Documentation in Support of Category 4e
Lake Arnold

Waterbody/Watershed Identification

Organization	City of Orlando
Point of Contact	Eva "Nicki" Wesson, PE City of Orlando, Project Manager 400 S. Orange Avenue Orlando, FL 32801 Nicki.Wesson@cityoforlando.net 407-246-3264
Waterbody(s)	WBID #3168Z3, Lake Arnold
No. Waterbody / Pollutant Combinations	Lake Arnold meets the verified list requirements as impaired for nutrients (Group4, Cycle 3) including total phosphorous (TP), total nitrogen (TN), and chlorophyll-a (Chl-a) and is on the State's Verified List.
EPA Completed TMDL	FDEP/EPA have not completed a TMDL for Lake Arnold.

Description of Baseline Conditions

Watershed(s): Kissimmee River

Baseline Data: Lake Arnold is a lake that is <40 Color (Platinum Cobalt Units), and <= 20 Alkalinity (CaCo3). Every year, Lake Arnold has exhibited Chlorophyll -a greater than 6 ug/l.

Year	TP AVG mg/l	TN AVG mg/l	Chlor AVG mg/m3	NNC Impairment
2007	0.024	0.853	23.10	Phosphorus + Nitrogen + Chlorophyll
2008	0.022	1.115	15.23	Phosphorus + Nitrogen + Chlorophyll
2009	0.034	1.160	31.51	Phosphorus + Nitrogen + Chlorophyll
2010	0.018	0.860	18.05	Phosphorus + Nitrogen + Chlorophyll
2011	0.021	0.865	7.76	Phosphorus + Nitrogen + Chlorophyll
2012	0.020	0.728	6.56	Phosphorus + Nitrogen + Chlorophyll
2013	0.020	0.783	6.81	Phosphorus + Nitrogen + Chlorophyll
2014	0.021	0.720	11.85	Phosphorus + Nitrogen + Chlorophyll
2015	0.026	1.138	20.88	Phosphorus + Nitrogen + Chlorophyll
2016	0.016	0.665	7.69	Phosphorus + Nitrogen + Chlorophyll
2017	0.022	0.669	15.25	Phosphorus + Nitrogen + Chlorophyll
2018	0.020	0.803	15.38	Phosphorus + Nitrogen + Chlorophyll
2019	0.017	0.660	16.86	Phosphorus + Nitrogen + Chlorophyll

Map: See below.

Figure 1. WBID #3168Z3, Lake Arnold

Evidence of Watershed Approach

Area of Effort	Lake Arnold is a +/-25 acre lake in a highly-urbanized section of the City of Orlando in Orange County. The lake is bounded by Lake Underhill Road on the north, S Crystal Lake Drive on the west, Curry Ford Road on the south, and Berwyn Avenue on the east in Section 32, Range 22, Township 30. Lake Arnold is encompassed by a ±250 acre watershed that is landlocked and served by a drainwell. Jurisdiction in the watershed is almost entirely the City of Orlando with a couple properties in the southwest portion within unincorporated Orange County. The Lake Arnold watershed has a combination of varying land uses, but consists primarily of 85% medium density residential development, 9% water, 4% commercial and institutional, 1% high density residential and 1% wetlands. See Figure 2 for the Watershed Boundary and Figure 3 for the Land Use information.
Key Stakeholders Involved and Their Roles	The City of Orlando is the key stakeholder that has assessments and existing best management practices in the watershed intended to restore water quality.

Watershed Plan & Other Supporting Documentation	The area includes the watershed drainage area from Lake Arnold within WBID #3168Z3. This WBID is impaired for nutrients (total nitrogen, total phosphorus, and chlorophyll-a) based on the annual geometric means exceeding the applicable criteria. The primary objective is to reduce the nutrient concentrations in the stormwater discharging to Lake Arnold. The City discovered an upwelling anomaly in the bottom of the lake with high concentrations of nutrients. The City is proposing to perform a study to characterize the quality of the water upwelling into the lake and the impact to the nutrient concentrations throughout the lake by sampling for nutrient concentrations at multiple locations in the lake and at various depths. The East Lake Arnold project is currently in the design phase and will reduce the nutrients in runoff from approximately 70 acres of residential area in the basin. This fully built-out area of the City has limited stormwater infrastructure to manage stormwater runoff from upstream areas and little water quality treatment is provided for the runoff prior to its discharge to Lake Arnold. The proposed project includes upgrading an existing 1st generation baffle box to a second-generation baffle box with media and adding three additional second-generation baffle boxes with media. The project will annually remove an estimated 128 kg/yr (283 lb/yr) of total nitrogen and 20 kg/yr (44 lb/yr) of total phosphorus. More detailed information on this project can be provided once the design is complete. The City constructed several roadside swales along Primrose Drive and Crystal Lake Drive about 20 years ago to provide water quality improvements to Lake Arnold. The City plans to remove the sediment accumulated in the bottom of the swales and reconstruct the swales as needed to ensure they are functioning as designed.
Point Sources and Indirect Source Monitoring (Sites)	The entire area is regulated by a Municipal Separate Storm Sewer System (MS4) permit. The City of Orlando is the holder of MS4 permit # FLS 000014-004. No point sources are located within the Lake Arnold watershed. Note: Generic Permits for stormwater discharge from large and small construction activities are considered temporary; therefore, are not included in this listing.
Nonpoint Sources	The nutrient loadings to Lake Arnold are primarily generated from nonpoint sources, including surface runoff, groundwater seepage entering the lake, precipitation directly on the lake surface, internal recycling associated with sediments in the lake bottom, and birds and other wildlife (through their feces if they feed outside of the waterbody and thus concentrate nutrients from other aquatic systems to Lake Arnold). Onsite sewage treatment and disposal systems (OSTDS) may also contribute nutrients and pollutants to the lake through the groundwater. There have been 7 septic-to-sanitary conversions within 1,000 ft of Lake Arnold since 1988 with 3 of those being lakefront homes. We found evidence of possibly 4 lots currently utilizing septic systems within 1,000 ft of the lake and therefore do not feel that the existing septic systems are likely to be a major contributor to the impairment of the lake.
Water Quality Criteria	Per the Numeric Nutrient Criteria, to avoid impairment status, TP must be less than 0.01 mg/l, TN must be less than 0.51 mg/l, and Chlorophyll-a must be less than 6 ug/l. The City of Orlando is striving for Lake Arnold to meet Class III surface water quality standards as

defined in Chapter 62-302, Florida Administrative Code upon successful completion of all projects and to the maximum extent possible.

Restoration Work

1. Existing City of Orlando BMPs

Basin Name	BASIN	Sweeper Route Length in Miles	Number of Inlet Baskets	Number of Baffle Boxes	Number of Exfiltration Trenches
Arnold	ORL-22	6.84	12	2	2

Street Sweeping: The Lake Arnold Basin, is swept twice a month - once using a mechanical sweeper and one time with an air vac sweeper. For 2019, the City of Orlando's street sweeping effort in the Lake Arnold Basin collected approximately 340 cubic feet of material which reduced the Total Nitrogen to the system by about 197 kg (435 lbs) and the Total Phosphorus to the system by about 127 kg (280 lbs). The street sweeping routes are shown on the attached basin map on Figure 4.

Inlet Baskets, Baffle Boxes and exfiltration trenches: The locations of these BMP's are shown on the attached basin map on Figure 4. The cleaning schedules vary for each of these based on the historic need. For 2019, cleaning of the City of Orlando's inlet baskets, baffle boxes and exfiltration trenches (constructed in 2001) collected approximately 18 CY of material which reduced the Total Nitrogen to the system by about 16 kg (36 lbs) and the Total Phosphorus to the system by about 6 kg (14 lbs).

The private dry retention pond was constructed with the neighborhood, Lake Arnold Reserve in about 2005 and 2006 with the neighborhood being built out by 2012. As this is a private pond, the City does not have any maintenance information on it.

See Figure 4 for the Lake Arnold Basin Street Sweeping Routes and BMP locations.

2. Previous Sanitary Sewer Improvements/Activities

Lift station #19 is located directly adjacent to Lake Arnold. This lift station was converted from a can type station to a submersible type station in 2008 to bring it up to current standards and eliminate confined space entry concerns for employee safety. The standby generator was replaced in 2012. We have no records of any sanitary sewer overflows associated with this lift station.

The service area for lift station #19 was smoke tested in 2019. As a result, the following repairs were performed in the Lake Arnold Basin in 2019 & 2020: 26 laterals were repaired and 28 manholes were lined along with the associated pipe.

There have been 7 septic-to-sanitary conversions within 1,000 ft of Lake Arnold since 1988 with 3 of those being lakefront homes. We found evidence of possibly 4 lots currently utilizing septic systems within 1,000 ft of the lake and therefore do not feel that the existing septic systems are likely to be a major contributor to the impairment of the lake.

3. Alum Treatment

In 1999, the City attempted to improve the water quality in Lake Arnold by applying alum. The goal was to improve the transparency of the water column so that submerged aquatic plants could be planted and sunlight could reach the new plants to aid in growth. On April 7, 1999, 2700 gallons of alum were applied to Lake Arnold (a much smaller dosage than is normally applied to a lake this size). This application resulted in a fish kill of over 10,000 fish. The lake has since been restocked. The City has no plans to apply alum to this lake again.

4. Upwelling Anomaly Study

In 2017, the City of Orlando found an upwelling anomaly at the deepest location in the bottom of the lake. At that time, divers were hired to collect a water sample from the lake bottom at the location of the upwelling. No attempt was made to determine the quantity of water coming into the lake but the diver observed the sand from the lake bottom being thrown up about one to one and a half feet above the lake bottom and could feel that the lake water near the anomaly was significantly colder than the rest of the lake. The nutrient concentrations found in this water (0.46 mg/L TP and 3.8 mg/L TN) were significantly higher than the background concentrations in the lake (0.02 mg/L TP and 0.63 mg/L TN). Currently, the City only has this one sample of the upwelling water to characterize it. The City is proposing to perform a study to characterize the quality of the water upwelling into the lake and the impact to the nutrient concentrations throughout the lake by sampling for nutrient concentrations at multiple locations in the lake and at various depths.

5. East Lake Arnold Drainage Basin Improvement

This project is currently under design. The project area is located on the south and east sides of Lake Arnold which is a fully built-out area consisting primarily of residential with a small amount of commercial along its southern boundary. Limited stormwater infrastructure exists to manage stormwater runoff from upstream areas and little water quality treatment is provided for the runoff prior to its discharge to Lake Arnold. The proposed project includes upgrading an existing 1st generation baffle boxes to a second-generation baffle box with media and adding three additional second-generation baffle boxes with media. The 4 baffle boxes serve a combined drainage basin of approximately 70 acres. Original estimates for the nutrient removals for the project include a 128 kg/yr (283 lb/yr) for total nitrogen and 20 kg/yr (44 lb/yr) for total phosphorus. The project is currently in the 90% design phase therefore the nutrient removal estimates will be refined as the design progresses.

See Figure 5 for a depiction of the East Lake Arnold project area.

6. Crystal Lake Drive and Primrose Drive Drainage Improvement Projects.

These are two drainage improvement projects that installed roadside swales and 2 exfiltration trenches within the Lake Arnold basin about 20 years ago. The City of Orlando is proposing to rehabilitate the roadside swales that were constructed by removing accumulated sediment from the swale bottoms and reconstructing the swales back to the permitted conditions.

See Figure 6 for a depiction of the swale locations.

Critical Milestones/Monitoring

Anticipated Critical Milestone(s) and Completion Dates:	1. Existing City of Orlando BMP's: Street Sweeping, cleaning of the baffle boxes, inlet baskets and exfiltration trenches will continue. 2. Lift Station renovation and smoke testing has already been completed along with the repairs to the system that were determined necessary by the smoke test. 3. Alum Treatment: No plans for future alum treatment. 4. Upwelling Anomaly Study: The City plans to begin the study this year and expects the study to last 2 years. We will report results to FDEP as the study progresses. 5. East Lake Arnold Drainage Basin Improvement Project: This project is currently under design and expected to be completed in 3 phases with construction occurring in 2021, 2022, and 2023. 6. Crystal Lake Drive and Primrose Drive Drainage Improvement project: The City is currently working on getting this work on their work plan. The plan is to do this project in two phases with the first phase being completed in 2021 and the second phase being completed in 2022.
Monitoring Component	The City of Orlando performs water quality monitoring within Lake Arnold on a quarterly basis. We sample in the northern central portion of the lake by capturing numerous field parameters. Wet chemistry and nutrient samples are collected on a quarterly basis; metals are collected on an annual basis. A list of sampled parameters is provided in Tables 1.1 – 1.3 at the end of this document. The data collected will be uploaded into WIN on an annual basis.

Other Key Dates

Estimated Date for Delisting from Verified List or Removal from Study List	The WBID is in the state's Group 4 Basin in the DEP Central District. The next review and assessment cycle (cycle 5) is expected in 2026; at which time sufficient data will be acquired to fully assess the WBID, and if not impaired, FDEP is expected to request the WBID be delisted from the Federal 303(d) list (if applicable). If the waterbody is determined to still not meet water quality standards, an evaluation of the reasonable progress towards attaining water quality standards will be completed.

Financial Commitments

Estimated Implementation Cost	The total cost for the East Lake Arnold project, including land acquisition (if applicable) is estimated at $2.9 million total. The total cost for the Anomaly sampling study is estimated at $20,000 total. Cost for rehabilitating the roadside swales is $TBD The cost includes a 319(h) Clean Water Act Section grant of $TBD (TBD% of construction and monitoring costs – if applicable) The estimated 20 year operation and maintenance cost is $TBD
Land Acquisition (if applicable)	**Funding Source:** Total……$ N/A
Design and Construction (if applicable)	**Funding Source: -** The City of Orlando Capital Allocation of Stormwater Utility Fees and Hazard Mitigation Grant from FEMA (contingent upon funding approval from each respective agency).
	Total – East Lake Arnold……...$2,900,000 Rehabilitating the roadside swales ……. $TBD

Water Quality Sampling Parameters

Table 1-1 Lake Monitoring Laboratory Parameters

Laboratory Parameters
Alkalinity
Ammonia as N
Biochemical Oxygen Demand (BOD)
Chlorophyll-a
Escherichia coli
Nitrate/Nitrite as N
Nitrite as N
Nitrate as N
Total Kjeldahl Nitrogen
Total Nitrogen
Total Phosphorus as P
Orthophosphate as P
Total Dissolved Solids
Total Suspended Solids
Volatile Suspended Solids
True Color
Turbidity

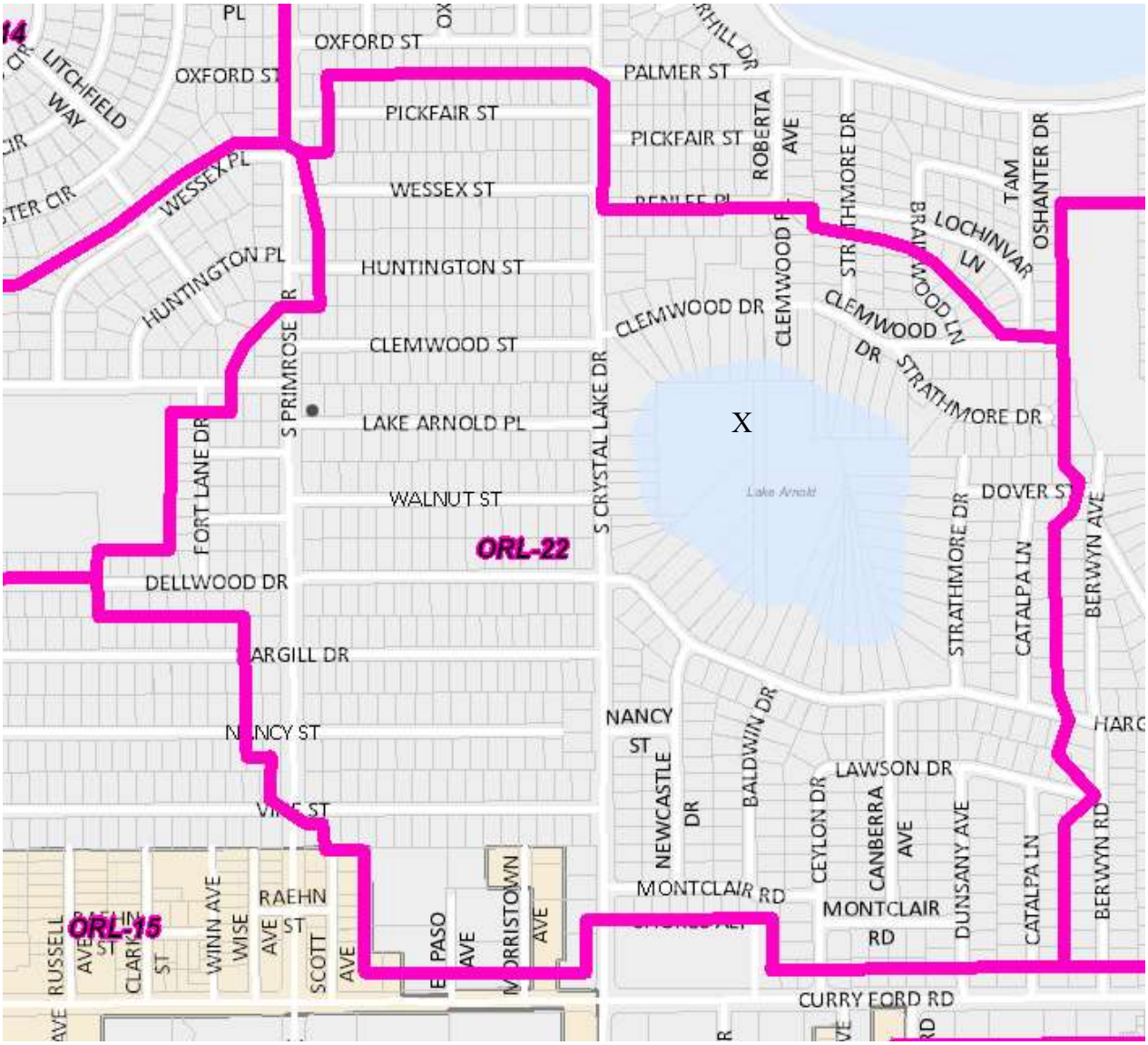
Table 1-2 Lake Monitoring Field Parameters

Field Parameters
pH
Dissolved Oxygen
Specific Conductance
Water Temperature
Ambient Temperature
Secchi Depth
% Cloud Cover
Wind Speed
Wind Direction

Table 1-3 Lake Monitoring Laboratory Metal Parameters

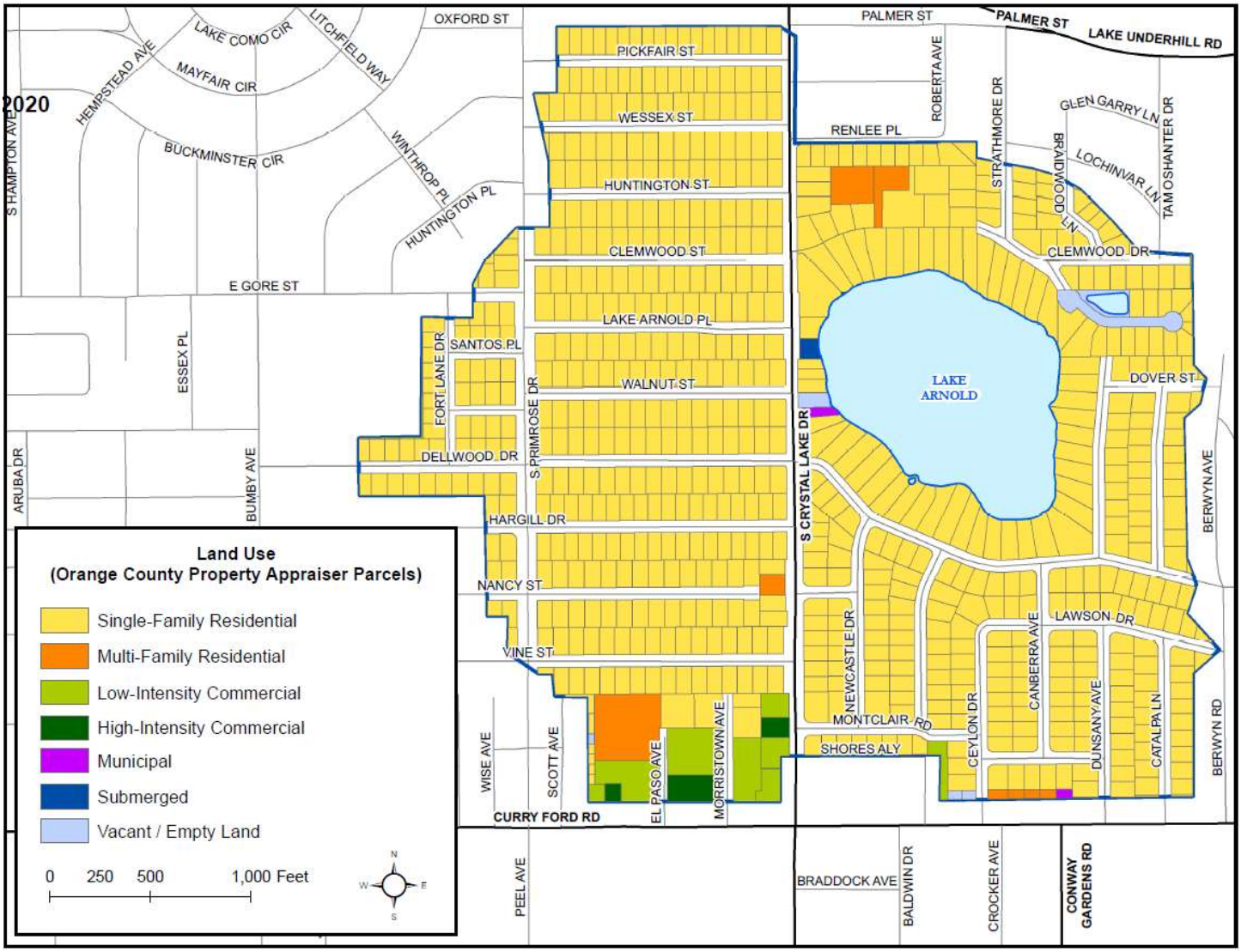
Laboratory Parameters
Arsenic
Beryllium
Cadmium
Chromium
Copper
Hardness
Iron
Lead
Magnesium
Mercury
Nickel
Selenium
Silver
Zinc

Figure 2. Lake Arnold Watershed with Water Quality Sampling Location



Station Name	Latitude	Longitude
ARNOLD	28° 31' 51.6"	81° 20' 31.2"

Figure 3. Land Use in the Lake Arnold Watershed



Water Body and Land Use Code	Land Use Description	City Area (Acres)	Percentage of Area
1200	Residential, medium density = 2-5 units/acre	222.5	85%
1300	Residential, high density = 6 or more units/acre	2.6	1%
1400	Commercial and Services	6.0	2%
1700	Institutional	5.1	2%
5200	Lakes	24.1	9%
6400	Vegetated Non-forested Wetlands	1.8	1%
	Total	262.0	100%

Figure 4: City of Orlando Street Sweeping and Inlet Basket Locations in the Lake Arnold Basin

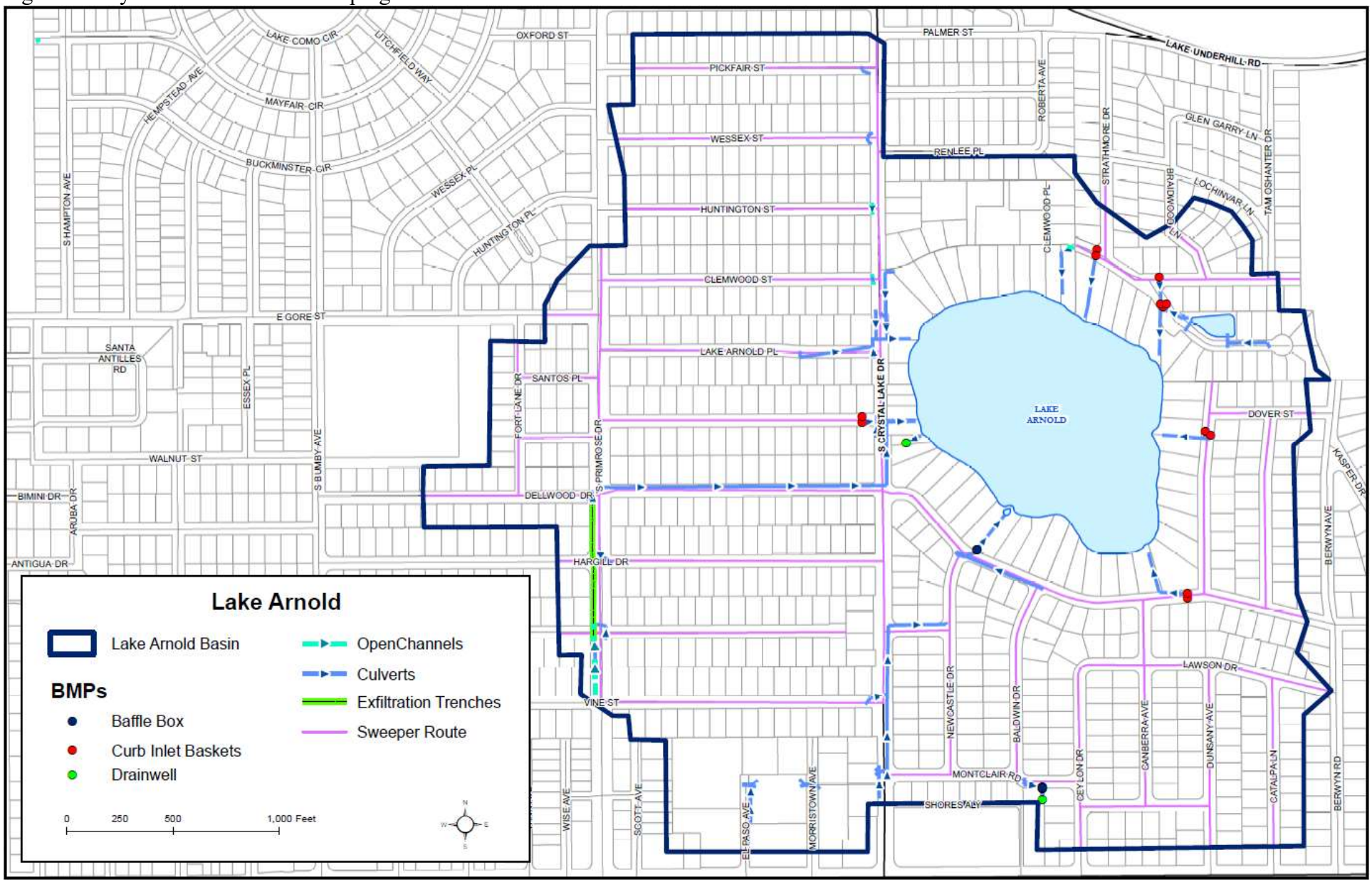


Figure 5: East Lake Arnold Drainage Improvement Project

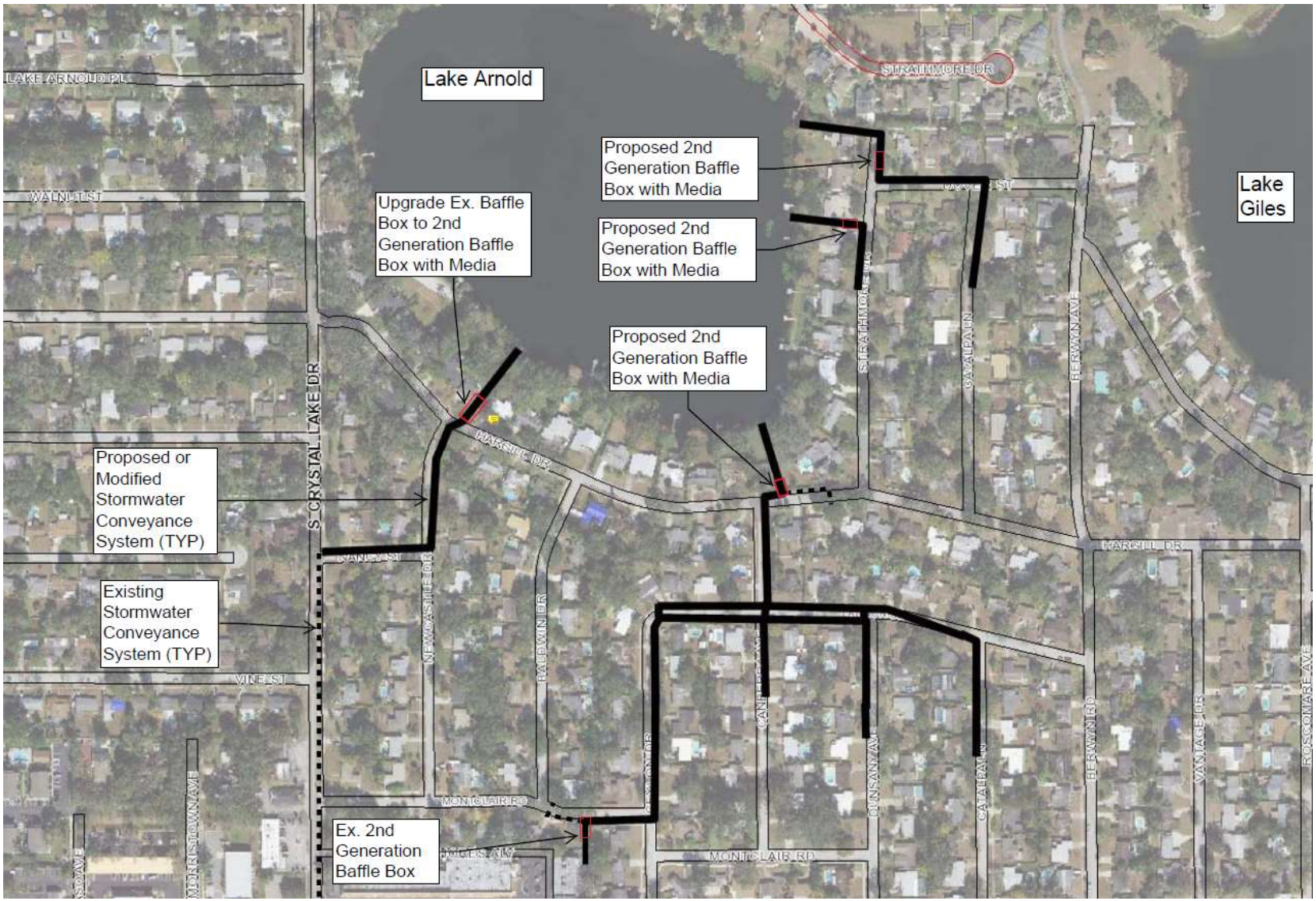
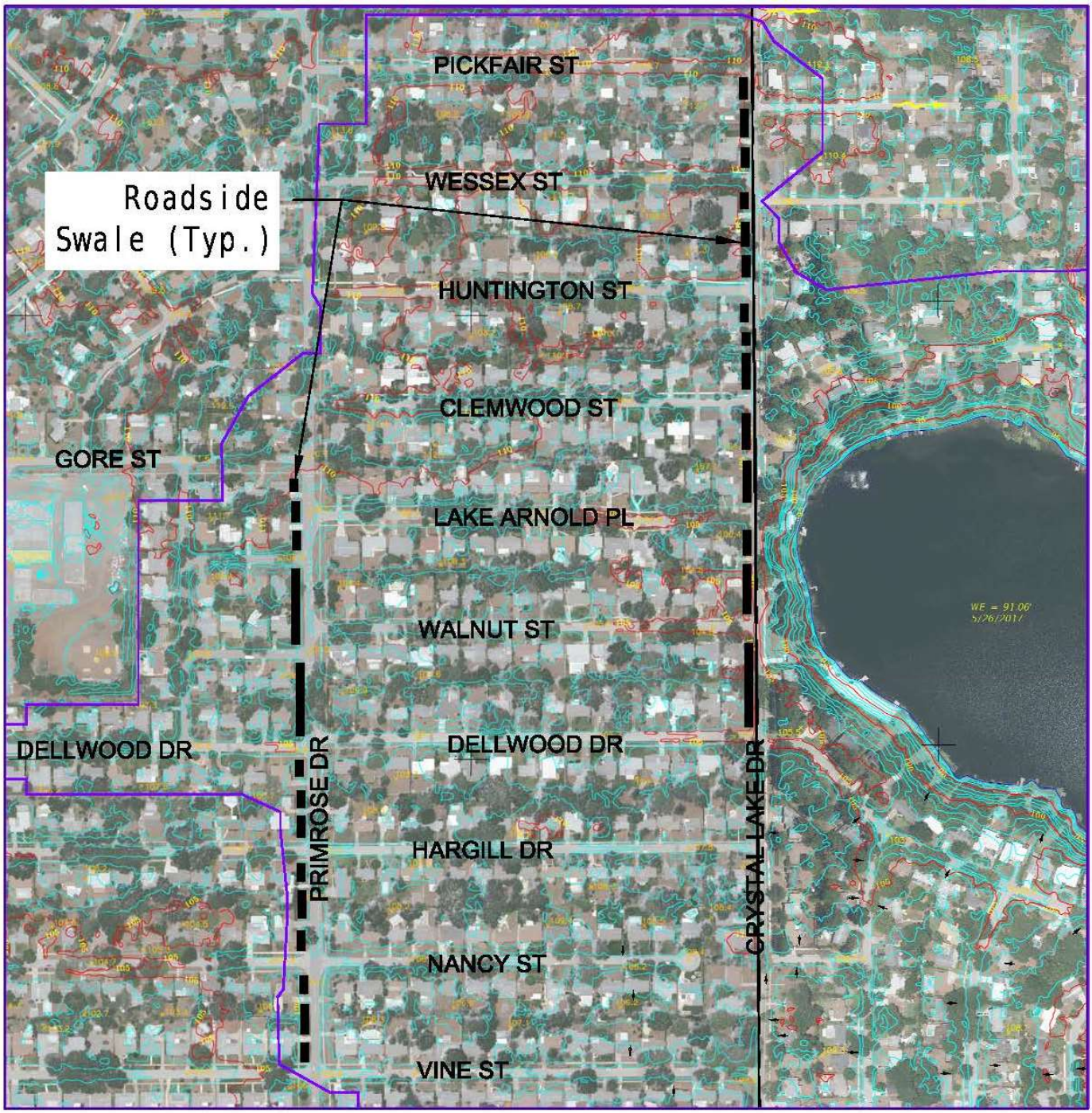


Figure 6: Crystal Lake Drive and Primrose Drive Swale Locations



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Primrose & Crystal Lake Dr Drainage Improvements

Lake Arnold 4e

Figure 6: Swale Locations

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DEPARTMENT OF PUBLIC WORKS - ENGINEERING SERVICES DIVISION

400 SOUTH ORANGE AVENUE, 8th FLOOR, ORLANDO, FLORIDA 32801