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REVISED August 5, 2019

Jeff Wikstrom
Evergreen Devco, Inc.
1873 South Bellaire Street, Suite 1200
Denver, Colorado 80222

Re: REVISED DRAFT Conceptual Design Approach for Beaver Pond Wetlands Enhancement Project at Santa Fe Park North Property, City of Littleton, Colorado

Dear Mr. Wikstrom:

SWCA Environmental Consultants (SWCA) has prepared this conceptual design approach for enhancing the Beaver Pond Wetlands on lands owned by the City of Littleton (City) and managed by South Suburban Parks and Recreation (SSPR). The Beaver Pond Wetlands are adjacent to the Santa Fe Park North development project (Development Project). The Beaver Pond Wetlands enhancement project (Enhancement Project) has been developed to help address SSPR concerns regarding deteriorating hydrology in this location and to promote environmentally beneficial drainage management at the Development Project.

Evergreen Devco, Inc. (Evergreen) has agreed to explore Enhancement Project alternatives at the request of SSPR and the City to facilitate the transfer of a portion of the City's land to be used by Evergreen for stormwater detention and water quality treatment. The intent of the conceptual plan developed by SWCA is to promote ecological function through the integration of the Development Project, Enhancement Project, and existing conditions in this area.

RELEVANT BACKGROUND INFORMATION

The Development Project is located at a sod farm and is bisected by the City Ditch which conveys water toward Denver (Figure 1 and Figure 2). The Development Project land drains toward the South Platte River valley bottom, which is owned by the City and managed by SSPR as open space. Just beyond the western perimeter of the Development Project is a wetland drainage swale that has historically been referred to as the Beaver Pond Wetlands.

General Historic and Current Conditions at Beaver Pond Wetlands

SWCA reviewed available information regarding the vegetation, soils, hydrology and extent of the Beaver Pond Wetlands. Information sources include a 1986 report titled "Wetlands Along the Proposed Mineral Avenue Extension Between South Santa Fe Drive and Platte Canyon Road" prepared by David J. Cooper, Ph. D., photographs and oral reports from SSPR staff, and aerial imagery available for sporadic

years ranging from 1937 to 2018. Based on the reviewed information, this area has undergone significant modifications over the previous 100 years. A summary of some of the notable conditions are as follows:

- From as early as 1937 (the oldest aerial image reviewed) until roughly 1975 (the year when Chatfield Dam was completed) the area known as the Beaver Pond Wetlands was an abandoned meander of the South Platte River. Aerial image signatures indicate that this area was a low-lying swale with dense herbaceous hydrophytic vegetation. The soils would be expected to be sandy alluvial deposits that would be subject to periodic scour and redeposition during South Platte River flooding events. In addition to groundwater associated with the South Platte River, sources of surface and shallow groundwater hydrology for this area would include seepage from City Ditch and irrigation return flows from adjacent, upgradient farmland located to the east.

- From roughly 1975 (when Chatfield Dam was completed) until the early 1990s (when the Mineral Avenue extension was completed), the general condition of the Beaver Pond Wetland is described by the 1986 David J. Cooper report referenced above. Based on this report, the Beaver Pond Wetlands' primary sources of water include a drainage swale which flows into the area from the south, a smaller drainage swale flowing into the area from the northeast (presumably associated with Jackass Gulch), and precipitation. The report identifies that prior to Chatfield Dam construction, overbank flows would be important for both floodplain morphology and hydrology. David Cooper reports that beaver activity, including dam construction, was active in 1989 and appeared to be responsible for an increase in overall wetland extent and hydrology. The attached Figure 3 represents the approximate Beaver Pond Wetlands extent during this time period, based on the Cooper report and SWCA's review of aerial imagery from this time period.

  The Cooper report also identifies vegetation communities associated with the Beaver Pond Wetlands, including 1) a pondweed (*Potamogeton pectinatus/crispus*) community in deep water areas; 2) a water hyssop- water cress (*Bacopa rotundifolia* and *Nasturtium officionale*) community wear the northeast drainage enters the complex; 3) a frogbit- smartweed (*Elodea canadensis* and *Persicaria coccinea*) community in shallow waters of the beaver ponds; 4) a plains cottonwood (*Populus sargentii*) swamp community present in the fringe of recently expanded beaver ponds; 5) a broad-leaved cattail- duckweed (*Typha latifolia* and *Lemna minor*) community along the beaver pond shoreline; 6) a sandbar willow- sedge (*Salix exigua* and *Carex langinosa*) community around the south drainage channel and beaver pond, in areas believed by Dr. Cooper to have a permanent high water table; 7) a sandbar willow- American black currant (*S. exigua* and *Ribes americana*) community that is well drained and constantly irrigated, resulting in a high degree of plant diversity; 8) a quackgrass- cress (*Agropyron repens* and *Rorippa sinuata)* community in openings between cottonwood stands; and 9) a plains cottonwood- quackgrass (*P. sarengetii* and *A. repens*) community in drier portions of the historic floodplain.

- From the early 1990s (when Mineral Avenue extension is complete) until the present, the Beaver Pond Wetlands condition appears to have undergone a series of declines in terms of overall extent, hydrology (availability), and plant biodiversity. When SWCA visited the area in early summer 2019, the Beaver Pond Wetland area included a roughly 20- to 40-foot-wide swale with dense broadleaf cattail (*T. latifolia*) growth interspersed with open water areas; large stands of reed canary grass (*Phalaris arundinacea*) in areas that formerly supported sedge and willows; and quackgrass (*A. repens)* interspersed with stands of plains cottonwood (*P. sargentii*) in drier portions of the floodplain.

  Flows in the swale, which originates to the south of the complex, were estimated at roughly 0.25 to 0.50 cubic feet per second (cfs). Flows from the northeast (associated with Jackass Gulch)

were not observed but appear to be present during and immediately following runoff events. A geotechnical study is planned to occur, but SWCA presumes that the underlying soils are historic alluvial deposits consisting of primarily sand and gravel material. When observed in 2019, the Beaver Pond Wetlands and surrounding floodplain areas were found to be lacking indications of recent South Platte River overbank events—sediment deposits, erosion/scour, and debris racking was not observed. The attached Figure 3 represents the approximate current extent of the Beaver Pond Wetlands, based on SWCA's site visit and aerial imagery review.[1]

Historic and Current Hydrology and Habitat Considerations

The Beaver Pond Wetlands is a low-lying area that has undergone a series of hydrological modifications, including the historic abandonment of this area by the South Platte River (presumably an oxbow avulsion that occurred prior to 1937), commencement of irrigation return flows from adjacent farmlands (presumably in the late 1800s), cessation of South Platte River overbank events (following Chatfield Dam construction), modification of surface runoff (most recently following completion of Mineral Avenue extension), and apparent ongoing but fluctuating levels of beaver activity. These modifications are believed to be responsible for much of the historically observed biodiversity in this area as well as the more recently observed decline in this area's wetland extent and function.

Conceptual Historical Evaluation

Based on the report by David Cooper, a primary source of hydrology for the Beaver Pond Wetlands was presumed to be from the channel that enters the area from the south. This channel appears to provide drainage relief for the sod farm located to the east and south of the Beaver Pond Wetland. The sod farm is expected to apply roughly 1 inch of irrigation water at least twice a week during the roughly 6-month-long growing season (approximated here as April through September). Assuming that the irrigation efficiency at the farm is 50% and that half of the loss is due to seepage, 25% of all applied water would infiltrate into the ground.[2] The rate of shallow groundwater recharge resulting from this irrigation is roughly 1 acre-foot (AF) per week or 25 AF per growing season. Based on SWCA's observations, shallow groundwater flows from the irrigated land would likely be intercepted by the drainage channel that leads to the Beaver Pond Wetlands. Ignoring lagged return flows through the alluvium, 1 AF of water per week would contribute roughly 0.1 cfs to the baseflow in the Beaver Pond Wetlands during the irrigation season.

The approximation of 0.1 cfs of flow contribution from the sod farm to the Beaver Pond Wetlands during the growing season is viewed as conservatively low based on the expectation that additional seepage would occur from sod pastures located to the east of City Ditch (which were omitted) as well as seepage from City Ditch itself, in addition to surface runoff from the irrigated pastures during rain events or irrigation application. This estimate appears low when compared to David Copper's estimate that 1-2 cfs was present in the channel during his evaluation.

SWCA also evaluated potential hydrologic and geomorphic changes resulting from the construction and operation of Chatfield Dam and Reservoir. Completed in 1975, Chatfield Dam and Reservoir have been attenuating high flows through this reach of the South Platte River for roughly 45 years. As a result, high flow events are less frequent than historically, resulting in a more stable South Platte River channel

[1] Please note that SWCA has not conducted a delineation the entire area known as the Beaver Pond Wetland using USACE methods.

[2] These assumptions are based on typical pasture/crop irrigation efficiency and losses. Based on the use of sandy soils for sod farming, and their high rates of percolation, it is reasonable to consider the estimates as conservatively low. Whereas 25% loss of irrigation water to percolation may be a reasonable rule of thumb for a wide range of crops, sod farming would likely have higher rates of percolation, resulting in greater than predicted flow contribution to the Beaver Pond Wetlands.

alignment but also reducing the frequency of overbank events that might have provided periodic pulses of hydrology for the Beaver Pond Wetlands. In fact, 1937 aerial imagery of this area depicts a historic oxbow of the South Platte River channel in the same location as the present-day Beaver Pond Wetlands. It is possible that while historic flood events would have flowed through this oxbow (and the area occupied by the Beaver Pond Wetlands), the frequency of these events was abruptly curtailed upon commencement of flood control operations at Chatfield Dam. The changes in the Beaver Pond Wetlands that have been observed by SSPR in recent years may be a continuation of a long-lasting transformation of this area triggered by the commencement of South Platte River flow management by Chatfield Dam.

An additional potential change in the hydrology of the Beaver Pond Wetlands may be the result of reduced beaver activity in this area. Whereas beaver dams can promote retention of water onsite and encourage development and sustenance of wetland hydrology, when these dams are abandoned, they begin to fail and allow water to pass freely through the channel. While SWCA is not able to confirm a decline in the relative level of beaver activity in this area, active beaver dams were not observed during the April 2019 site visit (which contrasts with observations shared by others familiar with this area).

Observations of Current Conditions

The current hydrology conditions in the Beaver Pond Wetlands appear to consist of low rates of baseflow with potential for infrequent runoff events during and immediately following storms. Additionally, the prevalence of reed canary grass around the perimeter of the wetland area indicates that groundwater is lower than historically—reed canary grass can tolerate longer periods of drought/inaccessibility to the water table than many of the desirable wetland plants that formerly occupied these areas.

The absence of erosion or channel scour within the drainage swale indicates that flow through this swale is of relatively low hydraulic energy. Additionally, the dense monoculture stands of cattail in the swale are indicative of a permanently saturated wetland with relatively low rates of flow variability. The current hydrology appears to be sufficient to maintain permanently saturated soils with intermittent open water areas within the narrow drainage corridor. Sediment that is transported into the Beaver Pond Wetlands is unlikely to be flushed out during storm events due to the low channel gradient and excessive growth of cattails. Further, the cattails are likely directly contributing to deposition in this area as a result of leaf loss and incomplete decomposition in saturated soils.

Development Project

The Development Project includes the construction of residential homes, roads, utilities, and appurtenant facilities. In order to satisfy local stormwater and drainageway management, the Development Project will implement a drainage plan that specifies the layout and specifications for stormwater facilities required to meet water quality and hydrology criteria (see attached Phase 2 Drainage Plan). The goal of the Drainage Plan is to protect downstream waters from adverse water quality and quantity effects that can occur as a result of development.

CONCEPTUAL ENHANCEMENT PLAN

Based on SWCA's review of available information, it appears that decreased water availability (in the form of groundwater and/or surface water) is likely responsible for some of the negative changes in the Beaver Pond Wetlands. A conceptual Beaver Pond Wetlands enhancement plan has been developed to promote water availability to the Beaver Pond Wetlands.

The conceptual enhancement plan consists of two parts: a Development Project drainage plan that promotes the delivery of flows to the Beaver Pond Wetlands; and a plan to promote hydrologic

enhancement in the Beaver Pond Wetlands through the installation of a sheet-pile cutoff wall that will create a localized high water table. Additionally, the cutoff wall could be constructed to include a small above ground weir that would allow surface water manipulation, promoting greater flow variability.

While overall wetland function is expected to increase following implementation of the enhancement plan, functional gain could be further enhanced through the implementation of weed management and revegetation activities. SWCA understands that SSPR is in the early stages of identifying vegetation management and enhancement activities that they would implement following construction of the sheet pile cutoff wall and pond outfalls. These vegetation management activities could focus on limiting the extent of reed canary grass while encouraging the development of beneficial herbaceous and woody plants in the Beaver Pond Wetlands.

Development Project Drainage Management

The attached Development Project Phase 2 Drainage Plan developed by Harris Kocher Smith (HKS) was designed to meet applicable stormwater and drainageway criteria but also includes design components to promote hydrologic contribution to the Beaver Pond Wetlands. When compared to current conditions, the Development Project would generate significantly more runoff during the storm events. For example, the 2-year design storm historic runoff from the project area is predicted to generate roughly 2.2 cfs of flow which is roughly $1/20^{th}$ of the runoff rate predicted to occur following implementation of the Development Project (roughly 44.9 cfs). This rate of runoff would be attenuated and prolonged as a result of the Phase 2 Drainage Plan—the plan includes construction of stormwater detention/water quality ponds with designed outlets that would slowly release treated flows. These flows have been designed to be released as far upgradient in the Beaver Pond Wetlands as possible to increase the areal extent of hydrologic enhancement (Figure 3). The stormwater outfalls will be constructed in a manner that both dissipates hydraulic energy (thus reducing the risk of channel scour) and also spreads discharged water (thus increasing the area of hydrologic enhancement).

SWCA expects that upon implementation of the Drainage Plan, flows through the Beaver Pond Wetlands will be enhanced, both from the perspective of total annual flow but also flow rates during and immediately following routine storm events. Based on the flat channel profile from the stormwater outfalls to the South Platte River, channel scour is not expected to occur as a result of increased flows and hydraulic energy resulting from implementation of the Drainage Plan.

Beaver Pond Wetlands Hydrology Enhancement Project

The conceptual plan for enhancing hydrology at the Beaver Pond Wetlands consists of installing a sheet-pile cutoff wall that will increase the elevation of the groundwater table in an area upgradient of the wall (see Figure 3 and the attached Sheet Pile Exhibit). This structure could be installed to be flush with the ground (as depicted on the Sheet Pile Exhibit), allowing it to intercept groundwater flowing from south-to-north along the drainage channel and historic Beaver Pond Wetlands area, encouraging a higher groundwater table in the zone of influence. Alternatively, the sheet pile wall could be constructed to have a small above-ground weir in the central portion of the drainage swale (as depicted on Figure 3), adding the additional benefit of allowing SSPR to modify surface flow through the area.

Additionally, the south stormwater quality pond's outfall is designed to discharge to the Beaver Pond Wetlands upstream of the sheet-pile wall structure. This will further enhance the groundwater effects of the sheet-pile cutoff wall.

Rationale for Sheet-Pile Wall Structure

This project approach is viewed as very likely to achieve desired hydrology enhancement based on the following rationale and assumptions:

- The general flow direction of groundwater is the same direction as the flow of surface water (i.e., flows are from south to north). This assumption will be evaluated upon completion of the planned geotechnical survey of this area.
- Currently, groundwater flows pass through highly permeable alluvial soils toward the South Platte River. Based on the expected high permeability of these soils, the relative volume and velocity of groundwater flows are high. These conditions should support the desired hydrologic effects from the cutoff wall.
- If a sheet pile cutoff wall is installed such that it blocks the path of groundwater, the result will be a localized increase in the water table elevation in the areas upgradient of the cutoff wall.
    - The degree to which the water table is elevated will depend on current water table elevations, soil permeability, and cutoff wall length. This will be better known following completion of a planned geotechnical survey of the area, but is preliminarily expected to result in enhanced wetland hydrology in the areas upgradient (i.e. south) of the cutoff wall, extending to areas with ground surface elevations that are within 12 inches of the ground elevation along the cutoff wall alignment.

The sheet-pile wall is viewed as a feasible means for enhancing Beaver Pond Wetland hydrology based on the following considerations:

- The project can be installed with a minimal impact footprint and in a short period of time.
- The project requires only minimal permitting due to the limited permanent impacts to waters of the U.S.
- The project can be designed to allow adaptive management of the elevation and size of the low-flow orifice.
- The project appears to promote a hydrologic regime that was present when beaver activity occurred in this area and when the Beaver Pond Wetlands were in better condition.

Project Design Criteria

If this approach is acceptable to SSPR, SWCA recommends developing a project design that meets the following general criteria.

- The location for the sheet-pile drop structure should be selected based on an evaluation of the existing topographic survey for the area. Based on the reviewed topography, the location and conceptual configuration depicted on Figure 3 appear likely to result in a significant hydrologic enhancement of the Beaver Pond Wetlands.
- The sheet-pile drop structure should be installed so that it extends beyond the existing swale's low-flow channel. This will lower the risk that a bypass channel forms around the perimeter of the structure. If surface hydrology control is desired, a small span of the cutoff wall can be installed above-ground, with removable weirs (as depicted in Figure 3). Alternatively, if only groundwater enhancement is desired, the entire sheet-pile wall should be installed to the existing ground's surface.
- Where it extends beyond the low-flow channel, the sheet-pile wall should be installed so that it is driven to be lower than the current ground elevation.

- Where it is installed in the low-flow channel, the orifice of the sheet-pile drop structure should be installed so that the bottom of the orifice is flush with the channel bed at the thalweg.
- If constructed to allow surface water manipulation (i.e., through the construction of an above-ground, adjustable weir), the sheet-pile wall should be installed to promote easy and safe access to the orifice. This will promote adaptive management of the release rates and water height.
    - This will allow operation of the structure in a manner that avoids injuring downstream water rights and the need to navigate a Colorado Water Court process.
- The project will require Clean Water Act Section 404 authorization. This authorization can likely be obtained by working under one of the U.S. Army Corps of Engineers' Nationwide Permits. These permits provide authorization for activities that have no more than minimal adverse environmental effects and which conform to the Nationwide Permit impact thresholds and other conditions. Notification to the U.S. Army Corps of Engineers is expected to be required for this project.

In developing the design for this drop structure, SWCA recommends incorporating local drainageway design criteria and input from SSPR.

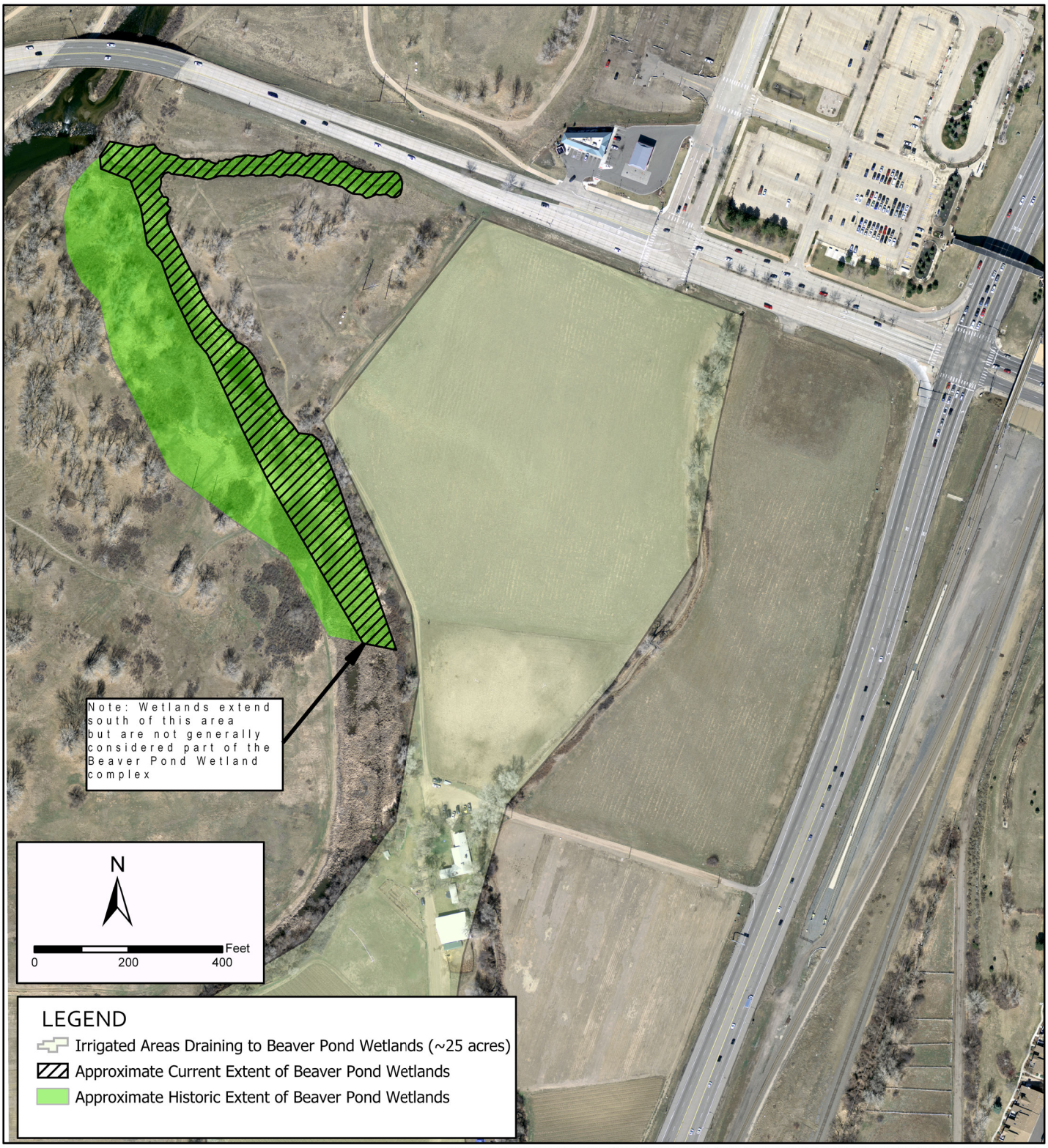
CONCLUSION

The Development Project's drainage plan and wetland hydrology enhancement project were developed to address SSPR concerns regarding the declining health of the Beaver Pond Wetlands. Based on SWCA's evaluation, the Development Project will promote an increase in overall water availability in this area when compared to the current condition. The increase in overall water availability, coupled with the expected increase in water surface elevation fluctuations, should enhance the hydrologic condition of this area. SSPR should expect that ongoing evaluation and adaptive management of this area will be required in order to achieve their desired improvement to the Beaver Pond Wetlands.

Sincerely,

Noah Greenberg, PWS
Project Manager and Aquatic Resource Scientist
SWCA Environmental Consultants

Attachments: Figures 1–3
Sheet Pile Exhibit
Phase 2 Drainage Plan



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BEAVER POND WETLAND ENHANCEMENT PROJECT
Current Conditions

FIGURE 1

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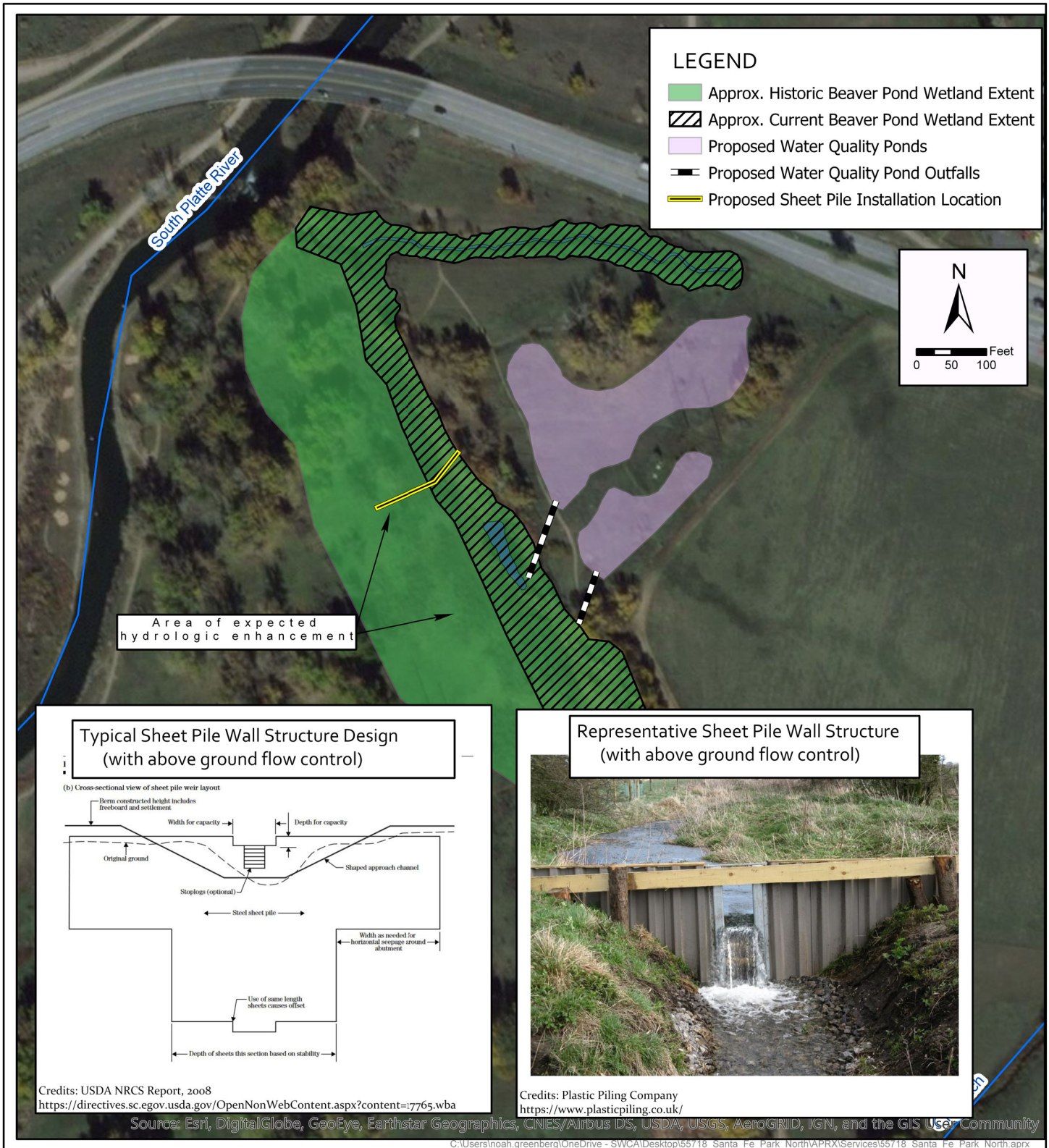
BEAVER POND WETLAND ENHANCEMENT PROJECT
Historical Conditions (1964)

FIGURE 2



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BEAVER POND WETLAND ENHANCEMENT PROJECT
Potential Hydrology Enhancement Design

FIGURE 3