

SUBJECT: PRE-SELECTION OF RAW SEWAGE PUMPS (RSP) & VARIABLE FREQUENCY DRIVES (VFD)

SOURCE: Public Works Department - Engineering Division

COMMENT: On February 5, 2013, the City Council authorized the selection of Carollo Engineers to design and prepare construction documents to replace four influent sewage pumps located at the "front end" of the wastewater treatment plant. Carollo Engineer's first task, as described in the February 5th staff report, was to prepare a pump and variable frequency drive (VFD) matrix comparing and contrasting the pieces of equipment offered by the different manufacturers.

Carollo Engineers has completed this task and recommends that the City pre-purchase the Flygt NT3301 Immersible Pump and the General Electric VFD. The Flygt pumps and the GE VFD are the least expensive of the pumps and VFD analyzed. Carollo Engineers has prepared a set of pre-procurement documents. The pre-procurement documents are extensive and therefore not included in staff's report. The complete documents are in the La Barca Room for Council's review.

The pre-procurement documents set the terms on the final purchase price for the pumps (\$261,000) and VFD (\$76,000), establishes general design & seismic criteria, shop drawing submittal procedures, testing and training protocols and informs the manufacturer of guaranty and performance bond requirements. Article 3, Section 00520-2 of the pre-procurement documents establishes the percentage of the contract amount that must be paid to initiate and complete the preparation of shop drawings for the influent pumps and VFDs. The shop drawings preparation fee is 10% of the contract amount or approximately \$34,000. The City's purchase order will reflect the full contract amount; however, the remaining 90% of the contract amount will be assigned to the general contractor per Article 6, Section 00520-4, "Assignment of Procurement Contract."

California Public Contract Law allows for the City to pre-select a specific brand or type of equipment and allows for the equipment to be incorporated into the specifications and bid requirements.

In order to expedite the manufacturing of the pumps and VFD, which can take up to ten weeks once shop drawings have been approved, staff requests that 10% of the cost be borne by the City up-front to initiate the preparation of shop drawings sooner than later. The pump and VFD equipment, and 90% of the cost, will be incorporated into the specifications and the general contract bid out by the City.

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It is staff's recommendation that the City Council authorize the Public Works Director to contact the pre-selected manufacturers and execute the pre-procurement documents on behalf of the City. Once the pump and VFD pre-procurement documents have been executed, Carollo Engineers will finalize equipment installation plans that incorporate the pre-selected equipment.

RECOMMENDATION: That the City Council:

1. Accept the Pre-Selection Matrix as presented by Carollo Engineers;
2. Authorize the Public Works Director to execute the Pre-Procurement documents;.
3. Authorize payment in the amount of 10% of the contract amount to initiate and complete pump and VFD shop drawings; and
4. Direct the Public Works Director to bring back an item requesting authorization to advertize for bids to install four influent pumps and companion VFDs at the Wastewater Treatment Plant.

ATTACHMENT: Pump & VFD Matrix
February 5, 2013 Agenda Item

PROJECT MEMORANDUM

Project Name: IPS Equipment Replacement Project **Date:** 03/26/2013
Client: City of Porterville **Project Number:** 9181A.10
Prepared By: Richard L. Gutierrez, P.E.
Reviewed By: Scott E. Parker, P.E., Penny Carlo, P.E.
Subject: Pump Evaluation Analysis
Distribution: Baldo Rodriguez, Robert Alvarez, Bryan Styles

1.0 INTRODUCTION

The purpose of this memorandum is to provide an evaluation and recommendation of acceptable pump equipment alternatives for replacing the City's existing raw sewage influent pumps at the Wastewater Treatment Facility's (WWTF) Influent Pump Station (IPS). The criteria used in this evaluation consisted of the following parameters: space and configuration constraints, reliability, pump efficiency, capital cost, and manufacturing lead-time.

1.1 Background

The existing IPS was originally constructed in 1976. The pump station currently consists of four (4) Fairbanks Morse 70 Hp line shaft pumps, which were installed in 1994. The pumps have a rated design capacity of 3,250 gallons per minute (gpm) at 52 feet of total dynamic head (TDH). Most of the facility is located below grade with the motors located just above grade at approximately 434-foot elevation. A minimum of three pumps are required to be in service to meet the WWTF's firm capacity requirements. The IPS typically operates with two pumps in service under most flow conditions with a third pump sometimes required when influent flow to the plant spikes in the afternoon during the wet weather season.

The project scope is to replace the four existing influent line shaft pumps with new pumps. Existing variable frequency drives (VFD's) will also be replaced as part of this project. The design will require reconfiguration and replacement of the inlet and outlet piping and valves to accommodate the layout of the new pumps since their configuration is significantly different from the existing pump equipment.

The electrical design shall include electrical power supply, starters, new VFD's, and new motor control centers (MCC's) associated with the pumps. The electrical design will involve changes to the system to meet current code requirements.

1.2 Pump Selection Alternatives

The City has indicated that they would like to replace the existing line-shaft pumps with immersible type pumps. Immersible pumps have several advantages over the line-shaft style of pumps. They eliminate the complexity and cost of long, extended shafts, which require regular

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lubrication of the intermediate bearings. The immersible pumps will also make the installation "flood-proof."

Two types of immersible pumps were evaluated for this project: Screw Centrifugal and Submersible Vertical Dry Pit pumps. Pumps from the following three manufacturers were evaluated for this application: Wemco Hidrostal, Xylem/Flygt (Flygt), and ABS. Of these three manufacturers, only Wemco and Flygt have pumps that are suitable for this application. We do not recommend the ABS pump for this application because it is not available with a Contra-bloc impeller in this size. The channel impeller they can provide with their pump selection is not recommended for a raw sewage application since rags can easily clog this type of impeller. Additionally, the impeller is only available in stainless steel, which is a softer metal and less resistant to grit than high-chrome, which we typically specify for this type of application. A summary and comparison of various parameters for each pump selection is provided in Table 1.1.

Table 1.1 - Pump Alternative Comparison			
Pump Model	Wemco Hidrostal 8"B5414L	Flygt 12"x10" NT3301	ABS XFP 250M-CH2
Base Cost per Pump	\$62,000	\$53,000	\$57,000
Base Cost for Four Pumps	\$248,000	\$212,000	\$228,000
Sales Tax (8.5% of Base Cost)	\$21,000	\$18,000	\$19,000
Freight, Start-up, and Training	\$25,000	\$25,000	\$25,000
Procurement Bonding and Insurance	\$7,000	\$6,000	\$6,500
Total Cost for Pump Procurement	\$301,000	\$261,000	\$278,500
Lead Time	20-22 weeks	9-10 weeks	12-16 weeks
Motor Size, Hp	75	70	70
Pump Speed, rpm	1,185	1,185	1,190
Efficiency @ Rated Design Point	79%	79%	74%
NPSHr @ Design Condition, ft	16	17.9	11.8
Minimum Flow, gpm	700	800	900

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Table 1.1 - Pump Alternative Comparison			
Pump Model	Wemco Hidrostral 8"B5414L	Flygt 12"x10" NT3301	ABS XFP 250M-CH2
Impeller Type	Helical Screw-Type	N-Type	Channel, 2 vane
Impeller Material	High Chrome Impeller/ High Chrome Suction Liner	High-Chrome	329 SST Impeller w/Hardened Wet End
Impeller Max Sphere Size Passing	5.125"	3.19"	3.5"
Capable of Passing Stringy/Fibrous Materials	Yes	Yes	No
Standard Warranty	5-year prorated on motor. 1-year on pump wet end	5-year prorated on pump and motor	5-year prorated on pump and motor

1.2.1 IPS Hydraulic Analysis

A hydraulic analysis of the existing pump station was performed to confirm the sizing for the new equipment. The existing pumps, which were installed in 1994, increased the firm capacity of the pump station to 14 mgd (3,250 gallons per minute (gpm) per pump with one pump out of service). Figure 1 shows the system curves for low and high wet-well conditions at the IPS along with the pump curves from the three manufacturers. All three manufacturers have pump selections that can meet the design flow and head conditions.

The existing suction piping was not modified during the 1994 project due to the complexity of retrofitting the suction piping, which is cast into the existing concrete wall of the wet-well. The suction velocities through the 10-inch diameter suction piping at the rated design condition are therefore higher than what is typically used in the design of this type of facility, approximately 13.3 feet per second (fps). This results in higher suction losses, which in turn reduces the NPSHa to the pump, and increases power consumption and costs. However, the costs, complexity, and construction risk required to increase the size of the piping would be significant. We reviewed these hydraulic conditions with both Flygt and Wemco. Both manufacturers were comfortable providing equipment that will operate under these conditions due to the following criteria being met:

- The worst-case condition NPSHa is 29 feet. Therefore, the NPSHa/NPSHr margin is greater than 1.5 and the NPSHa is greater than the NPSHr + 10 feet.
- The suction velocity of 13.3 ft/sec results in a dynamic head ($v^2/2g$) of 2.75 feet. The pump operating condition is at 52 feet TDH. The maximum disturbance at the inlet is equal to the dynamic head, which is 5% of the total head. Cavitation issues typically arise when the dynamic head component is greater than 10% of the total head.

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- The pump duty condition is close to best efficiency point (BEP) on the pump curve.

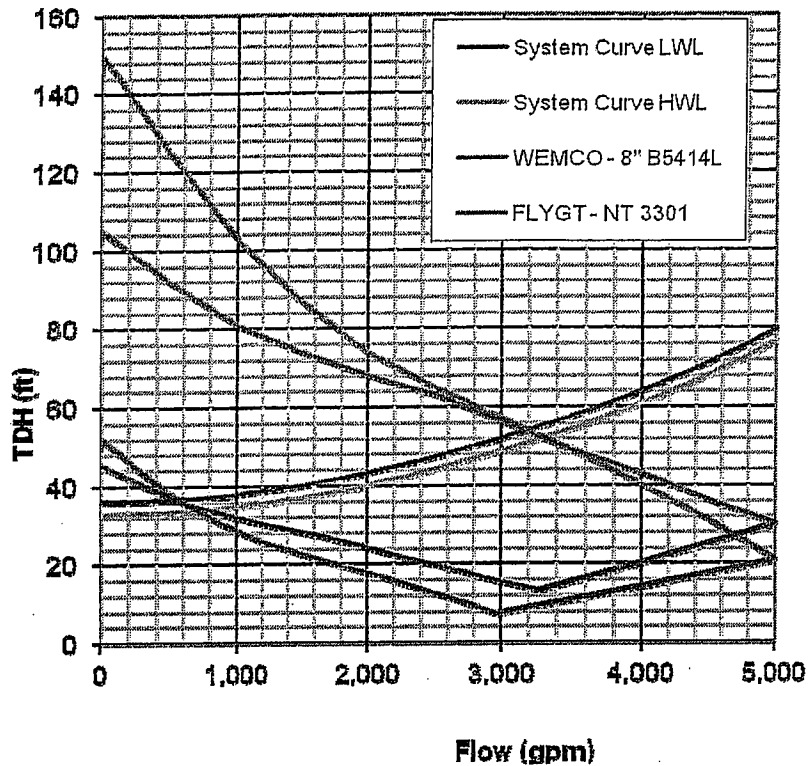


Figure 1 – IPS System Curve and Pump Curves from 3 Manufacturers

1.2.2 Configuration Constraints

Both the Wemco and Flygt pump selections can work within the existing pump station configuration constraints with some modifications to the existing discharge piping. The plan is to replace the suction piping and isolation valves up to the existing 10-inch by 16-inch eccentric reducer, which is cast in the concrete wall of the wet-well. Since the existing wall penetration will remain, this will set the elevation of the new suction piping to the pump. The centerline of the suction piping will be approximately 13.5 inches above the floor of the pump station. Both the Wemco and Flygt pumps can be provided with 10-inch diameter suction elbows to accommodate this constraint.

The existing discharge piping for the pumps is also 10-inch diameter, with a 10-inch by 8-inch reducer at the pump discharge. The existing pumps have a tangential discharge, with the discharge above and to the left side of the suction piping. Both of the new pump selections have the discharge located directly above the suction inlet pipe. Therefore, two 45-degree elbows will need to be added to the discharge to accommodate the new pumps. The Wemco pump has an 8-inch discharge. The Flygt pump has a 10-inch discharge.

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The available area for getting behind the pumps is also restricted. With the existing pump installation, there is only 23 inches of clearance between the pump and existing staircase. This does not allow much room for getting around Pump Nos. 2 and 3. With the Wemco pump selection, this clearance can be increased to 27 inches. With the Flygt selection, the clearance will be 26 inches. This requires a non-standard base pedestal for the Flygt selection but the manufacturer has confirmed that this can be provided and still meet Carollo's vibration criteria.

Another site constraint involves removal of the pumps for servicing. The existing pumps are removed by using a bar through the lift hooks provided on the underside of the beam located above the pumps. These hooks will not be adequate for removing the new pumps. A new 1.5-ton monorail will need to be installed adjacent to the existing beam above the pumps to facilitate their removal.

1.2.3 Reliability

Raw sewage pumping is an extremely harsh service, as the raw wastewater contains stringy, fibrous, abrasive materials. Furthermore, the conditions that the pumps must operate under, from minimum flows up to peak wet weather flows, complicate the requirements of this service. Finally, as the raw sewage pumps are the essential element separating the City from unplanned sanitary sewer overflows (SSO). Therefore, they must provide highly reliable and dependable service.

When evaluating reliability for this service application there are several parameters to consider; potential for stoppages or clogging of pumps, durability of pump materials of fabrication, availability of parts and servicing, and the pump manufacturer's track record based on previous experience in similar applications.

1.2.3.1 *Clogging Potential*

The Wemco Hidrostral pump provides the greatest resistance to clogging from both large solids and stringy/fibrous materials. However, both pump options have proven reliability in both screened and unscreened raw sewage installations. As listed in Table 1.1, the Wemco Hidrostral pump selected for this application can pass up to a 5.125-inch sphere through the impeller compared with 3.19-inch for the Flygt pump. The shape of the Wemco pump curve provides additional benefits when it comes to passing large material and preventing clogging. The curve is much steeper in comparison to the Flygt pump option, with less of a change in capacity as head increases. This large head reserve can help push out blockages when they occur. However, in this application, the IPS is located downstream of the screenings facility which has 0.5-inch Duperon screens. Therefore, large size debris will typically not be a concern for this installation.

For fibrous and stringy materials, both the Wemco and Flygt impellers are capable of handling this type of material. The design of the Flygt N-impeller is designed with a relief groove in the volute, which produces a self-cleaning flow path. The Wemco Hidrostral screw centrifugal impeller design works like a corkscrew to keep material moving through the pump cavity,

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minimizing clogging. Both impeller designs have been proven to be effective in minimizing clogging in raw sewage pumping applications.

1.2.3.2 *Materials of Construction*

Both the Flygt and Wemco pumps are available with High-Chrome impellers, which provide the best combination of corrosion resistance and durability. The Wemco pumps also include High-Chrome suction bowl liners that can be adjusted as wear occurs to maintain pump performance.

Both options are also available with the following submersible motor protection features:

- Top of motor cable entry that incorporates both sealing and strain relief functions to prevent moisture intrusion
- Tandem mechanical shaft seals to provide double protection against moisture intrusion
- Closed loop circulating cooling system with an air filled motor to enable continuous operation in air under full load conditions.
- Moisture probes and temperature sensors for motor protection
- Explosion proof motors

1.2.3.3 *O&M requirements*

There is not a significant difference in O&M requirements between the two pump alternatives. Both pump manufacturers have service centers in the Central Valley. Wemco utilizes Industrial Electric in Modesto as its local service center or the pumps can be shipped to the Wemco facility in Salt Lake City if necessary. Flygt utilizes Shape Inc. in Stockton and also has a Flygt service center in Fairfield, CA.

1.2.4 Efficiency

Both the Wemco and Flygt pump selections are near the BEP for the pumps at the design operating condition. The efficiency for both pump selections is about 79%. The Wemco Hidrostal pump is fitted with external adjusting screws to enable O&M staff to reset the clearance between the pump's impeller and suction liner such that the "as new" efficiencies can be retained over the wear lives of these components. This may provide a slight advantage in terms of power consumption over the life of the pump.

1.2.5 Capital Cost and Equipment Lead Time

As indicated in Table 1.1, the total cost for the Flygt pumps is approximately \$40,000 less than the Wemco Hidrostal.

In terms of lead-time for the equipment, Flygt has confirmed that they can deliver the equipment within 9 to 10 weeks after submittal approval. Wemco can deliver within 20 to 22 weeks after approval.

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1.3 Pump Recommendations

Carollo has had good experience with both Flygt and Wemco products on numerous projects over the years in similar applications. From a performance and reliability standpoint, both pumps are equally suitable for this application. When cost and lead-time are included in the analysis, the Flygt pump option is the clear winner. For this reason, it is our recommendation that these pumps be prepurchased by the City for this project.

1.4 VFD Recommendations

As noted above, the IPS pump VFDs will also be replaced as part of this project. Currently, Pumps Nos. 1 through 3 have VFDs while Pump No. 4 has a constant speed drive. Since Pump No. 4 does not have a VFD, the pump in that position is typically used as a "shelf spare," to swap out with another pump if it goes down. Due to the small size of the existing IPS wet well, when the constant speed pump is operated during normal flow conditions, it will drain down the wet well rapidly and therefore cycle on and off repeatedly. Having all four pumps on VFDs would therefore greatly improve the operation of the IPS and provide true firm capacity without requiring the pumps to be swapped out on a regular basis. It is therefore our recommendation that a fourth VFD for Pump No. 4 be provided.

During our site visit to the facility, we confirmed that there is 122-inches of space available for the VFD cabinets. Therefore, in order to provide the space for four cabinets, the width of the cabinets will need to be limited to 30 inches. Tables 1.2 and 1.3 provide a comparison of the cabinet dimensions, cost, and lead time for VFDs from the four manufacturers Carollo typically specifies.

Manufacturer	Dimensions (inches)		
	H	W	D
General Electric	90	30	20
Eaton/Cutler-Hammer	90	30	21
Schneider/Square D	90	36	25
Allen-Bradley	92	55	25

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Table 1.3 VFD Alternative Comparison - Cost							
Manufacturer	Base Cost per Unit	Base Cost Total	Freight, Testing & Training	Tax (8.5%)	Bonding and Insurance	Total Equipment Cost	Lead Time (weeks)
General Electric	\$15,800	\$63,000	\$5,000	\$6,000	\$2,000	\$76,000	12-15
Eaton/Cutler-Hammer	\$20,000	\$80,000	\$5,000	\$7,000	\$3,000	\$95,000	15-16
Schneider/Square D	\$30,000	\$120,000	\$5,000	\$11,000	\$4,000	\$140,000	15-16
Allen-Bradley	\$35,000	\$140,000	\$5,000	\$12,000	\$4,000	\$161,000	10-12

As indicated in Table 1.2, both General Electric and Eaton have VFD cabinets that meet the space requirements. However, based on the considerable lead time for this equipment, we recommend prepurchasing of the General Electric VFDs as they are the lowest cost option.

Prepared By:



Scott E. Parker, P.E.

SUBJECT: REQUEST FOR IMMEDIATE CONSULTANT SERVICES – WASTE WATER TREATMENT FACILITY RAW SEWAGE PUMPS PROJECT

SOURCE: PUBLIC WORKS DEPARTMENT – FIELD SERVICES DIVISION

COMMENT: Staff respectfully requests Council's authorization to negotiate a "not to exceed" \$60,000 contract for engineering services with Carollo Engineering for the purpose of preparing plans and specifications to remove and replace four (4) Raw Sewage Pumps (RSP) at the Wastewater Treatment Facility. The RSP are located at the front end of the treatment facility. Their sole purpose is to pump approximately five million gallons of daily sewage 27' from a sump up to ground level to begin the influent treatment process.

The four pumps in question are approximately 19 years old and their constant use has brought them close to the end of their useful life. Currently, one of the four pumps is out for repair and it is reasonable to assume that the remaining three pumps will soon begin to experience significant problems.

Obviously time is of the essence. Discussion with pump manufacturers indicates that once a set of plans have been approved, the lead time for pump delivery is approximately 16 to 18 weeks. Staff believes that Carollo Engineers are uniquely qualified to perform the necessary engineering due to the fact that Carollo Engineers designed the original system and were involved in its construction. Carollo Engineers have all of the original construction documents including the complete layout of that portion of the facility that houses the Raw Sewage Pumps.

The existing pumps are driven by a 27' shaft with motors placed directly above at ground level. While this was a proper design twenty years ago, new technology and better pumps allow for the installation of immersible pumps with variable frequency drives (VFD). Immersible pumps coupled with a VFD are significantly more efficient and consume less energy.

In order to minimize design time, staff requests Council's permission to have Carollo Engineers pre-select the pumps, VFD, and other appurtenances. By pre-selecting the equipment, there is the assurance that the new equipment will seamlessly match existing conditions with minimal disruption to the facility.

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If Council approves staff's request, Carollo Engineer's first task will be to recommend the pump and VFD. A subsequent staff report will be forthcoming identifying the pre-selected equipment with the request that the Council award a contract to the manufacturer of the pre-selected equipment. The funding source is the Wastewater Capital Reserve.

RECOMMENDATION: That the City Council:

- 1 Direct the Public Works Director to negotiate a Design Service Agreement with Carollo Engineers for a "Not to Exceed" \$60,000 fee;
- 2 Authorize the Mayor to execute the Design Service Agreement, if successfully negotiated, for a "Not to Exceed" \$60,000 fee; and
- 3 Direct staff to present a report no later than March 5, 2013, describing the recommended pre-selected equipment for Council's consideration.