
MEMORANDUM



DATE: September 6th, 2019 **ACE PROJECT NO.:** COFCFAIRWAY_ESTATES2019
TO: Chris Dietzler
Fairway Estates HOA
FROM: Travis Rounsaville, Anderson Consulting Engineers, Inc.
Brad Anderson, Anderson Consulting Engineers, Inc.
SUBJECT: Fairway Estates Pond – Assessment of Sediment and Water Quality

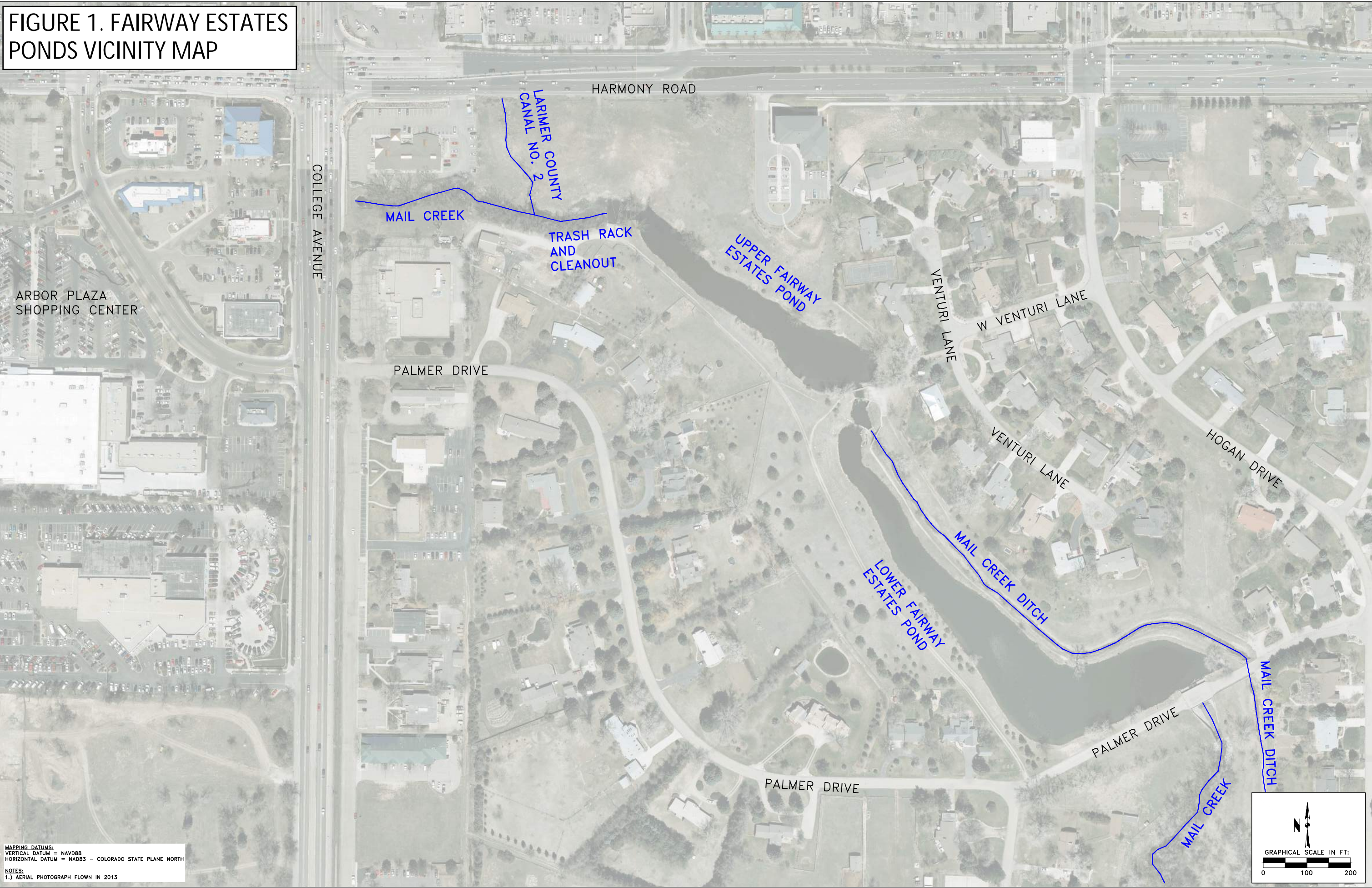
The purpose of this memo is to provide a brief history of the Mail Creek Basin and the Fairway Estates Ponds, and to summarize the steps and results of a preliminary assessment of sediment and water quality issues related to the Fairway Estates Ponds. This preliminary assessment includes the following tasks: 1) Identify How the Fairway Estates Ponds Function within the Mail Creek Basin; 2) Assess the extent of existing sediment and water quality problems in Fairway Estates Ponds; 3) Assess channel hydraulics and sediment transport capabilities of Mail Creek; and 4) Recommendations and potential solutions. To complete these tasks, Anderson Consulting Engineers (ACE) obtained effective hydraulic and hydrologic models from the City of Fort Collins and coordinated with City of Fort Collins Stormwater staff to discuss planned improvements for the Mail Creek Basin.

Background and Previous Studies

Mail Creek is a tributary of Fossil Creek. The Mail Creek Basin is located in southwest Fort Collins and covers approximately 1,676 acres. The basin drains from west to east, with the most upstream portion of the basin extending into the foothills just west of Taft Hill Road. The basin is generally bounded on the north by Horsetooth Road and extends approximately ¼ mile south of Harmony Road. The basin extends east nearly to Lemay Avenue, where Mail Creek joins Fossil Creek as a left bank tributary. Three irrigation canals flow through the basin as well.

The Mail Creek Basin was historically agricultural and undeveloped land. The first major developments in the basin started with the Fairway Estates ponds and neighborhood. Construction started on the ponds in the early 1960s, with development of the Fairway Estates neighborhood following thereafter and continuing through the 1970s. Several mixed-use residential developments were constructed west of College Avenue in the 1980s and 1990s. Construction of the Arbor Plaza Shopping Center on the southwest corner of College and Harmony was a major change in the basin, as Mail Creek became confined to a box culvert under the parking area for approximately 1,000 feet. Fairway Estates residents noted a lot of additional sediment and debris during and after construction of Arbor Plaza Shopping Center. Currently, the basin is mostly developed; the upper portion of the basin is mostly mixed-use residential, while the area near College Avenue consists mostly of commercial development. A vicinity map of the Fairway Estates Ponds is shown in Figure 1.

**FIGURE 1. FAIRWAY ESTATES
PONDS VICINITY MAP**



MAPPING DATUMS:
VERTICAL DATUM = NAVD83
HORIZONTAL DATUM = NAD83 - COLORADO STATE PLANE NORTH

NOTES:
1.) AERIAL PHOTOGRAPH FLOWN IN 2013

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The Mail Creek Basin experienced notable flood events in 1965, 1997, 1999, and 2013. The 1999 flood was particularly noteworthy for Fairway Estates, as a portion of the Upper Pond dam experienced undermining failure, resulting in large amounts of sediment deposited into the Lower Pond. The dam was repaired and wingwalls were added to the dam for additional protection. During the flood, a concrete apron in the Upper Pond, located just upstream of the dam, helped to limit damage to the structure.

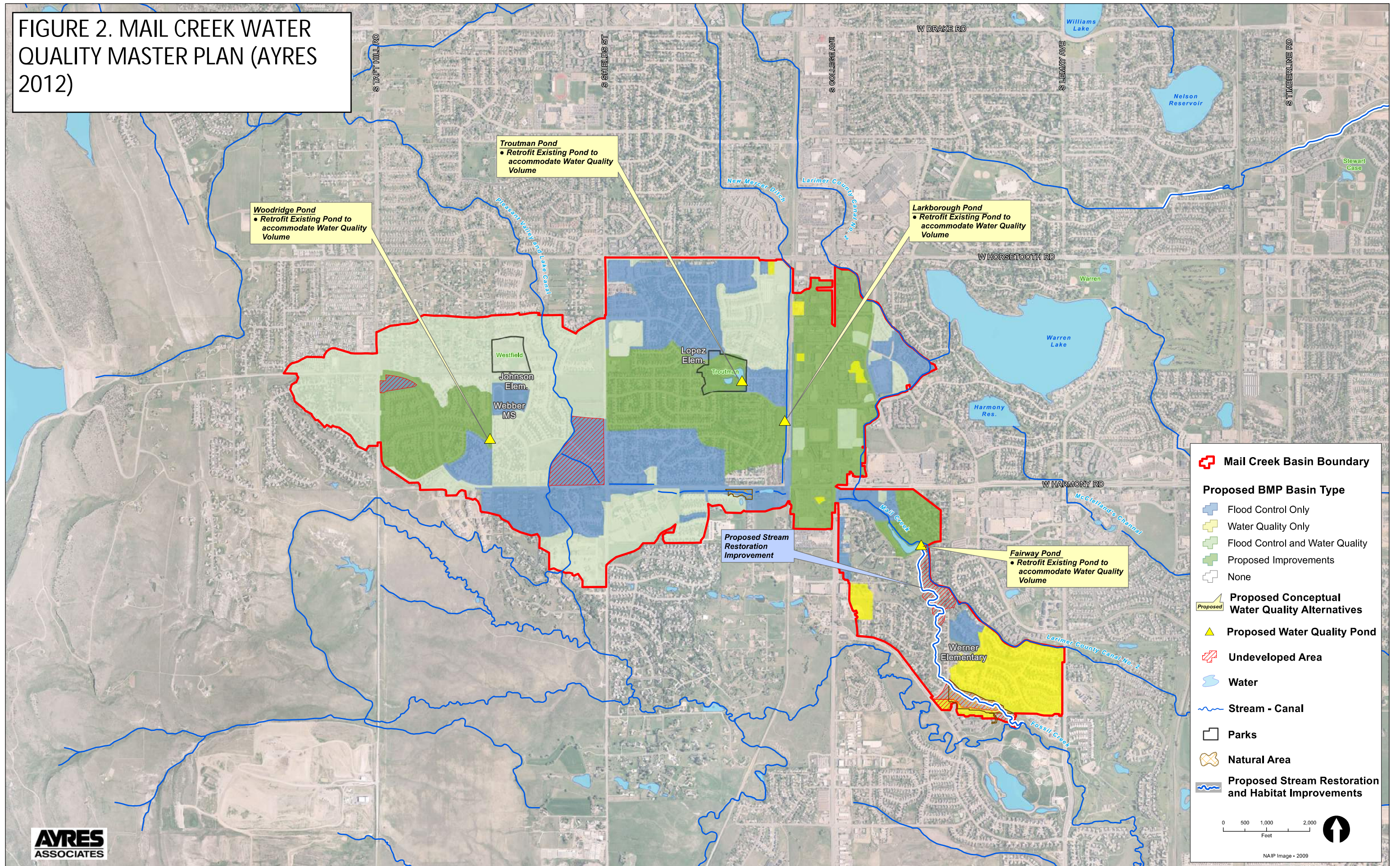
Through the years, several major studies have been completed on Mail Creek and the Mail Creek watershed. The first major study on Mail Creek was completed in 1980 by Cornell Consulting Company and was the basis for the initial Master Plan for the Mail Creek Basin. A stability study for Mail Creek was completed in 1993 by TST and Lidstone & Anderson. In 2012, Colorado State University completed an assessment and rehabilitation study for all creeks in Fort Collins, including Mail Creek. Ayres and Associates updated Mail Creek hydrology in 2010 and subsequently completed a Water Quality Master Plan for the Mail Creek Basin in 2012. The 2012 Ayres Water Quality Master Plan is the most current study on Mail Creek and provides information on future water quality improvements planned by the City of Fort Collins. A map of the 2012 Water Quality Master Plan is presented in Figure 2. A PDF of the Ayres 2012 Water Quality Master Plan report has been included as an electronic appendix on the disc attached to this memo.

In late 1990, a homeowner survey about sediment and trash/debris problems in Mail Creek was completed by Fairway Estates residents. These surveys provide useful anecdotal data describing both the sedimentation issues and trash problems in the ponds, along with some reported depth measurements/estimates for the ponds at various times between the early 1960s and 1990. A PDF of these surveys has been included as an electronic appendix on the disc attached to this memo. The surveys describe an extreme trash problem in both Fairway Estates ponds, including 50+ automobile tires, plastic sheeting, shopping carts, plastic bottles, cans, and even such oddities as dead pigs and jugs filled with horse urine. Residents of Fairway Estates historically held a spring-cleaning day in May, and the amount of trash collected on an annual basis was enough to fill two large “farm trucks” in addition to several pickup beds.

Based in part on this input from the residents of Fairway Estates, the City of Fort Collins constructed a trash rack upstream of the Upper Fairway Estates Pond in the mid-1990s (ACE was unable to determine the exact year the trash rack was constructed, but sometime between 1993 and 1998) in order to reduce the amount of trash flowing into the Fairway Estates Ponds. The pool upstream of the trash rack also collects sediment, reducing the sediment inflow into the Fairway Estates Ponds.

ACE was unable to obtain original design plans for the Fairway Estates Ponds, but a 2003 report on sedimentation of the Upper Pond provided by the Fairway Estates HOA reports that the Upper Pond had a maximum depth of 12 feet in the early 1960s. In the lower pond, a maximum depth of 20 feet was

FIGURE 2. MAIL CREEK WATER QUALITY MASTER PLAN (AYRES 2012)



Woodridge Pond
 • Retrofit Existing Pond to accommodate Water Quality Volume

Troutman Pond
 • Retrofit Existing Pond to accommodate Water Quality Volume

Larkborough Pond
 • Retrofit Existing Pond to accommodate Water Quality Volume

Fairway Pond
 • Retrofit Existing Pond to accommodate Water Quality Volume

Proposed Stream Restoration Improvement

+ Mail Creek Basin Boundary

Proposed BMP Basin Type

- Flood Control Only
- Water Quality Only
- Flood Control and Water Quality
- Proposed Improvements
- None

Proposed Conceptual Water Quality Alternatives

- ▲ Proposed Water Quality Pond
- ▨ Undeveloped Area
- Water
- Stream - Canal
- Parks
- Natural Area
- Proposed Stream Restoration and Habitat Improvements

0 500 1,000 2,000
 Feet

NAIP Image - 2009

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reported in the 1990 homeowner survey in an anecdote about anchoring a swimming platform in the deepest part of the pond. Over the years, depth and overall volume of the ponds has been visibly reduced by sediment inflow from the upper Mail Creek Basin. Sediment production in the Mail Creek Basin likely peaked during the 1980s and 1990s when construction and development of the western portion of the watershed were at their peak. By the early 2000s, development in the Mail Creek Basin was complete and sediment production potential of the basin likely dropped below the historic undeveloped and agricultural levels.

In the Upper Pond, loss of volume was a direct result of sediment production from the Mail Creek Basin. Between the early 1960s and 1980 the maximum reported depth of the pond decreased from 12 feet to 8 feet. Between 1980 and 1990, during the peak development of the basin, the maximum reported depth of the pond dropped from 8 feet to approximately 1 foot. By the late 1990s, the pond was reported to be full of sediment and only a small channel was left winding through the pond. As mentioned previously, a flood in 1999 resulted in an undermining failure of the Upper Pond dam, and a large amount of sediment was washed from the Upper Pond into the Lower Pond. Any sediment moved from the Upper Pond to the Lower Pond was replaced over the next few years, and by the early 2000s the Upper Pond was once again reported to be full of sediment.

In the winter of 2003 and 2004, Fairway Estates and the City of Fort Collins completed a dredging project, removing a reported total of 10,000 cubic yards of material from the Upper Pond. Some of the 10,000 cubic yards was material imported to create a ramp into the pond for equipment and subsequently removed. ACE estimates the post dredging volume of the pond was approximately 8,000 cubic yards (5.0 acre-feet) which corresponds to an estimated maximum depth of 10 feet (see Section 3 of this memo for more detail).

Since much of the sediment from the Mail Creek watershed was deposited in the Upper Pond, sediment inflow into the Lower Pond was much less. Loss of volume in the lower pond can largely be attributed to major events, rather than constant sediment inflow. The first major event was a construction project that doubled the size of the dam spillway. According to a resident who lived in Fairway Estates at the time, fill material was imported to divert flow around the construction site. Upon completion of construction, this material was reportedly not removed, but was instead spread and leveled throughout the pond. If this recollection is accurate, this imported material could have reduced the volume and maximum depth of the pond by a significant amount. The other large event was the previously mentioned flood of 1999, during which a significant amount of sediment was transported from the Upper Pond and deposited in the Lower pond while the upper dam was compromised.

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The following reports were utilized in background research for this study:

- A. Report “McClellands and Mail Creek Major Drainageway Plan” [Cornell Consulting Company, December 1980].
- B. Report “Trash Rack Analysis - Mail Creek Stability Study” [TST, inc, January 1991].
- C. Report “Preliminary Design Report - Mail Creek Stability Study” [TST, inc with Lidstone & Anderson, January 1993].
- D. Report “Mail Creek Basin Master Drainage Plan – Hydrology Technical Appendix” [Ayres Associates, October 2010].
- E. Report “Assessments and Rehabilitation Decision-Making Framework for the Streams of Fort Collins” [Colorado State University, January 2012].
- F. Report “Water Quality Selected Plans – Mail Creek Basin” [Ayres Associates, March 2012].
- G. FEPOA Annual Meeting Notes 2003.

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Preliminary Assessment of Sediment and Water Quality Issues Related to the Fairway Estates Ponds

Task 1. Identify How the Fairway Estates Ponds Function within the Mail Creek Basin

In the March 2012 Ayres Associates Water Quality Master Plan for the Mail Creek Basin, the Lower Fairway Estates Pond is identified as contributing flood control storage to the basin, with no water quality detention associated with either pond. The Lower Pond is assumed to have a storage volume (above the spillway crest) of 24.2 acre-feet in the existing condition but would still overtop in a 100-year event, based on Ayres's modeling.

In the selected Master Plan condition, the City of Fort Collins proposes to add 0.47 acre-feet of water quality storage to the Lower Fairway Estates Pond (above the spillway elevation), through grading modifications along the eastern side of the pond. The existing outlet structure will also be retrofitted with a "water quality orifice plate/structure." Once complete, the Lower Fairway Estates Pond will provide both flood control and water quality storage benefits to Mail Creek. No definite timeline has been identified for improvements to Lower Fairway Estates Pond but based on discussions with City of Fort Collins Stormwater staff, this project is not on the 2020-2022 funding list for major capital stormwater projects. City of Fort Collins staff also indicated that they would be interested in exploring project partner opportunities with Fairway Estates HOA. A map of the proposed improvements to the Lower Fairway Estates Pond is shown in Figure 3.

In addition to the proposed water quality storage improvements in the lower Fairway Estates Pond, the March 2012 Water Quality Master Plan identifies three other ponds upstream of Fairway Estates in the Mail Creek Basin for water quality storage improvements. Woodbridge Pond, Troutman Park Pond, and Larkborough Pond all have proposed improvements that would increase the water quality storage volume by a collective 5.1 acre-feet. An increase in water quality storage volume from improvements to these ponds would help improve the water quality of Mail Creek entering Fairway Estates. As with the proposed improvements for the lower Fairway Estates pond, no definite timeline has been established for these Water Quality Master Plan improvements. As previously mentioned, a PDF of the 2012 Ayres and Associates Water Quality Master Plan report for the Mail Creek Basin is included on the digital appendix disc.

FIGURE 3. PROPOSED WATER IMPROVEMENTS TO LOWER FAIRWAY ESTATES POND (AYRES 2012)



1" = 150'

FAIRWAY POND (100)

Figure C3

AYRES
ASSOCIATES

LEGEND	
	Storm Line/MH/Inlet
	Sanitary Line/Manhole
	Water Line/Hydrant
	Water Line/Hydrant
	Electric Line
	Fiber Optic Line
	Property Line

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Task 2. Assess the extent of existing sediment and water quality problems in Fairway Estates Ponds

ACE conducted two site visits with representatives of the Fairway Estates HOA, Christopher Dietzler and David Ramsay, to gain their insights about current and historic sediment and water quality problems in the Fairway Estates Ponds. ACE also conducted a site visit with aquatic biologist Ken Kehmeier and another site visit with City of Fort Collins stormwater quality engineer Basil Hamdan to gain their insight regarding water quality concerns and potential solutions. Finally, two additional site visits were made by ACE staff to gather bathymetric data to quantify the current maximum depth and volume for both ponds, and to estimate the quantity of sediment trapped upstream of the trash rack.

Ken Kehmeier of Ksqrdfish Aquatics LLC provided an initial assessment of the fishery along with a fisheries management prospectus. During his visit, Mr. Kehmeier observed a limited largemouth bass population, good populations of bluegill and green sunfish, and several large carp. He recommended emphasizing largemouth bass and bluegill for a recreational fishery. Mr. Kehmeier's primary concern was the lack of water quality data being collected and recommended comprehensive initial water quality testing for parameters including petroleum byproducts, metals, and other contaminants. He suggested the initial comprehensive testing be followed by quarterly water quality testing for temperature, oxygen, PH, Hardness, and alkalinity. Mr. Kehmeier's full report is included on the electronic appendix disc attached with this memo.

The trash rack, installed upstream of Fairway Estates Ponds in the mid-1990s, is currently functioning to trap trash from the Mail Creek drainage before it can enter the Fairway Estates Ponds. The City of Fort Collins is responsible for maintenance of the trash rack, and it is cleaned on approximately a quarterly basis. The amount of trash upstream of the rack varied from visit to visit, depending on how recently it had been cleaned by City of Fort Collins crews. During ACE site visits there was very little trash noted in either the Upper or Lower Fairway Estates ponds, therefore the trash rack is functioning well to trap most trash before it enters the ponds. The only limitations to effectiveness of the trash rack are high flows that could potentially overtop the trash rack, or the potential for over-accumulation of trash due to lack of maintenance.

The trash rack also serves as a sediment trap, and the pool upstream of the trash rack is currently filled with sediment. During one of the site visits, ACE measured sediment depths of up to 3 feet in the center of the pool upstream of the trash rack and based on several additional measurements made through the pool, an average sediment depth of 2 feet was assumed for volume calculations. ACE estimates at least 500 cubic yards of sediment are currently stored in the pool upstream of the trash rack.

ACE's bathymetric survey of the upper pond was completed while the pond had a water surface elevation of approximately 4999 (ft, NAVD88), with approximately 5 cfs spilling over the upper dam. At this water surface elevation, ACE found the upper pond has a maximum depth of 8.4 feet and a volume of 4.2 acre-

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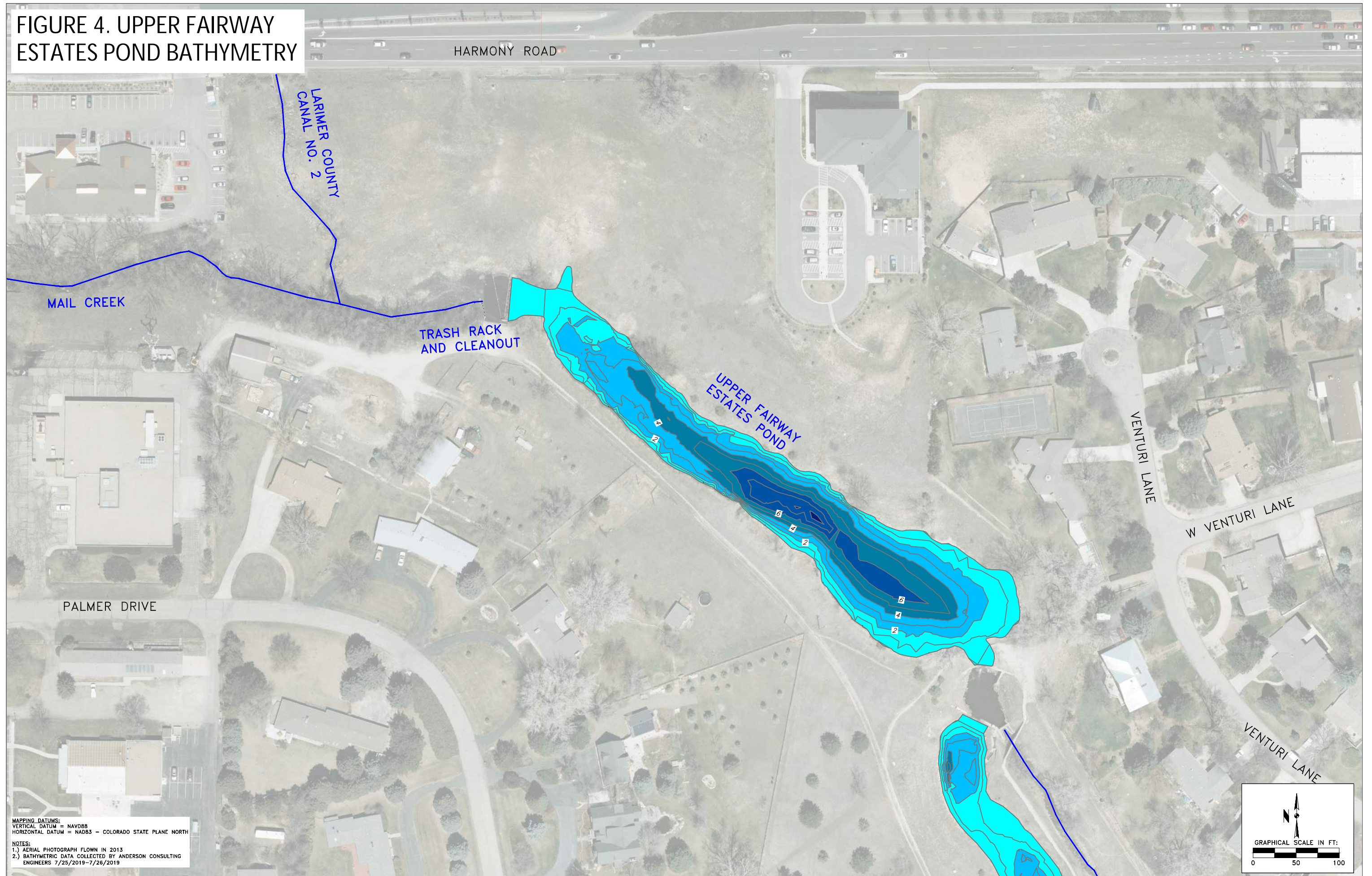


feet. This represents approximately 17% less than the estimated post 2003 dredging volume of 5.0 acre-feet and maximum depth of 10 feet, with the reduction in both maximum depth and volume likely due to sediment deposition since 2003. Analysis of bottom density shown by the sonar results showed a layer of soft material (likely sediment deposition) ranging between 6 inches and 2-feet over the top of a more armored bottom layer. Bathymetric survey data for the upper pond are shown in Figure 4

ACE's bathymetric survey of the lower pond was completed with a water surface elevation of approximately 4984.0 (ft, NAVD88), with water barely spilling through the middle two bays of the spillway. ACE found a maximum depth of 11.8 feet and computed a storage volume of 14.7 acre-feet below the crest of the spillway. The maximum depth of less than 12 feet is significantly less than reported historic depths of 20 feet. Analysis of bottom density shown in the sonar results revealed a hard bottom in the deepest southern portion of the pond. Hard bottom is not typically associated with depositional sediment, therefore, reduction of depth in this area can likely be attributed to the imported fill material used during construction of the improved spillway. In the northern arm of the pond, sonar results revealed a layer of soft bottom material (likely sediment deposition) of up to 2-3 feet over a hard bottom. Much of this sediment was likely deposited during the 1999 dam failure, with some amount of additional sediment deposition since then. Bathymetric survey data for the lower pond are shown in Figure 5.

Beyond water quality data that can be assessed visually or with sonar (trash and sediment), there is currently no water quality data being collected on Mail Creek. ACE met with Basil Hamden, stormwater quality engineer for the City of Fort Collins, to discuss additional water quality data that would be useful. Mr. Hamden explained that the City of Fort Collins collects quarterly "grab samples" at eight sites on direct tributaries to the Poudre River (Fossil Creek, Spring Creek, Boxelder Creek). The City also has several continuous water quality measurement devices on the Poudre River itself. Since Mail Creek is not a direct tributary to the Poudre River, no water quality data is currently collected by the City anywhere on the creek. Mr. Hamden recommended quarterly sampling for temperature, oxygen, PH, total Coliform/E Coli, total nitrogen, total phosphorus, total dissolved solids, and turbidity. Mr. Hamden also said water quality data for Mail Creek would be useful and that there may be a possibility for cost sharing or partnership.

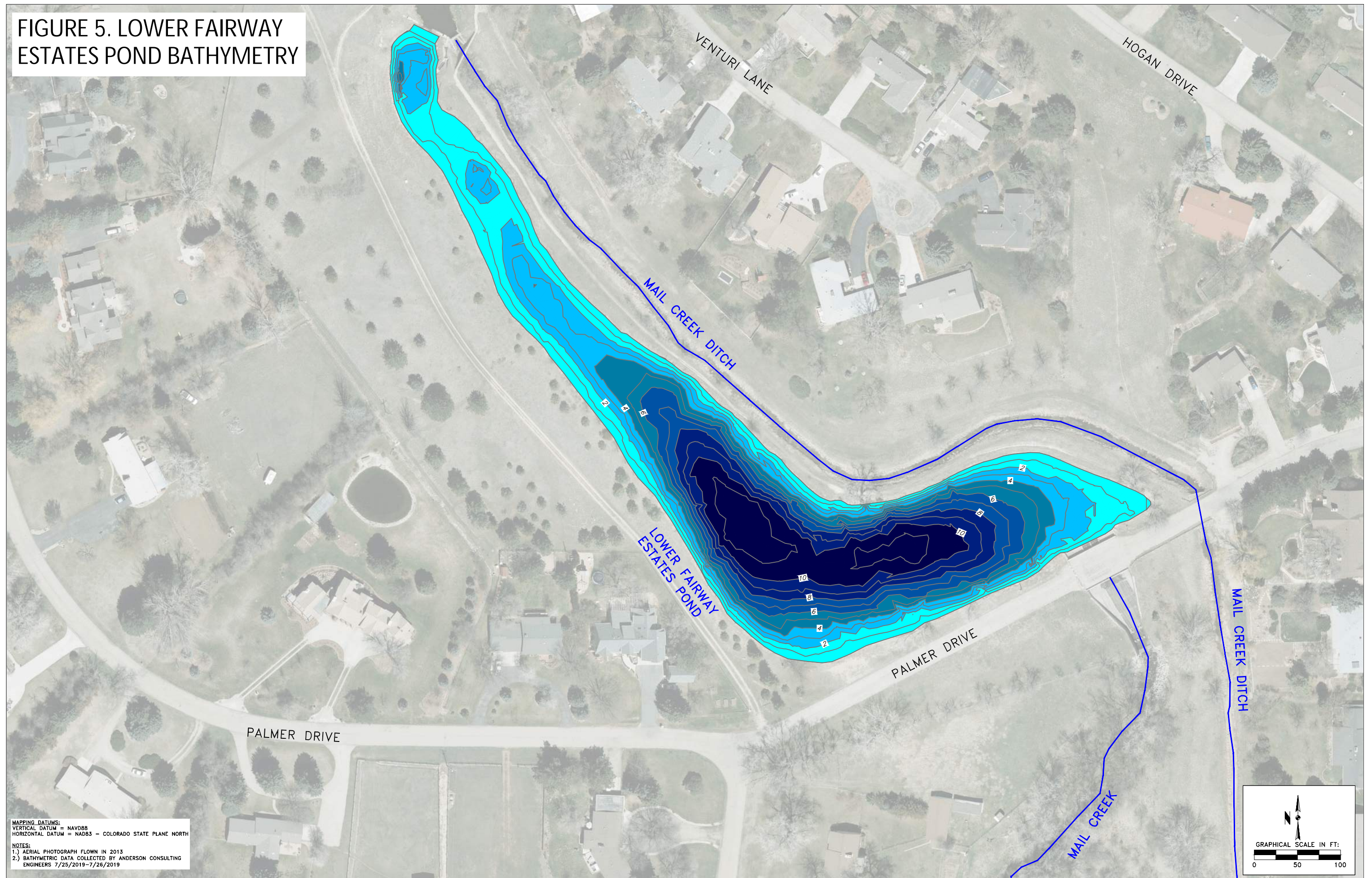
FIGURE 4. UPPER FAIRWAY ESTATES POND BATHYMETRY



MAPPING DATUMS:
VERTICAL DATUM = NAVD88
HORIZONTAL DATUM = NAD83 - COLORADO STATE PLANE NORTH

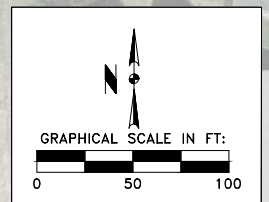
NOTES:
1.) AERIAL PHOTOGRAPH FLOWN IN 2013
2.) BATHYMETRIC DATA COLLECTED BY ANDERSON CONSULTING ENGINEERS 7/25/2019-7/26/2019

FIGURE 5. LOWER FAIRWAY ESTATES POND BATHYMETRY



MAPPING DATUMS:
VERTICAL DATUM = NAVD88
HORIZONTAL DATUM = NAD83 - COLORADO STATE PLANE NORTH

NOTES:
1.) AERIAL PHOTOGRAPH FLOWN IN 2013
2.) BATHYMETRIC DATA COLLECTED BY ANDERSON CONSULTING ENGINEERS 7/25/2019-7/26/2019



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Task 3. Assess Channel Hydraulics and Sediment Transport Capabilities of Mail Creek

ACE obtained the effective hydraulic model from the City of Fort Collins and evaluated the hydraulics and sediment transport for Mail Creek. It should be noted that the effective hydraulic model does not include the trash rack. ACE adjusted flows in the effective model to match the updated hydrology from Ayres 2010 study and added additional low flow profiles for 25cfs, 50cfs, 100cfs, 150cfs, and 200cfs to cover the range of typical spring irrigation influenced flows that are smaller than the 2-year flood event. ACE then evaluated the channel shear stress at four locations: in the Mail Creek channel just downstream of the Larimer Canal #2 confluence, in the Upper Pond, in the northwest corner of the Lower Pond, and in the southeast corner of the Lower Pond.

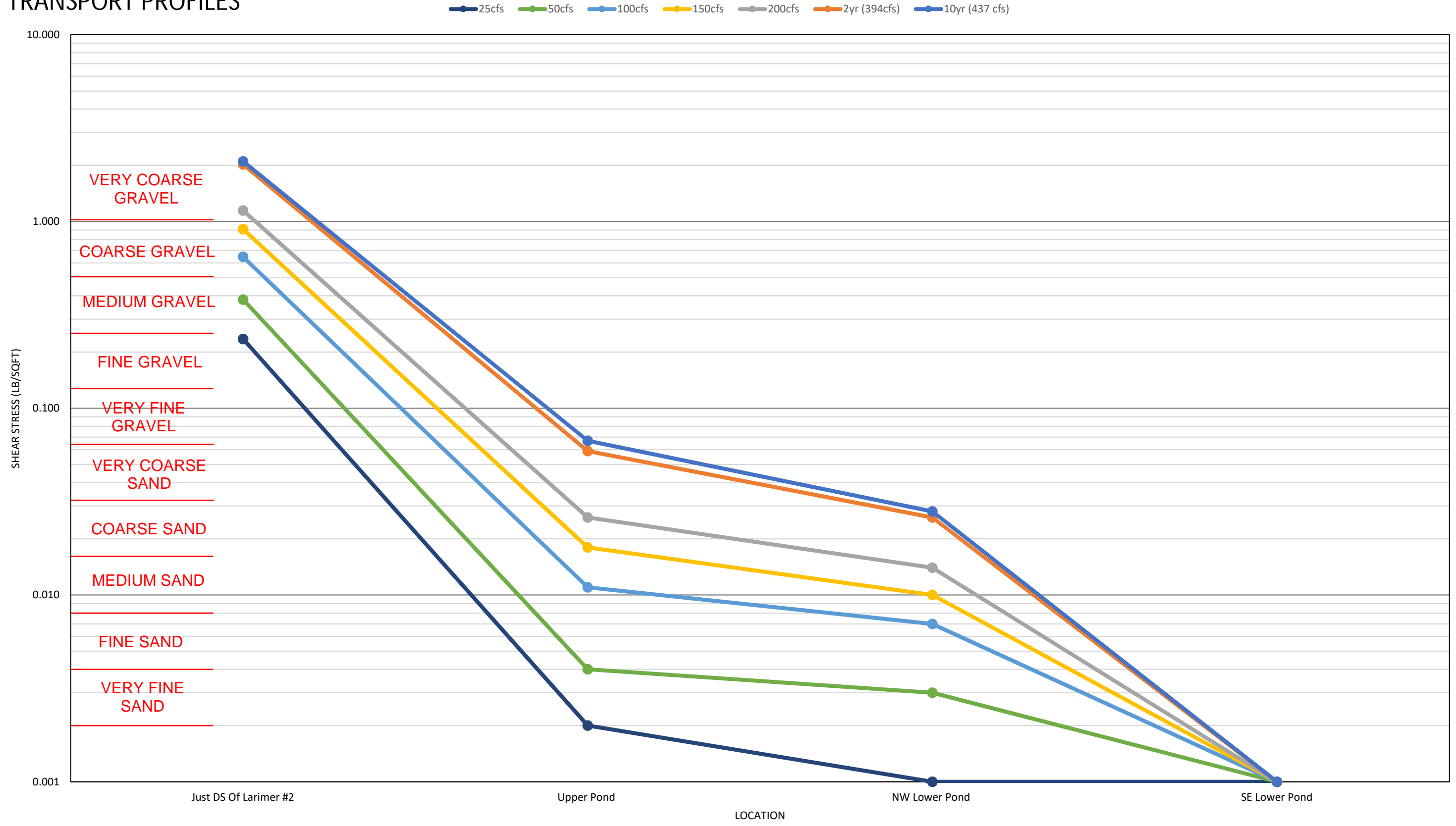
ACE compared channel shear stress values with incipient motion calculations for a variety of sediment sizes ranging from very fine sand to very coarse gravel. Sediment transport profiles which show the largest sediment size capable of being moved at each location during a range from 25cfs to the 10-year flood (437 cfs) were developed. These sediment transport profiles are shown in Figure 6, along with the largest sediment size capable of transport at a given shear stress. In the channel just downstream of the confluence with Larimer Canal #2, Mail Creek can convey very fine gravel and smaller sediment at flows as low as 25 cfs. For flows of 200 cfs and larger, Mail Creek has the hydraulic capability to transport all sediment up to and including very coarse gravel at this location.

While the trash rack is not included in the effective model, it is clear from ACE's site visit that the pool upstream of the trash rack does serve as an effective sediment trap, especially during normal flow periods. During higher flows, sediment stored upstream of the trash rack may become mobilized and be transported into the Upper Pond, but as long as there is capacity upstream of the trash rack, most of the larger sediment will be trapped at this location.

As Mail Creek enters the Upper Pond, water slows and shear stress decreases, resulting in a decrease of sediment transport capabilities. In the upper pond, flows between 25-200cfs can transport a range of sand sizes in the western end of the pond, depending on the flow (see Figure 6) but coarse sand and gravel are not transported at all. This hydraulic modeling indicates most of the larger sediment generated in the Mail Creek watershed settles in the western portion of the Upper Pond and is not transported to the Lower Pond. Only very fine material transported as wash-load (not included on the sediment transport curves) will be carried into the Lower Pond. The exception to this would be a failure, similar to that experienced during the 1999 flood

Sediment transport curves for the Lower Pond show even lower transport capabilities than in the Upper Pond. Any sediment transported through the Upper Pond during flood flows will settle somewhere in the northwest arm of the Lower Pond, as sediment transport rates in the main pool of the Lower Pond are practically zero, even during a 10-year flood.

FIGURE 6. SEDIMENT TRANSPORT PROFILES



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Since the channel upstream of the Fairway Estates ponds is capable of transporting gravel sized sediment even during flows as low as 25cfs, the amount of sediment transported into the trash rack pool and Upper Fairway Estates Pond is limited by the supply of sediment generated in the Mail Creek watershed.

In order to estimate the amount of sediment generated in the Mail Creek Basin, ACE utilized a combination of information gained during background research and bathymetric data collected in the field. A table of reported maximum depths and corresponding estimated volumes for the Upper Fairway Estates Pond was developed. Table 1 shows reported depths and corresponding storage volume estimates for the Upper Fairway Estates Pond.

Table 1. Reported Depths and Estimated Volumes for Upper Fairway Estates Pond

Date	Pond Area (Acres)	Reported/Estimated Max Depth (Feet)	Estimated Volume (Cubic Yards)	Estimated Volume (Acre-Feet)
Early 1960s	1.34	12.0	10,500	6.5
Early 1980s	1.34	8.0-8.5	7,000	4.3
Early 1990s	1.07 (80%)	1.0-2.0	900	0.6
2003 (Pre-Dredging)	0.54 (20%)	1.0	150	0.1
2004 (Post-Dredging)	1.34	10.0	8,000	5.0
2019	1.34	8.4	6,700	4.2

Utilizing these estimated depths and volumes, along with dates of known changes in the watershed, historic average annual sedimentation rates for the Upper Fairway Estates Pond during three distinct periods of watershed development were approximated: (a) Prior to development when the watershed was undeveloped/agricultural, (b)during peak development of the watershed, and (c)post development.

Between the early 1960s and early 1980s, the Mail Creek Basin was mostly agricultural and undeveloped lands. During this time period, the volume of the Upper Fairway Estates Pond decreased by an estimated 3,500 cubic yards over the 20-year period. This corresponds to an estimated average annual sedimentation rate of 175 cubic yards per year in the Upper Fairway Estates Pond.

Between 1980 and 1990, the Mail Creek Basin entered a period of rapid development, with peak development occurring in 1986-1987 when the Arbor Plaza Shopping Center (Wal-Mart area) and several large subdivisions were being developed in the basin. Between 1980 and 1990, the Upper Fairway Estates Pond decreased by an estimated 6,100 cubic yards over an approximately 10-year period. This corresponds to an estimated average annual sedimentation rate of 610 cubic yards per year over that time period, but the peak was likely much higher in 1986 and 1987. Reports from residents in the December 1990 survey indicate that the most obvious visible changes to the pond occurred in 1986 and 1987 with sedimentation rates of 1,000-2,000 cubic yards per year in the Upper Pond probable during that time frame.

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Between the early 1990s and early 2000s, the Mail Creek Basin and the Upper Fairway Estates ponds experienced two large flood events and several key changes to the basin. Development in the basin tapered off during this time period and by the early 2000s development in the watershed was mostly complete. The City of Fort Collins installed the trash rack just upstream of the Upper Pond in the mid-1990s, and this also served as a sediment trap reducing the amount of sediment entering the Upper Pond. In 1999, the flood and subsequent failure of the Upper Pond dam resulted in a large amount of sediment being flushed from the Upper Pond into the Lower Pond. By 2003, there wasn't an Upper Pond to speak of, just a creek channel winding through sediment deposition. Since the pond was already nearly full of sediment in 1990 and a large amount of sediment was flushed from the Upper Pond to the Lower Pond during the flood of 1999, it is difficult to estimate an average annual rate of sedimentation for the Upper Pond during this time period.

In the winter of 2003 and 2004, a reported 10,000 cubic yards of material were removed through dredging. After accounting for the fact that some of this material was initially imported to facilitate equipment access into the pond, and the fact that loose earth has a greater volume than the same material in-situ, the post-dredging volume of the pond was estimated to be 8,000 cubic yards or 5.0 acre-feet, with a maximum depth of 10.0 feet. A volume of approximately 8,000 cubic yards was also computed by subtracting areas with softer bottom readings (likely sediment deposition) from the 2019 bathymetric survey.

In 15 years between 2004 and the ACE bathymetric survey in 2019, the Upper Pond lost an estimated 1,300 cubic yards of capacity through sedimentation. This corresponds to an estimated average annual sedimentation rate of 87 cubic yards per year in the Upper Fairway Estates Pond, much lower than the peak rates of the 1980s. With a full bathymetric survey now available as a baseline, Fairway Estates can continue to monitor average annual sedimentation rates in the Upper Fairway Estates Pond with greater precision in the future.

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Task 4. Recommendations and Potential Solutions

ACE has provided the following six recommendations for the Fairway Estates Ponds. Figure 7 shows a map of recommendations relevant to the Upper Pond and Figure 8 shows a map of recommendations relevant to the Lower Pond.

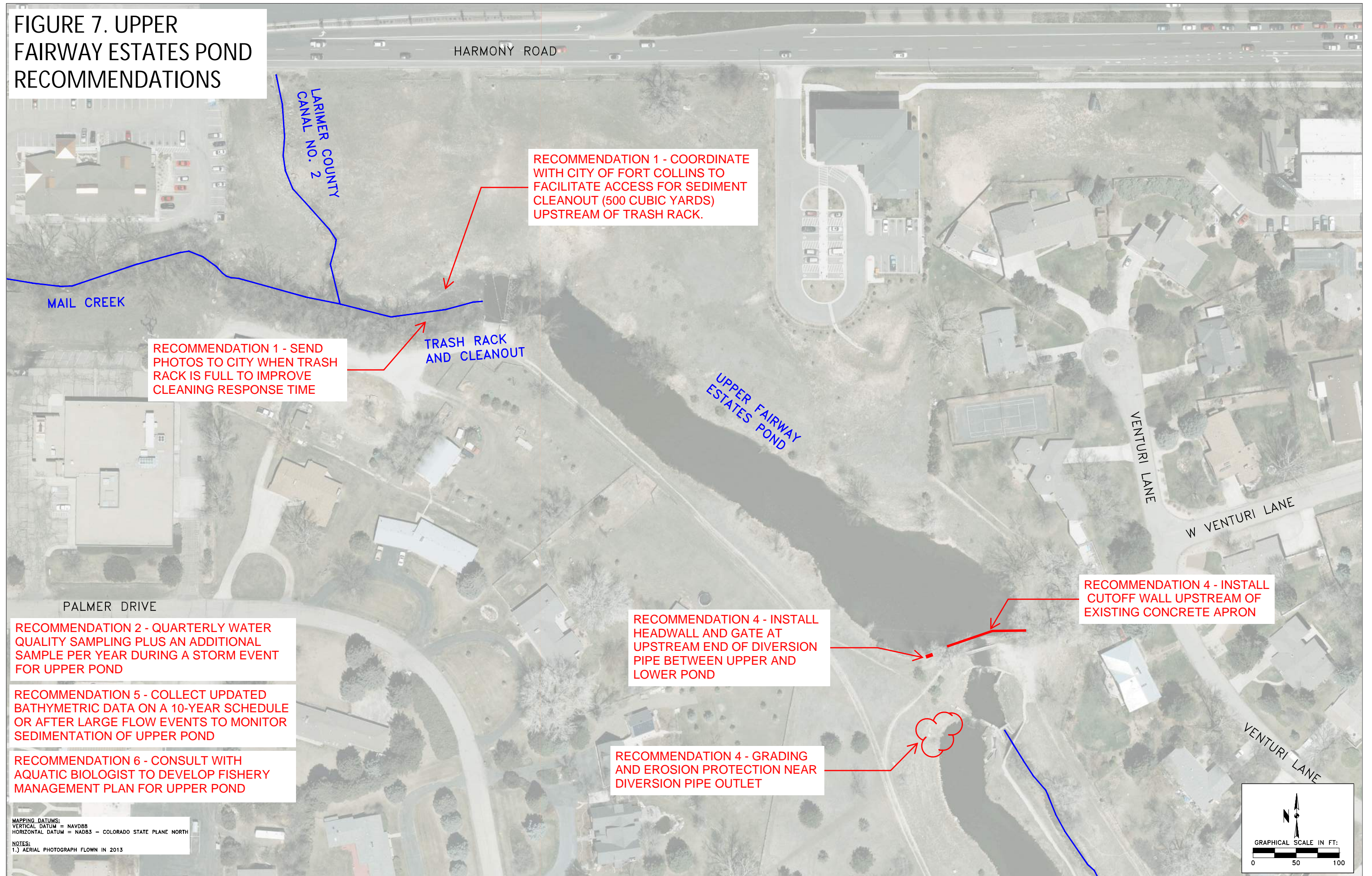
1. The existing trash rack upstream of the Fairway Estates ponds greatly reduces the amount of trash and sediment entering the ponds. The only limitations to the functionality of this trash rack are the possibility of overtopping in a larger flow events and the possibility of over-accumulation of trash or sediment due lack of maintenance. The City of Fort Collins is responsible for maintenance of the trash rack. Based on information from Doug Groves, the trash rack is checked at least once per month and is generally cleaned on a quarterly basis, or when excessive trash is noted during monthly checks. Mr. Groves did not have records of the last sediment cleanout upstream of the trash rack but believed sediment had been removed at least once before his tenure. Based on field work, ACE estimates at least 500 cubic yards of sediment are currently trapped upstream of the trash rack.

While the City of Fort Collins is responsible for maintaining and improving the trash rack upstream of the Fairway Estates ponds, the Fairway Estates HOA should continue to monitor the trash rack and send photos to City when it is full of trash, in order to improve cleanout response time. The HOA should also continue to inquire about planned sediment cleanout/dredging upstream of the trash rack. Mr. Groves mentioned it being a priority for their operations and maintenance budget in the next year or two, but additional coordination with the HOA in regard to access may be helpful. Mr. Groves mentioned a possible improvement to the trash rack would be the addition of a camera that could be monitored by his staff and the Fairway Estates HOA. A camera could improve the ability to monitor debris loading at the trash rack and improve City response times when the debris loading is high.

2. Beyond trash and sediment, which can be visually assessed or physically measured, there is currently a lack of additional water quality data for the Fairway Estates ponds. The City of Fort Collins collects quarterly “grab samples” at eight sites on direct tributaries to the Poudre River (Fossil Creek, Spring Creek, Boxelder Creek). The city also has several continuous water quality measurement devices on the Poudre River. Since Mail Creek is not a direct tributary to the Poudre River and the Fairway Estates ponds are private, it is unlikely that the City of Fort Collins will collect water quality data at this location without a partnership or cost sharing relationship with Fairway Estates.

ACE recommends collecting additional baseline water quality data using the same quarterly “grab sample” methodology utilized on other sites in town. Based on discussions with City Stormwater

FIGURE 7. UPPER FAIRWAY ESTATES POND RECOMMENDATIONS



RECOMMENDATION 1 - COORDINATE WITH CITY OF FORT COLLINS TO FACILITATE ACCESS FOR SEDIMENT CLEANOUT (500 CUBIC YARDS) UPSTREAM OF TRASH RACK.

RECOMMENDATION 1 - SEND PHOTOS TO CITY WHEN TRASH RACK IS FULL TO IMPROVE CLEANING RESPONSE TIME

TRASH RACK AND CLEANOUT

RECOMMENDATION 4 - INSTALL CUTOFF WALL UPSTREAM OF EXISTING CONCRETE APRON

RECOMMENDATION 4 - INSTALL HEADWALL AND GATE AT UPSTREAM END OF DIVERSION PIPE BETWEEN UPPER AND LOWER POND

RECOMMENDATION 4 - GRADING AND EROSION PROTECTION NEAR DIVERSION PIPE OUTLET

RECOMMENDATION 2 - QUARTERLY WATER QUALITY SAMPLING PLUS AN ADDITIONAL SAMPLE PER YEAR DURING A STORM EVENT FOR UPPER POND

RECOMMENDATION 5 - COLLECT UPDATED BATHYMETRIC DATA ON A 10-YEAR SCHEDULE OR AFTER LARGE FLOW EVENTS TO MONITOR SEDIMENTATION OF UPPER POND

RECOMMENDATION 6 - CONSULT WITH AQUATIC BIOLOGIST TO DEVELOP FISHERY MANAGEMENT PLAN FOR UPPER POND

MAPPING DATUMS:
 VERTICAL DATUM = NAVD88
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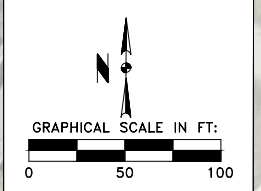
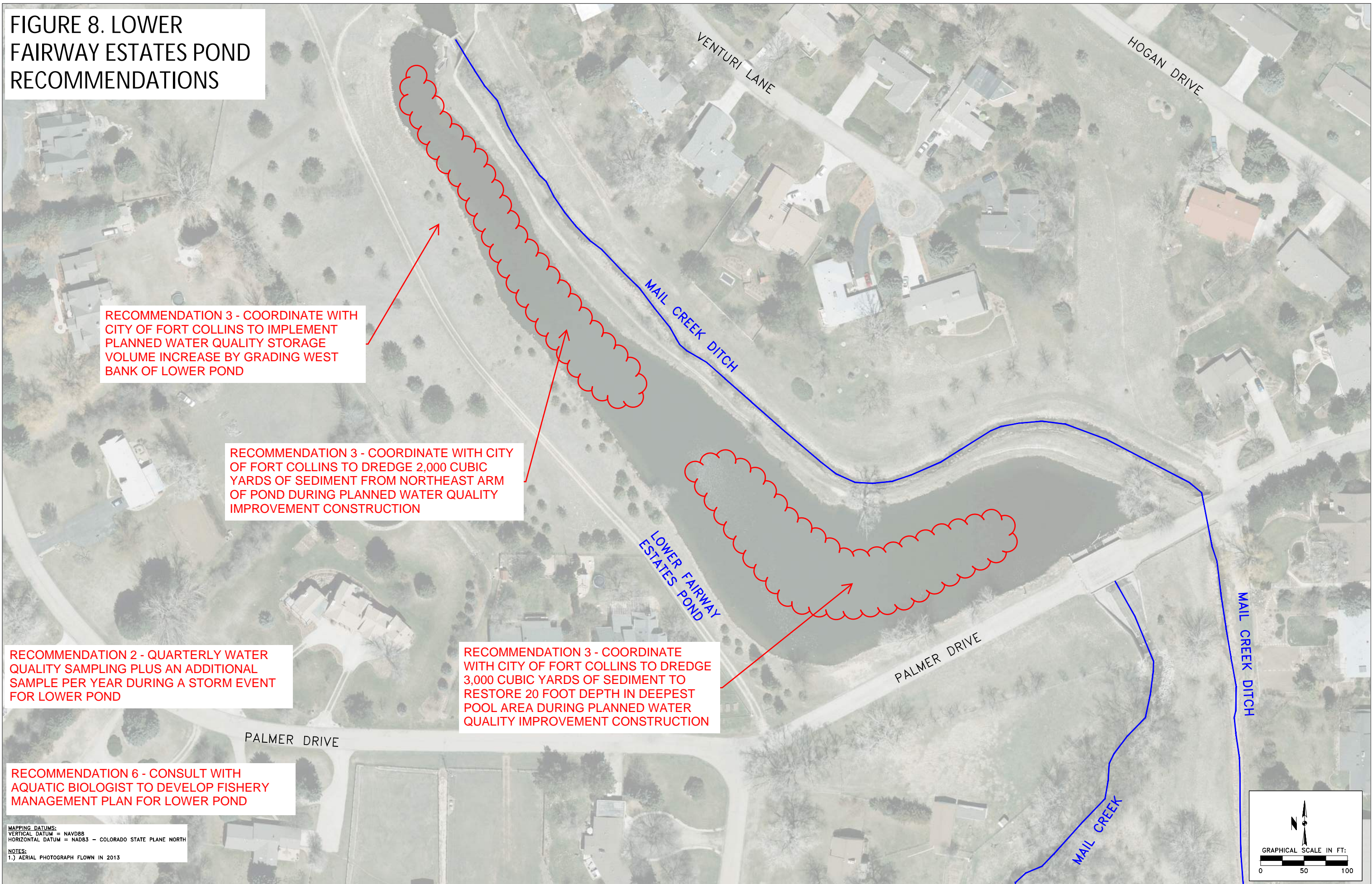


FIGURE 8. LOWER FAIRWAY ESTATES POND RECOMMENDATIONS



RECOMMENDATION 3 - COORDINATE WITH CITY OF FORT COLLINS TO IMPLEMENT PLANNED WATER QUALITY STORAGE VOLUME INCREASE BY GRADING WEST BANK OF LOWER POND

RECOMMENDATION 3 - COORDINATE WITH CITY OF FORT COLLINS TO DREDGE 2,000 CUBIC YARDS OF SEDIMENT FROM NORTHEAST ARM OF POND DURING PLANNED WATER QUALITY IMPROVEMENT CONSTRUCTION

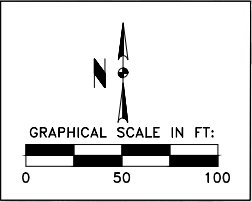
RECOMMENDATION 2 - QUARTERLY WATER QUALITY SAMPLING PLUS AN ADDITIONAL SAMPLE PER YEAR DURING A STORM EVENT FOR LOWER POND

RECOMMENDATION 3 - COORDINATE WITH CITY OF FORT COLLINS TO DREDGE 3,000 CUBIC YARDS OF SEDIMENT TO RESTORE 20 FOOT DEPTH IN DEEPEST POOL AREA DURING PLANNED WATER QUALITY IMPROVEMENT CONSTRUCTION

RECOMMENDATION 6 - CONSULT WITH AQUATIC BIOLOGIST TO DEVELOP FISHERY MANAGEMENT PLAN FOR LOWER POND

MAPPING DATUMS:
VERTICAL DATUM = NAVD88
HORIZONTAL DATUM = NAD83 - COLORADO STATE PLANE NORTH

NOTES:
1.) AERIAL PHOTOGRAPH FLOWN IN 2013



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Quality Engineer Basil Hamdan, the City of Fort Collins will not be able to provide testing services, because they are not allowed to compete with private labs. He did mention the potential for cost sharing opportunities, since he would find the data valuable. Additionally, sampling during high flows and storm events is also recommended, as this would help identify potential water quality problems that might not show up during quarterly testing.

Since the City of Fort Collins cannot provide water quality testing services, ACE reached out to MMS Laboratories for prices on additional water quality testing. Temperature, dissolved oxygen, and PH are collected by a technician in the field for a total cost of \$55 per visit. The technician would also collect a grab sample for additional testing in the laboratory. The laboratory offers a wide range of water quality tests, so ACE requested quotes for the tests specifically mentioned by Mr. Hamden. These lab tests include: Total Coliform/E Coli, Total Nitrogen, Total Phosphorus, Total Dissolved Solids, and Turbidity. The total for these lab tests for a grab sample would be \$252. Quarterly sampling of both ponds, plus a fifth yearly grab sample at each pond during a storm event would total \$3,070/year (\$1,535 per pond).

ACE has included email correspondence with the quoted testing prices, along with contact information for MMS laboratories in an electronic appendix on the disc attached to this memo.

3. Coordinate with the City of Fort Collins Stormwater staff to implement the Stormwater Quality Master Plan for the Lower Fairway Estates Pond. While this project isn't currently scheduled, the opportunity to partner with Fairway Estates may move this project up the priority list. Since this proposed project is focused on re-grading the eastern bank of the Lower Fairway Estates Pond, it presents a great opportunity to dredge the Lowe Pond. Dredging approximately 2,000 cubic yards of sediment from the northwest arm of the Lower Pond would increase the depth in this area from approximately 2 feet deep to approximately 5 feet deep, removing much of the sediment that was likely deposited in this area during the 1999 flood. Dredging an additional 3,000 cubic yards of material from the deepest portions of the lower pond would restore the original maximum depth of 20 feet.
4. Improvement of existing facilities between the upper and lower pond are recommended by 2030. While these facilities don't directly affect water quality or sediment issues in the ponds, failure of the upper dam in 1999 greatly affected the Lower Pond. Concerns over stability of the existing concrete apron and bypass pipe were mentioned by both members of the HOA as a priority. Damage during the upper dam blowout during the 1999 flood was limited by the concrete apron in the upper pond, but the apron is showing signs of age.

Recommended improvements to existing facilities include installing a headwall and gate for the

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diversion pipe between the ponds, grading and erosion protection at the outlet of the diversion pipe, and installation of a cutoff wall upstream of the existing concrete apron of the outlet/spillway of the upper fairway estates pond. Installation of a cutoff wall upstream of the existing concrete apron would further protect the upper dam/diversion. Ideally, improvements to existing facilities could be completed in conjunction with the City of Fort Collins Stormwater Quality Master Plan for Fairway Estates but could also be completed independently if necessary.

5. Continue to monitor sedimentation of the Upper Fairway Estates Pond by collecting new bathymetry data on a 10-year schedule or after large flow events. While ACE estimated the current average annual sedimentation rate to be approximately 87 cubic yards/year for the Upper Pond, the City's planned maintenance to remove sediment in the pool upstream of the trash rack will likely lower this estimated rate. Eventually another dredging project may be necessary to increase the volume of the Upper Pond, but for now ACE recommends monitoring.

6. Once a timeline has been identified for future projects and several quarters of water quality sampling have been collected, ACE recommends Fairway Estates consult with Ken Kehmeier or another aquatic biologist to discuss possible ways to improve the Fairway Estates ponds as a fishery. Ken's prospectus includes several cost estimates for management assistance and is included as an electronic appendix on the disc attached to this memo.