Wetland A
L39
North lot to Wetland C
L37-38
Lots 37 & 38 to Wetland B
L40
North lot to Wetland C
CB Y-2A
Lot 36 - piped to wetland
CB Y-1D
Lot 16 - piped to wetland
CB Y-2B
Add Lot 40 - piped to wetland
CB Y10
Lots - piped to wetland
CB Y2
Lots - piped to wetland
CB Y3
Lots - piped to wetland
CB Y-3A
Lot 3- piped to wetland
L3
Lot 3 to Wetland A
CB Y-3B
Lot 2 - piped to wetland
L2
Lot 2 to Wetland A
n=.30
Simulate spill from rock trench
30 LF
Simulate spill from rock trench
CB Y9
Lots - piped to wetland
CB Y-9
Lot 16 - piped to wetland
L16
Lot 16 to Wetland B
Subcat
Reach
Pond
Link
Routing Diagram for Parklands - Rear Yards to wetlands - n=0.30 - Final
Prepared by Hewlett-Packard Company, Printed 10/13/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC


CB Y1
CB Y-1A
CB Y-1B
CB Y-1C
CB Y-1D
CB Y-1E
Lots - piped to wetland
Lots - piped to wetland
Lots - piped to wetland
Lots - piped to wetland
Lots - piped to wetland
Lots - piped to wetland
L33
L34
L35
L36
L37
L38
North lots to Wetland A
North lots to Wetland A
North lots to Wetland A
North lots to Wetland A
North lots to Wetland A
North lots to Wetland A
Subcat
Reach
Pond
Link
Routing Diagram for Parklands - Rear Yards to wetlands - n=0.30 - Final
Prepared by Hewlett-Packard Company, Printed 10/13/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Summary for Subcatchment L33: North lots to Wetland A

Runoff = 0.08 cfs @ 7.99 hrs, Volume= 0.029 af, Depth> 1.22"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr WQ Rainfall=1.96"

	Area (sf)	CN	Description
*	6,500	98	Impervious (roof)
*	6,016	83	Remaing lawn
	12,516	91	Weighted Average
	6,016	83	48.07% Pervious Area
	6,500	98	51.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Assumed**

Summary for Subcatchment L34: North lots to Wetland A

Runoff = 0.08 cfs @ 7.99 hrs, Volume= 0.027 af, Depth> 1.29"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr WQ Rainfall=1.96"

	Area (sf)	CN	Description
*	6,500	98	Impervious (roof)
*	4,612	83	Remaing lawn
	11,112	92	Weighted Average
	4,612	83	41.50% Pervious Area
	6,500	98	58.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Assumed**

Summary for Subcatchment L35: North lots to Wetland A

Runoff = 0.08 cfs @ 7.99 hrs, Volume= 0.027 af, Depth> 1.29"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr WQ Rainfall=1.96"

	Area (sf)	CN	Description
*	6,500	98	Impervious (roof)
*	4,603	83	Remaing lawn
	11,103	92	Weighted Average
	4,603	83	41.46% Pervious Area
	6,500	98	58.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Assumed**

Summary for Subcatchment L36: North lots to Wetland A

Runoff = 0.08 cfs @ 7.99 hrs, Volume= 0.027 af, Depth> 1.29"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr WQ Rainfall=1.96"

	Area (sf)	CN	Description
*	6,500	98	Impervious (roof)
*	4,596	83	Remaing lawn
	11,096	92	Weighted Average
	4,596	83	41.42% Pervious Area
	6,500	98	58.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Assumed**

Summary for Subcatchment L37: North lots to Wetland A

Runoff = 0.08 cfs @ 7.99 hrs, Volume= 0.028 af, Depth> 1.27"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr WQ Rainfall=1.96"

	Area (sf)	CN	Description
*	6,500	98	Impervious (roof)
*	4,973	83	Remaing lawn
	11,473	91	Weighted Average
	4,973	83	43.35% Pervious Area
	6,500	98	56.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Assumed**

Summary for Subcatchment L38: North lots to Wetland A

Runoff = 0.08 cfs @ 7.99 hrs, Volume= 0.030 af, Depth> 1.17"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr WQ Rainfall=1.96"

	Area (sf)	CN	Description
*	6,500	98	Impervious (roof) composite for unconnected
*	7,044	83	Remaining lawn
	13,544	90	Weighted Average
	7,044	83	52.01% Pervious Area
	6,500	98	47.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Assumed**

Summary for Pond Y-1A: Lots - piped to wetland

Inflow Area = 1.626 ac, 55.05% Impervious, Inflow Depth > 1.25" for WQ event
Inflow = 0.46 cfs @ 7.99 hrs, Volume= 0.169 af
Outflow = 0.46 cfs @ 7.99 hrs, Volume= 0.169 af, Atten= 0%, Lag= 0.0 min
Primary = 0.46 cfs @ 7.99 hrs, Volume= 0.169 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 190.28' @ 7.99 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	189.61'	**10.0" Round Culvert** L= 90.0' Square-edged headwall, Ke= 0.500 Inlet / Outlet Invert= 189.61' / 189.16' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 0.55 sf

Primary OutFlow Max=0.46 cfs @ 7.99 hrs HW=190.28' TW=190.15' (Fixed TW Elev= 190.15')
↑—**1=Culvert** (Outlet Controls 0.46 cfs @ 1.34 fps)

Summary for Pond Y-1B: Lots - piped to wetland

Inflow Area = 1.084 ac, 55.07% Impervious, Inflow Depth > 1.25" for WQ event
Inflow = 0.31 cfs @ 7.99 hrs, Volume= 0.113 af
Outflow = 0.31 cfs @ 7.99 hrs, Volume= 0.113 af, Atten= 0%, Lag= 0.0 min
Primary = 0.31 cfs @ 7.99 hrs, Volume= 0.113 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 191.08' @ 7.99 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	190.75'	**8.0" Round Culvert** L= 95.0' Square-edged headwall, Ke= 0.500 Inlet / Outlet Invert= 190.75' / 189.99' S= 0.0080 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf

Primary OutFlow Max=0.31 cfs @ 7.99 hrs HW=191.08' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 0.31 cfs @ 2.57 fps)

Summary for Pond Y-1C: Lots - piped to wetland

Inflow Area = 0.829 ac, 54.00% Impervious, Inflow Depth > 1.24" for WQ event
Inflow = 0.23 cfs @ 7.99 hrs, Volume= 0.086 af
Outflow = 0.23 cfs @ 7.99 hrs, Volume= 0.086 af, Atten= 0%, Lag= 0.0 min
Primary = 0.23 cfs @ 7.99 hrs, Volume= 0.086 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 191.85' @ 7.99 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	191.56'	**8.0" Round Culvert** L= 102.0' Square-edged headwall, Ke= 0.500 Inlet / Outlet Invert= 191.56' / 190.75' S= 0.0079 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf

Primary OutFlow Max=0.23 cfs @ 7.99 hrs HW=191.85' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 0.23 cfs @ 2.39 fps)

Summary for Pond Y-1D: Lots - piped to wetland

Inflow Area = 0.574 ac, 51.96% Impervious, Inflow Depth > 1.22" for WQ event
Inflow = 0.16 cfs @ 7.99 hrs, Volume= 0.058 af
Outflow = 0.16 cfs @ 7.99 hrs, Volume= 0.058 af, Atten= 0%, Lag= 0.0 min
Primary = 0.16 cfs @ 7.99 hrs, Volume= 0.058 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 192.61' @ 7.99 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	192.38'	**8.0" Round Culvert** L= 102.0' Square-edged headwall, Ke= 0.500 Inlet / Outlet Invert= 192.38' / 191.56' S= 0.0080 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf

Primary OutFlow Max=0.16 cfs @ 7.99 hrs HW=192.61' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 0.16 cfs @ 2.16 fps)

Summary for Pond Y-1E: Lots - piped to wetland

Inflow Area = 0.311 ac, 47.99% Impervious, Inflow Depth > 1.17" for WQ event
Inflow = 0.08 cfs @ 7.99 hrs, Volume= 0.030 af
Outflow = 0.08 cfs @ 7.99 hrs, Volume= 0.030 af, Atten= 0%, Lag= 0.0 min
Primary = 0.08 cfs @ 7.99 hrs, Volume= 0.030 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 193.42' @ 7.99 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	193.25'	**8.0" Round Culvert** L= 109.0' Square-edged headwall, Ke= 0.500 Inlet / Outlet Invert= 193.25' / 192.38' S= 0.0080 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf

Primary OutFlow Max=0.08 cfs @ 7.99 hrs HW=193.42' (Free Discharge)
└**1=Culvert** (Barrel Controls 0.08 cfs @ 1.79 fps)

Summary for Pond Y1: Lots - piped to wetland

Inflow Area = 1.626 ac, 55.05% Impervious, Inflow Depth > 1.25" for WQ event
Inflow = 0.46 cfs @ 7.99 hrs, Volume= 0.169 af
Outflow = 0.46 cfs @ 7.99 hrs, Volume= 0.169 af, Atten= 0%, Lag= 0.0 min
Primary = 0.46 cfs @ 7.99 hrs, Volume= 0.169 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 190.15' @ 7.99 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	189.99'	**Tube/Siphon/Float Valve X 0.00** Discharges@189.99' 8.000" Diameter, C= 0.600 90.0' Long Tube, Hazen-Williams C= 130
#2	Primary	189.99'	**Special & User-Defined -Perf at 50% clogged** Head (feet) 0.00 0.17 0.50 0.67 Disch. (cfs) 0.000 0.480 1.850 2.745

Primary OutFlow Max=0.46 cfs @ 7.99 hrs HW=190.15' (Free Discharge)
├**1=Tube/Siphon/Float Valve** (Controls 0.00 cfs)
└**2=Special & User-Defined -Perf at 50% clogged** (Custom Controls 0.46 cfs)

APPENDIX E

Appendix E Appurtenances

E-1 Pipe Capacity and Velocity Calcs.

E-2 Catch Basin Design Comments

E-3 Energy Dissipator Manhole Design

E-4 Flow Dispersion System – Line A and Line C

APPENDIX E-1 INLET CACITY SUMMARY TABLE
10-YR EVENT

INLET CAPACITY CHECK - TR 55 METHODOLOGY

Inlet No.	Subcat ID	Location/ Station	Inlet Type	Inlet Condition	Long. Slope (ft/ft)	Flow to Inlet Q (cfs)	Bypass Inflow Q_B (cfs)	Total Inflow Q_T (cfs)	Intercept Flow Q_I (cfs)	Bypass Flow Q_B (cfs)	Bypass to Inlet No.	Spread T (ft)	Depth at Curb* (ft) (*less 1 inch)	Depth at Curb (ft) Include Depression
PARKLANDS (10-YR EVENT)														
PF-1A	E1, E1-9	Longbow Ln.	2' x 2'	OG	0.0320	0.23	0.00	0.23	0.23	0.00	N/A	1.80	0.02	0.10
PF-1B	G1, GN	Longbow Ln.	2' x 2'	LP	0.0030	0.64	0.00	0.64	0.64	0.00	N/A	1.83	0.02	0.10
PF-2	G2, GS	Longbow Ln.	2' x 2'	LP	0.0030	0.51	0.00	0.51	0.51	0	N/A	in gutter	0.00	0.07
PF-3	E3	McMaster Dr.	2' x 2'	LP	0.0030	0.28	0.00	0.28	0.28	0.00	N/A	in gutter	0.00	0.07
PF-4	E4	McMaster Dr.	2' x 2'	LP	0.0030	0.38	0.03	0.41	0.34	0.01	N/A	in gutter	0.00	0.07
PF-5	E5L,E5R	McMaster Dr.	2' x 2'	LP	0.0030	1.05	0.03	1.08	1.08	0	N/A	3.75	0.06	0.14
PF-6	E6	McMaster Dr.	2' x 2'	OG	0.0100	0.30	0.03	0.33	0.30	0.03	PF5	3.74	0.07	0.15
PF-7	E7	McMaster Dr.	2' x 2'	OG	0.0100	0.30	0.03	0.33	0.30	0.03	PF4	3.74	0.07	0.15
PF-8	E8	McMaster Dr.	2' x 2'	OG	0.0100	0.32	0.00	0.32	0.29	0.03	PF6	3.67	0.07	0.15
PF-9	E9	McMaster Dr.	2' x 2'	OG	0.0100	0.32	0.00	0.32	0.29	0.03	PF7	3.67	0.07	0.15
PF-15	A3	Pittock Place	2' x 2'	LP	0.0030	0.54	0.00	0.54	0.54	0.00	N/A	1.19	0.01	0.09
PF-18	CWS	Camas Meadows Drive	2' x 2'	LP	0.0030	0.50	0.00	0.50	0.50	0.00	N/A	in gutter	0.00	0.08
PF-19	CWN	Camas Meadows Drive	2' x 2'	LP	0.0030	0.39	0.00	0.39	0.39	0.00	N/A	in gutter	0.00	0.07
PF-20	CES	Camas Meadows Drive	2' x 2'	LP	0.0030	0.45	0.00	0.45	0.45	0.00	N/A	in gutter	0.00	0.07
PF-21	CEN	Camas Meadows Drive	2' x 2'	LP	0.0030	0.48	0.00	0.48	0.48	0.00	N/A	in gutter	0.00	0.08

Date: 14-Aug-16 Width of local depression: 12 inches Precipitation: 10-yr

Designed By: GME Amount of local depression (in): 1 inch below street cross-slope at gutter line

Checked By: GME * Depth of flow at curb measured from the normal cross slope

APP E-1 SECTION 2

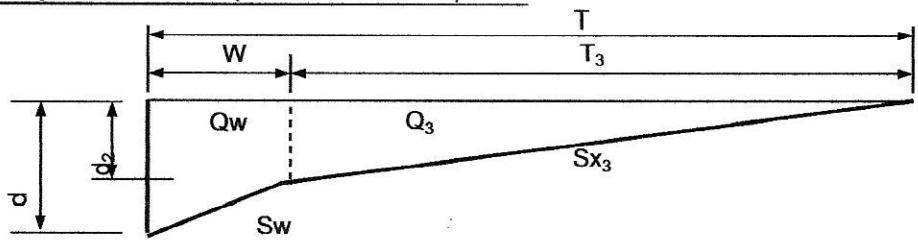
Job Name: **PARLANDS**
Job Number:
Date: 9/7/16 10:00 AM
Inlet Location: LONGBOW LN PF-1A

Design Values
Results

Note: Spread is based on conditions at a Combination Curb Inle

Flow Spread in Gutters

From ODOT Hydraulics Manual (3.3 *Flow in Gutters*)



$Q_3 = (0.56/n*Sx_3)*S^{1/2}(d_2^{2.67})$

$Qw = (0.56/n*Sw)S^{1/2}(d^{2.67}-d_2^{2.67})$

Where: $d = T_3*Sx_3+W*S_3$

$d = T_3*Sx_3$

$Q = Q_3+Qw$

$V = 2*Q/(T_3^{2}*Sx_3+W\text{^}2*Sw+2*W*T_3*Sx_3)$

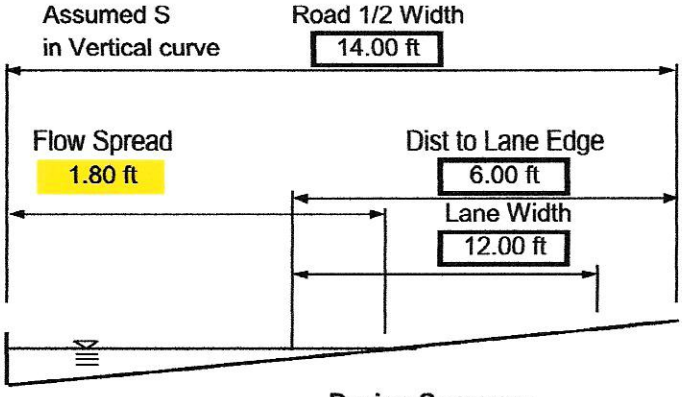
Where:

Q = Total gutter flow (cfs)
Q_1, Q_2, Q1 = Partial gutter flow (cfs)
Qw = Depressed gutter flow (cfs)
n = Manning's "n" value
Sx, Sx_1, Sx_2 = Gutter cross slope (ft/ft)
S = Longitudinal gutter slope (ft/ft)
(For sump locations S=0.3%, HEC 12, Pg 72)

T, T_1, T_2 = Flow width in gutter (ft)
V = Average gutter flow velocity (fps)
d = Flow depth at curb (ft)
d_2 = Flow depth at break in cross slope
Sw = Depressed gutter cross slope (ft/ft
W = Depressed gutter width (ft)

Assumed S - it is in vertical curve section

Q =	0.23 cfs		Sx_3 =	2.00%	Pavement X-Slope
S =	3.20%	(Longitudinal)	W =	1.00 ft	Gutter Width
n =	0.015		Sw =	10.50%	Gutter X-Slope



Design Summary

Flow Spread in Travel Lane	0.00 ft	Flow does not enter lane :: Design OK
Depth at Edge of Travel Lane	0.00 ft	Water does not enter travel lane. :: Design Ok

Job Name: **PARLANDS**
Job Number:
Date: 9/7/16 10:00 AM
Inlet Location: LONGBOW LN PF-1A

Design Values
Results

				Check
Flow Spread (T) =	1.80 ft	d =	0.12 ft	0.12
Q =	0.23 cfs			
S =	3.20%	V =	2.14 fps	
Sx =	2.00%			
n =	0.015			
a=	1.000			

Note: Flow spread is based on conditions at grate section

Grated Inlet Capacity Against a Curb, Ongrade Condition

Grate dimensions are for Combination Curb Inlet

Note: HEC-12, CH 7.4 states that combination curb inlets should be analysized ignoring the curb opening. Therefore, this spreadsheet also applies to combination curb inlets.

FROM HEC-12

(Eq 7) Eo = 1 - (1 - W/T)^2.67

Where:

Eo = Ratio of frontal flow intercepted to total frontal flow
W = Grate width (1.67' for herringbone pattern)
T = Total flow spread

L= disance along curb face

W = dist. from curb to outer edge of grate

W = 2.00 ft **Eo =** 100%

(Eq 9) Rf = 1 - 0.09*(V - Vo)

Where:

Rf = Ratio of frontal flow intercepted to total frontal flow
V = Velocity of flow
Vo = Splash-over Velocity (5 fps for herringbone pattern grate, WSDOT)

Vo = 5.00 fps **Rf =** 100%
Qif = 0.23 cfs

(Eq 8) Qs/Q = 1 - Eo

Where:

Qs/Q = Ratio of side flow to total flow **Qs/Q =** 0%

(Eq 10) Rs = 1 / (1 + (0.15*V^1.18)/(Sx*L^2.3))

Where:

Rs = Ratio of side flow intercepted to total side flow
L = Grate length (2.00' for herringbone pattern)

L= disance along curb face

W = dist. from curb to outer edge of grate

L = 2.00 ft **Rs =** 14%
Qis = 0.00 cfs

Grate Summary

Qi =	0.23 cfs	
Qbp =	0.00 cfs	(Flow Bypassed)
E =	100%	Grate efficiency

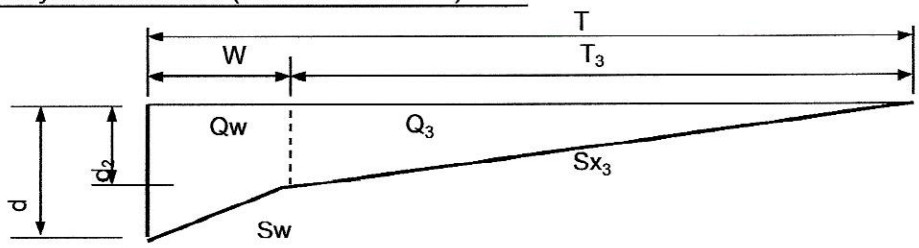
Job Name: **PARLANDS**
Job Number:
Date: 8/14/16 9:06 AM
Inlet Location: MCMASTER DR (PF-6 and PF-7 Note: Both have same inflow.

Design Values
Results

Note: Spread is based on conditions at a Combination Curb Inle

Flow Spread in Gutters

From ODOT Hydraulics Manual (3.3 *Flow in Gutters*)



$Q_3 = (0.56/n*Sx_3)*S^{1/2}(d_2^{2.67})$

$Qw = (0.56/n*Sw)S^{1/2}(d^{2.67}-d_2^{2.67})$

Where: $d = T_3*Sx_3+W*S_3$

$d = T_3*Sx_3$

$Q = Q_3+Qw$

$V = 2*Q/(T_3^{2}*Sx_3+W^2*Sw+2*W*T_3*Sx_3)$

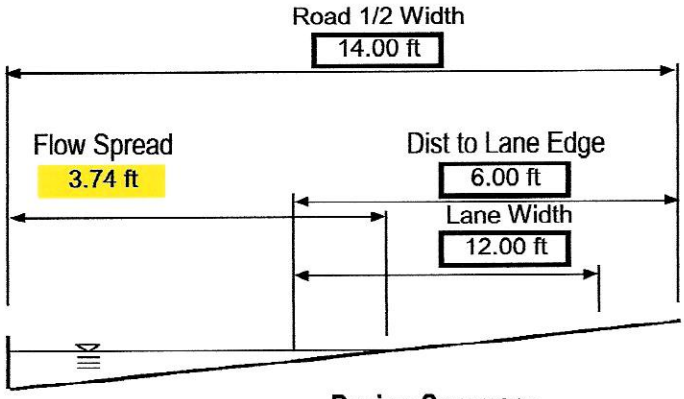
Where:

Q = Total gutter flow (cfs)
Q_1, Q_2, Q1 = Partial gutter flow (cfs)
Qw = Depressed gutter flow (cfs)
n = Manning's "n" value
Sx, Sx_1, Sx_2 = Gutter cross slope (ft/ft)
S = Longitudinal gutter slope (ft/ft)
(For sump locations S=0.3%, HEC 12, Pg 72)

T, T_1, T_2 = Flow width in gutter (ft)
V = Average gutter flow velocity (fps)
d = Flow depth at curb (ft)
d_2 = Flow depth at break in cross slope
Sw = Depressed gutter cross slope (ft/ft
W = Depressed gutter width (ft)

Note: Include bypass flow from PF-8 and PF-9 (0.03 cfs each)

Q =	0.33 cfs		Sx_3 =	2.00%	Pavement X-Slope
S =	1.00%	(Longitudinal)	W =	1.00 ft	Gutter Width
n =	0.015		Sw =	10.50%	Gutter X-Slope



Design Summary

Flow Spread in Travel Lane	0.00 ft	Flow does not enter lane :: Design OK
Depth at Edge of Travel Lane	0.00 ft	Water does not enter travel lane. :: Design Ok

Job Name: **PARLANDS**
Job Number:
Date: 8/14/16 9:06 AM
Inlet Location: MCMASTER DR (PF-6 and PF-7

Design Values
Results

Flow Spread (T) = 3.74 ft
Q = 0.33 cfs
S = 1.00%
Sx = 2.00%
n = 0.015
a= 1.000

d = 0.16 ft Check 0.16

V = 1.12 fps

Note: Flow spread is based on conditions at grate section

Grated Inlet Capacity Against a Curb, Ongrade Condition

Grate dimensions are for Combination Curb Inlet

Note: HEC-12, CH 7.4 states that combination curb inlets should be analysized ignoring the curb opening. Therefore, this spreadsheet also applies to combination curb inlets.

FROM HEC-12

(Eq 7) Eo = 1 - (1 - W/T)^2.67

Where:

Eo = Ratio of frontal flow intercepted to total frontal flow
W = Grate width (1.67' for herringbone pattern)
T = Total flow spread

L= disance along curb face

W = dist. from curb to outer edge of grate

W = 2.00 ft **Eo =** 87%

(Eq 9) Rf = 1 - 0.09*(V - Vo)

Where:

Rf = Ratio of frontal flow intercepted to total frontal flow
V = Velocity of flow
Vo = Splash-over Velocity (5 fps for herringbone pattern grate, WSDOT)

Vo = 5.00 fps **Rf =** 100%
Qif = 0.29 cfs

(Eq 8) Qs/Q = 1 - Eo

Where:

Qs/Q = Ratio of side flow to total flow **Qs/Q =** 13%

(Eq 10) Rs = 1 / (1 + (0.15*V^1.18)/(Sx*L^2.3))

Where:

Rs = Ratio of side flow intercepted to total side flow
L = Grate length (2.00' for herringbone pattern)

L= disance along curb face

W = dist. from curb to outer edge of grate

L = 2.00 ft **Rs =** 35%
Qis = 0.01 cfs

Grate Summary

Qi = 0.30 cfs
Qbp = 0.03 cfs (Flow Bypassed)
E = 92% Grate efficiency

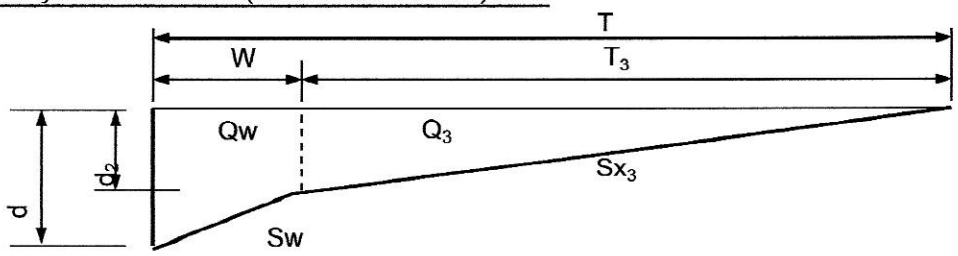
Job Name: **PARLANDS**
Job Number:
Date: 8/14/16 9:06 AM
Inlet Location: MCMASTER DR (PF-8 and PF-9 Note: Both have same inflow.

Design Values
Results

Note: Spread is based on conditions at a Combination Curb Inl

Flow Spread in Gutters

From ODOT Hydraulics Manual (3.3 *Flow in Gutters*)



$Q_3 = (0.56/n*Sx_3)*S^{1/2}(d_2^{2.67})$

$Qw = (0.56/n*Sw)S^{1/2}(d^{2.67}-d_2^{2.67})$

Where: $d = T_3*Sx_3+W*S_3$

$d = T_3*Sx_3$

$Q = Q_3+Qw$

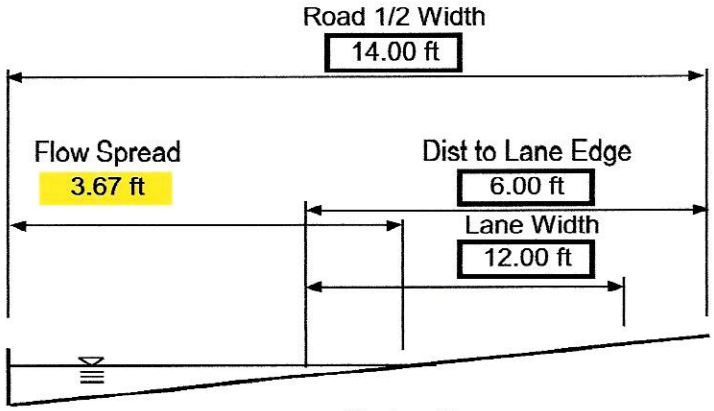
$V = 2*Q/(T_3^2*Sx_3+W\text{^}2*Sw+2*W*T_3*Sx_3)$

Where:

Q = Total gutter flow (cfs)
Q_1, Q_2, Q1 = Partial gutter flow (cfs)
Qw = Depressed gutter flow (cfs)
n = Manning's "n" value
Sx, Sx_1, Sx_2 = Gutter cross slope (ft/ft)
S = Longitudinal gutter slope (ft/ft)
(For sump locations S=0.3%, HEC 12, Pg 72)

T, T_1, T_2 = Flow width in gutter (ft)
V = Average gutter flow velocity (fps)
d = Flow depth at curb (ft)
d_2 = Flow depth at break in cross slope
Sw = Depressed gutter cross slope (ft/ft
W = Depressed gutter width (ft)

Q =	0.32 cfs		Sx_3 =	2.00%	Pavement X-Slope
S =	1.00%	(Longitudinal)	W =	1.00 ft	Gutter Width
n =	0.015		Sw =	10.50%	Gutter X-Slope



Design Summary

Flow Spread in Travel Lane	0.00 ft	Flow does not enter lane :: Design OK
Depth at Edge of Travel Lane	0.00 ft	Water does not enter travel lane. :: Design O

Job Name: **PARLANDS**
Job Number: 0
Date: 8/14/16 9:06 AM
Inlet Location: MCMASTER DR (PF-8 and PF-9

Design Values
Results

Flow Spread (T) = 3.67 ft
Q = 0.32 cfs
S = 1.00%
Sx = 2.00%
n = 0.015
a= 1.000

d = 0.16 ft 0.16

V = 1.11 fps

Note: Flow spread is based on conditions at grate section

Grated Inlet Capacity Against a Curb, Ongrade Condition

Grate dimensions are for Combination Curb Inlet

Note: HEC-12, CH 7.4 states that combination curb inlets should be analysized ignoring the curb opening. Therefore, this spreadsheet also applies to combination curb inlets.

FROM HEC-12

(Eq 7) Eo = 1 - (1 - W/T)^2.67

Where:

Eo = Ratio of frontal flow intercepted to total frontal flow
W = Grate width (1.67' for herringbone pattern)
T = Total flow spread

L= disance along curb face

W = dist. from curb to outer edge of grate

W = 2.00 ft **Eo =** 88%

(Eq 9) Rf = 1 - 0.09*(V - Vo)

Where:

Rf = Ratio of frontal flow intercepted to total frontal flow
V = Velocity of flow
Vo = Splash-over Velocity (5 fps for herringbone pattern grate, WSDOT)

Vo = 5.00 fps **Rf =** 100%
Qif = 0.28 cfs

(Eq 8) Qs/Q = 1 - Eo

Where:

Qs/Q = Ratio of side flow to total flow **Qs/Q =** 12%

(Eq 10) Rs = 1 / (1 + (0.15*V^1.18)/(Sx*L^2.3))

Where:

Rs = Ratio of side flow intercepted to total side flow
L = Grate length (2.00' for herringbone pattern)

L= disance along curb face

W = dist. from curb to outer edge of grate

L = 2.00 ft **Rs =** 35%
Qis = 0.01 cfs

Grate Summary

Qi = 0.29 cfs
Qbp = 0.03 cfs (Flow Bypassed)
E = 92% Grate efficiency

Job Name: _____
Job Number: _____
Date: 8/14/16 8:59 AM

Grated Inlet Capacity in a Sump Condition (SAG)

Reference: MODOT

640.1.5.2 Capacity of Grate Inlets Located at Low Points in Grade

A grate type drop inlet located at a low point in grade will behave either as a weir or as an orifice, dependent upon the depth of water at the grate. The capacity is independent of the geometric configuration of the grate.

For depths of water less than 0.4 ft. (120 mm), the capacity is governed by weir flow and may be calculated by the following equation:

$$Q_i = C_w p d^{1.5}$$

where:

Q_i = inlet capacity, ft^3/s (m^3/s)

C_w = constant, 3.0 - ENGLISH (1.66 - METRIC)

p = effective perimeter of the grate, ft. (m)

d = depth of water above the top of the grate, ft. (m)

The **effective perimeter** can be calculated using

(when there is a curb) $p = 2w + l$

(when there is no curb) $p = 2(w + l)$

where:

p = effective perimeter of the grate, ft. (m)

w = width of opening, ft. (m)

l = length of opening, ft. (m)

Only that portion of the grate's perimeter along which flow enters the inlet is considered when determining the effective perimeter.

When the depth of water exceeds 1.4 ft. (420 mm), the grate capacity is governed by orifice flow and may be calculated by the following equation

$$Q_i = C_o A (2gd)^{0.5}$$

where:

Q_i = inlet capacity, ft^3/s (m^3/s)

C_o = orifice coefficient = 0.67

A = clear opening area of the grate, ft^2 (m^2)

g = 32.2 ft/s^2 (9.80 m/s^2)

d = depth of water above the top of the grate, ft. (m)

Reference: HEC-22

Use of equation 4-27 requires the clear area of opening of the grate. Tests of three grates for the Federal Highway Administration (27) showed that for flat bar grates, such as the P-50x100 and P-30 grates, the clear opening is equal to the total area of the grate less the area occupied by longitudinal and lateral bars.

The curved vane grate performed about 10 percent better than a grate with a net opening equal to the total area less the area of the bars projected on a horizontal plane. That is, the projected area of the bars in a curved vane grate is 68 percent of the total area of the grate leaving a net opening of 32 percent, however the grate performed as a grate with a net opening of 35 percent.

Tilt-bar grates were not tested, but exploration of the above results would indicate a net opening area of 34 percent for the 30-degree tilt-bar and zero for the 45-degree tilt-bar grate. Obviously, the 45-degree tilt-bar grate would have greater than zero capacity.

Tilt-bar and curved vane grates are not recommended for sump locations where there is a chance that operation would be as an orifice.

Job Name: **Parklands**
Job Number:
Date: 8/16/16 2:35 PM
Perk Filter PF-2 and PF-1B

Note: Include print of desgn info sheet

KEY
Design Values
Results

Grated Inlet Capacity in a Sump Condition - No Clogging

From HEC-12 Eq. 17 (Weir condition)
$Q = CwPd^{1.5}$
Where:
Cw = 3.0
P = Perimeter of grate (Excluding sides against curbs)
d = Depth of flow

From HEC-12 Eq. 18 (Orifice condition)
$Q = CoA(2gd)^{0.5}$
Where:
Co = 0.67
A = Clear opening area of grate
g = 32.16 ft/s^2
d = Depth of flow

Inlet Description	Grate (Effective Length) Length	Grate (Effective Length) Width (Curb)	Against Curb (Y/N)	Total Clear Opening	Effective Area	Effective Perimeter
PERK FILTER 24" x 24"	1.75 ft	1.75 ft	Y	0.65 sf	**0.650 ft**	**7.00 ft**

See Fig. 5-5 (Hydraulics Manual, 1997)
35% for vaned

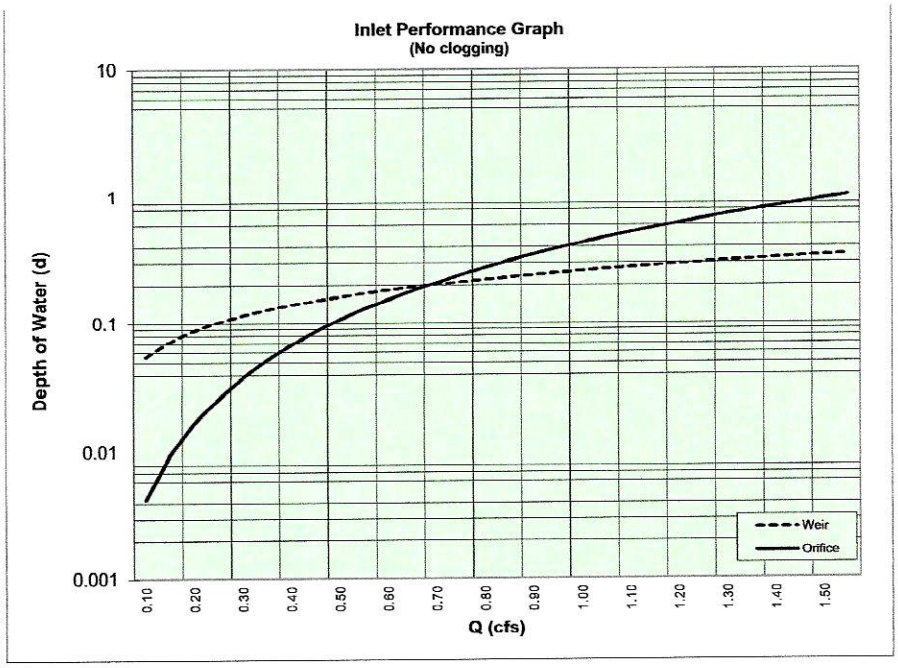
Standard Inlet Specifications	Effective Dimensions Grate Length	Grate Width	Open Area
WSDOT B-30.10 (Herringbone)	1.50 ft	1.71 ft	0.54 sf
WSDOT B-30.30 or 30.40 (Vaned)	1.25 ft	1.31 ft	0.57 sf
WSDOT 30.30 (Grate Inlet Type 1) A	3.85 ft	2.00 ft	5.88 sf
WSDOT 30.30 (Grate Inlet Type 1) B	3.85 ft	2.00 ft	5.88 sf

Table Initial Q: 0.50 cfs
Table Increment: 0.01 cfs

PF-2 = 0.51
PF-1B = 0.64
CB#: PF-1B - 10yr
Actual Q: 0.64 cfs
Depth weir: 0.10 ft

Depth orifice: 0.03 ft
Controlling Depth: 0.10 ft

Inlet Performance Table		
Q	d_{weir}	$d_{orifice}$
0.50 cfs	0.08 ft	0.02 ft
0.51 cfs	0.08 ft	0.02 ft
0.52 cfs	0.08 ft	0.02 ft
0.53 cfs	0.09 ft	0.02 ft
0.54 cfs	0.09 ft	0.02 ft
0.55 cfs	0.09 ft	0.02 ft
0.56 cfs	0.09 ft	0.03 ft
0.57 cfs	0.09 ft	0.03 ft
0.58 cfs	0.09 ft	0.03 ft
0.59 cfs	0.09 ft	0.03 ft
0.60 cfs	0.09 ft	0.03 ft
0.61 cfs	0.09 ft	0.03 ft
0.62 cfs	0.10 ft	0.03 ft
0.63 cfs	0.10 ft	0.03 ft
0.64 cfs	0.10 ft	0.03 ft
0.65 cfs	0.10 ft	0.03 ft
0.66 cfs	0.10 ft	0.04 ft
0.67 cfs	0.10 ft	0.04 ft
0.68 cfs	0.10 ft	0.04 ft
0.69 cfs	0.10 ft	0.04 ft
0.70 cfs	0.10 ft	0.04 ft
0.71 cfs	0.10 ft	0.04 ft
0.72 cfs	0.11 ft	0.04 ft
0.73 cfs	0.11 ft	0.04 ft
0.74 cfs	0.11 ft	0.04 ft
0.75 cfs	0.11 ft	0.05 ft
0.76 cfs	0.11 ft	0.05 ft
0.77 cfs	0.11 ft	0.05 ft
0.78 cfs	0.11 ft	0.05 ft
0.79 cfs	0.11 ft	0.05 ft



Subcatchment #'s	Sumped Inlet #	Total Q (cfs)	Controlling Depth		Flow Spread	Road Cross
PF2	PF-2	0.51	0.08	weir	within gutter	2.00%
			0.03	orifice	within gutter	2.00%
PF1B	PF-1B	0.64	0.10	weir	1.83	2.00%
			0.00	orifice	within gutter	2.00%

Job Name: **Parklands** Note: Include print of desgn info sheet

Job Number:

Date: 8/14/16 7:52 PM

Perk Filter PF-3

KEY
Design Values
Results

Grated Inlet Capacity in a Sump Condition - No Clogging

From HEC-12 Eq. 17 (Weir condition)

$Q = CwPd^{1.5}$

Where:

Cw = 3.0

P = Perimeter of grate (Excluding sides against curbs)

d = Depth of flow

From HEC-12 Eq. 18 (Orifice condition)

$Q = CoA(2gd)^{0.5}$

Where:

Co = 0.67

A = Clear opening area of grate

g = 32.16 ft/s^2

d = Depth of flow

Inlet Description	Grate (Effective Length) Length	Grate (Effective Length) Width (Curb)	Against Curb (Y/N)	Total Clear Opening	Effective Area	Effective Perimeter
PERK FILTER 24" x 24"	1.75 ft	1.75 ft	Y	0.65 sf	**0.650 ft**	**7.00 ft**

See Fig. 5-5 (Hydraulics Manual, 1997) 35% for vaned

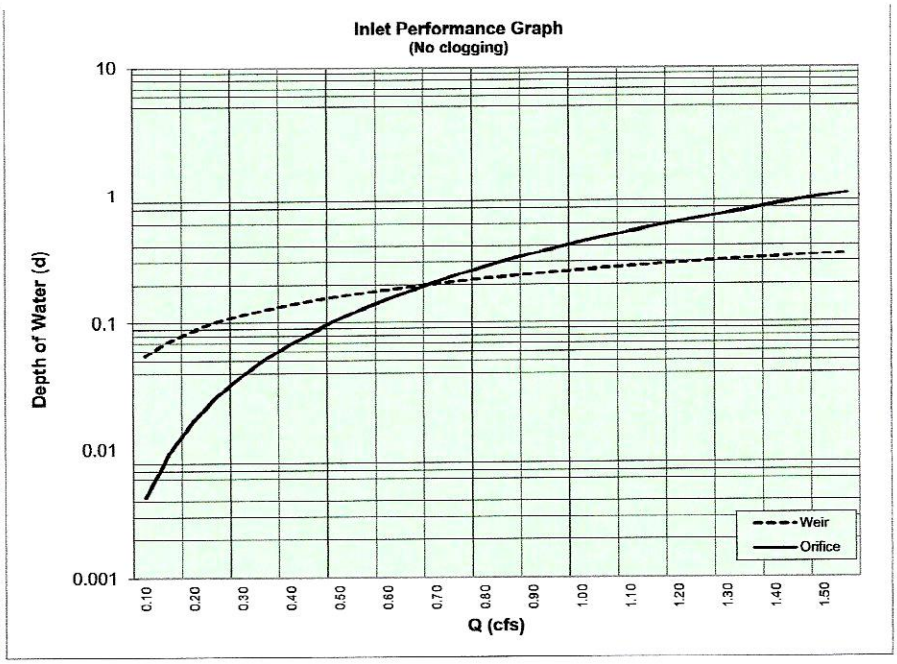
Standard Inlet Specifications	Effective Dimensions Grate Length	Grate Width	Open Area
WSDOT B-30.10 (Herringbone)	1.50 ft	1.71 ft	0.54 sf
WSDOT B-30.30 or 30.40 (Vaned)	1.25 ft	1.31 ft	0.57 sf
WSDOT 30.30 (Grate Inlet Type 1) A	3.85 ft	2.00 ft	5.88 sf
WSDOT 30.30 (Grate Inlet Type 1) B	3.85 ft	2.00 ft	5.88 sf

Table Initial Q: 0.20 cfs
Table Increment: 0.01 cfs

CB#: PF-3 - 10yr
Actual Q: 0.28 cfs
Depth weir: 0.05 ft

Depth orifice: 0.01 ft
Controlling Depth: 0.05 ft

Inlet Performance Table Q	d_{weir}	$d_{orifice}$
0.20 cfs	0.04 ft	0.00 ft
0.21 cfs	0.05 ft	0.00 ft
0.22 cfs	0.05 ft	0.00 ft
0.23 cfs	0.05 ft	0.00 ft
0.24 cfs	0.05 ft	0.00 ft
0.25 cfs	0.05 ft	0.01 ft
0.26 cfs	0.05 ft	0.01 ft
0.27 cfs	0.05 ft	0.01 ft
0.28 cfs	0.06 ft	0.01 ft
0.29 cfs	0.06 ft	0.01 ft
0.30 cfs	0.06 ft	0.01 ft
0.31 cfs	0.06 ft	0.01 ft
0.32 cfs	0.06 ft	0.01 ft
0.33 cfs	0.06 ft	0.01 ft
0.34 cfs	0.06 ft	0.01 ft
0.35 cfs	0.07 ft	0.01 ft
0.36 cfs	0.07 ft	0.01 ft
0.37 cfs	0.07 ft	0.01 ft
0.38 cfs	0.07 ft	0.01 ft
0.39 cfs	0.07 ft	0.01 ft
0.40 cfs	0.07 ft	0.01 ft
0.41 cfs	0.07 ft	0.01 ft
0.42 cfs	0.07 ft	0.01 ft
0.43 cfs	0.07 ft	0.02 ft
0.44 cfs	0.08 ft	0.02 ft
0.45 cfs	0.08 ft	0.02 ft
0.46 cfs	0.08 ft	0.02 ft
0.47 cfs	0.08 ft	0.02 ft
0.48 cfs	0.08 ft	0.02 ft
0.49 cfs	0.08 ft	0.02 ft



Subcatchment #'s	Sumped Inlet #	Total Q (cfs)	Controlling Depth		Flow Spread	Road Cross
PF-3	PF-3	0.28	0.05	weir	within gutter	2.00%
			0.01	orifice	within gutter	2.00%

Job Name: **Parklands** Note: Include print of desgn info sheet

Job Number:

Date: 8/14/16 7:48 PM

Perk Filter PF-4

KEY
Design Values
Results

Grated Inlet Capacity in a Sump Condition - No Clogging

From HEC-12 Eq. 17 (Weir condition)

$Q = CwPd^{1.5}$

Where:

Cw = 3.0

P = Perimeter of grate (Excluding sides against curbs)

d = Depth of flow

From HEC-12 Eq. 18 (Orifice condition)

$Q = CoA(2gd)^{0.5}$

Where:

Co = 0.67

A = Clear opening area of grate

g = 32.16 ft/s^2

d = Depth of flow

Inlet Description	Grate (Effective Length) Length	Grate (Effective Length) Width (Curb)	Against Curb (Y/N)	Total Clear Opening	Effective Area	Effective Perimeter
PERK FILTER 24" x 24"	1.75 ft	1.75 ft	Y	0.65 sf	**0.650 ft**	**7.00 ft**

See Fig. 5-5 (Hydraulics Manual, 1997) 35% for vaned

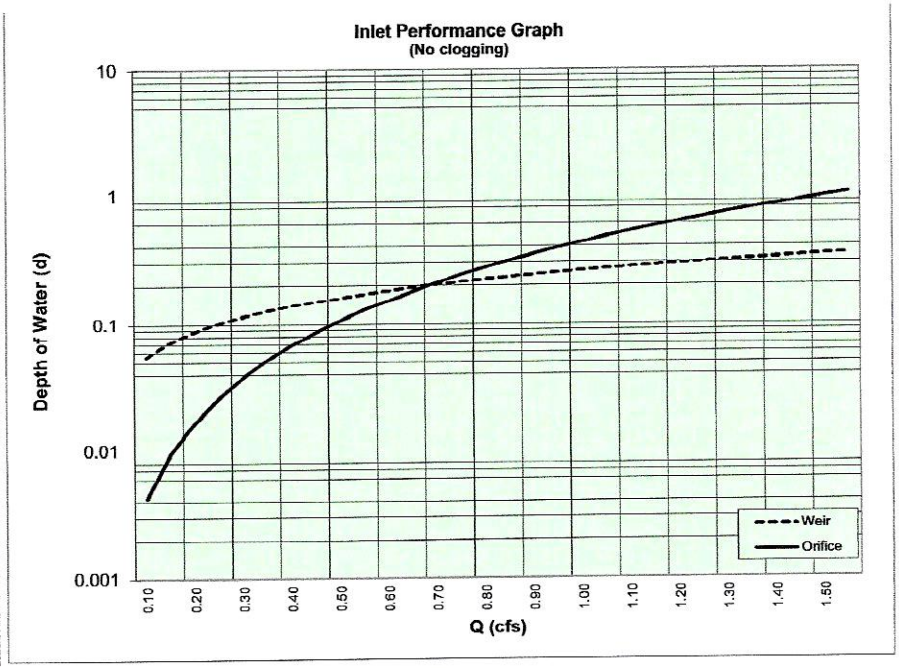
Standard Inlet Specifications	Effective Dimensions Grate Length	Grate Width	Open Area
WSDOT B-30.10 (Herringbone)	1.50 ft	1.71 ft	0.54 sf
WSDOT B-30.30 or 30.40 (Vaned)	1.25 ft	1.31 ft	0.57 sf
WSDOT 30.30 (Grate Inlet Type 1) A	3.85 ft	2.00 ft	5.88 sf
WSDOT 30.30 (Grate Inlet Type 1) B	3.85 ft	2.00 ft	5.88 sf

Table Initial Q: 0.30 cfs
Table Increment: 0.01 cfs

CB#: PF-4- 10yr
Actual Q: 0.38 cfs
Depth weir: 0.07 ft

Depth orifice: 0.01 ft
Controlling Depth: 0.07 ft

Inlet Performance Table		
Q	d_{weir}	$d_{orifice}$
0.30 cfs	0.06 ft	0.01 ft
0.31 cfs	0.06 ft	0.01 ft
0.32 cfs	0.06 ft	0.01 ft
0.33 cfs	0.06 ft	0.01 ft
0.34 cfs	0.06 ft	0.01 ft
0.35 cfs	0.07 ft	0.01 ft
0.36 cfs	0.07 ft	0.01 ft
0.37 cfs	0.07 ft	0.01 ft
0.38 cfs	0.07 ft	0.01 ft
0.39 cfs	0.07 ft	0.01 ft
0.40 cfs	0.07 ft	0.01 ft
0.41 cfs	0.07 ft	0.01 ft
0.42 cfs	0.07 ft	0.01 ft
0.43 cfs	0.07 ft	0.02 ft
0.44 cfs	0.08 ft	0.02 ft
0.45 cfs	0.08 ft	0.02 ft
0.46 cfs	0.08 ft	0.02 ft
0.47 cfs	0.08 ft	0.02 ft
0.48 cfs	0.08 ft	0.02 ft
0.49 cfs	0.08 ft	0.02 ft
0.50 cfs	0.08 ft	0.02 ft
0.51 cfs	0.08 ft	0.02 ft
0.52 cfs	0.08 ft	0.02 ft
0.53 cfs	0.09 ft	0.02 ft
0.54 cfs	0.09 ft	0.02 ft
0.55 cfs	0.09 ft	0.02 ft
0.56 cfs	0.09 ft	0.03 ft
0.57 cfs	0.09 ft	0.03 ft
0.58 cfs	0.09 ft	0.03 ft
0.59 cfs	0.09 ft	0.03 ft



Subcatchment #'s	Sumped Inlet #	Total Q (cfs)	Controlling Depth	Flow Spread		Road Cross
PF-4	PF-4	0.38	0.07	weir	in gutter	2.00%
			0.01	orifice	in gutter	2.00%

Job Name: **Parklands**
Job Number:
Date: 8/14/16 3:06 PM
Perk Filter PF-5

Note: Include print of desgn info sheet

Check 100-yr Flow

KEY
Design Values
Results

Grated Inlet Capacity in a Sump Condition - No Clogging

From HEC-12 Eq. 17 (Weir condition)
$Q = CwPd^{1.5}$
Where:
Cw = 3.0
P = Perimeter of grate (Excluding sides against curbs)
d = Depth of flow

From HEC-12 Eq. 18 (Orifice condition)
$Q = CoA(2gd)^{0.5}$
Where:
Co = 0.67
A = Clear opening area of grate
g = 32.16 ft/s^2
d = Depth of flow

Inlet Description	Grate (Effective Length) Length	Grate (Effective Length) Width (Curb)	Against Curb (Y/N)	Total Clear Opening	Effective Area	Effective Perimeter
PERK FILTER 24" x 24"	1.75 ft	1.75 ft	Y	0.65 sf	**0.650 ft**	**7.00 ft**

*Note: 50% reduction

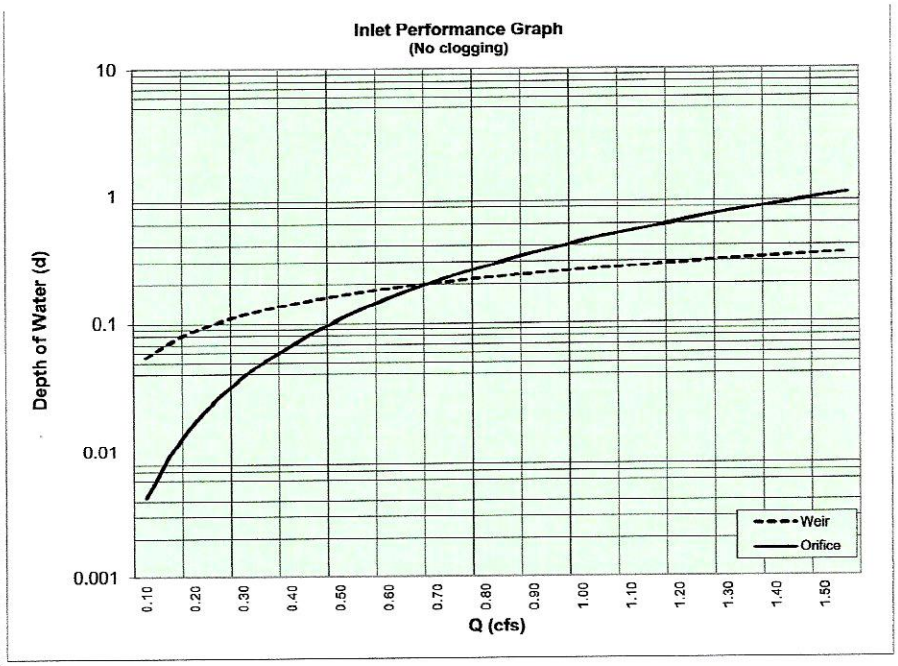
See Fig. 5-5 (Hydraulics Manual, 1997)
35% for vaned

Standard Inlet Specifications	Effective Dimensions Grate Length	Grate Width	Open Area
WSDOT B-30.10 (Herringbone)	1.50 ft	1.71 ft	0.54 sf
WSDOT B-30.30 or 30.40 (Vaned)	1.25 ft	1.31 ft	0.57 sf
WSDOT 30.30 (Grate Inlet Type 1) A	3.85 ft	2.00 ft	5.88 sf
WSDOT 30.30 (Grate Inlet Type 1) B	3.85 ft	2.00 ft	5.88 sf

Table Initial Q: 0.90 cfs
Table Increment: 0.01 cfs

CB#: PF-5 - 100-yr
Actual Q: 1.61 cfs
Depth weir: 0.15 ft
Depth orifice: 0.12 ft
Controlling Depth: 0.15 ft

Inlet Performance Table Q	d_{weir}	$d_{orifice}$
0.90 cfs	0.12 ft	0.07 ft
0.91 cfs	0.12 ft	0.07 ft
0.92 cfs	0.12 ft	0.07 ft
0.93 cfs	0.13 ft	0.07 ft
0.94 cfs	0.13 ft	0.07 ft
0.95 cfs	0.13 ft	0.07 ft
0.96 cfs	0.13 ft	0.08 ft
0.97 cfs	0.13 ft	0.08 ft
0.98 cfs	0.13 ft	0.08 ft
0.99 cfs	0.13 ft	0.08 ft
1.00 cfs	0.13 ft	0.08 ft
1.01 cfs	0.13 ft	0.08 ft
1.02 cfs	0.13 ft	0.09 ft
1.03 cfs	0.13 ft	0.09 ft
1.04 cfs	0.13 ft	0.09 ft
1.05 cfs	0.14 ft	0.09 ft
1.06 cfs	0.14 ft	0.09 ft
1.07 cfs	0.14 ft	0.09 ft
1.08 cfs	0.14 ft	0.10 ft
1.09 cfs	0.14 ft	0.10 ft
1.10 cfs	0.14 ft	0.10 ft
1.11 cfs	0.14 ft	0.10 ft
1.12 cfs	0.14 ft	0.10 ft
1.13 cfs	0.14 ft	0.10 ft
1.14 cfs	0.14 ft	0.11 ft
1.15 cfs	0.14 ft	0.11 ft
1.16 cfs	0.15 ft	0.11 ft
1.17 cfs	0.15 ft	0.11 ft
1.18 cfs	0.15 ft	0.11 ft
1.19 cfs	0.15 ft	0.12 ft



Subcatchment #'s	Sumped Inlet #	Total Q (cfs)	Controlling Depth		Flow Spread	Road Cross
PF-5	PF-5	1.61	0.15	weir	7.38	2.00%
			0.12	orifice	5.80	2.00%

Job Name: **Parklands**
Job Number:
Date: 8/14/16 7:49 PM
Perk Filter PF-5

Note: Include print of desgn info sheet

KEY
Design Values
Results

Grated Inlet Capacity in a Sump Condition - No Clogging

From HEC-12 Eq. 17 (Weir condition)
$Q = CwPd^{1.5}$
Where:
Cw = 3.0
P = Perimeter of grate (Excluding sides against curbs)
d = Depth of flow

From HEC-12 Eq. 18 (Orifice condition)
$Q = CoA(2gd)^{0.5}$
Where:
Co = 0.67
A = Clear opening area of grate
g = 32.16 ft/s^2
d = Depth of flow

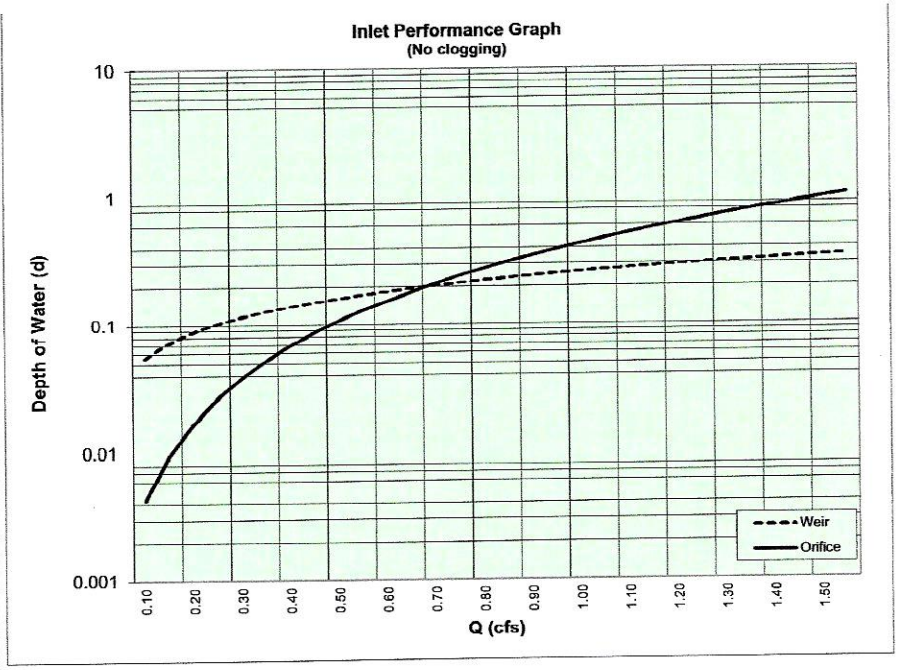
Inlet Description	Grate (Effective Length) Length	Grate (Effective Length) Width (Curb)	Against Curb (Y/N)	Total Clear Opening	Effective Area	Effective Perimeter
PERK FILTER 24" x 24"	1.75 ft	1.75 ft	Y	0.65 sf	**0.650 ft**	**7.00 ft**
	See Fig. 5-5 (Hydraulics Manual, 1997)			35% for vaned		

Standard Inlet Specifications	Effective Dimensions Grate Length	Grate Width	Open Area
WSDOT B-30.10 (Herringbone)	1.50 ft	1.71 ft	0.54 sf
WSDOT B-30.30 or 30.40 (Vaned)	1.25 ft	1.31 ft	0.57 sf
WSDOT 30.30 (Grate Inlet Type 1) A	3.85 ft	2.00 ft	5.88 sf
WSDOT 30.30 (Grate Inlet Type 1) B	3.85 ft	2.00 ft	5.88 sf

Table Initial Q: 0.90 cfs
Table Increment: 0.01 cfs

CB#: PF-5 - 10yr
Actual Q: 1.08 cfs
Depth weir: 0.14 ft
Depth orifice: 0.10 ft
Controlling Depth: 0.14 ft

Inlet Performance Table Q	d_{weir}	$d_{orifice}$
0.90 cfs	0.12 ft	0.07 ft
0.91 cfs	0.12 ft	0.07 ft
0.92 cfs	0.12 ft	0.07 ft
0.93 cfs	0.13 ft	0.07 ft
0.94 cfs	0.13 ft	0.07 ft
0.95 cfs	0.13 ft	0.07 ft
0.96 cfs	0.13 ft	0.08 ft
0.97 cfs	0.13 ft	0.08 ft
0.98 cfs	0.13 ft	0.08 ft
0.99 cfs	0.13 ft	0.08 ft
1.00 cfs	0.13 ft	0.08 ft
1.01 cfs	0.13 ft	0.08 ft
1.02 cfs	0.13 ft	0.09 ft
1.03 cfs	0.13 ft	0.09 ft
1.04 cfs	0.13 ft	0.09 ft
1.05 cfs	0.14 ft	0.09 ft
1.06 cfs	0.14 ft	0.09 ft
1.07 cfs	0.14 ft	0.09 ft
1.08 cfs	0.14 ft	0.10 ft
1.09 cfs	0.14 ft	0.10 ft
1.10 cfs	0.14 ft	0.10 ft
1.11 cfs	0.14 ft	0.10 ft
1.12 cfs	0.14 ft	0.10 ft
1.13 cfs	0.14 ft	0.10 ft
1.14 cfs	0.14 ft	0.11 ft
1.15 cfs	0.14 ft	0.11 ft
1.16 cfs	0.15 ft	0.11 ft
1.17 cfs	0.15 ft	0.11 ft
1.18 cfs	0.15 ft	0.11 ft
1.19 cfs	0.15 ft	0.12 ft



Subcatchment #'s	Sumped Inlet #	Total Q (cfs)	Controlling Depth		Flow Spread	Road Cross
PF-5	PF-5	1.08	0.14	weir	3.75	2.00%
			0.10	orifice	1.62	2.00%

Job Name: **Parklands**
Job Number:
Date: 8/14/16 8:12 PM

Perk Filter PF-5
add 0.09 bypass from PF-6

Note: Include print of desgn info sheet

Low Point McMaster Dr.

Check 100-yr Flow

KEY
Design Values
Results

Grated Inlet Capacity in a Sump Condition - Assume 50% Clogged

From HEC-12 Eq. 17 (Weir condition)

$Q = CwPd^{1.5}$

Where:
Cw = 3.0
P = Perimeter of grate (Excluding sides against curbs)
d = Depth of flow

From HEC-12 Eq. 18 (Orifice condition)

$Q = CoA(2gd)^{0.5}$

Where:
Co = 0.67
A = Clear opening area of grate
g = 32.16 ft/s^2
d = Depth of flow

Inlet Description	Grate (Effective Length) Length	Grate (Effective Length) Width (Curb)	Against Curb (Y/N)	Total Clear Opening	*Reduced Area	*Reduced Perimeter
PERK FILTER 24" x 24"	1.75 ft	1.75 ft	Y	0.65 sf	**0.325 ft**	**3.50 ft**

*Note: 50% reduction

See Fig. 5-5 (Hydraulics Manual, 1997) 35% for vaned

Standard Inlet Specifications — Effective Dimensions

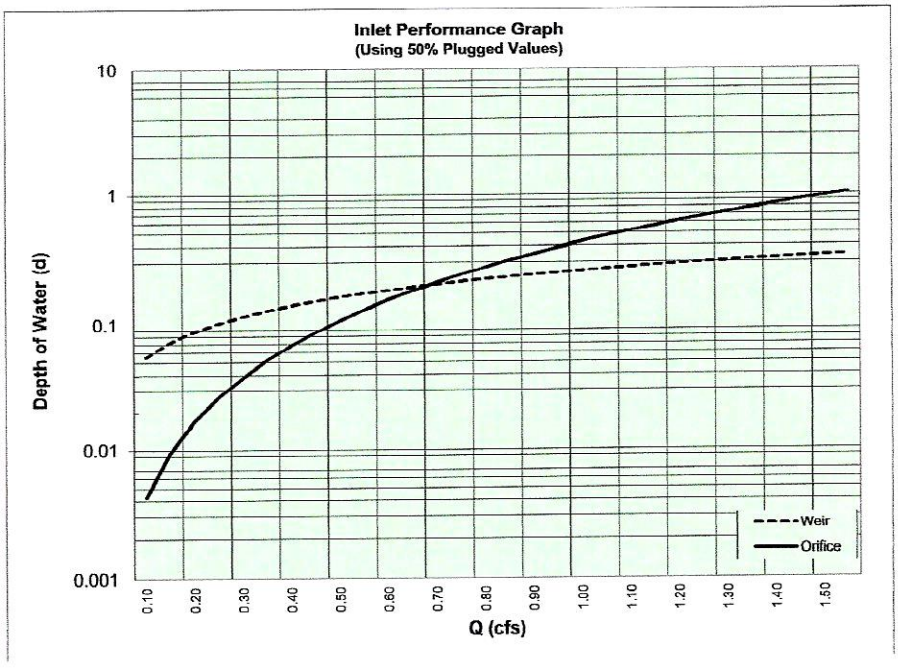
	Grate Length	Grate Width	Open Area
WSDOT B-30.10 (Herringbone)	1.50 ft	1.71 ft	0.54 sf
WSDOT B-30.30 or 30.40 (Vaned)	1.25 ft	1.31 ft	0.57 sf
WSDOT 30.30 (Grate Inlet Type 1) A	3.85 ft	2.00 ft	5.88 sf
WSDOT 30.30 (Grate Inlet Type 1) B	3.85 ft	2.00 ft	5.88 sf

Table Initial Q: 0.90 cfs
Table Increment: 0.01 cfs

CB#: PF-5 - 100-yr
Actual Q: 1.70 cfs
Depth weir: 0.23 ft

Depth orifice: 0.46 ft
Controlling Depth: 0.46 ft

Inlet Performance Table		
Q	d_{weir}	$d_{orifice}$
0.90 cfs	0.19 ft	0.27 ft
0.91 cfs	0.20 ft	0.27 ft
0.92 cfs	0.20 ft	0.28 ft
0.93 cfs	0.20 ft	0.28 ft
0.94 cfs	0.20 ft	0.29 ft
0.95 cfs	0.20 ft	0.30 ft
0.96 cfs	0.20 ft	0.30 ft
0.97 cfs	0.20 ft	0.31 ft
0.98 cfs	0.21 ft	0.31 ft
0.99 cfs	0.21 ft	0.32 ft
1.00 cfs	0.21 ft	0.33 ft
1.01 cfs	0.21 ft	0.33 ft
1.02 cfs	0.21 ft	0.34 ft
1.03 cfs	0.21 ft	0.35 ft
1.04 cfs	0.21 ft	0.35 ft
1.05 cfs	0.22 ft	0.36 ft
1.06 cfs	0.22 ft	0.37 ft
1.07 cfs	0.22 ft	0.38 ft
1.08 cfs	0.22 ft	0.38 ft
1.09 cfs	0.22 ft	0.39 ft
1.10 cfs	0.22 ft	0.40 ft
1.11 cfs	0.22 ft	0.40 ft
1.12 cfs	0.22 ft	0.41 ft
1.13 cfs	0.23 ft	0.42 ft
1.14 cfs	0.23 ft	0.43 ft
1.15 cfs	0.23 ft	0.43 ft
1.16 cfs	0.23 ft	0.44 ft
1.17 cfs	0.23 ft	0.45 ft
1.18 cfs	0.23 ft	0.46 ft
1.19 cfs	0.23 ft	0.46 ft



Subcatchment #'s	Sumped Inlet #'s	Total Q (cfs)	Controlling Depth		Flow Spread	Road Cross
PF-5	PF-5	1.70	0.23	weir	8.54	2.00%
			0.46	orifice	20.05	2.00%
Find flow for 14 ft spread condition (see 0.28 in chart)		1.02	0.34	orifice	14.00	2.00%

Note: Overflow to Inlet PF-3 and PF-4 (also low point inlets) would occur at 14 ft spread.
So overflow would be 1.70 cfs - 1.02 cfs = 0.68 cfs and PF-3 100-yr flow is only 0.40 cfs and PF-4, 100-yr flow is only 0.57 cfs*
PF-4 does have some bypass flow from PF-7, as well.

These two low point inlets have the same 1.02 cfs capacity as PF-5, or a total of 2.04 cfs
(0.40 + 0.57+0.09 bypass from PF-7)+ overflow from PF-5 = 1.74 cfs Less than 2.04 cfs, so OK.
Conservative, as this evaluation represents worst case with all three inlets at 50% clogged.

Job Name: **Parklands** Note: Include print of desgn info sheet

Job Number:

Date: 8/14/16 4:07 PM

Perk Filter PF-15

KEY
Design Values
Results

Grated Inlet Capacity in a Sump Condition - No Clogging

From HEC-12 Eq. 17 (Weir condition)

$Q = CwPd^{1.5}$

Where:

Cw = 3.0

P = Perimeter of grate (Excluding sides against curbs)

d = Depth of flow

From HEC-12 Eq. 18 (Orifice condition)

$Q = CoA(2gd)^{0.5}$

Where:

Co = 0.67

A = Clear opening area of grate

g = 32.16 ft/s^2

d = Depth of flow

Inlet Description	Grate (Effective Length) Length	Width (Curb)	Against Curb (Y/N)	Total Clear Opening	Effective Area	Effective Perimeter
PERK FILTER 24" x 24"	1.75 ft	1.75 ft	Y	0.65 sf	**0.650 ft**	**7.00 ft**

See Fig. 5-5 (Hydraulics Manual, 1997) 35% for vaned

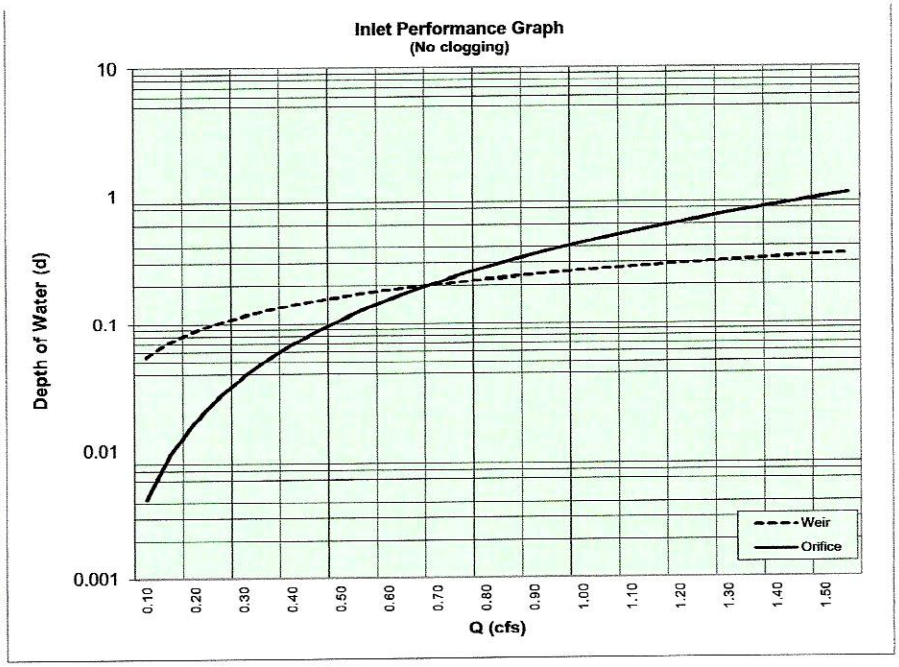
Standard Inlet Specifications	Effective Dimensions Grate Length	Grate Width	Open Area
WSDOT B-30.10 (Herringbone)	1.50 ft	1.71 ft	0.54 sf
WSDOT B-30.30 or 30.40 (Vaned)	1.25 ft	1.31 ft	0.57 sf
WSDOT 30.30 (Grate Inlet Type 1) A	3.85 ft	2.00 ft	5.88 sf
WSDOT 30.30 (Grate Inlet Type 1) B	3.85 ft	2.00 ft	5.88 sf

Table Initial Q: 0.50 cfs
Table Increment: 0.01 cfs

CB#: PF-15 - 10yr
Actual Q: 0.54 cfs
Depth weir: 0.09 ft

Depth orifice: 0.02 ft
Controlling Depth: 0.09 ft

Inlet Performance Table		
Q	d_{weir}	$d_{orifice}$
0.50 cfs	0.08 ft	0.02 ft
0.51 cfs	0.08 ft	0.02 ft
0.52 cfs	0.08 ft	0.02 ft
0.53 cfs	0.09 ft	0.02 ft
0.54 cfs	0.09 ft	0.02 ft
0.55 cfs	0.09 ft	0.02 ft
0.56 cfs	0.09 ft	0.03 ft
0.57 cfs	0.09 ft	0.03 ft
0.58 cfs	0.09 ft	0.03 ft
0.59 cfs	0.09 ft	0.03 ft
0.60 cfs	0.09 ft	0.03 ft
0.61 cfs	0.09 ft	0.03 ft
0.62 cfs	0.10 ft	0.03 ft
0.63 cfs	0.10 ft	0.03 ft
0.64 cfs	0.10 ft	0.03 ft
0.65 cfs	0.10 ft	0.03 ft
0.66 cfs	0.10 ft	0.04 ft
0.67 cfs	0.10 ft	0.04 ft
0.68 cfs	0.10 ft	0.04 ft
0.69 cfs	0.10 ft	0.04 ft
0.70 cfs	0.10 ft	0.04 ft
0.71 cfs	0.10 ft	0.04 ft
0.72 cfs	0.11 ft	0.04 ft
0.73 cfs	0.11 ft	0.04 ft
0.74 cfs	0.11 ft	0.04 ft
0.75 cfs	0.11 ft	0.05 ft
0.76 cfs	0.11 ft	0.05 ft
0.77 cfs	0.11 ft	0.05 ft
0.78 cfs	0.11 ft	0.05 ft
0.79 cfs	0.11 ft	0.05 ft



Subcatchment #'s	Sumped Inlet #	Total Q (cfs)	Controlling Depth		Flow Spread	Road Cross
PF-15	PF-15	0.54	0.09	weir	1.19	2.00%
			0.02	orifice	within gutter	2.00%

Job Name: **Parklands** Note: Include print of desgn info sheet

Job Number:

Date: 9/7/16 10:06 AM

Perk Filter PF-18,19, 20, & PF-21

KEY
Design Values
Results

Grated Inlet Capacity in a Sump Condition - No Clogging

From HEC-12 Eq. 17 (Weir condition)

$Q = CwPd^{1.5}$

Where:

Cw = 3.0

P = Perimeter of grate (Excluding sides against curbs)

d = Depth of flow

From HEC-12 Eq. 18 (Orifice condition)

$Q = CoA(2gd)^{0.5}$

Where:

Co = 0.67

A = Clear opening area of grate

g = 32.16 ft/s^2

d = Depth of flow

Inlet Description	Grate (Effective Length) Length	Width (Curb)	Against Curb (Y/N)	Total Clear Opening	Effective Area	Effective Perimeter
PERK FILTER 24" x 24"	1.75 ft	1.75 ft	Y	0.65 sf	**0.650 ft**	**7.00 ft**

See Fig. 5-5 (Hydraulics Manual, 1997) 35% for vaned

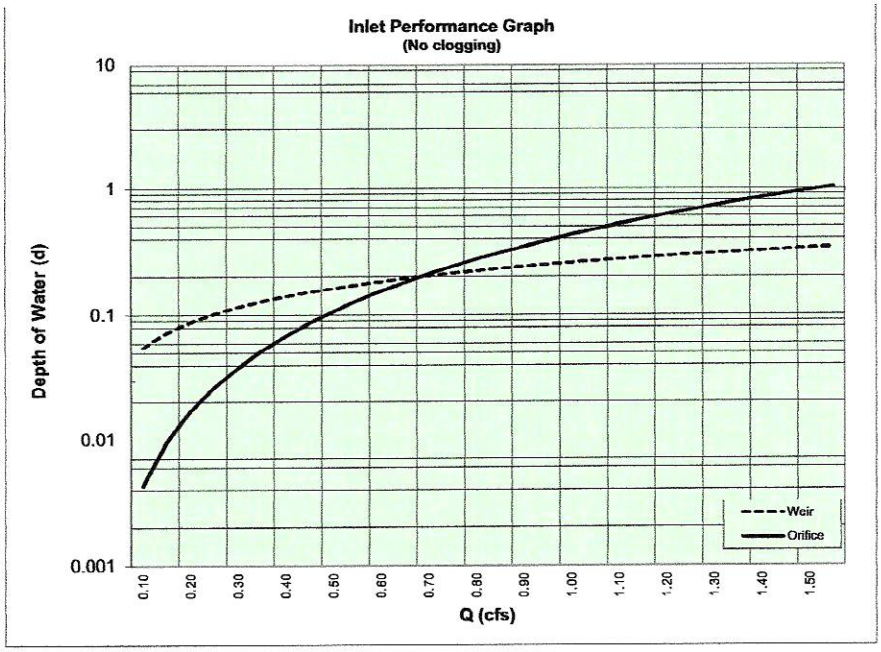
Standard Inlet Specifications	Effective Dimensions Grate Length	Grate Width	Open Area
WSDOT B-30.10 (Herringbone)	1.50 ft	1.71 ft	0.54 sf
WSDOT B-30.30 or 30.40 (Vaned)	1.25 ft	1.31 ft	0.57 sf
WSDOT 30.30 (Grate Inlet Type 1) A	3.85 ft	2.00 ft	5.88 sf
WSDOT 30.30 (Grate Inlet Type 1) B	3.85 ft	2.00 ft	5.88 sf

Table Initial Q: 0.30 cfs
Table Increment: 0.01 cfs

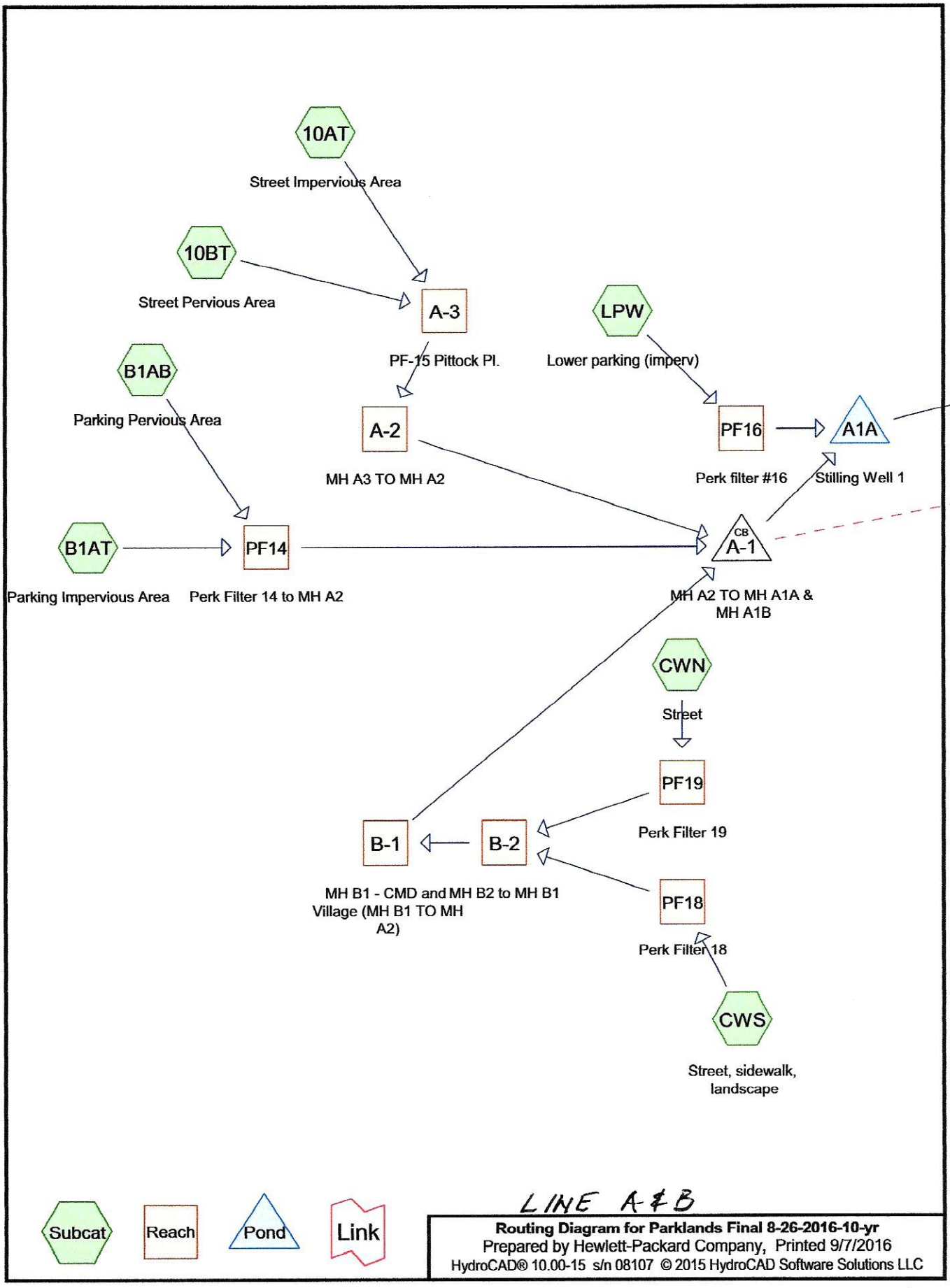
PF-18 = 0.50
PF-19 = 0.39
PF-20 = 0.43
PF-21 = 0.48
CB#: PF-2- 10yr
Actual Q: 0.50 cfs
Depth weir: 0.08 ft

Depth orifice: 0.02 ft
Controlling Depth: 0.08 ft

Inlet Performance Table		
Q	d_{weir}	$d_{orifice}$
0.30 cfs	0.06 ft	0.01 ft
0.31 cfs	0.06 ft	0.01 ft
0.32 cfs	0.06 ft	0.01 ft
0.33 cfs	0.06 ft	0.01 ft
0.34 cfs	0.06 ft	0.01 ft
0.35 cfs	0.07 ft	0.01 ft
0.36 cfs	0.07 ft	0.01 ft
0.37 cfs	0.07 ft	0.01 ft
0.38 cfs	0.07 ft	0.01 ft
0.39 cfs	0.07 ft	0.01 ft
0.40 cfs	0.07 ft	0.01 ft
0.41 cfs	0.07 ft	0.01 ft
0.42 cfs	0.07 ft	0.01 ft
0.43 cfs	0.07 ft	0.02 ft
0.44 cfs	0.08 ft	0.02 ft
0.45 cfs	0.08 ft	0.02 ft
0.46 cfs	0.08 ft	0.02 ft
0.47 cfs	0.08 ft	0.02 ft
0.48 cfs	0.08 ft	0.02 ft
0.49 cfs	0.08 ft	0.02 ft
0.50 cfs	0.08 ft	0.02 ft
0.51 cfs	0.08 ft	0.02 ft
0.52 cfs	0.08 ft	0.02 ft
0.53 cfs	0.09 ft	0.02 ft
0.54 cfs	0.09 ft	0.02 ft
0.55 cfs	0.09 ft	0.02 ft
0.56 cfs	0.09 ft	0.03 ft
0.57 cfs	0.09 ft	0.03 ft
0.58 cfs	0.09 ft	0.03 ft
0.59 cfs	0.09 ft	0.03 ft



Subcatchment #'s	Sumped Inlet #'s	Total Q (cfs)	Controlling Depth	Flow Spread		Road Cross
CWS	PF-18	0.50	0.08	weir	within gutter	2.00%
			0.02	orifice	within gutter	2.00%
CWN	PF-19	0.39	0.07	weir	within gutter	2.00%
			0.01	orifice	within gutter	2.00%
CES	PF-20	0.43	0.07	weir	within gutter	2.00%
			0.01	orifice	within gutter	2.00%
CEN	PF-21	0.48	0.08	weir	within gutter	2.00%
			0.02	orifice	within gutter	2.00%


10AT
Street Impervious Area
10BT
Street Pervious Area
A-3
PF-15 Pittock Pl.
LPW
Lower parking (imperv)
B1AB
Parking Pervious Area
A-2
MH A3 TO MH A2
PF16
Perk filter #16
A1A
Stilling Well 1
B1AT
Parking Impervious Area
PF14
Perk Filter 14 to MH A2
CB
A-1
MH A2 TO MH A1A & MH A1B
CWN
Street
PF19
Perk Filter 19
B-1
B-2
MH B1 - CMD and MH B2 to MH B1 Village (MH B1 TO MH A2)
PF18
Perk Filter 18
CWS
Street, sidewalk, landscape
Subcat
Reach
Pond
Link
LINE A & B
Routing Diagram for Parklands Final 8-26-2016-10-yr
Prepared by Hewlett-Packard Company, Printed 9/7/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

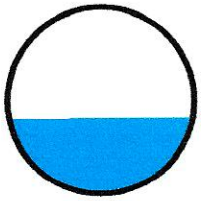
Summary for Reach A-3: PF-15 Pittock Pl.

Inflow Area = 0.687 ac, 66.25% Impervious, Inflow Depth = 3.16" for 10-yr event
Inflow = 0.54 cfs @ 7.90 hrs, Volume= 0.181 af
Outflow = 0.54 cfs @ 7.91 hrs, Volume= 0.181 af, Atten= 0%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 2.58 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 1.45 fps, Avg. Travel Time= 1.2 min

Peak Storage= 22 cf @ 7.91 hrs
Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 0.83' Flow Area= 0.5 sf, Capacity= 1.54 cfs

10.0" Round Pipe
n= 0.013
Length= 107.0' Slope= 0.0050 '/'
Inlet Invert= 201.36', Outlet Invert= 200.83'



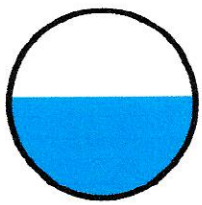
Summary for Reach PF14: Perk Filter 14 to MH A2

Inflow Area = 0.829 ac, 85.71% Impervious, Inflow Depth = 3.34" for 10-yr event
Inflow = 0.68 cfs @ 7.90 hrs, Volume= 0.230 af
Outflow = 0.68 cfs @ 7.90 hrs, Volume= 0.230 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 3.57 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 2.05 fps, Avg. Travel Time= 0.1 min

Peak Storage= 2 cf @ 7.90 hrs
Average Depth at Peak Storage= 0.36'
Bank-Full Depth= 0.67' Flow Area= 0.3 sf, Capacity= 1.21 cfs

8.0" Round Pipe
n= 0.013
Length= 8.0' Slope= 0.0100 '/'
Inlet Invert= 212.80', Outlet Invert= 212.72'



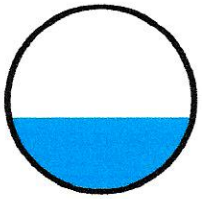
Summary for Reach PF16: Perk filter #16

Inflow Area = 0.484 ac, 93.53% Impervious, Inflow Depth = 3.47" for 10-yr event
Inflow = 0.42 cfs @ 7.89 hrs, Volume= 0.140 af
Outflow = 0.42 cfs @ 7.89 hrs, Volume= 0.140 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 3.15 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 1.79 fps, Avg. Travel Time= 0.1 min

Peak Storage= 1 cf @ 7.89 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 0.67' Flow Area= 0.3 sf, Capacity= 1.21 cfs

8.0" Round Pipe
n= 0.013
Length= 8.0' Slope= 0.0100 '/'
Inlet Invert= 296.17', Outlet Invert= 296.09'



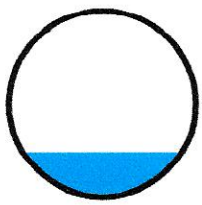
Summary for Reach PF18: Perk Filter 18

Inflow Area = 0.692 ac, 73.27% Impervious, Inflow Depth = 3.14" for 10-yr event
Inflow = 0.50 cfs @ 7.98 hrs, Volume= 0.181 af
Outflow = 0.50 cfs @ 7.98 hrs, Volume= 0.181 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 4.92 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.77 fps, Avg. Travel Time= 0.2 min

Peak Storage= 3 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.20'
Bank-Full Depth= 0.83' Flow Area= 0.5 sf, Capacity= 3.90 cfs

10.0" Round Pipe
n= 0.013
Length= 30.0' Slope= 0.0317 '/'
Inlet Invert= 216.64', Outlet Invert= 215.69'



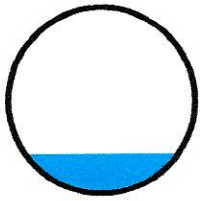
Summary for Reach PF19: Perk Filter 19

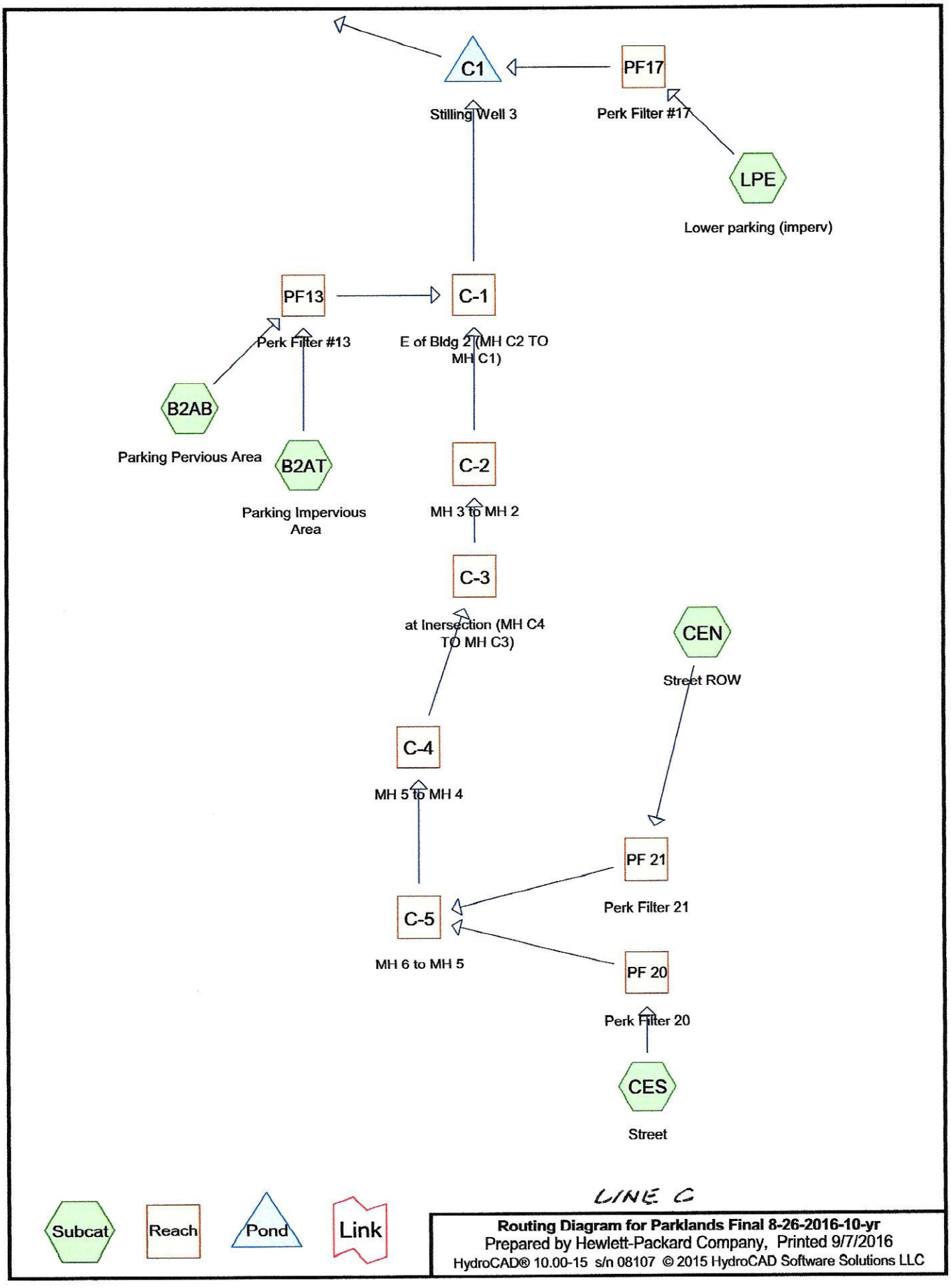
Inflow Area = 0.511 ac, 82.63% Impervious, Inflow Depth = 3.29" for 10-yr event
Inflow = 0.39 cfs @ 7.98 hrs, Volume= 0.140 af
Outflow = 0.39 cfs @ 7.98 hrs, Volume= 0.140 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 4.57 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.57 fps, Avg. Travel Time= 0.2 min

Peak Storage= 3 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.18'
Bank-Full Depth= 0.83' Flow Area= 0.5 sf, Capacity= 3.90 cfs

10.0" Round Pipe
n= 0.013
Length= 30.0' Slope= 0.0317 '/'
Inlet Invert= 216.64', Outlet Invert= 215.69'




C1
Stilling Well 3
PF17
Perk Filter #17
LPE
Lower parking (imperv)
PF13
Perk Filter #13
C-1
E of Bldg 2 (MH C2 TO MH C1)
B2AB
Parking Pervious Area
B2AT
Parking Impervious Area
C-2
MH 3 to MH 2
C-3
at Inersection (MH C4 TO MH C3)
CEN
Street ROW
C-4
MH 5 to MH 4
PF 21
Perk Filter 21
C-5
MH 6 to MH 5
PF 20
Perk Filter 20
CES
Street
Subcat
Reach
Pond
Link
LINE C
Routing Diagram for Parklands Final 8-26-2016-10-yr
Prepared by Hewlett-Packard Company, Printed 9/7/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

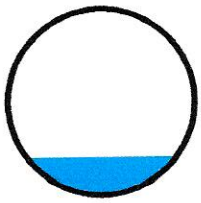
Summary for Reach PF 20: Perk Filter 20

Inflow Area = 0.598 ac, 72.87% Impervious, Inflow Depth = 3.11" for 10-yr event
Inflow = 0.43 cfs @ 7.98 hrs, Volume= 0.155 af
Outflow = 0.43 cfs @ 7.98 hrs, Volume= 0.155 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 5.53 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.11 fps, Avg. Travel Time= 0.1 min

Peak Storage= 2 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 0.83' Flow Area= 0.5 sf, Capacity= 4.90 cfs

10.0" Round Pipe
n= 0.013
Length= 23.6' Slope= 0.0500 '/'
Inlet Invert= 225.19', Outlet Invert= 224.01'



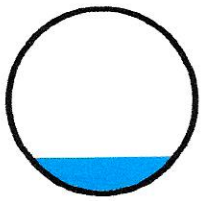
Summary for Reach PF 21: Perk Filter 21

Inflow Area = 0.633 ac, 81.52% Impervious, Inflow Depth = 3.25" for 10-yr event
Inflow = 0.48 cfs @ 7.98 hrs, Volume= 0.172 af
Outflow = 0.48 cfs @ 7.98 hrs, Volume= 0.172 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 6.87 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.86 fps, Avg. Travel Time= 0.1 min

Peak Storage= 2 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.15'
Bank-Full Depth= 0.83' Flow Area= 0.5 sf, Capacity= 6.37 cfs

10.0" Round Pipe
n= 0.013
Length= 24.0' Slope= 0.0846 '/'
Inlet Invert= 226.02', Outlet Invert= 223.99'



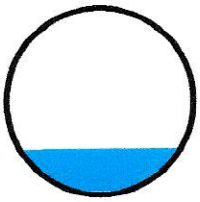
Summary for Reach PF13: Perk Filter #13

Inflow Area = 0.601 ac, 83.31% Impervious, Inflow Depth = 3.30" for 10-yr event
Inflow = 0.49 cfs @ 7.90 hrs, Volume= 0.165 af
Outflow = 0.49 cfs @ 7.90 hrs, Volume= 0.165 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 7.25 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.06 fps, Avg. Travel Time= 0.3 min

Peak Storage= 4 cf @ 7.90 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 0.67' Flow Area= 0.3 sf, Capacity= 3.63 cfs

8.0" Round Pipe
n= 0.013
Length= 65.0' Slope= 0.0903 '/'
Inlet Invert= 211.87', Outlet Invert= 206.00'



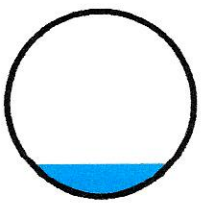
Summary for Reach PF17: Perk Filter #17

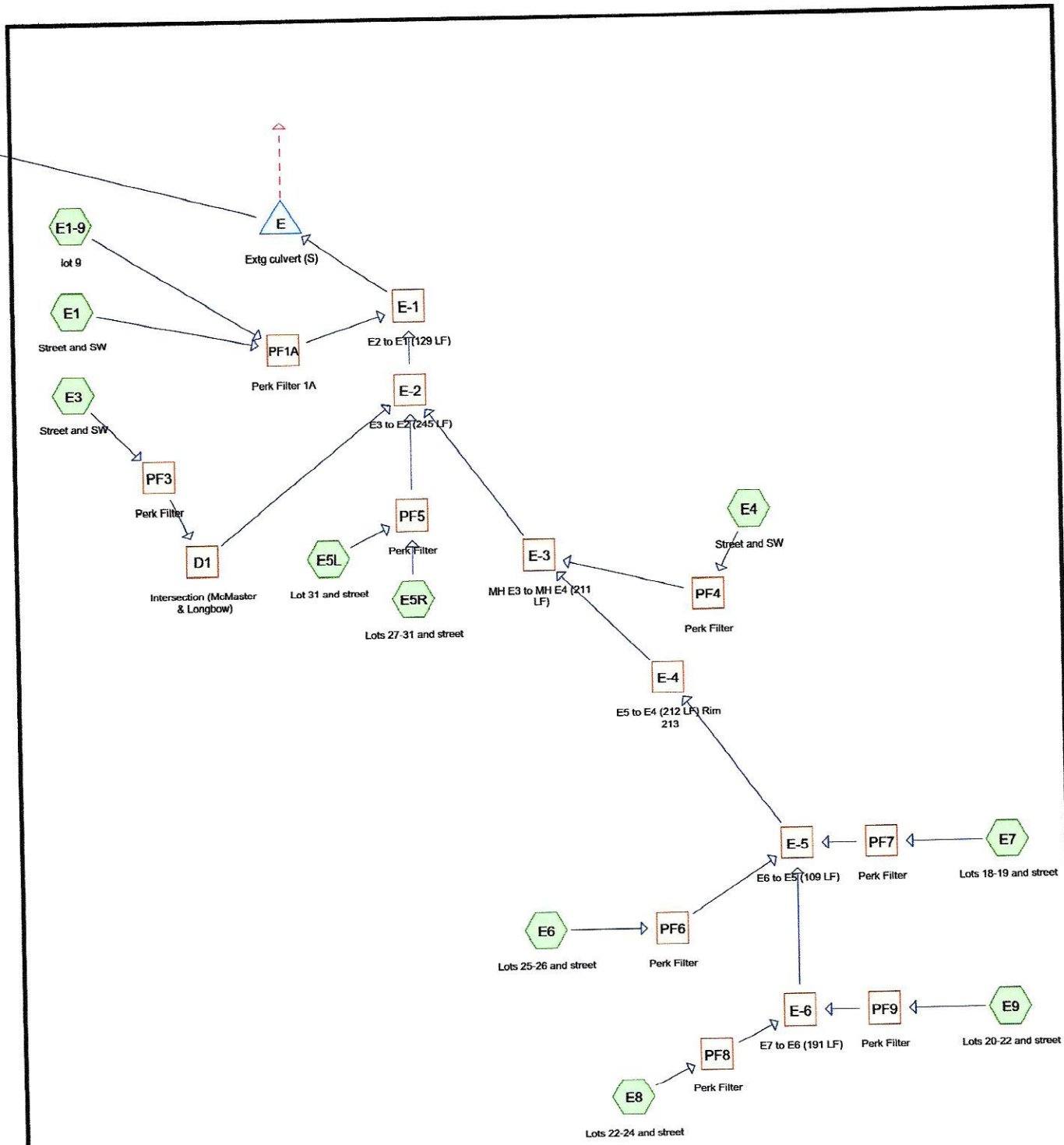
Inflow Area = 0.540 ac, 96.88% Impervious, Inflow Depth = 3.52" for 10-yr event
Inflow = 0.47 cfs @ 7.89 hrs, Volume= 0.158 af
Outflow = 0.47 cfs @ 7.89 hrs, Volume= 0.158 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 12.88 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 7.20 fps, Avg. Travel Time= 0.0 min

Peak Storage= 1 cf @ 7.89 hrs
Average Depth at Peak Storage= 0.11'
Bank-Full Depth= 0.67' Flow Area= 0.3 sf, Capacity= 8.28 cfs

8.0" Round Pipe
n= 0.013
Length= 20.0' Slope= 0.4690 '/'
Inlet Invert= 199.05', Outlet Invert= 189.67'




E
Extg culvert (S)
E1-9
lot 9
E1
Street and SW
PF1A
Perk Filter 1A
E-1
E2 to E1 (129 LF)
E-2
E3 to E2 (245 LF)
E3
Street and SW
PF3
Perk Filter
D1
Intersection (McMaster & Longbow)
E5L
Lot 31 and street
PF5
Perk Filter
E5R
Lots 27-31 and street
E-3
MH E3 to MH E4 (211 LF)
E4
Street and SW
PF4
Perk Filter
E-4
E5 to E4 (212 LF) Rim 213
E-5
E6 to E5 (109 LF)
PF7
Perk Filter
E7
Lots 18-19 and street
E6
Lots 25-26 and street
PF6
Perk Filter
E-6
E7 to E6 (191 LF)
PF9
Perk Filter
E9
Lots 20-22 and street
PF8
Perk Filter
E8
Lots 22-24 and street
Subcat
Reach
Pond
Link
LINE D, E, & F
Routing Diagram for Parklands Final 8-26-2016-10-yr
Prepared by Hewlett-Packard Company, Printed 9/7/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

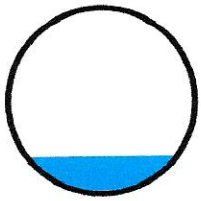
Summary for Reach PF1A: Perk Filter 1A

Inflow Area = 0.344 ac, 45.85% Impervious, Inflow Depth = 2.77" for 10-yr event
Inflow = 0.23 cfs @ 7.96 hrs, Volume= 0.079 af
Outflow = 0.23 cfs @ 7.96 hrs, Volume= 0.079 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 4.36 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.44 fps, Avg. Travel Time= 0.2 min

Peak Storage= 1 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 0.67' Flow Area= 0.3 sf, Capacity= 2.43 cfs

8.0" Round Pipe
n= 0.013
Length= 26.0' Slope= 0.0404 '/'
Inlet Invert= 188.52', Outlet Invert= 187.47'



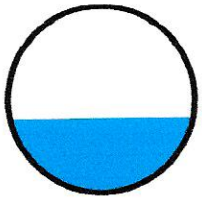
Summary for Reach PF3: Perk Filter

Inflow Area = 0.336 ac, 87.33% Impervious, Inflow Depth = 3.35" for 10-yr event
Inflow = 0.28 cfs @ 7.89 hrs, Volume= 0.094 af
Outflow = 0.28 cfs @ 7.89 hrs, Volume= 0.094 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 2.14 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.22 fps, Avg. Travel Time= 0.2 min

Peak Storage= 2 cf @ 7.89 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 0.67' Flow Area= 0.3 sf, Capacity= 0.83 cfs

8.0" Round Pipe
n= 0.013
Length= 15.0' Slope= 0.0047 '/'
Inlet Invert= 199.47', Outlet Invert= 199.40'



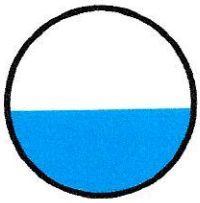
Summary for Reach PF4: Perk Filter

Inflow Area = 0.541 ac, 58.09% Impervious, Inflow Depth = 2.86" for 10-yr event
Inflow = 0.38 cfs @ 7.91 hrs, Volume= 0.129 af
Outflow = 0.38 cfs @ 7.91 hrs, Volume= 0.129 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 2.37 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.37 fps, Avg. Travel Time= 0.1 min

Peak Storage= 2 cf @ 7.91 hrs
Average Depth at Peak Storage= 0.31'
Bank-Full Depth= 0.67' Flow Area= 0.3 sf, Capacity= 0.85 cfs

8.0" Round Pipe
n= 0.013
Length= 10.0' Slope= 0.0050 '/'
Inlet Invert= 198.38', Outlet Invert= 198.33'



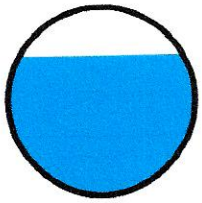
Summary for Reach PF5: Perk Filter

Inflow Area = 1.727 ac, 35.49% Impervious, Inflow Depth = 2.76" for 10-yr event
Inflow = 1.05 cfs @ 8.00 hrs, Volume= 0.398 af
Outflow = 1.05 cfs @ 8.00 hrs, Volume= 0.398 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 3.77 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.24 fps, Avg. Travel Time= 0.1 min

Peak Storage= 4 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.50'
Bank-Full Depth= 0.67' Flow Area= 0.3 sf, Capacity= 1.16 cfs

8.0" Round Pipe
n= 0.013
Length= 13.0' Slope= 0.0092 '/'
Inlet Invert= 198.41', Outlet Invert= 198.29'



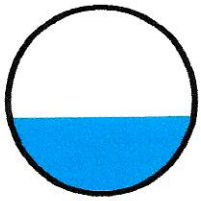
Summary for Reach PF6: Perk Filter

Inflow Area = 0.509 ac, 28.21% Impervious, Inflow Depth = 2.69" for 10-yr event
Inflow = 0.30 cfs @ 8.00 hrs, Volume= 0.114 af
Outflow = 0.30 cfs @ 8.00 hrs, Volume= 0.114 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 2.24 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.26 fps, Avg. Travel Time= 0.2 min

Peak Storage= 2 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 0.67' Flow Area= 0.3 sf, Capacity= 0.85 cfs

8.0" Round Pipe
n= 0.013
Length= 12.0' Slope= 0.0050 '/'
Inlet Invert= 210.21', Outlet Invert= 210.15'



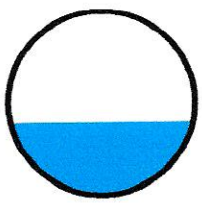
Summary for Reach PF7: Perk Filter

Inflow Area = 0.508 ac, 28.29% Impervious, Inflow Depth = 2.69" for 10-yr event
Inflow = 0.30 cfs @ 8.00 hrs, Volume= 0.114 af
Outflow = 0.30 cfs @ 8.00 hrs, Volume= 0.114 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 2.39 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.35 fps, Avg. Travel Time= 0.1 min

Peak Storage= 1 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 0.67' Flow Area= 0.3 sf, Capacity= 0.94 cfs

8.0" Round Pipe
n= 0.013
Length= 10.0' Slope= 0.0060 '/'
Inlet Invert= 210.21', Outlet Invert= 210.15'



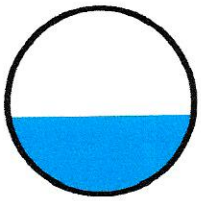
Summary for Reach PF8: Perk Filter

Inflow Area = 0.560 ac, 22.57% Impervious, Inflow Depth = 2.63" for 10-yr event
Inflow = 0.32 cfs @ 8.00 hrs, Volume= 0.123 af
Outflow = 0.32 cfs @ 8.00 hrs, Volume= 0.123 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 2.28 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.28 fps, Avg. Travel Time= 0.2 min

Peak Storage= 2 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.28'
Bank-Full Depth= 0.67' Flow Area= 0.3 sf, Capacity= 0.85 cfs

8.0" Round Pipe
n= 0.013
Length= 12.0' Slope= 0.0050 '/'
Inlet Invert= 212.21', Outlet Invert= 212.15'



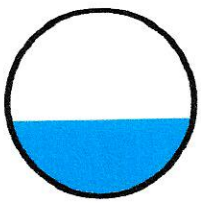
Summary for Reach PF9: Perk Filter

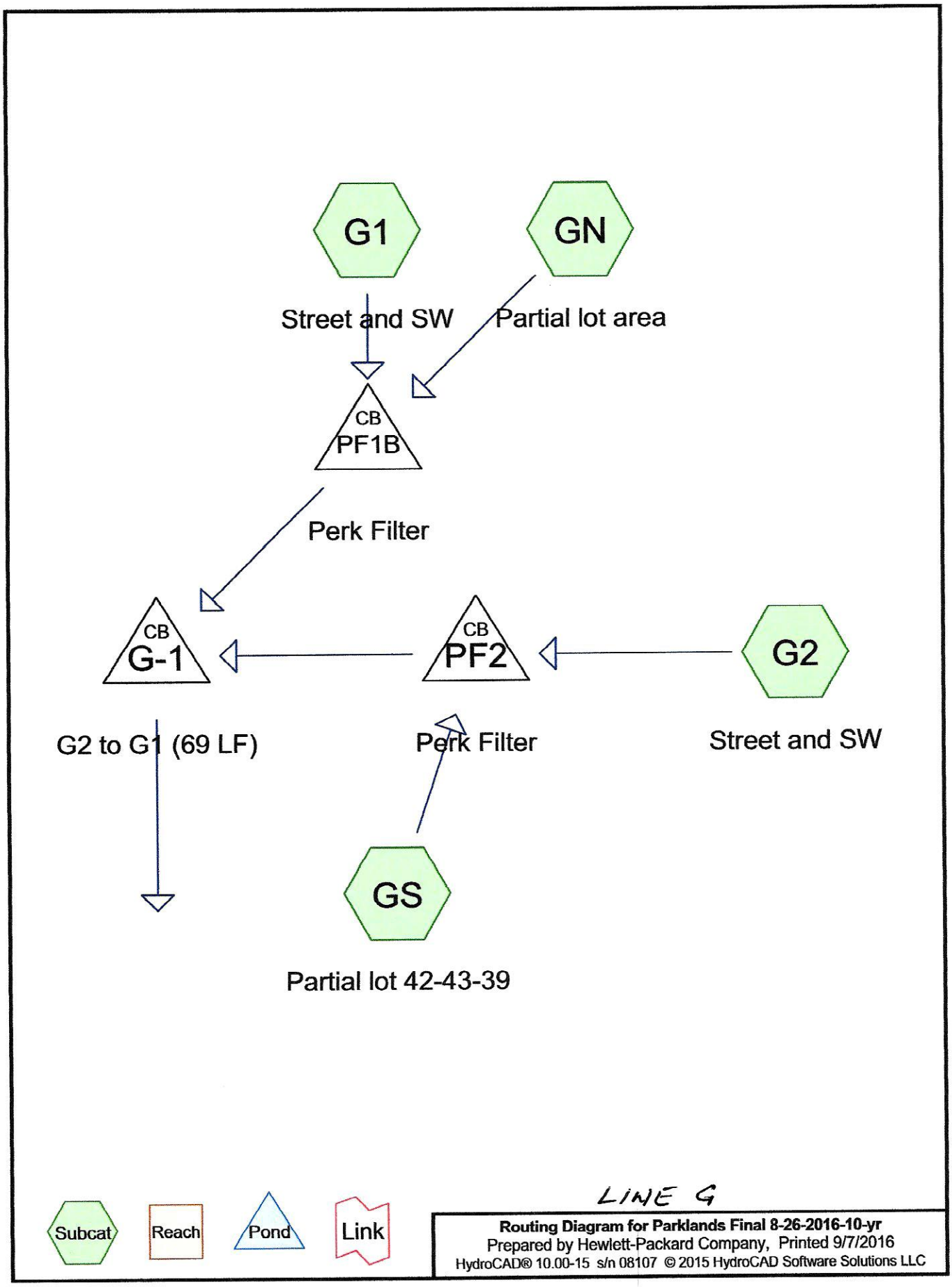
Inflow Area = 0.560 ac, 22.57% Impervious, Inflow Depth = 2.63" for 10-yr event
Inflow = 0.32 cfs @ 8.00 hrs, Volume= 0.123 af
Outflow = 0.32 cfs @ 8.00 hrs, Volume= 0.123 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 2.44 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.37 fps, Avg. Travel Time= 0.1 min

Peak Storage= 1 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 0.67' Flow Area= 0.3 sf, Capacity= 0.94 cfs

8.0" Round Pipe
n= 0.013
Length= 10.0' Slope= 0.0060 '/'
Inlet Invert= 212.21', Outlet Invert= 212.15'




G1
GN
Street and SW
Partial lot area
CB
PF1B
Perk Filter
CB
G-1
CB
PF2
G2
G2 to G1 (69 LF)
Perk Filter
Street and SW
GS
Partial lot 42-43-39
Subcat
Reach
Pond
Link
LINE G
Routing Diagram for Parklands Final 8-26-2016-10-yr
Prepared by Hewlett-Packard Company, Printed 9/7/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Summary for Pond PF1B: Perk Filter

Inflow Area = 0.932 ac, 55.10% Impervious, Inflow Depth = 2.89" for 10-yr event
Inflow = 0.64 cfs @ 7.95 hrs, Volume= 0.225 af
Outflow = 0.64 cfs @ 7.95 hrs, Volume= 0.225 af, Atten= 0%, Lag= 0.0 min
Primary = 0.64 cfs @ 7.95 hrs, Volume= 0.225 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Peak Elev= 188.65' @ 7.99 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	186.50'	**6.0" Round Culvert** L= 11.0' Square-edged headwall, Ke= 0.500 Inlet / Outlet Invert= 186.50' / 186.43' S= 0.0064 '/' Cc= 0.900 n= 0.013, Flow Area= 0.20 sf

Primary OutFlow Max=0.63 cfs @ 7.95 hrs HW=188.63' TW=188.19' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 0.63 cfs @ 3.19 fps)

Summary for Pond PF2: Perk Filter

Inflow Area = 0.736 ac, 53.88% Impervious, Inflow Depth = 2.89" for 10-yr event
Inflow = 0.51 cfs @ 7.95 hrs, Volume= 0.177 af
Outflow = 0.51 cfs @ 7.95 hrs, Volume= 0.177 af, Atten= 0%, Lag= 0.0 min
Primary = 0.51 cfs @ 7.95 hrs, Volume= 0.177 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Peak Elev= 188.48' @ 8.00 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	186.41'	**6.0" Round Culvert** L= 13.0' Square-edged headwall, Ke= 0.500 Inlet / Outlet Invert= 186.41' / 186.36' S= 0.0038 '/' Cc= 0.900 n= 0.013, Flow Area= 0.20 sf

Primary OutFlow Max=0.48 cfs @ 7.95 hrs HW=188.45' TW=188.19' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 0.48 cfs @ 2.47 fps)

APPENDIX E-2 CATCH BASIN DESIGN COMMENTS

8.2 Catch Basin Locations

Catch basins and inlets are required at the following locations:

1. At any low point in the roadway or curb returns at intersections.

   - **This criteria has been met.**

2. Where any roadway transitions from a crown section to a shed section to prevent gutter flow from flowing across the roadway.

   - **N/A**

3. Such that a maximum of 400 linear feet of paved street is collected by a single catch basin.

   - **Inlet calcs. provided**

4. Inlets shall be used at intersections to prevent street cross-flow, which could cause pedestrian or vehicular hazards. It is desirable to intercept 100 percent of any potential street cross-flow under these conditions. Intersection inlets should be placed on tangent curb sections near corners. Catch basins and inlets shall be placed so that water will not accumulate on walking surfaces per ADA guidelines.

   - **This criteria has been met**

5. In sag vertical curves, where significant ponding may occur, flanking inlets shall be placed to limit spread on low gradient approaches to the level point. The flanking inlets are intended to provide relief if the inlet at the low point becomes clogged or if the design spread is exceeded.

   - **Flanking inlets are not proposed. Inlet calcs. with 50% assumed clogging have been made for the 100-yr event.**

6. Combination inlets or curb opening inlets shall be used in sag locations. Grate inlets are not allowed because of their tendency to become clogged.

   - **Combination inlets are not proposed. The inlets are part of the Perk Filter units and are 24” x 24” grates.**

7. Combination curb inlets are required on slopes greater than 10 percent or when necessary to prevent bypass flow from crossing an ADA ramp. Curb ramps and their approaches shall be designed so that water will not accumulate on walking surfaces per ADA guidelines.

   - **Calculations to determine bypass have been provided and accounted for at downslope structures.**

APPENDIX E-2 CATCH BASIN DESIGN COMMENTS

Hydraulic Design of Energy Dissipators for Culverts and Channels

Hydraulic Engineering Circular No. 14

September 1983

U.S. Department of Transportation

Federal Highway Administration

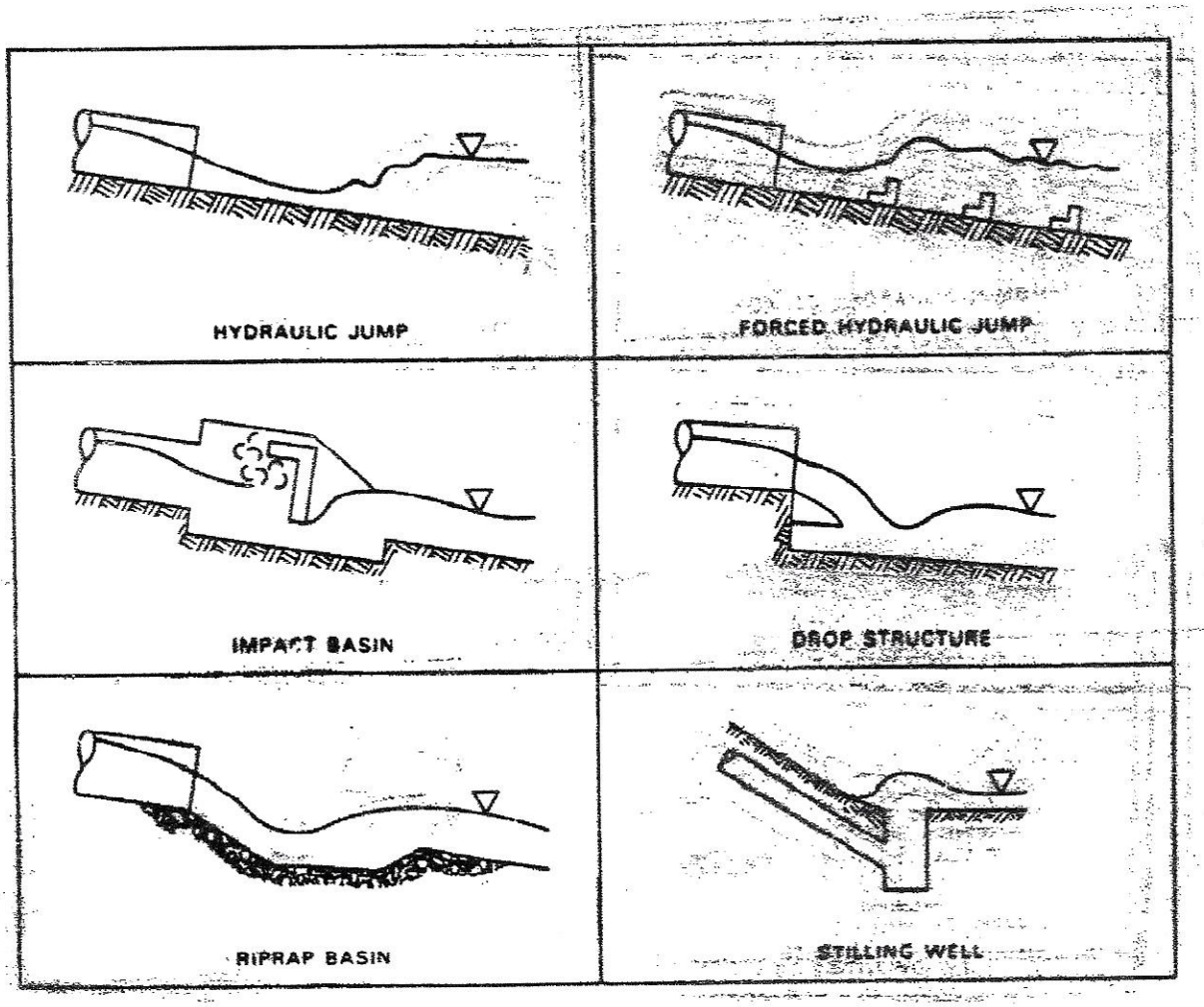


Exhibit 16 SP26-1005

X-B. CORPS OF ENGINEERS STILLING WELL

The design of this type of stilling well energy dissipator is based on model tests conducted by the Corps of Engineers. (X-B-1 and 2)

The dissipator has application where debris is not a serious problem. It will operate with moderate to high concentrations of sand and silt but is not recommended for areas where quantities of large floating or rolling debris is expected unless suitable debris-control structures are utilized. Its greatest potential, as far as highways are concerned, is at the outfalls of storm drains, median, and pipe down drains where little debris is expected. It may also be useful as a temporary erosion control device during construction.

Design Recommendations

The design is straightforward. Once the size and discharge of the incoming pipe are determined, figure X-B-1 is used to select the stilling well diameter (D_W). The model tests indicated that satisfactory performance can be maintained for $Q/D^{5/2}$ ratios as large as 10.0, with stilling well diameters of one, two, three, and five times that of the incoming conduits. These ratios were used to define the curves shown in figure X-B-1.

The tests also indicated that there is an optimum depth of stilling well below the invert of the incoming pipe. This depth is determined by entering figure X-B-2 with the slope of the incoming pipe and using the stilling well diameter (D_W) previously obtained from figure X-B-1.

The height of the stilling well above the invert is fixed at twice the diameter of the incoming pipe (2D). This dimension results in satisfactory operation and is practical from a cost standpoint; however, if increased, greater efficiency will result.

Tailwater also increases the efficiency of the stilling well. Whenever possible, it should be located in a sump or depressed area.

It is recommended that riprap or other types of channel protection be provided around the stilling well outlet and for a distance of at least $3D_W$ downstream.

The outlet may also be covered with a screen or grate for safety. However, the screen or grate should have a clear opening area of at least 75 percent of the total stilling well area and be capable of passing small floating debris such as cans and bottles.

Design Procedures

(1) Select approach pipe diameter (D) and discharge (Q).

(2) Obtain well diameter (D_W) from figure X-B-1.

(3) Calculate the culvert slope = (Vertical/horizontal distance). The depth of the well below the culvert invert (h_1) is determined from figure X-B-2.

(4) The depth of the well above the culvert invert (h_2) is equal to 2(D) as a minimum but may be greater if the site permits.

(5) The total height of the well (h_W) = h_1+h_2.

Example Problem

Given: 24" CMP downdrain on a 2:1 slope carrying a Q = 15 cfs

Find: Stilling well dimensions

Solution:

(1) D=2 ft., Q=15 cfs
(2) From figure X-B-1 $D_W=1.5D=3$ ft.
(3) Slope=1/2=.5, $h_1/D_W=.42$ from figure X-B-2
$h_1=.42(3.0)=1.26$ ft., Use $h_1=1.3$ ft.
(4) $h_2=2(D)=2(2)=4$ ft.
(5) $h_W= h_1+h_2=1.3+4=5.3$ ft.

X-B-1. IMPACT-TYPE ENERGY DISSIPATOR FOR STORM-DRAINAGE OUTFALLS STILLING WELL DESIGN, U. S. Army Corps of Engineers, Technical Report No. 2-620 March 1963, WES, Vicksburg, Mississippi.

X-B-2. Grace, J. L., Pickering, G. A., EVALUATION OF THREE ENERGY DISSIPATORS FOR STORM DRAIN OUTLETS, U.S. Army WES, HRB 1971, Washington, D.C.

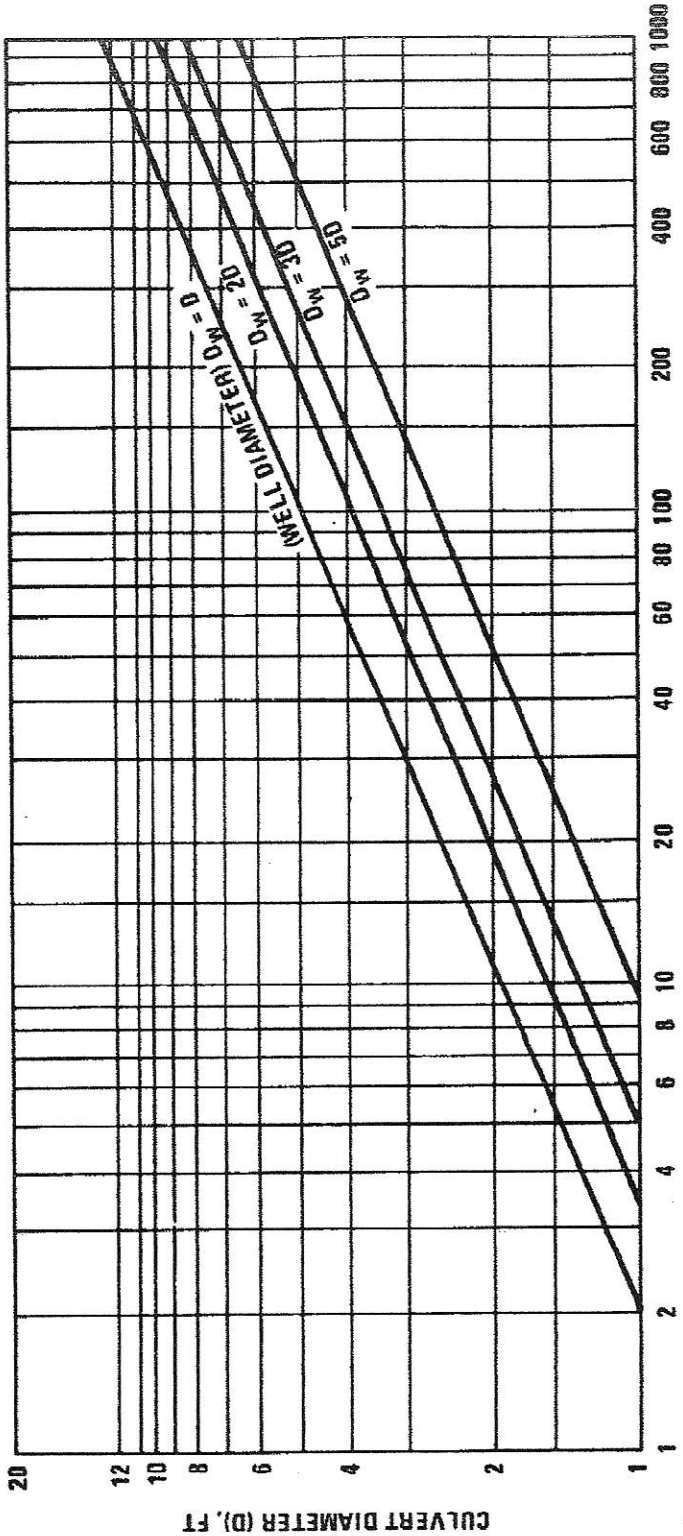


FIGURE X-B-1. STILLING WELL DIAMETER (D_W) FROM REFERENCE X-B-1

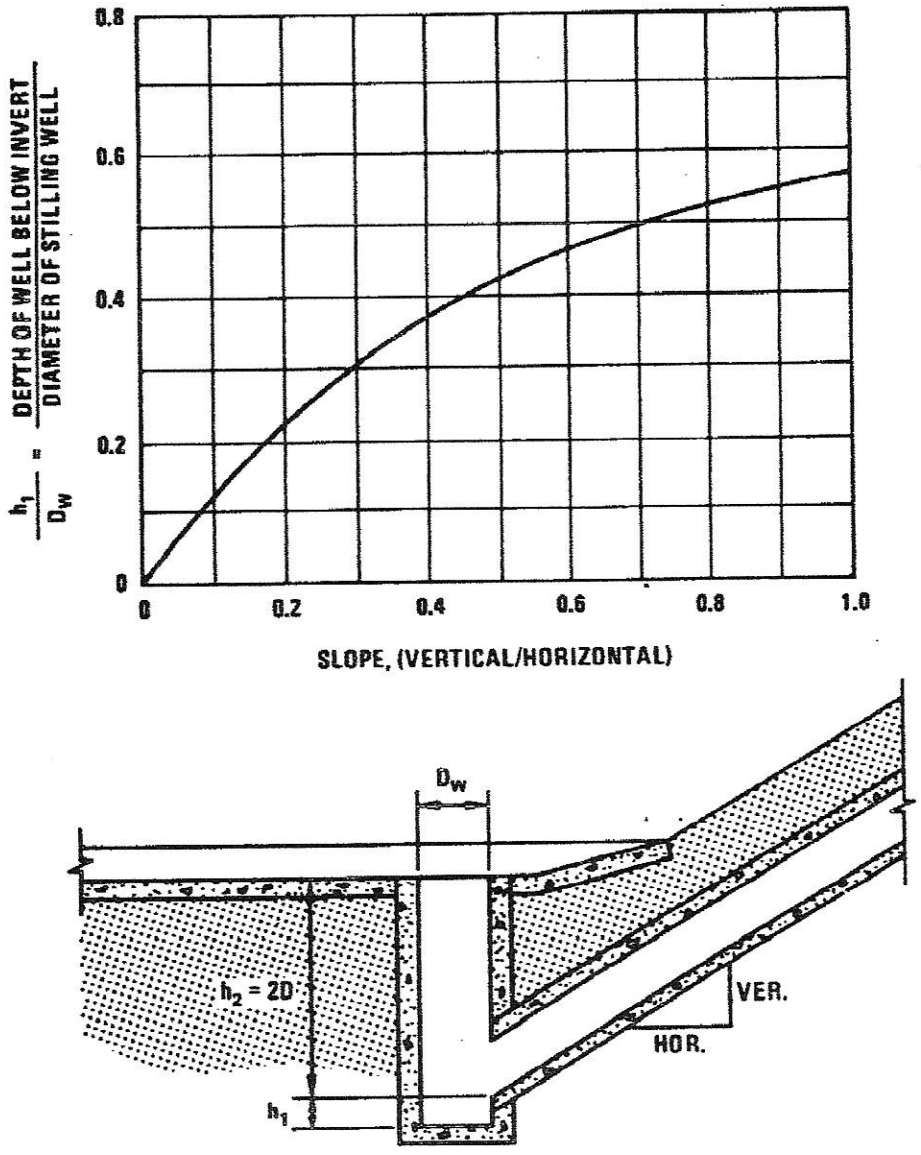


FIGURE X-B-2. STILLING WELL HEIGHT FROM REFERENCE X-B-1

E-3 ENERGY DISSIPATOR MANHOLE DESIGN
MH C1 - SW3

Job Name: **Parklands**
Job Number:
Date: 9/5/16 2:22 PM
Location: Main Outfall - Line C (MH C1) (use same size for MH A1 and MH A1B)

Stilling Well Design

Line C **(Q_{100} is 19.73 cfs)** ***SW3***

Reference: HEC #14, pages X-B-1 thru X-B-4

Design Procedure

1. Determine approach pipe diameterter (D) and discharge (Q). **(Q_{100} is about 19.7cfs)**

2. Determine Well Diameter (D_W) from figure X-B-1.

3. Calculte the culvert slope.

Determine the depth of the well below the culvert invert from figure X-B-2.

4. The depth of the well above the the culvert invert (h2) is equal to 2(D) .
as a minimum but may be greater if the site permits

5. The total height of the well is (hw) = h_1+h_2.

Stilling Well Design
SW3

Given			figure X-B-1	figure X-B-2	min = 2 x (D)	= h_1+h_2
Step 1	Step 1	Step 3	Step 2	Step 3, part 2	Step 4	Step 5
D	Q	Slope (s)	D_W	h_1	h_2	h_w
(ft)	(cfs)	%	(ft)	(ft)	(ft)	(ft)
1.5	19.7	7.42	4.00	2.00	3.00	5.00
	Assumptions		4D*	use 2 ft instead of 0.32**		

***but use 2.67D = 3 ft, since h_1 is being increased**

* find 4D per Fig. X-B-1

and, h_1/D_W = 2 divided by 4 = **0.50**
larger than 0.32, OK

Step 3, part 2

**From Fig. X-B-2 get approx. 0.08 ratio

** Find minimum h_1:

h_1 = D_W x ratio = 0.32 ft

Try 2.0 ft for design

APPENDIX E-4 FLOW DISSIPATION SYSTEM FOR STORM LINE A AND LINE C

Perforated Pipe Dissipation System

The input for modeling the perf pipe dissipation system was developed from rating tables published in an Advanced Drainage System (ADS) publication "Hydraulics Brochure" – outflow From Perforated Pipe 2.105. The published data is in gpm and has been converted to cfs. The data for the 24 inch perf pipe was derived by multiplying the data for an 18" pipe by a factor of 1.33. This is the increase in perforation area/LF in increasing from 18" to 24". The tabulated data was reduced by 50% to account for possible blockage from the rock aggregate placed around the 24 inch perf pipe.

The rating tables are based on a horizontal profile, so this system on a slight slope would have a better outflow rate than in input flow data per stage. The results indicate that the system can adequately manage the inflow. The spread length for the outflow is 180 ft plus 124 ft = 304 LF.

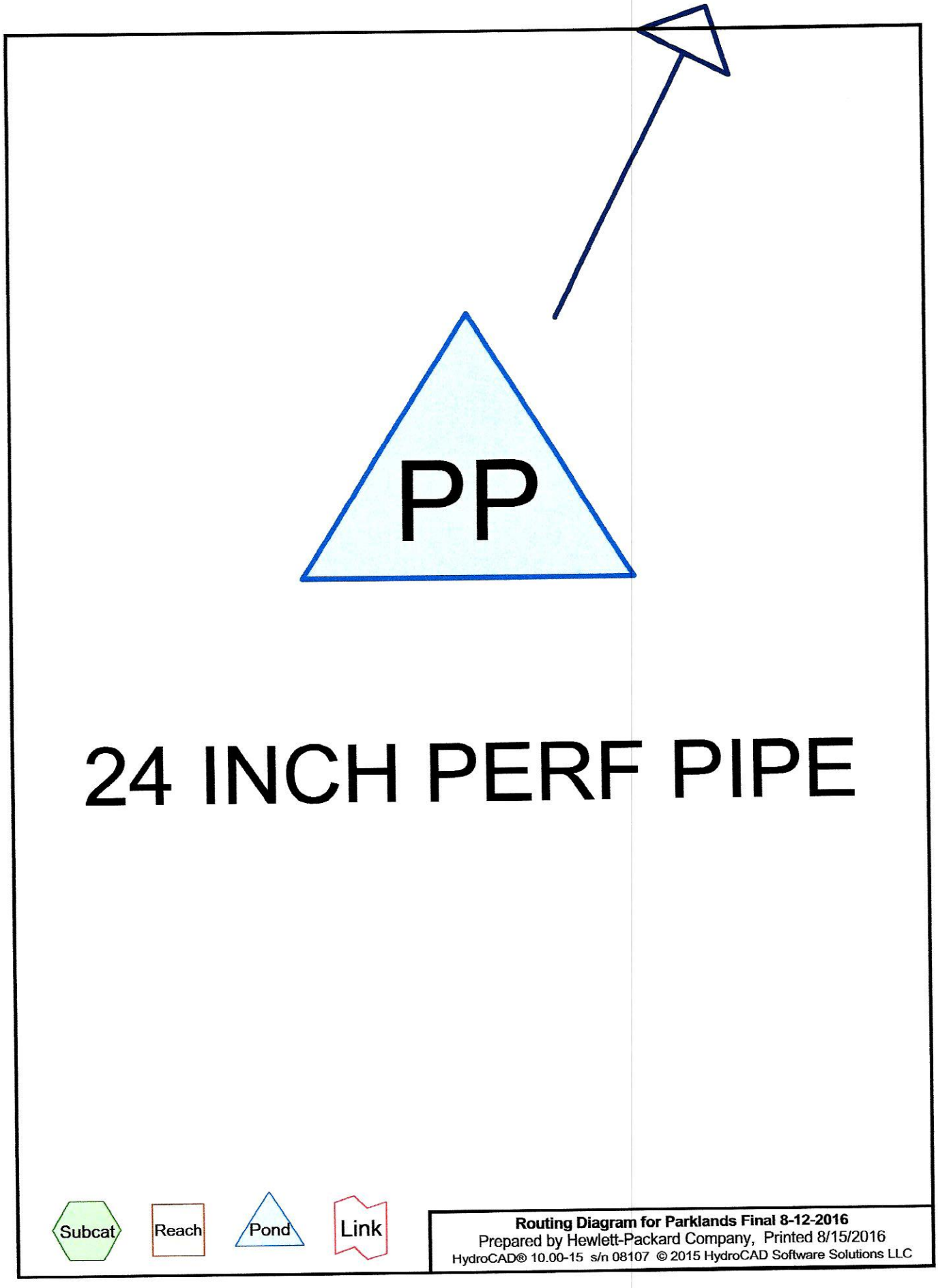
Note: This data is directly from ADS "Hyraulics Brochure" - Outflow from								
	perforated Pipe 2.105				**(Q in cfs has been added)**			
Head (H)	Pipe Dia.	Discharge (Q)	Q		Head (H)	Pipe Dia.	Discharge (Q)	Q
(inches)	(inches)	(gpm/ft)	(cfs/ft)		(inches)	(inches)	(gpm/ft)	(cfs/ft)
0	**6**	0.17	0.0004		0	**8**	0.12	0.0003
2	**6**	4.06	0.0091		2	**8**	4.81	0.0107
4	**6**	9.13	0.0204		4	**8**	10.92	0.0244
6	**6**	15.36	0.0343		6	**8**	18.43	0.0411
8	**6**	22.77	0.0508		8	**8**	27.35	0.0610
10	**6**	31.36	0.0699		10	**8**	37.69	0.0840
12	**6**	41.12	0.0917		12	**8**	49.43	0.1102
14	**6**	52.05	0.1161		14	**8**	62.59	0.1396
16	**6**	64.15	0.1431		16	**8**	77.16	0.1721
18	**6**	77.43	0.1727		18	**8**	93.13	0.2077
					20	**8**	110.52	0.2465
Head (H)	Pipe Dia.	Discharge (Q)	Q		Head (H)	Pipe Dia.	Discharge (Q)	Q
(inches)	(inches)	(gpm/ft)	(cfs/ft)		(inches)	(inches)	(gpm/ft)	(cfs/ft)
0	**10**	0.06	0.0001		0	**12**	-0.05	-0.0001
2	**10**	3.02	0.0067		2	**12**	2.60	0.0058
4	**10**	6.39	0.0142		4	**12**	5.93	0.0132
6	**10**	10.17	0.0227		6	**12**	9.96	0.0222
8	**10**	14.34	0.0320		8	**12**	14.68	0.0327
10	**10**	18.92	0.0422		10	**12**	20.09	0.0448
12	**10**	23.89	0.0533		12	**12**	26.20	0.0584
14	**10**	29.27	0.0653		14	**12**	32.99	0.0736
16	**10**	35.05	0.0782		16	**12**	40.48	0.0903

APPENDIX E-4 FLOW DISSIPATION SYSTEM FOR STORM LINE A AND LINE C

18	**10**	41.23	0.0919		18	**12**	48.67	0.1085
20	**10**	47.82	0.1066		20	**12**	57.54	0.1283
22	**10**	54.80	0.1222		22	**12**	67.11	0.1497
					24	**12**	77.37	0.1725
Head (H)	Pipe Dia.	Discharge (Q)	Q		Head (H)	Pipe Dia.	Discharge (Q)	Q
(inches)	(inches)	(gpm/ft)	(cfs/ft)		(inches)	(inches)	(gpm/ft)	(cfs/ft)
0	**15**	0.04	0.0001		0	**18**	0.04	0.0001
2	**15**	2.25	0.0050		2	**18**	2.51	0.0056
4	**15**	5.02	0.0112		4	**18**	5.96	0.0133
6	**15**	8.34	0.0186		6	**18**	10.37	0.0231
8	**15**	12.21	0.0272		8	**18**	15.76	0.0351
10	**15**	16.64	0.0371		10	**18**	22.11	0.0493
12	**15**	21.63	0.0482		12	**18**	29.42	0.0656
14	**15**	27.18	0.0606		14	**18**	37.71	0.0841
16	**15**	33.28	0.0742		16	**18**	46.96	0.1047
18	**15**	39.93	0.0890		18	**18**	57.19	0.1275
20	**15**	47.14	0.1051		20	**18**	68.38	0.1525
22	**15**	54.91	0.1224		22	**18**	80.53	0.1796
24	**15**	63.24	0.1410		24	**18**	93.66	0.2089
26	**15**	72.12	0.1608		26	**18**	107.75	0.2403
					28	**18**	122.82	0.2739
					30	**18**	138.85	0.3096

HCAD ID - PP represents input for 304 LF of 24" perf pipe

Head (H)	Pipe Dia.	Discharge (Q)	Q		Mult. by	Assume		
(inches)	(inches)	(gpm/ft)	(cfs/ft)		304 LF	50% Flow		
					(cfs)	(cfs)		
0	**24**	0.05	0.0001		0.036147	0.018073		
2	**24**	3.35	0.0075		2.268205	1.134103		
4	**24**	7.94	0.0177		5.385857	2.692929		
6	**24**	13.82	0.0308		9.371031	4.685515		
8	**24**	21.01	0.0468		14.2418	7.120899		
10	**24**	29.47	0.0657		19.98009	9.990043		
12	**24**	39.22	0.0875		26.58589	13.29295		
14	**24**	50.27	0.1121		34.0773	17.03865		
16	**24**	62.60	0.1396		42.43622	21.21811		
18	**24**	76.23	0.1700		51.68074	25.84037		
20	**24**	91.15	0.2033		61.79277	30.89639		
22	**24**	107.35	0.2394		72.77233	36.38617		
24	**24**	124.85	0.2784		84.63748	42.31874		
26	**24**	143.63	0.3203		97.37016	48.68508		
28	**24**	163.72	0.3651		110.9884	55.49421		
30	**24**	185.09	0.4127		125.4742	62.73711		


PP
24 INCH PERF PIPE
Subcat
Reach
Pond
Link
Routing Diagram for Parklands Final 8-12-2016
Prepared by Hewlett-Packard Company, Printed 8/15/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

Summary for Pond PP: 24 INCH PERF PIPE

Inflow Area = 38.351 ac, 36.72% Impervious, Inflow Depth = 4.14" for 100-yr event
Inflow = 36.94 cfs @ 7.97 hrs, Volume= 13.229 af
Outflow = 36.91 cfs @ 7.97 hrs, Volume= 13.229 af, Atten= 0%, Lag= 0.1 min
Primary = 36.91 cfs @ 7.97 hrs, Volume= 13.229 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Peak Elev= 192.81' @ 7.97 hrs Surf.Area= 0.013 ac Storage= 0.008 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (710.9 - 710.9)

Volume	Invert	Avail.Storage	Storage Description
#1	192.00'	0.013 af	**24.0" Round Pipe Storage** L= 180.0' S= 0.0028 '/'
#2	191.50'	0.009 af	**24.0" Round Pipe Storage** L= 124.0' S= 0.0040 '/'
		0.022 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	191.00'	**Special & User-Defined** Elev. (feet) 191.00 192.00 193.00 193.50 Disch. (cfs) 0.000 13.290 42.320 62.740

Primary OutFlow Max=36.86 cfs @ 7.97 hrs HW=192.81' TW=188.12' (Dynamic Tailwater)
↑—**1=Special & User-Defined** (Custom Controls 36.86 cfs)

APPENDIX F

Appendix F Offsite Analysis

Note: some flow from Payne road has been added to the model. The difference in depth for the Post analysis is only about 0.01 ft, so this file has not been updated.

APPENDIX F OFFSITE ANALYSIS

The hydraulics/hydrology analysis for this project has determined that development as proposed will not have a significant adverse impact on the downstream and\or upstream drainage system.

The offsite flow path (about 600 LF to Lacamas Lake) was determined from LiDAR data. This data provides spot elevations, from which, cross sections across the flow path route could be developed and input for modeling. The following results were determined.

Historic and Post-development Full Build

Summary of HydroCAD results for 100-yr,24-hr event

Cross-section ID	Depth of Flow (ft)		Depth Increase (ft)	Max. Velocity Post Full Build Max/Ave. (fps)
	Extg	Post		
CH and CP (26R)	0.96	1.29	0.33	0.73/0.27
DH and DP (25R)	1.29	1.54	0.25	0.28/0.11
EH and EP (24R)	0.54	0.67	0.13	2.00/0.85
FH and FP (23R)	0.49	0.65	0.16	1.76/0.62

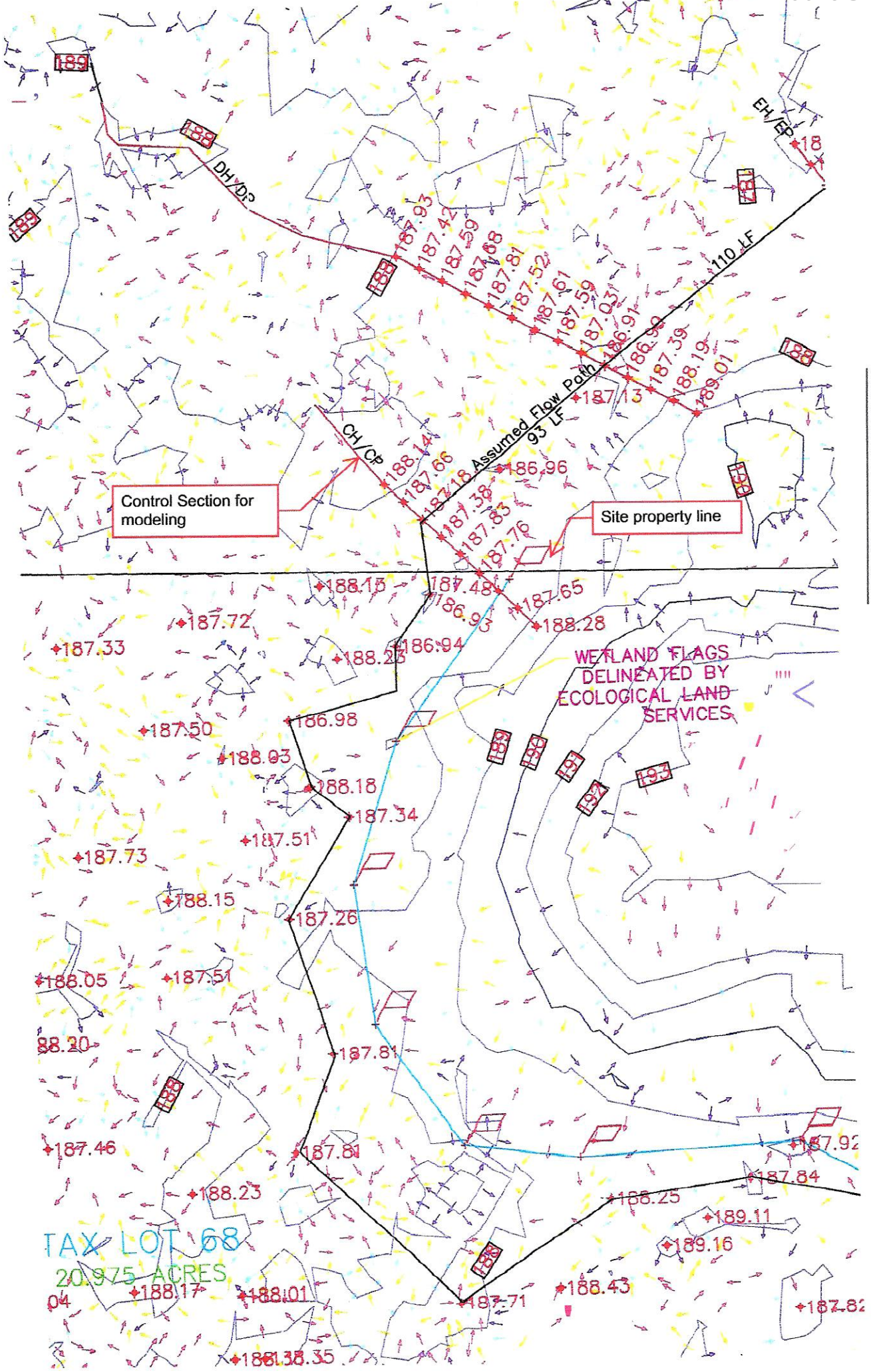
Notes:

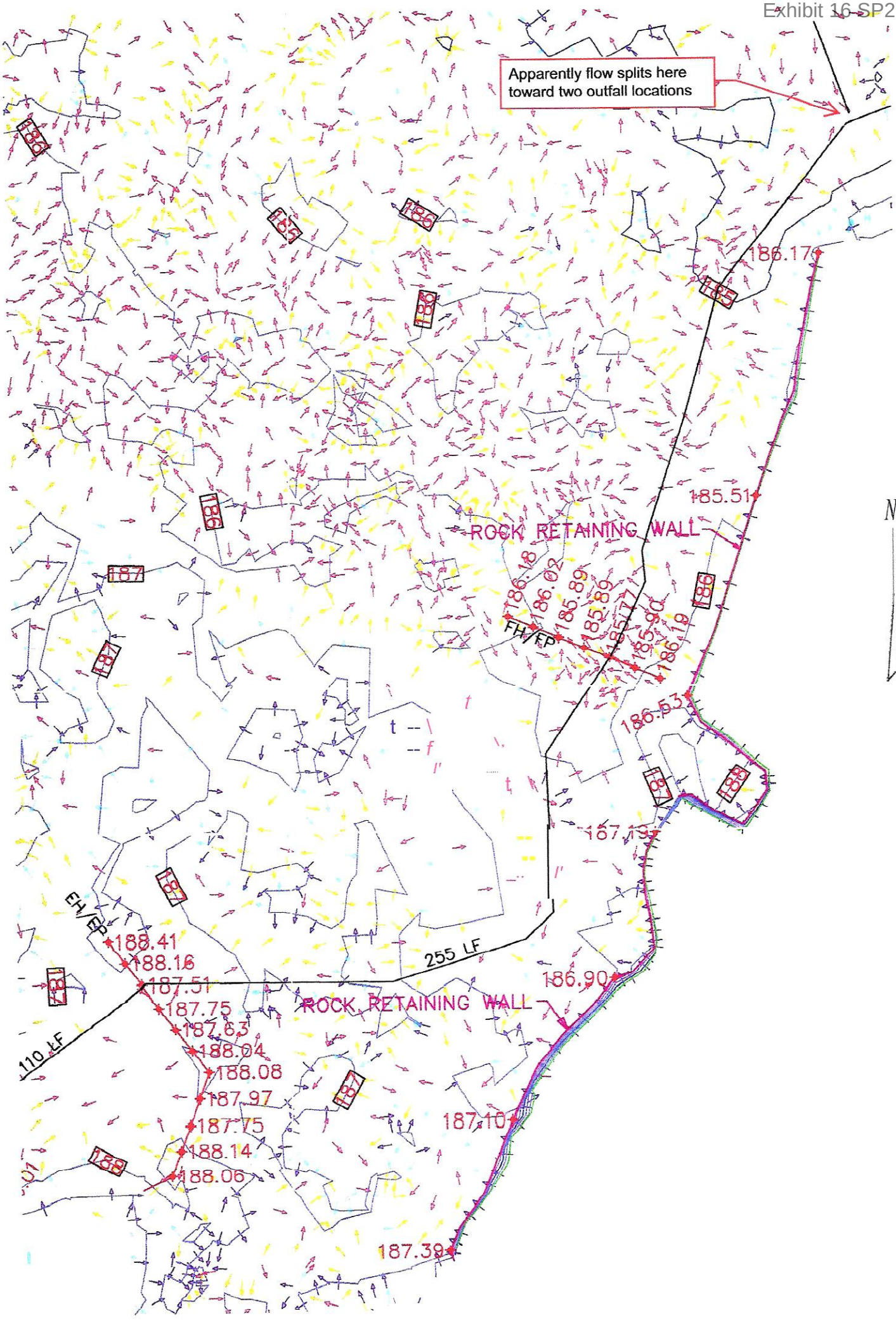
1) The apparent control channel section CH/CP is about 0.25 feet above the low spot elevation. near the property line for the site.

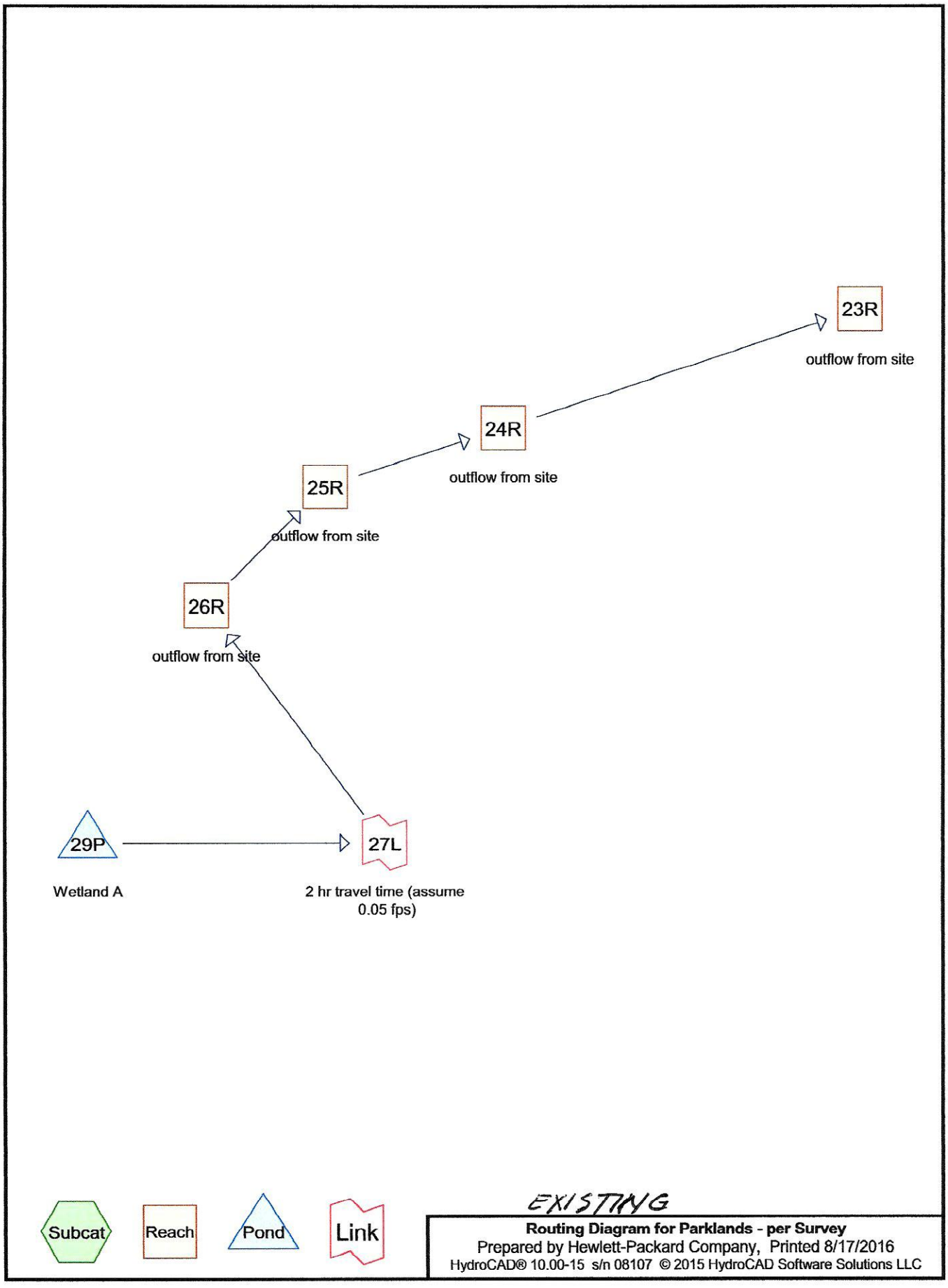
2) There is an effective hydraulic slope to this cross section through the wetland at 0.0025 ft/ft (1.07 ft in 434 LF.

3) The listed velocity along the flow path is below erosive velocities for grass lined flow regimes.

The LiDAR map info with cross section locations and IDs – see on following pages.


DH/DP
EH/EP
110 LF
Assumed Flow Path
93 LF
CH/CP
Control Section for modeling
Site property line
WETLAND FLAGS DELINEATED BY ECOLOGICAL LAND SERVICES
TAX LOT 68
20.975 ACRES
04


Apparently flow splits here toward two outfall locations
186.17
185.51
ROCK RETAINING WALL
186.18
186.02
185.89
185.89
185.17
185.90
186.19
FH/EP
186.53
187.13
255 LF
186.90
ROCK RETAINING WALL
187.10
187.39
FH/EP
188.41
188.16
187.51
187.75
187.63
188.04
188.08
187.97
187.75
188.14
188.06
110 LF
N


23R
outflow from site
24R
outflow from site
25R
outflow from site
26R
outflow from site
29P
Wetland A
27L
2 hr travel time (assume 0.05 fps)
Subcat
Reach
Pond
Link
EXISTING
Routing Diagram for Parklands - per Survey
Prepared by Hewlett-Packard Company, Printed 8/17/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

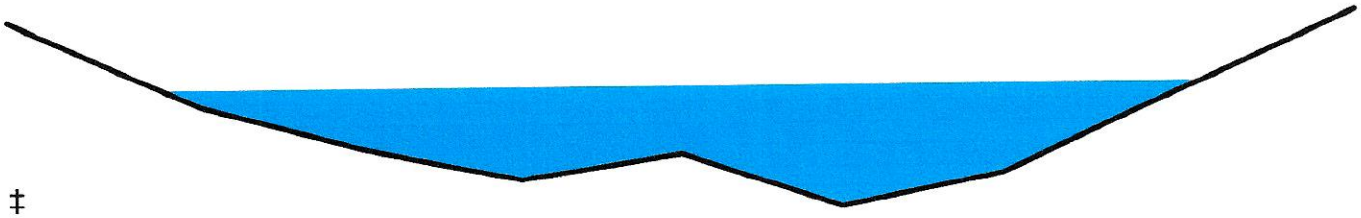
Summary for Reach 23R: outflow from site

Inflow Area = 77.960 ac, 0.00% Impervious, Inflow Depth = 3.25" for 100-yr event
Inflow = 25.61 cfs @ 11.42 hrs, Volume= 21.126 af
Outflow = 25.61 cfs @ 11.49 hrs, Volume= 21.126 af, Atten= 0%, Lag= 4.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs / 3
Max. Velocity= 1.42 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 0.67 fps, Avg. Travel Time= 5.4 min

Peak Storage= 3,881 cf @ 11.45 hrs
Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 0.76' Flow Area= 38.3 sf, Capacity= 75.41 cfs

Custom cross-section, Length= 215.0' Slope= 0.0045 '/'
Constant n= 0.030
Inlet Invert= 185.77', Outlet Invert= 184.80'



‡

Offset (feet)	Elevation (feet)	Chan.Depth (feet)
-12.00	186.53	0.00
0.00	186.19	0.34
10.00	186.02	0.51
20.00	185.89	0.64
30.00	185.99	0.54
40.00	185.77	0.76
50.00	185.90	0.63
60.00	186.19	0.34
72.00	186.53	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.12	0.9	14.7	190	0.45
0.13	1.0	17.7	224	0.53
0.22	3.7	40.8	790	2.46
0.25	4.9	44.1	1,064	3.83
0.42	13.8	60.0	2,967	17.24
0.76	38.3	84.0	8,230	75.41

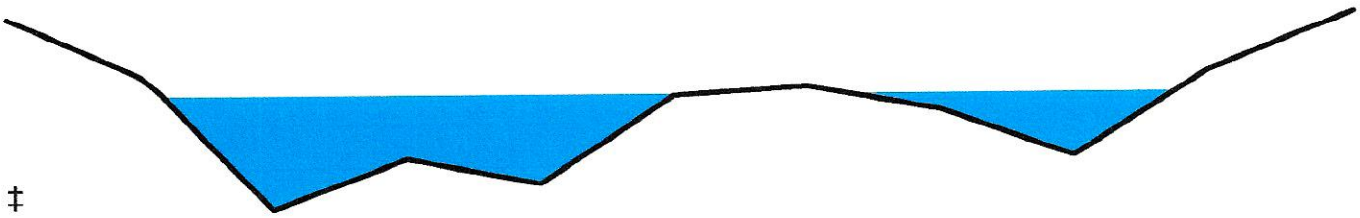
Summary for Reach 24R: outflow from site

Inflow Area = 77.960 ac, 0.00% Impervious, Inflow Depth = 3.25" for 100-yr event
Inflow = 25.63 cfs @ 11.33 hrs, Volume= 21.126 af
Outflow = 25.61 cfs @ 11.42 hrs, Volume= 21.126 af, Atten= 0%, Lag= 5.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs / 3
Max. Velocity= 1.68 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.86 fps, Avg. Travel Time= 4.3 min

Peak Storage= 3,448 cf @ 11.38 hrs
Average Depth at Peak Storage= 0.54'
Bank-Full Depth= 0.90' Flow Area= 46.8 sf, Capacity= 122.25 cfs

Custom cross-section, Length= 225.0' Slope= 0.0077 '/'
Constant n= 0.030
Inlet Invert= 187.51', Outlet Invert= 185.77'



‡

Offset (feet)	Elevation (feet)	Chan.Depth (feet)
0.00	188.41	0.00
10.00	188.14	0.27
11.54	188.06	0.35
20.00	187.51	0.90
30.00	187.75	0.66
40.00	187.63	0.78
50.00	188.04	0.37
60.00	188.08	0.33
70.00	187.97	0.44
80.00	187.75	0.66
90.00	188.14	0.27
101.00	188.41	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.12	0.4	6.9	93	0.27
0.24	2.4	26.6	544	2.14
0.46	11.0	51.0	2,466	17.11
0.53	14.9	62.0	3,355	25.07
0.55	16.2	69.6	3,651	26.77
0.57	17.7	77.3	3,982	29.01
0.63	22.4	80.0	5,043	41.79
0.90	46.8	101.0	10,541	122.25

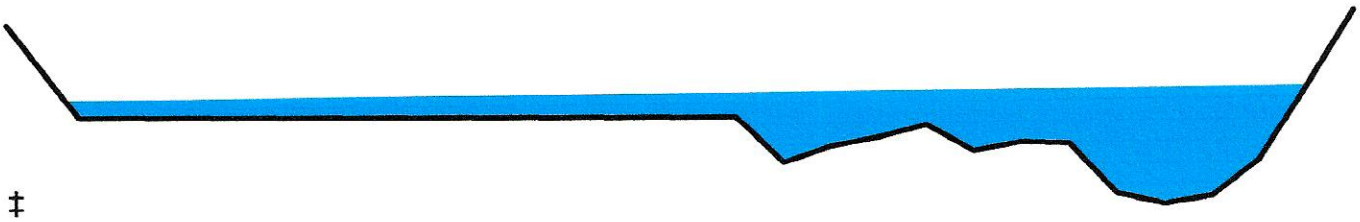
Summary for Reach 25R: outflow from site

Inflow Area = 77.960 ac, 0.00% Impervious, Inflow Depth = 3.25" for 100-yr event
Inflow = 25.66 cfs @ 11.09 hrs, Volume= 21.126 af
Outflow = 25.63 cfs @ 11.33 hrs, Volume= 21.126 af, Atten= 0%, Lag= 14.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs / 3
Max. Velocity= 0.21 fps, Min. Travel Time= 8.6 min
Avg. Velocity = 0.11 fps, Avg. Travel Time= 16.3 min

Peak Storage= 13,299 cf @ 11.18 hrs
Average Depth at Peak Storage= 1.29'
Bank-Full Depth= 2.09' Flow Area= 338.4 sf, Capacity= 134.98 cfs

Custom cross-section, Length= 110.0' Slope= 0.0001 '/' (105 Elevation Intervals)
Constant n= 0.040
Inlet Invert= 186.91', Outlet Invert= 186.90'



‡

Offset (feet)	Elevation (feet)	Chan.Depth (feet)
-153.00	189.00	0.00
-138.00	188.00	1.00
0.00	187.93	1.07
10.00	187.42	1.58
20.00	187.59	1.41
30.00	187.68	1.32
40.00	187.81	1.19
50.00	187.52	1.48
60.00	187.61	1.39
70.00	187.59	1.41
80.00	187.03	1.97
90.00	186.91	2.09
100.00	186.99	2.01
110.00	187.39	1.61
116.75	187.93	1.07
120.00	188.19	0.81
130.00	189.00	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.08	0.7	16.7	74	0.03
0.12	1.4	21.0	156	0.08
0.48	11.8	36.4	1,293	1.96
0.51	12.9	37.4	1,415	2.24
0.61	17.1	48.2	1,886	3.03
0.68	21.1	66.1	2,325	3.50
0.70	22.6	81.8	2,488	3.40
0.77	28.8	94.3	3,166	4.63
0.90	42.2	113.0	4,647	7.77
1.02	56.0	116.8	6,164	11.74
1.09	69.1	255.7	7,597	10.37
1.28	118.1	260.9	12,993	24.67
2.09	338.4	283.1	37,222	134.98

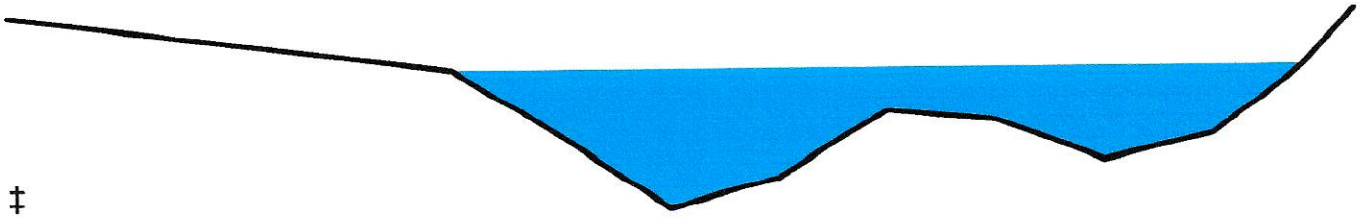
Summary for Reach 26R: outflow from site

Inflow Area = 77.960 ac, 0.00% Impervious, Inflow Depth = 3.25" for 100-yr event
Inflow = 25.67 cfs @ 11.02 hrs, Volume= 21.126 af
Outflow = 25.66 cfs @ 11.09 hrs, Volume= 21.126 af, Atten= 0%, Lag= 4.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs / 3
Max. Velocity= 0.64 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 0.30 fps, Avg. Travel Time= 5.2 min

Peak Storage= 3,734 cf @ 11.05 hrs
Average Depth at Peak Storage= 0.96'
Bank-Full Depth= 1.35' Flow Area= 79.4 sf, Capacity= 59.05 cfs

Custom cross-section, Length= 93.0' Slope= 0.0029 '/' (101 Elevation Intervals)
Constant n= 0.080 Earth, long dense weeds
Inlet Invert= 187.18', Outlet Invert= 186.91'



‡

Offset (feet)	Elevation (feet)	Chan.Depth (feet)
-41.00	188.53	0.00
0.00	188.14	0.39
10.00	187.66	0.87
20.00	187.18	1.35
30.00	187.38	1.15
40.00	187.83	0.70
50.00	187.76	0.77
60.00	187.48	1.05
70.00	187.65	0.88
78.30	188.14	0.39
83.00	188.53	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.20	1.4	14.2	132	0.31
0.30	3.0	18.5	284	0.91
0.47	8.2	41.9	761	2.76
0.48	8.6	42.8	800	2.95
0.58	13.4	52.4	1,243	5.37
0.65	17.5	66.6	1,630	7.22
0.96	40.0	78.4	3,719	25.53
1.35	79.4	124.1	7,387	59.05

Summary for Pond 29P: Wetland A

Inflow Area = 77.960 ac, 0.00% Impervious, Inflow Depth = 3.25" for 100-yr event
Inflow = 28.41 cfs @ 8.08 hrs, Volume= 21.126 af
Outflow = 25.67 cfs @ 9.02 hrs, Volume= 21.126 af, Atten= 10%, Lag= 56.2 min
Primary = 25.67 cfs @ 9.02 hrs, Volume= 21.126 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Peak Elev= 187.99' @ 9.02 hrs Surf.Area= 3.001 ac Storage= 0.907 af

Plug-Flow detention time= 24.7 min calculated for 21.113 af (100% of inflow)
Center-of-Mass det. time= 24.7 min (868.2 - 843.5)

Volume	Invert	Avail.Storage	Storage Description
#1	187.40'	5.478 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
187.40	0.050	0.000	0.000
188.00	3.027	0.923	0.923
188.05	3.147	0.154	1.077
189.00	6.117	4.400	5.478

Device	Routing	Invert	Outlet Devices
#1	Primary	187.40'	**Special & User-Defined**

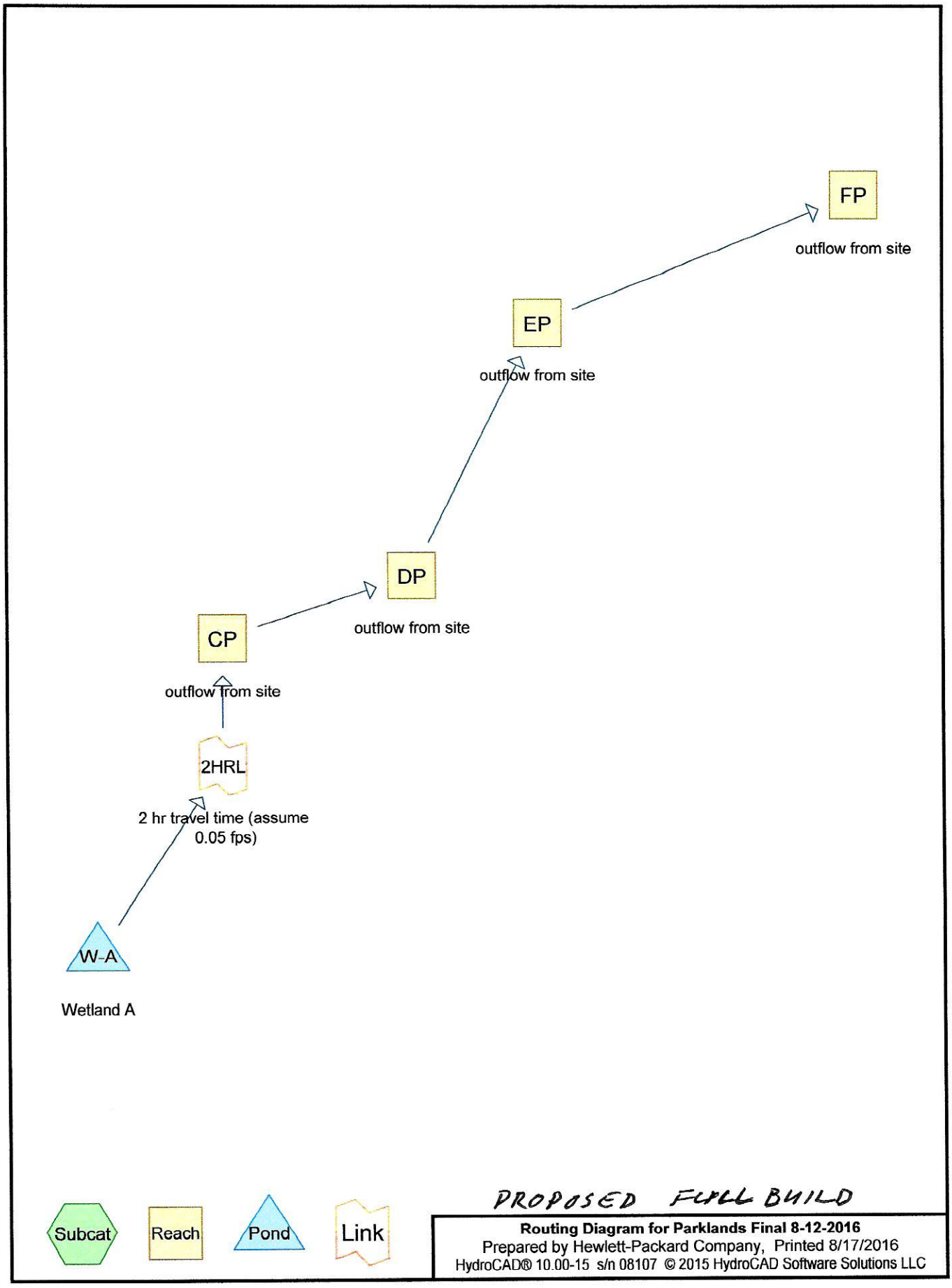
Head (feet)	0.00	0.20	0.40	0.60	0.80
Disch. (cfs)	0.000	2.270	12.170	26.030	71.260

Primary OutFlow Max=25.67 cfs @ 9.02 hrs HW=187.99' (Free Discharge)
↑—**1=Special & User-Defined** (Custom Controls 25.67 cfs)

Summary for Link 27L: 2 hr travel time (assume 0.05 fps)

Inflow Area = 77.960 ac, 0.00% Impervious, Inflow Depth = 3.25" for 100-yr event
Inflow = 25.67 cfs @ 9.02 hrs, Volume= 21.126 af
Primary = 25.67 cfs @ 11.02 hrs, Volume= 21.126 af, Atten= 0%, Lag= 120.0 min

Primary outflow = Inflow delayed by 120.0 min, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs


FP
outflow from site
EP
outflow from site
DP
outflow from site
CP
outflow from site
2HRL
2 hr travel time (assume 0.05 fps)
W-A
Wetland A
Subcat
Reach
Pond
Link
PROPOSED FULL BUILD
Routing Diagram for Parklands Final 8-12-2016
Prepared by Hewlett-Packard Company, Printed 8/17/2016
HydroCAD® 10.00-15 s/n 08107 © 2015 HydroCAD Software Solutions LLC

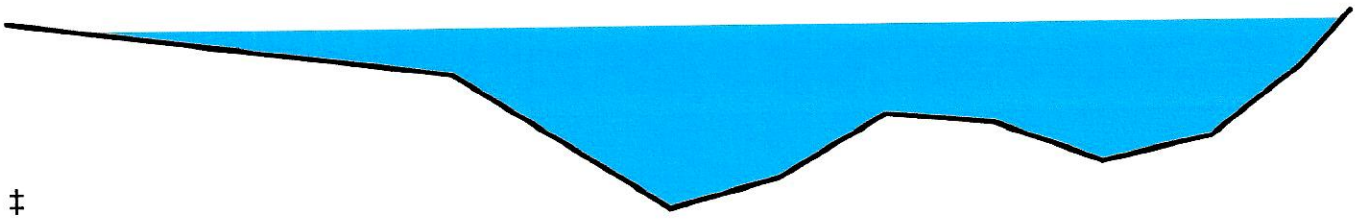
Summary for Reach CP: outflow from site

Inflow Area = 70.207 ac, 31.29% Impervious, Inflow Depth = 3.98" for 100-yr event
Inflow = 52.74 cfs @ 10.14 hrs, Volume= 23.268 af
Outflow = 52.64 cfs @ 10.17 hrs, Volume= 23.268 af, Atten= 0%, Lag= 1.9 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 0.73 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 0.27 fps, Avg. Travel Time= 5.7 min

Peak Storage= 6,742 cf @ 10.17 hrs
Average Depth at Peak Storage= 1.29'
Bank-Full Depth= 1.35' Flow Area= 79.4 sf, Capacity= 59.05 cfs

Custom cross-section, Length= 93.0' Slope= 0.0029 '/' (101 Elevation Intervals)
Constant n= 0.080 Earth, long dense weeds
Inlet Invert= 187.18', Outlet Invert= 186.91'



‡

Offset (feet)	Elevation (feet)	Chan.Depth (feet)
-41.00	188.53	0.00
0.00	188.14	0.39
10.00	187.66	0.87
20.00	187.18	1.35
30.00	187.38	1.15
40.00	187.83	0.70
50.00	187.76	0.77
60.00	187.48	1.05
70.00	187.65	0.88
78.30	188.14	0.39
83.00	188.53	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.20	1.4	14.2	132	0.31
0.30	3.0	18.5	284	0.91
0.47	8.2	41.9	761	2.76
0.48	8.6	42.8	800	2.95
0.58	13.4	52.4	1,243	5.37
0.65	17.5	66.6	1,630	7.22
0.96	40.0	78.4	3,719	25.53
1.35	79.4	124.1	7,387	59.05

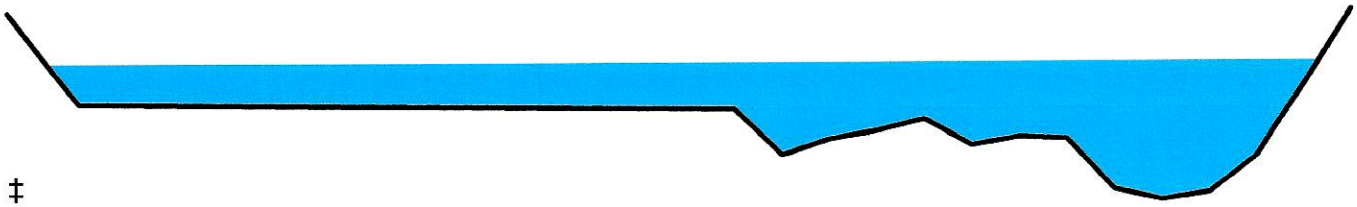
Summary for Reach DP: outflow from site

Inflow Area = 70.207 ac, 31.29% Impervious, Inflow Depth = 3.98" for 100-yr event
Inflow = 52.64 cfs @ 10.17 hrs, Volume= 23.268 af
Outflow = 51.97 cfs @ 10.25 hrs, Volume= 23.268 af, Atten= 1%, Lag= 4.9 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 0.28 fps, Min. Travel Time= 6.6 min
Avg. Velocity = 0.11 fps, Avg. Travel Time= 17.3 min

Peak Storage= 20,537 cf @ 10.25 hrs
Average Depth at Peak Storage= 1.54'
Bank-Full Depth= 2.09' Flow Area= 338.4 sf, Capacity= 134.98 cfs

Custom cross-section, Length= 110.0' Slope= 0.0001 '/' (105 Elevation Intervals)
Constant n= 0.040
Inlet Invert= 186.91', Outlet Invert= 186.90'



‡

Offset (feet)	Elevation (feet)	Chan.Depth (feet)
-153.00	189.00	0.00
-138.00	188.00	1.00
0.00	187.93	1.07
10.00	187.42	1.58
20.00	187.59	1.41
30.00	187.68	1.32
40.00	187.81	1.19
50.00	187.52	1.48
60.00	187.61	1.39
70.00	187.59	1.41
80.00	187.03	1.97
90.00	186.91	2.09
100.00	186.99	2.01
110.00	187.39	1.61
116.75	187.93	1.07
120.00	188.19	0.81
130.00	189.00	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.08	0.7	16.7	74	0.03
0.12	1.4	21.0	156	0.08
0.48	11.8	36.4	1,293	1.96
0.51	12.9	37.4	1,415	2.24
0.61	17.1	48.2	1,886	3.03
0.68	21.1	66.1	2,325	3.50
0.70	22.6	81.8	2,488	3.40
0.77	28.8	94.3	3,166	4.63
0.90	42.2	113.0	4,647	7.77
1.02	56.0	116.8	6,164	11.74
1.09	69.1	255.7	7,597	10.37
1.28	118.1	260.9	12,993	24.67
2.09	338.4	283.1	37,222	134.98

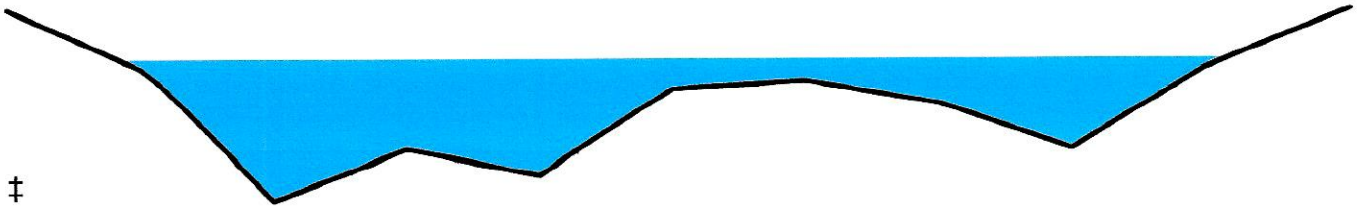
Summary for Reach EP: outflow from site

Inflow Area = 70.207 ac, 31.29% Impervious, Inflow Depth = 3.98" for 100-yr event
Inflow = 51.97 cfs @ 10.25 hrs, Volume= 23.268 af
Outflow = 51.92 cfs @ 10.28 hrs, Volume= 23.268 af, Atten= 0%, Lag= 1.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 2.00 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 0.85 fps, Avg. Travel Time= 4.4 min

Peak Storage= 5,840 cf @ 10.28 hrs
Average Depth at Peak Storage= 0.67'
Bank-Full Depth= 0.90' Flow Area= 46.8 sf, Capacity= 122.25 cfs

Custom cross-section, Length= 225.0' Slope= 0.0077 '/'
Constant n= 0.030
Inlet Invert= 187.51', Outlet Invert= 185.77'



‡

Offset (feet)	Elevation (feet)	Chan.Depth (feet)
0.00	188.41	0.00
10.00	188.14	0.27
11.54	188.06	0.35
20.00	187.51	0.90
30.00	187.75	0.66
40.00	187.63	0.78
50.00	188.04	0.37
60.00	188.08	0.33
70.00	187.97	0.44
80.00	187.75	0.66
90.00	188.14	0.27
101.00	188.41	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.12	0.4	6.9	93	0.27
0.24	2.4	26.6	544	2.14
0.46	11.0	51.0	2,466	17.11
0.53	14.9	62.0	3,355	25.07
0.55	16.2	69.6	3,651	26.77
0.57	17.7	77.3	3,982	29.01
0.63	22.4	80.0	5,043	41.79
0.90	46.8	101.0	10,541	122.25

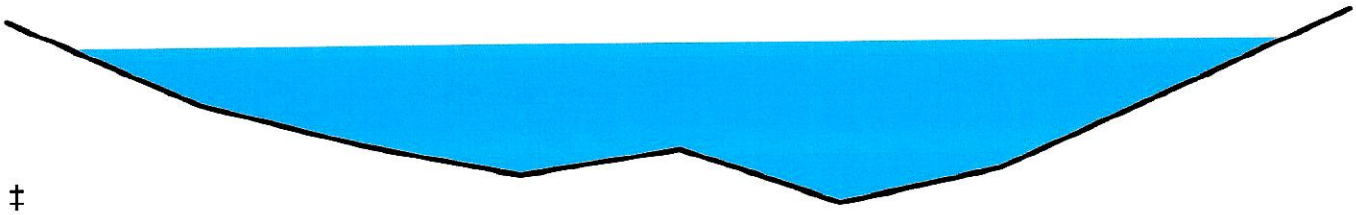
Summary for Reach FP: outflow from site

Inflow Area = 70.207 ac, 31.29% Impervious, Inflow Depth = 3.98" for 100-yr event
Inflow = 51.92 cfs @ 10.28 hrs, Volume= 23.268 af
Outflow = 51.86 cfs @ 10.30 hrs, Volume= 23.268 af, Atten= 0%, Lag= 1.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 1.76 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.62 fps, Avg. Travel Time= 5.8 min

Peak Storage= 6,322 cf @ 10.30 hrs
Average Depth at Peak Storage= 0.65'
Bank-Full Depth= 0.76' Flow Area= 38.3 sf, Capacity= 75.41 cfs

Custom cross-section, Length= 215.0' Slope= 0.0045 '/'
Constant n= 0.030
Inlet Invert= 185.77', Outlet Invert= 184.80'



‡

Offset (feet)	Elevation (feet)	Chan.Depth (feet)
-12.00	186.53	0.00
0.00	186.19	0.34
10.00	186.02	0.51
20.00	185.89	0.64
30.00	185.99	0.54
40.00	185.77	0.76
50.00	185.90	0.63
60.00	186.19	0.34
72.00	186.53	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.12	0.9	14.7	190	0.45
0.13	1.0	17.7	224	0.53
0.22	3.7	40.8	790	2.46
0.25	4.9	44.1	1,064	3.83
0.42	13.8	60.0	2,967	17.24
0.76	38.3	84.0	8,230	75.41

Summary for Pond W-A: Wetland A

Inflow Area = 70.207 ac, 31.29% Impervious, Inflow Depth = 3.98" for 100-yr event
Inflow = 58.13 cfs @ 8.00 hrs, Volume= 23.268 af
Outflow = 52.77 cfs @ 8.14 hrs, Volume= 23.268 af, Atten= 9%, Lag= 8.3 min
Primary = 52.77 cfs @ 8.14 hrs, Volume= 23.268 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Peak Elev= 188.12' @ 8.14 hrs Surf.Area= 3.360 ac Storage= 1.299 af

Plug-Flow detention time= 23.7 min calculated for 23.254 af (100% of inflow)
Center-of-Mass det. time= 23.7 min (746.9 - 723.3)

Volume	Invert	Avail.Storage	Storage Description
#1	187.40'	5.478 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
187.40	0.050	0.000	0.000
188.00	3.027	0.923	0.923
188.05	3.147	0.154	1.077
189.00	6.117	4.400	5.478

Device	Routing	Invert	Outlet Devices
#1	Primary	187.40'	**Special & User-Defined** Head (feet) 0.00 0.20 0.40 0.60 0.80 Disch. (cfs) 0.000 2.270 12.170 26.030 71.260

Primary OutFlow Max=52.75 cfs @ 8.14 hrs HW=188.12' TW=0.00' (Dynamic Tailwater)
↑—**1=Special & User-Defined** (Custom Controls 52.75 cfs)

Summary for Link 2HRL: 2 hr travel time (assume 0.05 fps)

Inflow Area = 70.207 ac, 31.29% Impervious, Inflow Depth = 3.98" for 100-yr event
Inflow = 52.77 cfs @ 8.14 hrs, Volume= 23.268 af
Primary = 52.74 cfs @ 10.14 hrs, Volume= 23.268 af, Atten= 0%, Lag= 120.1 min

Primary outflow = Inflow delayed by 120.0 min, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs

APPENDIX G

G-1 Geotech Report

G-2 Wetland Evaluation Regarding Wetlands Protection

Geotechnical Site Investigation

Parklands at Camas Meadows

Camas, Washington

June 23, 2015

Geotechnical ■ Environmental ■ Special Inspections

Columbia West

Engineering, Inc






11917 NE 95th Street
Vancouver, Washington
98682
Phone: 360-823-2900
Fax: 360-823-2901

www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

GEOTECHNICAL SITE INVESTIGATION
PARKLANDS AT CAMAS MEADOWS
CAMAS, WASHINGTON

Prepared For:

Mr. Aaron Barr & Mr. Kevin Deford
Parklands at Camas Meadows, LLC
PO Box 61962
Vancouver, WA 98666

Site Location:

NE of NW Payne Street and NW Camas Meadows Drive Intersection
Parcels 175948000 and 986031650
Camas, Washington

Prepared By:

Columbia West Engineering, Inc.
11917 NE 95th Street
Vancouver, Washington 98682
Phone: 360-823-2900
Fax: 360-823-2901

Date Prepared:

June 23, 2015

TABLE OF CONTENTS

LIST OF FIGURES		ii
LIST OF APPENDICES		iii
1.0	INTRODUCTION	1
	1.1 General Site Information	1
	1.2 Proposed Development	1
2.0	REGIONAL GEOLOGY AND SOIL CONDITIONS	1
3.0	REGIONAL SEISMOLOGY	2
4.0	GEOTECHNICAL FIELD INVESTIGATION	5
	4.1 Surface Investigation and Site Description	5
	4.2 Subsurface Exploration and Investigation	5
	4.2.1 Soil Type Description	5
	4.2.2 Groundwater	6
5.0	DESIGN RECOMMENDATIONS	6
	5.1 Site Preparation and Grading	7
	5.2 Engineered Structural Fill	7
	5.3 Cut and Fill Slopes	8
	5.4 Foundations	8
	5.5 Slabs on Grade	9
	5.6 Settlement	10
	5.7 Excavation	10
	5.8 Dewatering	11
	5.9 Lateral Earth Pressure	11
	5.10 Seismic Design Considerations	12
	5.11 Soil Liquefaction and Dynamic Settlement	13
	5.12 Drainage	14
	5.13 Bituminous Asphalt and Portland Cement Concrete	14
	5.14 Wet Weather Construction Methods and Techniques	15
	5.15 Erosion Control Measures	16
	5.16 Soil Shrink/Swell Potential	17
	5.17 Utility Installation	17
6.0	CONCLUSION AND LIMITATIONS	17
REFERENCES		
FIGURES		
APPENDICES		

LIST OF FIGURES

Number	Title
1	Site Location Map
2	Subsurface Exploration Location Map
3	Typical Cut and Fill Slope Cross-Section
4	Minimum Foundation Slope Setback Detail
5	Typical Perimeter Footing Drain Detail
6	Typical Perforated Drain Pipe Trench Detail

LIST OF APPENDICES

Number	Title
A	Analytical Laboratory Test Results
B	Subsurface Exploration Logs
C	Soil Classification Information
D	Photo Log
E	Report Limitations and Important Information

GEOTECHNICAL SITE INVESTIGATION
PARKLANDS AT CAMAS MEADOWS
CAMAS, WASHINGTON

1.0 INTRODUCTION

Columbia West Engineering, Inc. was retained by Parklands at Camas Meadows, LLC to conduct a geotechnical site investigation for proposed development on tax parcel numbers 986031650 and 175948000 in Camas, Washington. The purpose of the investigation was to observe and assess subsurface soil conditions at specific locations and provide subsequent appropriate geotechnical engineering analyses to support property development feasibility, planning, and design recommendations. The specific scope of services was outlined in a proposal contract dated May 27, 2015. This report summarizes the investigation and provides field assessment documentation and laboratory analytical test reports. This report is subject to the limitations expressed in Section 6.0, *Conclusion and Limitations*, and Appendix E.

1.1 General Site Information

As indicated on Figures 1 and 2, the subject site is located northeast of the intersection of NW Payne Street and NW Camas Meadows Drive in Camas, Washington. The site is comprised of two tax parcels numbered 986031650 and 175948000 totaling approximately 36.4 acres. The regulatory jurisdictional agency is the City of Camas, Washington. The approximate latitude and longitude are N 45° 37’ 40” and W 122° 26’ 54”, and the legal description is a portion of the SW and SE ¼ of Section 28, T2N, R3E, Willamette Meridian.

1.2 Proposed Development

Review of preliminary site plans provided by the client indicates that proposed development will consist of approximately 46 residential lots and 6 commercial buildings, parking areas, loading docks, private roadways and a future extension of NW Camas Meadows Drive. Stormwater facilities and underground utilities may also be constructed as part of proposed development. Columbia West understands that cut and fill areas will likely be proposed at the property. This report is based upon proposed development as described above and may not be applicable if modified.

2.0 REGIONAL GEOLOGY AND SOIL CONDITIONS

The subject site lies within the Willamette Valley/Puget Sound Lowland, a wide physiographic depression flanked by the mountainous Coast Range on the west and the Cascade Range on the east. Inclined or uplifted structural zones within the Willamette Valley/Puget Sound Lowland constitute highland areas and depressed structural zones form sediment-filled basins. The site is located within the central portion of the Portland/Vancouver Basin, an open, somewhat elliptical, northwest-trending syncline approximately 60 miles wide.

According to the *Geologic Map of the Lacamas Quadrangle, Clark County, Washington* (US Geological Survey, Science Investigations Map 2924, 2006), the primary geologic unit present at the site is a Pleistocene gravel facies unit deposited by cataclysmic, glacial-outburst floods associated with Lake Missoula in Montana. However, in the areas explored during subsurface excavation, the unconsolidated boulder to cobbly gravel unit was either extremely thin or missing completely. Instead, the subsurface investigation revealed that the bulk of the site is underlain by two similar sedimentary formations. Test pit exploration indicated that the western corner of the site is underlain by an unnamed, Pleistocene to Pliocene, semi-consolidated, pebble to cobble conglomerate (QTc). This geologic unit is lithologically similar to the Pliocene or late Miocene Troutdale Formation, differing primarily in age of emplacement, degree of weathering, and the presence of hyaloclastite interbeds. Previously published geologic mapping has identified this unit as the Troutdale Formation.

The southern and eastern portion of the site is underlain by the Hyaoclastic sandstone member of the Troutdale formation (Ttfh). This Pliocene to Pleistocene formation is comprised of coarse-grained sandstone and pebble conglomerate containing basalt pebbles and cobbles. This geologic unit is lithologically similar to the Pliocene or late Miocene Troutdale Formation, differing primarily in age of emplacement, degree of weathering, and the presence of hyaloclastite interbeds. Previously published geologic mapping has identified this unit as the Troutdale Formation.

The *Web Soil Survey (United States Department of Agriculture, Natural Resource Conservation Service [USDA NRCS], 2013 Website)* indicates the site is underlain by three soil types. Hesson clay loam soils are mapped on the majority of the site from the northwest corner to the southwest corner of the property, while Cove silty clay loam and Lauren gravelly loam soils are mapped in the northern and northwestern portions of the property, respectively. Soils resembling the Lauren series were not encountered during subsurface excavation.

Although actual on-site soils may vary from the broad USDA descriptions, Lauren soils are generally coarse-textured, well drained soils with rapid permeability. Cove soils are generally fine-textured, poorly drained soils with very slow permeability and high shrink-swell potential. Hesson soils are fine-textured, well drained soils with moderately slow permeability and moderate shrink-swell potential.

3.0 REGIONAL SEISMOLOGY

Recent research and subsurface mapping investigations within the Pacific Northwest appear to suggest the historic potential risk for a large earthquake event with strong localized ground movement may be underestimated. Past earthquakes in the Pacific Northwest appear to have caused landslides and ground subsidence, in addition to severe flooding near coastal areas. Earthquakes may also induce soil liquefaction, which occurs when elevated horizontal ground acceleration and velocity cause soil particles to interact as a fluid as opposed to a solid. Liquefaction of soil can result in lateral spreading and temporary loss of bearing capacity and shear strength.

There are at least four major known fault zones in the vicinity of the site that may be capable of generating potentially destructive horizontal accelerations. These fault zones are described briefly in the following text.

Portland Hills Fault Zone

The Portland Hills Fault Zone consists of several northwest-trending faults located along the northeastern margin of the Tualatin Mountains, also known as the Portland Hills, and the southwest margin of the Portland Basin. The fault zone is approximately 25 to 30 miles in length and is located approximately 17 miles southwest of the site. According to *Seismic Design Mapping, State of Oregon (Geomatrix Consultants, 1995),* there is no definitive consensus among geologists as to the zone fault type. Several alternate interpretations have been suggested.

According to the *USGS Earthquake Hazards Program*, the fault was originally mapped as a down-to-the-northeast normal fault, but has also been mapped as part of a regional-scale zone of right-lateral, oblique slip faults, and as a steep escarpment caused by asymmetrical folding above a south-west dipping, blind thrust fault. The Portland Hills fault offsets Miocene Columbia River Basalts, and Miocene to Pliocene sedimentary rocks of the Troutdale Formation. No fault scarps on surficial Quaternary deposits have been described along the fault trace, and the fault is mapped as buried by the Pleistocene aged Missoula flood deposits.

However, evidence is thought to exist which suggests that fault movement has impacted shallow Holocene deposits and deeper Pleistocene sediments. Seismologists recorded a M3.2 earthquake thought to be associated with the fault zone near Kelly Point Park in November 2012, a M3.9 earthquake thought to be associated with the fault zone near Kelly Point Park in April 2003, and a M3.5 earthquake possibly associated with the fault zone occurred approximately 1.3 miles east of the fault in 1991. Therefore, the Portland Hills Fault Zone is generally thought to be potentially active and capable of producing possible damaging earthquakes.

Gales Creek-Newberg-Mt. Angel Fault Zone

Located approximately 35 miles southwest of the site, the northwest-striking, approximately 50-mile long Gales Creek-Newberg-Mt. Angel Structural Zone forms the northwestern boundary between the Oregon Coast Range and the Willamette Valley, and consists of a series of discontinuous northwest-trending faults. The southern end the fault zone forms the southwest margin of the Tualatin basin. Possible late-Quaternary geomorphic surface deformation may exist along the structural zone *(Geomatrix Consultants, 1995)*.

According to the *USGS Earthquake Hazards Program*, the Mount Angel fault is mapped as a high-angle, reverse-oblique fault, which offsets Miocene rocks of the Columbia River Basalts, and Miocene and Pliocene sedimentary rocks. The fault appears to have controlled emplacement of the Frenchman Spring Member of the Wanapum Basalts, and thus must have a history that predates the Miocene age of these rocks. No unequivocal

evidence of deformation of Quaternary deposits has been described, but a thick sequence of sediments deposited by the Missoula floods covers much of the southern part of the fault trace.

Although no definitive evidence of impacts to Holocene sediments have clearly been identified, the Mount Angel fault appears to have been the location of minor earthquake swarms in 1990 near Woodburn, Oregon, and a M5.6 earthquake in March 1993 near Scotts Mills, approximately four miles south of the mapped extent of the Mt. Angel fault. It is unclear if the earthquake occurred along the fault zone or a parallel structure. Therefore, the Gales Creek-Newberg-Mt. Angel Structural Zone is considered potentially active.

Lacamas Lake-Sandy River Fault Zone

The northwest-trending Lacamas Creek Fault and northeast-trending Sandy River Fault intersect north of Camas, Washington approximately 1 mile east of the site, and form part of the northeastern margin of the Portland basin. According to *Geology and Groundwater Conditions of Clark County Washington (USGS Water Supply Paper 1600, Mundorff, 1964)* and the *Geologic Map of the Lake Oswego Quadrangle (Oregon DOGAMI Series GMS-59, 1989)*, the Lacamas Creek fault zone consists of shear contact between the Troutdale Formation and underlying Oligocene andesite-basalt bedrock. Secondary shear contact associated with the fault zone may have produced a series of prominent northwest-southeast geomorphic lineaments in proximity to the site.

According to the *USGS Earthquake Hazards Program* the fault has been mapped as a normal fault with down-to-the-southwest displacement, and has also been described as a steeply northeast or southwest-dipping, oblique, right-lateral, slip-fault. The trace of the Lacamas Lake fault is marked by the very linear lower reach of Lacamas Creek. No fault scarps on Quaternary surficial deposits have been described. The Lacamas Lake fault offsets Pliocene-aged sedimentary conglomerates generally identified as the Troutdale formation, and Pliocene to Pleistocene aged basalts generally identified as the Boring Lava formation.

Recent seismic reflection data across the probable trace of the fault under the Columbia River yielded no unequivocal evidence of displacement underlying the Missoula flood deposits, however, recorded mild seismic activity during the recent past indicates this area may be potentially seismogenic.

Cascadia Subduction Zone

The Cascadia Subduction Zone has recently been recognized as a potential source of strong earthquake activity in the Portland/Vancouver Basin. This phenomenon is the result of the earth's large tectonic plate movement. Geologic evidence indicates that volcanic ocean floor activity along the Juan de Fuca ridge in the Pacific Ocean causes the Juan de Fuca Plate to perpetually move east and subduct under the North American Continental Plate. The subduction zone results in historic volcanic and potential earthquake activity in proximity to the plate interface, believed to lie approximately 20 to 50 miles west of the general location of the Oregon and Washington coast *(Geomatrix Consultants, 1995)*.

4.0 GEOTECHNICAL FIELD INVESTIGATION

A geotechnical field investigation consisting of visual reconnaissance and eight test pits (TP-1 through TP-8) was conducted at the site on June 4, 2015. Subsurface soil profiles were logged in accordance with Unified Soil Classification System (USCS) specifications. Disturbed soil samples were collected from relevant soil horizons and submitted for laboratory analysis. Laboratory test results are presented in Appendix A. Subsurface exploration locations are indicated on Figure 2. Exploration logs are presented in Appendix B. Soil descriptions and classification information are provided in Appendix C. A photo log is provided in Appendix D.

4.1 Surface Investigation and Site Description

The approximately 36.4-acre subject site occupies two tax parcels to the east of the Camas Meadows Golf Club located at 4105 NW Camas Meadows Drive in Camas, Washington. The site was previously undeveloped and is densely vegetated with large fir and deciduous trees, associated understory vegetation, and a wetland area. The site lies at the toe of a north-facing slope near the western end of Lacamas Lake. Site elevations range from approximately 240 feet elevation in the southern portion of the site to approximately 190 feet elevation along the northern property boundary. Slope grades range from isolated short slopes of approximately 20 percent in the south central portion of the property to generally flat in the wetland area of the northern property boundary. Most slopes are gentle and range from 5 to 10 percent.

4.2 Subsurface Exploration and Investigation

Test pit explorations TP-1 through TP-8 were advanced at the site to a maximum depth of 16.5 feet using a track-mounted excavator on June 4, 2015. Subsurface exploration locations were selected to observe soil characteristics in proximity to proposed development areas and are indicated on Figure 2.

4.2.1 Soil Type Description

The field investigation indicated the site is generally covered with approximately 10 to 18 inches of topsoil and associated organic-rich root zone material at the locations observed. Underlying the topsoil layer, fine-textured silt and clay soils underlain by weathered conglomerate bedrock and competent conglomerate bedrock were encountered. Subsurface lithology may generally be described by the following soil types for engineering purposes.

Soil Type 1 – *Sandy SILT to Sandy FAT CLAY*

Soil Type 1 was observed to consist primarily of medium brown medium stiff, moist to wet, moderate to high plasticity sandy SILT to sandy FAT CLAY. Soil Type 1 was observed underlying the topsoil layer in test pits TP-3 through TP-6 and TP-8 to a maximum depth of 5 feet.

Analytical laboratory testing conducted upon representative soil samples obtained from test pits TP-3 (sandy SILT) and TP-6 (sandy FAT CLAY) indicate approximately 57 to 63 percent by weight passing the No. 200 sieve and in situ moisture content ranging from 32

to 36 percent. Atterberg test results indicated a liquid limit ranging from 44 to 51 percent and a plasticity index ranging from 16 to 25 percent. Soil Type 1 is classified as ML, sandy SILT, and CH, sandy FAT CLAY according to USCS specifications and A-7-6(7) and A-7-6(7) according to AASHTO specifications.

Soil Type 2 – Clayey SAND to Poorly Graded GRAVEL with silt and sand

Soil Type 2 was observed to consist primarily of light brown to multi-colored, dense to very dense, moist to wet, clayey SAND and poorly graded GRAVEL with silt and sand. Soil Type 2 represents weathered conglomerate bedrock. Soil Type 2 was encountered underlying surficial fine textured soils or topsoil in all test pits.

Analytical laboratory testing conducted upon representative soil samples obtained from test pit TP-8 indicate approximately 8 to 20 percent by weight passing the No. 200 sieve and in situ moisture content ranging from 33 to 43 percent. Atterberg test results indicated a liquid limit ranging from 43 to 46 percent and a plasticity index of 18 percent. Soil Type 2 is classified as SC, clayey SAND and GP-GM, poorly-graded GRAVEL with silt and sand according to USCS specifications and A-2-7(0) according to AASHTO specifications.

Soil Type 3: Weathered and Competent Conglomerate Bedrock

Weathered and competent conglomerate bedrock was encountered in all test pits at various depths. The conglomerate bedrock encountered generally resembled the descriptions of the unnamed Pleistocene to Pliocene, semi-consolidated, pebble to cobble conglomerate (QTc) and the Hyaoclastic sandstone member of the Troutdale formation (Ttfh). The bedrock consisted of angular to sub-rounded clasts of various sizes cemented in a matrix of sand, silt, and clay. The bedrock was very dense and excavator refusal was noted at various depths as indicated in Table 1 in Section 5.7, *Excavation.*

4.2.2 Groundwater

Groundwater was encountered in test pits TP-1 and TP-8 at depths of 2.5 feet and 15 feet below ground surface, respectively. Standing water was observed at the ground surface elevation in the wetland which occupies the central north portion of the site. According to *Clark County Maps Online*, the static aquifer elevation in the vicinity of the subject site ranges from 190 to 210 feet amsl. These elevations correspond to an approximate depth to groundwater between 0 and 20 feet below ground surface.

Groundwater levels are often subject to seasonal variance and may rise during extended periods of increased precipitation. Perched groundwater may also be present in localized areas. Seeps and springs may become evident during site grading, primarily along slopes or in areas cut below existing grade. Structures, roads, and drainage design should be planned accordingly. Piezometer installation and long-term monitoring, beyond the scope of this investigation, would be necessary to provide more detailed groundwater information.

5.0 DESIGN RECOMMENDATIONS

The geotechnical site investigation suggests the proposed development is generally compatible with surface and subsurface soils, provided the recommendations presented in

this report are utilized and incorporated into the design and construction processes. Design recommendations are presented in the following text sections.

5.1 Site Preparation and Grading

Vegetation, organic material, unsuitable fill, and deleterious material that may be encountered should be cleared from areas identified for structures and site grading. Vegetation, other organic material, and debris should be removed from the site. Stripped topsoil should also be removed, or used only as landscape fill in nonstructural areas with slopes less than 25 percent. The anticipated stripping depth for sod and highly organic topsoil is anticipated to vary from 10 to 18 inches. The required stripping depth may increase in areas of heavy organics, large tree root balls, or disturbed soil. Actual stripping depths should be determined based upon visual observations made during construction when soil conditions are exposed. The post-construction maximum depth of landscape fill placed or spread at any location onsite should not exceed one foot.

Previously disturbed soil, debris, unsuitable, or undocumented fill encountered during grading or construction activities should be removed completely and thoroughly from structural areas. This includes old foundations, basement walls, utilities, associated soft soils, and debris. Excavation areas should be backfilled with engineered structural fill.

Site grading activities should be performed in accordance with requirements specified in the 2012 *International Building Code* (IBC), Chapter 18 and Appendix J, with exceptions noted in the text herein. Site preparation, soil stripping, grading activities, and demolition debris removal verification should be observed and documented by an experienced geotechnical engineer or designated representative.

5.2 Engineered Structural Fill

Areas proposed for fill placement should be appropriately prepared as described in the preceding text. Surface soils should then be scarified and compacted prior to additional fill placement. Engineered structural fill should be placed upon prepared subgrade in loose lifts not exceeding 12 inches in depth and compacted using standard conventional compaction equipment. The soil moisture content should be within three percentage points of optimum conditions. A field density at least equal to 95 percent of the maximum dry density, obtained from the standard Proctor moisture-density relationship test (ASTM D698), is recommended for structural fill placement. Engineered structural fill placed on sloped grades should be benched to provide a horizontal surface for compaction.

Compaction of engineered structural fill should be verified by nuclear gauge field compaction testing performed in accordance with ASTM D6938. Field compaction testing should be performed for each vertical foot of engineered fill placed. Engineered fill placement should be observed by an experienced geotechnical engineer or designated representative.

Engineered structural fill placement activities should be performed during dry summer months if possible. If fill placement occurs during dry weather conditions, clean, fine-textured native soils are anticipated be suitable for use as structural fill if adequately

moisture-conditioned to achieve recommended compaction specifications. Areas of sandy FAT CLAY that may be encountered may not be suitable for building foundation subgrade or road subgrade embankments. The use of clay soils for structural fill should be analyzed by Columbia West during site grading activities.

Because they are moisture-sensitive, fine-textured soils such as Soil Type 1 are often difficult to excavate and compact during wet weather conditions. If adequate compaction is not achievable with clean, fine-textured soils, import fill consisting of well-graded granular material with a maximum particle size of three inches and no more than five percent passing the No. 200 sieve is recommended for structural fill.

Representative samples of proposed engineered structural fill should be submitted for laboratory analysis and approval by the geotechnical engineer prior to placement. Laboratory analyses should include particle-size gradation and Proctor moisture-density analysis.

5.3 Cut and Fill Slopes

Fill placed on existing grades steeper than 5H:1V should be horizontally benched at least 10 feet into the slope. Fill slopes greater than six feet in height should be vertically keyed into existing subsurface soil. A typical fill slope cross-section is shown in Figure 3. Drainage implementations, including subdrains or perforated drain pipe trenches, may also be necessary in proximity to cut and fill slopes if seeps or springs are encountered. Drainage design may be performed on a case-by-case basis. Extent, depth, and location of drainage may be determined in the field by the geotechnical engineer during construction when soil conditions are exposed. Failure to provide adequate drainage may result in soil sloughing, settlement, or erosion.

Final cut or fill slopes at the site should not exceed 2H:1V or 15 feet in total height without individual slope stability analysis. The values above assume a minimum horizontal setback for loads of 10 feet from top of cut or fill slope face or overall slope height divided by three (H/3), whichever is greater. A minimum slope setback detail for structures is presented in Figure 4.

Concentrated drainage or water flow over the face of slopes should be prohibited, and adequate protection against erosion is required. Fill slopes should be constructed by placing fill material in maximum 12-inch level lifts, compacting as described in Section 5.2, *Engineered Structural Fill* and horizontally benching where appropriate. Fill slopes should be overbuilt, compacted, and trimmed at least two feet horizontally to provide adequate compaction of the outer slope face. Proper cut and fill slope construction is critical to overall project stability and should be observed by an experienced geotechnical engineer.

5.4 Foundations

Review of preliminary site plans indicates that both residential and commercial/light industrial buildings are proposed. Foundations are anticipated to consist of shallow continuous perimeter or column spread footings. Footings should be designed by a licensed structural engineer and conform to the recommendations below. Typical building

loads are not expected to exceed approximately 3 to 4 kips per foot for perimeter footings or 80 kips per column. If actual loading exceeds anticipated loading, additional analysis should be conducted for the specific load conditions and proposed footing dimensions.

The existing ground surface should be prepared as described in Section 5.1, *Site Preparation and Grading*, and Section 5.2, *Engineered Structural Fill*. Foundations should bear upon a 12-inch-thick layer of crushed aggregate base compacted to at least 95 percent of modified Proctor maximum dry density (ASTM D1557) placed on firm competent in situ soil or engineered structural fill. Disturbed surface soils and unsuitable fill should be removed from foundation alignments and replaced with structural fill.

Footings should have a minimum width of 18 inches and extend to a depth at least 18 inches below lowest adjacent grade to provide adequate bearing capacity and protection against frost heave. Foundations constructed during wet weather conditions may require over-excavation of saturated subgrade soils and granular structural backfill prior to concrete placement. Over-excavation recommendations should be provided by a qualified geotechnical engineer during foundation excavation and construction. Excavations adjacent to foundations should not extend within a 1.5H:1V angle projected down from the outside bottom footing edge without additional geotechnical analysis.

Allowable bearing capacity is typically a function of footing dimension and subsurface soil properties, including settlement and shear resistance. Based upon in situ field testing and laboratory analysis, the estimated allowable bearing capacity for well-drained foundations prepared as described above and bearing on Soil Type 1 is 1,500 psf. The estimated allowable bearing capacity for well-drained foundations bearing upon Soil Types 2 and 3 is 2,000 psf. Bearing capacity may be increased by one-third for transient lateral forces such as seismic or wind. The estimated coefficient of friction between in situ compacted native soil or engineered structural fill and in-place poured concrete is 0.35. Lateral forces may also be resisted by an assumed passive soil equivalent fluid pressure of 250 psf/f against embedded footings. The upper six inches of soil should be neglected in passive pressure calculations.

Foundations should not be permitted to bear upon existing fill, soft soil, or disturbed soil. Because soil is often heterogeneous and anisotropic, it is recommended that an experienced geotechnical engineer or designated representative observe foundation excavations prior to placing forms or reinforcing bar to verify subgrade support conditions are as anticipated in this report.

5.5 Slabs on Grade

The proposed structures may have slab-on-grade floors. Slabs should be supported on firm, competent, in situ soil or engineered structural fill. Disturbed soils and unsuitable fills in proposed slab locations should be removed and replaced with structural fill.

Preparation and compaction beneath slabs should be performed in accordance with the recommendations presented in Section 5.1, *Site Preparation and Grading* and Section 5.2, *Engineered Structural Fill*. Slabs should be underlain by at least 6 inches of free-draining 1

¼"-0 crushed aggregate meeting WSDOT 9-03.9(3). Geotextile filter fabric conforming to *WSDOT 2010 Standard Specification M 41-10, 9-33.2(1), Geotextile Properties, Table 3: Geotextile for Separation or Soil Stabilization* may be used below the crushed aggregate to increase subgrade support. If desired, a moisture barrier may be constructed beneath the slabs. Slabs should be appropriately waterproofed in accordance with the desired type of finished flooring. Slab thickness and reinforcement should be designed by an experienced structural engineer in accordance with anticipated loads.

5.6 Settlement

Total long-term static footing displacement for shallow to medium-depth foundations constructed as described in this report is not anticipated to exceed approximately 1 inch. Differential settlement between comparably loaded footing elements is not expected to exceed approximately ½ inch over a span of 50 feet. The resulting vertical displacement after loading may be due to elastic distortion, dissipation of excess pore pressure, or soil creep.

5.7 Excavation

Soils at the site were explored to a maximum depth of 16.5 feet using a track-mounted excavator. As mentioned previously, weathered and competent conglomerate bedrock was encountered in all test pits at various depths ranging from 3 to 16.5 feet below ground surface. Table 1 presents a summary of depths to bedrock and groundwater.

Table 1. *Depth to bedrock and groundwater*.

Test Pit	Depth to Bedrock Refusal (feet below ground surface)	Depth of Seep or Groundwater (feet below ground surface)
TP-1	3	2.5
TP-2	3.5	not encountered
TP-3	4.5	not encountered
TP-4	3	not encountered
TP-5	4.5	not encountered
TP-6	6.5	not encountered
TP-7	3.5	not encountered
TP-8	16.5	15

The conglomerate was generally weathered in the top few feet, but became dense and massive with depth. If significant utilities or other excavations are designed at elevations that encounter bedrock, specialized rock-excavation techniques or blasting may be necessary. As mentioned previously, groundwater seeps were also observed during the site investigation, often at a depth coincident with the soil-to-bedrock interface.

Near-surface soils are likely classified as Washington State Industrial Safety and Health Administration (WISHA) Type C. For temporary open-cut excavations deeper than four feet, but less than 20 feet in soils of these types, the maximum allowable slope is 1.5H:1V. WISHA soil type should be confirmed during field construction activities by the contractor. Soil is often anisotropic and heterogeneous, and it is possible that WISHA soil types determined in the field may differ from those described above.

The contractor should be held responsible for site safety, sloping, and shoring. Columbia West is not responsible for contractor activities and in no case should excavation be conducted in excess of all applicable local, state, and federal laws.

5.8 Dewatering

Groundwater elevation and hydrostatic pressure should be carefully considered during design of utilities, retaining walls, or other structures that require below-grade excavation. As described previously, groundwater may be encountered in the vicinity of proposed development areas. Utility trenches in shallow groundwater areas or excavations and cuts that remain open for even short periods of time may undermine or collapse due to groundwater effects. Placement of layers of riprap or quarry spalls in localized areas on shallow excavation side slopes may be required to limit instability. Over-excavation and stabilization of pipe trenches or other excavations with imported crushed aggregate or gabion rock may also be necessary to provide adequate subgrade support.

Pumping and dewatering may be required to temporarily reduce the groundwater elevation to allow construction of proposed below-grade structures, installation of utilities, or placement of structural fills. Dewatering via a sump within excavation zones may be insufficient to control groundwater and provide excavation side slope stability. Dewatering may be more feasibly conducted by installing a system of temporary well points and pumps around proposed excavation areas or utility trenches. Depending on proposed utility depths, a site-specific dewatering plan may be necessary. Well pumps should remain functioning at all times during the excavation and construction period. Suitable back-up pumps and power supplies should be available to prevent unanticipated shut-down of dewatering equipment. Failure to operate pumps full-time may result in flooding of the excavation zones, resulting in damage to forms, slopes, or equipment.

5.9 Lateral Earth Pressure

If retaining walls are proposed, lateral earth pressures should be carefully considered for design. Hydrostatic pressure and additional surcharge loading should also be considered. Retained material may include engineered structural backfill or undisturbed soil. Structural wall backfill should consist of imported granular material meeting *Section 9-03.12(2)* of WSDOT Standard Specifications. Backfill should be prepared and compacted to at least 95 percent of maximum dry density as determined by the modified Proctor test (ASTM D1557). Recommended parameters for lateral earth pressures for in situ undisturbed native soils and engineered structural fill consisting of imported granular fill meeting WSDOT specifications for *Gravel Backfill for Walls 9-03.12(2)* are presented in Table 1. Soil Type 1 is excluded due to the relative thin profile observed on the site.

The design parameters presented in Table 2 are valid for static loading cases. The recommended earth pressures do not include surcharge loads, dynamic loading, hydrostatic pressure, or seismic design.

Table 2. Lateral Earth Pressure Parameters for Level Backfill

Backfill Material	Equivalent Fluid Pressure for Level Backfill			Wet Density	Drained Internal Angle of Friction
	At-rest	Active	Passive		
WSDOT 9-03.12(2) compacted aggregate backfill	54 pcf	33 pcf	589 pcf	135 pcf	38°
In situ undisturbed clayey SAND and Poorly Graded GRAVEL with silt and sand (Soil Type 2)	64 pcf	43 pcf	360 pcf	125 pcf	29°

** The upper 6 inches of soil should be neglected in passive pressure calculations. If exterior grade from top or toe of retaining wall is sloped, Columbia West should be contacted to provide location-specific lateral earth pressures.*

If seismic design is required, seismic forces may be calculated by superimposing a uniform lateral force of $10H^2$ pounds per lineal foot of wall, where H is the total wall height in feet. The resultant force should be applied at 0.6H from the base of the wall.

A continuous one-foot-thick zone of free-draining, washed, open-graded 1-inch by 2-inch drain rock and a 4-inch perforated gravity drain pipe is assumed behind retaining walls. Geotextile filter fabric should be placed between the drain rock and backfill soil. Specifications for drainpipe design are presented in Section 5.12, *Drainage*. If walls cannot be gravity drained, saturated base conditions and/or applicable hydrostatic pressures should be assumed.

Final retaining wall design should be reviewed and approved by Columbia West. Retaining wall subgrade and backfill activities should also be observed and tested for compliance with recommended specifications by the geotechnical engineer or designated representative during construction.

5.10 Seismic Design Considerations

According to the *United States Geologic Survey (USGS) 2010 ASCE 7 Seismic Design Maps Summary Report,* the anticipated peak ground and maximum considered earthquake spectral response accelerations resulting from seismic activity for the subject site are summarized in Table 3.

The listed probabilistic ground motion values are based upon “firm rock” sites with an assumed shear wave velocity of 2,500 ft/s in the upper 100 feet of soil profile. These values should be adjusted for site class effects by applying site coefficients Fa and Fv as defined in 2012 IBC Tables 1613.3.3(1) and (2). The site coefficients are intended to more accurately characterize estimated peak ground and respective earthquake spectral response accelerations by considering site-specific soil characteristics and index properties.

The *Site Class Map of Clark County, Washington (Washington State Department of Natural Resources, 2004),* indicates site soils may be represented by Site Class C. Based upon observed subsurface soil conditions at the site, and review of well logs and local

geologic maps, site soils may be considered to be Site Class C as defined in 2012 IBC Section 1613.3.5. This site class designation indicates that some amplification of seismic energy may occur during a seismic event because of subsurface conditions. This assessment is preliminary and is based upon limited field exploration and research of existing published literature. Additional exploration would be necessary to provide soil site class information at greater depths.

Table 3. Approximate Probabilistic Ground Motion Values for 'firm rock' sites based on subject property longitude and latitude

	2% Probability of Exceedance in 50 yrs
Peak Ground Acceleration	0.38 g
0.2 sec Spectral Acceleration	0.89 g
1.0 sec Spectral Acceleration	0.38 g

Localized peak ground accelerations exceeding the adjusted values may occur in some areas in direct proximity to an earthquake's origin. This may be a result of amplification of seismic energy due to depth to competent bedrock, compression and shear wave velocity of bedrock, presence and thickness of loose, unconsolidated alluvial deposits, soil plasticity, grain size, and other factors.

Identification of specific seismic response spectra for the site is beyond the scope of this investigation. If site structures are designed in accordance with recommendations specified in the 2012 IBC, the potential for peak ground accelerations in excess of the adjusted and amplified values should be understood.

5.11 Soil Liquefaction and Dynamic Settlement

According to the *Alternative Liquefaction Susceptibility Map of Clark County Washington (Washington State Department of Natural Resources, 2004)*, the site is mapped as very low susceptibility for liquefaction. Liquefaction, defined as the transformation of the behavior of a granular material from a solid to a liquid due to increased pore-water pressure and reduced effective stress, may occur when granular or non-plastic silt materials quickly compact under cyclic stresses caused by a seismic event. The effects of liquefaction may include immediate ground settlement and lateral spreading.

Soils most susceptible to liquefaction are generally saturated, cohesionless, loose to medium-dense sands within 50 feet of the ground surface. Recent research has also indicated that low plasticity silts and clays may also be subject to sand-like liquefaction behavior if the plasticity index determined by the Atterberg Limits analysis is less than 8. Potentially liquefiable soils located above the existing, historic, or expected ground water levels do not generally pose a liquefaction hazard. It is important to note that changes in

perched ground water elevation may occur due to project development or other factors not observed at the time of investigation.

Based upon the results of the geotechnical investigation, the potential for liquefaction of shallow soils at the site is considered to be low.

5.12 Drainage

At a minimum, site drainage should include surface water collection and conveyance to properly designed stormwater management structures and facilities. Drainage design in general should conform to City of Camas regulations. Finished site grading should be conducted with positive drainage away from structures. Depressions or shallow areas that may retain ponding water should be avoided. Roof drains, low-point drains, and perimeter foundation drains are recommended for structures. Drains should consist of separate systems and gravity flow with a minimum two-percent slope away from foundations into the stormwater system or approved discharge location. Concentrated discharge of water should be prohibited across slopes and water should not be diverted, routed, or allowed to flow over or across slope faces.

Perimeter foundation drains should consist of 3-inch perforated PVC pipe surrounded by a minimum of 1 ft^3 of clean, washed drain rock per linear foot of pipe and wrapped with geotextile filter fabric. Open-graded drain rock with a maximum particle size of 3 inches and less than 2 percent passing the No. 200 sieve is recommended. Geotextile filter fabric should consist of Mirafi 140N or approved equivalent, with AOS between No. 70 and No. 100 sieve. The water permittivity should be greater than 1.5/sec. Figure 5 presents a typical foundation drain. Perimeter drains may limit increased hydrostatic pressure beneath footings and assist in reducing potential perched moisture areas.

Subdrains should also be considered if portions of the site are cut below surrounding grades. Shallow groundwater, springs, or seeps should be conveyed via drainage channel or perforated pipe into the stormwater management system or an approved discharge. Recommendations for design and installation of perforated drainage pipe may be performed on a case-by-case basis by the geotechnical engineer during construction. Failure to provide adequate surface and sub-surface drainage may result in soil slumping or unanticipated settlement of structures exceeding tolerable limits. A typical perforated drain pipe trench detail is presented in Figure 6.

Foundation drains and subdrains should be closely monitored after construction to assess their effectiveness. If additional surface or shallow subsurface seeps become evident, the drainage provisions may require modification or additional drains. The geotechnical engineer should be consulted to provide appropriate recommendations.

5.13 Bituminous Asphalt and Portland Cement Concrete

Preliminary site plans indicate that proposed development includes private asphalt concrete driveways and parking areas. Additionally, an extension of the City of Camas' NW Camas Meadows Drive may be constructed as part of the development. Pavement section thickness should be carefully considered to provide adequate lifespan and

serviceability. Pavement section design is outside the scope of this investigation; however, Columbia West can provide section design services in the future if requested. Columbia West recommends adherence to the City of Camas standards for public works construction if improvements to public roads are proposed.

For dry weather construction, pavement surface sections should bear upon competent subgrade consisting of scarified and compacted native soil or engineered structural fill. Wet weather pavement construction is discussed later in Section 5.14, *Wet Weather Construction Methods and Techniques*. Areas proposed for asphalt pavement construction should be prepared as described in Section 5.1, *Site Preparation and Grading*. Subgrade conditions should be evaluated and tested by a licensed geotechnical engineer or designated representative prior to placement of crushed aggregate base. Subgrade evaluation should include nuclear gauge density testing and wheel proof-roll observations conducted with a 12-cubic yard, double-axle dump truck or equivalent. Nuclear gauge density testing should be conducted at 250-foot intervals or as determined by the onsite geotechnical engineer. Subgrade soil should be compacted to at least 95 percent of the modified Proctor dry density, as determined by ASTM D698. Areas of observed deflection or rutting during proof-roll evaluation should be excavated to a firm surface and replaced with compacted crushed aggregate.

Crushed aggregate base should be compacted and tested in accordance with the specifications outlined above. Asphalt concrete pavement should be compacted to at least 91 percent of maximum Rice density. Nuclear gauge density testing should be conducted to verify adherence to recommended specifications. Testing frequency should be in accordance with Washington Department of Transportation and City of Camas specifications.

Portland cement concrete curbs should be installed in accordance with the City of Camas specifications. Aggregate base should be observed and proof-rolled in the presence of an experienced geotechnical engineer or designated representative. Soft areas that deflect or rut should be stabilized prior to pouring concrete. Concrete should be tested during installation in accordance with ASTM C171, C138, C231, C143, C1064, and C31. This includes casting of cylinder specimen at a frequency of four cylinders per 100 cubic yards of poured concrete. Recommended field and analytical laboratory concrete testing includes slump, air entrainment, temperature, and unit weight.

5.14 Wet Weather Construction Methods and Techniques

Wet weather construction often results in significant shear strength reduction and soft areas that may rut or deflect. Installation of granular working layers may be necessary to provide a firm support base and sustain construction equipment. Granular layers should consist of all-weather gravel, 4-inch by 6-inch gabion, or other similar material (6-inch maximum size with less than 5 percent passing the No. 200 sieve).

Construction equipment traffic across exposed fine-textured soil should be minimized. Equipment traffic induces dynamic loading, which may result in weak areas and significant reduction in shear strength for soils above plastic limit. Wet weather construction may

generate significant excess quantities of soft wet soil, which should be removed from the site or stockpiled in a designated area.

Construction during wet weather conditions may require increased base thickness. Road base should consist of 3"-0 or 1¼"-0 crushed aggregate and should be placed on previously stripped and structurally competent subgrade. Over-excavation may be necessary to provide a firm base upon which to place crushed aggregate. Geotextile filter fabric such as Mirafi 500X or an approved equivalent is also recommended. Crushed aggregate base should be installed in a single lift with trucks end-dumping from an advancing layer of granular fill. During extended wet periods, stripping activities may also need to be conducted from an advancing layer of granular fill. Once installed, the crushed aggregate base should be compacted with several passes from a static drum roller. A vibratory compactor is not recommended because it may further disturb the subgrade. Subdrains may also be necessary to provide subgrade drainage and maintain structural integrity.

Crushed aggregate base should be compacted to at least 95 percent of maximum dry density according to the modified Proctor density test (ASTM D1557). Compaction should be verified by nuclear gauge density testing. Observation of a proof-roll with a loaded dump truck is also recommended as an indication of subgrade performance.

It should be understood that wet weather construction is risky and costly. An experienced geotechnical engineer or designated representative should observe and document wet weather construction activities. Proper construction methods and techniques are critical to overall project integrity.

5.15 Erosion Control Measures

Based upon field observations and laboratory testing, the erosion hazard for site soils in flat to shallow-gradient portions of the property is likely to be low. The potential for erosion generally increases in sloped areas. Therefore, disturbance to vegetation in sloped areas should be minimized during construction activities. Soil is also prone to erosion if unprotected and unvegetated during periods of increased precipitation. Erosion can be minimized by performing construction activities during dry summer months.

Site-specific erosion control measures should be implemented to address the maintenance of exposed areas. This may include silt fence, biofilter bags, straw wattles, or other suitable methods. During construction activities, exposed areas should be well-compacted and protected from erosion with visqueen, surface tactifier, or other means, as appropriate. Temporary slopes or exposed areas may be covered with straw, crushed aggregate, or riprap in localized areas to minimize erosion. Erosion and water runoff during wet weather conditions may be controlled by application of strategically placed channels and small detention depressions with overflow pipes.

After grading, exposed surfaces should be vegetated as soon as possible with erosion-resistant native species. Jute mesh or straw may be applied to enhance vegetation. Once established, vegetation should be properly maintained. Disturbance to existing native

vegetation and surrounding organic soil should also be minimized during construction activities.

5.16 Soil Shrink/Swell Potential

Based upon laboratory analysis, subsurface soils contain as much as 63 percent by weight passing the No. 200 sieve and exhibit a plasticity index ranging from 16 to 25 percent. This indicates low to moderate potential for soil shrinking or swelling.

5.17 Utility Installation

Utility installation may require subsurface excavation and trenching. Excavation, trenching and shoring should conform to federal (Occupational Safety and Health Administration) (OSHA) (29 CFR, Part 1926) and *WISHA* (WAC, Chapter 296-155) regulations. Site soils may slough when cut vertically and sudden precipitation events or perched groundwater may result in accumulation of water within excavation zones and trenches.

Utilities should be installed in general accordance with manufacturer's recommendations. Utility trench backfill should consist of crushed aggregate or other coarse-textured, free-draining material acceptable to the client, City of Camas, and the site geotechnical engineer. Trench backfill material within 18 inches of the top of utility pipes should be hand compacted (i.e., no heavy compaction equipment). The remaining backfill should be compacted to at least 95 percent of maximum dry density as determined by the standard Proctor moisture-density test (ASTM D698). Clean, free-draining, fine bedding sand is recommended for use in the pipe zone. With exception of the pipe zone, backfill should be placed in loose lifts not exceeding 12 inches in thickness.

Compaction of utility trench backfill material should be verified by nuclear gauge field compaction testing performed in accordance with ASTM D6938. It is recommended that field compaction testing be performed at 200-foot intervals along the utility trench centerline at the surface and midpoint depth of the trench. Compaction frequency and specifications may be modified for non-structural areas in accordance with recommendations of the site geotechnical engineer.

6.0 CONCLUSION AND LIMITATIONS

This geotechnical site investigation report was prepared in accordance with accepted standard conventional principles and practices of geotechnical engineering. This investigation pertains only to material tested and observed as of the date of this report, and is based upon proposed site development as described in the text herein. This report is a professional opinion containing recommendations established by engineering interpretations of subsurface soils based upon conditions observed during site exploration. Soil conditions may differ between tested locations or over time. Even slight variations may produce impacts to the performance of structural facilities if not adequately addressed. This underscores the importance of diligent QA/QC construction observation and testing to verify soil conditions are as anticipated in this report.

Therefore, this report contains several recommendations for field observation and testing by Columbia West personnel during construction activities. Columbia West cannot accept

responsibility for deviations from recommendations described in this report. Future performance of structural facilities is often related to the degree of construction observation by qualified personnel. These services should be performed to the full extent recommended.

This report is not an environmental assessment and should not be construed as a representative warranty of site subsurface conditions. The discovery of adverse environmental conditions, or subsurface soils that deviate significantly from those described in this report, should immediately prompt further investigation. The above statements are in lieu of all other statements expressed or implied.

This report was prepared solely for the client and is not to be reproduced without prior authorization from Columbia West. Final engineering plans and specifications for the project should be reviewed and approved by Columbia West as they relate to geotechnical and grading issues prior to final design approval. Columbia West is not responsible for independent conclusions or recommendations made by other parties based upon information presented in this report. Unless a particular service was expressly included in the scope, it was not performed and there should be no assumptions based upon services not provided. Additional report limitations and important information about this document are presented in Appendix E. This information should be carefully read and understood by the client and other parties reviewing this document.

Sincerely,

COLUMBIA WEST ENGINEERING, Inc.

Daniel E. Lehto, PE, GE
Principal



REFERENCES

Annual Book of ASTM Standards, Soil and Rock (I), v04.08, American Society for Testing and Materials, 1999.

Beeson, M.H., Tolan, T.L., Madin, I.P., *Geologic Map of the Lake Oswego Quadrangle, Clackamas, Multnomah, and Washington Counties, Oregon*; Oregon Department of Geology and Mineral Industries; Geological Map Series GMS-59, 1989.

Clark County Maps Online (http://gis.clark.wa.gov/ccgis/mol/property.htm)

Evarts, Russel C., *Geologic Map of the Lacamas Creek Quadrangle, Clark County, Washington.* US Geological Survey, Science Investigations Map 2924, 2006.

Geomatrix Consultants, *Seismic Design Mapping, State of Oregon*, January 1995.

International Building Code: *2012 International Building Code, 2012 edition*, International Code Council, 2012.

Mundorff, M.J., *Geology and Groundwater Conditions of Clark County*, USGS Water Supply Paper 1600, 1964.

Palmer, Stephen P., Magsino, Sammantha L., Poelstra, James L., and Niggemann, Rebecca A., *Site Class Map of Clark County, Washington; Liquefaction Susceptibility Map of Clark County Washington;* Washington State Department of Natural Resources, September 2004.

Phillips, William M., *Geological Map of the Vancouver Quadrangle, Washington and Oregon,* Open File Report 87-10, Washington State Department of Natural Resources, Division of Geology and Earth Resources, 1987.

Safety and Health Regulations for Construction, 29 CFR Part 1926, Occupational Safety and Health Administration (OSHA), revised July 1, 2001.

Safety Standards for Construction Work, Part N, Excavation, Trenching and Shoring, Washington Administrative Code, Chapter 296-155, Division of Industrial Safety and Health, Washington Department of Labor and Industries, February, 1993.

United States Geologic Survey (USGS)*, 2008 NSHMP PSHA Interactive Deaggregation,* Web Application, Accessed February 2014

Web Soil Survey, Natural Resources Conservation Service, United States Department of Agriculture *2013 website* (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm.).

Wong, Ivan, et al, *Earthquake Scenario and Probabilistic Earthquake Ground Shaking Maps for the Portland, Oregon, Metropolitan Area*, IMS-16, Oregon Department of Geology and Mineral Industries, 2000.

FIGURES



MAP SOURCE: Google Maps 2014

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc
11917 NE 95th Street
Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Design	Drawn: ASR		
Checked: DEL	Date: 6/12/15		
Client: PACM, LLC	Rev	By	Date
Job No.: 15153			
CAD File: FIGURE 1			
Scale: ~1:50,000			

SITE LOCATION MAP

PARKLANDS AT CAMAS MEADOWS
CAMAS, WASHINGTON

FIGURE 1



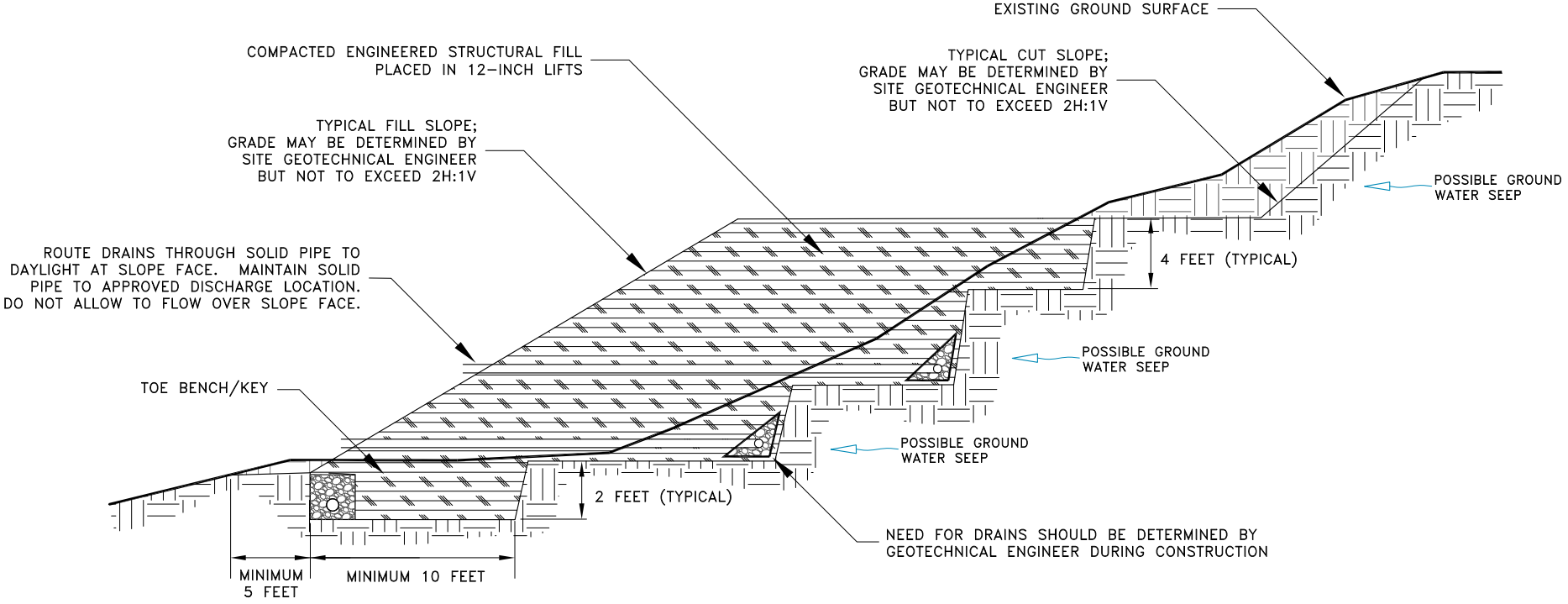
NOTES:
1. SITE LOCATION: 2150 NE IONE STREET.
2. DRAWING IS NOT TO SCALE.
3. BASE MAP OBTAINED FROM BING MAPS.
4. TEST PIT LOCATIONS ARE APPROXIMATE AND NOT SURVEYED.
5. SOIL BOTING BACKFILLED WITH BENTONITE ON 6-26-2013.

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc
11917 NE 95th STREET
VANCOUVER, WASHINGTON 98682
PHONE: 360-823-2900 FAX: 360-823-2901
www.columbiawestengineering.com

Design:	Drawn: ASR			SUBSURFACE EXPLORATION LOCATION MAP
Checked: DEL	Date: 6/12/15			
Client: PACM, LLC	Rev	By	Date	PARKLANDS AT CAMAS MEADOWS
Job No: 15153				CAMAS, WASHINGTON
CAD File: FIGURE 2				
Scale: NONE				

FIGURE 2

TYPICAL CUT AND FILL SLOPE CROSS-SECTION

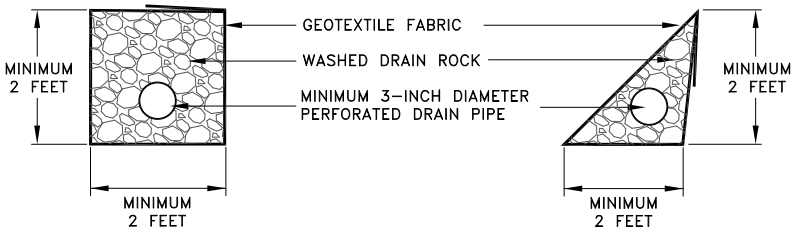


DRAIN SPECIFICATIONS

GEOTEXTILE FABRIC SHALL CONSIST OF MIRAFI 140N OR APPROVED EQUIVALENT WITH AOS BETWEEN No. 70 AND No. 100 SIEVE.

WASHED DRAIN ROCK SHALL BE OPEN-GRADED ANGULAR DRAIN ROCK WITH LESS THAN 2 PERCENT PASSING THE No. 200 SIEVE AND A MAXIMUM PARTICLE SIZE OF 3 INCHES.

TYPICAL DRAIN SECTION DETAIL



NOTES:
1. DRAWING IS NOT TO SCALE.
2. SLOPES AND PROFILES SHOWN ARE APPROXIMATE.
3. DRAWING REPRESENTS TYPICAL FILL AND CUT SLOPE SECTION, AND MAY NOT BE SITE-SPECIFIC.

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc
11917 NE 95th STREET
VANCOUVER, WASHINGTON 98682
PHONE: 360-823-2900 FAX: 360-823-2901
www.columbiawestengineering.com

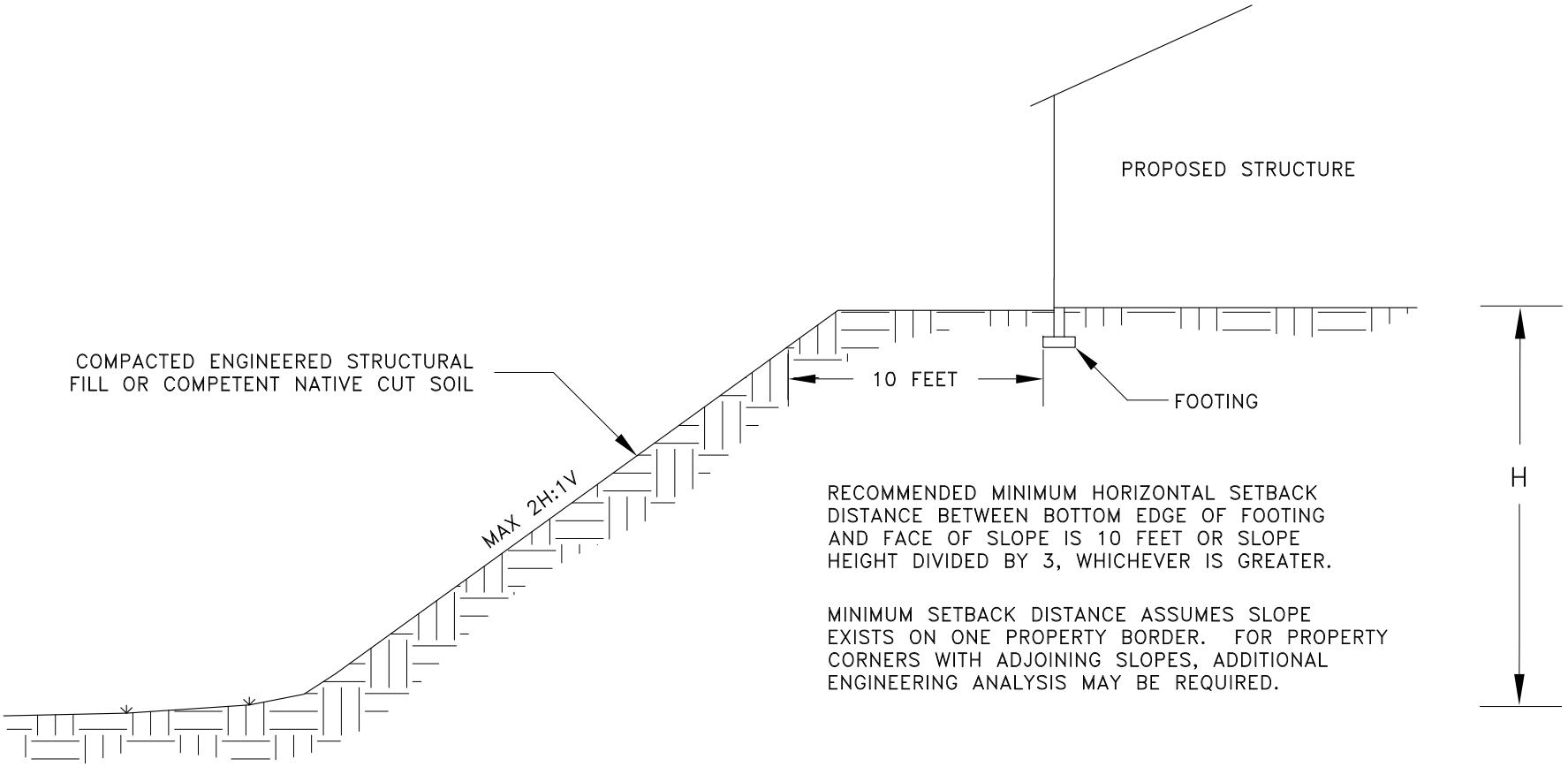
Design:	Drawn: ASR		
Checked: DEL	Date: 6/12/15		
Client: PACM, LLC	Rev	By	Date
Job No: 15153			
CAD File: FIGURE 3			
Scale: NONE			

TYPICAL CUT AND FILL SLOPE CROSS-SECTION

PARKLANDS AT CAMAS MEADOWS
CAMAS, WASHINGTON

FIGURE 3

TYPICAL CUT AND FILL SLOPE CROSS-SECTION



RECOMMENDED MINIMUM HORIZONTAL SETBACK DISTANCE BETWEEN BOTTOM EDGE OF FOOTING AND FACE OF SLOPE IS 10 FEET OR SLOPE HEIGHT DIVIDED BY 3, WHICHEVER IS GREATER.

MINIMUM SETBACK DISTANCE ASSUMES SLOPE EXISTS ON ONE PROPERTY BORDER. FOR PROPERTY CORNERS WITH ADJOINING SLOPES, ADDITIONAL ENGINEERING ANALYSIS MAY BE REQUIRED.

NOTES:
1. DRAWING IS NOT TO SCALE.
2. SLOPES AND PROFILES SHOWN ARE APPROXIMATE.
3. DRAWING REPRESENTS TYPICAL FOUNDATION SETBACK DETAIL, AND MAY NOT BE SITE-SPECIFIC.

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc
11917 NE 95th STREET
VANCOUVER, WASHINGTON 98682
PHONE: 360-823-2900 FAX: 360-823-2901
www.columbiawestengineering.com

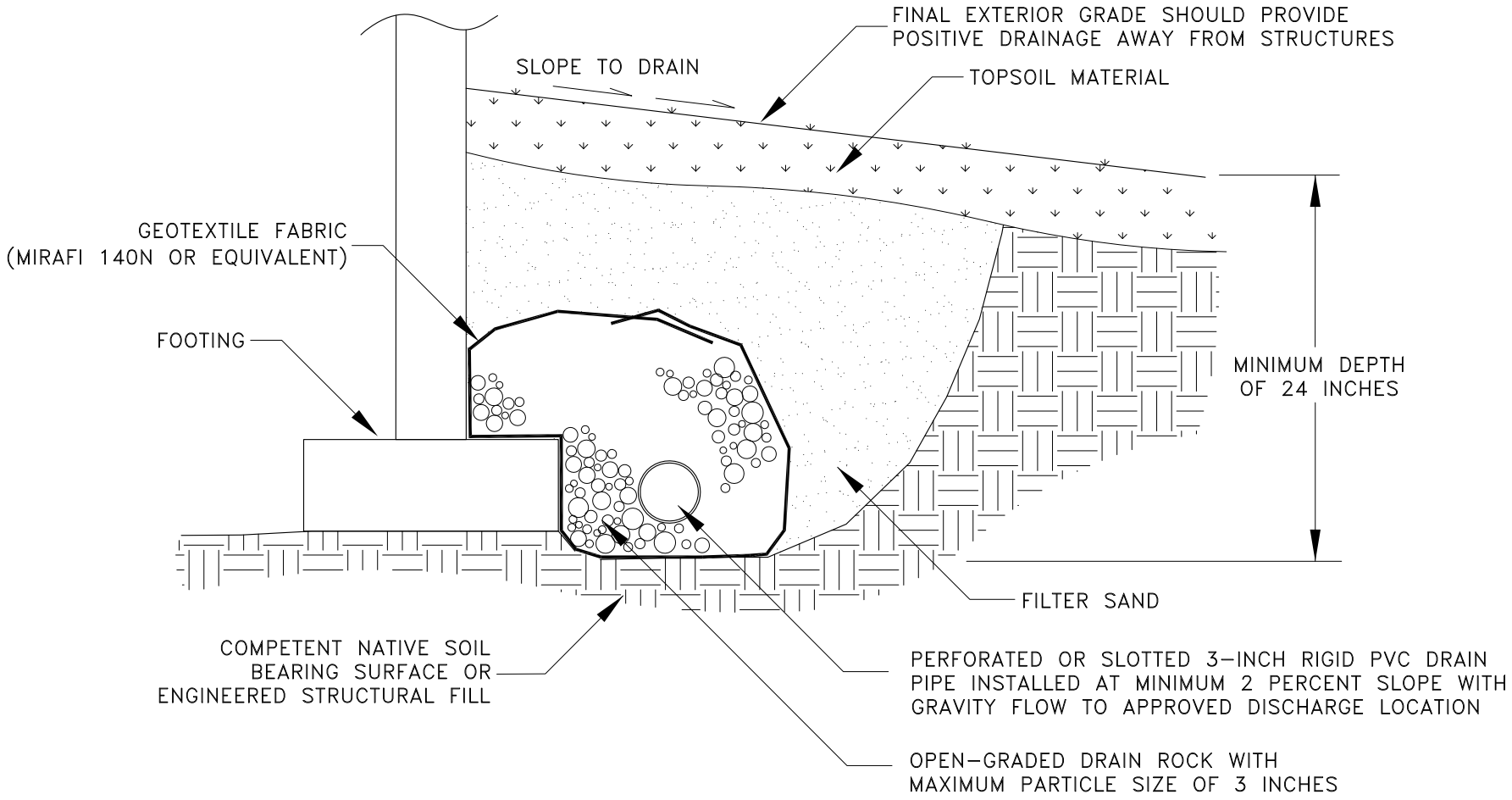
Design:	Drawn: ASR			
Checked: DEL	Date: 06/12/15			
Client: PACM, LLC	Rev	By	Date	
Job No: 15153				
CAD File: FIGURE 4				
Scale: NONE				

MINIMUM FOUNDATION SLOPE SETBACK DETAIL

PARKLANDS AT CAMAS MEADOWS
CAMAS, WASHINGTON

FIGURE
4

TYPICAL PERIMETER FOOTING DRAIN DETAIL



NOTES:
1. DRAWING IS NOT TO SCALE.
2. DRAWING REPRESENTS TYPICAL FOOTING DRAIN DETAIL AND MAY NOT BE SITE-SPECIFIC.

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc
11917 NE 95th STREET
VANCOUVER, WASHINGTON 98682
PHONE: 360-823-2900 FAX: 360-823-2901
www.columbiawestengineering.com

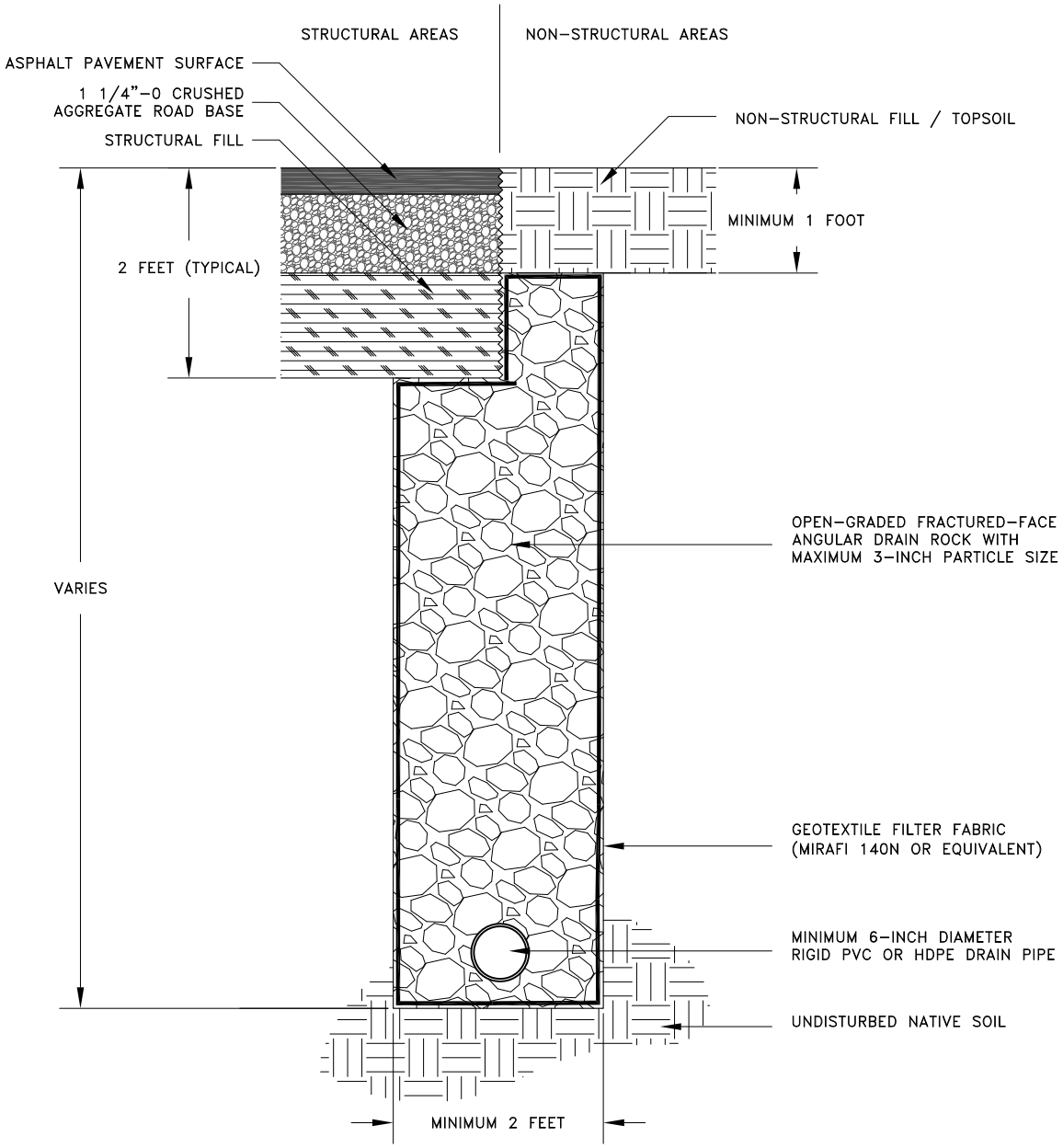
Design:	Drawn: ASR			
Checked: DEL	Date: 6/12/15			
Client: PACM, LLC	Rev	By	Date	
Job No: 15153				
CAD File: FIGURE 5				
Scale: NONE				

TYPICAL PERIMETER FOOTING DRAIN DETAIL

PARKLANDS AT CAMAS MEADOWS
CAMAS, WASHINGTON

FIGURE 5

TYPICAL PERFORATED DRAIN PIPE TRENCH DETAIL



NOTE: LOCATION, INVERT ELEVATION, DEPTH OF TRENCH, AND EXTENT OF PERFORATED PIPE REQUIRED MAY BE MODIFIED BY THE GEOTECHNICAL ENGINEER DURING CONSTRUCTION BASED UPON FIELD OBSERVATION AND SITE–SPECIFIC SOIL CONDITIONS.

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc
11917 NE 95th STREET
VANCOUVER, WASHINGTON 98682
PHONE: 360-823-2900 FAX: 360-823-2901
www.columbiawestengineering.com

Design:	Drawn: ASR		
Checked: DEL	Date: 06/12/15		
Client: PACM, LLC	Rev	By	Date
Job No: 15153			
CAD File: FIGURE 6			
Scale: NONE			

TYPICAL PERFORATED DRAIN PIPE TRENCH DETAIL

PARKLANDS AT CAMAS MEADOWS
CAMAS, WASHINGTON

FIGURE 6

APPENDIX A
ANALYTICAL LABORATORY TEST RESULTS

11917 NE 95th Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Parklands at Camas Meadows Camas, Washington	Mr. Aaron Barr & Mr. Kevin Deford Parklands at Camas Meadows, LLC PO Box 61962 Vancouver, WA 98666	15153	S15-359
		REPORT DATE 06/16/15	FIELD ID TP3.1
		DATE SAMPLED 06/04/15	SAMPLED BY HDG

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Sandy SILT	Test Pit TP-03 depth = 2 feet	ML, Sandy Silt
SPECIFICATIONS none		AASHTO SOIL TYPE A-7-6(7)

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Rainhart "Mary Ann" Sifter 637	ASTM D6913, D422

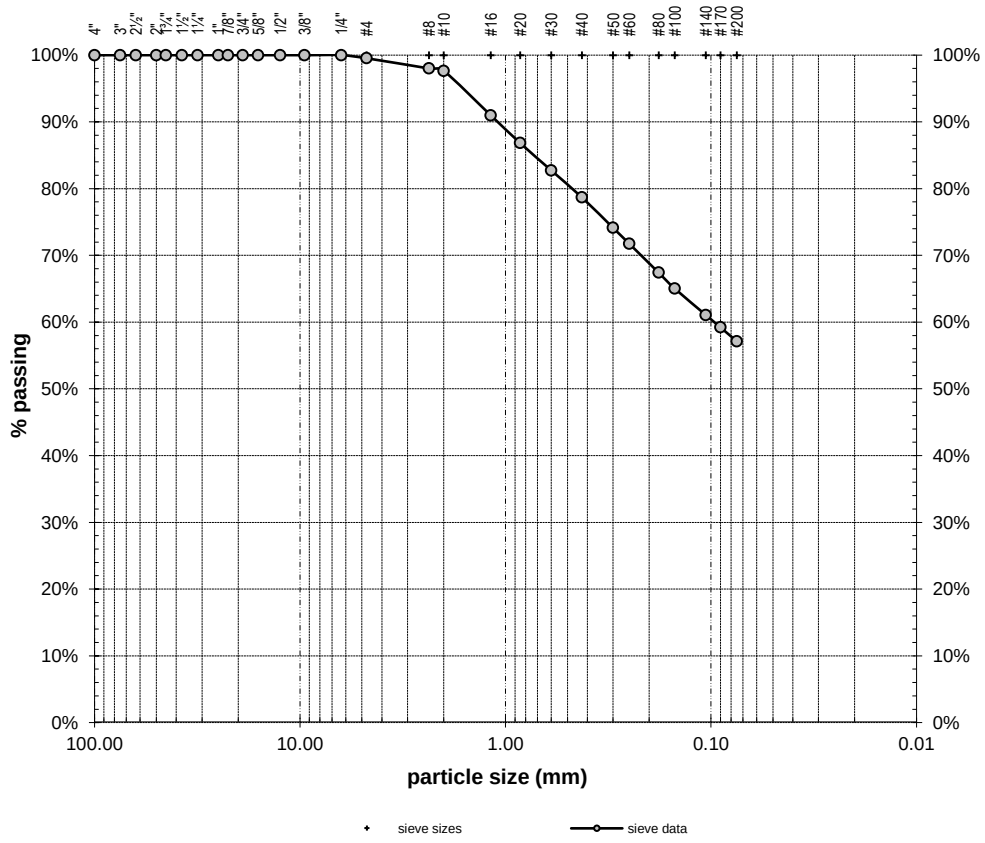
ADDITIONAL DATA

initial dry mass (g) =	158.3		
as-received moisture content =	36.4%	coefficient of curvature, C_C =	n/a
liquid limit =	44	coefficient of uniformity, C_U =	n/a
plastic limit =	28	effective size, $D_{(10)}$ =	n/a
plasticity index =	16	$D_{(30)}$ =	n/a
fineness modulus =	n/a	$D_{(60)}$ =	0.097 mm

SIEVE DATA

% gravel =	0.5%
% sand =	42.4%
% silt and clay =	57.1%

GRAIN SIZE DISTRIBUTION



	SIEVE SIZE US	SIEVE SIZE mm	PERCENT PASSING SIEVE act.	PERCENT PASSING SIEVE interp.	SPECS max	SPECS min
GRAVEL	6.00"	150.0		100.0%		
	4.00"	100.0		100.0%		
	3.00"	75.0		100.0%		
	2.50"	63.0		100.0%		
	2.00"	50.0		100.0%		
	1.75"	45.0		100.0%		
	1.50"	37.5		100.0%		
	1.25"	31.5		100.0%		
	1.00"	25.0		100.0%		
	7/8"	22.4		100.0%		
	3/4"	19.0		100.0%		
	5/8"	16.0		100.0%		
	1/2"	12.5		100.0%		
	3/8"	9.50		100.0%		
	1/4"	6.30	100.0%			
	#4	4.75	99.5%			
SAND	#8	2.36		98.0%		
	#10	2.00	97.6%			
	#16	1.18		91.0%		
	#20	0.850	86.8%			
	#30	0.600		82.7%		
	#40	0.425	78.7%			
	#50	0.300		74.1%		
	#60	0.250	71.7%			
	#80	0.180		67.4%		
	#100	0.150	65.0%			
	#140	0.106		61.1%		
	#170	0.090		59.2%		
	#200	0.075	57.1%			

DATE TESTED	TESTED BY
06/08/15	BTT/MJR

This report may not be reproduced except in full without prior written authorization by Columbia West Engineering, Inc.

COLUMBIA WEST ENGINEERING, INC. authorized signature

11917 NE 95th Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Parklands at Camas Meadows Camas, Washington	Mr. Aaron Barr & Mr. Kevin Deford Parklands at Camas Meadows, LLC PO Box 61962 Vancouver, WA 98666	15153	S15-359
		REPORT DATE: 06/16/15	FIELD ID: TP3.1
		DATE SAMPLED: 06/04/15	SAMPLED BY: HDG

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Sandy SILT	Test Pit TP-03 depth = 2 feet	ML, Sandy Silt

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Liquid Limit Machine, Hand Rolled

TEST PROCEDURE: ASTM D4318

ATTERBERG LIMITS

liquid limit = 44
plastic limit = 28
plasticity index = 16

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	33.30	33.31	33.93	
dry soil + pan weight, g =	29.59	29.37	29.72	
pan weight, g =	20.83	20.70	20.68	
N (blows) =	30	20	15	
moisture, % =	42.4 %	45.4 %	46.6 %	

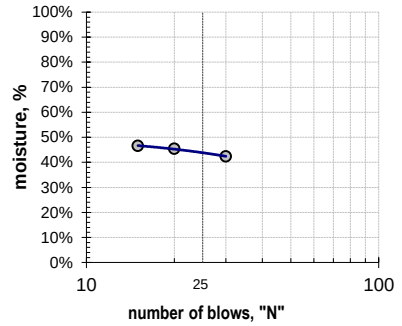
SHRINKAGE

shrinkage limit = n/a
shrinkage ratio = n/a

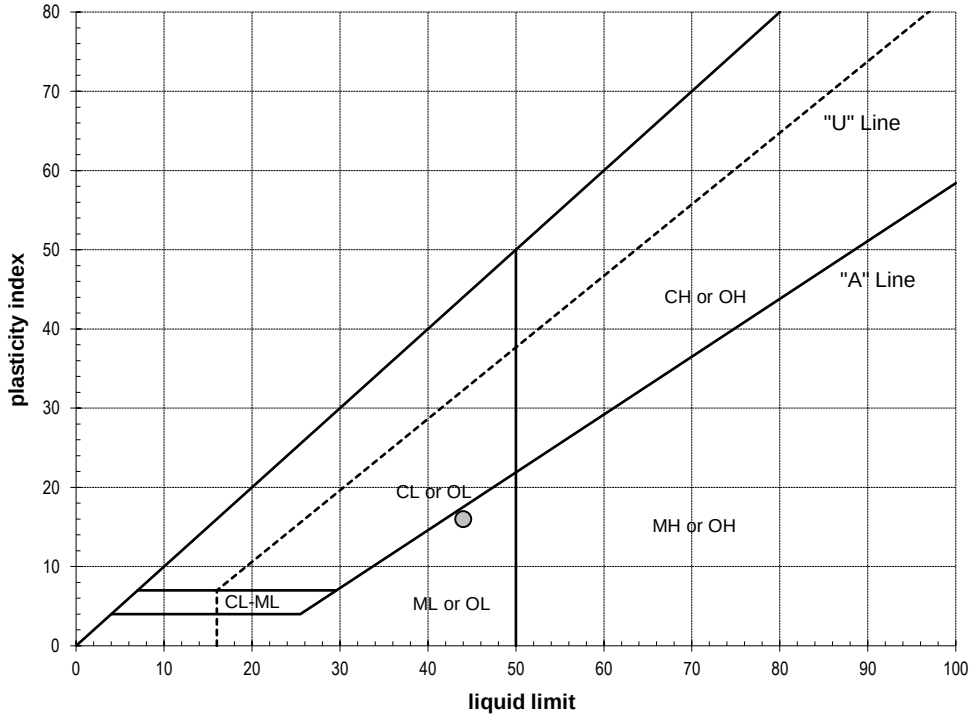
PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.85	27.97		
dry soil + pan weight, g =	26.28	26.35		
pan weight, g =	20.69	20.50		
moisture, % =	28.1 %	27.7 %		

LIQUID LIMIT



PLASTICITY CHART



ADDITIONAL DATA

% gravel =	0.5%
% sand =	42.4%
% silt and clay =	57.1%
% silt =	n/a
% clay =	n/a
moisture content =	36.4%

DATE TESTED	TESTED BY
06/15/15	MJR

This report may not be reproduced except in full without prior written authorization by Columbia West Engineering, Inc.

COLUMBIA WEST ENGINEERING, INC. authorized signature

11917 NE 95th Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Parklands at Camas Meadows Camas, Washington	Mr. Aaron Barr & Mr. Kevin Deford Parklands at Camas Meadows, LLC PO Box 61962 Vancouver, WA 98666	15153	S15-360
		REPORT DATE 06/16/15	FIELD ID TP6.1
		DATE SAMPLED 06/04/15	SAMPLED BY HDG

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Sandy Fat CLAY	Test Pit TP-06 depth = 2.5 feet	CH, Sandy Fat Clay
SPECIFICATIONS none		AASHTO SOIL TYPE A-7-6(14)

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Rainhart "Mary Ann" Sifter 637	ASTM D6913, D422

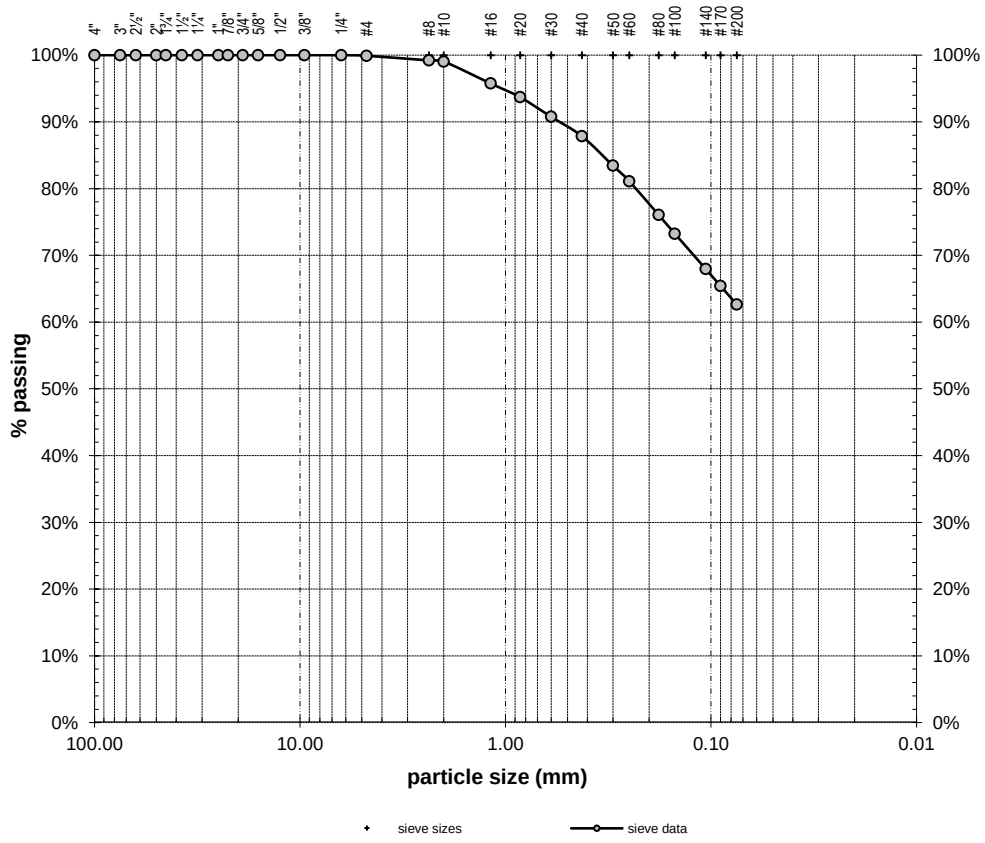
ADDITIONAL DATA

initial dry mass (g) =	173.4		
as-received moisture content =	32.3%	coefficient of curvature, C_C =	n/a
liquid limit =	51	coefficient of uniformity, C_U =	n/a
plastic limit =	26	effective size, $D_{(10)}$ =	n/a
plasticity index =	25	$D_{(30)}$ =	n/a
fineness modulus =	n/a	$D_{(60)}$ =	n/a

SIEVE DATA

% gravel =	0.1%
% sand =	37.3%
% silt and clay =	62.6%

GRAIN SIZE DISTRIBUTION



	SIEVE SIZE US	SIEVE SIZE mm	PERCENT PASSING SIEVE act.	PERCENT PASSING SIEVE interp.	SPECS max	SPECS min
GRAVEL	6.00"	150.0		100.0%		
	4.00"	100.0		100.0%		
	3.00"	75.0		100.0%		
	2.50"	63.0		100.0%		
	2.00"	50.0		100.0%		
	1.75"	45.0		100.0%		
	1.50"	37.5		100.0%		
	1.25"	31.5		100.0%		
	1.00"	25.0		100.0%		
	7/8"	22.4		100.0%		
	3/4"	19.0		100.0%		
	5/8"	16.0		100.0%		
	1/2"	12.5		100.0%		
	3/8"	9.50		100.0%		
	1/4"	6.30	100.0%			
	#4	4.75	99.9%			
SAND	#8	2.36		99.2%		
	#10	2.00	99.0%			
	#16	1.18		95.7%		
	#20	0.850	93.7%			
	#30	0.600		90.8%		
	#40	0.425	87.9%			
	#50	0.300		83.4%		
	#60	0.250	81.1%			
	#80	0.180		76.1%		
	#100	0.150	73.2%			
	#140	0.106		67.9%		
	#170	0.090		65.4%		
	#200	0.075	62.6%			

DATE TESTED	TESTED BY
06/08/15	BTT/MJR

This report may not be reproduced except in full without prior written authorization by Columbia West Engineering, Inc.

COLUMBIA WEST ENGINEERING, INC. authorized signature

11917 NE 95th Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Parklands at Camas Meadows Camas, Washington	Mr. Aaron Barr & Mr. Kevin Deford Parklands at Camas Meadows, LLC PO Box 61962 Vancouver, WA 98666	15153	S15-360
		REPORT DATE: 06/16/15	FIELD ID: TP6.1
		DATE SAMPLED: 06/04/15	SAMPLED BY: HDG

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Sandy Fat CLAY	Test Pit TP-06 depth = 2.5 feet	CH, Sandy Fat Clay

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Liquid Limit Machine, Hand Rolled

TEST PROCEDURE: ASTM D4318

ATTERBERG LIMITS

liquid limit =	51
plastic limit =	26
plasticity index =	25

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	34.63	34.09	37.32	
dry soil + pan weight, g =	30.07	29.61	31.60	
pan weight, g =	20.69	20.73	20.85	
N (blows) =	33	25	15	
moisture, % =	48.6 %	50.5 %	53.2 %	

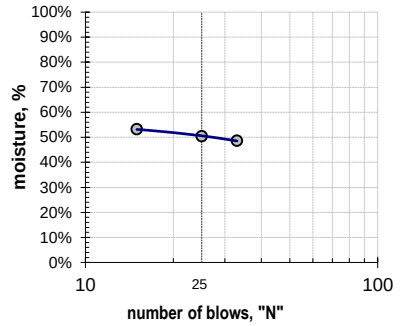
SHRINKAGE

shrinkage limit =	n/a
shrinkage ratio =	n/a

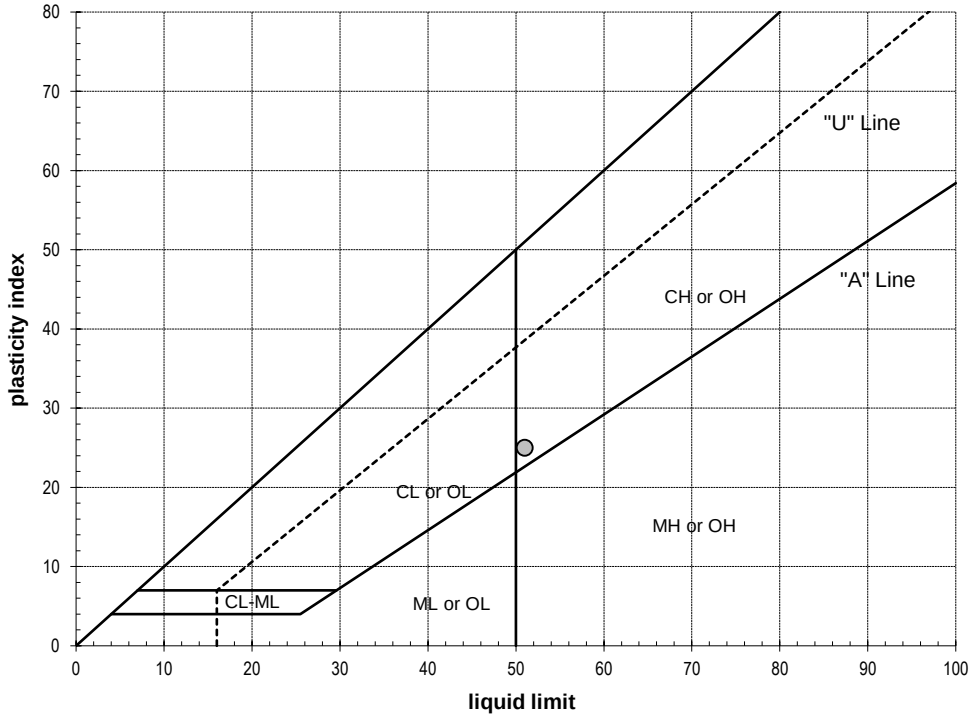
PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.64	27.63		
dry soil + pan weight, g =	26.18	26.21		
pan weight, g =	20.69	20.82		
moisture, % =	26.6 %	26.4 %		

LIQUID LIMIT



PLASTICITY CHART



ADDITIONAL DATA

% gravel =	0.1%
% sand =	37.3%
% silt and clay =	62.6%
% silt =	n/a
% clay =	n/a
moisture content =	32.3%

DATE TESTED	TESTED BY
06/15/15	MJR

This report may not be reproduced except in full without prior written authorization by Columbia West Engineering, Inc.

COLUMBIA WEST ENGINEERING, INC. authorized signature

11917 NE 95th Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Parklands at Camas Meadows Camas, Washington	Mr. Aaron Barr & Mr. Kevin Deford Parklands at Camas Meadows, LLC PO Box 61962 Vancouver, WA 98666	15153	S15-361
		REPORT DATE 06/16/15	FIELD ID TP8.2
		DATE SAMPLED 06/04/15	SAMPLED BY HDG

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Clayey SAND	Test Pit TP-08 depth = 8 feet	SC, Clayey Sand
SPECIFICATIONS none		AASHTO SOIL TYPE A-2-7(0)

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Rainhart "Mary Ann" Sifter 637	ASTM D6913, D422

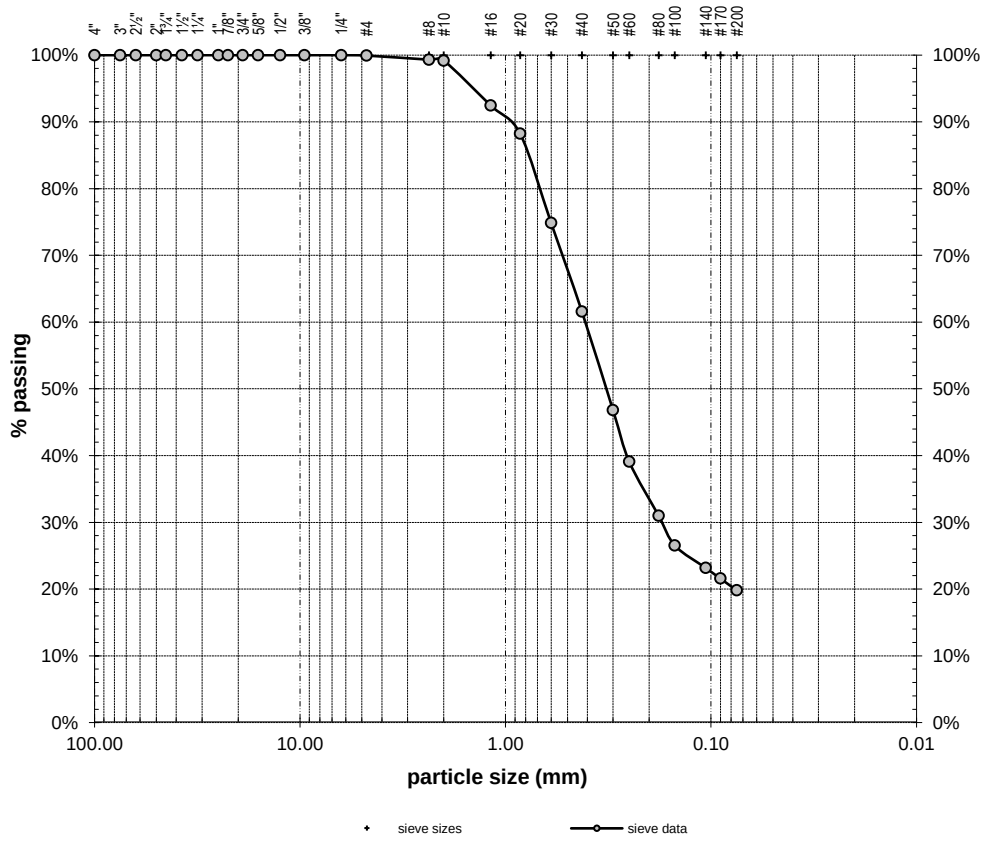
ADDITIONAL DATA

initial dry mass (g) =	151.9		
as-received moisture content =	42.6%	coefficient of curvature, C_C =	n/a
liquid limit =	43	coefficient of uniformity, C_U =	n/a
plastic limit =	25	effective size, $D_{(10)}$ =	n/a
plasticity index =	18	$D_{(30)}$ =	0.173 mm
fineness modulus =	n/a	$D_{(60)}$ =	0.410 mm

SIEVE DATA

% gravel =	0.1%
% sand =	80.1%
% silt and clay =	19.8%

GRAIN SIZE DISTRIBUTION



	SIEVE SIZE US	SIEVE SIZE mm	PERCENT PASSING SIEVE act.	PERCENT PASSING SIEVE interp.	SPECS max	SPECS min
GRAVEL	6.00"	150.0		100.0%		
	4.00"	100.0		100.0%		
	3.00"	75.0		100.0%		
	2.50"	63.0		100.0%		
	2.00"	50.0		100.0%		
	1.75"	45.0		100.0%		
	1.50"	37.5		100.0%		
	1.25"	31.5		100.0%		
	1.00"	25.0		100.0%		
	7/8"	22.4		100.0%		
	3/4"	19.0		100.0%		
	5/8"	16.0		100.0%		
	1/2"	12.5		100.0%		
	3/8"	9.50		100.0%		
	1/4"	6.30	100.0%			
	#4	4.75	99.9%			
SAND	#8	2.36		99.3%		
	#10	2.00	99.2%			
	#16	1.18		92.4%		
	#20	0.850	88.3%			
	#30	0.600		74.8%		
	#40	0.425	61.6%			
	#50	0.300		46.8%		
	#60	0.250	39.1%			
	#80	0.180		31.0%		
	#100	0.150	26.5%			
	#140	0.106		23.2%		
	#170	0.090		21.6%		
	#200	0.075	19.8%			

DATE TESTED	TESTED BY
06/08/15	BTT/MJR

This report may not be reproduced except in full without prior written authorization by Columbia West Engineering, Inc.

COLUMBIA WEST ENGINEERING, INC. authorized signature

11917 NE 95th Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Parklands at Camas Meadows Camas, Washington	Mr. Aaron Barr & Mr. Kevin Deford Parklands at Camas Meadows, LLC PO Box 61962 Vancouver, WA 98666	15153	S15-361
		REPORT DATE: 06/16/15	FIELD ID: TP8.2
		DATE SAMPLED: 06/04/15	SAMPLED BY: HDG

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Clayey SAND	Test Pit TP-08 depth = 8 feet	SC, Clayey Sand

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Liquid Limit Machine, Hand Rolled

TEST PROCEDURE: ASTM D4318

ATTERBERG LIMITS

liquid limit =	43
plastic limit =	25
plasticity index =	18

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	39.55	37.83	35.98	
dry soil + pan weight, g =	33.98	32.70	31.23	
pan weight, g =	20.69	20.73	20.63	
N (blows) =	30	23	17	
moisture, % =	41.9 %	42.9 %	44.8 %	

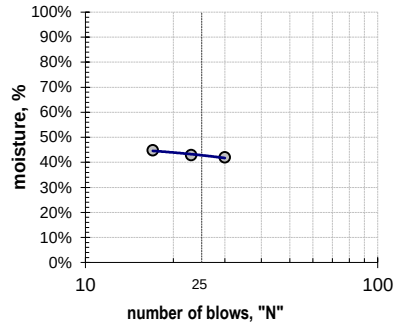
SHRINKAGE

shrinkage limit =	n/a
shrinkage ratio =	n/a

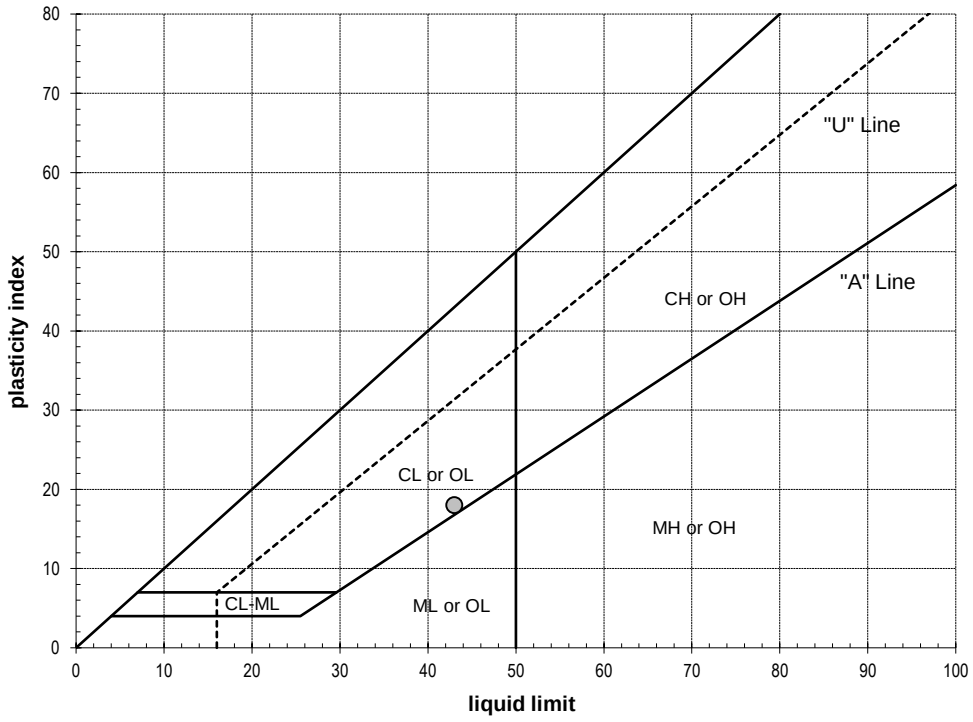
PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.97	28.28		
dry soil + pan weight, g =	26.54	26.79		
pan weight, g =	20.74	20.77		
moisture, % =	24.7 %	24.8 %		

LIQUID LIMIT



PLASTICITY CHART



ADDITIONAL DATA

% gravel =	0.1%
% sand =	80.1%
% silt and clay =	19.8%
% silt =	n/a
% clay =	n/a
moisture content =	42.6%

DATE TESTED	TESTED BY
06/15/15	MJR

This report may not be reproduced except in full without prior written authorization by Columbia West Engineering, Inc.

COLUMBIA WEST ENGINEERING, INC. authorized signature

11917 NE 95th Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Parklands at Camas Meadows Camas, Washington	Mr. Aaron Barr & Mr. Kevin Deford Parklands at Camas Meadows, LLC PO Box 61962 Vancouver, WA 98666	15153	S15-362
		REPORT DATE 06/16/15	FIELD ID TP8.3
		DATE SAMPLED 06/04/15	SAMPLED BY HDG

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Poorly graded GRAVEL with Silt and Sand	Test Pit TP-08 depth = 12 feet	GP-GM, Poorly graded gravel with silt and sand
SPECIFICATIONS none		AASHTO SOIL TYPE A-2-7(0)

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Rainhart "Mary Ann" Sifter 637	ASTM D6913, D422

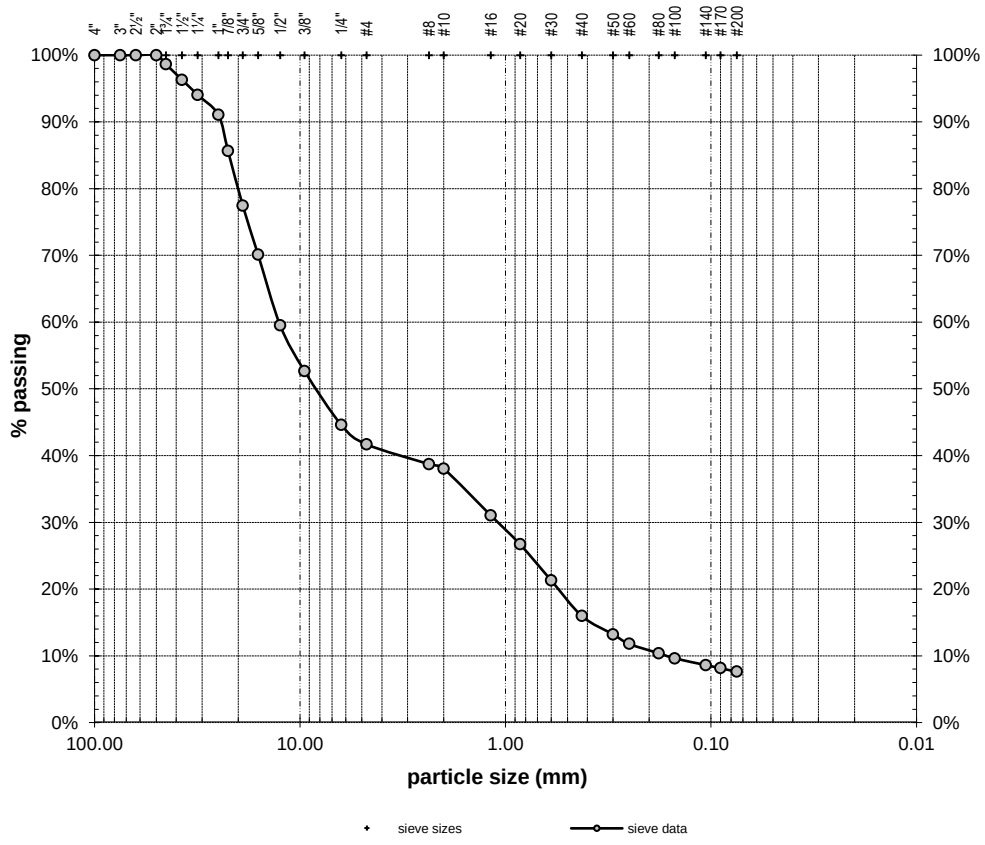
ADDITIONAL DATA

initial dry mass (g) =	3089.1		
as-received moisture content =	33.2%	coefficient of curvature, C_C =	0.57
liquid limit =	46	coefficient of uniformity, C_U =	76.93
plastic limit =	28	effective size, $D_{(10)}$ =	0.164 mm
plasticity index =	18	$D_{(30)}$ =	1.091 mm
fineness modulus =	n/a	$D_{(60)}$ =	12.637 mm

SIEVE DATA

% gravel = 58.3%
% sand = 34.1%
% silt and clay = 7.6%

GRAIN SIZE DISTRIBUTION



	SIEVE SIZE US	SIEVE SIZE mm	PERCENT PASSING SIEVE act.	PERCENT PASSING SIEVE interp.	SPECS max	SPECS min
GRAVEL	6.00"	150.0		100.0%		
	4.00"	100.0		100.0%		
	3.00"	75.0		100.0%		
	2.50"	63.0		100.0%		
	2.00"	50.0	100.0%			
	1.75"	45.0		98.6%		
	1.50"	37.5		96.3%		
	1.25"	31.5		94.0%		
	1.00"	25.0	91.1%			
	7/8"	22.4		85.6%		
	3/4"	19.0	77.5%			
	5/8"	16.0		70.1%		
	1/2"	12.5	59.5%			
	3/8"	9.50	52.6%			
	1/4"	6.30	44.6%			
	#4	4.75	41.7%			
SAND	#8	2.36		38.7%		
	#10	2.00	38.0%			
	#16	1.18		31.0%		
	#20	0.850	26.7%			
	#30	0.600		21.3%		
	#40	0.425	16.0%			
	#50	0.300		13.2%		
	#60	0.250	11.8%			
	#80	0.180		10.4%		
	#100	0.150	9.6%			
	#140	0.106		8.6%		
	#170	0.090		8.1%		
	#200	0.075	7.6%			

DATE TESTED	TESTED BY
06/08/15	BTT/MJR

This report may not be reproduced except in full without prior written authorization by Columbia West Engineering, Inc.

COLUMBIA WEST ENGINEERING, INC. authorized signature

11917 NE 95th Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Parklands at Camas Meadows Camas, Washington	Mr. Aaron Barr & Mr. Kevin Deford Parklands at Camas Meadows, LLC PO Box 61962 Vancouver, WA 98666	15153	S15-362
		REPORT DATE: 06/16/15	FIELD ID: TP8.3
		DATE SAMPLED: 06/04/15	SAMPLED BY: HDG

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Poorly graded GRAVEL with Silt and Sand	Test Pit TP-08 depth = 12 feet	GP-GM, Poorly graded gravel with silt and sand

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Liquid Limit Machine, Hand Rolled

TEST PROCEDURE: ASTM D4318

ATTERBERG LIMITS

liquid limit = 46
plastic limit = 28
plasticity index = 18

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	39.57	37.55	37.51	
dry soil + pan weight, g =	33.76	32.29	32.08	
pan weight, g =	20.69	20.82	20.87	
N (blows) =	35	25	18	
moisture, % =	44.5 %	45.9 %	48.4 %	

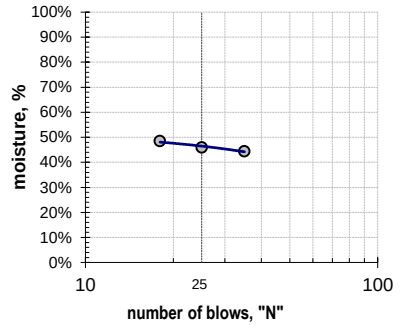
SHRINKAGE

shrinkage limit = n/a
shrinkage ratio = n/a

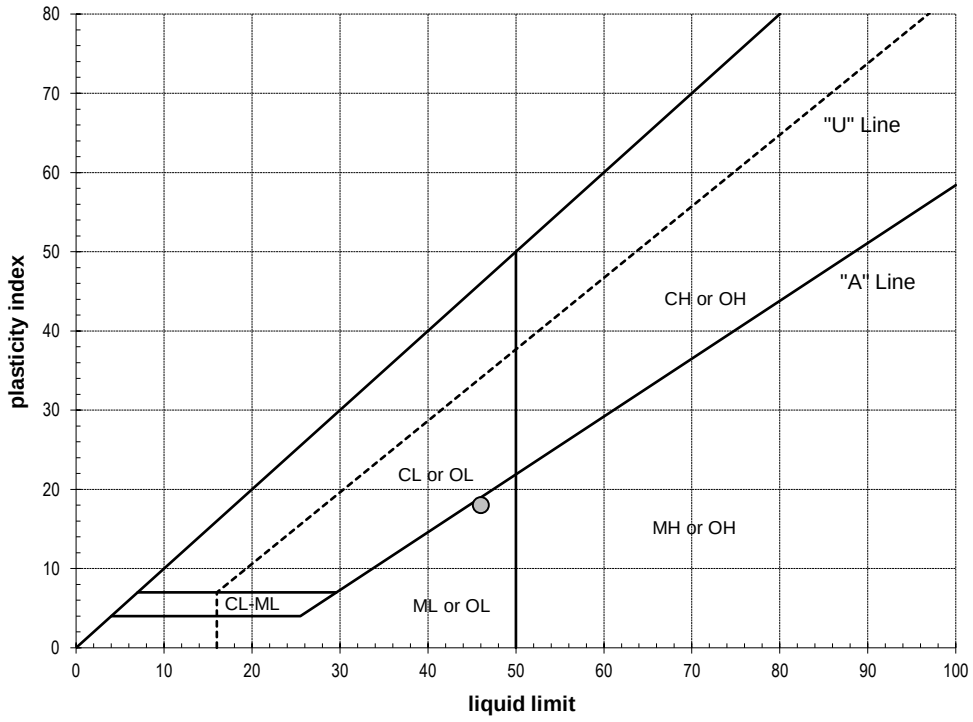
PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.57	27.51		
dry soil + pan weight, g =	26.11	26.06		
pan weight, g =	20.82	20.80		
moisture, % =	27.6 %	27.6 %		

LIQUID LIMIT



PLASTICITY CHART



ADDITIONAL DATA

% gravel = 58.3%
% sand = 34.1%
% silt and clay = 7.6%
% silt = n/a
% clay = n/a
moisture content = 33.2%

DATE TESTED	TESTED BY
06/15/15	MJR

This report may not be reproduced except in full without prior written authorization by Columbia West Engineering, Inc.

COLUMBIA WEST ENGINEERING, INC. authorized signature

APPENDIX B
SUBSURFACE EXPLORATION LOGS

11917 NE 95TH Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
The Parklands at Camas Meadows	Parklands, LLC		15153	TP-1
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER**	**DATE**
Camas, Washington		Excavator	HDG	6/4/15
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	186	2.5 ft bgs	1030	1035

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 10 to 12 inches of topsoil and root zone material.					
				GP-GM		Poorly graded GRAVEL with silt and sand, dense, wet to saturated. Represents weathered conglomerate bedrock.					
▼						Difficult excavation. 6" to 8" weathered cobbles observed.					
						Refusal at 3.0 feet, competent conglomerate bedrock encountered. Bottom of test pit at 3.0 feet. Groundwater encountered at 2.5 feet.					
5											
10											
15											
20											

11917 NE 95TH Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
The Parklands at Camas Meadows	Parklands, LLC		15153	TP-2
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER**	**DATE**
Camas, Washington		Excavator	HDG	6/4/15
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	190	Not encountered.	1000	1015

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 12 to 14 inches of topsoil and root zone material.					
				GP-GM		Poorly graded GRAVEL with silt and sand, dense, wet to saturated. Represents weathered conglomerate bedrock.					
						Difficult excavation. 6" to 8" weathered cobbles observed.					
						Refusal at 3.5 feet, competent conglomerate bedrock encountered. Bottom of test pit at 3.5 feet. Groundwater not encoutered.					
5											
10											
15											
20											

11917 NE 95TH Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
The Parklands at Camas Meadows	Parklands, LLC		15153	TP-3
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER**	**DATE**
Camas, Washington		Excavator	HDG	6/4/15
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	208	Not encountered.	1115	1130

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 16 to 18 inches of topsoil and root zone material.					
	TP3.1		A-7-6(7)	CL		Brown sandy CLAY, moist, medium stiff, fines are medium plasticity.	36.4	57.1	44	16	
				GP-GM		Poorly graded GRAVEL with silt and sand, dense, wet to saturated, gravels are rounded to subrounded. Represents weathered conglomerate bedrock. Difficult excavation.					
5						Refusal at 4.5 feet, competent conglomerate bedrock encountered. Bottom of test pit at 4.5 feet. Groundwater not encoutered.					
10											
15											
20											

11917 NE 95TH Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
The Parklands at Camas Meadows	Parklands, LLC		15153	TP-4
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER**	**DATE**
Camas, Washington		Excavator	HDG	6/4/15
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	214	Not encountered.	1150	1200

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 12 to 16 inches of topsoil and root zone material.					
				CL		Brown sandy CLAY, moist, medium stiff, fines are medium plasticity.					
				GP-GM		Poorly graded GRAVEL with silt and sand, dense, wet to saturated, gravels are rounded to subrounded. Represents weathered conglomerate bedrock.					
5						Refusal at 3.0 feet, competent conglomerate bedrock encountered. Bottom of test pit at 3.0 feet. Groundwater not encountered.					
10											
15											
20											

11917 NE 95TH Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
The Parklands at Camas Meadows	Parklands, LLC		15153	TP-5
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER**	**DATE**
Camas, Washington		Excavator	HDG	6/4/15
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	228	Not encountered.	1245	1255

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 12 to 14 inches of topsoil and root zone material.					
				CL		Brown sandy CLAY, moist, medium stiff, fines are medium plasticity.					
				GP-GM		Poorly graded GRAVEL with silt and sand, dense, wet to saturated, gravels are rounded to subrounded. Represents weathered conglomerate bedrock. Difficult excavation.					
5						Refusal at 4.5 feet, competent conglomerate bedrock encountered. Bottom of test pit at 4.5 feet. Groundwater not encoutered.					
10											
15											
20											

11917 NE 95TH Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc

TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
The Parklands at Camas Meadows	Parklands, LLC		15153	TP-6
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER**	**DATE**
Camas, Washington		Excavator	HDG	6/4/15
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	210	Not encountered.	1215	1230

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 12 to 14 inches of topsoil and root zone material.					
	TP6.1		A-7-6(14)	CH		Brown sandy FAT CLAY, moist, medium stiff, fines are moderate to high plasticity.	32.3	62.6	51	25	
5				GP-GM		Poorly graded GRAVEL with silt and sand, dense, wet to saturated, gravels are rounded to subrounded. Represents weathered conglomerate bedrock. Difficult excavation. 6" to 8" weathered cobbles observed.					
10						Refusal at 6.5 feet, competent conglomerate bedrock encountered. Bottom of test pit at 6.5 feet. Groundwater not encountered.					
15											
20											

11917 NE 95TH Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
The Parklands at Camas Meadows	Parklands, LLC		15153	TP-7
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER**	**DATE**
Camas, Washington		Excavator	HDG	6/4/15
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	218	Not encountered.	810	815

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 12 to 14 inches of topsoil and root zone material.					
				GP-GM		Poorly graded GRAVEL with silt and sand, dense, wet to saturated, gravels are rounded to subrounded. Represents weathered conglomerate bedrock. Difficult excavation. 6" to 8" weathered cobbles observed.					
5						Refusal at 3.5 feet, competent conglomerate bedrock encountered. Bottom of test pit at 3.5 feet. Groundwater not encoutered.					
10											
15											
20											

11917 NE 95TH Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc

TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
The Parklands at Camas Meadows	Parklands, LLC		15153	TP-8
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER**	**DATE**
Camas, Washington		Excavator	HDG	6/4/15
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	210	Not encountered	830	900

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 16 to 18 inches of topsoil and root zone material.					
				CL		Brown sandy CLAY, moist, medium stiff, fines are medium plasticity.					
5											
	TP8.2		A-2-7(0)	SC		Light brown clayey SAND, moist, dense, lightly cemented, fines are medium plasticity. Difficult excavation.	42.6	19.8	43	18	
10											
	TP8.3		A-2-7(0)	GP-GM		Poorly graded GRAVEL with silt and sand, dense, saturated, gravels are subrounded to rounded. Groundwater seep.	33.2	7.6	46	18	
15											
						Refusal at 16.5 feet, competent conglomerate bedrock encountered.. Bottom of test pit at 16.5 feet. Groundwater encoutered at 15.5 feet.					
20											

APPENDIX C
SOIL CLASSIFICATION INFORMATION

SOIL DESCRIPTION AND CLASSIFICATION GUIDELINES

Particle-Size Classification

COMPONENT	ASTM/USCS		AASHTO	
	size range	sieve size range	size range	sieve size range
Cobbles	> 75 mm	greater than 3 inches	> 75 mm	greater than 3 inches
Gravel	75 mm – 4.75 mm	3 inches to No. 4 sieve	75 mm – 2.00 mm	3 inches to No. 10 sieve
Coarse	75 mm – 19.0 mm	3 inches to 3/4-inch sieve	-	-
Fine	19.0 mm – 4.75 mm	3/4-inch to No. 4 sieve	-	-
Sand	4.75 mm – 0.075 mm	No. 4 to No. 200 sieve	2.00 mm – 0.075 mm	No. 10 to No. 200 sieve
Coarse	4.75 mm – 2.00 mm	No. 4 to No. 10 sieve	2.00 mm – 0.425 mm	No. 10 to No. 40 sieve
Medium	2.00 mm – 0.425 mm	No. 10 to No. 40 sieve	-	-
Fine	0.425 mm – 0.075 mm	No. 40 to No. 200 sieve	0.425 mm – 0.075 mm	No. 40 to No. 200 sieve
Fines (Silt and Clay)	< 0.075 mm	Passing No. 200 sieve	< 0.075 mm	Passing No. 200 sieve

Consistency for Cohesive Soil

CONSISTENCY	SPT N-VALUE (BLOWS PER FOOT)	POCKET PENETROMETER (UNCONFINED COMPRESSIVE STRENGTH, tsf)
Very Soft	2	less than 0.25
Soft	2 to 4	0.25 to 0.50
Medium Stiff	4 to 8	0.50 to 1.0
Stiff	8 to 15	1.0 to 2.0
Very Stiff	15 to 30	2.0 to 4.0
Hard	30 to 60	greater than 4.0
Very Hard	greater than 60	-

Relative Density for Granular Soil

RELATIVE DENSITY	SPT N-VALUE (BLOWS PER FOOT)
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	more than 50

Moisture Designations

TERM	FIELD IDENTIFICATION
Dry	No moisture. Dusty or dry.
Damp	Some moisture. Cohesive soils are usually below plastic limit and are moldable.
Moist	Grains appear darkened, but no visible water is present. Cohesive soils will clump. Sand will bulk. Soils are often at or near plastic limit.
Wet	Visible water on larger grains. Sand and silt exhibit dilatancy. Cohesive soil can be readily remolded. Soil leaves wetness on the hand when squeezed. Soil is much wetter than optimum moisture content and is above plastic limit.

AASHTO SOIL CLASSIFICATION SYSTEM

TABLE 1. Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35 Percent or Less Passing .075 mm)				Silt-Clay Materials (More than 35 Percent Passing 0.075)		
Group Classification	A-1	A-3	A-2	A-4	A-5	A-6	A-7
Sieve analysis, percent passing:							
2.00 mm (No. 10)	-	-	-				
0.425 mm (No. 40)	50 max	51 min	-	-	-	-	-
0.075 mm (No. 200)	25 max	10 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)							
Liquid limit				40 max	41 min	40 max	41 min
Plasticity index	6 max	N.P.		10 max	10 max	11 min	11 min
General rating as subgrade	Excellent to good				Fair to poor		

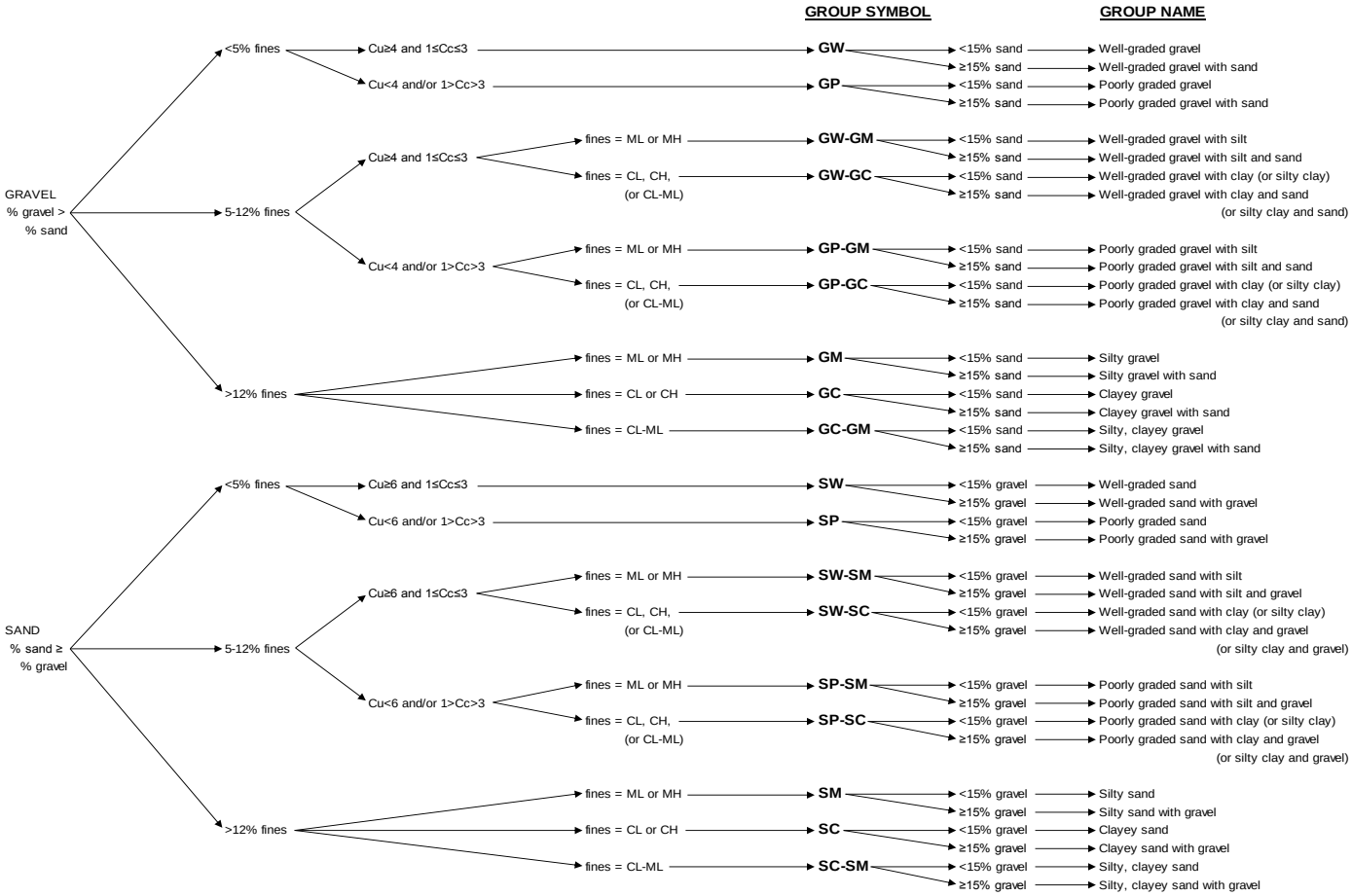
Note: The placing of A-3 before A-2 is necessary in the "left to right elimination process" and does not indicate superiority of A-3 over A-2.

TABLE 2. Classification of Soils and Soil-Aggregate Mixtures

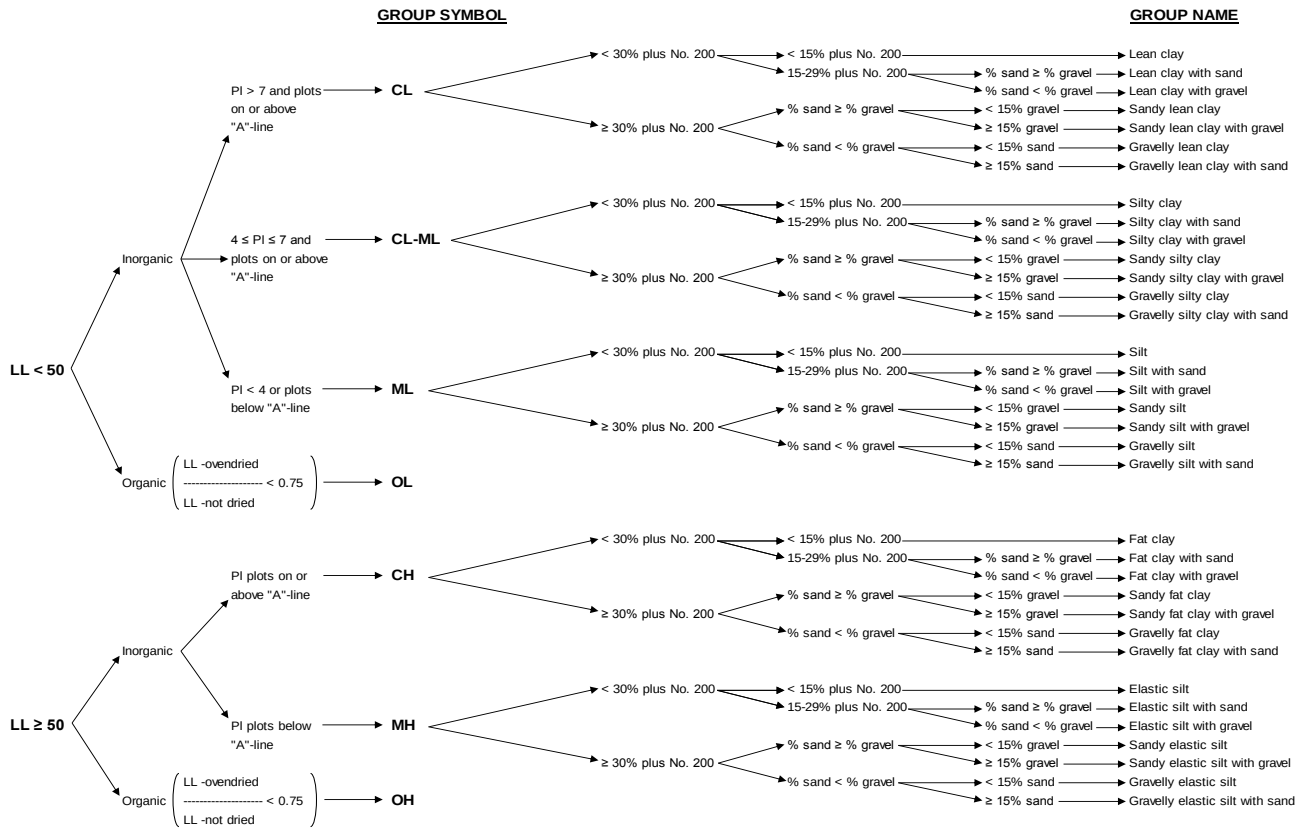
General Classification	Granular Materials (35 Percent or Less Passing 0.075 mm)							Silt-Clay Materials (More than 35 Percent Passing 0.075 mm)			
	A-1			A-2							A-7
Group Classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5, A-7-6
Sieve analysis, percent passing:											
2.00 mm (No. 10)	50 max	-	-	-	-	-	-	-	-	-	-
0.425 mm (No. 40)	30 max	50 max	51 min	-	-	-	-	-	-	-	-
0.075 mm (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)											
Liquid limit				40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11min
Usual types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General ratings as subgrade	Excellent to Good							Fair to poor			

Note: Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30 (see Figure 2).

AASHTO = American Association of State Highway and Transportation Officials



Flow Chart for Classifying Coarse-Grained Soils (More Than 50% Retained on No. 200 Sieve)



Flow Chart for Classifying Fine-Grained Soil (50% or More Passes No. 200 Sieve)

APPENDIX D
PHOTO LOG

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

PHOTO LOG
Parklands at Camas Meadows
Camas, Washington



Shallow conglomerate bedrock in Test Pit TP-1



Shallow hyaoclastic sandstone bedrock in Test Pit TP-3



Shallow groundwater near Test Pit TP-1



Deeper conglomerate bedrock encountered in Test Pit TP-8

APPENDIX E
REPORT LIMITATIONS AND IMPORTANT INFORMATION

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

Date: June 23, 2015
Project: Parklands at Camas Meadows
Camas, Washington

Geotechnical and Environmental Report Limitations and Important Information

Report Purpose, Use, and Standard of Care

This report has been prepared in accordance with standard fundamental principles and practices of geotechnical engineering and/or environmental consulting, and in a manner consistent with the level of care and skill typical of currently practicing local engineers and consultants. This report has been prepared to meet the specific needs of specific individuals for the indicated site. It may not be adequate for use by other consultants, contractors, or engineers, or if change in project ownership has occurred. It should not be used for any other reason than its stated purpose without prior consultation with Columbia West Engineering, Inc. (Columbia West). It is a unique report and not applicable for any other site or project. If site conditions are altered, or if modifications to the project description or proposed plans are made after the date of this report, it may not be valid. Columbia West cannot accept responsibility for use of this report by other individuals for unauthorized purposes, or if problems occur resulting from changes in site conditions for which Columbia West was not aware or informed.

Report Conclusions and Preliminary Nature

This geotechnical or environmental report should be considered preliminary and summary in nature. The recommendations contained herein have been established by engineering interpretations of subsurface soils based upon conditions observed during site exploration. The exploration and associated laboratory analysis of collected representative samples identifies soil conditions at specific discreet locations. It is assumed that these conditions are indicative of actual conditions throughout the subject property. However, soil conditions may differ between tested locations at different seasonal times of the year, either by natural causes or human activity. Distinction between soil types may be more abrupt or gradual than indicated on the soil logs. This report is not intended to stand alone without understanding of concomitant instructions, correspondence, communication, or potential supplemental reports that may have been provided to the client.

Because this report is based upon observations obtained at the time of exploration, its adequacy may be compromised with time. This is particularly relevant in the case of natural disasters, earthquakes, floods, or other significant events. Report conclusions or interpretations may also be subject to revision if significant development or other manmade impacts occur within or in proximity to the subject property. Groundwater conditions, if presented in this report, reflect observed conditions at the time of investigation. These conditions may change annually, seasonally or as a result of adjacent development.

Additional Investigation and Construction QA/QC

Columbia West should be consulted prior to construction to assess whether additional investigation above and beyond that presented in this report is necessary. Even slight variations in soil or site conditions may produce impacts to the performance of structural facilities if not adequately addressed. This underscores the importance of diligent QA/QC construction observation and testing to verify soil conditions do not differ materially or significantly from the interpreted conditions utilized for preparation of this report.

Therefore, this report contains several recommendations for field observation and testing by Columbia West personnel during construction activities. Actual subsurface conditions are more readily observed and discerned during the earthwork phase of construction when soils are exposed. Columbia West cannot accept responsibility for deviations from recommendations described in this report or future

performance of structural facilities if another consultant is retained during the construction phase or Columbia West is not engaged to provide construction observation to the full extent recommended.

Collected Samples

Uncontaminated samples of soil or rock collected in connection with this report will be retained for thirty days. Retention of such samples beyond thirty days will occur only at client's request and in return for payment of storage charges incurred. All contaminated or environmentally impacted materials or samples are the sole property of the client. Client maintains responsibility for proper disposal.

Report Contents

This geotechnical or environmental report should not be copied or duplicated unless in full, and even then only under prior written consent by Columbia West, as indicated in further detail in the following text section entitled *Report Ownership*. The recommendations, interpretations, and suggestions presented in this report are only understandable in context of reference to the whole report. Under no circumstances should the soil boring or test pit excavation logs, monitor well logs, or laboratory analytical reports be separated from the remainder of the report. The logs or reports should not be redrawn or summarized by other entities for inclusion in architectural or civil drawings, or other relevant applications.

Report Limitations for Contractors

Geotechnical or environmental reports, unless otherwise specifically noted, are not prepared for the purpose of developing cost estimates or bids by contractors. The extent of exploration or investigation conducted as part of this report is usually less than that necessary for contractor's needs. Contractors should be advised of these report limitations, particularly as they relate to development of cost estimates. Contractors may gain valuable information from this report, but should rely upon their own interpretations as to how subsurface conditions may affect cost, feasibility, accessibility and other components of the project work. If believed necessary or relevant, contractors should conduct additional exploratory investigation to obtain satisfactory data for the purposes of developing adequate cost estimates. Clients or developers cannot insulate themselves from attendant liability by disclaiming accuracy for subsurface ground conditions without advising contractors appropriately and providing the best information possible to limit potential for cost overruns, construction problems, or misunderstandings.

Report Ownership

Columbia West retains the ownership and copyright property rights to this entire report and its contents, which may include, but may not be limited to, figures, text, logs, electronic media, drawings, laboratory reports, and appendices. This report was prepared solely for the client, and other relevant approved users or parties, and its distribution must be contingent upon prior express written consent by Columbia West. Furthermore, client or approved users may not use, lend, sell, copy, or distribute this document without express written consent by Columbia West. Client does not own nor have rights to electronic media files that constitute this report, and under no circumstances should said electronic files be distributed or copied. Electronic media is susceptible to unauthorized manipulation or modification, and may not be reliable.

Consultant Responsibility

Geotechnical and environmental engineering and consulting is much less exact than other scientific or engineering disciplines, and relies heavily upon experience, judgment, interpretation, and opinion often based upon media (soils) that are variable, anisotropic, and non-homogenous. This often results in unrealistic expectations, unwarranted claims, and uninformed disputes against a geotechnical or environmental consultant. To reduce potential for these problems and assist relevant parties in better understanding of risk, liability, and responsibility, geotechnical and environmental reports often provide definitive statements or clauses defining and outlining consultant responsibility. The client is encouraged to read these statements carefully and request additional information from Columbia West if necessary.

Final Wetland Delineation Report
for

Parklands at Camas Meadows
Camas, Washington

Prepared for:

Parklands at Camas, LLC
20705 SE Evergreen Highway
Camas, Washington 98607
(360) 823-6222

Prepared by:

Ecological Land Services, Inc.
1157 3rd Avenue, Suite 220
Longview, Washington 98632
(360) 578-1371

Preliminary Draft August 2015
Interim Draft November 2015
Final Report December 2015 w/ Final Wetland Rating Summary
ELS Project #2255.01

SIGNATURES

The information and data in this report were compiled and prepared under the supervision and direction of the undersigned.

Timothy Haderly
Principal/Ecologist

Rachel Allison
Biologist

TABLE OF CONTENTS

INTRODUCTION *1*
METHODOLOGY *1*
Wetlands 3
Uplands 3
National Wetlands Inventory 4
Clark County Critical Areas 4
WETLANDS 4
Wetland Categorization and Buffer Requirements 5
LIMITATIONS *7*
REFERENCES *7*

Figures:

Figure 1 Vicinity Map
Figure 2 Site Map
Figure 3 Soil Survey Map
Figure 4 National Wetlands Inventory Map
Figure 5 Clark County Critical Areas Map

Appendix A:

Wetland Determination Data Forms

Appendix B:

Wetland Rating Form for Western Washington
Wetlands A, B, and C
Figure 6 150' Offset Rating Form
Figure 7 1 KM Offset Rating Form
Figure 8 Contributing Basin
Figure 9 Cowardin Classes
Figure 10 Hydroperiods
Figure 11 303(d) Listed Waters in Basin
Figure 12 TMDLs for WRIA in Unit

Photoplates 1 & 2

INTRODUCTION

Ecological Land Services, Inc. (ELS) has completed a wetland delineation for Parklands at Camas, LLC on NW 218th Avenue, in Camas, Washington. The study area consists of Tax Parcels 175948-000 and 986031-650, and is located in Section 28, Township 2 North, Range 3 East, of the Willamette Meridian in the City of Camas Water Resources Inventory Area 28 (Figure 1). This report summarizes the findings of the wetland determination according to the *City of Camas Municipal Code (CMC) Chapter16.53 – Wetlands.*

METHODOLOGY

ELS conducted a site visit on April 28, 2015 to delineate the onsite critical areas, assess wetland functions, and gather vegetation, soils, and hydrology data within the study area. Wetlands were delineated onsite with consecutively numbered wetland boundary flagging. The wetland boundaries were primarily determined by topographical changes and the presence of hydric soils, hydrology, and hydrophytic vegetation. Vegetation, soil, and hydrology data were collected from seven test plots within the study area to verify the presence and boundaries of the wetlands (Figure 2 and Appendix A). Soil colors in test plots were evaluated by hue, value, and chroma using the Munsell Soil Color Chart (Munsell 2000).

Wetlands A, B and C were delineated using the Routine Determination Method according to the *Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987), the *Final Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0)* (2010). The Routine Determination Method examines vegetation, hydrology, and soils to determine if wetlands exist in a given area. The presence of hydrology is critical in determining what qualifies as a wetland; however, since hydrologic conditions can change periodically (hourly, daily, or seasonally) it is necessary to determine if hydrophytic vegetation and hydric soils exist, indicating water is present long enough to support a wetland plant community. By definition, wetlands are those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands are regulated by the United States Army Corps of Engineers (Corps) as "Waters of the United States," by the Washington State Department of Ecology (Ecology) as "Waters of the State," and locally by the *City of Camas Municipal Code (CMC) Chapter 16.53 - Wetlands.*

SITE DESCRIPTION

The approximate 36-acre study area consists of mainly deciduous and coniferous forested wetlands, with small areas of forested upland hummocks interspersed. The area slopes gently to the northwest and currently there are no buildings or structures located in the study area.

Area surrounding the parcels consists of residential housing developments to the southeast, private land use (pasture) and private single-family residences to the southwest, open grassland

and a golf course to the northwest and northeast, with Lacamas Creek and Lacamas Lake on the other side of the golf course. The property is accessed from NW Camas Meadows Drive and NW Payne Street, along the western property boundary.

SOILS

The soils within the study area are mapped as Cove silty clay loam, 0 to 3 percent slopes (CvA), Hesson clay loam, 0 to 8 percent slopes (HcB), Hesson clay loam, 8 to 20 percent slopes (HcD), Hesson clay loam, 20 to 30 percent slopes (HcE), and Lauren gravelly loam, 0 to 8 percent slopes (LgB) (Figure 3).

Cove silty clay loam soil is found in concave drainage ways and in large, flat, old lakebeds. The slope is generally less than 1 percent. In a typical profile the surface layer is very dark gray silty clay loam about 4 inches thick. Below this is firm clay about 32 inches thick. Surface runoff is very slow, and ponding is common in winter unless drainage is provided. The Cove series consists of deep, poorly drained, mostly nearly level soils. The Hesson clay loam series soils are generally found on terraces and are formed from alluvium. The slopes range from 0 to 30 percent. In typical profiles, Hesson clay loams consist of clay loam from 0 to 12 inches below ground surface (BGS) and clay from 12 to 60 inches BGS. Hesson clay loam (HcE) differs slightly, in that a typical profile consists of clay loam from 0 to 9 inches BGS, and clay from 9 to 60 inches BGS. This soil series is well drained and has a very low tendency, to no tendency of ponding. Lauren gravelly loam is found on terraces and is formed from alluvium with volcanic ash. In a typical profile, the surface layer is gravelly medial loam from 0 to 6 inches, very gravelly medial loam from 6 to 33 inches, very gravelly coarse sandy loam from 33 to 44 inches, and very gravelly loamy coarse sand from 44 to 60 inches BGS. This soil is somewhat excessively drained, and has a very low tendency, to no tendency of ponding.

Cove silty clay loam is listed as a hydric soil on the *Washington State Hydric Soils List* (NRCS 2014). The presence or absence of hydric soil does not conclude that an area is wetland or upland; along with hydric soils, hydrology and wetland vegetation must also be present to determine an area as jurisdictional wetland. Because of localized, micro-variations in topography and hydrology, wetlands may be found in areas where hydric soils have not been mapped by the soil survey.

Site evaluated wetland soils generally ranged from very dark brown (10YR 2/2) clay to black (10YR 2/1) and dark gray (10YR 4/1) silty clay loams exhibiting redoximorphic features of dark yellowish brown (10YR 3/6) and dark red (2.5YR 3/6). The wetland soils were generally consistent with the mapped soil types, as the wetland generally follows the mapped Cove silty clay loam from the NRCS.

Site evaluated upland soils generally consisted of dark brown (10YR 3/3) silt loams and clays, and exhibited no redoximorphic features. The upland soils were generally consistent with the mapped soil types bordering Cove silty clay loam, as mapped by the NRCS.

VEGETATION

Wetlands

Dominant hydrophytic vegetation within the wetland areas onsite includes Oregon ash (*Fraxinus latifolia*, FACW), bigleaf maple (*Acer macrophyllum*, FACU), red alder (*Alnus rubra*, FAC), vine maple (*Acer circinatum*, FAC), red-osier dogwood (*Cornus sericea*, FACW), Douglas spiraea (*Spiraea douglasii*, FACW), salmonberry (*Rubus spectabilis*, FAC), California false hellebore (*Veratrum californicum,* FAC), water parsley (*Oenanthe sarmentosa*, OBL), reed canarygrass (*Phalaris arundinacea*, FACW), and skunk cabbage (*Symplocarpus foetidus*, OBL).

Uplands

Dominant vegetation within the upland areas onsite includes bigleaf maple, western redcedar (*Thuja plicata*, FAC), Douglas fir (*Pseudotsuga menziesii*, FACU), non-native cedar species (NI), saxifrage species (NI), Himalayan blackberry (*Rubus armeniacus*, FACU), trailing blackberry (*Rubus ursinus*, FACU), sword fern (*Polystichum munitum*, FACU), oceanspray (*Holodiscus discolor,* FACU), beaked hazelnut (*Corylus cornuta*, FACU), Indian plum (*Oemleria cerasiformis*, FACU), and threepetal bedstraw (*Galium trifidum*, FACW).

The dominant species of vegetation in each test plot have been recorded on the attached wetland delineation data sheets (Appendix A). The indicator categories following the common and scientific names indicate the likelihood of a species to be found in wetlands. Listed from most-likely to least-likely to be found in wetlands, the indicator categories are:

- **OBL** (obligate wetland) – Almost always occur in wetlands.
- **FACW** (facultative wetland) – Usually occur in wetlands, but may occur in non-wetlands.
- **FAC** (facultative) – Occur in wetlands and non-wetlands.
- **FACU** (facultative upland) – Usually occur in non-wetlands, but may occur in wetlands.
- **UPL** (obligate upland) – Almost never occur in wetlands.
- **NI** (no indicator) – Status not yet determined.

HYDROLOGY

Wetlands A,B, and C are hydrologically influenced primarily by precipitation (including stormwater discharge) and secondarily by a high groundwater table; hydrology into Wetlands A, B, and C can be attributed primarily to precipitation, but also from stormwater runoff from surrounding housing developments, agricultural land use, and golf courses. Wetland C is mostly hydrologically influenced by precipitation, but stormwater runoff from the housing development located directly to the southeast can be an attributing factor as well. Cumulative water flow within all wetlands follows a northwest trend, following the topography of the study area. Wetlands A, B, and C are depressional wetlands, with Wetland A and B occurring throughout the northern portion of the study area, and Wetland B occurring along the eastern border of the northern portion (Figure 2). Both wetlands have highly constricted outlets.

WETLANDS INVENTORY

National Wetlands Inventory

The U.S. Fish and Wildlife Service's National Wetlands Inventory (2014; NWI) map indicates the presence of a PFOA[1] wetland within the northern portion of the study area (Figure 4). A R2UBH[2] water body (Lacamas Lake) is mapped directly to the northeast of the study area. ELS agrees with the NWI, as two depressional, forested wetlands were delineated in generally the same location as the NWI mapped wetland.

Clark County Critical Areas

The Clark County Critical Areas (CCCA) (Figure 5) map indicates no presence of wetlands or other critical areas within the study boundary. The CCCA map does however; indicate the presence of a water body (Lacamas Lake) to the northeast, and not within the confines of the study area. ELS does not agree with the CCCA map, as a depressional, forested wetland was delineated in the northern portion of the study area.

NWI and CCCA maps are typically used to gather wetland information about a region and, because of the large scale necessary for regional mapping, are limited in accuracy for localized analyses.

CONCLUSIONS

WETLANDS

ELS staff delineated Wetlands A, B, and C within the study area encompassing Tax Parcels 175948-000 and 986031-650 on April 28, 2015 (Figure 2). All three wetlands are hydrologically connected through culverts observed onsite and locations mapped with a GPS unit and therefore were rated as one wetland unit according to the Ecology's *Wetland Rating Form (Rating Form) for Western Washington-Revised* (Hruby 2014). The wetland unit is a non-tidal, freshwater, palustrine depressional wetland and supports both emergent and forested vegetation. The outlet for the wetland unit is unconstricted and permanently flowing, so long as hydrology is present and in sufficient quantity to maintain flows periods. When inundation is present, water depths range from 6 to 20 inches. Hydrologic functions may consist of some water retention on surface depressions during high flow events. Overall, drainage is slow in the wetland, but flow does eventually and directly reach Lacamas Lake.

The wetland unit is considered to have low to moderate habitat potential onsite based on the plant community's interspersion and species richness (presence and diversity of emergent, scrub-shrub, and forested vegetation), a landscape that supports multiple hydroperiods (seasonal inundation, occasional inundation, and saturation), and the presence of "special habitat features".[3] Accessibility of habitat provided by the wetland unit to other wetlands or forested

[1] **P**=palustrine, **FO**=forested, **A**=temporarily flooded

[2] **R**=riverine, **2**=lower perennial, **UB**=unconsolidated bottom, **H**=permanently flooded

[3] "…certain habitat features in a wetland provide refuge and resources for many different species. The presence of these features increases the potential that a given wetland will provide a wide range of habitats" (Hruby, 2014)

area in the local vicinity is limited by adjacent residential, commercial, and agricultural land uses. Somewhat undisturbed connectivity between the wetland unit and Lacamas Lake can be seen from aerial photography: a narrow band of relatively unmanaged vegetation (Figure 7). With consideration of the adjacent and management practices and limited connectivity, the wetland unit provides low habitat value despite being a relatively well-developed forested wetland system. Foraging opportunities are available for small mammals, common resident and migratory song birds, and birds of prey. Larger mammals, such as deer, coyotes, raccoons, and other transitory species accustomed to urbanized or developed conditions may use the wetland for short-term refuge, grazing, or hunting. There was no evidence (browse, rubs, tracks, etc.) observed by ELS during the onsite wetland assessments.

Wetland Categorization and Buffer Requirements

The wetland unit was categorized according to CMC using the Department of Ecology *Washington State Wetland Rating System for Western Washington, Revised* (Hruby, 2014). Wetlands A, B, and C are Category III wetlands. Buffer widths are based on wetland category, wetland characteristics, and land use intensity (CMC 16.53.040(b)). In this case, the proposed land use activity is a residential subdivision, a structure that meets the criteria for high land use intensity (CMC 16.53.040-4). Category III wetlands with a habitat score of 5 and a high land use intensity proposal receive a designated buffer width of one hundred twenty feet (CMC 16.53.040-4 and Table 1).

Table 1. *Summary of Critical Areas On-site.*

Wetland	Hydrogeomorphic Classification	Cowardin[1] Class	Area (acres onsite)	Category[2]	Starting Buffer Width[3] (feet)	Mitigated Buffer Width[4] (feet)
Wetland A	Depressional	Forested	5.90	III	120	50
Wetland B	Depressional	Forested	1.33	III	120	50
Wetland C	Depressional	Forested	0.12	III	120	50

[1]Cowardin *et al.* 1979
[2]Ecology *Rating Form* (Hruby 2014).
[3] According to CMC Table 16.53.040-3
[4] According to CMC 16.53.050(C)(1)(c)

BUFFER WIDTH REDUCTION JUSTIFICATION NARRATIVE

This narrative addresses the process used to establish buffers on wetlands at the Parklands at Camas Meadows project near the Camas Meadows Golf Course. Parklands at Camas is a mixed use development including 42 single-family residential lots with an adjacent professional business park consisting of four or five buildings of varying size.

Wetland buffers at the proposed Parklands at Camas Meadows project are required according to Camas Municipal Code (CMC) Chapter 16.53 – WETLANDS. The wetlands at Parklands at Camas Meadows are Category III wetlands based on the 2014 Wetland Rating System for Western Washington.

The applicant is proposing a 50-foot wide buffer based on CMC 16.53.050(C)(1)(c) *Combined Reductions. Buffer width reductions allowed under subsections (C)(1)(a) and (C)(1)(b) of this section may be added provided that minimum buffer widths shall never..., or less than fifty feet for Category III wetlands,...*

CMC 16.53.050(C)(1)(a)(i) requires a 100 foot wide relatively undisturbed, vegetated corridor between the wetland and any other priority habitats. Given the configuration of the subject site, the fact that the property to the north is controlled by another entity (golf course), and the Priority Habitat is more than 1,000 feet away; this section is not applicable to the wetland buffer requirements on the subject site.

CMC 16.53.050(C)(1)(a)(ii) requires measures to minimize impacts to the land adjacent to the wetland to help reduce impacts to the wetland. The project applicants have agreed to implement the following measures to assure the on-site wetland is protected from the proposed adjacent developments:

1. CCR's will be written, recorded, and enforced as applicable to uses within and adjacent to wetlands and buffers.
2. Storm water from streets and traffic bearing surfaces will be collected, treated, and conveyed in facilities outside of the from wetlands and the associated buffers. The wetlands and buffers will **NOT be used for storm water treatment or detention/retention facilities.**
3. Native vegetation and soils will be retained in the wetland buffer areas.
4. Outdoor lighting will be designed to reduce the encroachment of light into the resource area. Use of green LED low watt bulbs and shielding will be encouraged.
5. Noise will be controlled by implementing an evening curfew quiet time period. All fireworks and other noise making devices will be strictly prohibited.
6. Wetland buffers will be demarcated be erecting black wrought iron or similar fencing with an open spacing design.
7. No personal gates will be allowed from back yards into the wetland buffer area.
8. Fertilizers, pesticides, and herbicides use in back yards will be discouraged.
9. Backyard landscaping will be focused on using native trees, shrubs, and ground covers to increase habitat and reduce to need for chemicals and irrigation.
10. Informational signage will be installed along the outer edge of the wetland buffer to further demarcate the resource area.

CMC 16.53.050(C)(1)(b) requires a 100 foot wide relatively undisturbed, vegetated corridor between the wetland and any other priority habitats. Given the configuration of the subject site, the fact that the property to the north is controlled by another entity (golf course), and the Priority Habitat is more than 1,000 feet away; this section is not applicable to the wetland buffer requirements on the subject site.

It is our opinion that a 50-foot wide buffer on the Category III wetland at the Parklands at Camas project site (1) meets the code requirements of CMC Chapter 16.53 and (2) will adequately protect the wetland from proposed developments at the site. With proper enhancements and protections outlined previously, we believe that a 50-foot wide buffer will provide functions equal to or greater than the standard 120-foot wide buffer.

LIMITATIONS

ELS personnel base the conclusions contained within this report on standard scientific methodology and best professional judgment. In our opinion, local, state, and federal regulatory agencies should agree with the findings presented in this report.

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. There are no other warranties, express or implied. The services preformed were consistent with our agreement with our client. This report is prepared solely for the use of our client and may not be used or relied upon by a third party for any purpose. Any such use or reliance will be at such party's risk.

The opinions and recommendations contained in this report apply to conditions existing when services were performed. ELS is not responsible for the impacts of any changes in environmental standards, practices, or regulations after the date of this report. ELS does not warrant the accuracy of supplemental information incorporated in this report that was supplied by others.

REFERENCES

City of Camas Municipal Code, *Chapter 16.53 - Wetlands*. Camas, Washington. https://www.municode.com/library/wa/camas/codes/code_of_ordinances?nodeId=TIT16EN_CRAR_CH16.53WE. Accessed June 2015

Environmental Laboratory. 1987. *Corps of Engineers Wetlands Delineation Manual,* Technical Report Y-87-1. U.S. Army Corps of Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Hruby, T. 2014. *Washington State Wetland Rating System for Western Washington – 2014 update*. Washington State Department of Ecology Publication #14-06-029.

Munsell Color. 2000. *Munsell Soil Color Charts*. New Windsor, NY: Gretagmacbeth.

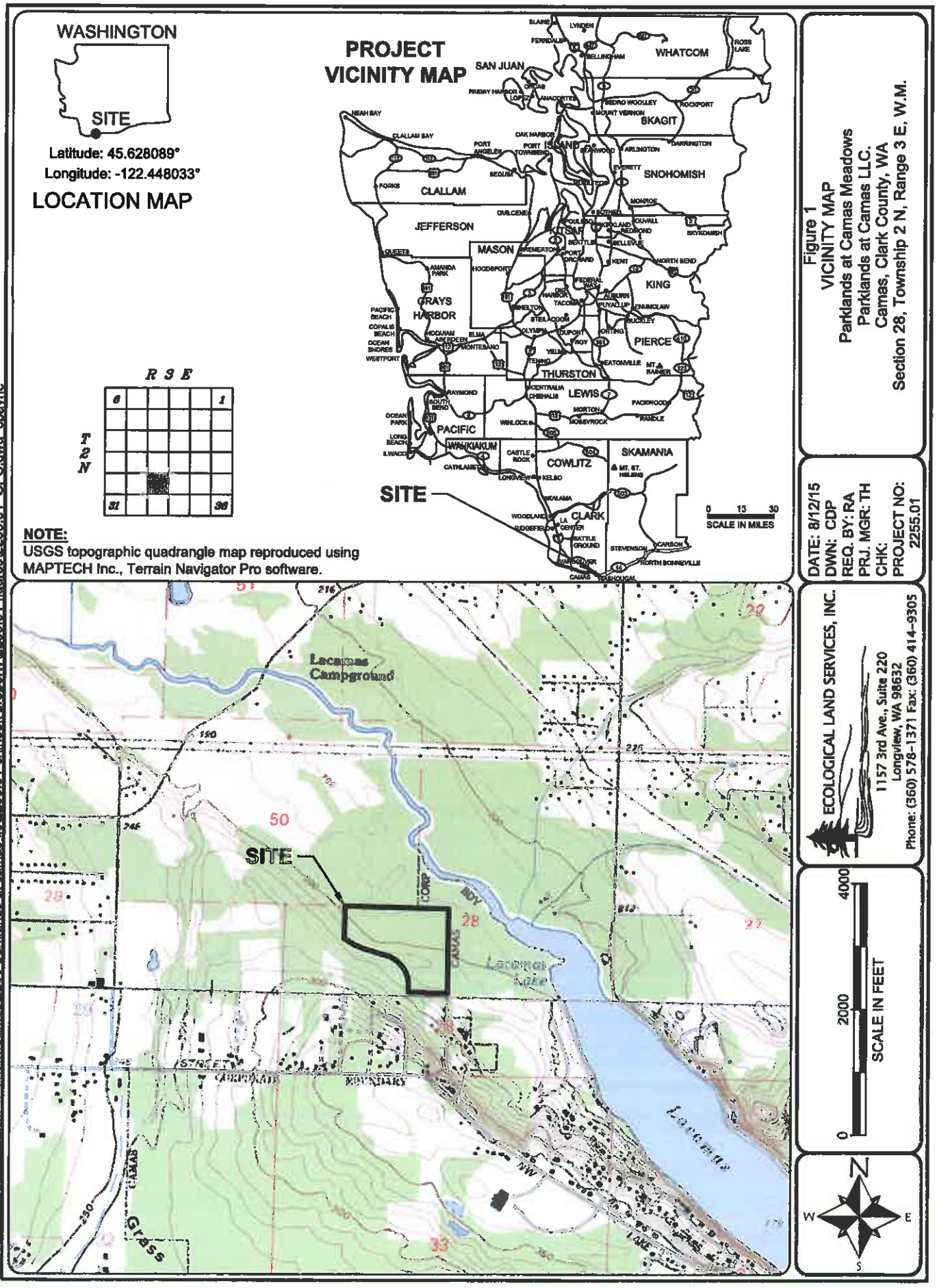
Natural Resource Conservation Service (NRCS). 2014. Soil *Survey of Clark County, Washington.* Online document <http://www.or.nrcs.usda.gov/pnw_soil/wa_reports.html>. Accessed June 2015.

U.S. Army Corps of Engineers. 2010. *Final Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0)*, ed. J.S. Wakeley, R.W. Lichvar, and C.V. Noble. ERDC/EL TR-08-13. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

U.S. Department of Agriculture, Natural Resource Conservation Service (NRCS). 2014. *Hydric Soil List for Washington.* Online document. http://soils.usda.gov/use/hydric/lists/state.html. Accessed June 2015.

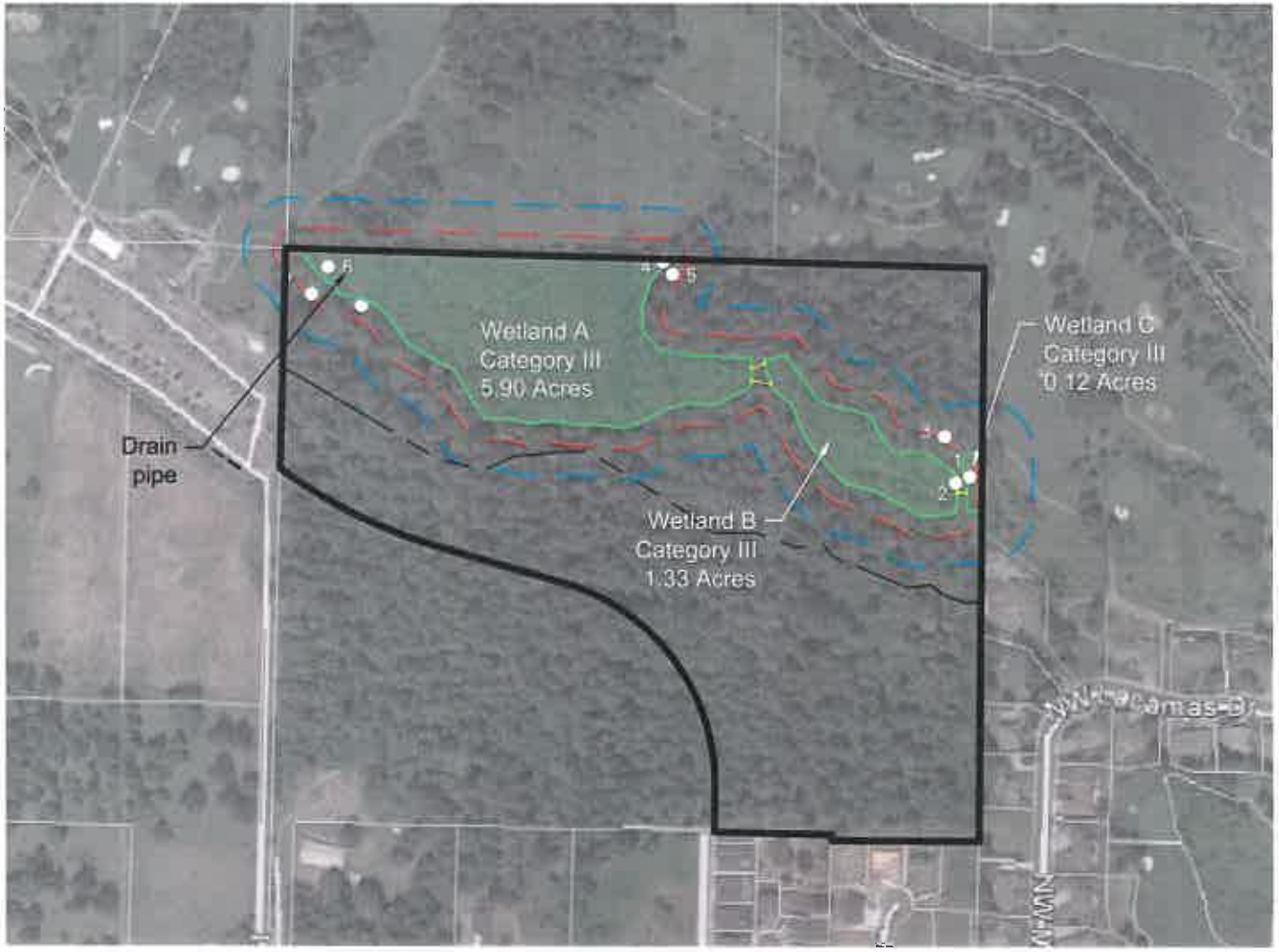
U.S. Fish and Wildlife Service. 1988. *National Wetlands Inventory.* http://wetlandsfws.er.usgs.gov/wtlnds/launch.html. Accessed June 2015.

FIGURES



8/12/2015 3:21 PM s:\ELS\WA\Clark\Camas\2255-parklands at camas llc\2255.01-chinook property\2255.01-figures\2255.01_GPS.dwg, cpayne

8/12/2015 3:21 PM s:\ELS\WA\Clark\Camas\2255-parklands at camas llc\2255.01-chinook property\2255.01-figures\2255.01_GPS.dwg cpayne



LEGEND:

- Site Boundary
- Wetland
- 120' Buffer
- 50' Reduced Buffer
- 1 ● Test Plot Location
- Culvert
- Parcel Boundary

NOTE(S):

1. Base map from ***Google Earth.***™

N W E S

0 400 800

SCALE IN FEET

ECOLOGICAL LAND SERVICES, INC.
1157 3rd Ave., Suite 220
Longview, WA 98632
Phone: (360) 578-1371 Fax: (360) 414-9305

DATE: 8/12/15
DWN: CDP
REQ. BY: RA
PRJ. MGR: TH
CHK:
PROJECT NO: 2255.01

Figure 2
SITE MAP
Parklands at Camas Meadows
Parklands at Camas LLC.
Camas, Clark County, WA
Section 28, Township 2 N, Range 3 E, W.M.

Exhibit 16 SP26-1005



Figure 3
SOIL SURVEY MAP
Parklands at Camas Meadows
Parklands at Camas LLC.
Camas, Clark County, WA
Section 28, Township 2 N, Range 3 E, W.M.

DATE: 8/12/15
DWN: CDP
REQ. BY: RA
PRJ. MGR: TH
CHK:
PROJECT NO: 2255.01

ECOLOGICAL LAND SERVICES, INC.
1157 3rd Ave., Suite 220
Longview, WA 98632
Phone: (360) 578-1371 Fax: (360) 414-9305

0 500 1000
SCALE IN FEET

N
W E
S

LEGEND:

CvA	Cove silty clay loam, 0 to 3 percent slopes. **Hydric**.
HcD	Hesson clay loam, 8 to 20 percent slopes. Not hydric.
HcB	Hesson clay loam, 0 to 8 percent slopes. Not hydric.
HcE	Hesson clay loam, 20 to 30 percent slopes. Not hydric.
LgB	Lauren gravelly loam, 0 to 8 percent slopes. Not hydric.

NOTE(S):

1. Map provided on-line by NRCS at web address: *http://websoilsurvey.nrcs.usda.gov/app/*

8/12/2015 3:21 PM s:\ELS\WA\Clark\Camas\2255-parklands at camas llc\2255.01-chinook property\2255.01 figures\2255.01 GPS.dwg cpayne



Figure 4
NATIONAL WETLANDS INVENTORY MAP
Parklands at Camas Meadows
Parklands at Camas LLC.
Camas, Clark County, WA
Section 28, Township 2 N, Range 3 E, W.M.

DATE: 8/12/15
DWN: CDP
REQ. BY: RA
PRJ. MGR: TH
CHK:
PROJECT NO: 2255.01

ECOLOGICAL LAND SERVICES, INC.
1157 3rd Ave., Suite 220
Longview, WA 98632
Phone: (360) 578-1371 Fax: (360) 414-9305

0 400 800
SCALE IN FEET

N
W E
S

Wetlands indicated onsite by US Fish & Wildlife Service.

LEGEND:

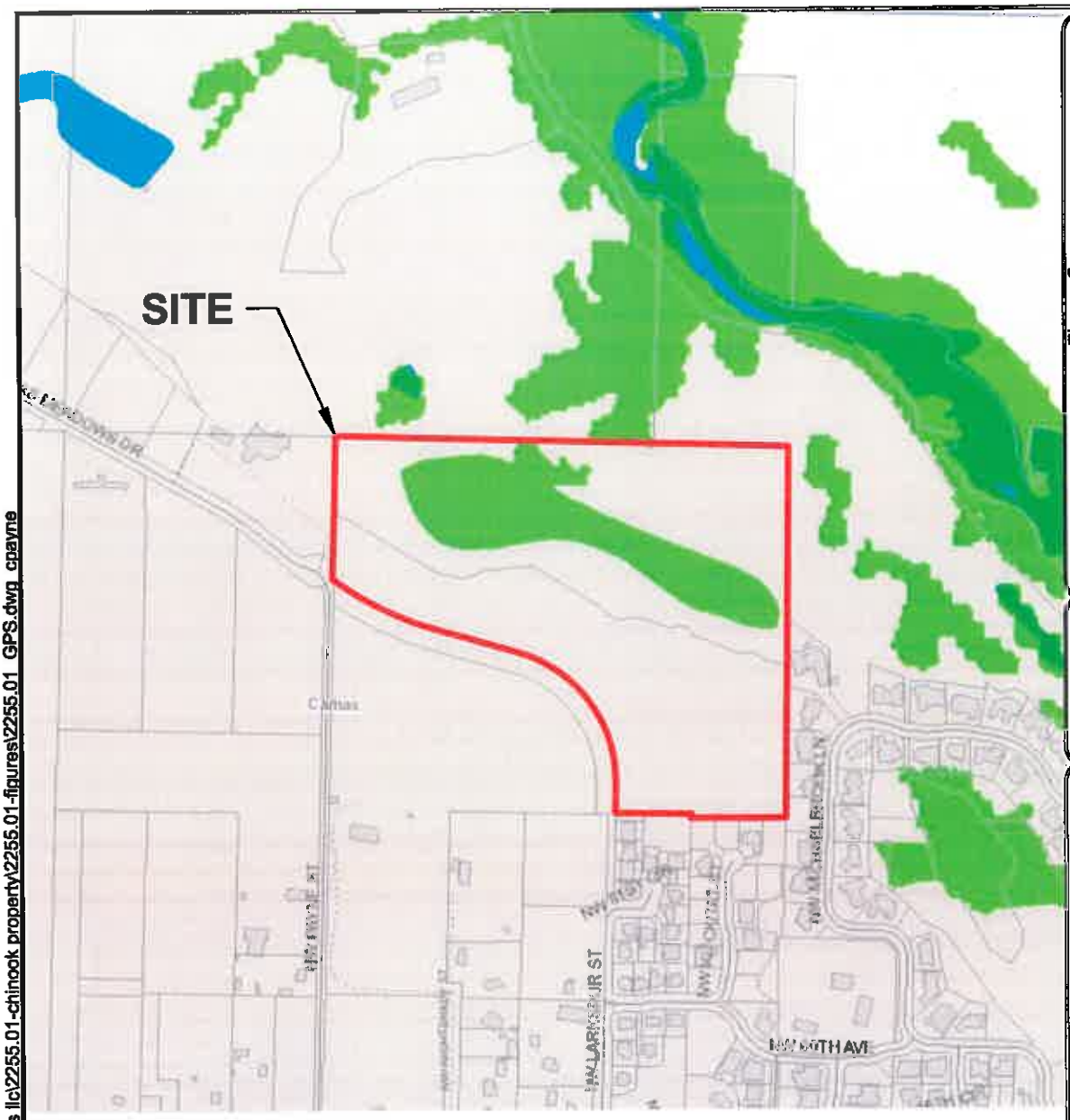
- Freshwater Forested/Shrub Wetland
- Riverine

R2UBH Riverine, Lower Perennial, Unconsolidated Bottom, Permanently Flooded.
PFOA Palustrine, forested, temporarily flooded.

NOTE(S):

1. Map provided on-line by US Fish & Wildlife Service at web address: *http://www.fws.gov/wetlands/data/index.html*

8/12/2015 3:21 PM s:\ELS\WA\Clark\Camas\2255-parklands at camas llc\2255.01-chinook property\2255.01-figures\2255.01_GPS.dwg cpayne



Wetlands indicated onsite by Clark County.

LEGEND:

Site Boundary

NOTE: Map provided on-line by Clark County, Washington at web address: *http://gis.clark.wa.gov/imf/imf.jsp?site=zoning*
This map combines NWI, mapped, permit and modeled wetlands in a single class. Identical to WETINV, except lacking its attribute data. Also excludes any of the modeled wetlands that were field verified to not possess wetland characteristics.

Figure 5
CLARK COUNTY CRITICAL AREAS
Parklands at Camas Meadows
Parklands at Camas LLC.
Camas, Clark County, WA
Section 28, Township 2 N, Range 3 E, W.M.

DATE: 8/12/15
DWN: CDP
REQ. BY: RA
PRJ. MGR: TH
CHK:
PROJECT NO: 2255.01

ECOLOGICAL LAND SERVICES, INC.
1157 3rd Ave., Suite 220
Longview, WA 98632
Phone: (360) 578-1371 Fax: (360) 414-9305

0 600 1200
SCALE IN FEET

N
W E
S

8/12/2015 3:21 PM s:\ELS\WA\Clark\Camas\2255-parklands at camas llc\2255.01-chinook property\2255.01-figures\2255.01 GPS.dwg cpayne

APPENDIX A- WETLAND DETERMINATION DATA FORMS

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Parklands at Camas Meadows City/County: Camas/Clark Sampling Date: 4/28/2015
Applicant/Owner: Parklands at Camas, LLC/Chinook Land Owners Group, LLC State: WA Sampling Point: TP-1
Investigator(s): T. Haderly & R.Allison Section, Township, Range: S28,T2N,R3E
Landform (hillslope, terrace, etc.): Terrace Local relief: Concave Slope (%): 20-30%
Subregion (LRR): A Lat: 45.3736 Long: -122.2654 Datum: NAD83
Soil Map Unit Name: HcE NWI classification: PFOA
Are climatic / hydrologic conditions on the site typical for this time of year? Yes☒ No☐ (If no, explain Remarks.)
Are Vegetation☐, Soil☐, or Hydrology☐ significantly disturbed? Area "Normal Circumstances" present? Yes☐ No☒
Are Vegetation☐, Soil☐, or Hydrology☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒	No ☐	**Is the Sampled Area within a Wetland?** Yes☒ No☐
Hydric Soils Present?	Yes ☐	No ☒	
Wetland Hydrology Present?	Yes ☒	No ☐	

Remarks: Although hydric soils are not present, TP-1 is determined to be within a wetland due to a strong presence of hydrophytic vegetation and wetland hydrology indicators.

VEGETATION (*Use scientific names*)

Tree Stratum (Plot size:30 ft radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Fraxinus latifolia*	20%	yes	FACW
2.	%		
3.	%		
4.	%		
Total Cover:	20%		
Sapling/Shrub Stratum (Plot size: 5 ft. radius)			
1. *Spiraea douglasii*	70%	yes	FACW
2. *Cornus sericea*	30%	yes	FACW
3.	%		
4.	%		
5.	%		
Total Cover:	100%		
Herb Stratum (Plot size: 5 ft radius)			
1. *Symplocarpus foetidu*	30%	yes	OBL
2. *Phalaris arundinacea*	10%	yes	FACW
3.	%		
4.	%		
5.	%		
6.	%		
7.	%		
8.	%		
Total Cover:	40%		
Woody Vine Stratum (Plot size: 30 ft radius)			
1.	%		
2.	%		
Total Cover:	%		

% Bare Ground in Herb Stratum 60%

Dominance Test Worksheet

Number of Dominant Species That Are OBL, FACW, or FAC: _____ (A)

Total Number of Dominant Species Across All Strata: _____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC _____ (A/B)

Prevalence Index worksheet

Total % Cover of:		Multiply by:	
OBL species		x 1=	
FACW species		x 2=	
FAC species		x 3=	
FACU species		x 4=	
UPL species		x 5=	
Column Totals:		(A)	(B)

Prevalence Index = B/A=

Hydrophytic Vegetation Indicators:

- ☒ 1 – Rapid Test for Hydrophytic Vegetation
- ☐ 2 – Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data In Remarks or on a separate sheet)
- ☐ Wetland Non-Vascular Plants[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology Must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes☒ No☐

Remarks:

SOIL

Sampling Point: TP-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-16	10YR 2/2	100%		%			Clay	
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosal (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Minerals (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and Wetland hydrology must be present

Restrictive Layer (if present):

Type: ____

Depth (inches):

Hydric Soil Present? Yes☐ No☒

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (min. of one required; check all that apply)

- ☐ Surface Water (A1)
- ☒ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or crust (B4)
- ☐ Iron Deposits (B5)
- ☐ **Surface Soil Cracks (B6)**
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, & 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stressed Plants (D1) **(LRR A)**
- ☐ **Other (Explain in Remarks)**
- ☐

Secondary Indicators (2 or more required)

- ☐ Water Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D4

Field Observations:

Surface Water Present?	Yes ☐	No ☒	Depth (Inches):
Water Table Present?	Yes ☒	No ☐	Depth (Inches): 0
Saturation Present? (Includes Capillary fringe)	Yes ☒	No ☐	Depth (Inches): 0

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (Stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Parklands at Camas Meadows City/County: Camas/Clark Sampling Date: 4/28/2015
Applicant/Owner: Parklands at Camas, LLC/Chinook Land Owners Group, LLC State: WA Sampling Point: TP-2
Investigator(s): T. Haderly & R.Allison Section, Township, Range: S28,T2N,R3E
Landform (hillslope, terrace, etc.): Terrace Local relief: Concave Slope (%): 0-3%
Subregion (LRR): A Lat: 45.3736 Long: -122.2654 Datum: NAD83
Soil Map Unit Name: CvA NWI classification: PFOA
Are climatic / hydrologic conditions on the site typical for this time of year? Yes☒ No☐ (If no, explain Remarks.)
Are Vegetation☐, Soil☐, or Hydrology☐ significantly disturbed? Area "Normal Circumstances" present? Yes☐ No☒
Are Vegetation☐, Soil☐, or Hydrology☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒	No ☐	**Is the Sampled Area within a Wetland?** Yes☒ No☐
Hydric Soils Present?	Yes ☐	No ☒	
Wetland Hydrology Present?	Yes ☒	No ☐	

Remarks: Although hydric soils are not present, TP-1 is determined to be within a wetland due to a strong presence of hydrophytic vegetation and wetland hydrology indicators.

VEGETATION (*Use scientific names*)

Tree Stratum (Plot size:30 ft radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Fraxinus latifolia*	20%	yes	FACW
2. *Alnus rubra*	20%	yes	FACW
3.	%		
4.	%		
Total Cover:	40%		

Sapling/Shrub Stratum (Plot size: 5 ft. radius)			
1. *Acer circinatum*	30%	yes	FAC
2. *Spiraea douglasii*	20%	yes	FACW
3.	%		
4.	%		
5.	%		
Total Cover:	50%		

Herb Stratum (Plot size: 5 ft radius)			
1. *Symplocarpus foetidus*	80%	yes	OBL
2. *Oenanthe sarmentosa*	15%	no	OBL
3. *Athyrium felix-femina*	5%	no	FAC
4.	%		
5.	%		
6.	%		
7.	%		
8.	%		
Total Cover:	100%		

Woody Vine Stratum (Plot size: 30 ft radius)			
1.	%		
2.	%		
Total Cover:	%		

% Bare Ground in Herb Stratum %

Dominance Test Worksheet

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet

Total % Cover of:		Multiply by:	
OBL species		x 1=	
FACW species		x 2=	
FAC species		x 3=	
FACU species		x 4=	
UPL species		x 5=	
Column Totals:	(A)		(B)

Prevalence Index = B/A=

Hydrophytic Vegetation Indicators:

- ☐ 1 – Rapid Test for Hydrophytic Vegetation
- ☒ 2 – Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data In Remarks or on a separate sheet)
- ☐ Wetland Non-Vascular Plants[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology Must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes☒ No☐

Remarks:

SOIL

Sampling Point: TP-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-16	10YR 2/2	%		%			Clay	
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosal (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Minerals (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and Wetland hydrology must be present

Restrictive Layer (if present):

Type: ____

Depth (inches):

Hydric Soil Present? Yes☐ No☒

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (min. of one required; check all that apply)

- ☐ Surface Water (A1)
- ☒ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, & 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stressed Plants (D1) **(LRR A)**
- ☐ Other (Explain in Remarks)
- ☐

Secondary Indicators (2 or more required)

- ☐ Water Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D4

Field Observations:

Surface Water Present?	Yes ☐	No ☒	Depth (Inches):
Water Table Present?	Yes ☒	No ☐	Depth (Inches): 0
Saturation Present? (Includes Capillary fringe)	Yes ☒	No ☐	Depth (Inches): 0

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (Stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Parklands at Camas Meadows City/County: Camas/Clark Sampling Date: 4/28/2015
Applicant/Owner: Parklands at Camas, LLC/Chinook Land Owners Group, LLC State: WA Sampling Point: TP-3
Investigator(s): T. Haderly & R.Allison Section, Township, Range: S28,T2N,R3E
Landform (hillslope, terrace, etc.): Terrace Local relief: None Slope (%): 0-3%
Subregion (LRR): A Lat: 45.3736 Long: -122.2654 Datum: NAD83
Soil Map Unit Name: CvA NWI classification: PFOA
Are climatic / hydrologic conditions on the site typical for this time of year? Yes☒ No☐ (If no, explain Remarks.)
Are Vegetation☐, Soil☐, or Hydrology☐ significantly disturbed? Area "Normal Circumstances" present? Yes☒ No☐
Are Vegetation☐, Soil☐, or Hydrology☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐ No ☒	**Is the Sampled Area within a Wetland?** Yes☐ No☒
Hydric Soils Present?	Yes ☐ No ☒	
Wetland Hydrology Present?	Yes ☐ No ☒	

Remarks:

VEGETATION (*Use scientific names*)

Tree Stratum (Plot size:30 ft radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Alnus rubra*	20%	yes	FAC
2. *Pseudotsuga menziesii*	20%	yes	FACU
3.	%		
4.	%		
Total Cover:	40%		

Sapling/Shrub Stratum (Plot size: 5 ft. radius)			
1. ***Symphoricarpos albus***	**15%**	**yes**	FACU
2. *Holodiscus discolor*	15%	yes	FACU
3. *Gaultheria shallon*	15%	yes	FACU
4. Rubus parviflorus	15%	yes	FAC
5.	%	yes	FACU
Total Cover:	60%		

Herb Stratum (Plot size: 5 ft radius)			
1.	%		
2.	%		
3.	%		
4.	%		
5.	%		
6.	%		
7.	%		
8.	%		
Total Cover:	%		

Woody Vine Stratum (Plot size: 30 ft radius)			
1. *Rubus armeniacus*	40%	yes	FACU
2.	%		
Total Cover:	40%		

% Bare Ground in Herb Stratum %

Dominance Test Worksheet

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 8 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC 13 (A/B)

Prevalence Index worksheet

Total % Cover of:		Multiply by:	
OBL species		x 1=	
FACW species		x 2=	
FAC species		x 3=	
FACU species		x 4=	
UPL species		x 5=	
Column Totals:	(A)		(B)

Prevalence Index = B/A=

Hydrophytic Vegetation Indicators:

- ☐ 1 – Rapid Test for Hydrophytic Vegetation
- ☐ 2 – Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data In Remarks or on a separate sheet)
- ☐ Wetland Non-Vascular Plants[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology Must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes☐ No☒

Remarks:

SOIL

Sampling Point: TP-3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-16	10YR 3/3	100%		%			Clay	
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosal (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Minerals (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and Wetland hydrology must be present

Restrictive Layer (if present):

Type: ____

Depth (inches):

Hydric Soil Present? Yes☐ No☒

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (min. of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, & 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stressed Plants (D1) **(LRR A)**
- ☐ Other (Explain in Remarks)
- ☐

Secondary Indicators (2 or more required)

- ☐ Water Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D4

Field Observations:

Surface Water Present?	Yes ☐	No ☒	Depth (Inches):
Water Table Present?	Yes ☐	No ☒	Depth (Inches):
Saturation Present? (Includes Capillary fringe)	Yes ☐	No ☒	Depth (Inches):

Wetland Hydrology Present? Yes ☐ No ☒

Describe Recorded Data (Stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Parklands at Camas Meadows City/County: Camas/Clark Sampling Date: 4/28/15
Applicant/Owner: Parklands at Camas, LLC/Chinook Land Owners Group, LLC State: WA Sampling Point: TP-4
Investigator(s): T. Haderly & R.Allison Section, Township, Range: S28,T2N,R3E
Landform (hillslope, terrace, etc.): Terrace Local relief: Concave Slope (%): 0-3%
Subregion (LRR): A Lat: 45.3736 Long: -122.2654 Datum: NAD83
Soil Map Unit Name: CvA NWI classification: None
Are climatic / hydrologic conditions on the site typical for this time of year? Yes☒ No☐ (If no, explain Remarks.)
Are Vegetation☐, Soil☐, or Hydrology☐ significantly disturbed? Area "Normal Circumstances" present? Yes☒ No☐
Are Vegetation☐, Soil☐, or Hydrology☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒ No ☐	**Is the Sampled Area within a Wetland?** Yes☒ No☐
Hydric Soils Present?	Yes ☒ No ☐	
Wetland Hydrology Present?	Yes ☒ No ☐	

Remarks:

VEGETATION (*Use scientific names*)

Tree Stratum (Plot size:30 ft radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Fraxinus latifolia*	30%	yes	FACW
2. *Alnus rubra*	20%	yes	FAC
3.	%		
4.	%		
Total Cover:	50%		
Sapling/Shrub Stratum (Plot size: 5 ft. radius)			
1. *Cornus sericea*	20%	yes	FACW
2. *Rubus spectabilis*	15%	yes	FAC
3.	%		
4.	%		
5.	%		
Total Cover:	35%		
Herb Stratum (Plot size: 5 ft radius)			
1. *Oenanthe sarmentosa*	40%	yes	OBL
2. *Symplocarpus foetidus*	30%	yes	OBL
3. *Phalaris arundinacea*	30%	yes	FACW
4.	%		
5.	%		
6.	%		
7.	%		
8.	%		
Total Cover:	100%		
Woody Vine Stratum (Plot size: 5 ft radius)			
1.	%		
2.	%		
Total Cover:	%		

% Bare Ground in Herb Stratum %

Dominance Test Worksheet

Number of Dominant Species That Are OBL, FACW, or FAC: 7 (A)

Total Number of Dominant Species Across All Strata: 7 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet

Total % Cover of:		Multiply by:	
OBL species		x 1=	
FACW species		x 2=	
FAC species		x 3=	
FACU species		x 4=	
UPL species		x 5=	
Column Totals:	(A)		(B)

Prevalence Index = B/A=

Hydrophytic Vegetation Indicators:

- ☐ 1 – Rapid Test for Hydrophytic Vegetation
- ☒ 2 – Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data In Remarks or on a separate sheet)
- ☐ Wetland Non-Vascular Plants[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology Must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes☒ No☐

Remarks:

SOIL

Sampling Point: TP-4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-16	10YR 2/1	80%	10YR 3/6	20%	C	M	Clay silt loam	
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosal (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Minerals (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☒ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and Wetland hydrology must be present

Restrictive Layer (if present):

Type: ____

Depth (inches):

Hydric Soil Present? Yes☒ No☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (min. of one required; check all that apply)

- ☐ Surface Water (A1)
- ☒ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, & 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stressed Plants (D1) **(LRR A)**
- ☐ Other (Explain in Remarks)
- ☐

Secondary Indicators (2 or more required)

- ☐ Water Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D4

Field Observations:

Surface Water Present?	Yes ☐	No ☒	Depth (Inches):
Water Table Present?	Yes ☒	No ☐	Depth (Inches): 0
Saturation Present? (Includes Capillary fringe)	Yes ☒	No ☐	Depth (Inches): 0

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (Stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Parklands at Camas Meadows City/County: Camas/Clark Sampling Date: 4/28/2015
Applicant/Owner: Parklands at Camas, LLC/Chinook Land Owners Group, LLC State: WA Sampling Point: TP-5
Investigator(s): T. Haderly & R.Allison Section, Township, Range: S28,T2N,R3E
Landform (hillslope, terrace, etc.): Terrace Local relief: Convex Slope (%): 0-3%
Subregion (LRR): A Lat: 45.3736 Long: -122.2654 Datum: NAD83
Soil Map Unit Name: CvA NWI classification: None
Are climatic / hydrologic conditions on the site typical for this time of year? Yes☒ No☐ (If no, explain Remarks.)
Are Vegetation☐, Soil☐, or Hydrology☐ significantly disturbed? Area "Normal Circumstances" present? Yes☒ No☐
Are Vegetation☐, Soil☐, or Hydrology☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes☐ No☒ Hydric Soils Present? Yes☐ No☒ Wetland Hydrology Present? Yes☐ No☒	**Is the Sampled Area within a Wetland?**	**Yes☐ No☒**

Remarks:

VEGETATION (*Use scientific names*)

Tree Stratum (Plot size:30 ft radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Corylus cornuta*	20%	yes	FACU
2.	%		
3.	%		
4.	%		
Total Cover:	20%		
Sapling/Shrub Stratum (Plot size: 5 ft. radius)			
1. *Holodiscus discolor*	10%	yes	FACU
2. *Oemleria cerasiformis*	5%	yes	FACU
3.	%		
4.	%		
5.	%		
Total Cover:	15%		
Herb Stratum (Plot size: 5 ft radius)			
1. *Galium trifidum*	40%	yes	FACW
2. *Polystichum munitum*	30%	yes	FACU
3. *Claytonia perfoliata*	10%	no	FAC
4.	%		
5.	%		
6.	%		
7.	%		
8.	%		
Total Cover:	80%		
Woody Vine Stratum (Plot size: 30 ft radius)			
1. *Rubus ursinus*	5%	yes	FACU
2.	%		
Total Cover:	5%		

% Bare Ground in Herb Stratum 20%

Dominance Test Worksheet

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 17 (A/B)

Prevalence Index worksheet

Total % Cover of:	Multiply by:
OBL species	x 1=
FACW species	x 2=
FAC species	x 3=
FACU species	x 4=
UPL species	x 5=
Column Totals: (A)	(B)

Prevalence Index = B/A=

Hydrophytic Vegetation Indicators:

- ☐ 1 – Rapid Test for Hydrophytic Vegetation
- ☐ 2 – Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data In Remarks or on a separate sheet)
- ☐ Wetland Non-Vascular Plants[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology Must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes☐ No☒

Remarks:

SOIL

Sampling Point: TP-5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-16	10YR 3/3	100%		%			Silt loam	
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosal (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Minerals (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and Wetland hydrology must be present

Restrictive Layer (if present):

Type: ____

Depth (inches):

Hydric Soil Present? Yes☐ No☒

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (min. of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or crust (B4)
- ☐ Iron Deposits (B5)
- ☐ **Surface Soil Cracks (B6)**
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, & 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stressed Plants (D1) **(LRR A)**
- ☐ Other (Explain in Remarks)
- ☐

Secondary Indicators (2 or more required)

- ☐ Water Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D4

Field Observations:

Surface Water Present?	Yes ☐	No ☒	Depth (Inches):
Water Table Present?	Yes ☐	No ☒	Depth (Inches):
Saturation Present? (Includes Capillary fringe)	Yes ☐	No ☒	Depth (Inches):

Wetland Hydrology Present? Yes ☐ No ☒

Describe Recorded Data (Stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Parklands at Camas Meadows City/County: Camas/Clark Sampling Date: 4/28/2015
Applicant/Owner: Parklands at Camas, LLC/Chinook Land Owners Group, LLC State: WA Sampling Point: TP-6
Investigator(s): T. Haderly & R.Allison Section, Township, Range: S28,T2N,R3E
Landform (hillslope, terrace, etc.): Terrace Local relief: Concave Slope (%): 8-20%
Subregion (LRR): A Lat: 45.3736 Long: -122.2654 Datum: NAD83
Soil Map Unit Name: HcD NWI classification: PFOA
Are climatic / hydrologic conditions on the site typical for this time of year? Yes☒ No☐ (If no, explain Remarks.)
Are Vegetation☐, Soil☐, or Hydrology☐ significantly disturbed? Area "Normal Circumstances" present? Yes☒ No☐
Are Vegetation☐, Soil☐, or Hydrology☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒ No ☐	**Is the Sampled Area within a Wetland?** Yes☒ No☐
Hydric Soils Present?	Yes ☒ No ☐	
Wetland Hydrology Present?	Yes ☒ No ☐	

Remarks:

VEGETATION (*Use scientific names*)

Tree Stratum (Plot size:30 ft radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Fraxinus latifolia*	20%	yes	FACW
2. *Acer macrophyllum*	10%	yes	FACU
3.	%		
4.	%		
Total Cover:	30%		

Sapling/Shrub Stratum (Plot size: 5 ft. radius)			
1. *Cornus sericea*	30%	yes	FACW
2.	%		
3.	%		
4.	%		
5.	%		
Total Cover:	30%		

Herb Stratum (Plot size: 5 ft radius)			
1. *Veratrum californicum*	40%	yes	FAC
2. *Oenanthe sarmentosa*	20%	yes	OBL
3. *Mentha arvensis*	10%	no	FACW
4.	%		
5.	%		
6.	%		
7.	%		
8.	%		
Total Cover:	70%		

Woody Vine Stratum (Plot size: 30 ft radius)			
1.	%		
2.	%		
Total Cover:	%		

% Bare Ground in Herb Stratum 30%

Dominance Test Worksheet

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC 80 (A/B)

Prevalence Index worksheet

Total % Cover of:		Multiply by:	
OBL species		x 1=	
FACW species		x 2=	
FAC species		x 3=	
FACU species		x 4=	
UPL species		x 5=	
Column Totals:	(A)		(B)

Prevalence Index = B/A=

Hydrophytic Vegetation Indicators:

- ☐ 1 – Rapid Test for Hydrophytic Vegetation
- ☒ 2 – Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data In Remarks or on a separate sheet)
- ☐ **Wetland Non-Vascular Plants[1]**
- ☐ **Problematic Hydrophytic Vegetation[1] (Explain)**

[1]Indicators of hydric soil and wetland hydrology Must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes☒ No☐

Remarks:

SOIL

Sampling Point: TP-6

Profile Description: (Describe to the depth needed to document the Indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-16	10YR 4/1	80%	2.5 YR 3/6	20%	C		Silt clay loam	
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosal (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Minerals (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☒ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and Wetland hydrology must be present

Restrictive Layer (if present):

Type: ____

Depth (inches):

Hydric Soil Present? **Yes☒ No☐**

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (min. of one required; check all that apply)

- ☐ Surface Water (A1)
- ☒ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or crust (B4)
- ☐ Iron Deposits (B5)
- ☐ **Surface Soil Cracks (B6)**
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, & 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stressed Plants (D1) **(LRR A)**
- ☐ **Other (Explain in Remarks)**
- ☐

Secondary Indicators (2 or more required)

- ☐ Water Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D4

Field Observations:

Surface Water Present?	Yes ☐	No ☒	Depth (Inches):
Water Table Present?	Yes ☒	No ☐	Depth (Inches): 4
Saturation Present? (Includes Capillary fringe)	Yes ☒	No ☐	Depth (Inches): 0

Wetland Hydrology Present? **Yes ☒ No ☐**

Describe Recorded Data (Stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Parklands at Camas Meadows City/County: Camas/Clark Sampling Date: 4/28/2015
Applicant/Owner: Parklands at Camas, LLC/Chinook Land Owners Group, LLC State: WA Sampling Point: TP-7
Investigator(s): T. Haderly & R.Allison Section, Township, Range: S28,T2N,R3E
Landform (hillslope, terrace, etc.): Terrace Local relief: Convex Slope (%): 8-20%
Subregion (LRR): A Lat: 45.3736 Long: -122.2654 Datum: NAD83
Soil Map Unit Name: HcD NWI classification: PFOA
Are climatic / hydrologic conditions on the site typical for this time of year? Yes☒ No☐ (If no, explain Remarks.)
Are Vegetation☐, Soil☐, or Hydrology☐ significantly disturbed? Area "Normal Circumstances" present? Yes☒ No☐
Are Vegetation☐, Soil☐, or Hydrology☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐ No ☒	**Is the Sampled Area within a Wetland?** Yes☐ No☒
Hydric Soils Present?	Yes ☐ No ☒	
Wetland Hydrology Present?	Yes ☐ No ☒	

Remarks:

VEGETATION (*Use scientific names*)

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:30 ft radius)			
1. *Thuja plicata*	20%	yes	FAC
2. *Pseudotsuga menziesii*	20%	yes	FACU
3. *(non- native) Cedar sp.*	20%	yes	
4. *Acer macrophyllum*	10%	no	FAC
Total Cover:	70%		
Sapling/Shrub Stratum (Plot size: 5 ft. radius)			
1.	%		
2.	%		
3.	%		
4.	%		
5.	%		
Total Cover:	%		
Herb Stratum (Plot size: 5 ft radius)			
1. *Saxifrage sp*	20%	yes	
2.	%		
3.	%		
4.	%		
5.	%		
6.	%		
7.	%		
8.	%		
Total Cover:	20%		
Woody Vine Stratum (Plot size: 30 ft radius)			
1. *Rubus armeniacus*	40%	yes	FACU
2.	%		
Total Cover:	40%		

% Bare Ground in Herb Stratum 40%

Dominance Test Worksheet

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 20 (A/B)

Prevalence Index worksheet

Total % Cover of:		Multiply by:	
OBL species		x 1=	
FACW species		x 2=	
FAC species		x 3=	
FACU species		x 4=	
UPL species		x 5=	
Column Totals:	(A)		(B)

Prevalence Index = B/A=

Hydrophytic Vegetation Indicators:

- ☐ 1 – Rapid Test for Hydrophytic Vegetation
- ☐ 2 – Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data In Remarks or on a separate sheet)
- ☐ Wetland Non-Vascular Plants[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology Must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes☐ No☒

Remarks:

SOIL

Sampling Point: TP-7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-16	10YR 3/3	100%		%			Silt loam	
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				
		%		%				

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosal (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Minerals (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and Wetland hydrology must be present

Restrictive Layer (if present):

Type: ____

Depth (inches):

Hydric Soil Present? Yes☐ No☒

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (min. of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or crust (B4)
- ☐ Iron Deposits (B5)
- ☐ **Surface Soil Cracks (B6)**
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, & 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stressed Plants (D1) **(LRR A)**
- ☐ **Other (Explain in Remarks)**
- ☐

Secondary Indicators (2 or more required)

- ☐ Water Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D4

Field Observations:

Surface Water Present?	Yes ☐	No ☒	Depth (Inches):
Water Table Present?	Yes ☐	No ☒	Depth (Inches):
Saturation Present? (Includes Capillary fringe)	Yes ☐	No ☒	Depth (Inches):

Wetland Hydrology Present? Yes ☐ No ☒

Describe Recorded Data (Stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

APPENDIX B- WETLAND RATING FORM AND FIGURES

Wetland name or number A,B & C

RATING SUMMARY – Western Washington

Name of wetland (or ID #): Wetlands A,B & C Date of site visit: 4/28/2015

Rated by Rachel Allison Trained by Ecology? Yes No Date of training March 2015

HGM Class used for rating Depressional Wetland has multiple HGM classes? ___Y __X__N

NOTE: Form is not complete without the figures requested *(figures can be combined).*

Source of base aerial photo/map Google Earth (2014)

OVERALL WETLAND CATEGORY III (based on functions X or special characteristics__)

1. Category of wetland based on FUNCTIONS

_____**Category I** – Total score = 23 – 27

_____**Category II** – Total score = 20 – 22

__X__**Category III** – Total score = 16 – 19

_____**Category IV** – Total score = 9 – 15

FUNCTION	Improving Water Quality	Hydrologic	Habitat	
		Circle the appropriate ratings		
Site Potential	H (M) L	H (M) L	H (M) L	
Landscape Potential	H (M) L	H (M) L	H M (L)	
Value	H (M) L	H M (L)	H (M) L	TOTAL
Score Based on Ratings	6	5	5	16

Score for each function based on three ratings *(order of ratings is not important)*

9 = H,H,H
8 = H,H,M
7 = H,H,L
7 = H,M,M
6 = H,M,L
6 = M,M,M
5 = H,L,L
5 = M,M,L
4 = M,L,L
3 = L,L,L

2. Category based on SPECIAL CHARACTERISTICS of wetland

CHARACTERISTIC	CATEGORY
Estuarine	I II
Wetland of High Conservation Value	I
Bog	I
Mature Forest	I
Old Growth Forest	I
Coastal Lagoon	I II
Interdunal	I II III IV
None of the above	Not Applicable

Wetland name or number A,B & C

Maps and figures required to answer questions correctly for Western Washington

Depressional Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	D 1.3, H 1.1, H 1.4	
Hydroperiods	D 1.4, H 1.2	
Location of outlet *(can be added to map of hydroperiods)*	D 1.1, D 4.1	
Boundary of area within 150 ft of the wetland *(can be added to another figure)*	D 2.2, D 5.2	
Map of the contributing basin	D 4.3, D 5.3	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	D 3.1, D 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	D 3.3	

Riverine Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	H 1.1, H 1.4	
Hydroperiods	H 1.2	
Ponded depressions	R 1.1	
Boundary of area within 150 ft of the wetland *(can be added to another figure)*	R 2.4	
Plant cover of trees, shrubs, and herbaceous plants	R 1.2, R 4.2	
Width of unit vs. width of stream *(can be added to another figure)*	R 4.1	
Map of the contributing basin	R 2.2, R 2.3, R 5.2	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	R 3.1	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	R 3.2, R 3.3	

Lake Fringe Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	L 1.1, L 4.1, H 1.1, H 1.4	
Plant cover of trees, shrubs, and herbaceous plants	L 1.2	
Boundary of area within 150 ft of the wetland *(can be added to another figure)*	L 2.2	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	L 3.1, L 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	L 3.3	

Slope Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	H 1.1, H 1.4	
Hydroperiods	H 1.2	
Plant cover of **dense** trees, shrubs, and herbaceous plants	S 1.3	
Plant cover of **dense, rigid** trees, shrubs, and herbaceous plants *(can be added to figure above)*	S 4.1	
Boundary of 150 ft buffer (can be added to another figure)	S 2.1, S 5.1	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	S 3.1, S 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	S 3.3	

Wetland name or number A,B &C

HGM Classification of Wetlands in Western Washington

For questions 1-7, the criteria described must apply to the entire unit being rated.

If the hydrologic criteria listed in each question do not apply to the entire unit being rated, you probably have a unit with multiple HGM classes. In this case, identify which hydrologic criteria in questions 1-7 apply, and go to Question 8.

1. Are the water levels in the entire unit usually controlled by tides except during floods?

   (NO) – go to 2 **YES** – the wetland class is **Tidal Fringe** – go to 1.1

   1.1 Is the salinity of the water during periods of annual low flow below 0.5 ppt (parts per thousand)?

   NO – Saltwater Tidal Fringe (Estuarine) **YES – Freshwater Tidal Fringe**
   *If your wetland can be classified as a Freshwater Tidal Fringe use the forms for **Riverine** wetlands. If it is Saltwater Tidal Fringe it is an **Estuarine** wetland and is not scored. This method **cannot** be used to score functions for estuarine wetlands.*

2. The entire wetland unit is flat and precipitation is the only source (>90%) of water to it. Groundwater and surface water runoff are NOT sources of water to the unit.

   (NO) – go to 3 **YES** – The wetland class is **Flats**
   *If your wetland can be classified as a Flats wetland, use the form for **Depressional** wetlands.*

3. Does the entire wetland unit **meet all** of the following criteria?
   ___The vegetated part of the wetland is on the shores of a body of permanent open water (without any plants on the surface at any time of the year) at least 20 ac (8 ha) in size;
   ___At least 30% of the open water area is deeper than 6.6 ft (2 m).

   (NO) – go to 4 **YES** – The wetland class is **Lake Fringe** (Lacustrine Fringe)

4. Does the entire wetland unit **meet all** of the following criteria?
   ___The wetland is on a slope (*slope can be very gradual*),
   ___The water flows through the wetland in one direction (unidirectional) and usually comes from seeps. It may flow subsurface, as sheetflow, or in a swale without distinct banks,
   ___The water leaves the wetland **without being impounded.**

   (NO) – go to 5 **YES** – The wetland class is **Slope**

   NOTE: Surface water does not pond in these type of wetlands except occasionally in very small and shallow depressions or behind hummocks (depressions are usually <3 ft diameter and less than 1 ft deep).

5. Does the entire wetland unit **meet all** of the following criteria?
   ___The unit is in a valley, or stream channel, where it gets inundated by overbank flooding from that stream or river,
   ___The overbank flooding occurs at least once every 2 years.

Wetland name or number A,B &C

(NO) – go to 6 **YES** – The wetland class is **Riverine**

NOTE: The Riverine unit can contain depressions that are filled with water when the river is not flooding

6. Is the entire wetland unit in a topographic depression in which water ponds, or is saturated to the surface, at some time during the year? *This means that any outlet, if present, is higher than the interior of the wetland.*

NO – go to 7 (YES) – The wetland class is **Depressional**

7. Is the entire wetland unit located in a very flat area with no obvious depression and no overbank flooding? The unit does not pond surface water more than a few inches. The unit seems to be maintained by high groundwater in the area. The wetland may be ditched, but has no obvious natural outlet.

NO – go to 8 **YES** – The wetland class is **Depressional**

8. Your wetland unit seems to be difficult to classify and probably contains several different HGM classes. For example, seeps at the base of a slope may grade into a riverine floodplain, or a small stream within a Depressional wetland has a zone of flooding along its sides. GO BACK AND IDENTIFY WHICH OF THE HYDROLOGIC REGIMES DESCRIBED IN QUESTIONS 1-7 APPLY TO DIFFERENT AREAS IN THE UNIT (make a rough sketch to help you decide). Use the following table to identify the appropriate class to use for the rating system if you have several HGM classes present within the wetland unit being scored.

NOTE: Use this table only if the class that is recommended in the second column represents 10% or more of the total area of the wetland unit being rated. If the area of the HGM class listed in column 2 is less than 10% of the unit; classify the wetland using the class that represents more than 90% of the total area.

HGM classes within the wetland unit being rated	HGM class to use in rating
Slope + Riverine	Riverine
Slope + Depressional	Depressional
Slope + Lake Fringe	Lake Fringe
Depressional + Riverine along stream within boundary of depression	Depressional
Depressional + Lake Fringe	Depressional
Riverine + Lake Fringe	Riverine
Salt Water Tidal Fringe and any other class of freshwater wetland	Treat as ESTUARINE

*If you are still unable to determine which of the above criteria apply to your wetland, or if you have **more than 2 HGM classes** within a wetland boundary, classify the wetland as Depressional for the rating.*

Wetland name or number A,B &C

DEPRESSIONAL AND FLATS WETLANDS

Water Quality Functions - Indicators that the site functions to improve water quality

D 1.0. Does the site have the potential to improve water quality?

D 1.1. Characteristics of surface water outflows from the wetland: Wetland is a depression or flat depression (QUESTION 7 on key) with no surface water leaving it (no outlet). points = 3 Wetland has an intermittently flowing stream or ditch, OR highly constricted permanently flowing outlet. points = 2 Wetland has an unconstricted, or slightly constricted, surface outlet that is permanently flowing points = 1 Wetland is a flat depression (QUESTION 7 on key), whose outlet is a permanently flowing ditch. points = 1	1
D 1.2. The soil 2 in below the surface (or duff layer) is true clay or true organic *(use NRCS definitions)*. Yes = 4 No = 0	0
D 1.3. Characteristics and distribution of persistent plants (Emergent, Scrub-shrub, and/or Forested Cowardin classes): Wetland has persistent, ungrazed, plants > 95% of area points = 5 Wetland has persistent, ungrazed, plants > ½ of area points = 3 Wetland has persistent, ungrazed plants > $^1/_{10}$ of area points = 1 Wetland has persistent, ungrazed plants < $^1/_{10}$ of area points = 0	5
D 1.4. Characteristics of seasonal ponding or inundation: *This is the area that is ponded for at least 2 months. See description in manual.* Area seasonally ponded is > ½ total area of wetland points = 4 Area seasonally ponded is > ¼ total area of wetland points = 2 Area seasonally ponded is < ¼ total area of wetland points = 0	4
Total for D 1 Add the points in the boxes above	10

Rating of Site Potential If score is: ___ **12-16 = H** __X__ **6-11 = M** ___ **0-5 = L** *Record the rating on the first page*

D 2.0. Does the landscape have the potential to support the water quality function of the site?

D 2.1. Does the wetland unit receive stormwater discharges? Yes = 1 No = 0	0
D 2.2. Is > 10% of the area within 150 ft of the wetland in land uses that generate pollutants? Yes = 1 No = 0	1
D 2.3. Are there septic systems within 250 ft of the wetland? Yes = 1 No = 0	0
D 2.4. Are there other sources of pollutants coming into the wetland that are not listed in questions D 2.1-D 2.3? Source: Nearby subdivision Yes = 1 No = 0	0
Total for D 2 Add the points in the boxes above	1

Rating of Landscape Potential If score is: ___ **3 or 4 = H** __X__ **1 or 2 = M** ___ **0 = L** *Record the rating on the first page*

D 3.0. Is the water quality improvement provided by the site valuable to society?

D 3.1. Does the wetland discharge directly (i.e., within 1 mi) to a stream, river, lake, or marine water that is on the 303(d) list? Yes = 1 No = 0	1
D 3.2. Is the wetland in a basin or sub-basin where an aquatic resource is on the 303(d) list? Yes = 1 No = 0	0
D 3.3. Has the site been identified in a watershed or local plan as important for maintaining water quality (*answer YES if there is a TMDL for the basin in which the unit is found*)? Yes = 2 No = 0	0
Total for D 3 Add the points in the boxes above	1

Rating of Value If score is: ___ **2-4 = H** __X__ **1 = M** ___ **0 = L** *Record the rating on the first page*

Wetland name or number A,B &C

DEPRESSIONAL AND FLATS WETLANDS

Hydrologic Functions - Indicators that the site functions to reduce flooding and stream degradation

D 4.0. Does the site have the potential to reduce flooding and erosion?

D 4.1. Characteristics of surface water outflows from the wetland: Wetland is a depression or flat depression with no surface water leaving it (no outlet) points = 4 Wetland has an intermittently flowing stream or ditch, OR highly constricted permanently flowing outlet points = 2 Wetland is a flat depression (QUESTION 7 on key), whose outlet is a permanently flowing ditch points = 1 Wetland has an unconstricted, or slightly constricted, surface outlet that is permanently flowing points = 0	0
D 4.2. Depth of storage during wet periods: *Estimate the height of ponding above the bottom of the outlet. For wetlands with no outlet, measure from the surface of permanent water or if dry, the deepest part.* Marks of ponding are 3 ft or more above the surface or bottom of outlet points = 7 Marks of ponding between 2 ft to < 3 ft from surface or bottom of outlet points = 5 Marks are at least 0.5 ft to < 2 ft from surface or bottom of outlet points = 3 The wetland is a "headwater" wetland points = 3 Wetland is flat but has small depressions on the surface that trap water points = 1 Marks of ponding less than 0.5 ft (6 in) points = 0	3
D 4.3. Contribution of the wetland to storage in the watershed: *Estimate the ratio of the area of upstream basin contributing surface water to the wetland to the area of the wetland unit itself.* The area of the basin is less than 10 times the area of the unit points = 5 The area of the basin is 10 to 100 times the area of the unit points = 3 The area of the basin is more than 100 times the area of the unit points = 0 Entire wetland is in the Flats class points = 5	3
Total for D 4 Add the points in the boxes above	6

Rating of Site Potential If score is: ___ **12-16 = H** __X__ **6-11 = M** ___ **0-5 = L** *Record the rating on the first page*

D 5.0. Does the landscape have the potential to support hydrologic functions of the site?

D 5.1. Does the wetland receive stormwater discharges? Yes = 1 No = 0	0
D 5.2. Is >10% of the area within 150 ft of the wetland in land uses that generate excess runoff? Yes = 1 No = 0	1
D 5.3. Is more than 25% of the contributing basin of the wetland covered with intensive human land uses (residential at >1 residence/ac, urban, commercial, agriculture, etc.)? Yes = 1 No = 0	1
Total for D 5 Add the points in the boxes above	2

Rating of Landscape Potential If score is: ___ **3 = H** __X__ **1 or 2 = M** ___ **0 = L** *Record the rating on the first page*

D 6.0. Are the hydrologic functions provided by the site valuable to society?

D 6.1. The unit is in a landscape that has flooding problems. *Choose the description that best matches conditions around the wetland unit being rated. Do not add points. Choose the highest score if more than one condition is met.* The wetland captures surface water that would otherwise flow down-gradient into areas where flooding has damaged human or natural resources (e.g., houses or salmon redds): • Flooding occurs in a sub-basin that is immediately down-gradient of unit. points = 2 • Surface flooding problems are in a sub-basin farther down-gradient. points = 1 Flooding from groundwater is an issue in the sub-basin. points = 1 The existing or potential outflow from the wetland is so constrained by human or natural conditions that the water stored by the wetland cannot reach areas that flood. *Explain why* _____ points = 0 There are no problems with flooding downstream of the wetland. points = 0	0
D 6.2. Has the site been identified as important for flood storage or flood conveyance in a regional flood control plan? Yes = 2 No = 0	0
Total for D 6 Add the points in the boxes above	0

Rating of Value If score is: ___ **2-4 = H** ___ **1 = M** __X__ **0 = L** *Record the rating on the first page*

Wetland name or number A,B &C

These questions apply to wetlands of all HGM classes.

HABITAT FUNCTIONS - Indicators that site functions to provide important habitat

H 1.0. Does the site have the potential to provide habitat?

H 1.1. Structure of plant community: *Indicators are Cowardin classes and strata within the Forested class.* Check the Cowardin plant classes in the wetland. *Up to 10 patches may be combined for each class to meet the threshold of ¼ ac or more than 10% of the unit if it is smaller than 2.5 ac. Add the number of structures checked.*

____Aquatic bed	4 structures or more: points = 4
__X__Emergent	3 structures: points = 2
__X__Scrub-shrub (areas where shrubs have > 30% cover)	2 structures: points = 1
__X__Forested (areas where trees have > 30% cover)	1 structure: points = 0

If the unit has a Forested class, check if:

__X__The Forested class has 3 out of 5 strata (canopy, sub-canopy, shrubs, herbaceous, moss/ground-cover) that each cover 20% within the Forested polygon

4

H 1.2. Hydroperiods

Check the types of water regimes (hydroperiods) present within the wetland. The water regime has to cover more than 10% of the wetland or ¼ ac to count (*see text for descriptions of hydroperiods*).

____Permanently flooded or inundated	4 or more types present: points = 3
__X__Seasonally flooded or inundated	3 types present: points = 2
__X__Occasionally flooded or inundated	2 types present: points = 1
__X__Saturated only	1 type present: points = 0
____Permanently flowing stream or river in, or adjacent to, the wetland	
____Seasonally flowing stream in, or adjacent to, the wetland	
____**Lake Fringe wetland**	**2 points**
____**Freshwater tidal wetland**	**2 points**

2

H 1.3. Richness of plant species

Count the number of plant species in the wetland that cover at least 10 ft^2.

Different patches of the same species can be combined to meet the size threshold and you do not have to name the species. ***Do not include Eurasian milfoil, reed canarygrass, purple loosestrife, Canadian thistle***

If you counted: > 19 species	points = 2
5 - 19 species	points = 1
< 5 species	points = 0

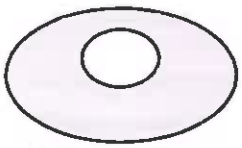
1

H 1.4. Interspersion of habitats

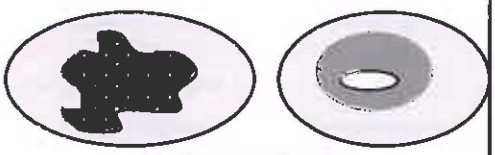
Decide from the diagrams below whether interspersion among Cowardin plants classes (described in H 1.1), or the classes and unvegetated areas (can include open water or mudflats) is high, moderate, low, or none. *If you have four or more plant classes or three classes and open water, the rating is always high.*



None = 0 points



Low = 1 point



Moderate = 2 points

All three diagrams in this row are **HIGH** = 3points



3

Wetland name or number A,B &C

H 1.5. Special habitat features: Check the habitat features that are present in the wetland. *The number of checks is the number of points.* __X__Large, downed, woody debris within the wetland (> 4 in diameter and 6 ft long). __X__Standing snags (dbh > 4 in) within the wetland ____Undercut banks are present for at least 6.6 ft (2 m) **and/or** overhanging plants extends at least 3.3 ft (1 m) over a stream (or ditch) in, or contiguous with the wetland, for at least 33 ft (10 m) ____Stable steep banks of fine material that might be used by beaver or muskrat for denning (> 30 degree slope) OR signs of recent beaver activity are present *(cut shrubs or trees that have not yet weathered where wood is exposed)* __X__At least ¼ ac of thin-stemmed persistent plants or woody branches are present in areas that are permanently or seasonally inundated *(structures for egg-laying by amphibians)* ____Invasive plants cover less than 25% of the wetland area in every stratum of plants (*see H 1.1 for list of strata*)	**3**
Total for H 1 Add the points in the boxes above	**13**

Rating of Site Potential If score is:___**15-18 = H** __**X**__**7-14 = M** ___**0-6 = L** *Record the rating on the first page*

H 2.0. Does the landscape have the potential to support the habitat functions of the site?	
H 2.1. Accessible habitat (include *only habitat that directly abuts wetland unit*). *Calculate:* % undisturbed habitat 7 + [(% moderate and low intensity land uses)/2] 7.5 = **14.5** % If total accessible habitat is: > 1/3 (33.3%) of 1 km Polygon points = 3 20-33% of 1 km Polygon points = 2 10-19% of 1 km Polygon points = 1 < 10% of 1 km Polygon points = 0	1
H 2.2. Undisturbed habitat in 1 km Polygon around the wetland. *Calculate:* % undisturbed habitat 28 + [(% moderate and low intensity land uses)/2] 7.5 = **35.5** % Undisturbed habitat > 50% of Polygon points = 3 Undisturbed habitat 10-50% and in 1-3 patches points = 2 Undisturbed habitat 10-50% and > 3 patches points = 1 Undisturbed habitat < 10% of 1 km Polygon points = 0	1
H 2.3. Land use intensity in 1 km Polygon: If > 50% of 1 km Polygon is high intensity land use points = (- 2) ≤ 50% of 1 km Polygon is high intensity points = 0	-2
Total for H 2 Add the points in the boxes above	0

Rating of Landscape Potential If score is:___**4-6 = H** ___**1-3 = M** __**X**__**< 1 = L** *Record the rating on the first page*

H 3.0. Is the habitat provided by the site valuable to society?

H 3.1. Does the site provide habitat for species valued in laws, regulations, or policies? *Choose only the highest score that applies to the wetland being rated.*

Site meets ANY of the following criteria: points = 2

- It has 3 or more priority habitats within 100 m (see next page)
- It provides habitat for Threatened or Endangered species (any plant or animal on the state or federal lists)
- It is mapped as a location for an individual WDFW priority species
- It is a Wetland of High Conservation Value as determined by the Department of Natural Resources
- It has been categorized as an important habitat site in a local or regional comprehensive plan, in a Shoreline Master Plan, or in a watershed plan

Site has 1 or 2 priority habitats (listed on next page) within 100 m points = 1

Site does not meet any of the criteria above points = 0

Rating of Value If score is:___**2 = H** __**X**__**1 = M** ___**0 = L** *Record the rating on the first page*

Wetland name or number A,B &C

WDFW Priority Habitats

Priority habitats listed by WDFW (see complete descriptions of WDFW priority habitats, and the counties in which they can be found, in: Washington Department of Fish and Wildlife. 2008. Priority Habitat and Species List. Olympia, Washington. 177 pp. http://wdfw.wa.gov/publications/00165/wdfw00165.pdf or access the list from here: http://wdfw.wa.gov/conservation/phs/list/)

Count how many of the following priority habitats are within 330 ft (100 m) of the wetland unit: ***NOTE:*** *This question is independent of the land use between the wetland unit and the priority habitat.*

— **Aspen Stands:** Pure or mixed stands of aspen greater than 1 ac (0.4 ha).

— **Biodiversity Areas and Corridors:** Areas of habitat that are relatively important to various species of native fish and wildlife (*full descriptions in WDFW PHS report*).

— **Herbaceous Balds:** Variable size patches of grass and forbs on shallow soils over bedrock.

— **Old-growth/Mature forests:** Old-growth west of Cascade crest – Stands of at least 2 tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/ac (20 trees/ha) > 32 in (81 cm) dbh or > 200 years of age. Mature forests – Stands with average diameters exceeding 21 in (53 cm) dbh; crown cover may be less than 100%; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; 80-200 years old west of the Cascade crest.

X **Oregon White Oak:** Woodland stands of pure oak or oak/conifer associations where canopy coverage of the oak component is important (*full descriptions in WDFW PHS report p. 158 – see web link above*).

— **Riparian:** The area adjacent to aquatic systems with flowing water that contains elements of both aquatic and terrestrial ecosystems which mutually influence each other.

— **Westside Prairies:** Herbaceous, non-forested plant communities that can either take the form of a dry prairie or a wet prairie (*full descriptions in WDFW PHS report p. 161 – see web link above*).

— **Instream:** The combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and wildlife resources.

— **Nearshore:** Relatively undisturbed nearshore habitats. These include Coastal Nearshore, Open Coast Nearshore, and Puget Sound Nearshore. (*full descriptions of habitats and the definition of relatively undisturbed are in WDFW report – see web link on previous page).*

— **Caves:** A naturally occurring cavity, recess, void, or system of interconnected passages under the earth in soils, rock, ice, or other geological formations and is large enough to contain a human.

— **Cliffs:** Greater than 25 ft (7.6 m) high and occurring below 5000 ft elevation.

— **Talus:** Homogenous areas of rock rubble ranging in average size 0.5 - 6.5 ft (0.15 - 2.0 m), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. May be associated with cliffs.

— **Snags and Logs:** Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a diameter at breast height of > 20 in (51 cm) in western Washington and are > 6.5 ft (2 m) in height. Priority logs are > 12 in (30 cm) in diameter at the largest end, and > 20 ft (6 m) long.

Note: All vegetated wetlands are by definition a priority habitat but are not included in this list because they are addressed elsewhere.

Wetland name or number A,B &C

CATEGORIZATION BASED ON SPECIAL CHARACTERISTICS

Wetland Type *Check off any criteria that apply to the wetland. Circle the category when the appropriate criteria are met.*	**Category**
SC 1.0. Estuarine wetlands Does the wetland meet the following criteria for Estuarine wetlands? — The dominant water regime is tidal, — Vegetated, and — With a salinity greater than 0.5 ppt Yes –Go to **SC 1.1** (No) **Not an estuarine wetland**	
SC 1.1. Is the wetland within a National Wildlife Refuge, National Park, National Estuary Reserve, Natural Area Preserve, State Park or Educational, Environmental, or Scientific Reserve designated under WAC 332-30-151? Yes = **Category I** No - Go to **SC 1.2**	**Cat. I**
SC 1.2. Is the wetland unit at least 1 ac in size and meets at least two of the following three conditions? — The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing, and has less than 10% cover of non-native plant species. (If non-native species are *Spartina*, see page 25) — At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland. — The wetland has at least two of the following features: tidal channels, depressions with open water, or contiguous freshwater wetlands. Yes = **Category I** No = **Category II**	**Cat. I** **Cat. II**
SC 2.0. Wetlands of High Conservation Value (WHCV) SC 2.1. Has the WA Department of Natural Resources updated their website to include the list of Wetlands of High Conservation Value? Yes – Go to **SC 2.2** (No) – Go to **SC 2.3** SC 2.2. Is the wetland listed on the WDNR database as a Wetland of High Conservation Value? Yes = **Category I** No = **Not a WHCV** SC 2.3. Is the wetland in a Section/Township/Range that contains a Natural Heritage wetland? http://www1.dnr.wa.gov/nhp/refdesk/datasearch/wnhpwetlands.pdf (Yes) – **Contact WNHP/WDNR and go to SC 2.4** No = **Not a WHCV** SC 2.4. Has WDNR identified the wetland within the S/T/R as a Wetland of High Conservation Value and listed it on their website? Yes = **Category I** (No) = **Not a WHCV**	**Cat. I** **Note***
SC 3.0. Bogs Does the wetland (or any part of the unit) meet both the criteria for soils and vegetation in bogs? *Use the key below.* ***If you answer YES you will still need to rate the wetland based on its functions.*** SC 3.1. Does an area within the wetland unit have organic soil horizons, either peats or mucks, that compose 16 in or more of the first 32 in of the soil profile? Yes – Go to **SC 3.3** (No) – Go to **SC 3.2** SC 3.2. Does an area within the wetland unit have organic soils, either peats or mucks, that are less than 16 in deep over bedrock, or an impermeable hardpan such as clay or volcanic ash, or that are floating on top of a lake or pond? Yes – Go to **SC 3.3** (No) = **Is not a bog** SC 3.3. Does an area with peats or mucks have more than 70% cover of mosses at ground level, AND at least a 30% cover of plant species listed in Table 4? Yes = **Is a Category I bog** No – Go to **SC 3.4** **NOTE:** If you are uncertain about the extent of mosses in the understory, you may substitute that criterion by measuring the pH of the water that seeps into a hole dug at least 16 in deep. If the pH is less than 5.0 and the plant species in Table 4 are present, the wetland is a bog. SC 3.4. Is an area with peats or mucks forested (> 30% cover) with Sitka spruce, subalpine fir, western red cedar, western hemlock, lodgepole pine, quaking aspen, Engelmann spruce, or western white pine, AND any of the species (or combination of species) listed in Table 4 provide more than 30% of the cover under the canopy? Yes = **Is a Category I bog** No = **Is not a bog**	**Cat. I**

Note: Contact was made with Joe Rocchio, Vegetation Ecologist, Washington Dept. of Natural Resources, Natural Heritage Program, on 6/15/2015. Mr. Rocchio confirmed the wetlands were not included in the list of Wetlands of High Conservation Value.

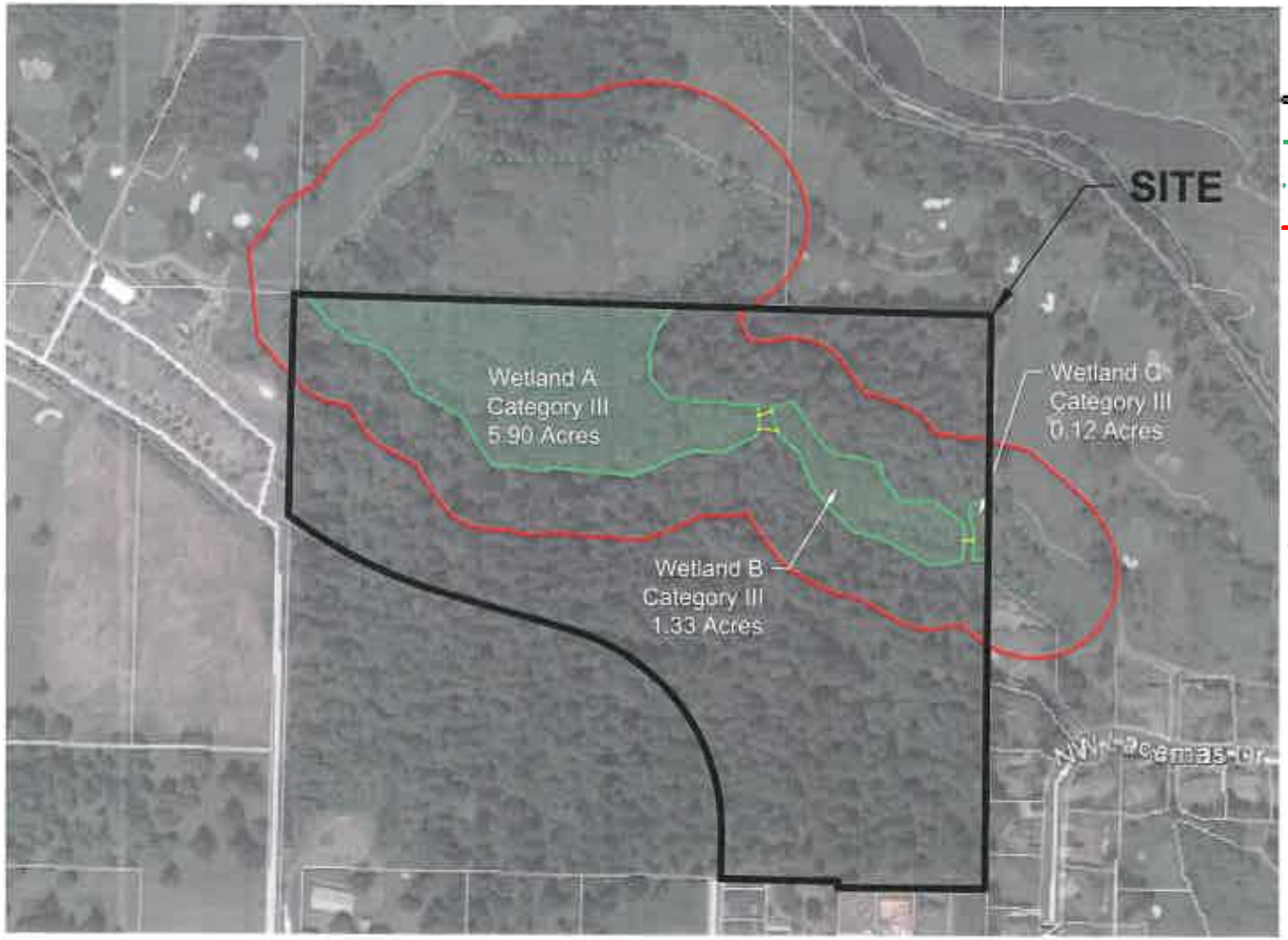
Wetland name or number A, B&C

SC 4.0. Forested Wetlands Does the wetland have at least 1 contiguous acre of forest that meets one of these criteria for the WA Department of Fish and Wildlife's forests as priority habitats? ***If you answer YES you will still need to rate the wetland based on its functions.*** — **Old-growth forests** (west of Cascade crest): Stands of at least two tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/ac (20 trees/ha) that are at least 200 years of age OR have a diameter at breast height (dbh) of 32 in (81 cm) or more. — **Mature forests** (west of the Cascade Crest): Stands where the largest trees are 80- 200 years old OR the species that make up the canopy have an average diameter (dbh) exceeding 21 in (53 cm). Yes = **Category I** (No) = **Not a forested wetland for this section**	**Cat. I**
SC 5.0. Wetlands in Coastal Lagoons Does the wetland meet all of the following criteria of a wetland in a coastal lagoon? — The wetland lies in a depression adjacent to marine waters that is wholly or partially separated from marine waters by sandbanks, gravel banks, shingle, or, less frequently, rocks — The lagoon in which the wetland is located contains ponded water that is saline or brackish (> 0.5 ppt) during most of the year in at least a portion of the lagoon *(needs to be measured near the bottom)* Yes – Go to **SC 5.1** (No) = **Not a wetland in a coastal lagoon**	**Cat. I**
SC 5.1. Does the wetland meet all of the following three conditions? — The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 20% cover of aggressive, opportunistic plant species (see list of species on p. 100). — At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland. — The wetland is larger than $^{1}/_{10}$ ac (4350 ft^2) Yes = **Category I** No = **Category II**	**Cat. II**
SC 6.0. Interdunal Wetlands Is the wetland west of the 1889 line (also called the Western Boundary of Upland Ownership or WBUO)? ***If you answer yes you will still need to rate the wetland based on its habitat functions.*** In practical terms that means the following geographic areas: — Long Beach Peninsula: Lands west of SR 103 — Grayland-Westport: Lands west of SR 105 — Ocean Shores-Copalis: Lands west of SR 115 and SR 109 Yes – Go to **SC 6.1** (No) = **not an interdunal wetland for rating**	**Cat I**
SC 6.1. Is the wetland 1 ac or larger and scores an 8 or 9 for the habitat functions on the form (rates H,H,H or H,H,M for the three aspects of function)? Yes = **Category I** No – Go to **SC 6.2**	**Cat. II**
SC 6.2. Is the wetland 1 ac or larger, or is it in a mosaic of wetlands that is 1 ac or larger? **Yes = Category II** No – Go to **SC 6.3**	**Cat. III**
SC 6.3. Is the unit between 0.1 and 1 ac, or is it in a mosaic of wetlands that is between 0.1 and 1 ac? Yes = **Category III** No = **Category IV**	**Cat. IV**
Category of wetland based on Special Characteristics If you answered No for all types, enter "Not Applicable" on Summary Form	**Not Applicable**

Wetland name or number A, B &C

This page left blank intentionally

8/12/2015 3:21 PM s:\ELS\WA\Clark\Camas\2255-parklands at camas llc\2255.01-chinook property\2255.01-figures\2255.01_GPS.dwg cpayne



LEGEND:

- Site Boundary
- Onsite portion of Wetland unit
- Offsite portion of Wetland unit
- Wetland 150' offset

D 2.2->10% of area within 150ft. of wetland in land uses that generate pollutants.

D 5.2- <10% of area within 150ft. of the wetland in land uses that generate excess runoff.

NOTE(S):

1. Base map from ***Google Earth***.™

N W E S

0 400 800
SCALE IN FEET

ECOLOGICAL LAND SERVICES, INC.
1157 3rd Ave., Suite 220
Longview, WA 98632
Phone: (360) 578-1371 Fax: (360) 414-9305

DATE: 8/12/15
DWN: CDP
REQ. BY: RA
PRJ. MGR: TH
CHK:
PROJECT NO: 2255.01

Figure 6
150' OFFSET RATING FORM
Parklands at Camas Meadows
Parklands at Camas LLC.
Camas, Clark County, WA
Section 28, Township 2 N, Range 3 E, W.M.

Exhibit 16 SP26-1005

8/12/2015 3:21 PM s:\ELS\WA\Clark\Camas\2255-parklands at camas llc\2255.01-chinook property\2255.01-figures\2255.01_GPS.dwg cpayne



LEGEND:

- Site Boundary
- Onsite portion of Wetland Unit
- Offsite portion of Wetland Unit
- 1 KM Offset

Accessible Land Uses: 7%
Moderate/Low intensity land uses: 13%
Undisturbed Land Uses: 28%
High intensity land uses: 52%

H 2.1- Accessible habitat directly abutting wetland <10% of 1 KM polygon.
H 2.2- Undisturbed habitat within 1KM polygon (10-50% and in 1-3 patches).
H 2.3- >50% of 1KM polygon is high intensity land use.

NOTE(S):

1. Base map from ***Google Earth.***™

N W E S

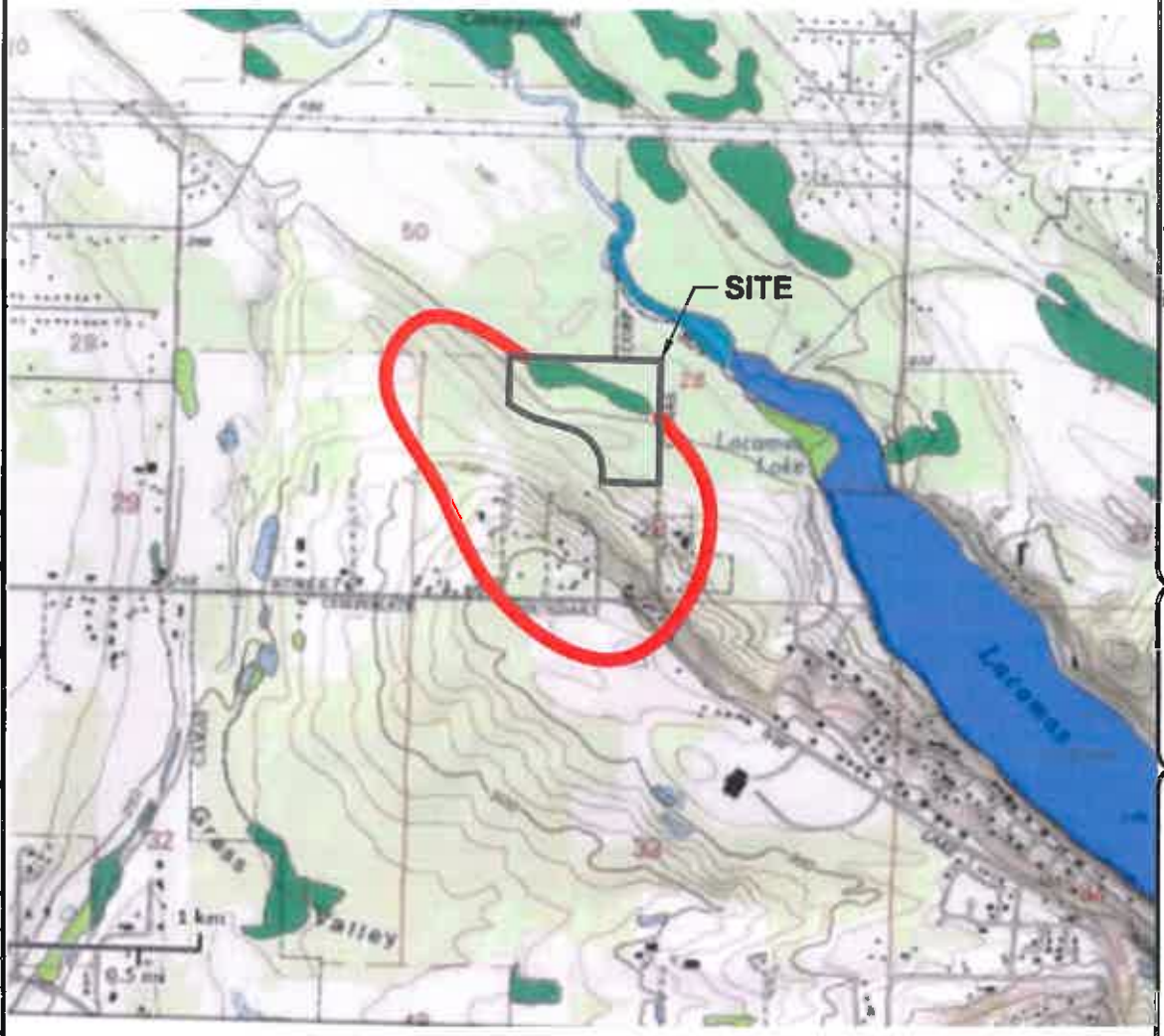
0 1500 3000
SCALE IN FEET

ECOLOGICAL LAND SERVICES, INC.
1157 3rd Ave., Suite 220
Longview, WA 98632
Phone: (360) 578-1371 Fax: (360) 414-9305

DATE: 8/12/15
DWN: CDP
REQ. BY: RA
PRJ. MGR: TH
CHK:
PROJECT NO: 2255.01

Figure 7
1 KM OFFSET RATING FORM
Parklands at Camas Meadows
Parklands at Camas LLC.
Camas, Clark County, WA
Section 28, Township 2 N, Range 3 E, W.M.

Exhibit 16 SP26-1005



Wetlands indicated onsite by US Fish & Wildlife Service.

LEGEND:

- Site Boundary
- Contributing Basin
- Freshwater Forested/Shrub Wetland
- Freshwater Emergent Wetland
- Riverine
- Freshwater Pond
- Lake

NOTE(S):

1. Map provided on-line by US Fish & Wildlife Service at web address: *http://www.fws.gov/wetlands/data/index.html*

Figure 8
CONTRIBUTING BASIN MAP
Parklands at Camas Meadows
Parklands at Camas LLC.
Camas, Clark County, WA
Section 28, Township 2 N, Range 3 E, W.M.

DATE: 8/12/15
DWN: CDP
REQ. BY: RA
PRJ. MGR: TH
CHK:
PROJECT NO: 2255.01

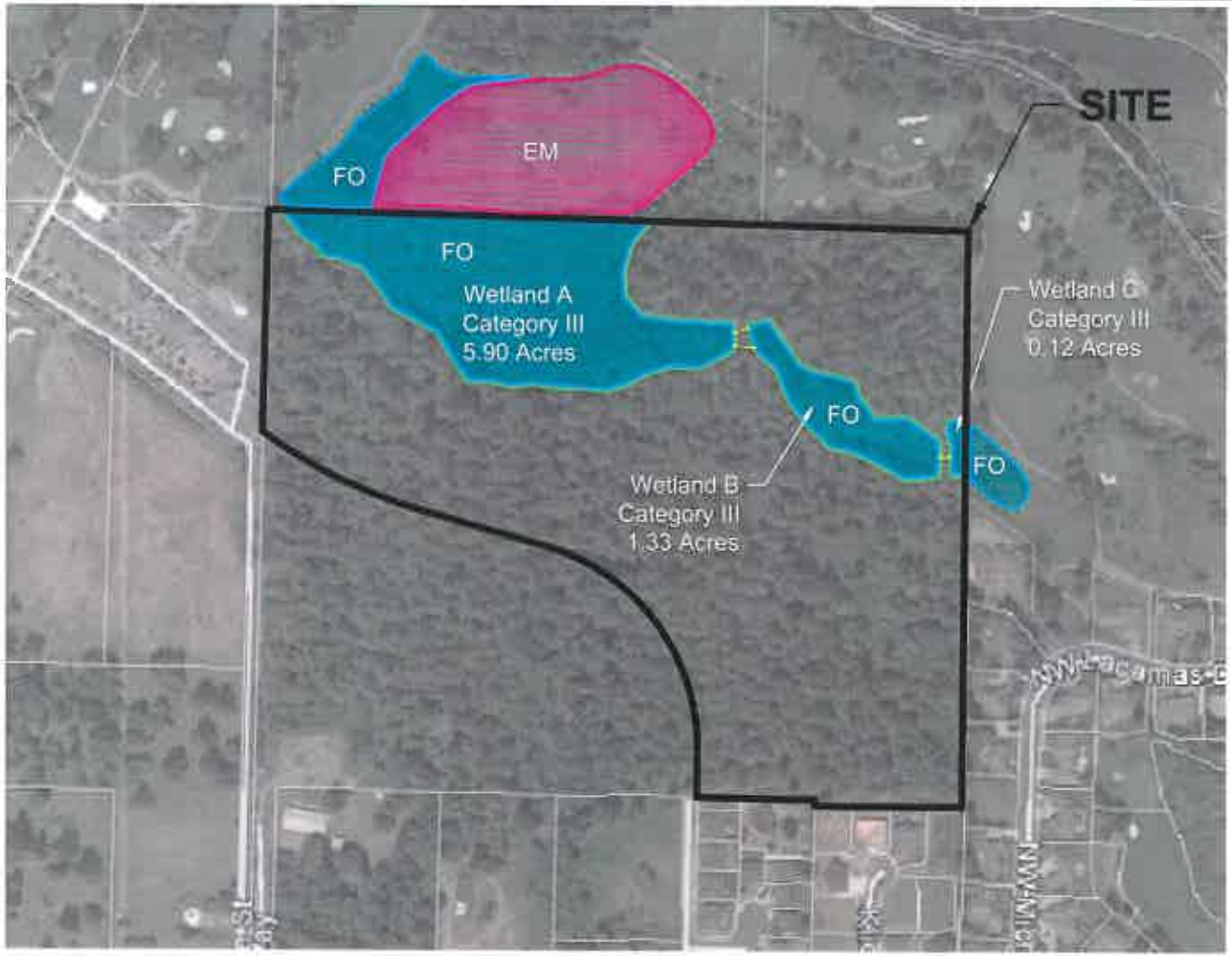
ECOLOGICAL LAND SERVICES, INC.
1157 3rd Ave., Suite 220
Longview, WA 98632
Phone: (360) 578-1371 Fax: (360) 414-9305

SCALE IN FEET
0 2000 4000

N W E S

8/12/2015 3:21 PM s:\ELS\WA\Clark\Camas\2255-parklands at camas llc\2255.01-chinook property\2255.01-figures\2255.01_GPS.dwg cpayne

8/12/2015 3:21 PM s:\ELS\WA\Clark\Camas\2255-parklands at camas llc\2255.01-chinook property\2255.01-figures\2255.01_GPS.dwg cpayne



LEGEND:

- Site Boundary
- Onsite portion of Wetland Unit
- Offsite portion of Wetland Unit
- Cowardin Classes

FO- Forested
EM- Emergent

D 1.3- Wetland has persistent, ungrazed plants >95% of area.
D 4.3- The area of the contributing basin is 10-100 times the area of the unit.
D 5.3- >25% of the contributing basin of the wetland is covered with intensive human land uses.
H 1.1- Emergent, scrub-shrub, forested and forested class has 3 out of 5, strata (moss-ground cover, herbaceous, shrubs, canopy).
H 1.4- Moderately interspersed.

NOTE(S):

1. Base map from ***Google Earth.***™

N W E S

0 400 800
SCALE IN FEET

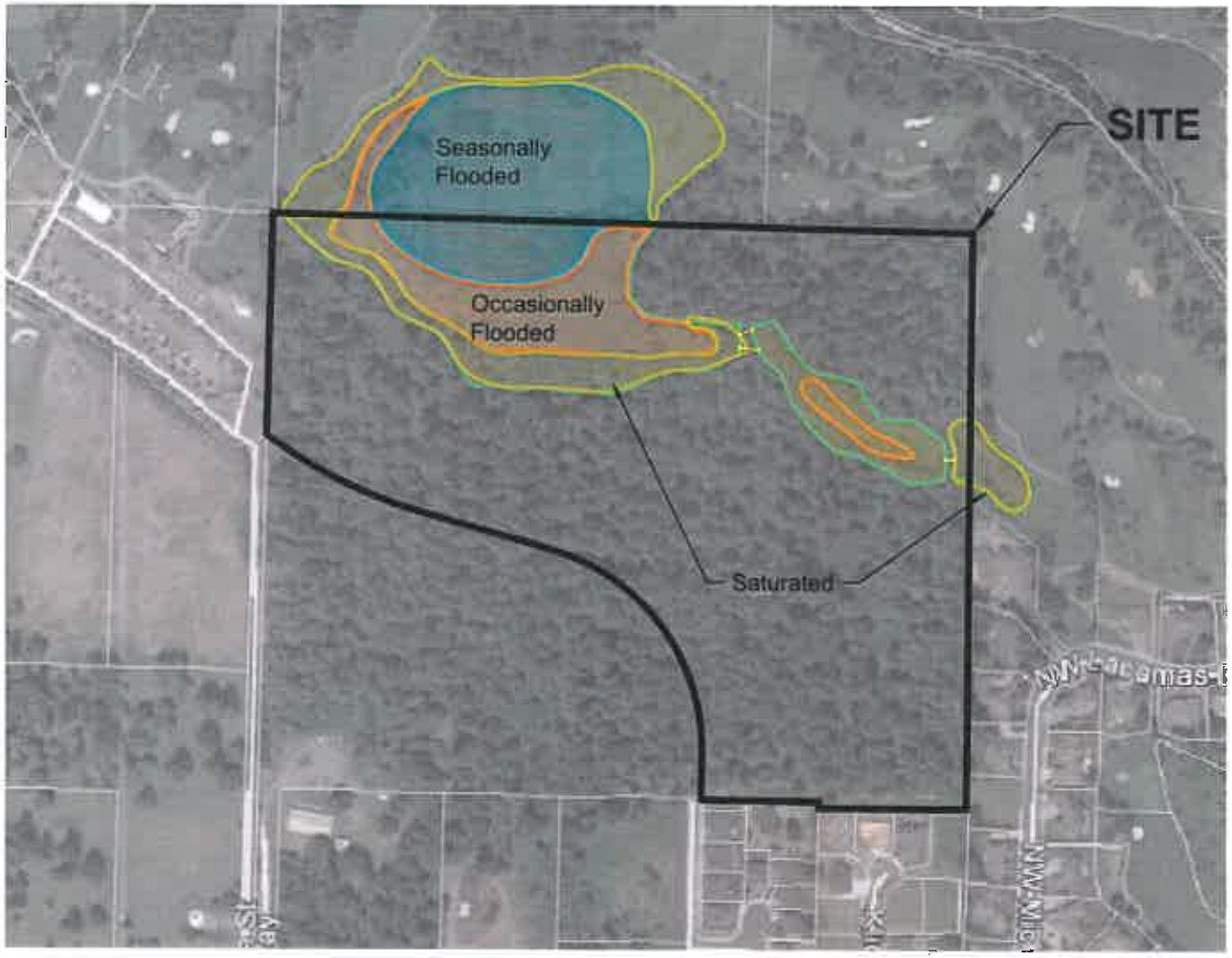
ECOLOGICAL LAND SERVICES, INC.
1157 3rd Ave., Suite 220
Longview, WA 98632
Phone: (360) 578-1371 Fax: (360) 414-9305

DATE: 8/12/15
DWN: CDP
REQ. BY: RA
PRJ. MGR: TH
CHK:
PROJECT NO: 2255.01

Figure 9
COWARDIN CLASSES MAP
Parklands at Camas Meadows
Parklands at Camas LLC.
Camas, Clark County, WA
Section 28, Township 2 N, Range 3 E, W.M.

Exhibit 16 SP26-1005

8/12/2015 3:21 PM s:\ELS\WA\Clark\Camas\2255-parklands at camas llc\2255.01-chinook property\2255.01-figures\2255.01_GPS.dwg cpayne



LEGEND:

- Site Boundary
- Wetland
- Saturated
- Occasionally Flooded
- Seasonally

D 1.1 Wetland has an unconstructed outlet.

D 1.4 Area seasonally ponded is >¼ of total wetland area.

H 1.2 Seasonally flooded or inundated occasionally flooded or inundated saturated only.

NOTE(S):

1. Base map from ***Google Earth***.™

N W E S

0 400 800

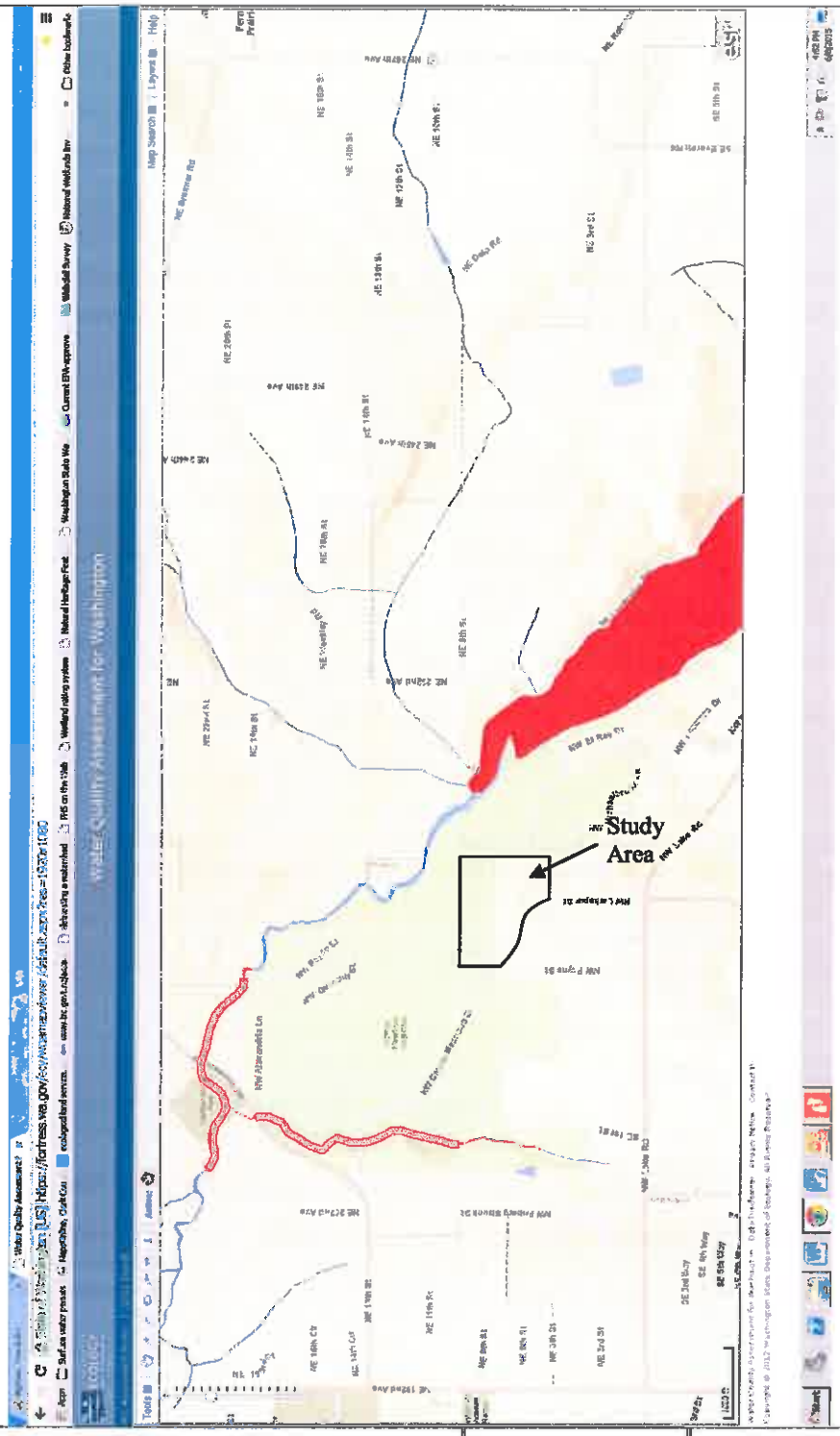
SCALE IN FEET

ECOLOGICAL LAND SERVICES, INC.
1157 3rd Ave., Suite 220
Longview, WA 98632
Phone: (360) 578-1371 Fax: (360) 414-9305

DATE: 8/12/15
DWN: CDP
REQ. BY: RA
PRJ. MGR: TH
CHK:
PROJECT NO: 2255.01

Figure 10
HYDROPERIODS MAP
Parklands at Camas Meadows
Parklands at Camas LLC.
Camas, Clark County, WA
Section 28, Township 2 N, Range 3 E, W.M.

Exhibit 16 SP26-1005

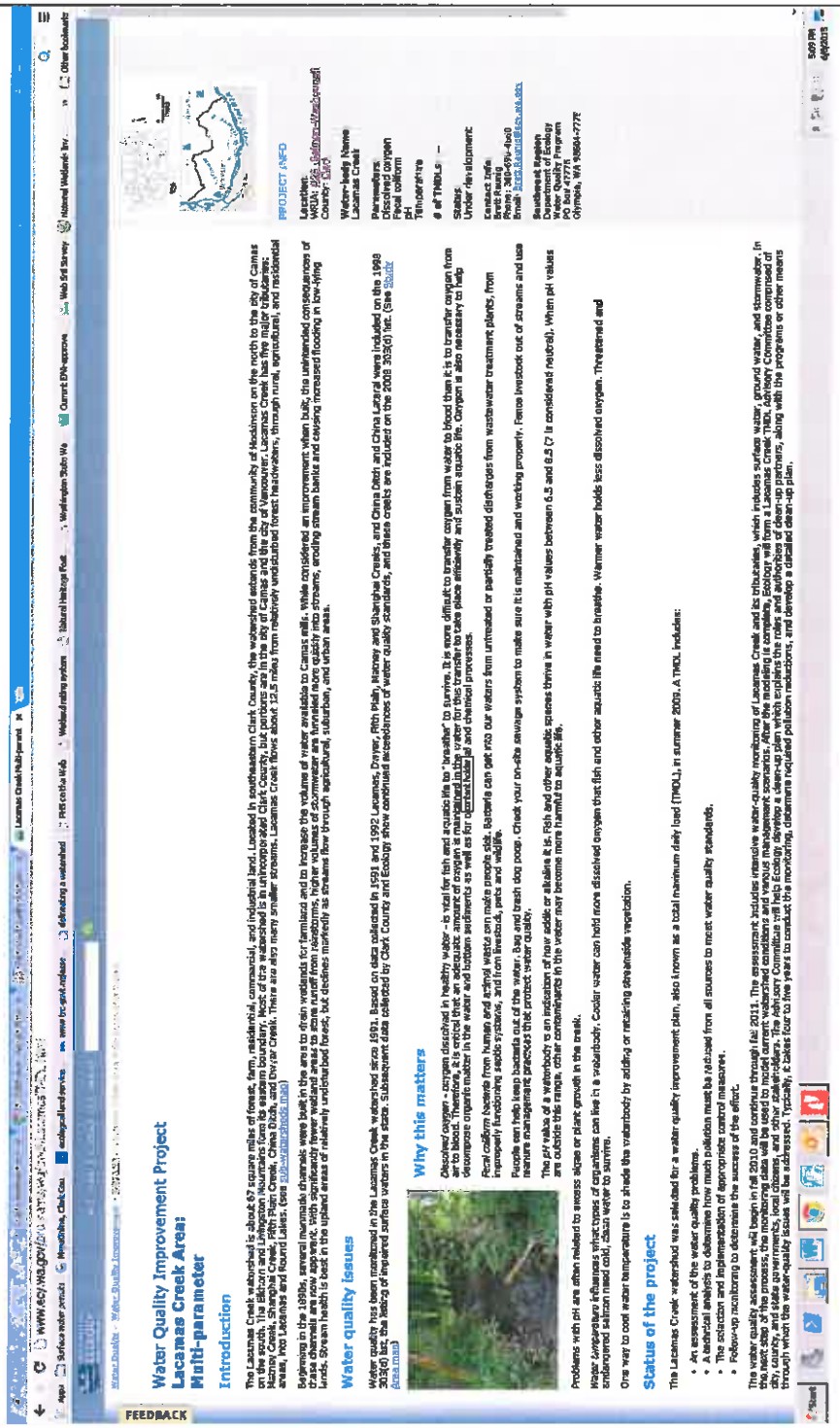


Ecological Land Services

1157 3rd Ave., Suite 220A
Longview, WA 98632
Phone: (360) 578-1371
Fax: (360) 414-9305

DATE: 6/9/15
DWN: LH
PRJ. MGR: TH
PROJ.#: 2255.01

Figure 11
303(d) Listed Waters in Basin



Ecological Land Services

1157 3rd Ave., Suite 220A
Longview, WA 98632
Phone: (360) 578-1371
Fax: (360) 414-9305

DATE: 6/9/15
DWN: LH
PRJ. MGR: TH
PROJ.#: 2255.01

Figure 12
TMDLs for WRIA in Unit

PHOTOPLATES 1 & 2



Photo 1: Southern border of Wetland A looking West.



Photo 2: TP6 in Wetland A.



Photo 3: Southern border of Wetland A looking East.

Ecological Land Services

1157 3rd Ave., Suite 220A
Longview, WA 98632
Phone: (360) 578-1371
Fax: (360) 414-9305

DATE: 6/9/15
DWN: LH
PRJ. MGR: TH
PROJ.#: 2255.01

Photoplate 1



Photo 4: Example of large ash tree in buffer.



Photo 5: Wetland B southern border looking northeast.



Photo 6: Photo of Himalayan blackberry in buffer.

Ecological Land Services

1157 3rd Ave., Suite 220A
Longview, WA 98632
Phone: (360) 578-1371
Fax: (360) 414-9305

DATE: 6/9/15
DWN: LH
PRJ. MGR: TH
PROJ.#: 2255.01

Photoplate 2

ECOLOGICAL LAND SERVICES, INC.

June 9, 2016

Phil Bourquin
Community Development Director
City of Camas
616 NE 4th Avenue
Camas, WA 98607

Re: Amendment #1 – Final Wetland Delineation Report for Parklands at Camas Meadows – Final Report December 2015.

Dear Mr. Bourquin,

Recent conversations with City staff and engineers working on the proposed Parklands at Camas Meadows project resulted in some concern about statements made in the final wetland delineation report for the project. After reviewing the wetland delineation report and taking comments from City staff and the project engineer into account, I believe the following amendments to the wetland delineation report are justified.

Storm Water Facilities in Wetland buffers

On page 6 of the wetland delineation report, the following bullet was listed:

> 2. Storm water from streets and traffic bearing surfaces will be collected, treated, and conveyed in facilities outside of the wetlands and the associated buffers. The wetlands and buffers will **NOT be used for storm water treatment or detention/retention facilities.**

The intent of this measure was to prohibit the construction of ponds, berms, or structures in the wetland buffer which result in land clearing, tree removal, and extensive grading. Using the wetland buffer to passively dispersive treated storm water should be allowed and will actually be beneficial to the wetland system. I recommend replacing the above bullet with the following:

> 2. ***Storm water from streets and traffic bearing surfaces will be collected and treated, - in facilities outside of the wetlands and the associated buffers. The current storm water design does not propose storm water treatment or detention in the wetlands or associated buffers. Site storm water may be conveyed across buffers via sheet flow or through existing conveyances to the wetlands as necessary.***

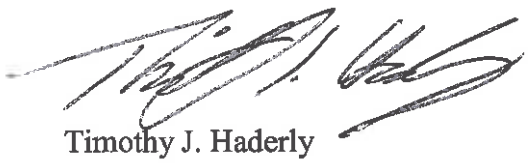
Trail in Wetland Buffer

Proposed site developments include the construction of a pedestrian trail through the wetland buffer areas. This trail is designed to provide passive recreational use of the area without having significant impacts to the functions and values of the wetland and associated buffer. That said, the

trail will be located within a sinuous corridor avoiding mature trees and other sensitive habitat features including snags, large stumps, nests, etc. The trail bed will be constructed using porous material including, but not limited to, wood chips, bark chips, porous gravel, porous pavers, and other materials that allow water to infiltrate while providing stable footing.

If you have any questions I can be contacted at (360) 578-1371 or timh@eco-land.com.

Sincerely,



Timothy J. Haderly
Senior Ecologist/Principal

APPENDIX H

H-1 Maintenance and Operations Manual

MAINTENANCE AND OPERATIONS MANUAL

PARKLANDS SUBDIVISION AND ARCHERY BUSINESS PARK

AUGUST 19, 2016

KESSI ENGINEERING
6400 NE Hwy 99 #G-169
Vancouver, WA 98665

TABLE OF CONTENTS

Only site specific elements have been selected
– the page references blow relate to the City of Camas Manual

Description	**Page**
Introduction	~~**5**~~ **now 3**
Background	
Purpose of the Manual	
Manual Layout	
Operation & Maintenance Procedures: Vegetated Facilities	~~**11**~~
~~Biofiltration Swales~~	
~~Filter Strips~~	
~~Detention Ponds/Facility~~	
~~Infiltration Facilities (Basins/Ponds/Trenches)~~	
~~Wet Biofiltration Ponds, Swales, and Treatment Wetlands~~	
~~Drainage Ditches~~	
Operation & Maintenance Procedures: Stormwater Structures	~~**27**~~ **now 5**
Catch Basins and Curb Inlets	
~~Debris Barriers/Trash Racks~~	
Energy Dissipaters	
Manholes	
~~Oil/Water Separators and Buried Wet Vaults~~	
~~Flow Control Structures/Flow Restrictors~~	
Storm Sewer/Drain Pipe	
~~Underground Detention Systems~~	
Operation and Maintenance Procedures: Special Facilities	~~**44**~~ **now 11**
~~Drywells~~	
~~StormFilter™ (Leaf Compost Filter)~~	
FloGard Perk Filter™ (using ZPC Filter Media) – new to document	
~~Infiltration System (work in progress)~~	
Operation & Maintenance Procedures: Miscellaneous Items	~~**52**~~
~~Fences, Gates, and Water Quality Signs~~	
Access Roads and Easements	
Pavement Sweeping	
Operation & Maintenance Procedures: Repair/Replacement Activities	~~**30**~~ **now 15**
Installation, Repair, and Replacement of Enclosed Drainage Systems	
Minor Culvert Repair (Not in a Stream)	
~~Major Culvert Repair (at a Stream Crossing)~~	

Operation & Maintenance Procedures: Vegetation Management ~~**68**~~ **now 17**
General Goals and Philosophy
General Procedures
~~Vegetation and Pest Management in Storm Sewer Facilities~~
~~Vegetation and Pest Management in Wetland Areas~~

~~**Appendix A**~~ ~~**76**~~
~~Example "Storm Sewer System Maintenance Notification"~~

Manual Layout
The manual breaks out the various storm sewer system components and the general maintenance activities required for said component. For each component or activity this manual will:

- Briefly describe the component type, e.g. facility or activity.
- List the water quality and non-water quality result of each facility or activity.
- List the *Best Management Practices (BMP's)* needed to meet the water quality and general maintenance requirements.

Additional information may be found in other manuals, such as the Washington Department of Ecology's *2005 Stormwater Management Manual for Western Washington, Vols. IV and V*, or site specific Operation and Maintenance (O&M) Manuals.

Maintenance is performed as a means to obtain specific results. The maintenance results, as listed below, are specified for each drainage feature or activity. They include maintaining performance and appearance of the facility, and the need to prevent maintenance work itself from becoming a pollutant source or damaging habitat.

Maintenance Results (R1-R10)
Water Quality Results:
R1 Avoid or minimize sediment and pollutant discharges from the work area.
R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
R3 Avoid or minimize vegetation removal.
R4 Preserve native vegetation.

Infrastructure Maintenance Results:
R5 Protect public safety and health.
R6 Prevent catastrophique infrastructure failures.
R7 Maintain and/or restore the intended infrastructure function.
R8 Prevent and/or reduce flooding.
R9 Protect infrastructure.
R10 Meet public expectations for aesthetics.

Storm sewer facility refers to specific drainage features, such as catch basins, pipes, ditches, ponds, biofiltration swales, and infiltration systems. Activities refer to maintenance tasks associated with operating and maintaining stormwater facilities such as vegetation management

and small repair projects. Depending on the extent of the maintenance, some property owners may be able to handle storm sewer maintenance themselves. Often, however, depending on the type of maintenance, the property owners will contract out the work. Landscapers are often employed to maintain vegetated facilities, such as swales and pond areas.

Heavier work, like cleaning catch basins, ditch inlets, outlet structures, or drywells often requires special equipment, such as trucks that can vacuum out sediment. When located within the city right-of-way, maintenance is typically the responsibility of the City. For those located on private property, a contractor would need to be contacted to perform this work. Check phone book listings, such as sewer and cleaning contractors, tank cleaning, and environmental and ecological services. Check with the contractor to ensure that all materials are disposed of according to solid waste and hazardous materials regulations. *Ultimately, the generator of the waste or hazardous material is responsible for proper disposal.*

Special Facilities:
Manufactured storm sewer facilities, such as leaf compost filters and oil/water separators often have maintenance requirements and manuals specified or written by the manufacturer. Also, larger or more complex storm sewer facilities may include specifications for maintenance and vegetation management that provide specific detail above and beyond this manual. Where the *Public Works Director* determines that these manuals or plans provide an equal or greater level of maintenance and water quality protection, then these procedures shall be followed by the owner. The Public Works Director must approve these individual maintenance plans, specifications, or manuals.

Catch Basins and Curb Inlets

Catch basins and curb inlets trap sediment and some oils that are washed off the road surface during a storm event. This sediment and the oils if not removed from the basins and inlets have the potential to pollute water bodies. They need to be inspected and cleaned at a minimum annually, more often if necessary; to remove accumulated sediment, fluids, and trash.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, facilities, and property from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function
- R8 Prevent or reduce flooding.
- R9 Protect infrastructure.

Procedures

Inspection

Inspect catch basins and curb inlets at least once per year, more often if necessary.

Periodically inspect the catch basin or curb inlets and surrounding areas for pollutants, such as leaks from dumpsters, minor spills, and oil dumping. Act to have the pollutant source removed. Ensure that grass clippings and leave debris is not being blown into the streets.

Cleaning

Clean catch basins and curb inlets when they become one third full in order to maintain sediment-trapping capacity. Catch basin, curb inlet, and manhole cleaning should be performed in a manner that keeps removed sediment and contaminated water from being discharged back into the storm sewer.

Clean putrid materials from the catch basins and curb inlets when discovered or reported.

Keep the inlet grates cleared of debris and litter.

Safety

Work inside underground structures (e.g. manholes) requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor for this work.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs

Repair any damages that prevent the catch basin or curb inlet from functioning as designed. An example is a broken or missing outlet elbow.

Follow the Procedures described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

Energy Dissipaters

Energy dissipaters are critical for preventing erosion at storm drain outfalls. There are a variety of designs, including wire gabion baskets, rock splash pads, trenches, and specially designed pools or manholes.

Maintenance Results

R1 Avoid or minimize sediment and pollutant discharges from the work area.
R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
R7 Maintain or restore the intended infrastructure function.
R8 Prevent or reduce flooding.
R9 Protect infrastructure.

Procedures

Inspection

Inspect at least once per year.

Cleaning

Remove any accumulated litter.
Dispersion trenches: remove sediment from pipe when it reaches 20 percent of the pipe diameter.

Repairs

Rock splash pads: replace missing or moved rocks to cover exposed soil and meet design standards.

Dispersion trenches: repair conditions that cause concentrated flow along the trench. Clean pipe perforations when one-half of them are plugged or if flows bypass or overflow the trench.

Manhole/Chamber: when the structure deteriorates to one-half its original size or it becomes structurally unsound, replace it to the design standards.

Follow the practice described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

Manholes

Manholes are large cylindrical vaults usually set at storm sewer pipe connections. Unless you have OSHA approved training and equipment, never enter a manhole. There is a considerable risk of poisonous gas and injury.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R8 Prevent or reduce flooding.
- R9 Protect infrastructure.

Procedures

Inspection

Inspect the manhole once per year. Check frame and lid for cracks and wear, such as rocking lids or lids move by traffic.

Periodically inspect the manhole and surrounding areas for pollutants such as leaks from dumpsters, minor spills, and oil dumping. Take action to have the pollutant source removed.

Cleaning

Clean manholes when there is a blockage of the stormwater channel. Cleaning should be performed in a way that ensures removed sediment and water is not discharged back into the storm sewer.

Safety

Never enter a confined space without proper training and safety gear. Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs
Repair all security and access features so they are fully functional. This includes locking lids, cover, and ladder rungs.

Replace broken parts or lids that rock or are moved by traffic.

Follow the practice described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

Storm Sewer/Drain Pipe

Storm sewer pipes convey stormwater. Storm pipes are constructed of many different types of materials and are sometimes perforated to allow groundwater to be collected by the storm system. Storm pipes are cleaned to remove sediment or blockages when problems are identified. Storm pipes must be clear of obstructions and breaks to prevent localized flooding.

Maintenance Results

- O1 Avoid or minimize sediment and pollutant discharges from the work area.
- O2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- O7 Maintain or restore the intended infrastructure function.
- O8 Prevent or reduce flooding.
- O9 Protect infrastructure.

Procedures

Inspection

Pipes are difficult to inspect requiring special equipment and training. Usually, if a problem occurs the owner needs to call a sewer of plumbing contractor to inspect, repair, or clean pipelines.

Cleaning

Clean pipes when sediment depth is greater than 20 percent of pipe diameter. When cleaning a pipe, minimize sediment and debris discharges from pipes to the storm sewer. Install downstream debris traps (where applicable) before cleaning and then remove material.

Generally, use mechanical methods to remove root obstructions from inside storm sewer pipes. Do not put root-dissolving chemicals in storm sewer pipes. If there is a problem, remove the vegetation over the line.

Safety

Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Sediment and debris from pipes should be disposed in the garbage as solid waste. Pick out any rocks first.

Repairs

Repair or replace pipes when a dent or break closes more than 20 percent of the pipe diameter.

Repair or replace pipes damaged by rust or deterioration.

Follow the practice described under the Activity: Installation, Repair, and Replacement of Enclosed Drainage Systems.

FloGard Perk Filter™ (using ZPC Filter Media)

Reference: June 2016 - GENERAL USE LEVEL DESIGNATION FOR BASIC AND PHOSPHORUS TREATMENT
For Kristar/Oldcastle Precast, Inc. FloGard Perk Filter™ (using ZPC Filter Media)

Maintenance: The required maintenance interval for stormwater treatment devices is often dependent upon the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured filter treatment device.

- Typically, Kristar/Oldcastle designs PerkFilter systems for a target filter media replacement interval of 12 months. Maintenance includes removing accumulated sediment from the vault, and replacing spent cartridges with recharged cartridges.

- Indications of the need for maintenance include effluent flow decreasing to below the design flow rate, as indicated by the scumline above the shoulder of the cartridge.

- Owners/operators must inspect PerkFilter for a minimum of twelve months from the start of post-construction operation to determine site-specific maintenance schedules and requirements. You must conduct inspections monthly during the wet season, and every other month during the dry season. (According to the SWMMWW, the wet season in western Washington is October 1 to April 30. According to SWMMEW, the wet season in eastern Washington is October 1 to June 30). After the first year of operation, owners/operators must conduct inspections based on the findings during the first year of inspections.

- Conduct inspections by qualified personnel, follow manufacturer's guidelines, and use methods capable of determining either a decrease in treated effluent flowrate and/or a decrease in pollutant removal ability. When inspections are performed, the following findings typically serve as maintenance triggers:
  - Accumulated vault sediment depths exceed an average of 2 inches, or
  - Accumulated sediment depths on the tops of the cartridges exceed an average of 0.5 inches, or
  - Standing water remains in the vault between rain events, or
  - Bypass occurs during storms smaller than the design storm.

- Note: If excessive floatables (trash and debris) are present, perform a minor maintenance consisting of gross solids removal, not cartridge replacement.

Maintenance Results

R1 Avoid or minimize sediment and pollutant discharges from the work area.
R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
R7 Maintain or restore the intended infrastructure function.
R9 Protect infrastructure.

Procedures

Inspection
Inspect the structure (see third bullet in above list). The inspection should determine sediment depth and the specific maintenance and repairs needed.

Inspect annually for cracks large enough to let soil enter the vault, broken or defective plates and baffles, and crushed or damaged pipes.

Periodically inspect the structure and surrounding areas for pollutants such as leaks from dumpsters, minor spills, and oil dumping. Take action to have the pollutant source removed.

Cleaning
Remove trash and litter from the vault, inlet, and piping.

Remove sediment when it accumulates to 2-inches in depth in the vault

Remove sediment when it accumulates on filter media.

Replace media cartridges per manufacture's recommendation.

Safety
Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.
Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs
Repair any cracked or defective plates or baffles. Cracks are repaired so that no cracks greater than ¼-inch are found.

Replace media cartridges if it takes longer than an hour for water to empty through media or if water frequently overflows the treatment chamber. Replace defective cartridges.

Repair all security and access features so they are fully functional. This includes locking lids, covers, and ladder rungs.

Follow the practice described under the Activity: Installation, Repair, and Replacement of Enclosed Drainage Systems.

Access Roads and Easements

Most stormwater facilities have access roads to bring in heavy equipment for facility maintenance. These roads should be maintained for inspection access and ease of equipment access.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

Inspect once a year or when facilities are maintained.

Cleaning

Remove litter when mowing or when there is any accumulation.

Remove any debris that blocks roads or may damage tires.

Vegetation Management

Manage vegetation as for the rest of the facility. Trees and shrubs may be removed from access roads and easements if they block access for necessary maintenance or will prevent or harm intended stormwater facility function. Use of pesticides is prohibited unless prior approval is received from the City.

Repairs

Correct any bare or eroded soils by seeding or a cover BMP.

Repair road surfaces when they may lead to erosion or limit equipment access.

Pavement Sweeping

Pavement sweeping is performed as a means of removing sand, dirt, and litter from streets and curb gutters. Sweeping also reduces dust during dry weather. Pavement sweeping is also part of storm sewer maintenance procedure because it limits the amount of sediment washed into the storm sewer facilities. The water quality procedure for street sweeping focuses on sediment removal and disposal. Reducing the amount of sediment washed into catch basins, curb inlets, detention facilities, drywells, and other facilities can save money because sweeping is generally cheaper that removing sediment from facilities. Sweeping also helps protect facilities from clogging with sediment.

Maintenance Results

- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R5 Protect public safety and health.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

Inspect on a weekly basis, depending on traffic volumes.

Cleaning

Sweep the site to help keep sediment from entering storm sewer systems and water bodies.

Sweeping is especially useful for cleaning up work areas.

Sweeping can be as easy as using a couple of push brooms or as involved as using mechanical methods.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Sweepings should be disposed of as solid waste or under a program permitted by the Southwest Washington Health District.

Installation, Repair, and Replacement of Enclosed Drainage Systems

This chapter includes tasks such as repair and replacement of pipe, catch basins, drywells, and manholes. It also includes drainage projects that add new pipes, catch basins, or infiltration structures. New drainage projects are subject to regulations under CMC 15.36 Erosion/Sediment Control Plans.

Maintenance Results

R1 Avoid or minimize sediment and pollutant discharges from the work area.
R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
R7 Maintain or restore the intended infrastructure function. R8 Prevent or reduce flooding.

Procedures

Cleaning

Avoid or minimize vegetation removal. If work is near a stream or wetland, there are regulatory requirements to must be met.

Prevent debris, oils, cleaning agents, and sediment from entering waterways.

Avoid or minimize work in wet weather. This will reduce the problems of containing sediment.

Carry spill control kit on-site to contain and clean up possible small spills in the work area, e.g. oil spills.

Protect our storm systems:

- Install sediment traps around curb inlets and catch basins, e.g. biobags or gravel filled pillows.
- Install catch basin inserts.
- Sweep or vacuum dust and debris from the repair job. Do not wash materials into storm sewers.
- Place stockpiles away from drainage ways, wetlands, and natural wetland and habitat buffers. Cover stockpiles or contain them with berms or other containment devices.
- At stream crossings, trap material using screens or another approved form of containment. Use containment BMP's to protect roadside ditches during wet weather.

Ensure that along with the approved erosion/sediment control measures that are in-place prior to construction, that there is an emergency sediment control kit for unexpected problems; e.g. trench dewatering. This should include:

- Sediment bag,
- Additional biobags and catch basin inserts,
- Push brooms and flat edge shovels.

Minor Culvert Repair (not in a natural stream)

This activity is for the replacement or repair of culverts and inlets. It applies only to structures that are in ditches that are specifically for storm drainage. These are ditches that do not carry water during dry weather. If there is any question about whether the ditch is a storm drain or a stream, consult with the Washington Department of Fish and Wildlife and the City of Camas Public Works Department.

Maintenance Results

R1 Avoid or minimize sediment and pollutant discharges from the work area. R3 Avoid or minimize vegetation removal.
R7 Maintain or restore the intended infrastructure function. R8 Prevent or reduce flooding.
R9 Protect infrastructure.

Procedures

Comply with erosion/sediment control requirements in CMC 15.32.

Avoid or minimize vegetation removal. If work is near a stream or wetland, there are likely to be regulatory requirements.

Other than to address a threat to public safety or property due to flooding, perform work during the dry season.

Minimize soil disturbance.

Use sediment controls to trap any sediment and prevent sediment from entering the storm sewer and water bodies. Sediment trapping BMP's are to be used to the extent practical during emergencies. An emergency sediment control kit is highly recommended.

Use cover BMP's to prevent erosion of bare soil. Vegetate bare soils.

Operation & Maintenance Procedures: Vegetation Management

General Goals and Philosophy

The City of Camas recognizes the special importance of the rivers, streams, wetlands, ponds, and stormwater control and treatment facilities. The sensitive nature of such habitat, their plant and animal communities, and their direct link with other waterways require that we establish specific policies to ensure their health. All landscape management decisions for controlling unwanted vegetation, diseases, and pests should follow Integrated Pest Management (IPM) principles and decision-making rationale. These are as follows:

- Proper planning and management decisions begin the IPM process.
- Cultural methods of vegetation and pest control are preferred and are first employed.
- Mechanical means of vegetation and pest control are next in line of preference, and are utilized where feasible.
- Biological methods of vegetation and pest control are considered before chemical means, where they are feasible.
- Botanical and synthetic pesticides are used only when no other feasible methods exist.

General Procedures

Use Only Appropriate Plants

The City of Camas has adopted a list of approved plants for use in development projects, and to assist homeowners in choosing appropriate plantings. The list also has prohibited undesirable plants. Only plants approved for use on the City of Camas Plant List are allowed for use within the City's right-of-way, storm sewer facilities, and wetland buffers.

Mulching

Mulches and other ground coverings are useful during the installation and restoration of landscapes as well as their ongoing maintenance. Mulches meet a variety of needs. They suppress weeds, help to retain moisture around plants, reduce possible erosion, and provide visual enhancement.

Always consider the possible impacts when using mulches, which may include:

- Inadvertent introduction of non-native plants and diseases to the site.
- Leaching of substances such as tannins from the mulch into nearby waterways.
- Migration of mulch material in waterways.
- Nutrient leaching into waterways.