Feasibility Study for Groundwater Availability for Spring Creek Creation at Squalicum Creek Park

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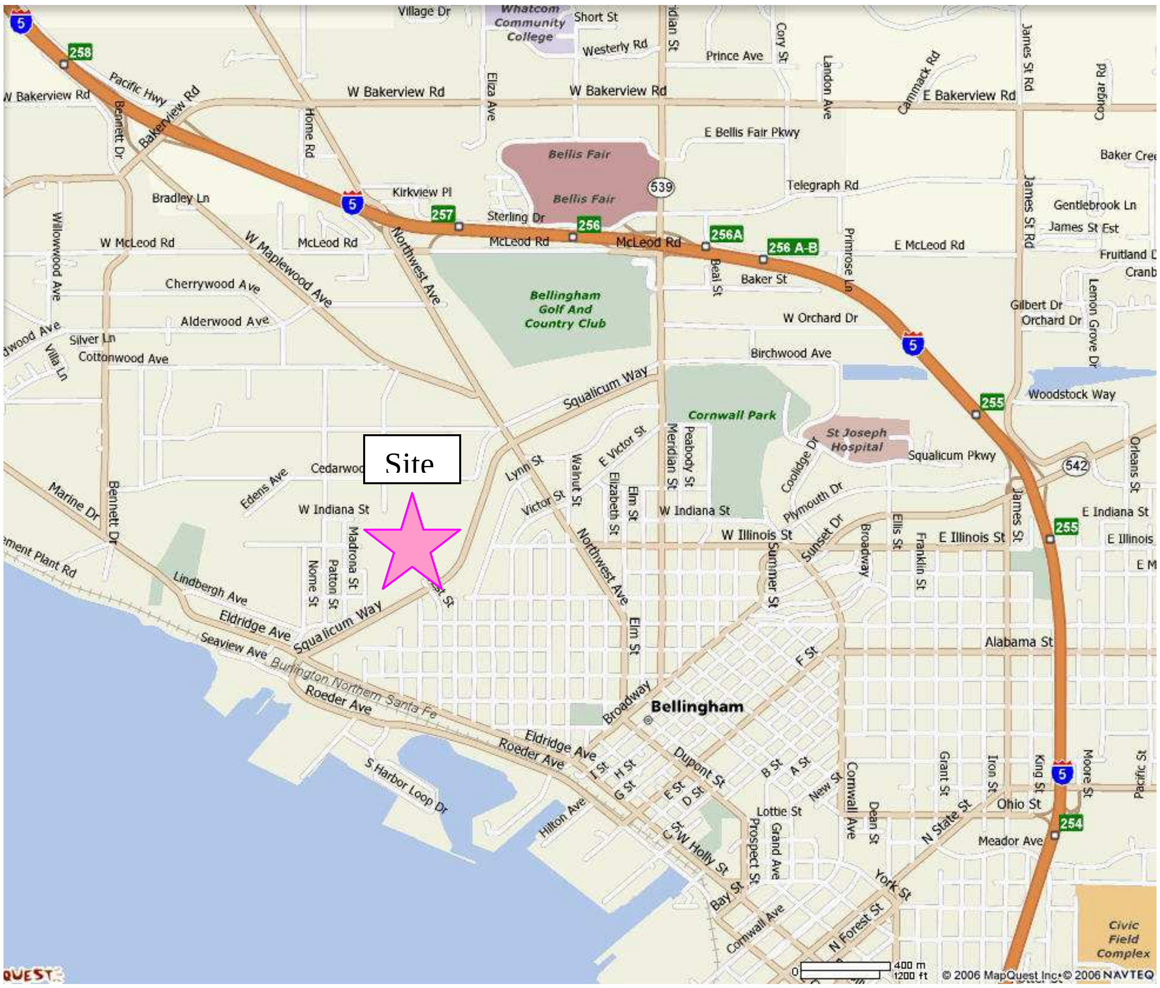
Introduction

The City of Bellingham intends to develop a former concrete facility and gravel mine into a park and sports facility for the local community. The Squalicum Creek Park site is located between the Birchwood and Columbia neighborhoods within city limits.



A master plan for the site was completed in March 2005 by J.A. Brennan Associates, PLLC that provided project direction and opportunities. One opportunity identified in the plan was the creation of a spring fed creek that would run north to south into Squalicum Creek within the property. A creek fed by local ground water sources would potentially provide rearing and possibly spawning habitat for coho and other salmonids. Initial geotechnical and water resources investigations were conducted by GeoEngineers in the November 2005 and March 2006. Work tasks for these efforts focused on geotechnical attributes of the site and how they may influence development and irrigation need.

Questions as to the feasibility of the existing drainage network to maintain a created channel were not investigated.

In September of 2006, Inter-Fluve Inc. was contacted to determine feasibility of daylighting a functional salmon spawning and rearing stream by: 1) evaluating the amount of flow within the existing drainage network; 2) setting up a series of piezometers that could be monitored through an entire water year; 3) conducting a pump test to estimate ground water yield and elevations that would also be useful in any future designed channel network and 4) summarize results into a feasibility report.

Site Visits and Data Collection

On September 27th, 2006 Mike McAllister (Hydraulic Engineer) and Mike Brunfelt (Fluvial Geomorphologist) reviewed the site with Dick Rothenbuhler (Park Specialist). Dick explained the existing drainage network location and local history of the site. On the following day, an excavator was rented to explore ground water elevations, install piezometers, access manholes, and conduct pump testing. Water surface elevations and existing drainage structure locations were recorded by total station. The spatial locations of the collected data was adjusted to correspond to ground and structure survey data of the provided by City of Belllingham.

Existing Drainage Network

The existing system drainage collection in the northwest quadrant of the property consists of two manholes, each with an open knockout hole approximately 15 inches in diameter. The manholes are installed in drain rock, which conveys groundwater toward the manholes, where the water enters through the knockout openings and floor. Once in the manholes, the collected groundwater is conveyed by metal pipe and along the western edge of the property. A series of concrete manholes occur along the pipeline at changes in pipe alignment, pipe size, or drops. These manholes allowed physical access to the drainage network. A drop manhole allowed access to a free-pouring pipe discharge (see inset detail in figure 1). The free-pour enabled a flow test to be completed that directly measured drainage water in the system. The water was measured using a 30 gallon plastic container and stop watch. Two trials indicated that the drainage discharge filled the 30 gallon container in 1 minute and 24 seconds, or a rate of 21 gallons per minute (gpm).

The drop manhole used to measure drainage was in the upper-middle half of the property. No other opportunities to directly measure the drainage network existed at the site without actually digging out a segment of pipe. However, a pump test was completed in the manhole using a two inch trash pump. The pump was adjusted over a period of two hours to determine static water surface within the pipe. When static water surface was obtained, a flow measurement 24 gpm was measured. The 3 gpm inconsistency between the direct measurement and the pump test appears to be the result of water gain from subsurface sources rising into the manhole. The discharge measured out of the pipe collected water from a relatively closed system above the manhole and therefore appears to have missed a small volume of gaining water entering the open manhole floor. The water surface elevation at the bottom of the manhole was 31.53 ft. Piezometer 2 adjacent to the manhole had a static water elevation of 34.41 ft fourteen hours after installation. This indicates the manhole was gaining 3 gpm of ambient groundwater as it was pumped.

Pump Test

To further explore the potential water yield in a daylighted spring creek, a pump test was completed near the northern property boundary approximately 50 feet from the existing well and pumping facility. To conduct the test, a 7 foot by 30 foot trench was excavated to 3 feet below static groundwater elevation, which was at elevation 37.5 ft. A two inch trash pump was run at full throttle to dewater the trench to a stable water level. After 5 hours, the water surface was stable at evation 35.7 ft (1.8 ft below the initial level), and the constant pump discharge was measured to be approximately 120 gpm. The pump test location is indicated in Figure 1 (at Piezometer 1).

Piezometer Installations

Five piezometers were installed approximately equidistant from the north to the south end of the property. Piezometers were measured approximately 14 hours after installation to allow ample time for the water surface to stabilize. It is expected that City of Bellingham will collect monthly measurements at these piezometers to determine fluctuations in groundwater elevations throughout the year. The Piezometer and pump test locations, and recorded water surface elevations can be viewed in Figure 1.

Findings

The discussion below addresses the results of the site explorations described above, and the relevance of these results in the framework of a potential constructed spring fed channel.

Soils

A broad range of soil types were encountered during excavations. Generally, clays and silts were found in areas assumed to be relic wash ponds from Pacific Concrete operations. Encountered native materials appeared to be silts, sands, and gravels consistent with Sumas Outwash. The sands and gravels expressed groundwater easily, and excavation into these materials below groundwater surface was rapidly filled by water.

As these coarser-grained soils were observed to rapidly deliver groundwater to the excavated voids, they would obviously rapidly drain away water that is delivered to them above the static groundwater level. To prevent the constructed channel from losing water, the infiltration could be prevented by excavating the new channel to below the static groundwater levels along its length. This way, the water in the channel will at all times be at or below the level of ambient groundwater, and the channel will always be gaining water, not losing it.

However, if the channel is to be constructed above ambient groundwater, infiltration must be prevented by lining the channel with an impermeable material.

Daylighting Existing Drainage Pipe

Based on the measurements within the existing drainage system, a minimum of 24 gpm (0.1 cfs) can be expected if the existing subsurface drainage network is daylighted into a constructed stream channel.

It is assumed that the September 2006 readings are representative of low groundwater conditions as it has been a particularly dry summer. The drainage network water discharges will probably be greater during the winter and spring, and future piezometer readings will allow an estimation of expected ambient groundwater during these wetter periods. It can be expected that higher groundwater levels will yield higher flowrates in the existing drainage network, but it would be unlikely to collect more than 0.2 cfs.

Suggested Improved Groundwater Collection

Pump testing was conducted in a 30 ft long excavated trench along the northern property boundary, near the existing drainage collection manholes (Figure 1). The trench produced 120 gpm with groundwater level static at elevation 35.7 ft. (1.8 feet of drawdown from static level before the pump test). This is a considerable amount of water indicating that if a larger and more efficient groundwater collection system is installed, then 1-2 cfs of groundwater could be delivered via gravity pipe to the head of the new channel, with no pumping required.

Created Creek and Wetland

If the channel is not to be lined by an impermeable material to prevent infiltration, then it must be installed below the lowest ambient groundwater levels. This way, it can be expected to gain water along its length. The channel would generally be excavated to 6-10 feet below existing ground. Channel profile slopes would range 0.25% to 1.0% depending on channel length and planform design. Conceptual channel dimensions would vary based on design criteria that will be developed before channel design. But to provide a general estimate of expected channel shape, one can look at slope and discharge. Based on our findings, a stream on this site could have slopes between 0.25% and 1.0% and flowrates between 0.1 and 2.0 cfs. Given these parameters, channel width could be between 1 foot and 8 feet wide.

The channel could be fed by either (a) daylighting the existing drainage network, or (b) by an improved groundwater collection system.

By daylighting the existing drainage network, a minimum of 0.1 cfs can be expected. This is very little flow for a stream and the channel would not be suitable as spawning habitat for salmonids, and would be marginally utilized for rearing. However, it could sustain a wetland and provide velocity refuge and foraging opportunities for salmonids during Squalicum Creek flooding.

Installing a better groundwater collection system would increase discharge to 1-2 cfs. This would create a wetland and stream complex with the same velocity refuge and foraging opportunities as the drainage-daylighting scenario, but would also provide considerably more suitable rearing and thermal refuge habitat, and even the possibility of spawning habitat.

The location and alignment of the channel could fit within or near the conceptual location and dimensions presented within the Squalicum Creek Park Master

Plan. This alignment would allow a 0.8% profile slope, which is a good slope for aquatic insect production and could be suitable for spawning given enough discharge to create optimal depth and velocity. That said, spawning habitat may not be the prime habitat needed, whereas rearing habitat is limited in the nearby Squalicum Creek system. So greater rearing habitat could be achieved by increasing the length of the created spring channel, providing more space for fish to find essential cold-water habitat. Therefore, doubling the length of the created channel could increase fish benefit 10-fold by providing this much needed rearing habitat, but spawning habitat would not be ideal since doubling channel length also halves the profile slope to less than 0.4%, which is sub-optimal for spawning.

Willow Creek Connection to Squalicum Creek

Squalicum Creek crosses under Squalicum Parkway near the road intersection of West Street and Squalicum Parkway. The creek then flows between the southwestern quadrant of the project property and the north side of Squalicum Parkway for several hundred feet before crossing again to the south side of the parkway. The new Willow Creek channel will outlet to Squalicum Creek along the section. Survey by others indicates that two culvert exist below the railroad alignment. Either location will be suitable for the channel outlet, but modifications to the selected culvert may be required to facilitate fish passage. Either outlet would be suitable for creek function, although the outlet on the Allsop property may be preferred because less excavation would be required in the existing pond area.

Figure 2 depicts a conceptual alignment that fits within the general area shown in the Squalicum Creek Park Masterplan. This concept assumes the channel is watered by a groundwater collection gallery installed near the spring along the northern project boundary, and conveyed by buried pipe to the constructed channel. The channel could be configured many ways, including extending northward to increase its length and available habitat. A channel and wetland not fed by a collection gallery, but fed only by the existing drainage network would be considerably smaller than depicted in Figure 2.