Design of Lift Station and Wastewater Treatment Facility in Ascension Parish

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Ascension Parish Map
Ascension Parish Map
Background

- Biggest cities in Ascension Parish: Donaldsonville, Gonzales and Sorrento
- Fastest growing parish in the state of Louisiana
- Population of 103,538 and average of three person per household
Due to the growing population, there is a need for a new wastewater treatment facility.

The local Public Works and LADOTD are coordinating to install a trunkline sewer system along LA Highway 42.

We are proposing to design master lift station and wastewater treatment facility to enhance future system.
Area Map
Objectives

1. Design Lift Station

2. Design a wastewater treatment facility
Objectives 1- Tasks

- Determine site location
- Determine the design peak flow
- Investigate and select best lift station alternative
- Design lift station
What is a lift station

• Lift stations are hydraulic structures that are designed to move wastewater from a lower elevation up to a higher one, so that it can be transported through municipal sewer lines for eventual processing and cleaning at a treatment plant.

• Lift stations operation:
  ○ A water level monitoring mechanism sends a signal to the station's control panel to indicate that the liquid sewage level has risen to the trigger point for pump operation.
  ○ Once the liquid has been evacuated to the shutoff trigger level and discharged to the main sewer line, the system resets and waits for the chamber to fill again.
Components of a Lift Station

- Pumps
- Motors
- Power sources
- Controls
- Wet well
- Discharge conduits
A pump is a machine for raising, driving, exhausting, or compressing fluids or gases by means of a piston, plunger, or impeller.

Pumps may also be used to elevate wastewater from a sewer to a wastewater treatment facility.

Typically categorized as:
- kinetic pumps
- positive displacement pumps
Classification of Pumps

Pumps

Positive displacement

Kinetic
Pump Selection

- Pump selection evaluation should consider flow rates, system curve, station location and area served, and force main velocities.
- A system curve is the combination of the system head capacity curve and the pump curve. This system curve presents a picture of how the system will operate.
Example of System Curve
Types of Lift Stations

- Wet-Well, Submersible
- Wet-Well/Dry-well, Suction
- Wet-Well, Suction
Lift stations using submersible, non-clog, centrifugal pumps are the most frequently specified systems for pumping raw sewage.

They are equipped with pumps that operate while submerged in the wet well.
Wet-Well/Dry-Well, Suction Lift Station

- These type of stations place mechanical equipment in a dry-well that is separated by a divider wall from the wet-well.

- This arrangement provides good equipment accessibility, and because of the more favorable operating conditions, there is a high degree of reliability.
In a wet-well mounted lift station, the pumps are located at ground level above the wet well. The water rises up from the wet well to the pump through a vertical suction pipe.

The pumps can be self-priming or primed with a small vacuum pump. The pumps, valves, and control panel are located above grade.
# Required Elements for Lift Station Hydraulic Design

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input flow rate</td>
<td>The total storm flood collected into the pump station, calculated from hydrology.</td>
</tr>
<tr>
<td>Water surface elevation of discharge</td>
<td>Higher elevation to which the water must be raised.</td>
</tr>
<tr>
<td>Pump cut-off elevation</td>
<td>Elevation at which the last pump shuts off.</td>
</tr>
<tr>
<td>Number of pumps</td>
<td>A minimum of two pumps should be provided.</td>
</tr>
<tr>
<td>Wet-well sump dimensions</td>
<td>The process of establishing a suitable size is often one of trial and error to optimize costs. As the sump size is increased, the required pump capacity decreases.</td>
</tr>
</tbody>
</table>
Lift Station Design

*Peak Flow Rate:* \( PFR = (\text{Peak Factor} \times P \times 70) + (P \times 30) + \text{Inflow} \)

*Where:*

\[
\text{Peak Factor} = \frac{(18 + \sqrt{P})}{(4 + \sqrt{P})}
\]

\( P = \text{Population, thousands} \)

Population, Arithmetic: \( \frac{dP}{dt} = k_a \)

*Where:*

\( P = \text{Population} \)

\( t = \text{Time} \)

\( k_a = \text{Arithmetic growth constant} = \frac{p_2 - p_1}{t_2 - t_1} \)
Lift Station Design (contd.)

Flow, Hazen – Williams: \( Q = 0.432C d^{2.63} S^{0.54} \) (English Units)

Where:

\[
C = \text{Hazen – Williams coefficient of roughness}
\]
\[
S = \text{Slope of energy gradient} = \frac{h_f}{L}
\]
\[
d = \text{Diameter}
\]

Where:

\[
h_f = \text{Head loss}
\]
\[
L = \text{length of pipe}
\]

Wet – Well Volume: \( V = \frac{\theta q}{4} \)

Where:

\[
V = \text{required capacity, gal}
\]
\[
\theta = \text{minimum time of one pumping cycle or time between successive starts or speed increases of a pump operating over the control range, min}
\]
\[
q = \text{pump capacity, gpm, or increment in pumping capacity where one pump is operating already and a second pump is started, or where pump speed is increased}
\]
Lift Station Design (contd.)

Energy Equation: \[ \frac{P_1}{\gamma} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + z_2 + h_f \]

Where:

\[ P = \text{Pressure} \]
\[ \gamma = \text{Specific Weight} \]
\[ v = \text{Velocity} \]
\[ g = \text{gravity} \]
\[ z = \text{Elevation} \]
Lift Station Standards

- 10 State Standards
- EPA Reliability and Redundancy
- Hydraulic Institute Standards
Technical Approach - Lift Station Selection Criteria

- **Operational Cost**: assessed based on how inexpensive the alternative is
- **Space Factors**: How much area does the alternative occupy
- **Effectiveness of system**: Overall efficiency
- **Maintenance**: The time it takes to fix broken machinery and how easy it is to fix the problem
- **Environmental Impact**: an assessment of the possible positive or negative impact that a proposed project may have on the environment
## Design Criteria - Lift Station

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Alternative 1 Wet-Well, Submersible</th>
<th>Alternative 2 Wet-Well/Dry-Well, Suction</th>
<th>Alternative 3 Wet-Well, Suction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational Cost</td>
<td>9</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Space Factors</td>
<td>9</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Effectiveness of the System</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Maintenance</td>
<td>6</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Environmental Impact</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>38</strong></td>
<td><strong>32</strong></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>
Lift Station Design Selection

Alternative 1: Wet-Well, Submersible

- Efficient
- High in capacity
- Requires very little maintenance
- Generally very economical
## Design Criteria - Wastewater Treatment Facility

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Alternative 1 Activated Sludge</th>
<th>Alternative 2 Tricking Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational Cost:</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Space Factors:</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Effectiveness of system</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Maintenance:</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Environmental Impact:</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>35</strong></td>
<td><strong>32</strong></td>
</tr>
</tbody>
</table>
Secondary Treatment Selection

Alternative 1 - Activated Sludge

- Low construction cost
- Occupies small area
- Relatively low odor
- Removes a high percent of BOD
Looking Forward - Second Semester of Senior Design

- To successfully complete a major engineering design project using the team approach.
- Describe the fundamental components or steps in the engineering design process
- Present engineering project plans in a professional manner
- Apply appropriate and accepted planning strategies to open-ended design projects and maintain accurate project records and project schedule
Questions

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