EXHIBIT 54
SUB17-02

Stormwater Report

Narrative revisions

Sections A-H

Section A – Project Overview

1. **Describe the site location.**

   The proposed Dawson's Ridge development consists of a residential subdivision with 43 new single family lots and 6 existing single family lots. The project site is approximately 31.5 acres in size and located in Camas south of NW McIntosh Road and north of State Route 14. (SE corner of Section 8, Township 1 North, Range 3 East of the Willamette Meridian.) The 6 existing lots within the site are 3.9 acres in size. The site is bounded on the west by SE Brady Rd. and tax parcels 125609-000, 125615-000, 125666-000, and 125604-000. The site is also bounded on the north by NW McIntosh Road, on the east by tax parcel 986028-088, and on the south by State Route 14.

2. **Describe the topography, natural drainage patterns, vegetative ground cover, and presence of critical areas (CMC Title 16). Critical areas that receive runoff from the site shall be described to a minimum of ¼ mile away from the site boundary.**

   The existing site slopes generally from south to north with slopes ranging from 1% to 20%. There is an existing house, guest house, horse arena, horse stalls, and associated outbuildings located within the site. The site is vegetated primarily with meadow grasses and a few trees. Stormwater runoff from the site drains north and east to an existing stream located along the south side of NW McIntosh Road. The existing stream then flows to the west along McIntosh Road and eventually discharges to the Columbia River.

3. **Identify and discuss existing onsite stormwater systems and their functions**

   There are no known existing onsite stormwater systems other than roof drains located on the existing buildings. All roof drains are dispersed across existing vegetation within the site.

4. **Identify and discuss site parameters that influence stormwater system design.**

   According to the Geotechnical Engineering Reports completed by PBS Engineering & Environmental and GRI, the onsite soils are very fine grained and at, or close, to saturation (see Geotechnical Reports in Appendix H). Therefore, all stormwater modeling in WWHM assumed saturated soil conditions with Soil Group 4 characteristics. This is described in greater detail in Section C "Soils Evaluation" of this report.

5. **Describe drainage to and from adjacent properties.**

   There are no contributing stormwater flows to this site from offsite sources. Stormwater runoff from within the site drains generally north and east to an existing stream located along the south side of NW McIntosh Road.

6. **Describe adjacent areas, including streams, lakes, wetland areas, residential areas, and roads that might be affected by the construction project.**

   According to a Wetland Delineation and Assessment Report by The Resource Company, Inc. there are Category 3 and 4 wetlands located at the north end of the site along the existing stream. These wetlands are to remain undisturbed and will not be impacted by this development. Refer to the McIntosh Ridge Wetland Delineation and Assessment by The Resource Company, Inc. provided under separate cover.

7. **Generally describe proposed site construction, size of improvements, and proposed methods of mitigating stormwater runoff quantity and quality impacts.**

   Within the existing 31.48 acre Dawson's Ridge site, approximately 16.45 acres are to be disturbed for construction of the subdivision. This development will result in approximately 9.42 acres of new impervious surface (5.74 acres of new roof area, 2.06 acres of new paved street, 0.22 acres of new gravel access road, 0.69 acres of new driveway, and 0.71 acres of new sidewalk) and 7.03 acres of grass/landscape. These areas assume that all roofs are routed to the proposed storm facility and also account for the developed runoff from the six existing parcels to the south of the site. The existing equestrian facility located at the north end of the site is to be demolished in order to accommodate new lots.

   All stormwater from the proposed development is to be captured and routed to one of two stormwater facilities for treatment and detention prior to being released to the existing stream located along the north boundary of the site. The main Stormwater Facility "A" is located at the north end of the site and is to be comprised of a cartridge filter vault in order to meet treatment requirements and subsurface detention pipe to meet flow control requirments. Stormwater flows are to be released from the facility via a flow-control manhole and will be conveyed to an existing culvert located beneath the existing driveway located at the northwest end of the site. The second Stormwater Facility "B" is located at the north end of the site next to the entrance road to the subdivision. This stormwater facility is to be comprised of a cartridge filter manhole in order to meet treatment requirements and a subsurface detention pipe in order to meet flow control requirements. Stormwater treatment and detention design is to be in accordance with the City of Camas Stormwater Design Standards Manual and the 2014 Stormwater Management Manual for Western Washington.

Section B – Minimum Requirements

1. **Describe the land-disturbing activity and document the applicable minimum requirements for the project site. Include the following information in table form: a) amount of existing impervious surface, b) new impervious surface, c) replaced impervious surface, d) native vegetation converted to lawn or landscaping, e) native vegetation converted to pasture, and f) total amount of land-disturbing activity in table format.**

   The entire site lies within the same Threshold Discharge Area (TDA1) and ultimately discharges to the existing stream north of the development. For purposes of sizing the two stormwater treatment and detention facilities, the TDA has been divided into two separate catchment areas. The new onsite land-disturbing activity for this project is approximately 16.45 acres of the 31.48 acre site. The remaining 15.03 acres of the site are primarily comprised of existing grass and are to remain undisturbed. The site is vegetated primarily with meadow grasses and a few trees. According to a Wetland Delineation and Assessment Report by The Resource Company, Inc. there are Category 3 and 4 wetlands located at the north end of the site along the existing stream. These wetlands are to remain undisturbed and will not be impacted by this development.

   The proposed development includes the addition of 5.74 acres of new roof, 2.06 acres of new paved street, 0.22 acres of new gravel access road, 0.69 acres of new driveway, and 0.71 acre of new sidewalks that are all classified as "New Impervious Surface". The proposed development also includes 7.03 acres of new landscaping that is classified as "Native Vegetation Converted to Lawn or Landscaping". The remaining 15.03 acres is to remain as undisturbed grass pasture.

   Per Figure 1.1 from the City of Camas Stormwater Design Standards Manual, the development needs to apply the Minimum Requirements as outlined in Figure 1.2. This was determined because the project site will not discharge stormwater directly into a Municipal Separate Storm Sewer System owned and operated by the City of Camas and there will be more than 5,000 square feet of impervious surface. Per Figure 1.2, since the site has less than 35% of existing impervious surface and the development will add more than 5,000 square feet of new impervious surface, Minimum Requirements #1 through #9 will apply to the new impervious surfaces and the converted pervious surfaces.

   Refer to Fig. 1.1 and 1.2, included in Appendix C.

The following table summarizes the proposed site changes:

	TDA 1
Existing Impervious Surface (Acres)	2.633
New Impervious Surface (Acres)	9.423
Replaced Impervious Surface (Acres)	0.000
Existing Impervious Surface to Remain (Acres)	0.000
Native vegetation converted to lawn or landscaping (Acres)	7.029
Native vegetation converted to pasture (Acres)	0.000
Total land-disturbing activity (Acres)	16.452

Table B1: Site Improvement Summary

2. **Provide a statement that confirms the minimum requirements that will apply to the development activity. For land-disturbing activities where minimum requirements 1 through 10 must be met include the following: a) Provide the amount of effective impervious area in each TDA, and document through an approved continuous runoff simulation model the increase in the 100-year flood frequency from pre-developed to developed conditions for each TDA, b) list the TDAs that must meet the runoff control requirements listed in Minimum Requirement 6, c) list the TDAs that must meet the flow control requirements listed in Minimum Requirement 7, and d) list the TDAs that must meet the wetlands protection requirements listed in Minimum Requirement 8.**

   The 2.28 acres of new gravel and pavement road is classified as "Effective Pollution Generating Impervious Surface" (PGIS). The following table summarizes the additional characteristics that determine compliance with Minimum Requirements 6, 7, and 8:

	TDA 1
Effective Pollution Generating Impervious Surface (PGIS) (Acres)	2.28
Effective Pollution Generating Pervious Surface (PGPS) (Acres)	0.00
Does the Large Water Body Exemption apply to this project?	No
Does the 100-year runoff increase by more than 0.1 cfs?	Yes
Does the project discharge directly or indirectly (through a conveyance system) into a wetland?	Yes

Table B2: Additional Compliance Characteristics

As a result of these surface cover characteristics, the following Minimum Requirements are triggered for this project per the City of Camas Stormwater Design Standards Manual:

	TDA1
Minimum Requirement 2 (Construction Stormwater Pollution Prevention)	Yes
Minimum Requirements 1, 3, 4, and 5 (Stormwater Site Plans, Source Control, Preservation of Natural Drainage Systems & Outfalls, Onsite Stormwater Management)	Yes
Minimum Requirement 6 (Runoff Treatment)	Yes
Minimum Requirement 7 (Flow Control)	Yes
Minimum Requirement 8 (Wetlands Protection)	Yes

Table B3: Applicable Minimum Requirements

Section C – Soils Evaluation

1. **Describe the site's suitability for stormwater infiltration for flow control, runoff treatment, and low impact development (LID) measures.**

   A Geotechnical Engineering Report has been completed by PBS Engineering & Environmental dated September 29, 2015. In addition, a Geotechnical Investigation was also completed by GRI dated August 10, 2006 (see Appendix H). Portions of the site are located within an area identified by Clark County as "Areas of Potential Instability". A Licensed Engineering Geologist (LEG) from PBS completed a walking reconnaissance of the project area including mapping and photo-documentation of visible geologic features that can be indicators of landslides such as outcrops, scarps, cracks, springs, etc. PBS completed 25 test pits at the site (referred to as TP-1 through TP-25). Test pits were excavated to depths ranging from 4.5 feet to 12.5 feet below the existing ground surface (bgs). The test pits were logged and representative soil samples were collected by a PBS engineer. Groundwater was not encountered in any of the explorations except for a perched zone at 12.5 feet bgs in TP-4. Although groundwater was not present in any of the other test pits, the report noted that groundwater may fluctuate during periods of heavy and/or prolonged rainfall. Since the native soils in the area are known to be relatively saturated with low permeability, infiltration is not proposed for this development and all stormwater modeling in WWHM assumed saturated soil conditions with Soil Group 4 characteristics.

2. **Identify water table elevations, flow directions (where available), and data on seasonal water table fluctuations with minimum and maximum water table elevations where these may affect stormwater facilities.**

   Refer to the section above and the Geotechnical Investigation Reports by PBS Engineering & Environmental and GRI in Appendix H.

3. **Identify and describe soil parameters and design methods for use in hydrologic and hydraulic design of proposed facilities.**

   According to the Soil Survey of Clark County, the soil on-site is classified as:

   1. PoB, PoD, PoE – Powell silt loam.

   2. Permeability (from Table 7):

      Powell silt loam –

      0-23 inch depth 0.63-0.20 inches/hour

      23-63 inch depth 0.06-0.20 inches/hour

3. Soil hydrologic groups:

Powell silt loam –

Soil group C / SG3

Refer to the soils map in the Vicinity Maps section and Appendix A.

Curve Numbers:	Grass/Landscape:	CN=86
	Pavement/Sidewalk:	CN=98
	Roof:	CN=98

A detailed list of the runoff curve numbers used in conveyance design is included in Appendix B. The presence of clay soils and moist/wet soils indicates the soils onsite will likely accept little runoff and would be expected to behave more as a Hydrologic Soil Group 4 soil rather than Soil Group 3. As a result, onsite soils have been modeled as a Hydrologic Soil Group 4 for purposes of the stormwater calculations.

Conveyance design for the development is to be completed at time of final design. Runoff for conveyance design is to be estimated using the Santa Barbara Urban Hydrograph (SBUH) methodology. The following design storms are to be used in the hydrologic analysis:

2-year, 24-hour storm	2.7 inches of rainfall
10-year, 24-hour storm	3.6 inches of rainfall
100-year, 24-hour storm	4.8 inches of rainfall

An isopluvial maps for the 10-year and 100-year storms are included in Appendix B.

4. Report findings of testing and analysis used to determine the infiltration rate.

Due to the high moist/wet soils, infiltration is not being proposed for this development.

5. Where unstable or complex soil conditions exist that may significantly affect the design of stormwater facilities, the responsible official may require a preliminary soils report that addresses stormwater design considerations arising from soil conditions. The preliminary soils report shall be prepared by a registered professional engineer proficient in geotechnical investigation and engineering or a registered soil scientist. The preliminary soils report shall include a soils map developed using the criteria set in the *NRCS National Soil Survey Handbook* (NRCS 2007) and the *SCS Soil Survey Manual* (SCS 1993), at a minimum scale of 1:5,000 (12.7 inch/mile).

A Geotechnical Engineering Report has been completed by PBS Engineering & Environmental dated September 29, 2015. In addition, a Geotechnical Investigation was also completed by GRI dated August 10, 2006 (see Appendix H). Portions of the site are located within an area identified by Clark County as "Areas of Potential Instability". A Licensed Engineering Geologist (LEG) from PBS completed a walking reconnaissance

of the project area including mapping and photo-documentation of visible geologic features that can be indicators of landslides such as outcrops, scarps, cracks, springs, etc. A geotechnical setback line has been determined and all proposed structures, utilities, and stormwater facilities have been located outside of this area. Refer to the Geotechnical Engineering Report for additional information on potential for slope instability.

Section D – Source Control

1. **If the development activity includes any of the activities listed in Section 2.2 of Volume IV of the *Stormwater Management Manual for Western Washington* (SMMWW), identify the source control BMPs to be used with the land-disturbing activity.**

The following Source Control BMPs apply to this project:

- BMPs for Landscaping and Lawn/Vegetation Management
  - Install engineered soil/landscape systems to improve the infiltration and regulation of stormwater in landscaped areas.
  - Do not dispose of collected vegetation into waterways or storm drainage systems.

- BMPs for Maintenance of Stormwater Drainage and Treatment Systems
  - Inspect and clean dispersion trench, conveyance system, and catch basins as needed, and determine whether improvements in O & M are needed.
  - Promptly repair any deterioration threatening the structural integrity of the facilities. These include replacement of clean-out gates, catch basin lids, and rock in dispersion trench.
  - Ensure that storm sewer capacities are not exceeded and that heavy sediment discharges to the sewer system are prevented.
  - Regularly remove debris and sludge from BMPs used for peak-rate control, treatment, etc. and discharge to sanitary sewer if approved by the sewer authority, or truck to a local or state government approved disposal site.
  - Clean catch basins when the depth of deposits reaches 60 percent of the sump depth as measured from the bottom of basin to invert of lowest pipe into or out of the basin. However, in no case should there be less than six inches clearance from the debris surface to the invert of the lowest pipe.
  - Clean woody debris in catch basins as frequently as needed to ensure proper operation of the catch basin.
  - Post warning signs; "Dump No Waste – Drains to Ground Water," "Streams," "Lakes," or emboss on or adjacent to all storm drain inlets where practical.
  - Disposal of sediments and liquids must comply with "Recommendations for Management of Street Wastes" described in Appendix IV-G of Volume IV of the Stormwater Manual.

- BMPs for Urban Streets
  - For maximum Stormwater pollutant reductions on curbed streets and high volume parking lots use efficient vacuum sweepers.
  - For moderate stormwater pollutant reductions on curbed streets use regenerative air sweepers or tandem sweeping operations.
  - For minimal stormwater pollutant reductions on curbed streets use mechanical sweepers.
  - Conduct sweeping at optimal frequencies. Optimal frequencies are those scheduled sweeping intervals that produce the most cost-effective annual reduction of pollutants normally found in stormwater and can vary depending on land use, traffic volume and rainfall patterns.

- Disposal of street sweeping solids must comply with "Recommendations for Management of Street Wastes" described in Appendix IV-G of Volume IV of the Stormwater Manual.
- Inform citizens about eliminating yard debris, oil and other wastes in street gutters to reduce street pollutant sources.

Additional recommended BMPs can be found in Section 2.2 of Volume IV of the Stormwater Manual.

Section E – Onsite Stormwater Management BMPs

1. **On the preliminary development plan or other maps, show the site areas where on-site stormwater management BMPs will be effectively implemented. The plan must show the areas of retained native vegetation and required flow lengths and vegetated flow paths, as required for proper implementation of each onsite stormwater BMP. Arrows must show the stormwater flow path to each BMP.**

   All stormwater from the proposed development is to be captured and routed to one of two stormwater facilities for treatment and detention prior to being released to the existing stream located along the north boundary of the site. The main Stormwater Facility "A" is located at the north end of the site and is to be comprised of a cartridge filter vault in order to meet treatment requirements and subsurface detention pipe to meet flow control requirments. Stormwater flows are to be released from the facility via a flow-control manhole and will be conveyed to an existing culvert located beneath the existing driveway located at the northwest end of the site. The second Stormwater Facility "B" is located at the north end of the site next to the entrance road to the subdivision. This stormwater facility is to be comprised of a cartridge filter manhole in order to meet treatment requirements and a subsurface detention pipe in order to meet flow control requirements. (Refer to Preliminary Development Plan in Appendix G for stormwater facility locations).

2. **Identify and describe geotechnical studies or other information used to complete the analysis and design of each on-site stormwater BMP.**

   A Geotechnical Engineering Report has been completed by PBS Engineering & Environmental dated September 29, 2015. In addition, a Geotechnical Investigation was also completed by GRI dated August 10, 2006 (see Appendix H). Portions of the site are located within an area identified by Clark County as "Areas of Potential Instability". A Licensed Engineering Geologist (LEG) from PBS completed a walking reconnaissance of the project area including mapping and photo-documentation of visible geologic features that can be indicators of landslides such as outcrops, scarps, cracks, springs, etc. PBS completed 25 test pits at the site (referred to as TP-1 through TP-25). Test pits were excavated to depths ranging from 4.5 feet to 12.5 feet below the existing ground surface (bgs). The test pits were logged and representative soil samples were collected by a PBS engineer. Groundwater was not encountered in any of the explorations except for a perched zone at 12.5 feet bgs in TP-4. Although groundwater was not present in any of the other test pits, the report noted that groundwater may fluctuate during periods of heavy and/or prolonged rainfall. Since the native soils in the area are known to be relatively saturated with low permeability, infiltration is not proposed for this development and all stormwater modeling in WWHM assumed saturated soil conditions with Soil Group 4 characteristics. Stormwater facilities have been located outside of Geotechnical Setback Areas.

3. **Identify the criteria (and their source) used to complete analyses for each on-site stormwater BMP.**

   The facilities have been designed to provide treatment for the water quality storm (91% of the 24-hour continuous runoff volume) in accordance with City of Camas Stormwater

Design Standards Manual Section 5.03 and Volume V of the Stormwater Management Manual for Western Washington (SMMWW) and detention for the continuous storm in accordance with the requirements of the City of Camas Stormwater Design Standards Manual Section 4.02 and Volume III of the SMMWW. WWHM2012 has been used for the continuous simulation model for this development.

4. **Describe how design criteria will be met for each proposed on-site stormwater management BMP.**

   Each stormwater facility will utilize cartridge filter systems for stormwater treatment. Stormwater Facility "A" at the north end of the site will include an 8'X24' StormFilter Vault with 63 ea. 27" filter cartridges. Stormwater Facility "B" near the site entrance will include a 60" StormFilter Manhole with 4 ea. 27" filter cartridges. The cartridge filter systems were designed according to the guidelines set forth by the City of Camas Stormwater Design Standards Manual and Volume V of the Stormwater Management Manual for Western Washington (SMMWW).

   Each stormwater facility will utilize underground detention pipe with a flow control structure for stormwater detention. Stormwater Facility "A" at the north end of the site will include 1,780 LF of 72" dia. CMP. Stormwater Facility "B" near the site entrance will include 52 LF of 72" dia. CMP. The detention facilities were designed according to the guidelines set forth by the City of Camas Stormwater Design Standards Manual and Volume III, Section 3.2 of the SMMWW. Flow control structures with an orifice and weir will be utilized in order to control stormwater flows from the facilities. (Refer to Appendix G for Stormwater Facility Plans and Details).

5. **Describe any on-site application of LID measures planned for the project. Provide a plan that shows the proposed location and approximate size of each LID facility.**

   Due to the soil characteristics and conditions, infiltration LID measures are not applicable to this project.

6. **Identify and describe any assumptions used to complete the analysis.**

   Groundwater elevation was assumed to be below the detention volume for purposes of designing the stormwater detention facilities. The detention volume was assumed to be dry at the beginning of the modeled storm event.

7. **Describe site suitability, including hydrologic soil groups, slopes, areas of native vegetation, and adequate location of each BMP.**

   The Soil Survey of Clark County by the Soil Conservation Service shows the soil onsite is primarily Powell Silt Loam (PoB, PoD, and PoE). According to the Geotechnical Engineering Reports by P.B.S. Engineering and Environmental and GRI. (See Appendix H), onsite soils are moist with low permeability. As a result, infiltration is not proposed and onsite soils have been modeled as a Hydrologic Soil Group 4 for purposes of the stormwater calculations. The proposed stormwater facilities have been located within the relative low areas of the site in order to provide for the most efficient drainage for the developed site. Each facility is also located outside of the geotechnical setback areas and will discharge stormwater runoff to the existing stream at the north end of the site.

Section F – Runoff Treatment Analysis and Design

1. **Document the level of treatment required (basic, enhanced, phosphorus, oil/water separation) based on procedures in Vol. V, Chapter 2 of the SMMWW.**

   According to the procedures outlined in Vol. V, Ch. 2 of the Stormwater Manual, the project requires a basic level of treatment. (See Treatment Facility Selection Flow Chart in Appendix C).

2. **Provide background and description to support the selection of the treatment BMP being proposed. Include an analysis of initial implementation costs and long-term maitenance costs.**

   Due to site topography and the low permeability of the soil, it was determined that cartridge filter systems would be used as the treatment BMP for the project. A cost analysis has not been prepared, but could be provided if deemed to be necessary.

3. **Identify geotechnical or soils studies or other information used to complete the analysis and design.**

   A Geotechnical Engineering Report has been completed by PBS Engineering & Environmental dated September 29, 2015. In addition, a Geotechnical Investigation was also completed by GRI dated August 10, 2006 (see Appendix H). Portions of the site are located within an area identified by Clark County as "Areas of Potential Instability". A Licensed Engineering Geologist (LEG) from PBS completed a walking reconnaissance of the project area including mapping and photo-documentation of visible geologic features that can be indicators of landslides such as outcrops, scarps, cracks, springs, etc. PBS completed 25 test pits at the site (referred to as TP-1 through TP-25). Test pits were excavated to depths ranging from 4.5 feet to 12.5 feet below the existing ground surface (bgs). The test pits were logged and representative soil samples were collected by a PBS engineer. Groundwater was not encountered in any of the explorations except for a perched zone at 12.5 feet bgs in TP-4. Although groundwater was not present in any of the other test pits, the report noted that groundwater may fluctuate during periods of heavy and/or prolonged rainfall. Since the native soils in the area are known to be relatively saturated with low permeability, infiltration is not proposed for this development and all stormwater modeling in WWHM assumed saturated soil conditions with Soil Group 4 characteristics. Stormwater facilities have been located outside of Geotechnical Setback Areas.

4. **Identify the BMPs used in the design, and their sources.**

   Each stormwater facility will utilize cartridge filter systems for stormwater treatment. Stormwater Facility "A" at the north end of the site will include an 8'X24' StormFilter Vault with 63 ea. 27" filter cartridges. Stormwater Facility "B" near the site entrance will include a 60" StormFilter Manhole with 4 ea. 27" filter cartridges. The cartridge filter systems were sized to capture and treat 91% of the total runoff volume predicted by WWHM as required by the City's stormwater ordinance and Volume V of SMMWW (Refer to Appendix G for Stormwater Facility Plans and Details).

5. Summarize the results of the runoff treatment design, and describe how the proposed design meets the requirements of CMC Chapter 14.02 and the Stormwater Manual.

Each stormwater facility will utilize cartridge filter systems for stormwater treatment. Stormwater Facility "A" at the north end of the site will include an 8'X24' StormFilter Vault with 63 ea. 27" filter cartridges. Stormwater Facility "B" near the site entrance will include a 60" StormFilter Manhole with 4 ea. 27" filter cartridges. The cartridge filter systems have been designed to provide treatment for the water quality storm (91% of the 24-hour continuous runoff volume) in accordance with City of Camas Stormwater Design Standards Manual Section 5.03 and Volume V of the SMMWW. The water quality storm was modeled using Western Washington Hydrology Model (WWHM2012). The number of 27" filter cartridges required for the cartridge filter systems was determined using Stormwater Management specifications and the following equation:

For StormFilter cartridges with an 27" effective cartridge height:

$$\text{Number of Cartridges} = \frac{\text{Q cfs}}{\text{0.025cfs/cartridge}}$$

The following table summarizes the flow that will be treated by the cartridge filter catch system for the water quality design storm. It also indicates the size and number of cartridge filters that are required to treat the flow along with the applicable StormFilter model:

Storm Sewer Facility	Catchment No.	Flow to StormFilters (CFS)	Effective Cartridge Height (IN)	No. Cartridges (EA)	Stormfilter Model Required
A	1S	1.5624	27"	63	(1ea) 8'x24' StormFilter Vault w/ 63ea filter cartridges
B	2S	0.0821	27"	4	(1ea) StormFilter Catch Basins w/ 4ea filter cartridges

Table F1: StormFilter Treatment Facility Sizing

Maintenance for the StormFilter catch basin will be performed by the property owner. See Appendix I for a maintenance schedule from the manufacturer.

6. **Provide a table that lists the amount of Pollution-Generating Pervious Surfaces (PGPS) and Pollution-Generating Impervious Surfaces (PGIS) for each Threshold Discharge Area (TDA).**

The following table lists the areas of Pollution-Generating Pervious Surfaces (PGPS) and Pollution-Generating Impervious Surfaces (PGIS) for each Threshold Discharge Area (TDA):

	TDA 1
Effective Pollution Generating Impervious Surface (PGIS) (Acres)	2.28
Effective Pollution Generating Pervious Surface (PGPS) (Acres)	0.00

Table F2: Effective Pollution Generating Surface Summary

Section G – Flow Control Analysis and Design

1. **Identify the site's suitability for stormwater infiltration for flow control, including tested infiltration rates, logs of soil borings, and other information.**

   A Geotechnical Engineering Report has been completed by PBS Engineering & Environmental dated September 29, 2015. In addition, a Geotechnical Investigation was also completed by GRI dated August 10, 2006 (see Appendix H). Test pits were excavated to depths ranging from 4.5 feet to 12.5 feet below the existing ground surface (bgs). The test pits were logged and representative soil samples were collected by a PBS engineer. Groundwater was not encountered in any of the explorations except for a perched zone at 12.5 feet bgs in TP-4. Although groundwater was not present in any of the other test pits, the report noted that groundwater may fluctuate during periods of heavy and/or prolonged rainfall. Since the native soils in the area are known to be relatively saturated with low permeability, infiltration is not proposed for this development and all stormwater modeling in WWHM assumed saturated soil conditions with Soil Group 4 characteristics. Stormwater facilities have been located outside of Geotechnical Setback Areas.

2. **Identify and describe geotechnical or other studies used to complete the analysis and design.**

   A Geotechnical Engineering Report has been completed by PBS Engineering & Environmental dated September 29, 2015. In addition, a Geotechnical Investigation was also completed by GRI dated August 10, 2006 (see Appendix H). Refer to the section above for further details.

3. **If infiltration cannot be utilized for flow control, provide the following additional information:**

   a. **Identify areas where flow control credits can be obtained for dispersion, LID, or other measures, per the requirements in the Stormwater Manual.**

   Since the native soils in the area are known to be relatively saturated with low permeability, infiltration LID measures are not applicable to this project.

   b. **Provide the approximate sizing and location of flow control facilities for each TDA, per Volume III of the Stormwater Manual.**

   Each stormwater facility will utilize underground detention pipe with a flow control structure for stormwater detention. Stormwater Facility "A" at the north end of the site will include 1,780 LF of 72" dia. CMP. Stormwater Facility "B" near the site entrance will include 52 LF of 72" dia. CMP. The detention facilities were designed according to the guidelines set forth by the City of Camas Stormwater Design Standards Manual and Volume III, Section 3.2 of the SMMWW. Flow control structures with an orifice and weir will be utilized in order to control stormwater flows from the facilities. (Refer to Appendix G for Stormwater Facility Plans and Details).

c. Identify the criteria (and their sources) used to complete the analysis, including pre-developed and post-developed land use characteristics.

The detention facilities have been designed to provide detention for the continuous storm in accordance with the requirements of the City of Camas Stormwater Design Standards Manual Section 4.02 and Volume III of the SMMWW. WWHM2012 has been used for the continuous simulation model for this development. P.B.S. Engineering and Environmental has completed a Geotechnical Investigation Report for the development (See Appendix H). Since the native soils in the area are known to be relatively saturated with low permeability, infiltration is not proposed for this development and all stormwater modeling in WWHM assumed saturated soil conditions with Soil Group 4 characteristics.

The pre-developed TDA 1 includes Basins 1P and 2P and the developed (mitigated) TDA 1 includes Basins 1D and 2D. (see Catchment Plans in Appendix K for locations). Basins 1P and 1D were used for Stormwater Facility "A" at the north end of the site. Basins 2P and 2D were used for Stormwater Facility "B" located at near the site entrance. All of the stormwater facilities discharge to the existing stream north of the development. A summary of the pre-developed and developed catchment data are shown in the tables below:

Pre-developed catchment areas:

Subbasin	Description	Area (acres)
Basin 1P	SG4, Forest, Mod.	16.067
Basin 2P	SG4, Forest, Mod.	0.385

Table G1: Hydrologic parameters used in pre-developed catchment analysis

Developed catchment areas:

Subbasin	Description	Area (acres)
Basin 1D	Roads, Mod.	2.036
	Roof Tops, Flat	5.739
	Driveways, Mod.	0.689
	Sidewalks, Mod.	0.644
	SG4, Lawn, Mod.	6.959
Basin 2D	Roads, Mod.	0.247
	Sidewalks, Mod.	0.068
	SG4, Lawn, Mod.	0.070

Table G2: Hydrologic parameters used in developed catchment analysis

A summary of the pre-developed and developed TDA 1 land use areas are shown in the tables below:

Pre-developed TDA 1:

Land Use	Description	Area (ac)
Pervious	SG4, Forest, Mod.	16.452
Impervious	N/A	0.000

Table G3: Land use areas for pre-developed TDA 1

Developed TDA 1:

Land Use	Description	Area (ac)
Pervious	SG4, Lawn, Mod.	7.029
Impervious	Roads, Mod.	2.283
	Roof Tops, Mod.	5.739
	Driveways, Mod.	0.689
	Sidewalks, Mod.	0.712

Table G4: Land use areas for developed TDA 1

4. **For sites considered to be historical prairie, submit a project site report prepared by a wetland scientist or horticulturist experienced in identifying soils, plans, and other evidence associated with historic prairies to demonstrate the existence of historic prairie on the project site. Areas within Camas that were historically prairie include Fern and Lacamas prairies. Contact City staff for a map showing potential prairie locations.**

   This section does not apply.

5. **Complete a hydrologic analysis for existing and developed site conditions, in accordance with the requirements of Chapter 4 of this manual and Chapter 2, Volume III of the Stormwater Manual, using an approved continuous runoff simulation model. Compute existing and developed flow duration for all subbasins. Provide an output table from the continuous flow model.**

   The detention portion of this facility has been designed in accordance with the guidelines set forth in Section 4.02 of the City of Camas Stormwater Design Standards Manual and Volume III, Section 3.2 of the SMMWW. The detention volume design for each of the facilities is detailed as follows:

   Stormwater Facility "A":
   This detention facility is located at the north end of the site and will include 1,780 LF of 72" dia. CMP. The resulting total detention volume is approximately 50,328 CF. Refer to the Stormwater Facility Plans and Details in Appendix G.

A summary of the pre-developed and developed flows for the detention system from the WWHM2012 calculations is shown in the table below:

Return Period	Pre-developed Flow (cfs)	Developed Flow (cfs)
2-Year	4.52	2.63
10-Year	8.28	4.85
50-Year	10.41	7.65
100-Year	11.06	9.13

Table G5: Pre-developed and developed flows for detention facility.

A summary of the developed flows and stormwater facility storage volumes and stage elevations for the detention facility from the WWHM2012 calculations is shown in the table below:

Return Period	Developed Flow (cfs)	Detention Volume (ac-ft)	Detention Stage Elevation (ft)
2-Year	2.63	0.76	3.73
10-Year	4.85	0.98	4.73
50-Year	7.65	1.06	5.13
100-Year	9.13	1.07	5.27

Table G6: Developed flows and stormwater facility storage volumes / stage elevations for detention facility

From the tables above, it can be seen that the proposed design meets the flow-control requirements, as specified in the City of Camas Stormwater Design Standards Manual Section 4.02 and Volume III of the SMMWW. It can also be seen that the proposed detention volume is sufficient to detain the stormwater from the developed catchment area.

Stormwater Facility "B":

This detention facility is located near the site entrance and will include 52 LF of 72" dia. CMP. The resulting total detention volume is approximately 1,470 CF. Refer to the Stormwater Facility Plans and Details in Appendix G.

A summary of the pre-developed and developed flows for the detention system from the WWHM2012 calculations is shown in the table below:

Return Period	Pre-developed Flow (cfs)	Developed Flow (cfs)
2-Year	0.11	0.07
10-Year	0.20	0.13
50-Year	0.25	0.21
100-Year	0.26	0.25

Table G7: Pre-developed and developed flows for detention facility.

A summary of the developed flows and stormwater facility storage volumes and stage elevations for the detention facility from the WWHM2012 calculations is shown in the table below:

Return Period	Developed Flow (cfs)	Detention Volume (ac-ft)	Detention Stage Elevation (ft)
2-Year	0.07	0.02	3.73
10-Year	0.13	0.03	4.73
50-Year	0.21	0.03	5.00
100-Year	0.25	0.08	5.00

Table G8: Developed flows and stormwater facility storage volumes / stage elevations for detention facility

From the tables above, it can be seen that the proposed design meets the flow-control requirements, as specified in the City of Camas Stormwater Design Standards Manual Section 4.02 and Volume III of the SMMWW. It can also be seen that the proposed detention volume is sufficient to detain the stormwater from the developed catchment area.

Refer to the stormwater facility plans and details in Appendix G.

6. Include and reference all hydrologic computations, equations, graphs, and any other aids necessary to clearly show the methodology and results.

Refer to Appendix E for a detailed WWHM2012 hydraulic analysis of the pre-developed and developed site during the 2-, 10-, 50-, and 100-yr. continuous storm events.

7. Include all maps, exhibits, graphics, and references used to determine existing and developed site hydrology.

Refer to the Catchment Plans in Appendix K for catchment area locations and the specific locations of the stormwater facilities.

Refer to the Maps section of this report.

Section H – Wetlands Protection

Refer to the McIntosh Ridge Wetland Delineation and Assessment prepared by The Resource Company, Inc. submitted under separate cover.