Green Project Checklist[1]

Project Name: Phase II Wastewater Treatment Facility Improvements

Applicant: Clearfield Municipal Authority

County: Clearfield, PA

PV Project Number: 17039041101-CS

DEP RO Reviewer:

Date:

I. DEP RO Reviewer If the project is *not* Green (See the attached EPA April 21, 2010 guidance) check here. ( ) The review is complete.

II. (RO) Is the project *categorically* Green (See the attached EPA April 21, 2010 guidance)?

Yes No

Explain (if yes, include reference to a section in the guidance) and proceed to "IV" below:

III. (RO) If the project is green, but not categorically green, it must have a Business Case to be approved.

A Business Case is a brief report which briefly describes what the project is and why it is green. All Business Cases must show that the project has identifiable and substantial benefits. Those benefits must be quantified (in terms of water, energy and dollars whenever possible). All projects must be cost-effective.

Describe the Green scope of the project:
Summarize the basis of the Green determination in the Business Case:

List documented water, energy and cost savings:

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[1] Based on EPA April 21, 2010 Guidance

Is the Business Case approvable?

Yes
No

Explain:

Attach the business case.

IV: (RO) Category and Dollars

What is the predominant green category?

Water Efficiency	( )
Energy Efficiency	(x)
Green Infrastructure	( )
Environmentally Innovative	( )

What is your estimate of the cost of the green components? $

III. (CO) Provide an electronic copy of the Business Case to PennVest (for entry to the website).

Done	(x)
N/A	( )

IV. (CO) Priority List Followup:

If the above confirms that the project is Green, ensure that the priority list shows:

1. The project is approved as Green
2. Which Green category (Water Efficiency, Energy Efficiency, Green Infrastructure, or Environmental Innovative)
3. Whether or not the project is "Categorical" Green
4. Eligible Green dollars

American Recovery and Reinvestment Act
Green Infrastructure Criteria Analysis and Business Case

Applicant Name:	**Clearfield Municipal Authority**
Project Title:	**Phase II Wastewater Treatment Facility Improvements**
Total Project Cost:	**$29,870,290 (Construction Cost)**
Project Cost for "Green" Components:	**$852,884**

<u>Project Abstract:</u>
The Clearfield Municipal Authority (CMA) operates a regional wastewater treatment facility serving the Clearfield Borough and surrounding portions of Lawrence Township, Clearfield County. The existing CMA wastewater treatment facility (WWTF) was originally constructed in 1958 with primary treatment capability, but in 1977 it was upgraded to meet secondary treatment effluent limits of biochemical oxygen demand (BOD), total suspended solids (TSS), dissolved oxygen (DO), pH, fecal coliform, and total residual chlorine (TRC). In 2005, the plant's solids processing equipment was upgraded through the installation of a new sludge dewatering centrifuge building.

Since its inception, the plant has complied with all water quality and effluent parameters specified in the state/federal discharge permit (i.e. National Pollutant Discharge Elimination System (NPDES) permit). Since October 2010 the CMA WWTF has been mandated to comply with annual nutrient loading limits of total nitrogen (TN) and total phosphorus (TP) in addition to the secondary treatment limits. These limits were imposed due to the Chesapeake Bay Tributary Strategy, which was implemented by PADEP in December 2004 to reduce nutrient and sediment loadings to the bay.

Implementation of the proposed project will result in a treatment system capable of achieving the Chesapeake Bay Initiative and new NPDES limits for annual total nitrogen and phosphorus loading in addition to organic and suspended solids removal and more adequately handle and treat wet weather flow which has historically burdened the facility and overall treatment capabilities.

To comply with aging infrastructure, hydraulic capacity and annual TN and TP loading limits and to treat higher flows, the Authority will construct a new treatment facility adjacent to the existing treatment facility. The project will also maximize the utilization of the existing infrastructure. The major elements of the upgrade project include the following: construction of a new influent wastewater pumping station, new pretreatment/headworks building, construction of an influent distribution box, construction of three (3) BNR reactors and blower building, construction of a final clarifier influent distribution box and final clarifiers, installation of two (2) new channel UV disinfection units, construction of an effluent channel and flow meter, cascade aeration, RAS distribution box and RAS pump and chemical feed building, sludge processing and storage systems, one (1) chemical feed building, flow conveyance channels and pipes and upgrades to the instrumentation and control systems.

The existing Digester and Control building will be upgraded into a new sludge processing facility. The anaerobic digesters will be converted to aerobic with new blowers provided. Mechanical thickening will be provided along with sludge handling pumps and piping. The existing blower and pump building will be retained and used for utility water system and other ancillary equipment and storage.

In addition, the planning and design of this infrastructure improvements project has been diligent to utilize the most effective and efficient means and methods which are practical and cost attentive. Attention and implementation of "green infrastructure" to allow for energy efficiency and overall environmental sustainability has been incorporated in this project and will be outlined in the subsequent sections.

American Recovery and Reinvestment Act
Green Infrastructure Criteria Analysis and Business Case

Applicant Name:	**Clearfield Municipal Authority**
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Project Cost for "Green" Components:	**$852,884**

Green Project Criteria:

Energy Efficiency:
The construction of a new treatment facility building and appurtenances allows for the implementation of energy efficient building materials exceeding the minimum R-Value required by the IEC-2009, the implementation of energy efficient lighting, efficient HVAC systems, and implementation of the most energy efficient pumps and motor controls practical for the application. Variable frequency drives (VFD) will be used to control motors allowing for optimum operation and overall conservation via the automated process. Utilization of VFD's allows a wider array of operating conditions to occur via one pump and motor control, which can be regulated to demand as opposed to a steady state operation which is inefficient and wasteful. All chemical metering pumps will be flow paced allowing for efficient and effective treatment and overall conservation of energy resources. The proper design, selection and automation of such process controls allows for superior operational efficiency over the existing treatment facility and processes.

Implementation of such innovative and conservative practices is necessary in today's environment to conserve natural resources, maintain cost effective and efficient operations and stay at the forefront of sustainability.

The design and specifications for the infrastructure components compiling the treatment facility have been specified to utilize recycled material meeting structural stability requirements, and serves as a means of reducing the dependency on natural non-renewable resources.

Proposed Facility Process

The following shall serve as an outline of the proposed facility processes coupled with detailed descriptions of specifications for "green" design and sustainability.

1. Aeration Blowers

The new blowers are sized to more accurately match the air requirements of the new process. The existing aeration tanks use coarse bubble air diffusers for aeration and mixing purposes. Coarse bubble diffusers are less economical and have less oxygen transfer efficiency when compared to fine bubble air diffusers. Thus, fine bubble diffusers are proposed for the new treatment process. The existing aeration blowers are not sufficient for the higher pressures of a fine bubble diffused air system, thus the need for the replacement of the blowers in the new treatment process. Currently the WWTF has four (4) aeration blowers, all 100 HP. The new design utilizes four (4) blowers, two (2) for Reactors 1 and 2 and two (2) for Reactors 3 and 4. Each set includes one (1) 100 HP and one (1) 150 HP blower; with VFD controls. This allows more precise air control and also significantly reduces electrical costs. At low and average flows, the facility will run a 100 HP blower (120 amp load) which is the same as they are using now. At peak daily flow for the proposed plant, all two (2) blowers will run for a total of 250 HP (302 amp load) verses two (2) 240 HP blowers. The size increase of the new blowers is necessary for the proposed expanded plant that is designed for a peak flow rate of 25 MGD versus a design flow rate of 4.5 MGD at the existing facility. Note the new blowers are high efficiency turbo blowers with better turn down capacity.

2. Pumps

Recycle flow varies based on influent flow. VFD's on the pumps allow the pump speed to vary to match the recycle flow requirement. We evaluated the Main Influent Wastewater Pumps, Return Activated Sludge Pumps and Waste Activated Sludge Pumps for this project. Refer to the below calculations.

Main Influent Wastewater Pumps – The main influent pumping station at the plant is equipped with two variable speed sewage pumps and one constant speed pump. Each existing pump is rated at 1,800 GPM each with 30 HP motors. At an Average Daily Flow (ADF) of 2.55 MGD, one pump will run for 24 hours/day. At a Peak Daily Flow (PDF) three (3) existing pumps will run for 24 hours/day.

At the new main influent pumping station, there will be five high efficient variable speed pumps (1 spare) rated at 2,850 GPM each with 90 HP motors. At an Average Daily Flow (ADF) of 2.55 MGD, one pump will run for 14.9 hours/day. At a future Peak Daily Flow (PDF) four (4) proposed pumps will run for 24 hours/day.

ADF Existing Pumps:

$$\text{kwh} = \frac{(1\text{ pump})\ (30\text{ HP})\ (746)\ (24\text{ hrs/day})}{1{,}000} = 537\text{ kwh}$$

ADF Proposed Pumps:

$$\text{kwh} = \frac{(1\text{ pump})\ (90\text{ HP})\ (746)\ (15.9\text{ hrs/day})}{1{,}000} = 1{,}000\text{ kwh}$$

PDF Existing Pumps:

$$\text{kwh} = \frac{(3\text{ pump})\ (30\text{ HP})\ (746)\ (24\text{ hrs/day})}{1{,}000} = 1{,}611\text{ kwh}$$

PDF Proposed Pumps:

$$\text{kwh} = \frac{(4\text{ pump})\ (90\text{ HP})\ (746)\ (24\text{ hrs/day})}{1{,}000} = 6{,}445\text{ kwh}$$

Return Activated Sludge(RAS) Pumps – There are two existing 5 HP RAS pumps and one existing 10 HP RAS pump operating 24 hours/day. There are four proposed 60 HP RAS pumps (1 spare) operating 24 hours/day.

Existing Pumps:

$$\text{kwh} = \frac{(2\text{ pumps})\ (5\text{ HP})\ (746)\ (24\text{ hrs/day})}{1{,}000} = 179\text{ kwh}$$

$$\text{kwh} = \frac{(1\text{ pumps})\ (10\text{ HP})\ (746)\ (24\text{ hrs/day})}{1{,}000} = 179\text{ kwh}$$

Proposed Pumps:

$$\text{kwh} = \frac{(3\text{ pumps})\ (60\text{ HP})\ (746)\ (24\text{ hrs/day})}{1{,}000} = 3{,}223\text{ kwh}$$

Waste Activated Sludge (WAS) Pumps – There is one existing 10 HP WAS pump operating 3 hours/day for 4 days/week. When sludge is being wasted to the thickener centrifuge, the existing 10 HP RAS pump is used as the WAS pump. There are two (2) proposed 30 HP WAS pumps (1 spare) and four proposed 7.5 HP thickened sludge and digested sludge pumps (1 spare) which will operate 6.5 hours/day for 5 days/week.

Existing WAS Pumps:

$$\text{kwh} = \frac{(1\text{ pump})\ (10\text{ HP})\ (746)\ (3\text{ hrs/day})}{1{,}000} = 22\text{ kwh}$$

Proposed WAS Pumps:

$$\text{kwh} = \frac{(1\text{ pumps})\ (30\text{ HP})\ (746)\ (6.5\text{ hrs/day})}{1{,}000} = 145\text{ kwh}$$

Summary of Pumps - The total existing energy demand of the aeration blowers, main influent wastewater pumps, RAS pumps and WAS pumps is 917 kwh/day whereas the proposed energy demand for the same components is 4,368 kwh/day. An important factor to note is that the existing plant is designed for a flow rate of 4.5 MGD whereas the proposed plant is designed for a flow rate of 25 MGD. Also, many components of the existing plant are now under-designed for the existing peak flow rates at the plant.

If you apply the ratio of the proposed plant's design flow rate to the existing plant's design flow rate (25 MGD/4.5 MGD = 5.55 factor) to the existing energy consumption of the plant (917 kwh/day * 5.55 = 5,094 kwh/day), the proposed plant utilizes less energy consumption relative to the design flow rate (4,368 kwh/day < 5,094 kwh/day). This savings in energy consumption is 726 kwh/day. Assuming the Authority pays \$0.0516/kwh for electric power, the annual energy savings is (726 kwh/day) (365 days) (\$0.0516/kwh) = \$13,673/year. The 20-year energy savings is \$273,460.

3. Energy Efficient Lighting

Energy efficient lighting will be installed. Energy saving electronic ballasts will be installed in new buildings associated with this project. Utilizing electronic energy savings ballasts instead of standard magnetic ballasts produces an average demand savings of 20 watts per ballast. On this particular project, the demand savings created by using electronic ballasts in fluorescent fixtures is roughly 8.0 kW. The demand cost savings that is tabulated by taking the demand savings x the demand charge x the number of months the equipment is operating.

The average demand cost savings for the fluorescent lighting on this project is:
8.0 kW (x) \$6.65/kW x 12 months = \$638 per year. The 20-year energy savings is \$12,760.

Energy saving electronic ballast usage contributes to a greater than 30% savings over conventional magnetic ballast usage.

4. VFD Drives

Variable Frequency Drives will be used on all blowers and process pumps. Variable Frequency drives provide automatic speed control via the SCADA system. While pumps and blowers are designed to handle peak loads, control of this process equipment by standard full voltage motor starters or reduced voltage motor starters leads to energy inefficiency because the load requirements vary greatly during various times of the day and season to season and the wastewater treatment system often operates at reduced load for long periods of time. The ability to adjust motor speed in direct relations to the load requirements at any particular point in time, allows immense energy savings and rapid payback of the costs associated with the purchase of the drives.

Many factors such as total head, system curves, pump or blower design points, motor efficiency and pump efficiency must all be taken into account when tabulating energy savings. Premium efficiency motors provide anywhere from 2 to 8% in energy savings while the use of VFDs to vary output based on motor speed can typically **save as much as 30%** over standard motor controls. However, because of so many variables it is not feasible to provide detailed analysis and calculations for this component. We propose that in accordance with the "Guidance for Determining Project Eligibility" Part A, CWSRF, Part 5.2 the project was designed to enable equipment to operate most efficiently which strengthens this Business Case.

5. System Control and Data Acquisition Systems:

System Control and Data Acquisition Systems (SCADA) will be utilized to effectively monitor system operations and will improve efficiency by conservative operation of the system in conjunction with automation of process controls. The new treatment facility and appurtenances will be equipped with a state-of-the-art Supervisory Control and Data Acquisition (SCADA) system allowing for real-time analysis of process activities, control of process components and equipped with system alarms to ensure the safe treatment of wastewater and immediate cessation of process activities should an alarm set point be triggered. Utilization of such automation improves overall process efficiency and conservation of resources. However, because of so many variables it is not feasible to provide detailed analysis and calculations for this component. We propose that in accordance with the "Guidance for Determining Project Eligibility" Part A, CWSRF, Part 5.2 the project was designed to enable equipment to operate most efficiently which strengthens this Business Case.

Cost Estimates of Green Components

Aeration Blowers	$392,388
Pumps – Main Influent	$278,784
Pumps - WAS	$24,394
Pumps - RAS	$74,488
Lighting	$82,830
TOTAL	**$852,884**

SECTION 11930
PUMPING EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Scope

1. The Work covered under this section shall consist of providing all plant, labor, and material required to furnish, install, test, and place in operation the Pumping Equipment, as set forth on the Drawings and in accordance with this section of the Specifications.

2. The pumping equipment and associated items to be provided under this Contract includes, but is not limited to, the following:

a. Pumping equipment.

1) Four (4) installed Main Influent Wastewater Pumps and one (1) spare, five (5) total

2) Six (6) Installed Nitrate Recycle Centrifugal Solids Handling Pumps and one (1) spare, seven (7) total

3) Three (3) Installed Mixed Liquor Recycle Centrifugal Solids Handling Pumps and one (1) spare, four (4) total

4) Three (3) Installed Return Activated Sludge Screw Centrifugal Solids Handling Pumps and one (1) spare, four (4) total

5) Two (2) Installed Clarifier Submersible Scum Pumps, Duplex Pump Station with Controls and one (1) spare, three (3) total

6) Six (6) Installed Waste Activated, Thickened and Digested Sludge Pumps.

b. Special tools.

c. Spare parts.

d. Operation and maintenance training.

B. Related Work Specified Elsewhere in Contract Documents

1. The provisions of this section are a direct extension of Equipment General Provisions Section 11000 and, although set forth only once within these Specifications, shall apply equally to this section.

2. Section 01340: Shop Drawings, Product Data and Samples.
3. Section 01650: Equipment, Systems and Facility Start-up and Commissioning.

4. Section 01730: Operation and Maintenance Data.

manufacturer's name, model number, parts list, and brief description of all pumping equipment and their basic operating features. List in the maintenance manuals routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Manuals shall be approved prior to the training of Owner's personnel.

PART 2 - PRODUCTS

2.01 MAIN INFLUENT WASTEWATER PUMPS

A. Requirements

1. Furnish and install four (4) submersible non-clog wastewater pumps and furnish one (1) spare. Each pump shall be equipped with a close coupled 90 HP, submersible electric motor connected for operation on 460 volts, 3 phase, 60 hertz, with 50' linear feet of submersible cable (SUBCAB) suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards. Also, 50 linear feet of multi-conductor submersible cable (SUBCAB) will be used to convey pump monitoring device signals.

B. Pump Design Configuration

1. Each pump shall be capable of operating in a continuous non submerged condition in a vertical (NT) position in a dry pit installation and permanently connected to inlet and outlet pipes. Pump shall be of submersible construction and will continue to operate satisfactorily should the dry pit be subjected to flooding.

2. Each pump shall be supplied with a mating cast iron suction and discharge connections and be capable of delivering 2850 GPM at 82 FT. TDH. Additional points on the same curve shall be 3500 GPM at 65, 2609 GPM at 86.4 ft. Shut off head shall be 135 feet (minimum). Static head is 60 ft.

   Pumps shall be capable of operating on variable frequency drive and provide a minimum flow of 700 GPM.

C. Pump Construction

1. Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be AISI type 316 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

2. Sealing design shall incorporate **metal-to-metal contact** between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile rubber O-rings. Joint sealing will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific bolt torque limit. Rectangular cross sectioned rubber, paper or synthetic gaskets that require specific torque limits to

2.02 NITRATE RECYCLE, MIXED LIQUOR AND RETURN ACTIVATED SLUDGE PUMPS

A. General

1. Furnish and install as shown by the plans dry pit screw centrifugal pumps specifically designed to pump nitrate recycle, mixed liquor, return activate sludge, raw unscreened sewage, biosolids, or other media containing solids and/or rags and other fibrous materials without clogging.

2. Screw centrifugal pump, complete with motor, baseplate, necessary guards, and all other specified accessories and appurtenances shall be furnished by the pump manufacturer to insure compatibility and integrity of the individual components, and provide the specified warranty for all components. The pump manufacturer shall accept unit responsibility for each pump complete assembly.

3. The screw centrifugal pumps specified in this section shall be furnished by and be the product of one manufacturer.

4. All screw centrifugal solids handling pumps shall be individually tested for capacity and performance in complete accordance with the applicable ANSI/HI pump test standards.

B. Performance

1. The pumps shall be designed for continuous operation and will be operated continuously under normal service. To minimize operation power costs, the hydraulic efficiencies listed for each pump are the minimum acceptable, and must be guaranteed by the manufacturer.

2. Operating Conditions

Nitrate Recycle Pumps

	Flow GPM	TDH FT	Max. Pump RPM	Pump Efficiency %	Brake HP Required	Min. Shut-Off TDH	Max. Motor Size	Max. Moto r RPM
Design Condition	2100	28	1145	77	19.3	55	25	1160
Secondary Condition	850	23.5	850	63	8			

Mixed Liquor Return Pumps

	Flow GPM	TDH FT	Max. Pump RPM	Pump Efficiency %	Brake HP Required	Min. Shut-Off TDH	Max. Motor Size	Max. Moto r RPM
Design	2100	10	1050	63	8.4	41	20	1180

Condition								
Secondary Condition	1000	23	960	8.4				

Return Activated Sludge Pumps

	Flow GPM	TDH FT	Max. Pump RPM	Pump Efficiency %	Brake HP Required	Min. Shut-Off TDH	Max. Motor Size	Max. Motor RPM
Design Condition	2800	42	1690	75	39.6	107	60	1780
Secondary Condition	1000	23	960	8.4				

3. Pump Criteria

   a. Minimum suction diameter: 10-inch
   b. Minimum discharge diameter: 10-inch
   c. Minimum non-compressible solids passage: 4-inch
   d. Minimum B-10 bearing life: 50,000 hrs.

C. Pumps

1. Design

   a. The basic design shall be a single passage, clog free pump, utilizing a screw centrifugal impeller. The overall pump design shall combine high efficiency, low required NPSH, a large solid passage, and the ability to handle rags or other fibrous material without plugging.

   b. The hydraulic design of the impeller shall combine the action of a positive displacement screw with the action of a single vane centrifugal impeller to provide a single, non bifurcated flowstream with only gradual changes in flow direction.

      1) The leading edge of the impeller vane shall blend into the impeller body in such a way that any rag or other fibrous material caught on the leading edge and folded over both sides of the vane will be unfolded and released as the textile follows the flowstream through the pump.

      2) The impeller flange or impeller shall contain a spiral groove on the rear face so that any solids in the pumped media are discharged from the space between the backplate and the rear of the impeller.

   c. In order to maintain optimum running clearances along the entire length of the impeller to maintain design hydraulic efficiencies, the geometry of the impeller and suction piece shall be conical, so any axial adjustment of the impeller will cause the clearance between the impeller and suction piece to change uniformly along the entire length of the impeller. Designs control circuits. The transformer primary and secondary circuits shall be fused.

7) A line voltage rated adjustable phase monitor to sense low voltage, loss of power, reversed phasing and loss of phase. The control circuit shall de energize upon sensing any of the previously mentioned faults and automatically re energize upon return to normal power.

8) A mini-CAS monitor to monitor temperature and leakage switches at each pump motor.

9) Ground wire alarm relay.

2.04 WASTE ACTIVATED SLUDGE, THICKENED SLUDGE AND DIGESTED SLUDGE

A. Furnish and install six (6) progressing cavity type sludge pumps complete with motors, baseplates, thermal dry running protection, over pressure protection and all appurtenances. The following specification reference Netzsch pumps in terms of operating conditions, materials and performance criteria and shall be used as a basis of comparison for other specified pumping systems. The pump manufacture shall be NETZSCH Inc., 119 Pickering Way, Exton, PA 19341-1393 (Phone: 610-363-8010) (Basis of Bid); Moyno, Inc., 1895 West Jefferson, Springfield, OH 45506 (Phone: 877-486-6966); Seepex, Inc., 511 Speedway Drive, Enon, OH 45323 (Phone: 937-864-7150), or approved equal.

1. Performance Characteristics

APPLICATION DATA

Pump Number	**WAS-1**	**WAS-2**	**TS-1**	**TS-2**	**DS-1**	**DS-2**
Description	**To Thickener Centrifuge**	**Spare**	**To Digester No. 1 (Primary)**	**Spare**	**To Digester No. 2 (Secondary)**	**To Sludge Holding Tank**
Pumped Medium	Sludge	Sludge	Sludge	Sludge	Sludge	Sludge
Operating Temperature, degrees F	50-86	50-86	50-86	50-86	50-86	50-86
Solid Content, approx. % DS	0.35	0.35	4 to 6	4 to 6	2 to 4	2 to 4
Suction Type	Flooded	Flooded	Flooded	Flooded	Flooded	Flooded
Capacity, GPM	50-500	50-500	25-125	25-125	25-125	25-125
Pressure (max.), PSI	22.7	22.7	-0.9	-0.9	13.1	10.3
Speed, RPM	215	215	245	245	245	245
Required Power, HP	16	16	3	3	3	3
Motor Horsepower, HP	30	30	7.5	7.5	7.5	7.5
Installation area	inside, dry	inside, dry	inside, dry	inside, dry	inside, dry	inside, dry
Model/Type	1 (see below)	1 (see below)	2 (see below)	2 (see below)	2 (see below)	2 (see below)
Suction connection, inches, 125lb ANSI Flange	8	8	6	6	6	6
Discharge connection, inches, 125lb ANSI Flange	6	6	4	4	4	4