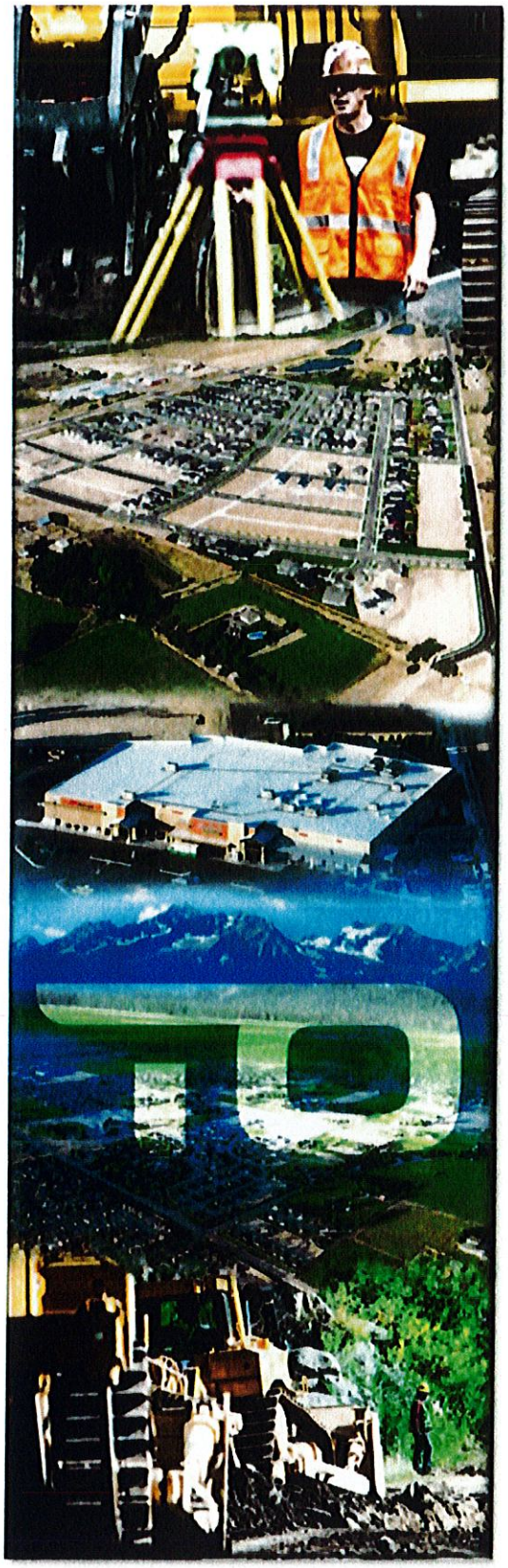
ATTACHMENT C



HYDRAULIC REPORT

FOR

MCGHEE SUBDIVISION
PONDERAY, IDAHO
BONNER COUNTY

T-O PROJECT NUMBER: 200535

July 13, 2022

Prepared for Bobby McGhee Golf and RV Resort LLC

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Introduction

McGhee subdivision will ultimately be developed on two parcels of land totaling approximately 192 acres just north of Sandpoint, Idaho in the City of Ponderay. The land is currently between Sand Creek to the west and Boyer Slough to the east. The flow of water across the site is southeast where it flows into a ditch that runs parallel to a railroad and off the site. According to the City of Ponderay Code: Stormwater Management Ordinance Chapter 4 Section 8-4-8, the development is required to maintain existing conveyance for the drainage. Additionally, the city Code specifies that peak flows should be calculated using TR-55 or another method approved by city engineer for drainages larger than 10 acres. This preliminary hydraulic report summarizes the methods and results of the existing and proposed hydrologic and hydraulic conditions of the site.

The existing site consists of relatively flat fields that were once tilled farmland. The site appears to have grasses, shrubs and trees. There is a Union Pacific railroad along the south-eastern corner of the property and McGhee Road is the eastern boundary of the site. Two existing 30-inch culverts convey water off the site under the railroad.

The purpose of this report is to evaluate the existing drainages contributing to flows that historically pass through the proposed project area. This report is meant to compliment the "Preliminary Stormwater Management Narrative" (T-O Engineers, 2022), which is referenced below for flow rates and volumes used in the hydraulic analysis.

Existing Hydrology

According to the USGS Web Soil Survey, the predominant soil class for the area is Class D, with a small section on the north side that is Class B. The NRCS Web Soil Survey data for the site indicates that the groundwater table is approximately 6 to 18 inches beneath the surface.

A review of FEMA flood maps indicated that the area is an area of little flood concern. However, observed rain on snow events indicate significant ponding on the site. Eyewitness accounts from Spring of 2022 indicate that the site becomes a large pond during rain on snow events. A stream also forms and flows from the approximate middle of the site toward the south outlet and along the railroad berm.

Modified Rational Method (25-year storm)

The results below are from the "Preliminary Stormwater Management Narrative" (T-O Engineers, 2022). The existing runoff volume and flow rate is summarized in **Table 1 and 2** below:

TABLE 1: EXISTING CONDITIONS 25-YEAR FLOW RATES

	WEIGHTED C	AREA	A*C	INTENSITY	FLOW
		(ACRES)		(IN/HR)	(CFS)
Existing	0.30	22.04	6.61	2.80	18.5

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TABLE 2: EXISTING 25-YEAR STORM VOLUME-SUBDIVISION ONLY

25-year Storm	Detention Basin AC-FT
Existing Subdivision Area	0.2

WMS and HEC-1 (100-year storm)

The existing hydrology of the site consists of two main drainage basins, each with its own outlet. The Northern Basin collects water to an outlet in the area where the railroad crosses McGhee Road, and the Southern Basin collects water to an outlet in the area where the railroad crosses the southern border of the property, just north of the Ponderay Mobile Home Park.

Watershed Modeling System (WMS) Version 11.1, developed by Aquaveo, was utilized to model two hydrologic conditions: average and wet. These are represented by the Antecedent Moisture Condition numbers (AMC), which are coefficients calculated based on land use and soil data. AMC II indicates average soil saturation and AMC III indicates higher soil saturation. The primary method used to evaluate the 100-year flow and respective hydrographs for the drainage was HEC-1. HEC-1 was chosen because the results differ only slightly from TR-55, and HEC-1 provided a more detailed hydrograph for results. Because the volume of the storm was needed for the pond sizing, the more detailed hydrograph was necessary. The existing basin results are summarized in **Table 3**. (See Appendix A for the basin map and Appendix B for detailed Hydrologic Analysis Methods).

TABLE 3. EXISTING CONDITIONS 100-YEAR FLOW RATES

Parameter	AMC II		AMC III	
	North	South	North	South
Peak Flow (cfs)	36	19	74	17
Volume (ac*ft)	9	4	14	4
Time to Peak (min)	780	765	750	765

Proposed Hydrology

Modified Rational Method (25-year storm)

The results below are from the "Preliminary Stormwater Management Narrative" (T-O Engineers, 2022). The proposed runoff volume and flow rate is summarized below in **Table 4 and 5**:

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TABLE 4: PROPOSED CONDITIONS 25-YEAR FLOW RATES

25-Year Storm	WEIGHTED C	AREA	A*C	INTENSITY	FLOW
		(ACRES)		(IN/HR)	(CFS)
Proposed	0.48	22.04	10.62	2.80	29.7

TABLE 5. PROPOSED CONDITIONS 25-YEAR TREATMENT VOLUME

25-year Storm	Detention Basin AC-FT
Detention Volume	0.3

WMS and HEC-1 (100-year storm)

A hydrologic analysis was performed using the proposed conditions in WMS. The curve numbers were adjusted based on the impermeable land use area. The HEC-1 results with the adjusted curve numbers are shown below in **Table 6**.

TABLE 6. PROPOSED CONDITIONS 100-YEAR FLOW RATES

100-Year Storm	AMC II		AMC III	
	North	South	North	South
Peak Flow (CFS)	65	35	107	35
Volume (AC-FT)	13	6	18	6
Time to Peak (min)	765	750	750	750

Existing Hydraulics

The culverts that convey drainage underneath the railroad were evaluated for maximum capacity using the observed ordinary high-water mark on the southern culvert and existing terrain elevations surrounding the northern culvert. The existing flow split between the north and the south culvert is unknown for conditions less than the maximum capacity.

A summary of the analysis is shown below in **Table 7**. The calculations are included in Appendix B.

TABLE 7: RAILROAD CULVERT MAXIMUM CAPACITY

Railroad Culverts	US Invert	DS Invert	Size	WSE	Flow
Culvert	ft	ft	ft	ft	cfs
Upstream (Northern)	2128.1	2127.3	2.5	2130	12
Downstream (Southern)	2124.4	2122.5	2.5	2128	30

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Proposed Hydraulics

The two culverts that pass flow from the north and south basin beneath Jim Berry Way, and into the proposed detention pond were sized using the hydrographs for each basin. The culverts are designed to pass the peak flow for each respective basin. A summary of the analysis is shown below in **Table 8**. The calculations are included in Appendix B.

TABLE 8: SUBDIVISION CULVERT CAPACITY FOR BASIN PEAK FLOW

Subdivision Crossings	US Invert	DS Invert	Size	WSE	Flow
Culvert	ft	ft	ft	ft	cfs
1 (Northern)	2128	2128	4x6	2131.65	106
2 (Southern)	2129	2128	3	2131.97	35

The outflow from the pond will be controlled to the outflow for the existing 25-year and 100-year flows. The proposed design will be an orifice weir with a smaller diameter orifice for the 25-year flow and a larger diameter for the 100-year flow. The maximum capacity was used for the 100-year event and assumed a full pond. Flow for the 25-year event was reduced to approximately half of the 100-year flow for each culvert. The results are summarized below in **Table 9**. The calculations are included in Appendix B.

TABLE 9: POND OUTLET WEIRS SIZED TO FLOW RECURRENCE

Pond	Flow Rate	Calc H (ft)	L (ft)	V (ft/s)	Pipe Diameter (in)	WSE (ft)
Pipe to Northern Culvert-25-Year	7	1.1	1.6	3.8	6	2129.5
Pipe to Northern Culvert-25-Year	12	1.3	2.1	4.3	8	2130.1
Pipe to Southern Culvert-25-Year	12	1.0	3.1	3.7	12	2129.5
Pipe to Southern Culvert-100-Year	30	1.1	7.1	3.8	27	2130.1

Recommendations and Conclusions

Proposed 25-Year Flow

The outflow from the pond will be moderated to the existing 25-year flow for smaller events. The existing outflow through the existing culverts under the railroad for the 25-year event was not estimated. The recommended design flow shown below in **Table 10** was derived from the "Preliminary Stormwater Management Narrative." The culvert flows were derived from the pond outlet weirs shown in Table 9 above.

TABLE 10: ESTIMATED 25-YEAR RUNOFF FROM PROPOSED SUBDIVISION AREA

25-Year Storm	Total FLOW	Northern Culvert	Southern Culvert
North and South Basins	(CFS)	(CFS)	(CFS)
Existing	18.5	--	--
Proposed	18.5	7	12

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Proposed 100-Year Flow

It is recommended that the AMC III conditions and results are used for design. This recommendation is made because rain on snow events have been known to cause flooding on the site. It is assumed that these parameters for the curve number best represent the runoff for the rain on snow condition.

The recommended outflow for the site is limited by the existing culverts under the railroad. They have an estimated max conveyance of 42 cfs (See Appendix B for Calculations). The northern outlet culvert has a capacity of 12 cfs. The southern outlet culvert has a capacity of 30 cfs. The outflow from the pond is limited to the outflow of the respective culverts under the pond. Culverts within the subdivision should be sized to convey the peak flow from the proposed conditions event for each basin as shown below in **Table 11**. The recommended design outflows from the detention pond to the existing culverts under the railroad are shown in **Table 12**. Refer to the Proposed Conditions map in Appendix A for culvert locations.

TABLE 11: SUMMARY OF RECOMMENDED DESIGN FLOW RATES FOR 100-YEAR FLOW

100-Year Storm AMC III	Existing Flow		Proposed Flow	
	North	South	North (Culvert 1)	South (Culvert 2)
Peak Flow (CFS)	74	17	107	35

TABLE 12: ESTIMATED 100-YEAR OUTFLOW FROM PROPOSED SUBDIVISION AREA

100-Year Storm	Total FLOW	Northern Culvert	Southern Culvert
North and South Basins	(CFS)	(CFS)	(CFS)
Existing	42	12	30
Proposed	42	12	30

Pond Sizing 25 Year Flow

The pond will be sized to detain the 100-year flow. The volume is also sufficient to store the 25-year storm.

Pond Sizing 100 Year Flow

Ponding is observed for the existing condition indicating that the culverts beneath the railroad limit the outflow from the site for both the existing and proposed condition. Flows exceeding the estimated 42 cfs outflow will need to be detained onsite. The accumulated volume for the combined basin for the existing and proposed condition is shown below in **Table 13**. These volumes were calculated from the HEC-1 hydrographs based on the 100-year storm using the trapezoidal integration method for flows exceeding 42 cfs for both conditions.

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TABLE 13. DETENTION VOLUME 100-YEAR FLOW

Pond Volume	Proposed ACRE-FT
	AMC III
Existing Detention	4.8
Proposed Detention	6.9

References

"Preliminary Stormwater Management Narrative" (T-O Engineers, 2022). Preliminary Plat Narrative Submittal. Dated July 13, 2022.

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US Department of Commerce, N.O.A.A. (n.d.). NGS Coordinate Conversion and Transformation Tool (NCAT). National Geodetic Survey. Retrieved May 31, 2022, from https://geodesy.noaa.gov/NCAT/

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Appendix A