CONCEPTUAL DRAINAGE REPORT

For

CRYSTAL RIDGE SOUTH
2500 W 17TH AVENUE
PARCEL # 25252.0032

CITY OF SPOKANE, WASHINGTON

Prepared for:

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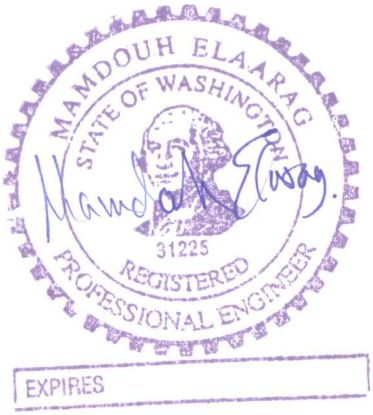
August 7, 2021

Conceptual Drainage Report
Crystal Ridge South
Parcel # 25252.0032
City of Spokane, WA.

The data, calculations, text and graphic information contained in this document were compiled and published under the supervision and direction of the undersigned, whose seal as a professional engineer licensed to practice as such in the State of Washington, is affixed below.



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(Consultant/Professional Engineer)

Date 8-7-21

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I. Introduction

I.1. Site Description

The project is located at 2500 W 17th Avenue, Spokane, Washington. It is bordered by the Fish Lake Trail on the east side, which runs parallel with Highway 195, and the Union Pacific Railway on the west side. The subject site is identified as Tax Assessor Parcel 25252.0032. The size of the property is approximately 14.25 acres.

I.2. Proposed Project

The proposed project will divide the site into (56) residential lots for construction of single family residence. Construction will include clearing and grading of the site, installation of underground utilities and on-site paving. Appendix C – Post-Development Conditions shows the layout of the development and proposed improvements.

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NOT TO SCALE

MHE ENGINEERING 9702 W. MASTERS LANE CHENEY, WA 99004 509-230-1960 MELAARAGEYAHOO.COM	**CRYSTAL RIDGE SOUTH** SPOKANE, WASHINGTON DRAINAGE REPORT	**FIGURE 1** **SCALE: NTS** **DRAWN BY: MHE**	**VICINITY MAP**

II.Background Information

II.1. Topography

The site generally sloped towards the east and slopes ranged from 7 percent to vertical. The steepest slopes were along the eastern margin of the site adjacent to the Fish Lake Trail. The highest points of elevation were observed along the western margin of the site at 2024 and 2028 feet in the south and north, respectively, while the lowest point of elevation was observed in the northeast corner of 1931 feet.

The elevations presented in Appendix B – Pre-Development Conditions are based on a topographic survey conducted by Gordon Surveying for this project.

The site is generally covered with brush, grasses, other vegetation and scattered trees.

II.2. Soils

Please refer to the geotechnical report prepared by Budinger and Associates in Appendix "A" for information on the soils and drainage determination of the site.

II.3.Drainage System Determination

The best means to deal with runoff appears to be the use of bio-infiltration pond in conjunction with drywells consistent with the geotechnical report recommendations.

II.4.Critical Areas

The subject property does not contain critical areas.

II.5.Down-Gradient Analysis

Stormwater runoff generated by the proposed development will be directed into the stormwater drainage ponds. The stormwater will be treated and stored in the drainage ponds and drywells.

The stormwater runoff generated by the proposed project will treated and stored on site and will not have any down-gradient adverse impacts.

II.6.Operational Characteristics

The operational characteristics of this project are simple and straight forward. Stormwater runoff will flow cross the paved surface to the stormwater drainage pond. The runoff will then fill

the grassy pond up to the rim of the drywell and then overflow into the drywell where it will be stored and infiltrate into the subsurface soil.

II.7.Perpetual Maintenance of Facilities

A maintenance agreement will be developed for the perpetual operation and maintenance of the stormwater system.

III.Drainage Narrative

III.1.Theory

The storm drainage facilities on this project have been designed to dispose of runoff from a ten-year design storm, as required by the Spokane Regional Stormwater Manual SRSM. For this project, the 10- year intensity curves from the SRSM Section 5.5.3 were used, as well as the SCS iso-pluvial rainfall curves. An intensity of 2.62 in/hr is used in the 10-year design storm event.

This development is within the Aquifer Sensitive Area of Spokane County and the '208' requirements were followed. The Bowstring Method was used to verify the designed swale/pond volumes are adequate for storage of the onsite runoff generated during the design storm event.

III.2. Off Site

Based upon the general geographic tendencies surrounding this site, there will be no offsite flows entering the development.

III.3. Pre-Developed

In the pre-developed condition, the site will be considered as three basins. The basins were determined by the natural topography of the plat. Calculations for the 10- and 50-year storm events were performed.

III.4. Post-Developed

All runoff within the proposed drainage basins will be collected and treated using the '208' runoff method as described in the SRSM. In the developed condition, the project includes two (2) on-site basins (see Figure 3). Weighted "C" Runoff Coefficients were calculated for each basin of less than 10 acres as required by the SRMS. Table 1 provides the basin size, total impervious areas, and runoff coefficients for the post developed condition.

Table No. 1 – Runoff Coefficient Summary

Basin	Total Area (SF)	Total Area (AC)	'208' Impervious Area (SF)	Total Impervious Area (SF)	Runoff Coefficient "C"
A	204296	4.69	46260	94260	0.52
B	187308	4.3	49060	111060	0.62

In calculating the '208' impervious area (PGIS) the assumed driveway area was 400 square feet. An assumed roof area of 2,000 square feet per lot was used in the total impervious area.

III.5. '208' Calculations

The '208' storage volume for each basin was designed to adequately contain the runoff created by the first half-inch of rainfall upon the '208' impervious areas within the basin it serves. The provided '208' treatment volume shown in Table 2 is based on pond bottom areas and 3:1 side slopes at a maximum six-inch treatment depth of the swale. See Appendix "C" for swale volume calculations.

Table 2 summarizes the requirements and designs of the ponds by basin.

Table No. 2 – '208' Volume Summary

Pond	Pond Bottom Area (SF)	'208' Volume Required (CF)	Provided Pond '208' Volume (CF)
A	2400	1200	1277
B	2400	1280	1277

III.6. Total Stormwater Storage Calculations

Since the contributing area is from the on-site area, the minimum storage volumes of the swales are designed for the 10-year storm event. Bowstring calculations have been included for each basin to determine the extent of storm drainage required for the 10-year storm event. The provided storm/storage volume shown in Table 3 is based on pond bottom areas and 3:1 side slopes at a maximum twelve-inch depth. See Appendix "C" for swale volume calculations.

Table 3 summarizes the total storage volume proposed for each basin.

Table No. 3 – Storm/Storage Volume Summary

Basin	10-Year Volume Required (CF)	Storage Volume Provided (CF)
A	2508	2718
B	2500	2718

III.7 Larger Storm Events

An analysis was done to evaluate the affects of larger storm events or failure of proposed facilities. A visual inspection was conducted and the following was concluded:

- The proposed project engineering plans will neither aggravate an existing drainage problem nor create a new drainage problem.
- All storm water runoff from the proposed project will discharge at the natural, pre-developed location and will not adversely affect any private property.

IV.Conclusion

As demonstrated by the calculations and body of this report the '208' volume can be treated on site within the proposed drainage swale, and the 10-year storm events can be stored and disposed of on site with the drainage swale.

Therefore, the drainage facilities proposed within this design will adequately remove the streets, treat, store and dispose of the stormwater from the site for the 10-year design storm as required by the Spokane Regional Stormwater Manual SRSM.

APPENDIX A – GEOTECHNICAL REPORT

APPENDIX B – PRE-DEVELOPED MAP & DRAINAGE ANALYSIS

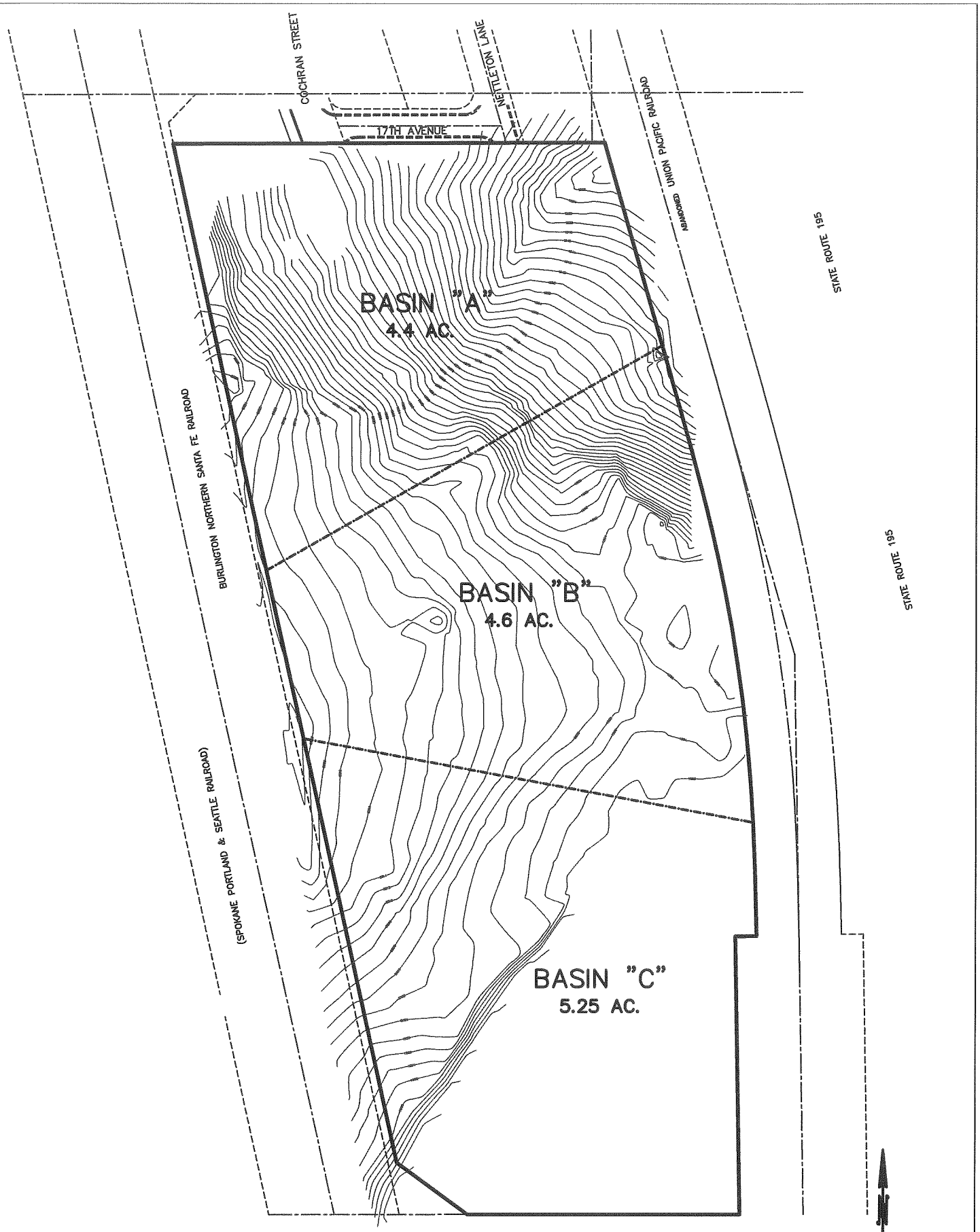

FIGURE 2 - PREDEVELOPMENT CONDITIONS

NOT TO SCALE
CONTOUR INTERVAL = 1'

MHE ENGINEERING 9702 W. MASTERS LANE CHENEY, WA 99004 509-230-1960 MELAARAG@YAHOO.COM	CRYSTAL RIDGE SOUTH SPOKANE, WASHINGTON DRAINAGE REPORT	FIGURE 2 SCALE: NTS DRAWN BY: MHE

PEAK FLOW CALCULATION PROJECT: **Crystal Ridge South**
10-Year Design Storm

Basin: Pre-A

Tot. Area 4.4 Acres

Per. C 0.35 (for Hilly Meadows and Pasture Land)

I (10 yr) = 2.62 in/hr.

Q10 = CIA = 0.35 x 2.62 in/hr. x 4.4 acres = 4.0 cfs

PEAK FLOW CALCULATION PROJECT: **Crystal Ridge South**
50-Year Design Storm

Basin: Pre-A

Tot. Area 4.4 Acres

Per. C 0.35 (for Hilly Meadows and Pasture Land)

I (50 yr) = 3.2 in/hr.

Q50 = CIA = 0.35 x 3.2 in/hr. x 4.4 acres = 4.9 cfs

PEAK FLOW CALCULATION PROJECT: **Crystal Ridge South**
10-Year Design Storm

Basin: Pre-B

Tot. Area 4.6 Acres

Per. C 0.35 (for Hilly Meadows and Pasture Land)

I (10 yr) = 2.62 in/hr.

Q10 = CIA = 0.35 x 2.62 in/hr. x 4.6 acres = 4.2 cfs

PEAK FLOW CALCULATION PROJECT: **Crystal Ridge South**
50-Year Design Storm

Basin: Pre-B

Tot. Area 4.6 Acres

Per. C 0.35 (for Hilly Meadows and Pasture Land)

I (50 yr) = 3.2 in/hr.

Q50 = CIA = 0.35 x 3.2 in/hr. x 4.6 acres = 5.2 cfs

PEAK FLOW CALCULATION PROJECT: **Crystal Ridge South**
10-Year Design Storm

Basin: Pre-C

Tot. Area 5.25 Acres

Per. C 0.35 (for Hilly Meadows and Pasture Land)

I (10 yr) = 2.62 in/hr.

Q10 = CIA = 0.35 x 2.62 in/hr. x 5.25 acres = 4.8 cfs

PEAK FLOW CALCULATION PROJECT: **Crystal Ridge Second Addition**
50-Year Design Storm

Basin: Pre-C

Tot. Area 5.25 Acres

Per. C 0.35 (for Hilly Meadows and Pasture Land)

I (50 yr) = 3.2 in/hr.

Q50 = CIA = 0.35 x 3.2 in/hr. x 5.25 acres = 5.9 cfs

APPENDIX C – POST-DEVELOPED MAP & DRAINAGE ANALYSIS

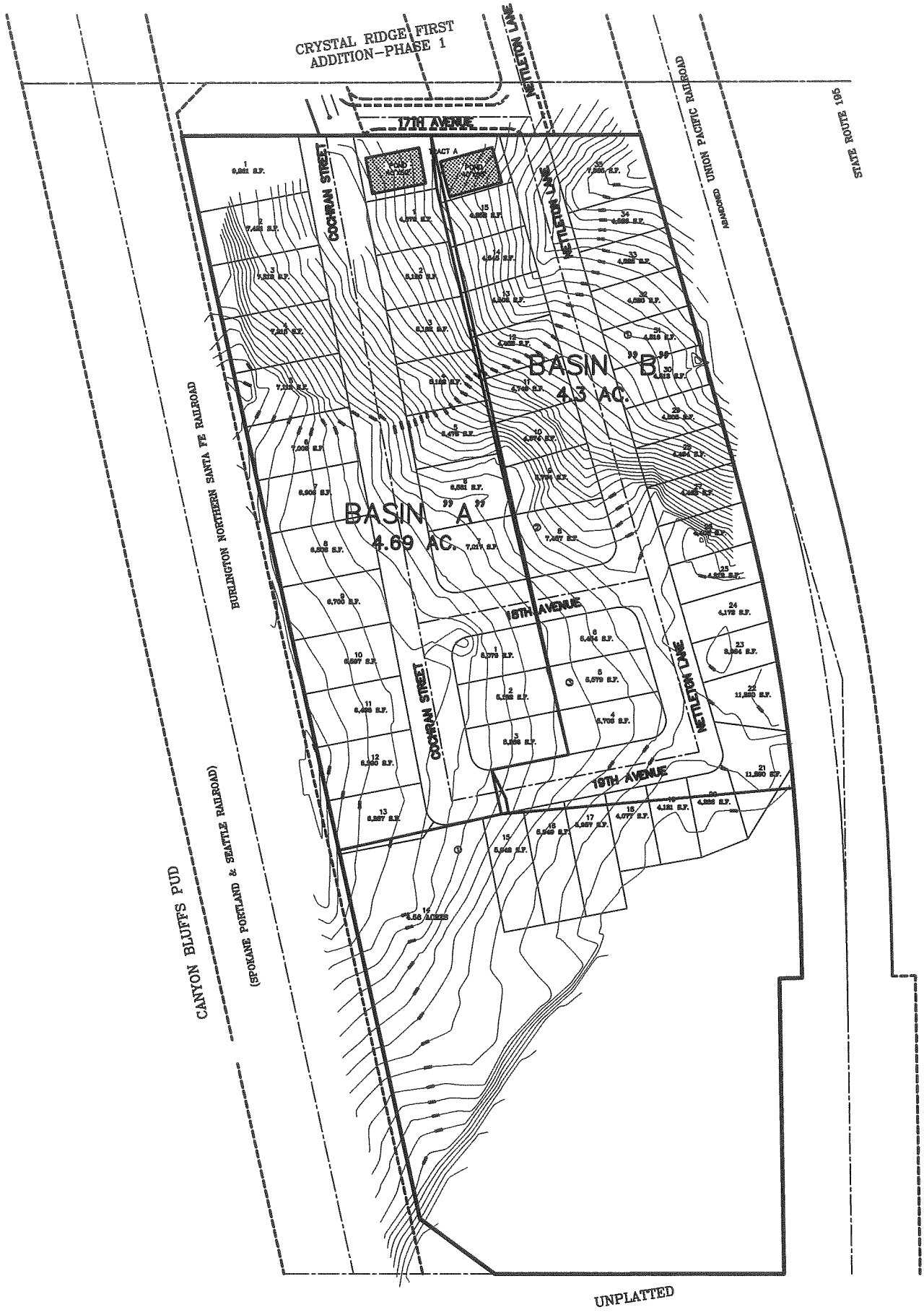

FIGURE 3 - POSTDEVELOPMENT CONDITIONS

NOT TO SCALE
CONTOUR INTERVAL = 1'

MHE ENGINEERING 9702 W. MASTERS LANE CHENEY, WA 99004 509-230-1960 MELAARAG@YAHOO.COM	CRYSTAL RIDGE SOUTH SPOKANE, WASHINGTON DRAINAGE REPORT	FIGURE 3 SCALE: NTS DRAWN BY: MHE

BASIN "A"

Total Area = 4.69 acres.

Roof Area

24 x 2000 = 48,000 Ft² C=0.90

Paved Area + Concrete Curb & Gutter

780' x 37' = 28,860 Ft²

Total Paved Area = 28,860 Ft² = 0.6625 acres. C=0.90

Concrete Driveways

24 x400 = 9600 Ft² C=0.90

Concrete Sidewalk

780' x 10= 7800 Ft² C=0.90

Lawns

4.69 – 2.16 = 2.53 acres C=0.20

Weighted "C" Factor

(0.9 x 2.16) + (0.20 x 2.53) divided by 4.69

= 0.52

Required Swale Volume

V = 1133 A, where
V= Volume of swale (cubic feet)
A= Pollution generating impervious surface (acres)

V = 1133 x 1.06 acres

= 1200 CF

BOWSTRING METHOD
DETENTION BASIN DESIGN

PROJECT: **Crystal Ridge South**
Basin: A

Time Increment (min.)	5
Time of Conc. (min.)	5.0
Outflow (cfs)	0.9
Design Year Flow	10
Area (acres)	4.69
Impervious Area (sf)	94260
'C' Factor	0.52
Area x C	2.44

Time (min)	Time (sec)	I (in/hr)	Qdev (cfs)	Vin (cu. ft.)	Vout (cu. Ft.)	Storage (cu. Ft.)
5	300	2.62	6.39	2569	270	2299
10	600	1.72	4.19	2945	540	2405
15	900	1.34	3.27	3275	810	2465
20	1200	1.13	2.76	3588	1080	2508
25	1500	0.98	2.39	3829	1350	2479
30	1800	0.88	2.15	4082	1620	2462
35	2100	0.8	1.95	4296	1890	2406
40	2400	0.74	1.80	4515	2160	2355
45	2700	0.69	1.68	4715	2430	2285
50	3000	0.64	1.56	4842	2700	2142
55	3300	0.61	1.49	5061	2970	2091
60	3600	0.58	1.41	5236	3240	1996
65	3900	0.55	1.34	5368	3510	1858
70	4200	0.53	1.29	5561	3780	1781
75	4500	0.5	1.22	5612	4050	1562
80	4800	0.48	1.17	5738	4320	1418
85	5100	0.47	1.15	5963	4590	1373
90	5400	0.45	1.10	6038	4860	1178
95	5700	0.44	1.07	6226	5130	1096
100	6000	0.42	1.02	6250	5400	850

"208" TREATMENT REQUIREMENTS

Minimum "208" Volume Required	1200 cu. Ft.
Provided Treatment Volume	1277 cu.ft.

DRYWELL REQUIREMENTS – 10 YEAR DESIGN STORM

Maximum Storage Required by Bowstring	2508 cu. Ft.
Provided Storage Volume at 12" depth	2718 cu. Ft.
Number and type of Drywells Required	3 Single
	0 Double

Provided Treatment/Storage Volume:

A stormwater pond will be constructed to provide the required treatment and storage volume. The pond will have a bottom area of 2400 square feet and will be at least one foot deep:

DRAINAGE POND DIMENSIONS		
Pond Side Slope	3	:1
Bottom Length (ft)	60	
Bottom Width (ft)	40	
Bottom Area (SF)	2400	
Treatment Depth (ft)	0.5	
Treatment Area (SF)	2709	
Treatment Volume (CF)	1,277	
Storage Depth (ft)	1	
Storage Area (SF)	3036	
Storage Volume (CF)	2718	

BASIN "B"

Total Area = 4.3 acres.

Roof Area

31 x 2000 = 62,000 Ft² C=0.90

Paved Area + Concrete Curb & Gutter

780' x 37' = 28,860 Ft²

Total Paved Area = 28,860 Ft² = 0.6625 acres. C=0.90

Concrete Driveways

31 x400 = 12400 Ft² C=0.90

Concrete Sidewalk

780' x 10= 7800 Ft² C=0.90

Lawns

4.3 – 2.55 = 1.75 acres C=0.20

Weighted "C" Factor

(0.9 x 2.55) + (0.20 x 1.75) divided by 4.3

= 0.62

Required Swale Volume

V = 1133 A, where
V= Volume of swale (cubic feet)
A= Pollution generating impervious surface (acres)

V = 1133 x 1.13 acres

= 1280 CF

BOWSTRING METHOD
DETENTION BASIN DESIGN

PROJECT: **Crystal Ridge South**
Basin: B

Time Increment (min.)	5
Time of Conc. (min.)	5.0
Outflow (cfs)	1.2
Design Year Flow	10
Area (acres)	4.3
Impervious Area (sf)	111060
'C' Factor	0.62
Area x C	2.666

Time (min)	Time (sec)	I (in/hr)	Qdev (cfs)	Vin (cu. ft.)	Vout (cu. Ft.)	Storage (cu. Ft.)
5	300	2.62	6.98	2808	360	2448
10	600	1.72	4.59	3219	720	2499
15	900	1.34	3.57	3580	1080	2500
20	1200	1.13	3.01	3922	1440	2482
25	1500	0.98	2.61	4186	1800	2386
30	1800	0.88	2.35	4462	2160	2302
35	2100	0.8	2.13	4696	2520	2176
40	2400	0.74	1.97	4936	2880	2056
45	2700	0.69	1.84	5154	3240	1914
50	3000	0.64	1.71	5293	3600	1693
55	3300	0.61	1.63	5533	3960	1573
60	3600	0.58	1.55	5724	4320	1404
65	3900	0.55	1.47	5868	4680	1188
70	4200	0.53	1.41	6079	5040	1039
75	4500	0.5	1.33	6134	5400	734
80	4800	0.48	1.28	6273	5760	513
85	5100	0.47	1.25	6518	6120	398
90	5400	0.45	1.20	6601	6480	121
95	5700	0.44	1.17	6806	6840	-34
100	6000	0.42	1.12	6833	7200	-367

"208" TREATMENT REQUIREMENTS

Minimum "208" Volume Required	1280 cu. Ft.
Provided Treatment Volume	1277 cu.ft.

DRYWELL REQUIREMENTS – 10 YEAR DESIGN STORM

Maximum Storage Required by Bowstring	2500 cu. Ft.
Provided Storage Volume at 12" depth	2718 cu. Ft.
Number and type of Drywells Required	4 Single
	0 Double

Provided Treatment/Storage Volume:

A stormwater pond will be constructed to provide the required treatment and storage volume. The pond will have a bottom area of 2400 square feet and will be at least one foot deep:

DRAINAGE POND DIMENSIONS		
Pond Side Slope	3	:1
Bottom Length (ft)	60	
Bottom Width (ft)	40	
Bottom Area (SF)	2400	
Treatment Depth (ft)	0.5	
Treatment Area (SF)	2709	
Treatment Volume (CF)	1,277	
Storage Depth (ft)	1	
Storage Area (SF)	3036	
Storage Volume (CF)	2718	