MEMORANDUM

TO: Whom it may concern

FROM: Romin A. Khavari, City Engineer **RAK**

DATE: October 30, 2015

SUBJECT: **DOMESTIC WASTEWATER AND LIFT STATION DESIGN CRITERIA 2015 UPDATE**

Please ensure that the following updated design criteria are used on all projects in the City of Grand Prairie, along with the revised Wastewater and Lift Station Standard Details plan sheets.

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DOMESTIC WASTEWATER DESIGN CRITERIA

1.0 Planning and Projected Flow

The Engineer shall reference the latest City Wastewater Master Plan to ensure the adequacy of the proposed design is consistent with the latest planning information. Several variables help make up the calculation for projected flows. These include housing density (units per acre), population count (persons per unit), infiltration and inflow (I/I), and peaking factors based on calculated population. Standards for developing sewer design criteria may also vary depending on the flow characteristics the City wishes to achieve through its system. At a minimum, sewer lines within the City of Grand Prairie shall be designed in accordance with the latest edition of the rules set forth by the Texas Commission of Environmental Quality, 30 TAC §217 Design Criteria for Domestic Wastewater Systems; www.tceq.state.tx.us/rules/indxpdf.html. Please also refer to the City's Wastewater Master Plan and compare to the following criteria for the recommended pipe sizing. Where the City's design criteria varies from the City's Wastewater Master Plan or TCEQ's design criteria, the more restrictive criteria shall be used. The City Engineer or his designee shall make the final decision as to pipe sizing, in case of conflicts.

Wastewater Design Flow Estimation with Limited Available Data

Source	Remarks	Average Daily Wastewater Flow (gals/person)
Municipality	Residential	100
Subdivision	Residential	100
Trailer Park (Transient)	2½ Persons per Trailer	60
Mobile Home Park	3 Persons per Trailer	75
School	Cafeteria & Showers Cafeteria / No Showers	20 15
Recreational Parks	Overnight User Day User	30 5
Office Building Factory	A facility must be designed for the largest shift	25 20
Hotel/Motel	Per Bed	75
Restaurant	Per Meal	10
Restaurant with bar or cocktail lounge	Per Meal	12
Hospital	Per Bed	250
Nursing Home	Per Bed	125
Apartments	Per Unit	250

Source (Modified): 30 TAC §217.32(a)(3): Design Organic Loading

Design for any wastewater main should utilize Manning's Equation to determine characteristics for both partial and full pipe flow conditions. Since most wastewater installations today require the carrier pipe to either be lined with a poly-type material or made of plastic, an n-value of 0.013 should be utilized. In accordance with the TCEQ, pipe slope must, at a minimum, provide a full-flow velocity of 2.0 feet per second (fps) and not exceed 10.0 fps. The City of Grand Prairie's minimum full-flow velocity is 2.3 fps with a maximum of 10.0 fps. The minimum pipe diameter for any public gravity wastewater collection main shall be 8 inches for maintenance and easy cleaning. Pipe diameters 6-inches or less are no longer allowed for new gravity wastewater mains.

1.1 Planning (Discharge Area) Maps: Both off-site investigation and on-site investigation is necessary for planning any proposed development or expansion of the City's infrastructure.

1.1.1 Off-Site: Use a 1 inch = 200 feet map showing all the contributing areas designated with a chart showing the calculated flows and the pipe sizing calculations. Use the larger size incremental pipe, as specified below, to maintain the minimum cleaning velocity in the main.

1.1.2 On-Site: Use a 1 inch = 100 feet map showing all the contributing areas designated with a chart showing the calculated flows and the pipe sizing calculations. Use the larger size incremental pipe as specified below to maintain the minimum cleaning velocity in the main.

2.0 Pipeline Design

2.1 Minimum and Maximum Slope

The following is a table indicating the maximum and minimum pipe slopes is based on requirements for minimum and maximum pipe velocity, 2.3 fps and 10.0 fps, respectfully, using the stated Manning's equation.

Pipe Diameter (Inches)	Minimum Pipe Slope (%)	Maximum Slope (%)
8	0.44	8.4
10	0.33	6.23
12	0.26	4.88
15	0.19	3.62
18	0.15	2.83
21	0.12	2.30
24	0.10	1.93
27	0.087	1.65

2.2 Design Flows

Manning's Equation

$$V = \frac{1.49R^{2/3}\,S^{1/2}}{n}$$

V = velocity (fps)
A = cross-sectional area of pipe (ft^2)
R = hydraulic radius (ft) = A/ P
P = wetted perimeter (ft) = πD
S = pipe slope (ft / ft)
n = Manning's roughness coefficient = 0.013

Capacity Flow

$$Q = V \times A$$

Q = flow rate for proposed pipe (cfs)

Capacity Demand Calculations
Single Family Dwelling – * 4 dwelling units per acre-Population = 3.0 persons / unit

Multi-Family Dwelling (apartments, condo, etc) – * 24 dwelling units per acre – Population = 2.5 persons / unit

* Minimum design requirements; The Design Engineer may increase the number at own discretion and as approved by City Engineer.

2.3 Average Flow Rate = 100 gallons / person / day (gpcd)

2.4 Peaking Factor: Use the following equation to calculate the anticipate peaking factor for the planned development.

Harmon's Formula

$$M = 1 + \frac{14}{4 + P^{1/2}}$$

M = Ratio of design flow to average flow (Peaking Factor)
P = Population on the thousand
Note: The Peaking Factor should not be less than 4.0 for pipelines less than 19 inches in diameter.

In absence of actual peaking flow, the following table can be used to determine the minimum peaking flow.

Wastewater Peaking Factor*

Pipe Size (inches)	Peaking Factor	Depth of Flow
Less than 18	4.0	Full
18 thru 30	3.75	Full
Larger Than 30	3.0	Full

*Peaking factors may be evaluated by the Engineer from known metering and flow data for the particular basin or area under design.

2.5 Inflow and Infiltration (I / I): Inflow and Infiltration flow can be anticipated in all wastewater conveyances and can be estimated using the following equation:

I / I = 500** gallons / day (gpd) / inch diameter of pipe / mile of pipe

** To only be used in determining the pipe capacity in pipe sizes. Infiltration / exfiltration tests shall be conducted in accordance with 30 TAC §217 Design Criteria for Domestic Wastewater Systems.

Example: 7,500 linear feet of 12-inch diameter pipe. Determine the amount of flow anticipated due to I / I:

$$I / I = \frac{(12) \times (7{,}500\ \text{LF}) \times (500\ \text{gpd})}{5{,}280\ \text{LF / mile}} = 8{,}523\ \text{gpd}$$

Defining acceptable flow rates for industrial, commercial and municipal developments is difficult to identify with any reasonable accuracy since type of use for a given parcel of land can vary greatly. It is recommended that each developer / owner for proposed facilities provide specific flow rates based on the type of use, service and / or product that will be provided to the community, with specific flow characteristics that will impact the collecting sewer system. This information should be reviewed and approved by the City prior to completing the design of the supporting collection sewer lines and appurtenances. For industrial / commercial areas that are undeveloped, a factor of 3,500 gallons per day per acre (includes Peak and I / I) should be utilized for the initial design of system facilities, recognizing that later improvement may be required, should this estimate prove less than required.

2.6 Flow Calculation for Pipe Design

Ultimate Peak Wet Weather Flow for Proposed Developments

$Q_{(ultimate)}$ = (number of units) x (persons / unit) x (100 gpcd) x (M) + I / I

Example: 200 Unit Single-Family Developments
1,200 LF of 8-inch sewer
2,300 LF of 12-inch sewer

P = 200 x 3.0 = 600 or 0.6 (thousands)

$M = 1 + 14 / (4 + (0.6)^{1/2}) = 3.9$

$$Q_{(\text{ ultimate})} = (200 \times 3.0 \times 100 \times 3.9) + \frac{(8 \times 500 \times 1{,}200) + (12 \times 500 \times 2{,}300)}{5{,}280}$$

$Q_{(ultimate)}$ = 0.2375 MGD

2.7 Ultimate Peak Wet Weather Flow for Undeveloped Land

Housing based on designated zoning = Units / Acre

$Q_{(ultimate)}$ = (Developable acreage) x (zoned units / acre) x (persons / unit) x (100 gpcd) x (M + I / I)

2.8 Depth of Cover

The depth of cover is measured from the top of the pipe to the natural or finished ground surface above the pipe. The main must be deep enough to serve adjacent properties. The minimum depth of cover shall be 4 feet.

Minimum Depth of Cover for Wastewater Main

Size of Main (inches)	Min. Depth (ft.)		
	Unimproved	Improved	Highway / Railroad Crossing
12 and Smaller	6	4	6
16	6	5	6
20 and Larger	7	6	6

2.9 Service Line Connections:

Service line connections are generally not allowed on large interceptors, except at manhole locations, because interceptors are generally buried deeper thus more difficult to access for repairs of tap connections. A shallower collection line will be required for collecting services then discharged into an interceptor manhole, as necessary. All Developers and Engineers shall verify with City staff the alignment locations of all collection lines and interceptors to insure future capital project improvements by the City will not be impacted.

Wastewater Mains Classifications and Service Line Connection

Type of Main	Size Range (inches)	Direct Service Connection
Collection	Less than 18	Permitted
Interceptor	18 to 30	*Not Permitted
	Larger than 30	Not Permitted

*Note: Service connection may be allowed through a manhole upon approval from City Operations.

2.10 Minimum Easement

The minimum easement width required to install and maintain a single City wastewater main are summarized in the following table:

Minimum Easement Width

Size of Main (inches)	Depth of Pipe* (feet)	Minimum Width** (feet)
8 through 12	≤ 8 > 8	20 25
16 through 24	≤ 8 > 8	25 35
30 through 66	≤ 8 > 8	40 50
72 and Larger	≤ 8 > 8	60 70

Notes: *Depth of pipe shall be measured from the top of pipe to the ground surface.

** Pipe shall be centered in the easement.

The minimum vertical clearance above any easement is 25 feet. This allows the typical backhoe to maneuver in the case where a repair is necessary and minimizes risk to both City and the party who is granting the easement.

The Engineer shall request a Surveyor to prepare a legal description (field notes) for the required easement. This request shall include, but not be limited to, the following information:

- Type of Easement: Permanent or temporary / construction
- Purpose of Easement: Water and / or wastewater easement
- Project Schedule: Planned advertisement and construction date
- Location Map: A map showing location of easement with coordinates and dimensions.

The legal description shall be submitted to the City for review and approval, as necessary.

3.0 Field Investigation

Field investigations including Geotechnical Investigation, Subsurface Utility Engineering (SUE), Environmental Site Assessment, or Land Survey Investigation shall be conducted for water and wastewater main design as necessary or if requested by City.

The design and construction of wastewater mains must account for the variability of the uncertain subsurface conditions, and the potential project cost associated with the variability. This is especially critical on large projects or projects containing complex or difficult geotechnical problems where alignment and / or grade changes may be appropriate based on geotechnical recommendations.

3.1 Geotechnical Investigation includes:

3.1.1 A geotechnical investigation may be conducted prior to design and / or construction of a project. However, data from earlier project design activity can be incorporated if sufficient and reliable for the current project.

3.1.2 Soil borings shall be spaced no greater than 500 feet with additional borings spaced closer to better defined areas of inconsistent stratigraphy.

3.1.3 Boring locations shall be within an offset distance of no more than twenty (20) feet from the centerline alignment of the wastewater main or at the location of the proposed structure.

3.1.4 Open Cut Construction: Minimum boring depths shall be:

3.1.4.1 Trench depth plus five (5) feet for trenches up to ten (10) feet deep.

3.1.4.2 Trench depth plus ten (10) feet for trenches from ten (10) to twenty-five (25) feet deep.

3.1.4.3 One and half times trench depth for trench greater than twenty-five (25) feet deep.

3.1.5 Bore an additional five (5) feet if the last planned sample is in water-bearing sand.

3.1.6 Trenchless Construction: Minimum boring depth shall be:

3.1.6.1 Entry / exit pit depth plus five (5) feet

3.1.6.2 Pipe invert plus five (5) feet

3.2 Subsurface Utility Engineering: A Subsurface Utility Engineering (SUE) investigation process may be conducted in project planning, design or construction phase(s) to obtain reliable subsurface utility information. Using this technology, it will be possible to avoid many utilities' relocation before construction and many unexpected encounters during construction; thereby eliminating many costly, time-consuming project delays. In addition, all existing utilities shall be located and marked prior to initiation of survey for design. SUE shall be conducted by well-trained, experienced and capable individuals using state-of-the-art designating equipment, vacuum excavation or comparable non-destructive locating equipment, state-of-the-art surveying and other data recording equipment and software systems, as necessary.

3.2.1 Utility Quality Level (QL) attributes are described in "Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, CI / ASCE 38-02" by American Society of Civil Engineers (ASCE), Latest Edition. Accordingly, four (4) Quality Levels (QLs) of SUE can be conducted, as needed:

3.2.1.1 Quality Level D:

- Information derived from existing records or oral recollections.
- This work shall be conducted by the Engineer during the preliminary project planning.

3.2.1.2 Quality Level C:

- Information obtained by surveying and plotting visible above-ground utility features and by using professional judgment in correlating this information to Quality Level D.
- This work shall be conducted during the survey for design.

3.2.1.3 Quality Level B:

- Information obtained through the application of appropriate surface geophysical methods to determine the existence and approximate horizontal position of subsurface utilities.
- This work shall be performed to obtain horizontal location of subsurface utilities in areas with congested utilities (i.e. central business district), areas where utility information is sparse or where a specific utility of high importance is being crossed (i.e. gas line).

3.2.1.4 Quality Level A:

- Precise horizontal and vertical location of utilities obtained by the actual exposure and subsequent measurement of subsurface utilities, usually at a specific point.
- This work shall be performed to obtain precise horizontal and vertical locations of subsurface utilities in areas with congested utilities (i.e. central business district), areas where utility information is sparse or where a specific utility of high importance is being crossed (i.e. gas line).

3.3 Environmental Site Assessment: The Engineer shall evaluate all available resources to identify any potential environmental issues, including possible soil or groundwater contamination, during the planning phase of wastewater main construction projects. The Developer or Engineer shall contact the City to determine if an Environmental Site Assessment (ESA) will be needed for the proposed project. If the project involves a property acquisition, a Phase I ESA from a qualified and experienced environmental consultant shall be requested. Federally funded projects generally require a Phase II ESA.

4.0 <u>Manholes</u>

4.1 Manholes shall be placed at:

4.1.1 All points of horizontal or vertical changes in pipe alignments, grade, size and material;

4.1.2 At intersection of all pipes;

4.1.3 At the end of all pipes that may be extended in the future. Manholes placed at the end of a wastewater collection system pipe that may be extended in the future must include pipe stub outs with plugs;

4.1.4 On each side of major stream crossing or at siphon crossings; and

4.1.5 At all force main air release device and isolation valve locations.

Manhole Spacing Criteria

Pipe Diameter (inches)	Max. Manhole Spacing (feet)
8-15	500
18-30	750
36-or larger	1,000*

* TCEQ allows longer spacing for 54-inch diameter lines and larger, if approved by City Engineer.

4.2 Variances

4.2.1 Tunnels are exempt from manhole spacing requirements because of construction restraints.

4.2.2 A manhole must not be located in the flow path of a watercourse, or in an area where ponding of surface water is probable.

4.3 Manhole Sizing: Manhole sizing is dependent up on the largest pipe size connected to the manhole. See table below:

Manhole Sizing Criteria

Pipe Diameter (inches)	Min. Manhole Diameter (feet)
8-18	4
21-30	5
33-48	6
48 or Larger	As Approved By City

5.0 Buoyancy Force

Buoyancy force calculations of sewers shall be considered for all projects within the floodplain and where groundwater existing within ten (10) feet of the bottom of the trench embedment. Buoyancy force calculation must be shown in the final plans if flotation of the pipe is an issue in the design. Anti-flotation devices shall be provided with appropriate construction methods where high groundwater conditions are anticipated.

6.0 Casing Requirement

Casing of a carrier wastewater pipeline is required when crossing TxDOT highways, railroad properties, crossing flood control levees, potable water lines and occasionally when crossing stormwater pipelines. Casing maybe be required if the City believes the property crossing dictates special care and protection for the pipeline. All casing pipe shall be steel casing. Concrete encasement of a pipeline maybe required when crossing streams or creeks for erosion protection.

7.0 Separation Distances

In the event that a proposed wastewater line crosses an existing or proposed water main or storm drain line, 30 TAC §217 Design Criteria for Domestic Wastewater Systems and 30 TAC §290 Public Drinking Water design criteria shall be used. All proposed water lines shall have minimum horizontal clearances of nine feet (9') from existing wastewater lines; nine feet (9') distance shall be measured from edge of pipes. In the event a wastewater line crosses within four feet (4') of an existing or proposed water line or storm drain line, the wastewater line needs to be encased in 6-inch concrete for 10 liner feet in length (i.e., 5 feet in each direction from the outside diameter of the crossing.). Class 150 PSI pressure rated pipe may be used instead of encasement. Steel casing pipe may be substituted in lieu of concrete or required in specific cases, to be considered by the Engineering and Public Works Departments.

8.0 Aerial Crossings

Aerial crossings shall be as per TCEQ and the City of Grand Prairie requirements to include the following:

8.1 Crossing shall be designed for the fully developed creek section as approved by the City.

8.2 Future erosion shall be addressed as part of the design.

8.3 PVC pipe aerial crossings shall be steel encased; ductile iron material shall have an inside polyethylene liner. Other pipe material shall be approved by the City Engineer.

8.4 Piers shall be a minimum of 24-inch in diameter and embedded in adequate material to be determined by a Geotechnical Engineer in a report to be submitted to the City. The information shall be fully specified and shown on the plans and specifications. The casing pipe shall be sufficiently restrained to minimize movement due to all external forces exerted on said pipe.

9.0 On-Site Sewerage Facilities

On-site sewerage facilities are not allowed with the City of Grand Prairie or its extraterritorial jurisdiction (ETJ), unless approved by the Environmental Services Department at 972-237-8055.

WASTEWATER LIFT STATION DESIGN CRITERIA

1.0 General Requirements

All wastewater lift stations and force mains shall be designed strictly in accordance with 30 TAC § 217.59-63 while meeting or exceeding the following design criteria.

1.1 Preliminary Design Report: A Preliminary Design Report (PDR) sealed by a Texas PE must be submitted to the City for review and approval for all proposed lift station designs. The PDR shall discuss the lift station justification, wet well and pump sizing, site analysis, odor control, emergency power, capital costs and operation costs.

1.1.1 Lift stations will only be considered a viable option if the cost effective analysis clearly shows that the gravity sewer solution is not economically feasible.

1.1.2 Lift station design shall consider the potential for future expansion to build out densities. The design of lift stations shall incorporate a wet well for the final capacity of the lift station.

1.1.3 Lift stations can be phased construction if approved by the City.

1.1.4 Lift stations must be located and sized so they can serve as much of the entire wastewater drainage area as possible. This may require that the lift station be located off-site from the developed area.

2.0 Types of Lift Pumps

All sanitary lift stations' pumps shall be submersible non-clog lift pump type stations. Other lift station designs using centrifugal pumps with wet pit / dry pit configuration, suction lift pumps or package type lift station designs, will be considered on a case by case basis. Grinder pumps will only be allowed on small lift pumping situations where necessary or where the design pump cannot pass a 3-inch sphere.

2.1 All lift station submersible pump motors should be based on fixed speed motors. Variable Frequency Drive (VFD) motor assemblies will be considered on a case by case basis by the City. For lift stations with pumps and motors assemblies larger than 50 HP, the Engineer must compare using VFD to fixed speed motor assemblies to evaluate the benefits for more flexible pumping capacity to the increased capital cost and O&M cost.

2.2 Firm pumping capacity: All lift stations must be capable of pumping the firm pumping capacity expected. Firm pumping capacity is defined as total pumping capacity with the largest pumping unit out of service. The firm pumping capacity shall be greater than the expected Peak Wet Weather Flow.

3.0 Lift Station Site Layout

3.1 Lift Station site layouts shall consider clearances for unimpeded maintenance operations. The area surrounding the lift station components including, but not limited to, the wet well, pump and motor slabs, valve slabs, generator, electric service rack and shall be large enough to permit heavy equipment and vehicles ample room to maneuver. The lift station site shall be designed to allow maintenance vehicles to have direct access to the wet well, electric controls, generator and bypass facilities.

3.1.1 The lift station site, including all electrical and mechanical equipment, shall be located and protected from a 100-year flood event and remain fully operational during such event. Provide a letter dated, signed and sealed by a Texas Professional Engineer certifying the site is protected from such an event. Attach floodplain map and evaluations.

3.1.2 All lift stations shall have a permanent access road located in a dedicated right-of-way or permanent easement. The access road surface shall have a minimum width of sixteen (16) feet and the pavement shall meet AASHTO HS 20-44 standard. Crushed stone, flexible base or similar materials are not considered as "permanent all weather materials." A temporary access road pavement design will be considered on a case by case basis by City Engineer, but a permanent design must also be provided. The access road surface, either temporary or permanent, shall be designed to be above the water level caused by a 25-year storm event.

3.1.3 Large lift station facilities shall be completely paved inside the fenced in area and have adequate turnaround capabilities for large tanker truck to safely turn around. The pavement section shall be reinforced concrete pavement, meeting the AASHTO HS 20-44.

3.1.4 Design shall provide for ¾-inch diameter minimum freeze-proof potable water service with hose bib vacuum breaker attached to the hose connection. It shall be located within 20-foot radius of wet well.

3.1.5 The design of all lift stations must minimize potential odors. All lift stations must address the potential of odors and measures to mitigate hydrogen sulfide generation in force main (chemical treatment) and wet well (vapor phase treatment). Odor control recommendations will be reviewed on a case by case basis based upon the specific location and age of the wastewater. Odor control equipment shall be located in an area where it can be serviced easily.

3.1.6 Large lift stations may be required to leave space (outside of fenced area) for a transformer pad, with street access by the electrical provider for the area.

3.1.7 The lift station site shall be located as remotely as possible from residential development.

3.1.8 Security area lighting must be provided with dusk till dawn photo cell feature. Overhead lighting focused on the wet well should be provided.

3.1.9 All exposed pipe, valves, and fittings outside the wet well shall receive a 100% solids epoxy coating system with a top coat system of urethane, suitable for the environment after installation. All pump discharge pipe and fittings within wet well, should be stainless steel SS 316. No PVC piping will be acceptable inside the wet well. If allowed by City Engineer, non-SS 316 pipe and fittings within the wet well shall receive protective coating and linings as approved by the City. All accessory hardware in the wet well including but not limited to chains, cables, bolts, nuts, fasteners, brackets, anchor bolts, washers, cable holders and slide rails, shall be minimum stainless steel SS 316.

3.1.10 A lift station pump must operate automatically, based on the water level in a wet well. The location of a wet well level mechanism must ensure that the mechanism is unaffected by currents, rags, grease, or other floating materials. A level mechanism must be accessible without entering the wet well.

3.1.11 If used, motor control centers must be mounted at least 4.0 inches above grade to prevent water intrusion and corrosion from standing water in the enclosure.

3.1.12 Electrical equipment and electrical connections in a wet well or a dry well must meet National Fire Prevention Association 70 National Electric Code explosion prevention requirements, unless continuous ventilation is provided.

3.1.13 Electric service poles shall be located within lift station sites at a location where electric overhead wires do not cross over the lift station site. Locate service poles as indicated in Standard Drawings preferably; alternate locations must be evaluated and approved by City. Service poles must be located twenty (20) feet away from the SCADA tower structure.

4.0 <u>Wet Well Design</u>

4.1 Dimensions: The minimum wet well design will be 72 inches in diameter; larger as necessary to accommodate submersible pumping equipment, piping, supports, emergency storage volume and to support pump cycle times. Depth of wet wells shall consider, but not be limited to all the following: emergency storage volume and adequate submergence of submersible pumps.

4.2 A wet well must be enclosed by watertight and gas tight walls and cover. The wet well cover shall have appropriately sized openings for accessing each pump and have fall protection. Any penetration through the walls of a wet well must be gas tight. A wet well must not contain equipment requiring regular or routine inspection or maintenance, unless inspection and maintenance can be done without staff entering the wet well. The influent gravity line discharging into a wet well must be located so that the invert elevation is above the liquid level of a pump's "on" setting. The lift station operation should not use the storage capacity of the collection system for its routine operation, unless approved by the City Engineer.

4.3 Gate valves and check valves are prohibited in a wet well. Gate valves and check valves shall be located in a separate watertight valve vault next to a wet well. All valve vaults shall have a cover to protect against the weather, and shall have a three foot by three foot (3’ by 3’) opening for accessing each valve assembly.

4.4 The wet well volume shall be calculated based on the projected final peak flows. The minimum operating volume of a wet well can be determined by the following method:

$$V = \frac{(T \times Q)}{(4 \times 7.48)}$$

V = Active Volume, $ft.^3$

Q = Pump Capacity, gpm

T = Cycle Times, minutes

7.48 = Conversion Factor (gallons / ft^3)

4.5 Pump cycle time, based on peak flow, must equal or exceed those in the following:

Pump Cycle Time

Pump Horsepower	Minimum Cycle Times (Minutes)
< 50	6
50-100	10
> 100	15

4.6 The wet well floor shall be sloped 10% to the pump intakes and have a smooth finish in order to become a self-cleaning wet well. There shall be no wet well projections that will allow deposition of solids under normal operating conditions.

4.7 Construction of concrete wet wells shall include a full monolithic structure or a precast wet well structure with monolithic base. The Engineer shall evaluate the thicknesses of the wet well wall and slabs, but the following thicknesses shall be met as minimum: wet well wall thickness ten (10) inches, wet well base slab twelve (12) inches and wet well top slab ten (10) inches.

4.8 Concrete wet well interior surfaces shall have a protective coating applied to concrete surfaces, as approved by the City.

4.9 All lift stations shall incorporate hoisting / crane equipment into the design, or access for equipment, for removal of pumps, motors, valves, etc. The City will determine if permanent hoisting equipment or a crane shall be included in the lift station design, depending on size of equipment. When the largest pumping unit weighs more than 1,000 pounds, then an overhead crane will be required. When the largest pumping unit weigh less than 1,000 pounds, then a portable hoist will be required. The hoisting equipment must be acceptable and approved by the City.

4.10 Wet Well Testing: An Exfiltration Test must be performed immediately after the wet well has been backfilled and compacted. Exfiltration shall not exceed 0.0142 gallons per hour per foot diameter per foot of depth. The test must be done by plugging the gravity invert and filling up the wet well with water to either 1-foot below the wet well top slab, or up to the elevation of the manhole lid with the lowest elevation in the system. (This level must be clearly marked in the wet well internal wall). Once the wet well is filled, it must be left for stabilization for 48 hours minimum prior to beginning the Exfiltration Test. After the stabilization period, the wet well must be refilled up to the mark to begin the test. The test shall be done for two hours minimum, and no water may be added to the wet well during the test period. The Exfiltration Test must be determined by measuring the amount of water required to raise the wet well level back to the mark at the end of the test period. The maximum allowable water loss to pass the test is determined by the following equation:

Water Loss (gallons) = 0.0142tDh

t = test time period (2 hours)
D = wet well diameter (in feet)
h = water level depth within wet well (in feet)

4.10.1 If the Exfiltration Test fails, the Design Engineer must work with the Contractor to determine all the necessary corrective actions to reduce the exfiltration. Once the repairs are completed, the test shall be repeated. The wet well will pass the test when the exfiltration is equal or less than the allowable water loss. The City Inspector, Contractor and Design Engineer shall witness the complete Exfiltration Test. The Design Engineer shall provide a certified letter showing the results of the Exfiltration Test to the City Inspector. The certification letter shall include a description of all steps taken to complete the Exfiltration Test, including water loss, wet well level mark, and any corrective actions taken if a prior test failed.

4.11 A floor drain from the adjacent valve vault to a wet well must prevent gas from entering a valve vault by including flap valves, "P" traps, submerged outlets, or a combination of these devices.

5.0 Lift Station Pumping Equipment Design

5.1 All lift stations shall contain a minimum of two (2) pumps and shall be capable of handling peak flows with one (1) pump out of service. Each pump should have its own discharge pipe feeding into one (1) common header.

5.2 The firm pumping capacity of a lift station must handle the expected peak flow. Typically, the firm capacity is defined as the capacity of the lift station with the largest pump out of service. Lead pump shall alternate at each pump cycle.

Peak Daily Flow (gpm)	Minimum No. of Pumps
500 or less	2 Pumps: 1 Lead, 1 Standby
501-1200	3 Pumps: 1 Lead, 1 Lag, 1 Standby
1201-3000	4 Pumps: 1 Lead, 2 Lag, 1 Standby
Over 3001	5 Pumps: 1 Lead, 3 Lag, 1 Standby

5.3 A submersible pump must use a rail-type pump support system (as developed by Flygt) with manufacturer-approved mechanisms designed to allow personnel to remove and replace any single pump without entering or dewatering the wet well. Submersible pump rails and lifting chains must be constructed of a material that performs to at least the standard of stainless steel SS 316.

5.4 Pump Head Calculations:

5.4.1 A pump shall be selected based upon analysis of the system head and pump capacity curves that determine the pumping capacities alone and with each other.

5.4.2 The pipe head loss calculations, using the Hydraulic Institute Standards, pertaining to head losses through pipes, valves, and fittings, must be considered.

5.4.3 The selected friction coefficient (Hazen-Williams "C" value) used in friction head loss calculations must be based on the pipe material selected.

5.4.4 For a lift station with more than two (2) pumps, a force main in excess of one-half mile, or firm pumping capacity of 100 gpm or greater, system curves must be provided for both the normal and peak operating conditions at “C” values for proposed and existing pipe.

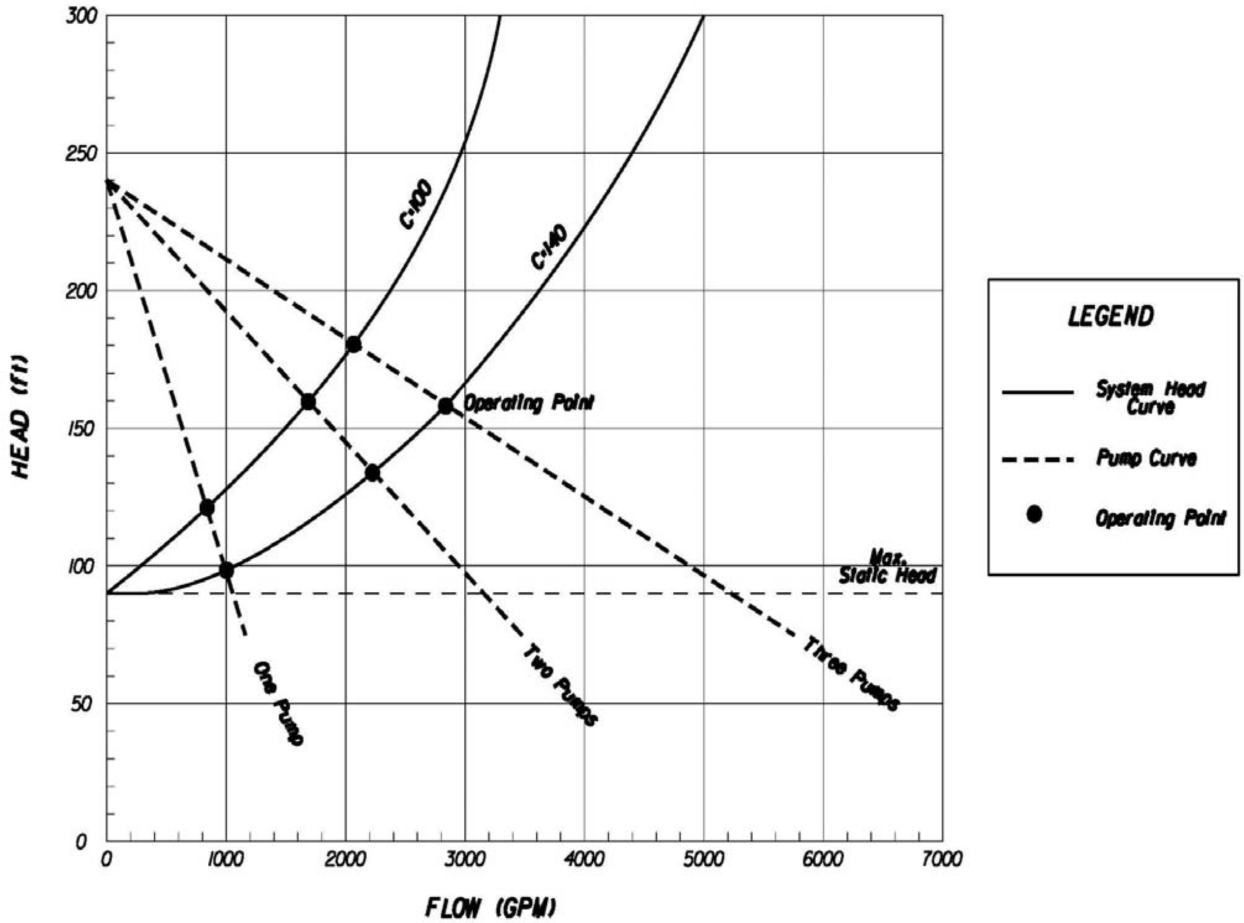
5.4.5 A family of system head curves shall be developed to indicate the operating envelope of the pumps throughout the life of the facility. These curves shall be constructed by using varying friction factors (C) and wet well levels. At a minimum, curves will be established for both the “pump off” level and the “pump on” level using “C” values of 100 to 130 for ductile iron force main pipe and “C” values of 120 to 140 for PVC for force main pipe.

5.4.6 Once the system curve is developed, various pumps shall be analyzed to determine which pump curves best fit the system curve. Multiple pumps may be required to produce the necessary flow at the required head.

5.4.7 Upon selecting the pump, the motor rating (horsepower) and impeller size shall be established. In the case where Variable Frequency Drives (VFDs) are used, the Engineer shall prepare reduced speed curves as necessary.

5.4.8 The most efficient pumps shall be selected for the given head-capacity situation as approved by the City. The selected pumps have a Net Positive Suction Head Required (NPSHR) that is less than the system's Net Positive Suction Head Available (NPSHA) under the worst case scenario.

5.4.9 The use of constant speed pumps is typically preferred by the City. Lift stations may consider variable speed drive (VFD) motor if the hydraulic analysis shows them to be more efficient and approved by the City.



5.5 The proposed elevation of all critical components shall be shown in the plansheets including, but not limited to pump intake line inverts, control and alarm levels, top of the wet well, top of the dry well, influent line invert(s).

5.6 All electrical equipment / panels and controls for the lift pumps shall be above ground.

6.0 Lift Station Piping, Valves and Accessories

6.1 Each pump shall have one isolation gate valve downstream of the pump and check valve inside a separate watertight valve vault. This vault shall be covered and protected from the weather and have a three foot by three foot (3' by 3') spring open access door.

6.2 Check valves shall be located upstream of the isolation valve. A check valve must be a swing-type valve with an external weight and lever.

6.3 A grinder pump installation must include a swing-type check valve in the piping assembly. A ball check valve will not be accepted.

6.4 Air release valves of a type suitable for wastewater service shall be installed along the common header at the high point in the line where the force main would be prone to trapped air. An air release valve at the lift station may also need to have odor control system as necessary.

6.5 When required, surge relief valve size shall be selected based on Firm Pumping Capacity flow. It shall be rated for raw sewage service, and it shall have an isolation valve on the inlet side. The opening setting shall not exceed 5 psi above normal operating pressure of the system at header when firm pumping capacity flow is being discharged. Surge relief pipe shall be routed back to either the wet well or the manhole upstream to the wet well. The engineering report must include analysis and reference information showing how the valve was selected.

6.6 Emergency bypass piping flanged connection shall be included on the discharge header, downstream of the valve vault. Bypass piping shall be extended above ground by 1.5 feet and have a 3-inch quick connect coupling with cap. During an emergency situation in the case of power failure and pump failure, temporary portable pumps would be able to take suction from the wet well and discharge pumped flow into the bypass quick connection coupling to the discharge header. The bypass shutoff valve stack and the lid at ground level must be painted green.

6.7 For very large lift stations, the City may require piping provisions for a pig launch station / pigging cleaning operation.

7.0 Supervisory Control and Data Acquisition (SCADA) and Conduits

7.1 All lift stations must incorporate SCADA (see Standard Details). The City's SCADA Contractor shall be contacted by the Engineer to coordinate the proposed lift station SCADA design. All SCADA design shall conform to the City's Standard Details.

7.2 Any alternative SCADA wireless technology must be addressed in the PDR and approved by the City Engineer.

7.3 Lightning surge arresters must be provided on main power supply, SCADA, and all other electronic equipment. Lightning protection shall be provided for antenna mast, security light pole, emergency generator building and roof covering (if provided over electrical and other facilities).

7.4 Antenna must be provided for the SCADA equipment, and a Path Study must be provided by the SCADA Contractor for all antenna designs to verify the correct height of the antenna.

8.0 Emergency Provisions

8.1 A full capacity backup on-site generator with an automatic transfer switch should be installed in all lift stations capable of providing power to pump its Firm Pumping Capacity. Portable generators may be allowed at smaller lift stations if approved by the City Engineer.

8.2 Smaller lift stations (less than 100 gpm firm yield pumping capacity) must be equipped with a tested quick-connect mechanism or a transfer switch properly sized to connect to a portable generator, if not equipped with an on-site generator.

8.3 Lift stations must include an audiovisual alarm system, and the system must transmit all alarm conditions to the Supervisory Control and Data Acquisition (SCADA) system.

8.4 An alarm system must self-activate for a power outage, pump failure, or a high wet well water level.

8.5 The retention capacity in a lift station's wet well and incoming gravity pipes must prevent discharges of untreated wastewater at the lift station or any point upstream for a period of time equal to the longest electrical outage recorded during the past 24 months, but not less than 20 minutes.

8.6 The City may allow / require a spill containment structure to provide means for preventing an upstream SSO based upon available storage in the system and adequate response time by City during an emergency situation.

8.7 All wet well level control systems must be approved by the City Engineer, if using other than an Ultrasonic or Pressure Sensor. All wet wells shall have a backup mercury switch for high water alarm.

9.0 Private Lift Station Design (neither City owned nor City maintained)

9.1 Private lift stations may be considered to serve a single property where gravity sewer is not available or cannot be used because of elevation grade.

9.2 The City does not maintain private lift stations. Any maintenance of these assets is the sole responsibility of the property owner.

9.3 Two or more lots cannot be served through a single private lift station.

9.4 A private manhole is also required at the downstream end of the force main, prior to the gravity flow into the City collection system.

9.5 A wastewater backflow prevention device or check valve assembly shall be provided for all private lift station.

10.0 Housekeeping and Final Walk Through Inspection

10.1 The Contractor shall maintain good housekeeping and cleanliness of the project work site at all times. This includes providing litter control, trash pickup and proper sanitation for Contractor's workers. Housekeeping includes sweeping City streets adjacent to the project work site and removing all mud, rocks and debris emanating from the project work site, due to the egress and ingress to the project work site.

10.2 A final walk through and punch list / check list will be completed at the end of the Project, prior to finalization and acceptance of the Project. All components of the Project shall be tested for compliance with the Project's specification and City Standards.

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