TETRA TECH

Memo

To:	Sarah Poulton, Town of Chapel Hill
From:	Holly Miller, Tetra Tech
CC:	Rick Shmurak, Jason Wright, Elise Cormier - Tetra Tech
Subject:	Town of Chapel Hill Legion Pond Dam Phase 1 Site Recommendations

This memo summarizes the Phase 1 dam assessment process to prioritize the potential options for the Town of Chapel Hill Legion Pond Dam. The assessment included initial options and benefits, a hydrologic and hydraulic HEC-RAS model dam analysis, refined options ranking matrix, project option scoring, and recommended options. Section 1.0 outlines the options considered by the group and benefits of each, Section 2.0 discusses the hydrological analysis performed to assist with evaluating the possible options and downstream impacts, Section 3.0 outlines prioritization matrix, ranking, and scoring methods, and Section 4.0 summarizes the final recommended option.

1.0 BACKGROUND AND OPTIONS OVERVIEW

The American Legion Pond is a 3-acre pond with a high hazard, small sized dam. The pond sits within a 13-acre watershed located northeast of the Town of Chapel Hill, North Carolina. The 36.2-acre American Legion property, located at 1714 Legion Road, was purchased by the Town in 2017 and will be redeveloped to provide passive and active community recreational facilities and affordable housing (***Figure 1-1***). Tetra Tech understands that a great deal of time, work, thought, and effort has been put into considering the future use of the American Legion property primarily through the American Legion Task Force (ALTF) and Legion Property Committee (LPC).

1.1 LEGION POND DAM ALTERNATIVE OPTIONS

Based on discussions with Town staff, the following options were identified as potential options to rehabilitate and or convert the existing pond. Discussion and decisions on each option are provided in the section below. Alternative options included keeping the pond, reducing the pond size, implementing a stormwater control measure (SCM), or removing the pond. Below is a list of the initial options and refinement to two options, 1B: reduce pond size and 2A: convert the pond to a constructed wetland SCM.

Table 1-1. Legion Pond Dam Options List

Number	Option	Decision
0	Keep Pond: Do Nothing	No
1A	Keep Pond: Rehab Dam, Keep Pond Size Same	No
1B	**Keep Pond: Rehab/Reduce and Lower Dam, Reduce Pond Size**	**Possible**
2A	**Convert Pond: Replace/Remove Dam, Install SCM – Constructed Wetland**	**Possible**
2B	Convert Pond: Replace/Remove Dam, Install SCM – Wet Pond with RSC Step Pool	No
3A	Remove Pond: Remove Dam, Bottomland Forest	No

Tetra Tech Engineering, P.C.
4000 Sancar Way, Suite 200, Research Triangle Park, NC 27709
Tel +1.919.485.2059 | tetratech.com

3B	Remove Pond: Remove Dam, Stabilize Site, SCM Elsewhere (Affordable Housing and Parks Plans)	No

1.1.1 Option 0: Keep Pond – Do Nothing

Decision: *No*

The do nothing approach was quickly ruled out in group discussion. Factors considered by the group included downstream impacts, flooding, operation and maintenance, dam failure, and future affordable housing plans.

1.1.2 Option 1A: Keep Pond – Rehabilitate Dam, Keep Pond Same Size

Decision: *No*

Rehabilitating the pond and keeping it the same size was ruled out in group discussion. Factors considered in making this decision included downstream impacts, flooding, operation and maintenance, and future affordable housing plans.

1.1.3 Option 1B: Keep Pond – Rehabilitate/Reduce and Lower Dam, Reduce Pond Size

Decision: *Possible*

Rehabilitating the pond dam, lowering the pond dam, and reducing the pond size was deemed possible. Factors considered in making this decision included downstream impacts, flooding, operation and maintenance, and future affordable housing plans.

Additional benefit considerations discussed during alternative option selection for Option 1B:

- **Water Quantity:** pond "bathtub" holds water, provides little pollutant removal (water quality).
- **Feature Size**: water feature and pond storage will be reduced from current volume.
- **Hydrology**: post-development flow should equal post-development flow (Q pre = Q post), meaning no increase in downstream impacts for volume. This requires onsite stormwater on the Affordable Housing parcel.
- **Flooding and Safety Concerns**: no flooding increase, dam failure safety concern decreased. Onsite affordable housing detention needed due to increased impervious surface.
- **Space Constraints**: limited space available. Elevation height needed for required detention, pond storage, and dam constrains location. This option limits the placement of additional park amenities (trail expansion, ADA access, benches, and public educational opportunities). The pond anchors the Affordable Housing site to conform to the pond option layout/location. This may require the Affordable Housing site to add retaining walls and large amounts of fill and grading to level the site. This added cost for the Affordable Housing site can be further explored during pond re-design in collaboration with DHIC.
- **Collaboration**: requires close coordination with DHIC on the Affordable Housing for onsite stormwater control measures (SCMs) and greater stormwater detention needed elsewhere due to reduced pond size. Grading plan between two sites will need to be collaborated to ensure topography alignment.

- **Dewatering**: partial dewatering needed but only during construction phase.
- **Liability Reduction**: reduces the Town's dam liability.
- **Recreational Use**: maintains open water views and fishing opportunities.
- **Site Amenities**: fountain possible, possible trail expansion, small variety of plants, large sightlines due to open water, geese possible.
- **Connectivity**: site flow limited and connections to future site amenities may not be possible due to grade differences.
- **Education**: limited educational opportunities to support NPDES MS4 Phase II Stormwater public education/outreach.
- **Biodiversity**: offers greater habitat variety for dragonflies, butterflies, birds, and small fish.
- **Alternative Pond Location**: a large pond elsewhere in park that poses less hazards downstream, less flooding, no homes/businesses directly impacted. This is an option but not required.

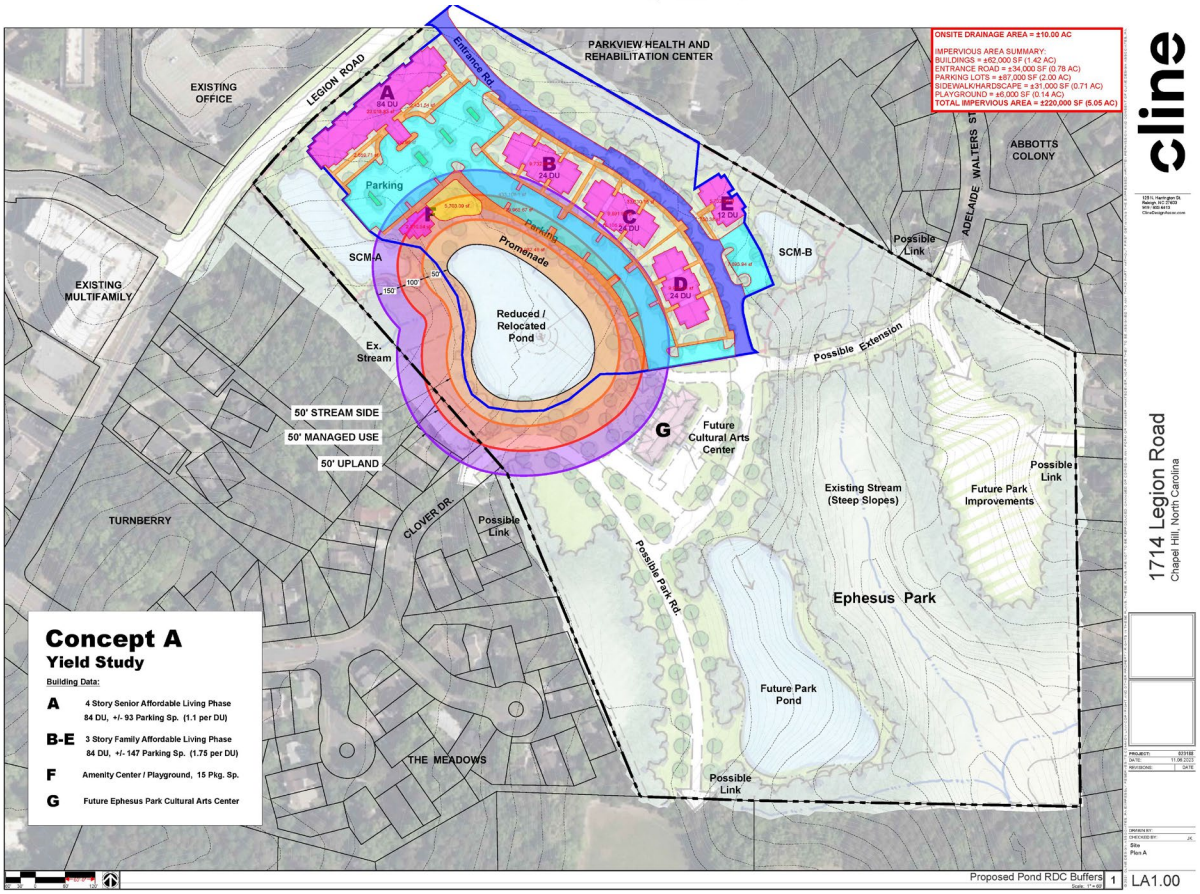

Figure 1-1. Option 1B: Reduce Pond Size – Preliminary Designs for Legion Pond in Relation to the Affordable Housing Project. (Designs from DHIC/cline provided for reference only)

1.1.4 Option 2A: SCM Conversion –Remove Dam and Install a Constructed Wetland SCM

Decision: *Possible*

SCM conversion was considered as an alternative to the pond and dam. Specifically, under this option the dam and pond are removed and replaced with a constructed wetland which increases space available to accommodate the future affordable housing drainage area. In addition to a smaller surface area, a constructed wetland will provide open water at depths between 0.5 feet to 3.0 feet. Example photos of constructed wetlands in the vicinity of Chapel Hill are shown in ***Figure 1-2***. The constructed wetland will have a wide variety of native, non-invasive plants suited to various water depths and displaying seasonal interest (***Figure 1-3***). The constructed wetland will provide a habitat that supports a range of wildlife including fish, insects, invertebrates, birds, mammals, and various bottomland forest plants. It will also attract beneficial insects like dragonflies and damselflies, which help control mosquito populations.

The constructed wetland will provide control of water quantity (volume) and water quality (nitrogen, phosphorus, sediment). Of the SCMs approved by NCDEQ, constructed wetlands have the highest water quality pollutant removal rate.

Additional benefit considerations discussed during alternative option selection for Option 2A:

- **Water Quantity**: multifunctional stormwater benefits that act like a "sponge" to detain water (quantity) and pollutant filtration/removal (quality).
- **Feature Size**: features smaller pools of open water. Constructed wetlands can be shaped generally with less grading than a pond and have the versatility to adjust configurations. This would be a significant benefit for the Affordable Housing site rather than a constraint.
- **Hydrology**: post-development flow should equal post-development flow (Q pre = Q post), meaning no increase in downstream impacts for volume.
- **Flooding and Safety Concerns**: no flooding increase, safety concern removed. Onsite Affordable Housing detention needed onsite due to increased impervious surface or in collaboration with wetland.
- **Space Constraints**: larger space available for connection and detention due to less grading and storage height. The constructed wetland can be shaped to accommodate varying elevations, grades, future trails, future park and site amenities, and the Affordable Housing site. Due to the low elevation of a constructed wetland (of up to 3 feet depth vs. 19 feet for the pond), the constructed wetland may provide added savings to the Affordable Housing development by potentially not requiring a retaining wall, large amounts of fill, and excessive grading. This added value cost savings can be further explored during design.
- **Collaboration**: requires close coordination with Affordable Housing for onsite stormwater control measures (SCMs) and greater stormwater detention needed elsewhere due to increased impervious surface.
- **Dewatering**: full dewatering needed during construction .
- **Liability Reduction**: removes the Town's dam liability.
- **Recreational Use**: connection to nature, future trail, public education.

- **Site Amenities**: extensive for varying plants (texture, color, short height of less than 3 feet) and water depths (0 to 3 feet), trail, pedestrian bridge, overlook, educational opportunities, public art.
- **Connectivity**: excellent site flow and connections to site amenities and future park trails.
- **Education**: extensive educational opportunities to support NPDES MS4 Phase II Stormwater public education/outreach.
- **Biodiversity**: offers greater habitat variety for dragonflies, butterflies, birds, and small fish.
- **Alternative Pond Location**: ability to establish a large pond elsewhere in park that poses less hazards downstream, less flooding, no homes/businesses directly impacted.

Figure 1-2. Option 2A: Constructed Wetland - Examples of Constructed Wetlands with Native, Non-Invasive Plants.

Figure 1-3. Option 2A: Constructed Wetland - Native, Non-Invasive Plants in Constructed Wetlands may include plants such as Marsh Mallow (top left), Black Eyed Susan (top right), Cardinal Flower (bottom left), and educational opportunities (bottom right).

1.1.5 Option 2B: SCM Conversion – Remove Dam and Install a Wet Pond with Regenerative Stormwater Conveyance (RSC) Step Pool SCM

Decision: *No (possibly combine with Option 2A)*

Like the pond and constructed wetland options, a wet pond will be a combination of the two measures with open water and a riser structure for drawdown and overflow. Along with the wet pond, a regenerative stormwater conveyance or RSC is a step pool system that can be install in areas of elevation or grade difference. An RSC can be added at the wet pond riser outlet in lieu of a rip rap dissipator pad. The RSC can add sound and give movement to a wet pond while slowing erosive velocities and adding additional volume storage. Plants can be added around the perimeter of the wet pond and RSC to attract animals and insects, while limiting geese.

This option was ruled out in group discussion as a standalone alternative. Instead, this option can be combined with Option 2A.

Figure 1-4. Option 2B: Wet Pond with Regenerative Stormwater Conveyance - Conceptual Plan for Linear RSC.

1.1.6 Option 3A: No Pond – Remove Dam, Bottomland Forest

Decision: *No*

Option 3A will remove the dam and pond. It would entail planting and establishing a bottomland forest, utilizing the removed trees from the dam as habitat enhancements, and adaptive management of planted native non-invasive plants to establish a natural area. This option could incorporate a larger affordable housing footprint, boardwalks, greenways, and educational signage with a variety of non-aquatic flora, fauna, animals, and insects.

This option was ruled out in group discussion due to concerns of downstream flooding due to no water quantity detention or water quality improvement.

1.1.7 Option 3B: No Pond – Remove Dam, Stabilize Site, SCM Elsewhere (within Affordable Housing Site and Future Parks Plans)

Decision: *No*

Like Option 3A, Option 3B will remove the dam and pond. This option entails re-grading the site, reseeding, and managing the area's regeneration to a natural state. This option would incorporate a larger affordable housing footprint, boardwalks, greenways, and educational signage with a variety of non-aquatic flora, fauna, animals, and insects. The natural area would begin as an open grassy area then slowly transform into a forest. Adaptive management will be required to maintain a natural plant community while the forest establishes.

This option was ruled out in group discussion due to concerns of downstream flooding due to no water quantity detention or water quality improvement.

1.2 SUMMARY OF ADDITIONAL PREFERRED OPTION BENEFITS

The two possible options refined, outlined, and discussed above (Option 1B and 2A) each have unique qualities that provide the Town of Chapel Hill with additional benefits in addition to water quantity/volume storage. Below, in **Table 1-2**, a side by side has been developed to outline and compare the additional benefits of each option. Option 1B: Reduce Pond Size, provided 7 out of 14 benefits and Option 2A: Constructed Wetland, provided 14 out of 14 benefits.

Table 1-2. Dam Options Additional Benefit Summary.

Option Benefit	Option 1B: Reduce Pond Size	Option 2A: Constructed Wetland
Water Quantity (volume storage)	☑	☑
Water Quality (pollutant removal)		☑
Feature Size	☑	☑
Hydrology Modeling	☑	☑
Flooding and Safety Concerns Reduced	☑	☑
Space Constraints Eliminated		☑
Affordable Housing Collaboration	☑	☑
Dewatering Needed	☑	☑
Liability Reduction	☑	☑
Recreational Use (most amenable)		☑
Site Amenities (most amenable)		☑
Connectivity to Future Park		☑
Educational Opportunities		☑

Biodiversity Provided		☑
Cost Savings		☑
Total Count of Identified Additional Benefits Met	**7**	**14**

2.0 OPTION 1A AND 1B: DAM EXISTING AND FUTURE CONDITIONS – HYDROLOGICS AND HYDRAULICS MODELING (H&H)

2.1 HYDROLOGY AND HYDRAULICS OBJECTIVES

The goal of this analysis is to determine existing hydraulic performance of the American Legion Pond Dam and if it meets current dam safety standards. Therefore, the Town of Chapel Hill has requested that Tetra Tech evaluate the existing dam capacities and propose an alternative design that safely passes the design storm. The purpose of the models is to determine if the existing dam can safely pass the design storm as established by State of North Carolina's dam safety criteria. Once an existing model was developed, the results were evaluated for peak discharge and peak water surface elevation (WSE) for design storms and index storms. A feasible proposed alternative option will then be developed based on the existing conditions results to satisfy the design objectives.

2.2 PROCEDURE – HYDROLOGIC ANALYSIS

2.2.1 Delineation

Based on the location of the dam, the contributing drainage area was delineated using the 12-digit Hydrologic Unit Code (HUC-12) watershed data layer downloaded from National Hydrography Dataset (NHD) Plus hydrologic framework built by United States Environmental Protection Agency (USEPA) assisted by the United States Geological Survey (USGS). The watershed area was contained within a HUC-12 watershed, 030300020603, Little Creek River (**Figure 2-1**). The HUC-12 watershed representation was used as a guideline for further delineation. The watershed was manually delineated using the ~3 feet resolution Light Detection and Ranging (LiDAR) data downloaded from North Carolina's Spatial Database[1]

[1] North Carolina Spatial Data Download (nc.gov)

(**Figure 2-2**). The manual watershed delineation was verified using the auto-delineation feature within USGS's spatial analytical tool, USGS StreamStats (**Figure 2-3**) to confirm its accuracy.

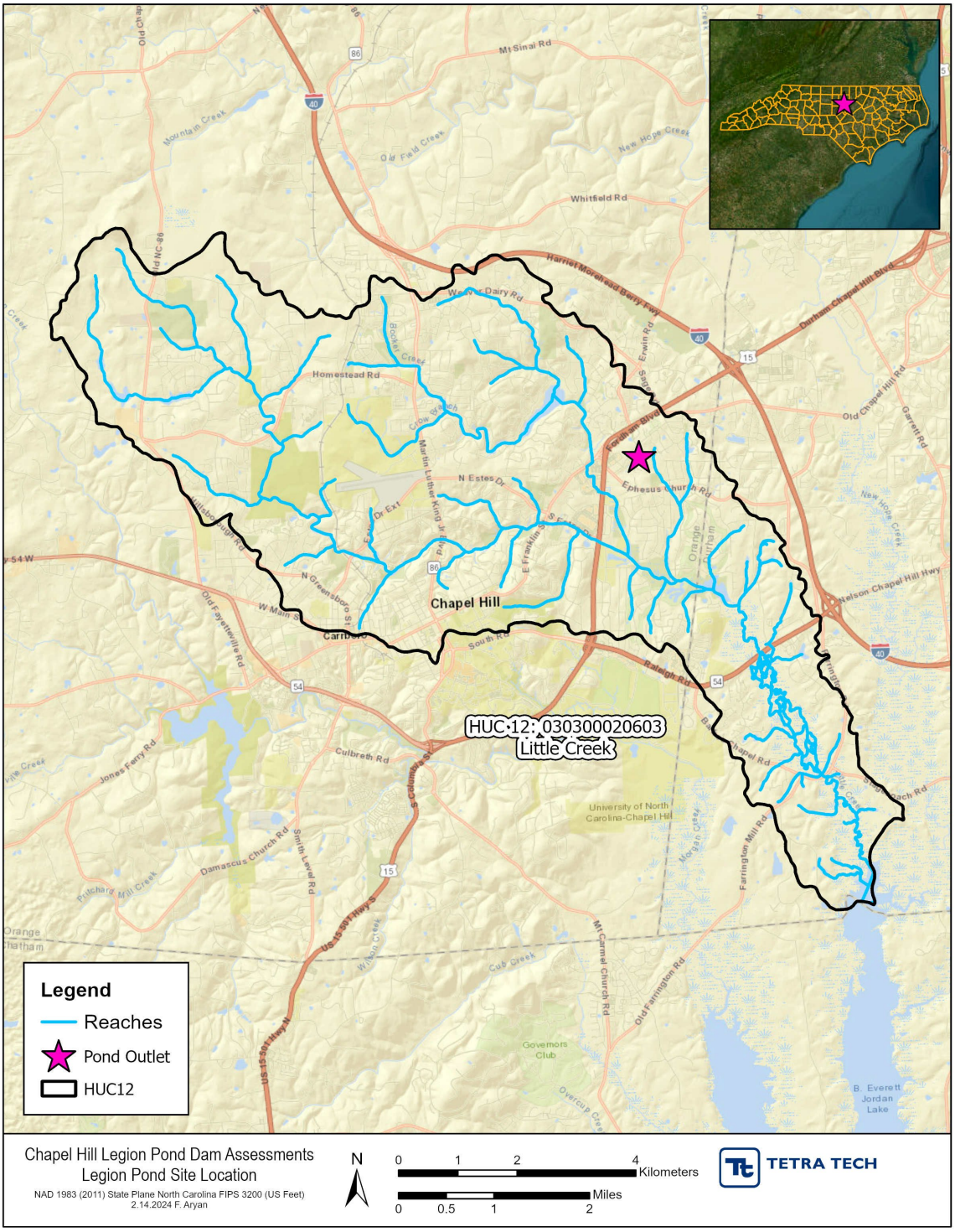

Figure 2-1. Location of the American Legion Pond Dam.

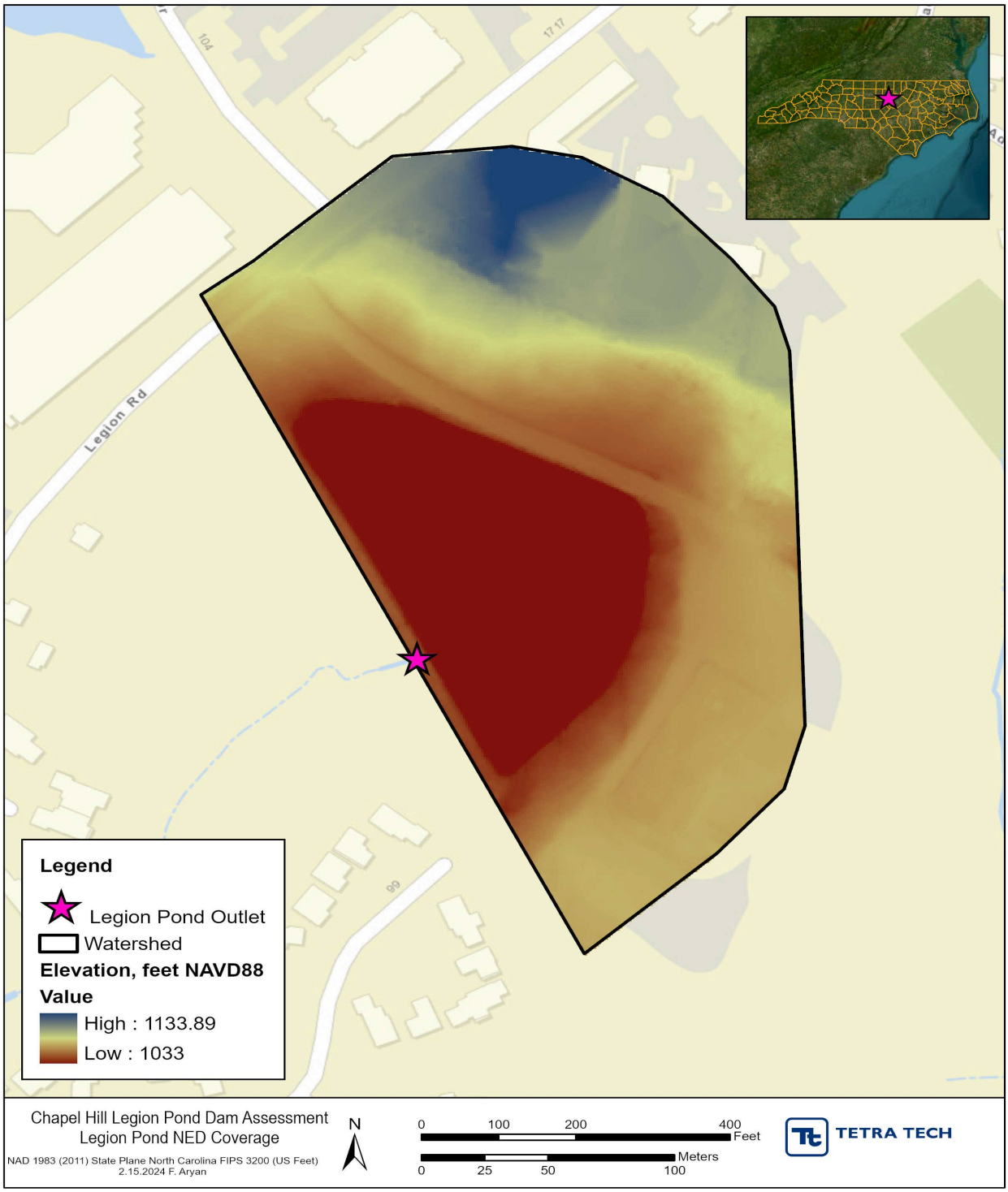

Figure 2-2. Topography of American Legion Pond Watershed.

Figure 2-3. Delineation of the American Legion Pond Dam Watershed.

2.2.2 Hydrologic Parameters

Runoff from storm rainfall was estimated by using the NRCS Technical Release 55 (TR-55) runoff Curve Number (CN) method (NEH 630.0901 2004, NEH 630.1001 2004). Factors that determine the CN are the hydrologic soil group (HSG), land use, and Antecedent Moisture Conditions (AMC) conditions (NRCS 1986). Soil data for the watershed was obtained from the Soil Survey Geographic Database (SSURGO). This database was produced and distributed by the NRCS – National Geospatial Management Center (NGMC), formerly National Cartography and Geospatial Center (NCGC). The entirety of the American Legion Pond watershed is in HSG D soils.

Land use data was downloaded from USGS's National Land Cover Database (NLCD) coverage for the year 2021. The NLCD coverage indicated that 92% of the American Legion Pond watershed is developed (**Table 2-1**). The CN for the watershed was calculated based on AMC II conditions (NEH 630.1001 2004) (**Table 2-2**). Based on the available data for the watershed and the hydrologic and land use conditions, watershed lag method was used to calculate the time of concentration (T_C) and lag times (L) (NEH 630. 1502 2010) (**Table 2-3**).

Table 2-1. Summary of Current Land Use Coverage in the American Legion Pond Dam Watershed.

Land Use Classification	NLCD Land use Code	Area (acres)
Open Water	11	1
Developed, Open Space	21	5
Developed, Low Intensity	22	5
Developed, Medium Intensity	23	2
Deciduous Forest	41	0
Total		13

Table 2-2. Estimated Existing Curve Number Based on AMC Conditions.

AMC Condition	Curve Number
AMC II	87

Table 2-3. Summary of Existing AMC II based Time of Concentration and Lag Times.

Parameter	Time (minutes)
Time of Concentration	5.5
Lag time	3.3

2.2.3 Precipitation

The 24-hour point precipitation frequency estimates for the 2-, 5-, 10-, 25-, 50-, and 100-year index storms were obtained from National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 10, Version 3. Additionally, Hydro Meteorological Report (HMR) 51 was used to estimate the Probable Maximum Precipitation (PMP) for the required storm event for the watershed. Based on North Carolina's Dam safety standards for a High Hazard (Class C) Small sized dam, 1/3 PMP is the design storm. Therefore, the all-season 24-hour PMP storm for a 10 square mile watershed was used to establish the 1/3 PMP for the watershed (**Table 2-4**). NRCS's Soil Conservation Service's (SCS) Type-II distribution was used for the index storms (2-, 5-, 10-, 25-, 50-, and 100-year 24-hr), as well as for 1/3 PMP, 24-hour storm.

Table 2-4. Summary of Precipitation Depths used in the American Legion Pond Analysis.

Rainfall Event	Rainfall Depth (inches)
1/3 PMP, 24-hr	13.20
2-year, 24-hour	3.57
5-year, 24-hour	4.46
10-year, 24-hour	5.16
25-year, 24-hour	6.10
50-year, 24-hour	6.84
100-year, 24-hour	7.80

2.2.4 Rating Curves

Summit Engineering completed a survey of the pond location and dam configuration on April 24, 2024. The elevations in the survey were referenced to North American Vertical Datum of 1988 (NAVD88). The top of dam (TOD) elevation was measured at 319 feet and the normal pool elevation measured at the time of survey was 315 feet. Elevation data pertaining to TOD elevation, crest of the dam, the siphon spillway pipe dimension, as well as upstream and downstream inverts of the siphon spillway pipe were used to calculate the rating curves (**Table 2-5**).

The stage-storage rating curve was developed using 1-foot contours.

The stage-discharge rating curve for American Legion Pond Dam was calculated using 1-foot contours and Bernoulli's equation as well as orifice equation for the 8-inch siphon spillway pipe (**Figure 2-4**). The TOD was assumed to be broad a crested weir and the flows computed from them were added to the flows developed for the principal siphon spillway pipe. Based on the stage-storage rating curve developed for the American Legion Pond Dam, the reservoir covers an area of 0.08 acres at the normal pool elevation. It covers an area of 0.28 acres at the TOD elevation.

The existing pond volume discharge (Qpre) was calculated to be 7 cubic feet per second (cfs). The pond detains the excess stormwater runoff volume and limits downstream erosive velocities. This limiting factor is consistent and will be used as the Qpost runoff volume target in the future selected option design for the pond or SCM.

Table 2-5. Existing Dam Details for American Legion Pond.

Dam Details	Value (ft)
Normal Pool Elevation	315.00
Top of Dam Elevation	319.00
Downstream Invert Elevation	299.47
Siphon Spillway Diameter	0.67 (8 inches)
Top of Dam Length	540.00

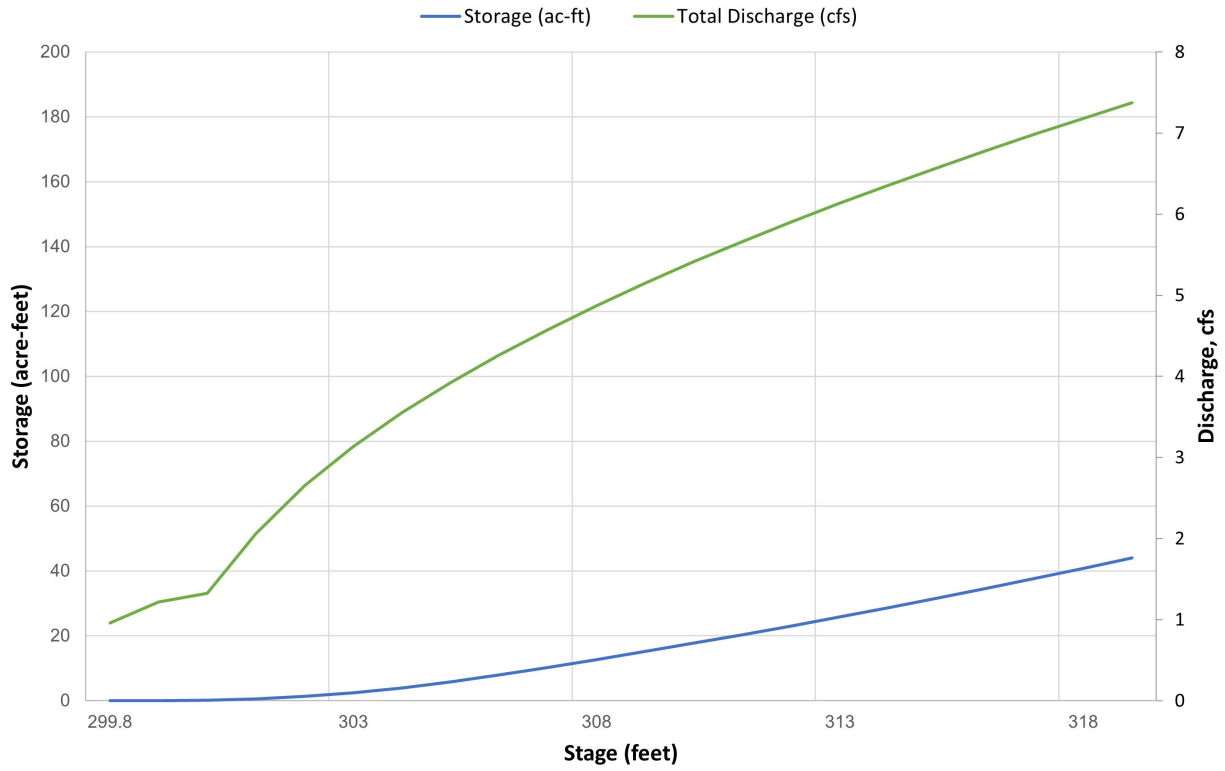

Figure 2-4. Stage-Storage-Discharge Rating Curve Developed for American Legion Pond Dam.

Hydrologic criteria were set based on the guidelines presented in North Carolina Dam Safety Regulations. US Army Corps of Engineer's (USACE) Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS 4.11) was used for the 24-hour index storms and 1/3 PMP storm. HEC-HMS is used to simulate the complete hydrologic processes of watershed systems. For the purposes of this project, HEC-HMS was used to analyze inflow, discharge, and water elevation at the dam location.

2.3 HYDROLOGIC AND HYDRAULIC FINDINGS

2.3.1 Existing Conditions

The hydrologic analysis was performed to determine if discharge from the American Legion Pond dam impacts its downstream structures. Although lag time was calculated to be 3.3 minutes (**Table 2-3**), it was input as 5 minutes into HEC-HMS to account for the model's 5-minute time increment.

Peak discharges and peak water surface elevations (WSEs) from the index storms, and the 1/3 PMP storm were obtained from the HEC-HMS model for existing conditions (**Table 2-6**). The results suggest that peak discharges remained consistent for both the index storms and the 1/3 PMP storm event. Additionally, while the peak WSEs showed consistency across the index storms, a 0.7-foot increase was observed during the 1/3 PMP event (**Table 2-6**). During all the index storms, the American Legion Pond Dam will have a freeboard of 4 feet, and a freeboard of 3.3 feet during the 1/3 PMP storm.

Table 2-6. Summary of Hydrologic Model Results (Existing Conditions).

Criteria	TOD Elevation (feet-NAVD88)	Inflow Peak Discharge (cfs)	Outflow Peak Discharge (cfs)	Peak Elevation (feet – NAVD88)	Dam Overtops	Freeboard Depth (feet)
2-year, 24-hour	319	39	7	315.0	NO	4.0
5-year, 24-hour	319	52	7	315.0	NO	4.0
10-year, 24-hour	319	62	7	315.0	NO	4.0
25-year, 24-hour	319	76	7	315.0	NO	4.0
50-year, 24-hour	319	87	7	315.0	NO	4.0
100-year, 24-hour	319	101	7	315.0	NO	4.0
1/3 PMP, 24-hour	319	180	7	315.7	NO	3.3

2.3.2 Dam Alternative Option Analysis

For the dam alternative option analysis, TOD was lowered from 319 feet to 318.2 feet (0.8 feet or 9.6 inches) while still providing a minimum of 2.5 feet of freeboard during the design storm. The primary spillway was maintained as an 8-inch diameter siphon with the control elevation remaining at the normal pool. A 25-foot wide articulated concrete block auxiliary spillway was modeled at elevation 315.7 feet and activates above the 100-year storm. Peak discharges remain consistent across all index storms but increases by 91% from the existing conditions in the 1/3 PMP storm. However, this is above the regulated discharge.

Table 2-7. Summary of Peak Discharges from HEC-HMS During Index Storms (Alternatives Analysis).

Criteria	Existing Conditions	Option 1B	Percent Difference (%)
	Peak Discharge (cfs)		
2-year, 24-hour	7	7	0%
5-year, 24-hour	7	7	0%
10-year, 24-hour	7	7	0%
25-year, 24-hour	7	7	0%
50-year, 24-hour	7	7	0%
100-year, 24-hour	7	7	0%
1/3 PMP, 24-hour	7	13	91%

The American Association of Cost Engineers (AACE) recommends dividing engineering construction cost estimates into three basic categories: Order of Magnitude, Budget, and Definitive Estimates. Tetra Tech calculated what can be considered general Order of Magnitude Costs without detailed engineering data. This level of cost estimating is intended for project screening, concept evaluation and alternative scheme analysis, and would be accurate within -30 percent to +50 percent. Engineering construction cost estimates were generated using current, localized RSMeans unit cost data from 2023 and line items for the anticipated construction activities, as well as professional estimates from similar projects. It is assumed that a detailed design alternative analysis and subsequent value engineering will occur during the planning phase and a more detailed cost estimate will be completed at that time.

Costs for the following components are estimated:

- Mobilization/staging
- Principal spillway conduit, earth fill, and excavation
- Rip rap
- Concrete
- Revegetation
- Engineering/construction oversight costs

The total estimated construction cost for the alternative Option 1B concept to rehab the dam is estimated at $1,180,000.

2.4 DAM REHABILITATION RECOMMENDATIONS

Considering the dam does not meet current dam safety requirements, Tetra Tech recommends the following actions be implemented at the American Legion Pond for dam rehabilitation:

1. Remove all trees and improper vegetation
2. Lower the TOD 0.8 feet in order to maintain approximately 2.5 feet of freeboard during the design storm
3. Install a 25-foot-wide articulated concrete block auxiliary spillway over the TOD, which is activated above the 100-year storm
4. Replace existing spillway pipe with permanent self-priming 8” PVC siphoning system
5. Construct new rip rap plunge pool

6. Establish proper grass/ground cover

Note that these recommendations and analysis do not consider changes to land use as a result of future onsite land development or provide water quality benefits; however, the proposed recommendations will maintain existing peak flow rates.

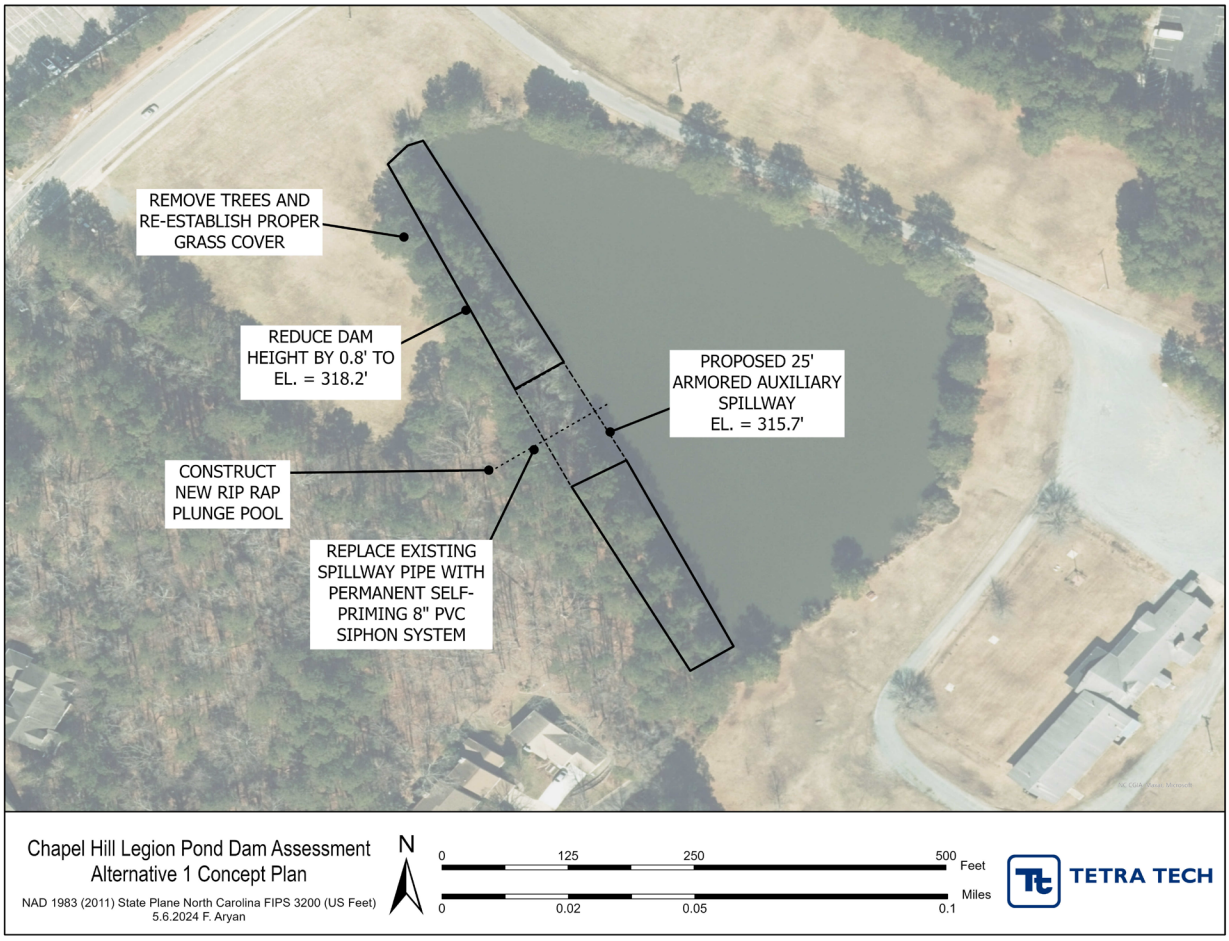

Figure 2-5. Option 1B: Lower Dam and Resize Pond – Dam and Spillway Concept Plan.

3.0 OPTIONS PRIORITIZATION MATRIX, RANKING AND SCORING

To evaluate the two options and determine which should be the potential project option for the Legion Pond Dam to accommodate the Affordable Housing, Tetra Tech developed a options ranking matrix (**Table 3-1**) that includes eleven (11) risk ranking categories: safety, flooding, economic, aesthetics/benefits, equity, housing units, future conditions, public/private, regulatory, economic impact, and operation and maintenance.

Each category includes risk subcategories, assigned a score based on the likelihood of occurrence:

- 0 – 2: Very Low/ Very Unlikely
- 3 – 4: Low/Low Likelihood
- 5 – 6: Medium/Likely
- 7 – 8: High/Highly Likely
- 9 – 10: Very High/Near Certain

The subcategory scores for each area were totaled to assign an overall ranking for each option. The possible option with the highest number of points received the highest (number 1) ranking for potential project recommendation.

In addition to the initial scoring, the Town wanted to weight specific categories with additional emphasis on importance and value to the Town. Weighted score multipliers were from 0 to 3, with 3 being the highest.

1. **Flood**: Reduction of Building Flood Impact (Minor, less than 50% substantial damage, less than 4 feet), multiplier of 2
2. **Economic**: Affordable Housing Feasibility and Cost, multiplier of 2
3. **Aesthetic/Benefits**: Promotes biodiversity (birds, pollinators, others), multiplier of 2
4. **Housing Units**: Maximizing AH units, multiplier of 3

Table 3-1. Ranking and Scoring Matrix to Evaluate Dam Options.

Risk Category	Consequence Subcategory	Ranking and Score: Impact and Probability of Occurrence				
		Very Low/ Very Unlikely	Low/Low Likelihood	Medium/ Likely	High/Highly Likely	Very High/ Near Certain
Safety	Reduces High Hazard Dam Liability (dam failure)	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
	Lower O&M Costs, reduce Chapel Hill OSHA recordables	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
	Reduces/Removes 3'+ Deep Water Drowning Potential	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
	Reduction of Downstream Impacts	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
Flooding	Reduction of Yard Flooding	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
	Reduction of Building Flood Impact (Minor, less than 50% substantial damage, less than 4 feet)	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
	Reduction of Roadway Flooding	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
	Reduction of Ditch/Inlet Flooding	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
Economic	Future Park SCM Expansion	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
	Affordable Housing Feasibility and Cost	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
	Reduction to Town Infrastructure Maintenance Costs	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
Aesthetic / Benefits	Enhances Natural Features	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
	Obtains Water Feature	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
	Promotes biodiversity (birds, pollinators, others)	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
	Public art opportunities	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
	Connection of People to Water	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
	Obtains Fishing/Aquatic Habitat	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
Equity	Disadvantaged Communities (based on US EPA EJScreen metrics - demographics, MHI, age, etc.)	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
Housing Units	Maximizing AH units	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
Future Conditions	Climate Change, Future Affordable Housing and Park Impervious Surface	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
Private / Public	Ease of Access, Amenity	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
Regulatory	Impervious surface, zoning, buffers, setbacks, tree save, SCMs	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10

Economic Impact	H, M, L	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10
Cost	High ($1M), Medium ($500K), Low ($250K or less)	0 – 2	3 – 4	5 – 6	7 – 8	9 – 10

3.1 RANKING ASSESSMENT OF OPTIONS AND COSTS

To provide information to the Town for evaluation of the potential options, Tetra Tech developed a ranking matrix that summarizes the construction cost, operation and maintenance (O&M) cost, and flooding impact for each option.

In addition to the initial scoring, the Town wanted to weight specific categories with additional emphasis on importance and value to the Town. Weighted score multipliers were from 0 to 3, with 3 being the highest.

1. **Flood**: Reduction of Building Flood Impact (Minor, less than 50% substantial damage, less than 4 feet), multiplier of 2
2. **Economic**: Affordable Housing Feasibility and Cost, multiplier of 2
3. **Aesthetic/Benefits**: Promotes biodiversity (birds, pollinators, others), multiplier of 2
4. **Housing Units**: Maximizing AH units, multiplier of 3

Table 3-1 shows the scores and ranking results for the two alternative dam project options: Option 1B and Option 2A.

Table 3-2 outlines high level cost, operation and maintenance (O&M) costs, and flooding impacts for these two options, along with a summary discussion of construction costs, O&M considerations, and flooding impacts.

Table 3-2. Ranking Results for Legion Pond Dam Options.

Risk Category	Consequence Subcategory	Weighted Scoring Multiplier	Project Options and Ranking	
			Option 1B: Rehab Dam and Reduce Pond Size	**Option 2A: Remove Dam and Install a Constructed Wetland SCM**
Safety	Reduces High Hazard Dam Liability (dam failure)		8	10
	Lower O&M Costs, reduce Chapel Hill OSHA recordables		8	7
	Reduces/Removes 3'+ Deep Water Drowning Potential		6	8
	Reduction of Downstream Impacts		8	8
Flooding	Reduction of Yard Flooding		7	7
	Reduction of Building Flood Impact (Minor, less than 50% substantial damage, less than 4 feet)	2	7	7
	Reduction of Roadway Flooding		8	8
	Reduction of Ditch/Inlet Flooding		8	8
Economic	Future Park SCM Expansion		4	8
	Affordable Housing Feasibility and Cost	2	6	8
	Reduction to Town Infrastructure Maintenance Costs		7	8
	Enhances Natural Features		7	8
Aesthetic / Benefits	Obtains Water Feature		9	7
	Promotes biodiversity (birds, pollinators, others)	2	6	10
	Public art opportunities		8	9
	Connection of People to Water		9	8
	Obtains Fishing/Aquatic Habitat		9	5
Equity	Disadvantaged Communities (based on US EPA EJScreen metrics - demographics, MHI, age, etc.)		7	7
Housing Units	Maximizing Affordable House units	3	8	9
Future Conditions	Climate Change, Future Affordable Housing and Park Impervious Surface		7	8
Private / Public	Ease of Access, Amenity		7	8
Regulatory	Impervious surface, zoning, buffers, setbacks, tree save, SCMs		6	8
Economic Impact	H, M, L		M	M
Cost	High ($1M), Medium ($500K), Low ($250K or less)		L	M
Flooding Improvement / Impact	H, M, L		M	M
O&M	H, M, L (additional staff, costs, and training)		L	M
	Unweighted Score		***132***	***141***
	Weighted Score		***35***	***43***
	Combined Total Score		***167***	***184***
	Stormwater Management Plan Project Ranking		***2***	***1***

Table 3-3. Project Options: General Cost.

Project Options	Proposed Solution	Initial Construction Cost	O&M Cost	Flooding Impact	Total Overall Cost
Option 1B	Rehab Dam and Reduce Pond Size	Low	Medium	Medium	**Medium**
Option 2A	Remove Dam and Install a Constructed Wetland SCM	Medium	Low	Low	**Low**

Stormwater Management Potential Options Matrix – Cost Designation Criteria Parameters:

- **Initial Construction Cost Parameters (not for budgeting purposes)**
  - **High**: Initial cost estimates are over $1,000,000
  - **Medium**: Initial costs estimates are between $500,000 and $1,000,000
  - **Low:** Initial cost estimates are under $500,000
- **O&M Cost Parameters**
  - **High**: O&M cost estimates are over $100,000/annually
  - **Medium**: O&M costs estimates are between $50,000 and $100,000/annually
  - **Low:** O&M cost estimates are under $50,000/annually
- **Flooding Impact Parameters**
  - **High:** Addresses over 75% of the flooding issues (estimated)
  - **Medium:** Addresses between 50% and 75% of the flooding issues (estimated)
  - **Low:** Addresses under 25% of the flooding issues (estimated)

4.0 ASSESSMENT SUMMARY AND RECOMMENDED OPTION

The Legion Pond Dam repair, retrofit, and removal options included an assessment of additional benefits for the two refined options, hydrologic and hydraulic modeling of existing conditions, risk ranking analysis, and general lifetime cost assessment. Option 2A: Constructed Wetland scored and ranked higher in all four assessment categories as noted in **Table 4-1** below.

Table 4-1. Dam Options Assessment Summary

Assessment Category	Option 1B: Reduce Pond Size		Option 2A: Constructed Wetland	
	Score	Best Benefit	Score	Best Benefit
Additional Benefits	7 out of 14		14 out of 14	☑
Hydrologic and Hydraulic Modeling	No Impact	☑	No Impact	☑
Risk Rank Analysis (Total Weighted Score)	167		184	☑
Lifetime Cost	Medium		Low	☑
Dam Retrofit Option Recommendation				☑

Based on the dam options assessment summary above, Tetra Tech recommends that the Town of Chapel Hill select **Option 2A by removing and replacing the Legion Dam Pond with a constructed wetland SCM**. The additional benefits, high scoring ranking analysis, and lower lifetime cost makes the constructed wetland a solid choice for the site, Affordable Housing development, and future park.

5.0 REFERENCES

NRCS 1986. Urban Hydrology for Small Watershed, TR-55. (Second Edition). United States Department of Agriculture.

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