Technical Memorandum

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Subject: **Northlake Water Supply Study – Phase 1 (REVISION 2)**

The City of Coppell is looking for alternatives to maintain specific water surface elevation in North Lake. The following Technical Memorandum was developed for analyzing the volume required to maintain the required water level in Northlake and the associated costs of both the facilities and to purchase treated or untreated wholesale water.

North Lake, physically located in the City of Dallas, was originally constructed by Dallas Power and Light to provide cooling water for a power plant on the north shore. Originally, the lake did not have sufficient watershed to supply power plant operations and maintain normal water levels from rainfall. A pump station was built on Elm Fork of the Trinity River at the intersection of the river and Sandy Lake Road to supply the lake. Recently, after the decommissioning of the power plant, ownership of the lake, raw water pump station and pipeline was transferred to the City of Coppell.

Contractual obligations now exist that require the City to maintain a normal pool elevation in the Northlake. Although the area of the lake has been reduced as part of the Cypress Waters development, there is still insufficient watershed to maintain the required lake level in drought years, and provide irrigation supply to Cypress Waters.

This feasibility analysis evaluates three options for water supply to Northlake:

Option 1) Flushing treated water from the southern sector into the Northlake watershed

Option 2) Raw water via rehabilitation of the raw water pump station and pipeline

Option 3) Building a well field and pumping groundwater into Northlake.

This evaluation considers a comparison of infrastructure costs and their related treated or raw water wholesale purchase rates.

I. Existing Information

The following information on the existing conditions of North Lake was obtained from the "North Lake Dam Operation and Maintenance Manual" written in September 2015.

Required Pool Elevation:	484 ft-msl
Surface Area @ Required Pool Elevation:	273 acres (11,891,880 sqft)
Capacity @ Required Pool Elevation:	2900 acre-feet (944 Mgal)
Spillway Crest Elevation:	484 ft-msl

II. Estimated Water Demand

The demand is composed of evaporation and irrigation demand. Drought, peak year irrigation demand was provided for the new Cypress Waters development by the City of Coppell. Evaporation and precipitation data was obtained from measurements recorded at the DFW International Airport between 2001 and 2015 as listed on the National Weather Service Weather Forecast Office. The evaporation data was obtained from measurements in Dallas County between 2000 and 2014 as listed on the Texas Water Development Board website. Two methods were used to estimate the required supplemental water supply volume. Method 1 is generally a straightforward approach of summing precipitation, evaporation and irrigation demand for the area encompassed by the lake. Method 2 utilizes the Integrated Storm Water Management (iSWM) system as developed by the NCTCOG, and considers the entire watershed that contributes runoff to Northlake.

Method 1: Historical Weather Data

The ***Annual Volume,*** corresponding ***Average & Peak Daily Flow Rates*** required to maintain the normal pool elevation of 484 ft-msl were calculated for maximum, minimum and average annual precipitation for maximum, minimum and average annual evaporation. To ensure a conservative estimate, the following was assumed:

- Precipitation is captured within the Lake perimeter only. The watershed is not included.
- Evaporation occurs when water levels in the lake are at required pool elevation which represents a surface area of 273 acres.
- Worst case scenario includes peak irrigation demand of 1,250 ac-ft per year, with 15% of total taken in 3 peak months (June-August)
- Average conditions include irrigation demand assumed to be half of peak demand.

The estimated Daily Flow Rates, using the assumptions above, are calculated for annual precipitation conditions as measured between 2001 and 2015 in Dallas-Fort Worth. The evaporation data was obtained from measurements obtained between 2000 and 2014 in Dallas County only.

BEST CASE CONDITIONS								
Minimum Evaporation (2007)		Maximum Precipitation (2007)		Cypress Waters Irrigation Annual Demand		Annual Vol. to maintain Normal Pool Elev. (Mgal)	Average Daily Flow Rate Req. (MGD)	Peak Daily Flow Rate Req. (MGD)
Measured (in.)	Total (Mgal)	Measured (in.)	Total (Mgal)	(Ac-ft)	(Mgal)			
50.70	375.85	50.05	371.03	0.0	0.0	4.82	0.01	0.02

AVERAGE ANNUAL CONDITIONS								
Average Evaporation		Average Precipitation		Cypress Waters Irrigation Annual Demand		Annual Vol. to maintain Normal Pool Elev. (Mgal)	Average Daily Flow Rate Req. (MGD)	Peak Daily Flow Rate Req. (MGD)
Measured (in.)	Total (Mgal)	Measured (in.)	Total (Mgal)	(Ac-ft)	(Mgal)			
57.88	429.07	36.14	267.93	626	204	365.14	1.00	1.83

WORST CASE CONDITIONS								
Maximum Evaporation (2011)		Minimum Precipitation (2005)		Cypress Waters Irrigation Annual Demand		Annual Vol. to maintain Normal Pool Elev. (Mgal)	Average Daily Flow Rate Req. (MGD)	Peak Daily Flow Rate Req. (MGD)
Measured (in.)	Total (Mgal)	Measured (in.)	Total (Mgal)	(Ac-ft)	(Mgal)			
69.75	517.07	18.97	140.63	1,250	407	783.44	2.15	3.92

Method 2: iSWM™ Monthly Water Balance

This analysis utilizes the Integrated Storm Water Management (iSWM) system as developed by the NCTCOG. Unlike the annual averaging used in Method 1 above, this method uses a monthly water balance approach that considers additional factors such as the watershed runoff, and spillway overflow. The water balance equation is below, with an explanation of variables and assumptions:

$$\Delta V = P + R + B - I - E - E_t - O$$

- ΔV is change in volume – or in this case the supply required to keep Northlake at level.
- P is monthly precipitation – using the same worst case conditions as used in Method 1, the monthly precipitation was from 2005.
- R is the runoff – a drainage basin of 1,675 acres was delineated from existing topography and the storm drain systems to calculate runoff.
- B is baseflow – baseflow contributions are negligible for ponds outside of a stream system and non-existent for Northlake, thus was assumed to be 0.

- I is infiltration into the soil – infiltration is negligible since Northlake is situated in the fatty clays overlying the Eagle Ford Shale which have very low infiltration rates, and was assume to be 0.
- E is monthly evaporation - using the same worst case conditions as used in Method 1, the monthly evaporation was from 2011.
- E_t is evapotranspiration – evapotranspiration is only considered when wetland vegetation dominates, and was assumed to be 0.
- O is overflow – the monthly surplus over the normal pool capacity which is lost over the spillway, and subtracted from the water balance if 485 ft-msl is assumed to be maintained.

The graphical results for the supplemental daily flow are shown below in Figures1 and 2, and the complete water balance table is provided in Attachment A.

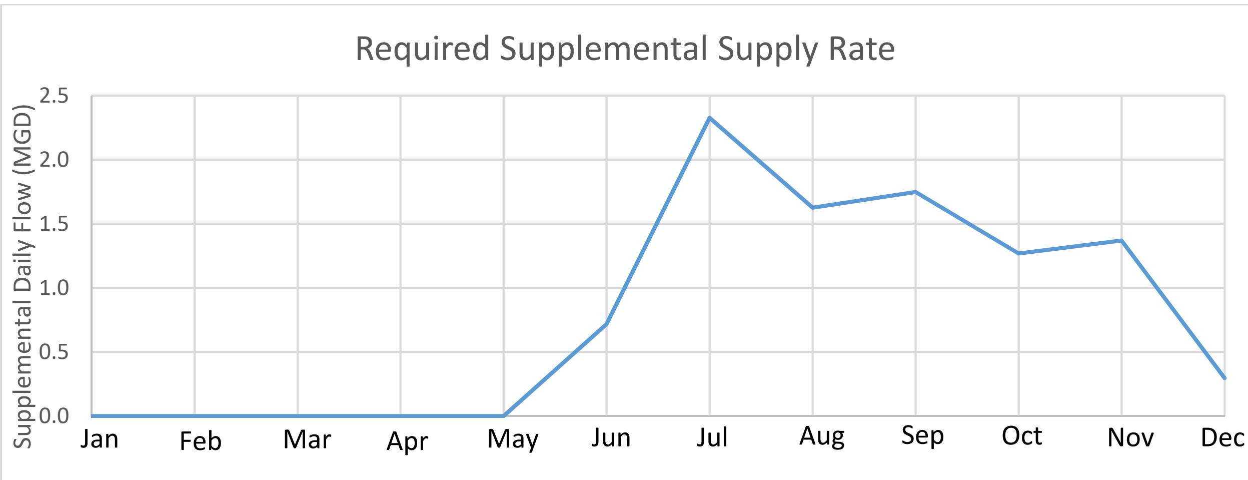

Figure 1 – Supplemental Pumping Rates by Month for Average Case Conditions (Average Rainfall, Average Evaporation, & Half of Maximum Irrigation Demand)

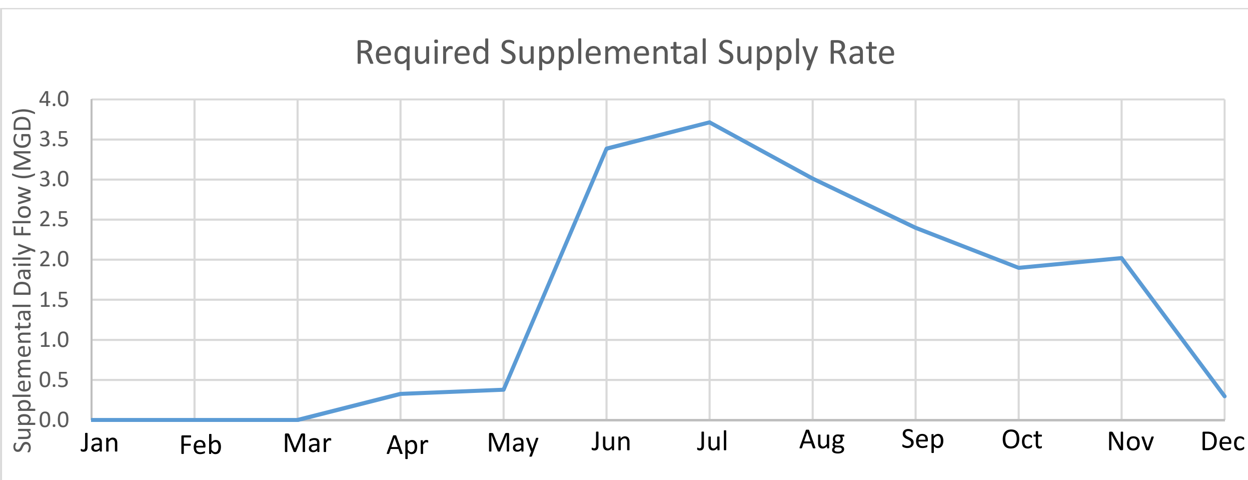

Figure 2 – Supplemental Pumping Rates by Month for Worst Case Conditions (Minimum Rainfall, Maximum Evaporation & Maximum Irrigation Demand)

The worst case scenario monthly pattern including Cypress Waters maximum irrigation demand is estimated to require a total annual supplemental supply of approximately 573 Mgal/year, with a peak supply rate of approximately 3.71 MGD (July) to maintain normal pool capacity at 484 ft-msl.

The average monthly pattern including Cypress Waters average irrigation demand is estimated to require a total annual supplemental supply of approximately 64 Mgal/year, with a peak supply rate of approximately 1.36 MGD (July) to maintain normal pool capacity at 484 ft-msl.

In an average year, the minimum daily supplemental flowrate required per Method 1 and 2 is estimated to be between 1.8 and 1.4 MGD respectively. In a drought year, the maximum supplemental flow rate, or peak design flowrate required, is estimated to be 3.9 to 3.7 MGD respectively. The difference in results between the methods is primarily that 2 considers the entire watershed for Northlake, and thus should be considered more accurate.

III. Cost Analysis

The two primary components of cost are the infrastructure improvements and the water purchase cost for each option. Since the facilities must be sized to convey the maximum rate possible, a flowrate of approximately 4.0 MGD, or 2800 gpm was assumed per the discussion above.

Infrastructure Costs

Treated Water – This option proposes that flushing stations be installed in the southern sector, which is the area west of Northlake south of Southwestern Blvd. This area is in the Northlake watershed and treated water flushed to the storm drain system would feed Northlake. This area also experiences water quality issues due to low usage and flushing would likely improve the flow in the pipe network and likely the water quality in the distribution system in this area. The flushing stations should be constructed to convey water from the water system to the storm drain system that flows to the lake. A flushing station should be equipped with an automatic SCADA controlled valve, meter, air gap, dechlorination chemicals and feed equipment. Three stations with 1,000 gpm discharge capacity each were assumed for adequate supply and redundancy.

Treated Water Flushing Stations	
Flushing station piping & air gap connection	$ 40,000
Dechlorinating station	$ 60,000
Meter Vault with automatic valve	$ 75,000
SCADA and electrical	$ 25,000
Sub-total	$ 200,000
Sub-total (for three stations)	$ 600,000
Contingency (25%)	$ 150,000
Engineering (20%)	$ 150,000
Total for Three stations	**$ 900,000**

Raw Water – For a raw water supply, portions of the existing Northlake Pump Station (NPS) and pipeline could be used to deliver raw water from the Elm Fork of the Trinity River to Northlake as was done by Dallas Power and Light since the 1950's. Due to the age, condition and size of the existing equipment it is recommended that, at a minimum, the existing pumps and electrical equipment be replaced. The costs presented in this memo assume that the existing intake structure, pump deck and influent channel can be reused with little modification or rehabilitation. However, it is possible that an entirely new intake structure and influent channel may be required. A full evaluation of the intake structure and survey of the adjacent river channel is recommended.

The NPS currently has two 28 MGD pumps and one 14 MGD pump to convey water to Northlake via a 42" pipeline. The proposed maximum flowrate is approximately 4.0 MGD, which would have a maximum velocity of less than 0.6 feet per second in a 42-inch pipeline. This would allow sediment to accumulate, and ultimately pipeline blockage. To achieve non-settling velocities of three to five feet per second, a smaller pipeline of approximately 12-14 inch diameter is recommended. This newer smaller pipeline could be installed either on top of or inside of (sliplininig) the existing pipe.

Northlake Raw Water Pump Station	
Intake improvements and dredging	$ 250,000
Pumps & piping modifications	$ 300,000
Demolition of ex. Station and transformer removal	$ 250,000
SCADA & electrical	$ 150,000
24" Transmission main (Sliplining of ex. 42")	$ 800,000
Sub-total	$ 1,750,000
Contingency (25%)	$ 437,500
Engineering (20%)	$ 437,500
Total	**$ 2,625,000**

Groundwater – The alternative to purchasing water is a groundwater well field supply. This option only presents cost for the infrastructure and annual O&M, as groundwater is free if available. Upon review of the Texas Water Development Board's groundwater database, and calls to local drillers, a 6" well has been reported to produce up to 100 gpm and a 10" well may produce up to 200 gpm. To achieve a 4.0 MGD rate, or 2,800 gpm, fourteen 10" wells would be required. In addition to the wells, a network of piping would be required to bring the water from each well to an outfall structure on the lake, or multiple outfall structures as needed to limit the piping runs.

Well Field	
Water wells[1] (14~10" wells at $400,000 each)	$ 5,600,000
Piping and related infrastructure[2]	$ 350,000
Well pad site & access road	$ 700,000
SCADA & electrical	$ 700,000
Sub-total	$ 7,350,000
Contingency (25%)	$ 1,837,500
Engineering (20%)	$ 1,837,500
Total	**$11,025,000**
1. Assumes 200 gpm safe yield per well, for 4.0 MGD supply 2. Assumes 20,000 LF of 4"-6" connecting piping to multiple outfalls.	

Water Cost

Water is currently obtained per the Wholesale Treated Water Contract between the City of Coppell and the City of Dallas dated October 27th, 1987. Per the contract, the rates established are subject to changes by the Dallas City Council. Below is a table reflecting wholesale water rates for treated and untreated water from DWU per their "Cost Study" dated June 2017.

Rates Table

Proposed Wholesale Rates	
Regular Untreated Water	$ 1.02
Interruptible Untreated Water	$ 0.4761
Treated Water Demand (per MGD/year) Treated Water Volume	$ 280,458 $ 0.4565
Treated Water Flat Rate	$ 2.2094

Rates Description

- Regular Untreated Water: Raw water pumped from the source (lake or river).
- Interruptible Untreated Water: Raw water during flood stage.
- Treated Water Demand + Volume: Demand charge paid for operational costs plus volume charge paid per thousand gallons of water pumped.
- Treated Water Flat Rate: Payment required for volume taken. If take exceeds 1 MGD, then the contract may be transferred to a "Treated Water Demand/Volume" rate.

Method 2 (iSWM water balance)	Annual Vol. (Mgal)	Raw Water	Treated Water: Demand + Vol. Rate	Treated Water: Flat Rate
Best Case Weather Year	5	$ 5,100	$ 1,124,115	$ 11,032
Average Weather Year	64	$ 65,280	$ 1,151,048	$ 141,209
Worst Case Weather Year	580	$ 591,600	$ 1,386,602	$ 1,279,712

Total Costs

The annual costs, not including any capital expenditure or debt service, consist of water purchase, power and Operations and Maintenance (O&M), and are summarized in the table below. An average weather year is assumed and can vary for drought or wet years. O&M is assumed to be 1% of the capital cost expenditure.

Annual Estimated Cost			
	Treated Water	**Raw Water**	**Well Water**
Water [1]	$ 1,151,048	$ 65,280	$ 0
Power Cost[3]	$ 0	$ 9,000	$ 58,000
O&M[4]	$ 9,000	$ 26,250	$ 110,250
Total	$ 1,160,048	$ 100,530	$ 168,250
See next table for reference notes			

Total Estimated Cost (20 yr. Present Value)			
	Treated Water (Demand + Vol. Rate)	**Raw Water**	**Well Water**
Water [1]	$ 23,020,960	$ 1,305,600	$ 0
Infrastructure	$ 900,000	$ 2,625,000	$ 11,025,000
Debt interest[2]	$ 298,000	$ 869,000	$ 3,650,000
Power Cost[3]	$ 0	$ 180,000	$ 1,160,000
O&M[4]	$ 180,000	$ 525,000	$ 2,205,000
Total	$ 24,398,960	$ 5,504,600	$ 18,040,000

1. No change in water rates assumed over 20 year analysis.
2. Interest on debt assumed to be 3% per annum, for 20 year debt obligation, rounded up to nearest $1,000.
3. 5 cents/kWh assumed for electrical rate.
4. Assumed to be 1% of capital cost times 20 years.

IV. Discussion and Recommendations

The treated water option has the lowest infrastructure cost, but it is significantly higher than the other options due to the cost to purchase the treated water from DWU, which is mostly due to the increase in the demand charge ($280,458 per MGD). If water cannot be obtained at the "Flat Rate", it is recommended that treated water be eliminated from consideration.

Groundwater would be a less expensive water supply option than treated water on an annual basis, but the infrastructure cost is high is due to the cost of drilling and completing multiple water wells and the related wellfield piping. This infrastructure could be less if the yield of the wells is higher than estimated, but the specific yield of any well cannot be determined with certainty until it is drilled and tested. It was assumed each well should be spaced 1,000 feet apart, but a hydrogeologist should be consulted before exploring this option further. No costs for easements or right-of-way were included and should be considered for access to well sites.

From both a long term and short term financial perspective, a raw water supply appears to be the most attractive. The raw water purchase cost may be less if the "Interruptible Rate" can be applied, but it is only likely in the event of a wet year when the supplemental supply to Northlake will be low. Although there are some unknowns regarding the condition and feasibility of reusing the existing Northlake raw water pump station and pipeline, it costs significantly less than the other two options, and may present less risk compared to wellfield development.