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Memorandum

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Project: Plymouth Creek Restoration Phase 1

Subject: Plymouth Creek Restoration Design Memo

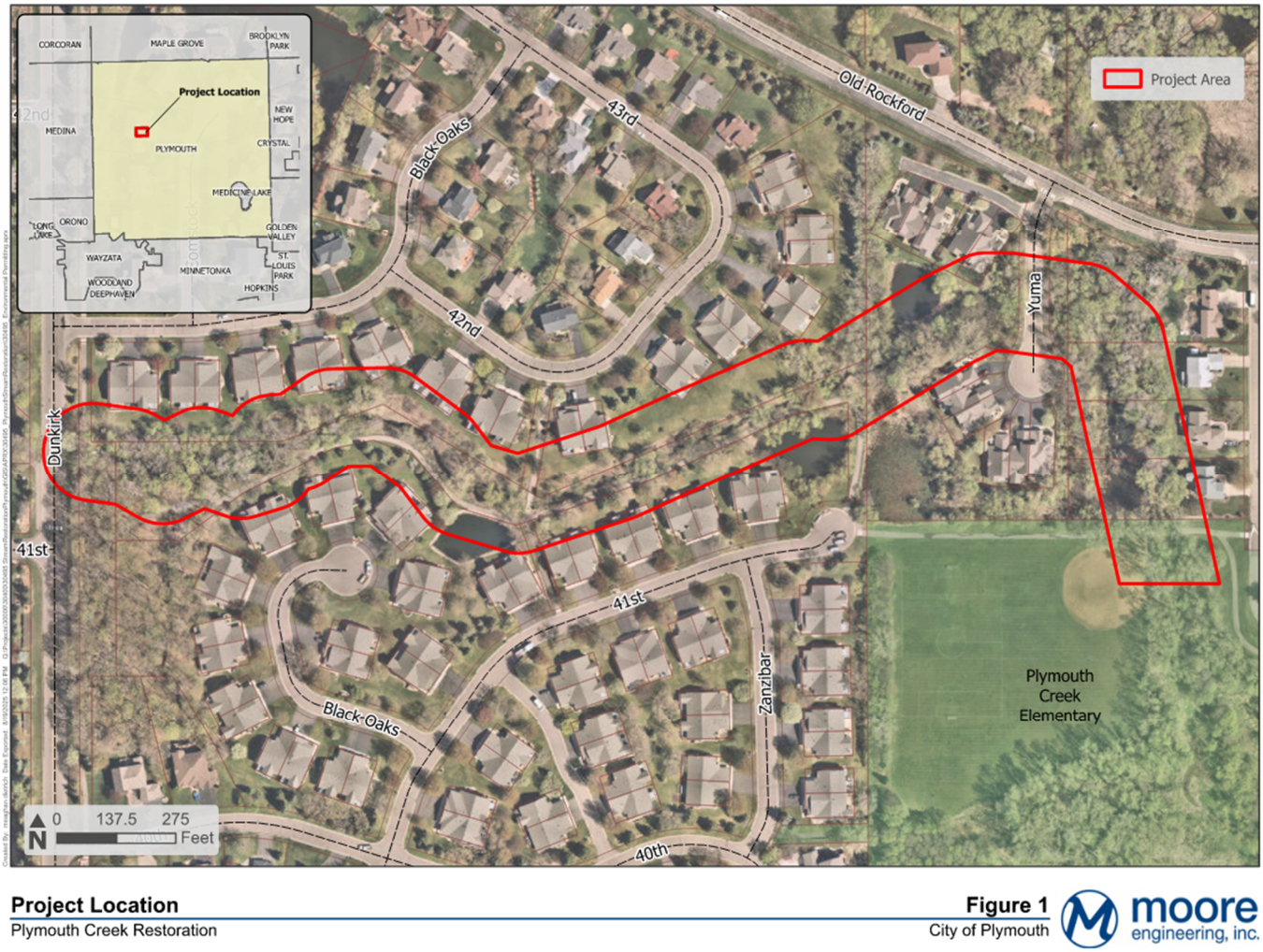
Narrative:

The City of Plymouth (City) contracted Moore Engineering, Inc. (Moore) to prepare construction plans for the restoration of Plymouth Creek from Dunkirk Lane to 38th Avenue North. The project is split into two phases with the first phase starting at Dunkirk Lane and ending downstream of a trail crossing at 41St Avenue North. This memo will discuss the project background and need, along with Moore's design approach in preparing the construction plans for the first phase of the restoration project.

Background

The Bassett Creek Watershed Management Commission (BCWMC) completed a feasibility study of Plymouth Creek between Dunkirk Lane and 38th Avenue reviewing the existing conditions of the stream and proposed restoration options. This feasibility study was presented to BCWMC and the City of Plymouth for their review and consideration. The feasibility study evaluated three options for restoration which were essentially broken out as completing restoration as Option 1 – High Priority Areas, Option 2 – High and Moderate Priority Areas, Options 3- All Identified Restoration Areas. BCWMC and the City decided to move forward with Option 3 in the feasibility study, which included completing all the proposed sediment removal, stream restoration, meander, and vegetation management presented in the feasibility study.

Upon review of the entire proposed project and the level of effort needed to complete the full Option 3 design, the City decided to then break out the creek restoration into two phases. The first phase will focus on the stream from Dunkirk Lane to the trail crossing near 41st Avenue, see Figure 1 below. The second phase will then start where the first phase ends and continue until 38th Avenue. The goal is to design and permit the first phase of the project in fall and winter of 2025 and construct the project in early winter and spring of 2026. Phase two would then be designed and permitted starting in spring of 2026 and constructed over the 2026/2027 winter.



Project Location
Plymouth Creek Restoration

Figure 1
City of Plymouth

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Figure 1: Project Location – Phase 1 Restoration from Dunkirk Ln to 41st Avenue Trail

Data Collection

Moore was provided the feasibility study along with ArcGIS shapefiles of the proposed practices shown in the feasibility study figures by the City. Velocity and flow information for the stream from BCWMC XPSWMM model was provided to Moore by Barr Engineering, the BCWMC District Engineer. The study was dated May 2024, and therefore it was assumed that the field investigation was completed in 2023. Both 2024 and 2025 were wetter years on average and had large rainfall events, so it was assumed some field conditions would have changed. It was determined that a field investigation was warranted to evaluate current channel conditions. The received shapefiles of the improvement practices identified in the feasibility study were added to an online web map to compare existing conditions with what was previously proposed. Along with the field evaluation to confirm existing conditions, a topographical survey of the stream was also completed. The survey collected cross sections of the stream including the centerline, toe, and top of the stream along with shots 75 feet past the top of the bank. These cross sections were taken approximately every 100 feet throughout the phase 1 reach; additional cross section density was added at channel bends. Stream centerline, toe and top of bank shots were taken approximately every 20 feet. A wetland delineation and desktop cultural review were also completed for this phase of the project.

Existing Conditions

Moore walked the extents of the first phase of the project multiple times, including documenting the entire channel through videos filmed while walking through the stream. For most of the stream, current conditions generally matched what was stated in the feasibility study. Preliminary construction plans have been created and are attached to this report. Stationing listed in the report refers to stationing listed in the plans. Existing flow rates, velocities, and flow depths are shown in Table 1 below. Velocities greater than two feet per second are highlighted in yellow and velocities greater than four feet per second are highlighted in red. Channel instability typically begins when channel velocities exceed two feet per second. When areas reach or exceed four feet per second, practices that include armoring are required to stabilize banks and address channel instability.

Station	2-year			10-year			100-year		
	Flow Rate (cfs)	Velocity (fps)	Flow Depth (ft)	Flow Rate (cfs)	Velocity (fps)	Flow Depth (ft)	Flow Rate (cfs)	Velocity (fps)	Flow Depth (ft)
1+10	46.2	2.1	1.8	56.2	2.1	2.0	144.8	2.1	3.3
3+50	46.2	4.4	2.1	56.2	4.7	2.2	144.8	5.3	3.3
5+70	46.2	4.0	3.5	56.2	4.3	3.9	144.8	5.3	5.4
7+50	46.2	1.6	3.5	56.2	1.8	4.0	144.8	2.7	5.4
8+00	46.3	1.2	3.5	56.3	1.4	4.0	144.9	2.3	5.3
9+00	51.5	1.4	3.4	65.9	1.6	3.9	145.6	2.6	5.1
13+50	59.4	2.7	3.0	79.2	2.9	3.4	103.8	3.1	4.0
18+20	60.9	4.1	1.6	119.9	4.5	2.0	105.3	5.0	2.8
23+00	53.4	2.0	2.8	85.1	2.6	3.3	206.3	5.8	4.8
Average	50.7	2.6	2.8	70.1	2.9	3.2	142.8	3.8	4.4

Table 1: Summary of Flows and Velocities

Station 0+00 to 9+50

The first 650 feet of phase one showed many signs of erosion and instability. Banks in this section were near vertical or uncut with adjacent plant roots exposed. The channel has also widened in portions of this reach. The bank full width of the stream was determined to be 12 feet wide based on top of bank width and depth of flow information. There are portions of the channel that are over 20 feet wide between the banks. The upland area was mostly covered by tree canopy with vegetation coverage mainly being stinging nettle. After station 6+50 the canopy opens, the open area above the banks that had good vegetation establishment. From station 6+50 to the pedestrian bridge at station 9+70 the channel was more stable but still had incised banks. The channel cross section was more consistent in this section with the wetted perimeter consistently covering a larger portion of channel and more pools being present. The banks near the bends around station 8+50 were vertical with subsoil and roots exposed. Based on velocity information from BCWMC's model, the velocity in the 2-year event for the first 500 feet downstream of Dunkirk Lane was around four feet per second. From station 7+00 to 9+50 the velocity slowed to be around one and half feet per second.

Station 9+50 to 18+50

From station 10+00 to 15+00 the riparian area of the stream is dominated by a shrub and brush community with limited mature tree overstory. The creek runs very close to the City trail that is along the south side of the creek. There are sections of the stream that are within five feet of the trail from the top of bank. Eroded banks were observed where the creek encroached close to the trail. There were two

outlet pipes from a nearby city stormwater pond at station 15+00 that are almost completely blocked by sediment. Near station 16+50 there is a sharp drop in the stream that has created an over widened pool area that extends to station 17+00. After this pool the creek narrows back to a typical width and is mostly stable, with the exception of some undercut banks on the south. The upland vegetation is mostly shrubs and brush from station 10+00 to 15+00, after station 15+00 it transitioned back to a wooded area with a thicker canopy. Velocities in this stretch range from two to four feet per second.

Station 19+25 to 25+00

Between station 19+25 and 20+50 the north bank is extremely eroded, at station 20+00 the north bank had nearly five feet of exposed subsoil. The south bank was in far better condition with just some bank under cutting near station 20+50. From station 20+50 to the trail crossing at station 24+00 the channel opened to wetland. After discussion with the City, it was determined that this area was intended to act as a pond and was meant to be completely open. The area last had sediment removed in 2004 and since has accumulated sediment deposits and with vegetation growing through the area. A channel is still present in this area but there is obvious sediment deltas spread throughout the area. Soil probes were completed in this section and found that a hard bottom was present around elevation 960 which matched the channel bottom in this area. Sediment deltas ranged from two to four feet deep. Downstream of the trail crossing a head cut has formed from the culvert invert to the channel bottom, this drop is about two and a half feet.

Proposed Conditions

After reviewing the proposed restoration best management practiced (BMP) shown in the feasibility study, channel velocities, and completing the evaluation of existing site conditions, Moore prepared preliminary construction plans for Plymouth Creek. The proposed BMPs shown in the construction plans generally follow what was presented in the feasibility study with updates based on the field review. Moore is proposing the same types of BMPs and channel improvements for the phase 1 restoration project as the feasibility study, including bank grading with erosion control blanket, vegetated riprap, coir toe, and brush mattress. The limited differences in the proposed design compared to the feasibility study include either extending vegetated riprap further along an unstable bank or switching from a softer touch BMP such as limited bank grading with vegetation enhancement over to a practice that will provide more stability based on current channel conditions, such as implementing coir toe or riprap toe to provide increased protection. The feasibility study did call for vegetated reinforced soil stabilization (VRSS) which closely matches the vegetated riprap detail that is called out in the current Moore plans. Due to the relatively narrow overall channel, Moore has recommended using vegetated riprap in the areas that had been identified for VRSS to simplify constructability. The vegetated riprap will adequately protect the stream banks within the sections of channel that are identified to have higher velocities from BCWD's stormwater model. Due to constructability concerns with the relatively narrow creek, J-hook riprap vanes were replaced with stream-width rock vanes. Further details on BMP location and standard sections can be found in the attached preliminary plans. A cost estimate has also been prepared and attached to this memo.

Recommendations

Moore recommends using the attached preliminary construction drawings to submit to permitting agencies. The practices shown in the plans follow both the recommendations of the BCWMC initial feasibility study and have been expanded to match the current conditions of the stream based on Moore's field review. Comments from permitting agencies can then be incorporated into the final construction plans for the project.