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Can Reuse of Stormwater Detention Pond Water Meet Community Urban Agriculture Needs?

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Abstract: Urbanization and population growth in coastal communities increase demands on local food and water sectors. Due to this, urban communities are reimagining stormwater pond infrastructure, asking whether the stormwater can be used to irrigate food and grow fish for local consumption. Studies exploring this feasibility are limited in the literature. Driven by a community's desire to co-locate community gardens with stormwater pond spaces, this research monitored the water quality of a 23.4-hectare stormwater pond located in East Tampa, Florida over one year using the grab sample technique and compared the results with U.S. Environmental Protection Agency (EPA) reuse recommendations, EPA national recommended water quality criteria for aquatic life, and human health. pH and conductivity levels were acceptable for irrigating crops. Heavy metal (arsenic, cadmium, copper, lead, and zinc) concentrations were below the maximum recommended reuse levels (100, 10, 200, 5000 and 2000 µg/L, respectively), while zinc and lead were above the criteria for aquatic life (120 and 2.5 µg/L, respectively). *E. coli* concentrations ranged from 310 to greater than 200,000 MPN/100 mL, above the 0 CFU/100 mL irrigation requirements for raw food consumption and 200 CFU/100 mL requirements for commercial food processing. Synthetic organic compounds also exceeded criteria for human health.

Keywords: stormwater reuse; water resources; urban agriculture; water quality; irrigation; gardens; urban water reuse; stormwater irrigation; food

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1. Introduction

Access to a reliable water source is essential for food and cash crop production. In 2015, the U.S. Geological Survey reported that 42% of the United States' total freshwater withdrawals were used for irrigation of agricultural lands [1]. In Florida, public supply makes up approximately 54% of total water withdrawals, with agriculture second at 30% [2]. For residents, urban agriculture (i.e., residential and community gardens) offers a pathway to food security and a suite of other social, economic, and ecological co-benefits [3–5]. However, considering the growth rate of coastal communities in the United States, it is essential to explore alternative water source options like stormwater ponds for urban agriculture irrigation [6,7].

The dependence of urban agriculture on municipal water increases the demands on utilities and cost burdens on residents [8–10]. Water management agencies and municipalities have been exploring avenues to account for this increase in demand such as using reclaimed water [11]. Florida has successfully used reclaimed water for over 40 years to irrigate urban and agricultural landscapes; however, as of 2022, only 8% of Florida reuse is applied to agriculture [12] and the perceptions around its use on a residential level are still a major challenge towards adoption [13,14]. Extension agents and gardeners have also investigated innovative ways to promote water conservation and overall sustainability in their gardens such as through adopting aquaponics and hydroponics systems, container farming, and growing low maintenance plants [9]. The discussion of stormwater reuse for irrigation of urban agriculture in the literature is mainly focused on rainwater harvesting, replenishing aquifers, the construction of a large multi-step treatment train, or is a variable considered in systems modeling studies [9,15,16].

While engineering handbooks claim stormwater harvesting systems can be used to irrigate landscapes such as golf courses, recreational areas, and agriculture, the actual implementation of these systems are mostly limited to the irrigation of residential lawns or ornamental landscapes [17–19]. Studies exploring the potential reuse of water from stormwater ponds for irrigation of urban agriculture are scarce in the scientific literature and in practice [17,20–23]. Stormwater harvesting configurations include several example projects in Australia with the Moreland City Council [17] such as Mutton Reserve and Dunstan Reserve which have pollutant traps, storage tanks, rain gardens, and UV disinfection systems. There has been a recent push to expand these systems to irrigate community gardens and orchards in these reserves [17]. The city of Austin, Texas is also well known for its unique retention irrigation (RI) systems that are not commonly implemented in other parts of the United States [20]. These RI systems consist of a retention pond, wet well, pumps, distribution pipes, and sprinklers used to irrigate nearby vegetated lands [20]. Similarly, the Lake Lawne Stormwater Reuse Facility in Orlando, Florida was created to reduce nutrient pollutant loading into Lake Lawne and be used for irrigation within Barnett Park, a 159-acre green space [21]. Other examples of stormwater harvesting in Florida include the Willows Project, a 19.32-acre subdivision, and a project in Nocatee that irrigates 308 acres of land [22,23]. However, there is no mention of irrigating land used for food production.

The lack of case studies can be due to the highly variable nature of stormwater within and between rainfall events and water catchment areas [17]. Additionally, recent spotlights on complex organic–chemical mixtures including bioactive chemicals (i.e., pharmaceuticals, pesticides), carcinogens (i.e., polycyclic aromatic hydrocarbons (PAHs)), endocrine disrupting chemicals, and other contaminants of emerging concern (CECs) being found in surface waters, poses questions on the reusability of these waters [11]. The application of stormwater to land supporting urban gardens fits within the paradigm of integrated wastewater management for the valorization of embedded nutrients for food production while lowering surface water discharge [24]. For coastal communities like Tampa Bay, this is important because urban surface discharge can lead to negative ecological impacts such as habitat degradation and harmful algae blooms from excess nutrients [25].

Furthermore, residents we have interacted with have continually shown interest in utilizing these stormwater pond spaces for fishing to supplement protein intake, especially in under-resourced areas [26,27]. However, pollutant accumulation in fish in these ponds has been a recurring concern as these spaces can pose localized human and ecological health risks [7,28,29]. Data on stormwater pond quality have received little attention from management agencies compared to natural water bodies which could be attributed to the engineered intention to trap (and not treat) pollutants in stormwater ponds. Understanding the complexity of these systems is important not only to the wildlife these ponds support and the watersheds they reside in, but the communities and people they are surrounded by.

Accordingly, the objective of this study was to evaluate if the water quality of a wet stormwater detention pond can support residents' desires to reimagine these spaces as multifunctional, so they provide assets to the community such as irrigating community gardens and growing healthy fish. This research was performed over one year during one dry and one rainy season. The findings of this sampling event contribute to data gaps on stormwater ponds not only in the southeastern United States but also for the many areas of the world with similar land uses and food security needs. The findings from this study can assist other coastal communities whose stormwater pond and coastal spaces are interlinked to assess and improve the current state of their infrastructure for community and coastal resilience.

2. Materials and Methods

2.1. Study Site

The stormwater pond is located at N. 22nd Street and E. Chelsea Street in East Tampa, Florida, a historically African American community. East Tampa is surrounded by two major highways (I-4 and I-275) and has state roads (Hillsborough Avenue, Martin Luther King Jr.) that run through it. Approximately 33% of the population lives below the poverty level [29] and the community faces food justice challenges (Figure 1). The population of this community is 16,355 [30].

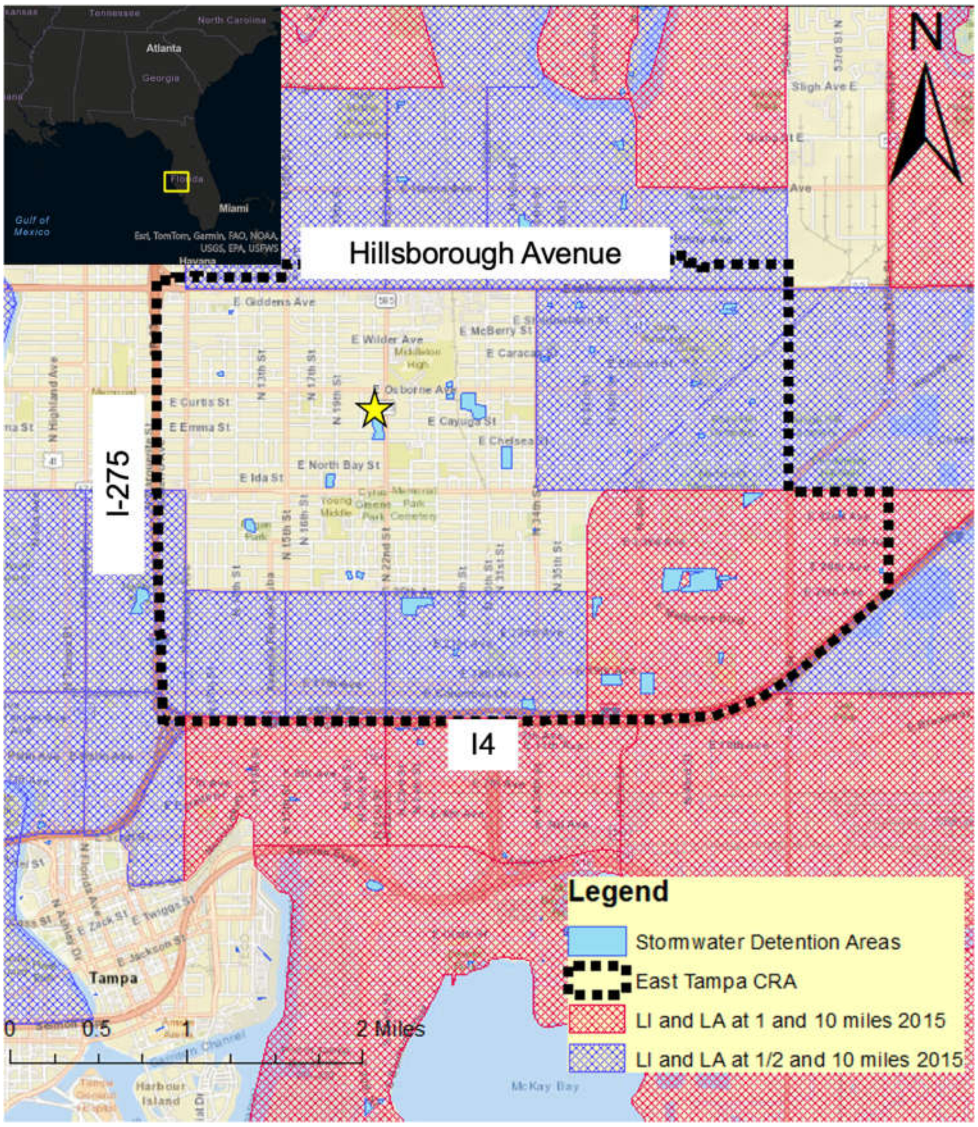

Figure 1. Map showing food access in the East Tampa Community Redevelopment Area (CRA), a ~7 square mile area where a percentage of property taxes can be used to spur economic development

and reduce blight. The map in the top left corner shows the location of the study site in relation to the southeastern portion of the United States. Census tract data were obtained from the United States Department of Agriculture 2019. Residents in the red areas live greater than 1 mile from the nearest supermarket, while those in the blue areas live greater than 0.5 mile from the nearest supermarket. The stormwater pond of interest is shown by the yellow star. Crossing of a busy state road is required to get to the nearest grocery store from that pond.

Figure 2 shows that the area surrounding the stormwater pond is a high-density residential area with major commercial and service land use nearby. This area also has limited areas designated as upland forests. Table 1 shows the total rainfall for each sampled month. The Tampa Bay watershed's climate is subtropical and has temperature ranges between 65 and 95 degrees Fahrenheit [31]. Its rainy season is from June to September, and its drier season from October to May [32]. The general soil type for this region is spodosols (soils of the flatwoods), which is characterized as somewhat poorly to poorly drained sandy soils with dark, sandy subsoil layers [33].

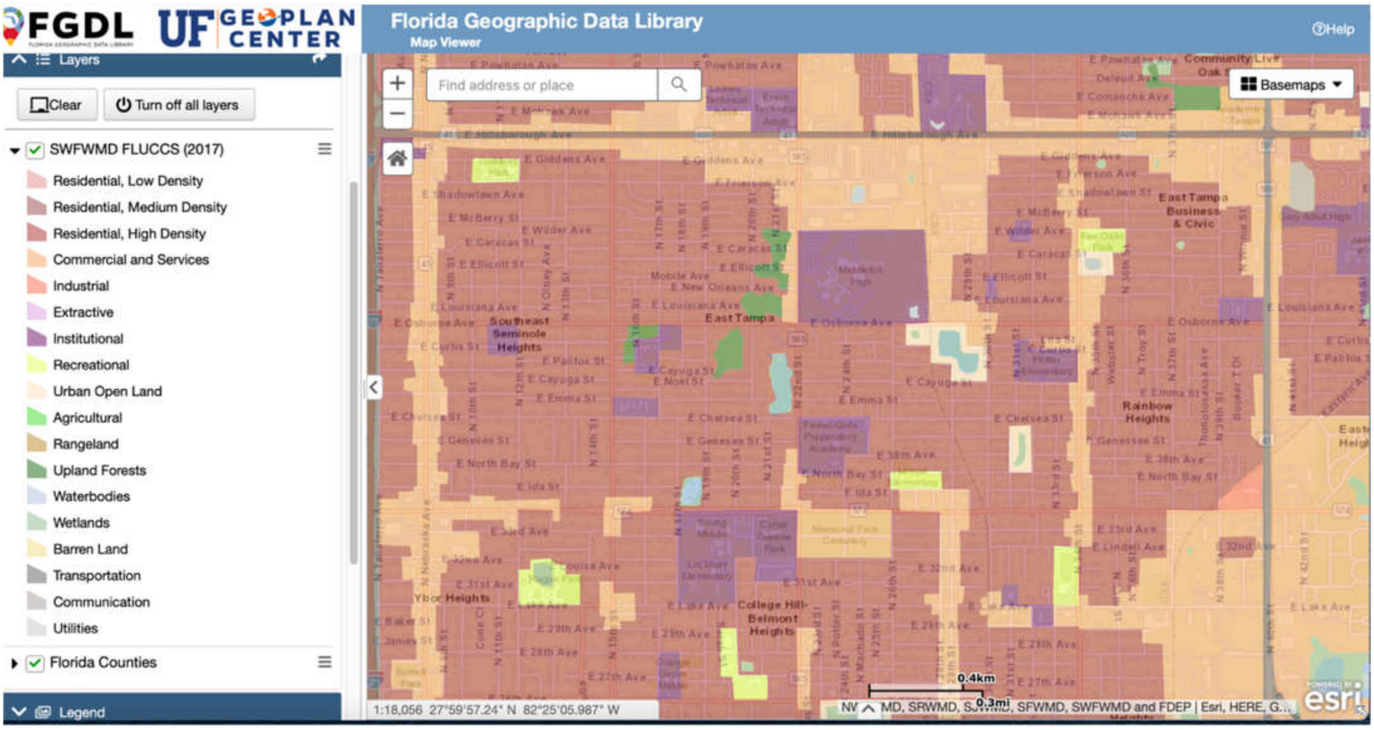

Figure 2. Land use map near the study's stormwater pond. The map is from the University of Florida Geoplan Center Florida Geographic Data Library (FGDL).

Table 1. Rainfall data from the Hillsborough County Water Atlas, Robles Park Pump Station (Station ID: RoblesPark), Agency: City of Tampa Rainfall Monitoring Network (October 2023–August 2024) and the Hillsborough River at Platt Street at Tampa, FL station (July and August 2023).

Date	Total Rainfall for the Month (in)
July 2023	3.88
August 2023	7.81
October 2023	1.28
November 2023	1.76
December 2023	5.78
January 2024	4.39
March 2024	4.35
April 2024	3.47

Table 1. *Cont.*

Date	Total Rainfall for the Month (in)
May 2024	1.43
June 2024	20.23
July 2024	18.1
August 2024	17.55

2.2. Sampling Procedure

Water quality monitoring began in July 2023 and lasted until August 2024 in order to document how water quality changed over 1 rainy and 1 dry season. Sampling occurred in the morning between 8 am and 9 am. Sampling points are shown in Figure 3. The approximate GPS coordinates of these sample locations can be found in Table S1. Each sampling point also was assigned a field blank which contained deionized water. Sample collection followed the grab sample procedure [34,35]. Samples were collected in triplicate at each location in 10% hydrochloric acid-washed 1000 mL HDPE containers. A total of 93 samples were collected with 27 field blanks. Researchers were not able to make it to the field in September and February.

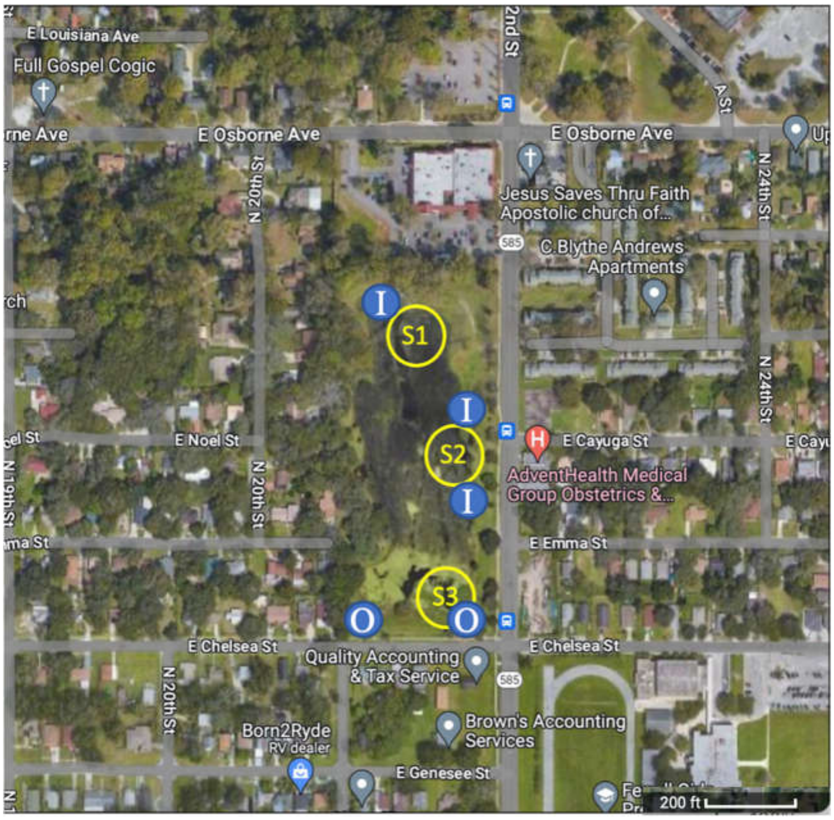

Figure 3. Sampling locations noted as S1, S2, and S3. Inlet and outlet locations for the stormwater pond are depicted by the blue circles labeled "I" and "O", respectively.

A Nasco Swing Sampler (Manufacturer Number B01366, Fisher Scientific, Waltham, MA, USA) was used to collect samples approximately 15 cm below the water's surface. Figure 3 shows the sampling locations selected for collection. Given the size of the pond, a total of 3 sampling points encompassing the pond were selected [35,36]. The stormwater collected on E. Osborne Avenue and N. 22nd Street drains into the inlets by S1 and S2 and exits the pond near the outlets at S3. S3 is also located next to the community garden of interest for irrigation. The most readily available data for the holding capacity of the pond come from an As-Built from a 1973 29th Street Outfall Drainage System study put forth by the City of Tampa [37]. The pond has a 25-year storage capacity of 59.97 acre-ft, first inch storage capacity of 5.13 acre-ft, total storage capacity of 65.10 acre-ft, 25-year design high water elevation of 48.15 (usually in ft above sea level or local reference point), design low water elevation of 39.60 (ft) (baseline), and a 2:1 slope.

Following typical surface water sample collection protocols, the sample container was rinsed 2–3 times with pond water prior to collection [35,36]. Samples were placed in a cooler with ice and immediately transported to the laboratory for analysis. Multimeter probes (YSI 556 and YSI ProDSS, YSI, Yellow Springs, OH, USA) were used to record temperature, pH, conductivity and dissolved oxygen (DO). These probes were calibrated each time before sampling using the Thermo Scientific Orion Conductivity Standard, 1413 µS/cm, 692 ppm as NaCl, and YSI-certified pH buffers 4, 7, and 10. DO was calibrated by placing about 1/8 inch of water in the calibration cup and following the standard DO calibration procedure in the YSI manual.

2.3. Analytical Procedures

2.3.1. Heavy Metals Analysis

The heavy metals analyzed were lead (Pb), cadmium (Cd), zinc (Zn), copper (Cu), and arsenic (As). For dissolved heavy metals (DHMs), samples were filtered through a 0.45 µm (FlipMate Catalog #SC0308, Environmental Express, Charleston, SC, USA) PES with PTFE prefilter and then acidified with concentrated certified ACS Plus-grade (Fisher Scientific) nitric acid (HNO_3) (3 mL/L) [38]. Unfiltered samples for total heavy metals (THM) analysis were also acidified with concentrated HNO_3.

Heavy metals were analyzed on a PerkinElmer NexION 2000 Inductively Coupled Plasma Mass Spectrometer (ICP-MS) according to EPA Method 200.8 (Perkin Elmer, Waltham, MA, USA) [38]. The calibration curve standards were prepared from high-purity standard stock solutions and diluted with 2% nitric acid prepared from Fisher Chemical Trace Metal Grade (TMG) (Fisher Scientific, Waltham, MA, USA) nitric acid (70% *v*/*v*). Calibration standards for Cu, Zn, As, Cd, and Pb ranged from 0.01 ppb to 750 ppb. Two quality control (QC) standards were made with different concentrations to ensure optimal performance of the instrument. Trace metal drinking water (TMDW) diluted 1:1 with 2% TMG nitric acid was used as a certified reference material (CRM). Internal standards Ge, Rh, and In were added manually at a constant 20 ppb concentration to blanks, calibration standards, QCs, CRM, and samples. For each sample and blank, 10 mL was extracted and placed in 15 mL plastic vials and 0.2 µL of the internal standard was added. This internal standardization allows for correcting any changes in the instrument's operating conditions and any sample-specific matrix effects which may occur and alter the analyte signal [39]. During analysis, two isotopes of Cu and Cd were monitored within the analytical run. As was measured with and without correction equations to monitor any interferences with the argon (Ar) gas used for running the ICP-MS and chloride (Cl) used in the digestion procedure of THM.

2.3.2. Nutrient Analysis

The nutrients NO_X-N (nitrate (NO_3^-) + nitrite (NO_2^-)), total ammonia nitrogen (TAN), total phosphorus (TP), and orthophosphate (PO_4^{3-}) were analyzed. Samples were filtered through a 0.45 µm PES with a PTFE prefilter filter and acidified with Fisher Scientific ACS Grade concentrated sulfuric acid (H_2SO_4) if they were not analyzed immediately. The analysis of NOx-N and TAN were all performed on the Timberline Ammonia Analyzer TL-2800 (Timberline Instrument, Boulder, CO, USA). TP and orthophosphate analysis followed the Ascorbic Acid Method using the HACH TNT 843 test kits.

2.3.3. Microbial Water Quality Analysis

Total coliforms and *E. coli* were measured using the Colilert-18 method from IDEXX Laboratories, Inc. (Westbrook, ME, USA). Unfiltered samples were diluted by a factor of 1000 with DI water prior to addition of the Colilert-18 reagent. Samples collected in December 2024 were diluted by a factor of 100. Sealed Quanti-Tray/2000 with samples were incubated at 35 °C for 18–22 h prior to counting for total coliform and *E. coli* colonies.

2.3.4. Synthetic Organic Compounds Analysis

Masoner et al.'s study [40] was used as a guide to select the synthetic organic compounds for analysis. Synthetic organic compounds were analyzed from samples collected at the beginning and end of this study (July 2023 and July 2024) in order to understand how concentrations may have changed over the course of 1 year. A full list of synthetic organic compounds analyzed is found in Table S3. Analysis of all compounds except for BTEX follow EPA method 8270 [41]. BTEX follows EPA method 8260 [42].

3. Results and Discussion

3.1. Physicochemical Parameters

Values for pH, conductivity, DO, and temperature for stormwater pond samples collected from July 2023 to August 2024 ranged from 6.58 to 8.79 (n = 30), 133.1 to 1027.0 µS/cm (n = 36), 0.27 to 9.1 mg/L (n = 36), and 12.7 to 23.7 °C (n = 36), respectively (Table 2). The average values and standard deviations for the four parameters were 7.28 ± 0.48, 384.4 ± 225.0 µS/cm, 2.54 ± 1.95 mg/L, and 22.1 ± 5.9 °C, respectively. Of the samples collected, 3 out of 36 (8%) would have slight to moderate irrigation restrictions based on conductivity, and 1 out of 30 (3%) would have been outside the normal pH range for irrigation.

Table 2. Water quality results compared to the recommended levels for the irrigation of food crops.

Parameter	Range	Average	Restriction on Irrigation [43]	National Recommended Aquatic Life Criteria—Freshwater Chronic
pH [-]	6.58–8.79	7.28 ± 0.48	Normal range 6.5–8.4	6.5–9
Conductivity (µS/cm)	133.1–1027.0	384.4 ± 225.0	<700	-
DO (mg/L)	0.27–9.1	2.54 ± 1.95	-	-
Temperature (°C)	12.7–23.7	22.1 ± 5.9	-	Criteria are species dependent

The values for pH in this study are similar to other studies on stormwater ponds in the Tampa Bay area [44,45] and generally fell in the acceptable State of Florida ranges (6.5 to 8.5). Monitoring three stormwater ponds in the Tampa Bay area from 1996 to 2003, Rushton et al. [45] found that DO levels did not exceed 10 mg/L with lower levels of DO in ponds covered in floating mats of vegetation [45]. Similar observations for low DO levels were observed in this study (Figure 4). Though conductivity ranges fell within the 50 to 1500 µS/cm ranges found in lake and river water in the U.S., some values fell outside the range to support healthy fish populations (150 to 500 µS/cm) [46].

Figure 4. Water quantity and quality fluctuations at the studied stormwater pond over the period of a year in East Tampa, Florida.

3.2. Heavy Metals

Table 3 provides the measured concentration ranges and averages of total and dissolved heavy metals in comparison to the EPA water reuse guidelines [43]and the National Recommended Aquatic Life Criteria [47] for freshwater acute effects. Figures S1–S12 provide a more granular perspective of the concentrations of total and dissolved heavy metals for each sampling location within the stormwater pond. As can be seen, none of the maximum concentrations for heavy metals exceed irrigation restrictions.

Table 3. Heavy metal constituents compared to various water criteria for reuse and surface water in µg/L. The bold values indicate concentrations surpassed the criteria.

Constituent	Total Heavy Metals Range (µg/L)	Total Heavy Metals Average (µg/L)	Dissolved Heavy Metals Concentration Range (µg/L)	Dissolved Heavy Metals Average (µg/L)	Maximum Concentration for Irrigation (µg/L) [43]	National Recommended Aquatic Life Criteria for Freshwater Chronic Effects (µg/L) [47]
Arsenic	0.07–2.16	1.19 ± 0.57	0.5–2.63	1.35 ± 0.55	100	150
Cadmium	0.006–0.81	0.11 ± 0.18	0.002–0.31	0.045 ± 0.08	10	1.8 (acute)
Copper	1.75–50.1	6.67 ± 8.74	0.44–6.4	1.78 ± 1.55	200	-
Lead	0.34–44.2	6.27 ± 10.8	0.16–6.19	0.99 ± 1.60	5000	**2.5**
Mercury	0.03–0.23	0.09 ± 0.06	0.005 ± 0.096	0.028 ± 0.025	-	0.77
Zinc	4.88–382.7	43.6 ± 73.9	0.45–89.4	15.1 ± 29.1	2000	**120**

However, the measured concentrations of total zinc and total and dissolved lead do exceed the EPA's National Recommended Aquatic Life Criteria for freshwater chronic effects. Heavy metal accumulation in fish has been a concern, especially for those residing in stormwater ponds [47].

Higher concentrations of zinc, mercury, lead, copper, and total cadmium in the stormwater pond may be attributed to an influx of pollutants during the rainy season and higher rainfall rates following a dry period as seen in Table 1 [48]. For arsenic and dissolved cadmium, however, potential dilution is observed with lower concentrations during the wet months of June and July 2024, which could indicate higher concentrations downstream [49]. Stoker [49] evaluated the effectiveness of a stormwater collection and detention system in reducing pollutant loads in Pinellas County, Florida [49], finding outflow average arsenic concentrations to be 5.4 µg/L, an average lead concentration of 2.8 µg/L, and an average mercury concentration of 0.09 µg/L. The results from this study are within a similar range. Lusk and Chapman [50] found that dissolved copper concentrations in the water column rarely exceeded 20 µg/L in stormwater ponds treated with copper sulfate throughout Tampa, Florida. While our highest dissolved copper concentrations were less than Lusk and Chapman's results at 6.36 µg/L, the high total copper concentrations (50.07 µg/L) can be indicative of the amount of particle-bound copper that accumulates in the pond. Rushton et al. [45] found total zinc concentrations up to 60 µg/L for a pond receiving runoff from the roof of the Florida Aquarium, and up to 15 µg/L for a pond draining from the street. The average total zinc concentration of 43.6 µg/L found in this study is likely due to a combination of the residential and commercial buildings and proximity to major state and local roads.

In order to reduce these heavy metal concentrations to safe levels, stormwater managers can look to improve the maintenance of stormwater pond spaces by disposing accumulated sediment to maintain the sedimentation function of the pond that removes many pollutants [7,51].

3.3. Nutrients: Nitrogen and Phosphorus

Table 4 shows nitrate and nitrite (NO_X) concentrations as N, total ammonia nitrogen as N, and total phosphorus (TP) and orthophosphate as P concentration ranges and averages over the study period. On occasion, concentrations reached below the detection limit (BDL) for the nitrogen species. NO_X-N and TAN concentrations are based on 9 months of data and TP and orthophosphate on 10 months.

Table 4. Nutrient constituents and their concentrations in mg N or P/L.

Constituent	Range (mg/L)	Average (mg/L)
NO_X-N	BDL–0.64	0.14 ± 0.17
Total Ammonia Nitrogen	BDL–1.29	0.23 ± 0.32
Total Phosphorus as P	0.04–0.29	0.13 ± 0.06
Orthophosphate as P	0.01–0.19	0.09 ± 0.05

These observed nutrient levels in the pond can be beneficial to supplement the nutrient requirements of the edible crops grown at the community garden and reduce reliance on fertilizers [52]. As can be seen, nitrogen concentrations are slightly higher than phosphorus which can assist in plant establishment, development, and flowering [53]. Theoretically, nutrients would not need to be treated for as they would be land-applied and taken up by the plants, helping to reduce the presence of algae blooms in the pond.

3.4. Synthetic Organic Compounds

Samples from June 2023 (six samples in total) and July 2024 (nine samples in total) were analyzed for 100 synthetic organic compounds. Table S4 shows the measured average concentrations of all detected synthetic organic compounds in the stormwater pond for July 2023 and July 2024. While the EPA does not include many of the analytes identified in our study under the National Recommended Water Quality Criteria for aquatic life, we used the EPA Recommended Water Quality Criteria for Human Health to determine the safety of consuming the fish in the pond [54]. The maximum concentration of each synthetic organic analyte detected in July 2023 and July 2024 is compared to these health criteria in Table 5. All listed compounds in Table 5 are based on a carcinogenicity risk of 10^{-6} except for fluoranthene and pyrene. Benzo[a]anthracene, chrysene, beno[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, and indeno(1,2,3-cd) pyrene are PAHs and are designated as probable human carcinogens [40].

Chrysene, fluoranthene, and pyrene were found in half or more of the samples for both the July 2023 and July 2024 sampling event, whereas other organic compounds appeared less consistently. For example, Benzo[a]pyrene was found in 4 out of the 6 (67%) samples for July 2023 and in none of the samples for July 2024. Benzo[b]fluoranthene was detected in 5 out of the 6 (83%) samples for July 2023 and in 2 of the 9 (22%) samples for July 2024. Benzo[g,h,i]perylene was found in 4 of the 6 (67%) samples for July 2023 and in none of the samples for July 2024. The concentrations for these synthetic organic compounds may have been higher for July 2023 than July 2024 due to dilution as July 2024 had higher rainfall than July 2023.

Table 5. Maximum synthetic organic compound concentrations found in the July 2023 and 2024 sampling events compared to the EPA's National Recommended Water Quality Criteria for Human Health [54]. The bold values indicate concentrations surpassed the criteria.

Synthetic Organic Compound	Maximum Concentration Detected in Samples (µg/L)	Human Health for the Consumption of Organism Only (µg/L)
Benzo[a]anthracene	1.0	**0.0013**
Benzo[a]pyrene	2.1	**0.00013**
Benzo[b]fluoranthene	3.6	**0.0013**
Benzo[k]fluoranthene	0.033	**0.013**
Chrysene	2.2	**0.13**
Dibenzo[a,h]anthracene	0.12	**0.00013**
Fluoranthene	2.7	20
Indeno(1,2,3-cd)pyrene	2.1	**0.0013**
Pyrene	2.5	30

A multiagency study of organic and inorganic chemicals in urban stormwater was performed by Masoner et al. [40] across 50 runoff events in the United States. This study found frequently detected PAHs similar to this study including benzo[a]anthracene, benzo[a]pyrene, benzo[g,h,i]perylene, chrysene, benzo[b]fluoranthene, fluoranthene, pyrene, phenathrene, benzo[k]fluoranthene, and indeno(1,2,3-cd)pyrene. Comparatively, our maximum concentrations were less, with their concentrations ranging from 13.5 µg/L to 36.7 ug/L for fluoranthene, pyrene, phenathrene, benzo[b]fluoranthene, chrysene, and benzo[a]pyrene, which can be due to land use and land cover [40].

While maximum fluoranthene and pyrene concentrations were found below their respective criteria, all other maximum concentrations exceeded their criteria, indicating human consumption of organisms and water or just organisms found in this pond can increase their risk of cancer. This would pose a greater than one in a million chance of developing cancer over a lifetime of exposure.

Previous work has found that bioretention systems can treat PAHs likely through biodegradation [55]. PAHs are said to often be sediment-bound; therefore, structures that reduce sediments such as wetlands, bioretention cells, and filter strips may provide additional treatment [56]. If used as a part of a treatment train for irrigation, meticulous contingency plans should be in place in case of contamination as exposure to UV light can increase the toxicity of some PAH compounds [55,56].

3.5. Microbial Quality

Table 6 shows the average total coliform concentrations reached higher than 200,500 MPN/100 mL at location S1 for June 2024 to as low as 6470 MPN/100 mL at location S2 during the May 2024 sampling event. Average *E. coli* concentrations reached as high as 5300 MPN/100 mL at location S1 during the July 2024 sampling event to less than 1000 MPN/100 mL for several sampling events, particularly April, May, and July, at location S2. The high total coliforms and *E. coli* levels observed in the summer may be attributed to more rainfall (and thus runoff) during those months as opposed to May 2024, when the pond was the driest.

Table 6. Total coliforms and *E. coli* MPN per 100 mL for stormwater pond samples collected from December 2023 to August 2024.

Date	Total Coliforms (MPN/100 mL)			*E. coli* (MPN/100 mL)		
	S1	S2	S3	S1	S2	S3
December 2023	18,900 ± 2040	20,050 ± 0.00	>20,050	3390 ± 577	1200 ± 193	310 ± 110
January 2024	16,700 ± 6950	64,100 ± 16,500	35,700 ± 2310	2430 ± 2480	<1000	1000 ± 0.00
April 2024	10,400 ± 3130	17,100 ± 6240	16,900 ± 3930	<1000	1000	<1000
May 2024	21,300 ± 3840	6470 ± 3020	16,900 ± 3530	<1000	2050 ± 1490	<1000
June 2024	>200,500	117,000 ± 14,300	165,000 ± 41,200	3470 ± 2540	3470 ± 635	2030 ± 1050
July 2024	163,000 ± 32,300	22,600 ± 7280	130,000 ± 24,900	5300 ± 2200	<1000	2400 ± 1640
August 2024	63,200 ± 17,500	50,200 ± 10,600	34,400 ± 19,800	2400 ± 1640	1700 ± 1210	1000 ± 0.00

According to EPA 2012 reuse guidelines [43], there should be no detectable fecal coliform units per 100 mL for food crops that are intended for raw consumption. For surface irrigation of food crops that will be commercially processed, fecal coliform colonies should be less than 200 fecal coliforms units per 100 mL. As can be seen in Table 6, *E. coli* concentrations surpass this criterion throughout the entire sampling period. Our results are supported by previous studies showing *E. coli* concentrations higher than 1000 CFU/100 mL over an extended period in similar stormwater ponds [57,58].

Microbial constituents can be reduced by not directly withdrawing water directly from the stormwater pond. In fact, the Florida Department of Environmental Protection (FDEP) recommends withdrawing water from a stormwater harvesting system through a minimum of 4 feet of native soils or clean sands using a horizontal well located adjacent or under the pond using a sand filter [18]. This process is similar to riverbank filtration that has been demonstrated to reduce source tracking markers pepper mild mottle virus and HF183 Bacteroides by 2.9 and 5.5 $\log_{10}$ units, respectively [59]. This process would remove microbial water quality constituents and some possible chemical pollutants to acceptable levels; however, further studies are needed to assess its effectiveness of reaching levels appropriate for irrigating food crops either directly or indirectly (such as through drip irrigation), especially in high volume traffic areas like East Tampa, Florida.

4. Conclusions

This study assessed the water quality of an urban wet stormwater detention pond to see if reclaimed pond water could be used for irrigating community gardens and supporting the catch of healthy fish. The stormwater pond in this study was sampled over a one-year period for physicochemical parameters (i.e., pH, conductivity, DO, and temperature), total and dissolved heavy metals, nutrients (i.e., NO_X-N, TAN, TP, and orthophosphate), total coliforms and *E. coli*, and several synthetic organic compounds. While pH, temperature, and conductivity were within acceptable ranges to support aquatic life, DO values were quite low throughout the pond and varied over the sampling period. Heavy metal concentrations did not exceed EPA reuse guidelines; however, they did surpass the EPA's National Recommended Aquatic Life Criteria for freshwater chronic effects for total zinc and total and dissolved lead. High synthetic organic compound concentrations were also found in this pond and surpass the EPA's National Recommended Water Quality Criteria for Human Health. Microbial quality determined by the measurement of total coliforms and *E. coli* in the pond water exceeded irrigation guidelines during the entire sampling period, suggesting some form of bank filtration would be needed to reduce levels to acceptable levels. Nutrients present in the pond water can be used to supplement fertilizer requirements of crops grown in the community garden. Although collection of stormwaters in the pond during the rainy season for irrigation would be optimal, the increase in pollutant loads for heavy metals (lead, mercury, zinc, and copper) and total coliforms and *E. coli* during this period poses a concern. Furthermore, many gardeners are not cultivating food crops during the warmer summer months in tropical climates like Florida; therefore, future research can explore how to account for variations in rainfall and quality in these systems to meet demand at other times of the year. Overall, this research study elucidated seasonal water quality trends within a stormwater pond in a coastal community and determined its potential for reuse.

5. Recommendations and Future Actions

Following FDEP stormwater harvesting guidelines [18], proper maintenance of stormwater pond sediment and adding green infrastructure such as bioretention cells and filter strips can reduce microbial, heavy metal, and synthetic organic compound concentrations in these stormwater ponds and make them fit for irrigation. Future work can also explore how water quality potentially changes with the bathymetric profile of the stormwater ponds of interest for reuse. Identifying soil types and testing their suitability for supporting reuse systems is another important aspect to consider, especially for older ponds. Other components to consider with these systems include sediment sample quality to understand biogeochemical transformations within the pond, and risk assessments on edible crops. Future research should also consider contingency plans in case of natural disasters and impacts from climate change to reduce food injustice in coastal communities.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su17020523/s1, Table S1: GPS Coordinates of water quality sampling locations around the N. 22nd Street and E. Chelsea St. Pond in East Tampa, FL; Table S2: Detection limits for heavy metals, nutrients and synthetic organic compounds analyses; Table S3. Complete list of organic compounds analyzed for July 2023 and July 2024; Table S4. Average synthetic organic compound concentrations for July 2023 and July 2024 in µg/L; Figure S1. Average (n = 3) total copper concentrations over 10 months at three different sampling sites, S1, S2, and S3, in the stormwater pond at N. 22nd Street and East Chelsea Street in East Tampa, FL; Figure S2. Average (n = 3) dissolved copper concentrations over 10 months at three different sampling sites, S1, S2, and S3, in the stormwater pond at N. 22nd Street and East Chelsea in East Tampa, FL; Figure S3. Average (n = 3) total zinc concentrations over 10 months at three different sampling sites, S1, S2, and S3, in the stormwater pond at N. 22nd Street and East Chelsea Street in East Tampa, FL; Figure S4. Average (n = 3) dissolved zinc concentrations over 9 months at three different sampling sites, S1, S2, and S3, in the stormwater pond at N. 22nd Street and East Chelsea in East Tampa, FL; Figure S5. Average (n = 3) total cadmium concentrations over 10 months at three different sampling sites, S1, S2, and S3, in the stormwater pond at N. 22nd Street and East Chelsea in East Tampa, FL; Figure S6. Average (n = 3) dissolved cadmium concentrations over 10 months at three different sampling sites, S1, S2, and S3, in the stormwater pond at N. 22nd Street and East Chelsea in East Tampa, FL; Figure S7. Average (n = 3) total arsenic concentrations over 10 months at three different sampling sites, S1, S2, and S3, in the stormwater pond at N. 22nd Street and East Chelsea in East Tampa, FL; Figure S8. Average (n = 3) dissolved arsenic concentrations over 10 months at three different sampling sites, S1, S2, and S3 in the stormwater pond at N. 22nd Street and East Chelsea in East Tampa, FL.; Figure S9. Average (n = 3) total lead concentrations over 10 months at three different sampling sites, S1, S2, and S3, in the stormwater pond at N. 22nd Street and East Chelsea in East Tampa, FL; Figure S10. Average (n = 3) dissolved lead concentrations over 10 months at three different sampling sites, S1, S2, and S3, in the stormwater pond at N. 22nd Street and East Chelsea in East Tampa, FL; Figure S11. Average (n = 3) total mercury concentrations over 10 months at three different sampling sites, S1, S2, and S3, in the stormwater pond at N. 22nd Street and East Chelsea in East Tampa, FL; Figure S12. Average (n = 3) dissolved mercury concentrations over 10 months at three different sampling sites, S1, S2, and S3, in the stormwater pond at N. 22nd Street and East Chelsea in East Tampa, FL.

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References

1. Dieter, C.A.; Maupin, M.A.; Caldwell, R.R.; Harris, M.A.; Ivahnenko, T.I.; Lovelace, J.K.; Barber, N.L.; Linsey, K.S. *Estimated Use of the Water in the United States in 2015*; U.S. Geological Survey: Reston, VA, USA, 2018.
2. Southwest Florida Water Management District 2022 Estimated Water Use Report. Available online: https://www.swfwmd.state.fl.us/sites/default/files/medias/documents/2022%20EWU%20Report.pdf (accessed on 1 November 2024).
3. Langemeyer, J.; Madrid-Lopez, C.; Mendoza Beltran, A.; Villalba Mendez, G. Urban Agriculture—A Necessary Pathway Towards Urban Resilience and Global Sustainability? *Landsc. Urban Plan.* **2021**, *210*, 104055. [CrossRef]
4. Capnerhurst, H.; Quigley, H.; Hawes, J.K. Sustainable Agriculture Impacts in Urban Settings Make the Case for Federal Investments. *J. Agric. Food Syst. Community Dev.* **2024**, *14*, 1–13. [CrossRef]
5. Artmann, M.; Sartison, K. The Role of Urban Agriculture as a Nature-based Solution: A Review for Developing a Systemic Assessment Framework. *Sustainability* **2018**, *10*, 1937. [CrossRef]
6. What Percentage of the American Population Lives Near the Coast? Available online: https://oceanservice.noaa.gov/facts/population.html (accessed on 1 November 2024).
7. Beckingham, B.; Callahan, T.; Vulava, V. Stormwater Ponds in the Southeastern U.S. Coastal Plain: Hydrogeology, Contaminant Fate, and the Need for a Social-ecological Framework. *Front. Environ. Sci.* **2019**, *7*, 117. [CrossRef]
8. Deksissa, T.; Trobman, H.; Zendehdel, K.; Azam, H. Integrating Urban Agriculture and Stormwater Management in a Circular Economy to Enhance Ecosystem Services: Connecting the Dots. *Sustainability* **2021**, *13*, 8293. [CrossRef]
9. Alberti, M.A.; Blanco, I.; Vox, G.; Scarascia-Mugnozza, G.; Schettini, E.; Pimentel da Silva, L. The Challenge of Urban Food Production and Sustainable Water Use: Current Situation and Future Perspectives of the Urban Agriculture in Brazil and Italy. *Sustain. Cities Soc.* **2022**, *83*, 103961. [CrossRef]
10. Cooper, C.M.; Troutman, J.P.; Awal, R.; Habibi, H.; Fares, A. Climate Change-induced Variations in Blue and Green Water Usage in U.S. Urban Agriculture. *J. Clean. Prod.* **2022**, *348*, 131326. [CrossRef]
11. Masoner, J.R.; Kolpin, D.W.; Cozzarelli, I.M.; Bradley, P.M.; Arnall, B.B.; Forshay, K.J.; Gray, J.L.; Groves, J.F.; Hladik, M.L.; Hubbard, L.E.; et al. Contaminant Exposure and Transport from Three Potential Reuse Waters with a Single Watershed. *Environ. Sci. Technol.* **2023**, *57*, 1353–1365. [CrossRef]
12. Florida Department of Environmental Protection. Florida's Reuse Activities. Available online: https://floridadep.gov/water/domestic-wastewater/content/floridas-reuse-activities (accessed on 12 November 2024).
13. Southwest Florida Water Management District Reclaimed Water, a Reliable, Safe Alternative Water Supply. Available online: https://www.swfwmd.state.fl.us/sites/default/files/medias/documents/reclaimed_water_lev2_08.09.pdf (accessed on 1 November 2024).
14. Here's a Look at Tampa Bay's Reclaimed Water, and the Future of Reuse. Available online: https://www.tampabay.com/news/environment/2024/03/28/reclaimed-water-definition-pinellas-hillsborough-pasco-direct-potable-reuse/ (accessed on 1 November 2024).

15. Feng, W.; Liu, Y.; Gao, L. Stormwater Treatment for Reuse: Current Practice and Future Development—A Review. *J. Environ. Manag.* **2022**, *301*, 113830. [CrossRef] [PubMed]
16. Valencia, A.; Zhang, W.; Gu, L.; Chang, N.B.; Wanielista, M.P. Synergies of Green Building Retrofit Strategies for Improving Sustainability and Resilience via a Building-scale Food-Energy-Water Nexus. *Resour. Conserv. Recycl.* **2022**, *176*, 105939. [CrossRef]
17. Hatt, B. Irrigating Food Crops with Stormwater. Available online: https://www.clearwatervic.com.au/user-data/resource-files/irrigating-food-crops-with-stormwater_report_final.pdf (accessed on 12 November 2024).
18. Florida Department of Environmental Protection. Stormwater Quality Applicant's Handbook. Available online: https://www.fdot.gov/docs/default-source/roadway/drainage/files/StormwaterQualityAppHB-DRAFT.pdf (accessed on 12 November 2024).
19. Devo Engineering. The Stormwater Harvesting BMP—An Overview & Its Enhanced Importance in the Forthcoming Statewide Stormwater Treatment Rule. Available online: https://www.devoeng.com/workshops/OCU_Dec-10-09/OCU_Dec-10-09.pdf (accessed on 12 November 2024).
20. Kannan, N.; Jeong, J.; Arnold, J.; Gosselink, L.; Glick, R.; Srinivasan, R. Hydrologic Modeling of a Retention Irrigation System. *J. Hydrol. Eng.* **2014**, *19*, 1036–1041. [CrossRef]
21. Orange County Environmental Protection Division. 2019 FSA Awards Program Submittal Form-Lake Lawne Stormwater Reuse Facility. Available online: https://www.florida-stormwater.org/assets/MemberServices/AwardsProgram/2019/OA%20-%20Orange%20County.pdf (accessed on 12 November 2024).
22. St. Johns River Water Management District. Stormwater Harvesting. Available online: https://www.sjrwmd.com/data/stormwater-harvesting/#willows (accessed on 12 November 2024).
23. FDEP. CCUA Stormwater Harvesting Project—Florida GSI. Available online: https://gsi.floridadep.gov/ccua-stormwater-harvesting-project/ (accessed on 12 November 2024).
24. Oakley, S.M. *Integrated Wastewater Management for Health and Valorization: A Design Manual for Resource Challenged Cities*; IWA Publishing: Dorset, UK, 2022.
25. Hess, K.M.; Sinclair, J.S.; Reisinger, A.J.; Bean, E.Z.; Iannone, B.V., III. Are Stormwater Detention Ponds Protecting Urban Aquatic Ecosystems? A Case Study Using Depressional Wetlands. *Urban Ecosyst.* **2022**, *25*, 1155–1168. [CrossRef]
26. Lehigh, G.R.; Wells, E.C.; Diaz, D. Evidence-Informed Strategies for Promoting Equitability in Brownfields Redevelopment. *J. Environ. Manag.* **2020**, *261*, 110150. [CrossRef]
27. Adams, L.W.; Dove, L.E.; Leedy, D.L. Public Attitudes Toward Urban Wetlands for Stormwater Control and Wildlife Enhancement. *Wildl. Soc. Bull.* **1987**, *15*, 372–380.
28. Campbell, K.R. Concentrations of Heavy Metals Associated with Urban Runoff in Fish Living in Stormwater Treatment Ponds. *Arch. Environ. Contam. Toxicol.* **1994**, *27*, 352–356. [CrossRef]
29. Brown, A.S.; Yun, X.; McKenzie, E.R.; Heron, C.G.; Field, J.A.; Salice, C.J. Spatial and Temporal Variability of Per- and Polyfluoroalkyl substances (PFAS) in Environmental Media of a Small Pond: Toward an Improved Understanding of PFAS Bioaccumulation in Fish. *Sci. Total Environ.* **2023**, *880*, 163149. [CrossRef] [PubMed]
30. U.S. Census. Available online: https://data.census.gov/profile?q=Tampa,%20Florida (accessed on 1 November 2024).
31. Garcia, L.; Anastasiou, C.; Robinson, D. Tampa Bay Surface Water Improvement and Management (SWIM) Plan Update. Available online: https://www.swfwmd.state.fl.us/sites/default/files/medias/documents/tampa_bay_swim_plan_finalforgb_10242023_0.pdf (accessed on 4 January 2025).
32. SWFWMD. Rainfall Cycle. Available online: https://www.swfwmd.state.fl.us/about/newsroom/rainfall-cycle#:~:text=The%20rainy%20season%20typically%20results,around%203%20inches%20per%20month (accessed on 4 January 2025).
33. UF/IFAS. General Soils Map of Florida. Available online: https://soils.ifas.ufl.edu/extension/soil-and-water-resources/general-soils-map-of-florida/ (accessed on 4 January 2025).
34. Rice, E.W.; Baird, R.B.; Eaton, A.D. *Standard Methods for the Examination of Water & Wastewater*, 23rd ed.; American Water Works Association: Washington, DC, USA, 2017; pp. 410–412.
35. DEP SOPs. Available online: https://floridadep.gov/dear/quality-assurance/content/dep-sops (accessed on 1 November 2024).
36. Florida LAKEWATCH. Available online: https://lakewatch.ifas.ufl.edu/for-volunteers/ (accessed on 1 November 2024).
37. City of Tampa. Preliminary Report Phase II 29th Street Outfall Drainage System. Available online: https://www.tampa.gov/sites/default/files/content/files/migrated/Prelim_Rpt_PH2_29th_13300601.pdf (accessed on 4 January 2025).
38. EPA Method 200.8: Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry. Available online: https://www.epa.gov/esam/epa-method-2008-determination-trace-elements-waters-and-wastes-inductively-coupled-plasma-mass (accessed on 1 November 2024).
39. Wilschefski, S.C.; Baxter, M.R. Inductively Coupled Plasma Mass Spectrometry: Introduction to Analytical Aspects. *Clin. Biochem. Rev.* **2019**, *40*, 115–133. [CrossRef]

40. Masoner, J.R.; Kolpin, D.W.; Cozzarelli, I.M.; Barber, L.B.; Burden, D.S.; Foreman, W.T.; Forshay, K.J.; Furlong, E.T.; Groves, J.F.; Hladik, M.L.; et al. Urban Stormwater: An Overlooked Pathway of Extensive Mixed Contaminants to Surface and Groundwaters in the United States. *Environ. Sci. Technol.* **2019**, *53*, 10070–10081. [CrossRef] [PubMed]
41. U.S. EPA. Method 8270E (SW-846): Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS). Available online: https://www.epa.gov/esam/epa-method-8270e-sw-846-semivolatile-organic-compounds-gas-chromatographymass-spectrometry-gc (accessed on 19 November 2024).
42. U.S. EPA. Method 8260D (SW-846): Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS). Available online: https://www.epa.gov/esam/epa-method-8260d-sw-846-volatile-organic-compounds-gas-chromatography-mass-spectrometry-gcms (accessed on 19 November 2024).
43. U.S. EPA. Guidelines for Water Reuse. Available online: https://www.epa.gov/sites/default/files/2019-08/documents/2012-guidelines-water-reuse.pdf (accessed on 12 November 2024).
44. Lusk, M.G.; Chapman, K. Chemical Fractionation of Sediment Phosphorus in Residential Urban Stormwater Ponds in Florida, USA. *Urban Sci.* **2021**, *5*, 81. [CrossRef]
45. Rushton, B.; Huneycutt, D.; Teague, K. *Characterization of Three Stormwater Ponds*; Southwest Florida Water Management District: Brooksville, FL, USA, 2004.
46. U.S. EPA. Conductivity. Available online: https://archive.epa.gov/water/archive/web/html/vms59.html#:~:text=Studies%20of%20inland%20fresh%20waters,high%20as%2010,000%20%C2%B5mhos/cm (accessed on 4 January 2025).
47. National Recommended Water Quality Criteria—Aquatic Life Criteria Table. Available online: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table (accessed on 1 November 2024).
48. Conrad, S.R.; Santos, I.R.; White, S.A.; Hessey, S.; Sanders, C.J. Elevated dissolved heavy metal discharge following rainfall downstream of intensive horticulture. *Appl. Geochem.* **2020**, *113*, 104490. [CrossRef]
49. Stoker, Y.E. Effectiveness of a Stormwater Collection and Detention System for Reducing Constituent Loads from Bridge Runoff in Pinellas County, Florida. Available online: https://pubs.usgs.gov/of/1996/0484/report.pdf (accessed on 4 January 2025).
50. Lusk, M.G.; Chapman, K. Copper Concentration Data for Water, Sediments, and Vegetation of Urban Stormwater Ponds Treated with Copper Sulfate Algaecide. *Data Brief* **2020**, *31*, 105982. [CrossRef]
51. Karlsson, F. Urban Stormwater Ponds: Evaluation of Heavy Metals and Organic Pollutants in Stormwater and Stormwater Sediments. Master's Thesis, Luleå University of Technology, Luleå, Sweden, 2021; 48p.
52. Maiga, Y.; Tidiane Compaore, C.O.; Diallo/Kone, M.; Kossi Sossou, S.; YempalaSome, H.; Sawadogo, M.; Nagalo, I.; Mihelcic, J.R.; Sidiki Ouattara, A. Development of a Constructed Wetland for Greywater Treatment for Reuse in Arid Regions: Case Study in Rural Burkina Faso. *Water* **2024**, *16*, 1927. [CrossRef]
53. Shober, A.L.; Reisinger, A.J. Soils and Fertilizers for Master Gardeners: The Florida Gardener's Guide to Landscape Fertilizers. Available online: https://edis.ifas.ufl.edu/publication/MG448 (accessed on 19 November 2024).
54. National Recommended Water Quality Criteria—Human Health Criteria Table. Available online: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table (accessed on 21 November 2024).
55. Wright, J.D.; Hunt, W.F.; Burchell, M.R.; Perrin, C.A.; McCoy, E.R. Implementation and Performance of Stormwater Best Management Practices Retrofits in Wilmington, NC. In *World Environmental and Water Resources Congress 2009*; ASCE: Reston, VA, USA, 2009; Volume 342, pp. 5293–5530.
56. Garrett, C.L. *Priority Substances of Interest in the Georgia Basin: Profiles and Background Information on Current Toxics Issues: Report of the Canadian Toxics Work Group*; Environment Canada: Vancouver, BC, Canada, 2004.
57. DeLorenzo, M.E.; Thompson, B.; Cooper, E.; Moore, J.; Fulton, M.H. A Long-term Monitoring Study of Chlorophyll, Microbial Contaminants, and Pesticides in a Coastal Residential Stormwater Pond and its Adjacent Tidal Creek. *Environ. Monit. Assess.* **2011**, *184*, 343–359. [CrossRef] [PubMed]
58. Olson, E.; Hargiss, C.L.M.; Norland, J. Escherichia coli Levels and Microbial Source Tracking in Stormwater Retention Ponds and Detention Basins. *Water Environ. Res.* **2021**, *94*, e1675. [CrossRef] [PubMed]
59. Verbyla, M.E.; Symonds, E.M.; Kafle, R.C.; Cairns, M.R.; Iriarte, M.; Mercado Guzman, A.; Coronado, O.; Breitbart, M.; Ledo, C.; Mihelcic, J.R. Managing Microbial Risks from Indirect Wastewater Reuse for Irrigation in Urbanizing Watersheds. *Environ. Sci. Technol.* **2016**, *50*, 6803–6813. [CrossRef] [PubMed]