TECHNICAL MEMORANDUM

Date:	April 13, 2016	**Project No.:**	14-03741-601
To:	Roger Dane	**Company:**	City of Redmond
From:	David Thurman, PE Scott Stoneman, PE		
cc:	Jim Johnson, LG, LEG	**Email:**	dthurman@golder.com sstoneman@golder.com
RE:	**SMITH WOODS POND – INTERIM CHANNEL STABILIZATION**		

The City of Redmond (City) recently lowered the water surface elevation of the pond at Smith Woods Park as an emergency response to observed sink holes around the outlet pipe and flows overtopping the containment berm. To maintain the lowered water surface the City cut a new channel into the pond berm. This process was reviewed and completed following recommendations by Golder Associates Inc. (Golder) in a technical memorandum Smith Woods Park – Pond Embankment Inspection, dated December 3, 2015. The outlet channel was then armored with plastic sheeting anchored with sandbags. The new outlet channel was intended as a short-term action that would soon need to be restored; however, we understand that a permanent restoration by the City may not be feasible for approximately five years. An interim design is needed to bridge this timespan that can minimize erosion and sediment transport potential and protect the pond berm.

Golder was asked to provide design recommendations to the City for an interim channel stabilization for up to the 10-year flow recurrence interval. A hydrologic assessment for peak discharge, estimates for channel dimensions and rock sizes were completed to support the interim design. The design methodology and recommendations are provided within this technical memorandum along with conceptual design sketches. Detailed designs are not part of this interim channel design recommendations. We understand that the City may be pursuing parallel efforts to begin pre-design on the long-term solution.

The hydrologic assessment for the Smith Woods Pond was completed using a continuous simulation hydrology model, Western Washington Hydrologic Runoff Model (WWHM). The model incorporated basin delineation and land-use data provided by the City of Redmond. The delineated contributing basin is approximately 85 acres. Land-use was then converted into WWHM land cover types including: impervious, pasture, grass, lawn and forest. Hydrologic soil groups of the existing soils were obtained from the National Resources Conservation Services (NRCS) Web Soil Survey for stormwater modeling purposes (NRCS 2015). The hydrologic soil groups are categorized based on estimates of the runoff potential. The basin is classified as having predominately Group B soils as a gravelly sandy loam with moderate water transmission rates. The hydrologic cover types are provided in Table 1.

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Table 1: WWHM Input Land-Use Areas

Land-use	WWHM Input Land-Use Areas (Acres)			
	Impervious	Pervious Pasture	Pervious Lawn	Forest
Open Water	1.1	0.0	0.0	0.0
Developed, Open Space	0.0	4.2	8.2	4.2
Developed, Low intensity	1.2	12.4	27.6	0.0
Developed, Medium Intensity	1.0	0.0	4.7	0.0
Deciduous Forest	0.0	0.0	0.0	0.7
Evergreen Forest	0.0	0.0	0.0	7.4
Mixed Forest	0.0	0.0	0.0	2.5
Pasture/Hay	0.0	0.1	0.0	0.0
Woody Wetlands	3.6	0.0	0.0	0.0
Emergent Herbaceous Wetlands	6.0	0.0	0.0	0.0
Total	12.9	16.6	40.5	14.7

These parameters were then input into WWHM. Peak discharges for the standard return intervals for the Smith Woods Pond are shown in Table 2. The 10-year peak flow is estimated to be 8.8 cubic feet per second (cfs).

Table 2: Resulting Peak Discharge

Return Interval (years)	Peak Discharge (cfs)
2	5.2
5	7.2
10	8.8
25	11.0
50	12.9
100	15.0

The City provided field measurements of the existing channel profile from the top of pond berm downstream to the NE 122nd Street culvert and typical cross-sections. The survey ended at the new temporary spillway which was hand-excavated, adjacent to the existing emergency spillway concrete pad, and lined with plastic anchored with sandbags.

The proposed interim channel is to extend from the top of the pond berm down to the top of the woody debris jam at the toe of the pond berm. The proposed interim channel geometry is sized based upon a slightly entrenched channel geometry that mimics the downstream cross-sections. Channel dimensions selected were a 2-foot bottom channel width with 2:1 side slopes that daylight to existing ground. Based on Manning's equation, the 10-year event has a normal depth of 0.56 feet.

Analysis of the streambed aggregate sizing for stabilization was completed using several empirical equations which yielded similar results. The Bathurst equation, which is a unit discharge equation for incipient motion on coarse material, high-gradient streams, was selected among these equations to estimate the D84 particle (Bathurst 1987). A grainsize distribution was then developed based on the resulting D84 and the Washington Department of Fish and Wildlife – Water Crossing Design Guideline document (WDFW 2013). The recommended grainsize distribution for the 10-year event and selected channel geometry is shown below in Table 3.

Table 3: Grainsize Distribution for North Pond Outlet Channel

Particle Size Percent Passing	Streambed Aggregate (inches)
100	18
85	7
50	3
15	1

Channel construction should generally follow the existing creek vertical profile with streambed aggregate to be excavated to a minimum 6-inch depth as shown in the attached Figure 1 - Channel Profile and Cross-Section. As an optional protection measure streambed aggregate has been shown to be transitioned to a depth of approximately 24 inches upstream of the log jam (Figure 1). This additional material will provide armoring in the event that the downstream log jam were to break apart.

Cross log structures may be placed within the channel limits sufficiently buried within the banks to control buoyancy and flanking. The logs also serve to hold grade and limit the quantity of streambed aggregate imported to the site. Channel spanning logs with a minimum diameter of 12-inches should be installed flush with the streambed. Alternatively, a low-flow notch can be used with a minimum 18-inches in diameter log where the notch invert is set flush with the streambed.

We appreciate the opportunity to work with the City of Redmond on this exciting project and look forward to continuing to support you on this project and throughout our community.

GOLDER ASSOCIATES INC.

Scott Stoneman, PE
Senior Engineer

For David Thurman, PE
Senior Project Engineer

James G. Johnson, LG, LEG
Principal

Attachment: Figure 1

DT/SS/JGJ/sb

REFERENCES

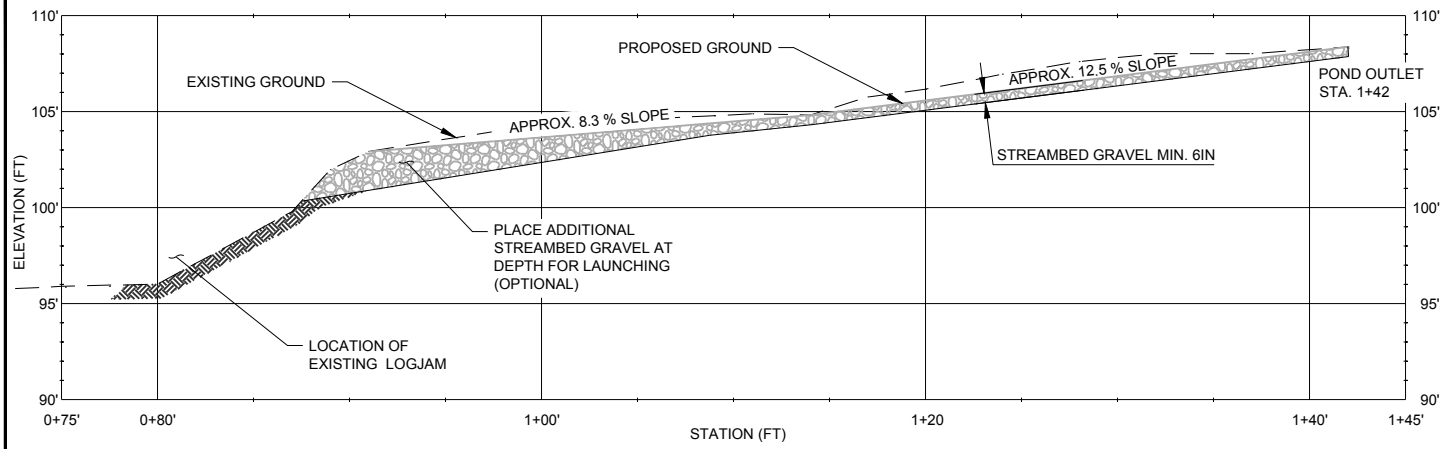
Bathurst, J. C. 1987. "Critical conditions for bed material movement in steep, boulder-bed streams "International Association of Hydrological Sciences Publication 165: 309-318.

Golder Associates Inc. (Golder). 2015. Smith Woods Park – Pond Embankment Inspection Technical Memorandum for the City of Redmond. December 3.

National Resources Conservation Service. Urban Hydrology for Small Watersheds, Technical Release 55(TR-55). Second Edition. June 1986.

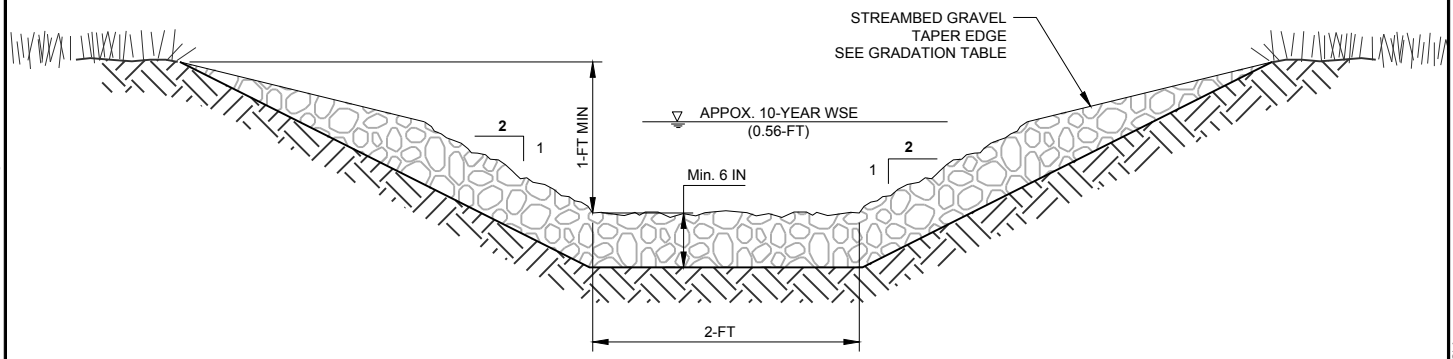
Washington Department of Ecology. (Ecology) 2012. Western Washington Continuous Simulation Hydrology Model (WWHM). Washington State Department of Ecology. 2012.

Washington Department of Fish and Wildlife (WDFW) 2013. Barnard, R. J., J. Johnson, P. Brooks, K. M. Bates, B. Heiner, J. P. Klavas, D.C. Ponder, P.D. Smith, and P. D. Powers (2013), Water Crossings Design Guidelines, Washington Department of Fish and Wildlife, Olympia, Washington.



CHANNEL PROFILE

SCALE 1"=10'



PROPOSED CHANNEL SECTION

SCALE N.T.S

NOTES

1. FINAL CONFIGURATION OF ROW RESTORATION MEASURES TO BE DETERMINED BASED ON CONDITIONS ENCOUNTERED AT TIME OF CONSTRUCTION.
2. CHANNEL DIMENSIONS ARE FOR COMPLETED CHANNEL (AFTER ROCK PLACEMENT). CHANNEL MUST BE OVER EXCAVATED A SUFFICIENT AMOUNT TO ALLOW FOR THE VOLUME OF ROCK PLACED WITH THE CHANNEL WHILE PROVIDING THE SPECIFIED FINISHED DIMENSIONS.
3. THE MINIMUM STREAMBED AGGREGATE THICKNESS IS 0.5-FT TWO TIMES THE D50 AGGREGATE SIZE.
4. CHANNEL DIMENSIONS MAY VARY DEPENDING ON SITE CONDITIONS AND AS DIRECTED BY THE CITY OF REDMOND.
5. REFER TO TABLE FOR STREAMBED AGGREGATE GRADATIONS.
6. CREEK PROFILE TAKEN FROM SURVEY COMPLETED BY CONSERVATION CORPS DATED FEBRUARY 1, 2016.

Percent Passing (%)	**Streambed Aggregate Size** (inches)
100	18
85	7
50	3
15	1

CLIENT
CITY OF REDMOND

PROJECT
SMITH WOODS POND
INTERIM CHANNEL STABILIZATION

CONSULTANT

Golder Associates

YYYY-MM-DD	2016-04-08
PREPARED	DRT
DESIGN	DRT
REVIEW	SJS
APPROVED	SJS

TITLE
CHANNEL PROFILE AND CROSS-SECTION

PROJECT No.	ISSUED FOR	Rev.	FIGURE
1403741.601	FINAL	0	1

Path: \\redmondgeomat$\geomatics\CityofRedmond\Redmond\99_PROJECTS\1403741_Smith Woods Pond\60\102_PRODUCTION\DWG\ | File Name: SMITH WOODS POND INTERIM CHANNEL\0.dwg
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A