

ONE DESIGN ENGINEER'S FAVORITE WASTEWATER PUMP STATION DESIGN FEATURES

(And Some Things To Avoid)

CWEA Annual Conference
Sacramento, CA April 20, 2012

Bonneau Dickson, PE
Consulting Sanitary Engineer
2428 McGee Avenue
Berkeley, CA 94703

Tel. 510 845 8625
Fax. 510 845 4606
dickson.bonneau@gmail.com

THIS PRESENTATION

- Introduction
- Evolution of pump station design
- Number of pumps
- Backup/standby/reliability facilities
- Design details
- Future trends
- Case histories/Horror stories

THE SPEAKER'S PERSPECTIVE

- Independent consulting sanitary engineer
- Smaller pump stations
- Wastewater rather than clean water
- United States versus third world

NEVER BUT NEVER QUESTION



ENGINEER'S

JUDGEMENT

TYPES OF PUMP STATIONS

.

EVOLUTION DUE TO CHANGES IN TECHNOLOGY

- Non clog pumps
-
- Submersible motors
-
- Variable frequency drives (VFDs)
-
- Magnetic flow meters
-
- Plastic liners

EVOLUTION DUE TO CHANGES IN REGULATIONS

- Confined space
-
- Fall restraint and arrest
-
- Environmental exposure
-
- Arc flash

WASTEWATER PUMP STATION CONFIGURATIONS

- Dry pit/wet pit. Forever.
- Pneumatic ejectors. 1950s.
- Package vertical shaft. (Vaughn Chopper Pumps). 1960s. Marine intake. Fire pump.
- Underground pump stations. (Smith & Loveless). 1960s.
- Suction lift pump stations. (Gorman Rupp). 1980s.
- Submersible pump stations. 1980s.
- Dry pit submersible pumps
- Small grinder pumps and small pressure sewers

DRY PIT PUMP STATION



Bonneau Dickson, PE Consulting Sanitary
Engineer

PUMPS IN SERIES WITH A SINGLE BELT DRIVE



Bonneau Dickson, PE Consulting Sanitary
Engineer

POSSUM FAT? BAD WINE??



Bonneau Dickson, PE Consulting Sanitary
Engineer

SAN BRUNO OLYMPIC PUMP STATION



Bonneau Dickson, PE Consulting Sanitary
Engineer

SAN BRUNO OLYMPIC VERTICAL SHAFT PUMP STATION



Bonneau Dickson, PE Consulting Sanitary
Engineer

SAN BRUNO CRESTMOOR SUCTION LIFT PUMP STATION



Bonneau Dickson, PE Consulting Sanitary
Engineer

Underground Pump Stations



Bonneau Dickson, PE Consulting Sanitary
Engineer

UNDERGROUND PUMP STATION ENTRANCE TUBE



Bonneau Dickson, PE Consulting Sanitary
Engineer

Gavilan College Pump Station



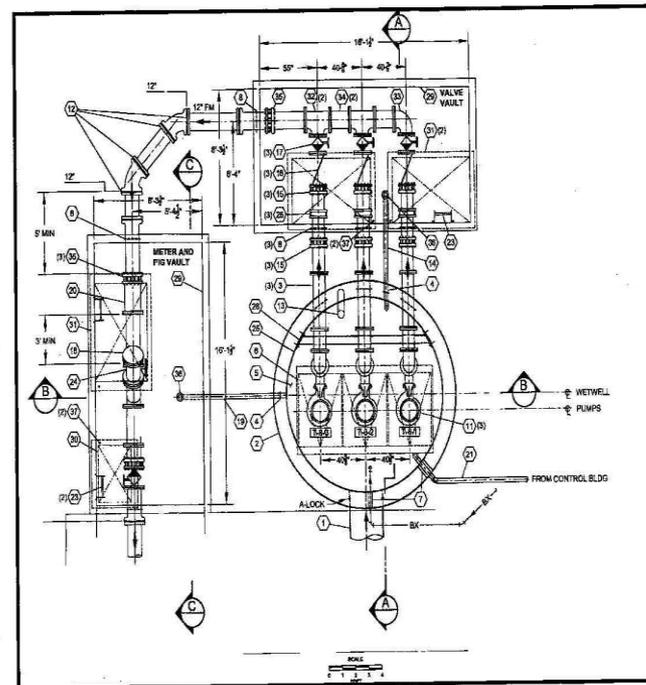
Bonneau Dickson, PE Consulting Sanitary
Engineer

SUBMERSIBLE PUMP STATION AT A CHEESE FACTORY, SONOMA, CA



Bonneau Dickson, PE Consulting Sanitary
Engineer

PLAN OF SUBMERSIBLE PUMP STATION



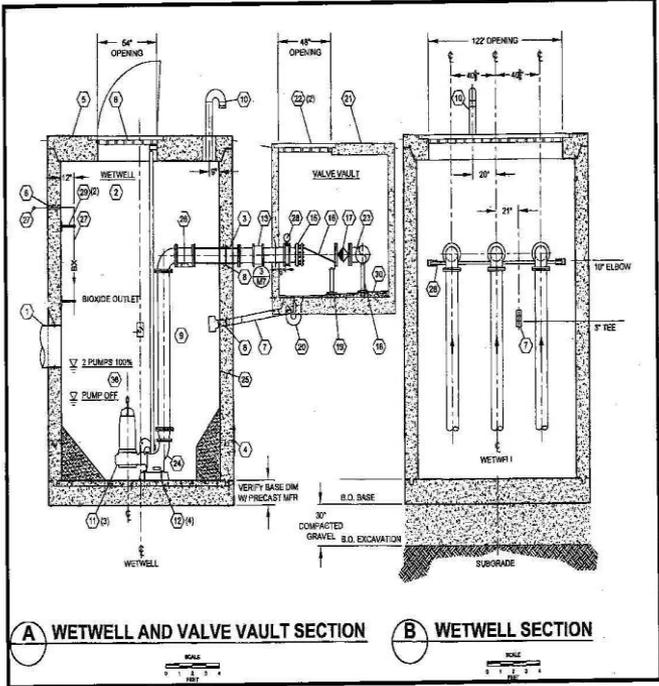
\\nas3\projects\2011\114310_00_GlendaleCherryChaseSewer\09-Reports\09-Report\PRD_Appendix

Kennedy/Jenks Consultants
CITY OF GLENDALE
CHEVY CHASE DIVERSION SEWER
SUBMERSIBLE PUMP STATION
PLAN

1183210700
FIGURE 4-11.2

Bonneau Dickson, PE Consulting Sanitary
Engineer

SECTION THROUGH SUBMERSIBLE PUMP STATION



\\s03\proj\jedi20111183010_00_Glendale\ChevyChaseSewer\09-Report\B.09-Report\FOR_Appendices

Kennedy/Jenks Consultants
 CITY OF GLENDALE
 CHEVY CHASE DIVERSION SEWER
 SUBMERSIBLE PUMP STATION
 SECTION

1183010'00
 FIGURE 4-11.3

SMALL SUBMERSIBLE STATION



Bonneau Dickson, PE Consulting Sanitary
Engineer

SMALL SUBMERSIBLE STATION

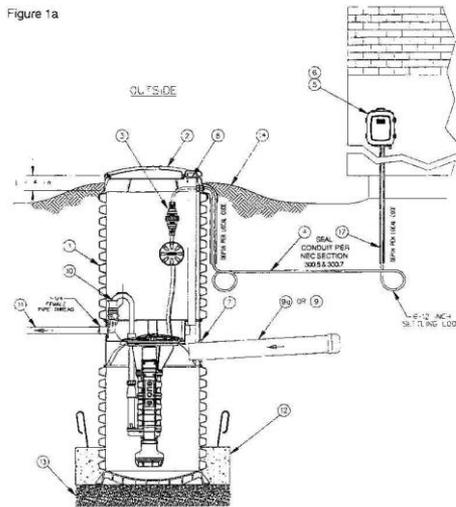


12/07/2011 13:53

Bonneau Dickson, PE Consulting Sanitary
Engineer

SMALL GRINDER PUMP STATION

Figure 1a



**SMALL GRINDER PUMP STATION
WITH SMALL DIAMETER FORCE MAIN**

REHABS

- Many possibilities
- Dry pit submersibles in existing dry pits
- Wet well in a wet well
- Pumps in a septic tank
- Additional pumps in the wet well of a dry pit pump station

SUBMERSIBLE PUMP STATION ADVANTAGES

- Pumping equipment not accessible to unauthorized persons
-
- Pump can be easily withdrawn for maintenance
-
- Wet well rarely has to be entered
-
- Minimal confined space problems
-
- No superstructure
-
- No noise
-
- Lower cost

SUBMERSIBLE PUMP STATIONS DISADVANTAGES

- Danger of falling into the wet well
- Motor requires specialized maintenance
- Electrical equipment is above ground
- (But you can have a building)
- Requires a separate valve box

BACKUP/STANDBY RELIABILITY FACILITIES

- What are the likely causes of failure?
-
- What do you need?
-
- What do you have?
-

GENERATORS

- Only serve to replace utility power.
-
- Cannot help if electrical system is burned out.
-
- Do allow controls to be used.
-
- Provide lighting and use of electrical tools.

STATIONARY GENERATORS

- Time To Spill, Hours
- Design Decision
- ≤ 1
- Probably ought to have a stationary generator, unless a spill will do little harm.
- 1 to 4
- Case by case basis.
- ≥ 4
- Probably can back the station up by other means.

STATIONARY GENERATOR, SECLINE PUMP STATION, NORTH LAKE TAHOE



Bonneau Dickson, PE Consulting Sanitary
Engineer

STATIONARY GENERATORS (Cont.)

- Considerable maintenance.
-
- Need to be exercised. 30 minutes/month +/-.
-
- Noisy. (But exercise time can be selected).
-
- \$50,000 to \$100,000 in small sizes. (≤ 100 KW).
-
- Diesel versus natural gas.

MOBILE GENERATORS

- Time to deploy.
-
- Traffic delays.
-
- Manual control, must be attended.
-
- Same limitations as stationary generators -- only electrical.

MOBIL GENERATOR AND QUICK CONNECT, NORTH LAKE TAHOE



Bonneau Dickson, PE Consulting Sanitary
Engineer

MOBILE GENERATORS (Cont).

- Manual transfer switch
-
- The receptacle problem
-
- Multiple voltages. 110, 208?, 220, 440.
-
- Limited size. Rarely have a really big one.

MOBILE PUMPS

- Don't need the electrical facilities.
-
- Time to deploy.
-
- Traffic delays.
-
- Manual control, must be attended.
-
- Need access to the force main.

OTHER BACKUP METHODS

- Alternative power feeder
-
- Engine driven pumps
-
- Storage
-
- Gravity overflow/diversion
-
- Spare pumps
-
- Trucks
-
- Small generators. Welders.

STORAGE

- Placer County Standards allow storage in lieu of a generator
-
- Can be a large horizontal pipe
-
- There can be a large amount of "horizontal storage" in flat country
-
- Large tankage usually is prohibitively expensive. \$2/gallon.

GRAVITY OVERFLOW

- Overflow to a different sewer system before spilling
-
- May silt up if used for a long time
-
- Usually feasible only in flat country
-

ARVIN, CA. GRAVITY OVERFLOW?



Bonneau Dickson, PE Consulting Sanitary
Engineer

TRUCKS

- Vactor trucks. Can load themselves.
-
- Tanker trucks. Need separate pumps.
-
- Septic service trucks.

OUTSIDE HELP

- Mutual aid from other agencies or other parts of your organization
-
- Equipment rental companies
-
- Purchases of equipment
-
- Local contractors
-
- Septic service companies

STANDBY STRATEGY

- Which backup equipment can back up which pump stations?
-
- If power fails to all pump stations (the earthquake scenario), where should the available standby facilities be deployed?
-
- The Standby Alternatives matrix
-

AVAILABLE STANDBY EQUIPMENT

TABLE 4-1
LIST OF STANDBY EQUIPMENT

Alternative	GPM	Head, Feet	Remarks
Deutz Mobile Pump	600	80	
Lister Mobile Pump	300	100	
Deutz and Lister Pumps	900	75	Both pumps together.
Electric Driven Mobile Pump	600	35	Requires electric power.
Teel 5 HP Trash Pump	200	20	
Edison Diaphragm Pump	30	High	3 HP Briggs & Stratton engine.
Wilden Diaphragm Pump, Air Driven	20	High	Requires the 10 HP air compressor.
Ebarra Electric (3 Pumps)	21	24	Require electric power.
Rented Pumps	Any	Any	May take some time to rent.
Stationary Generator	50 KW. Only available at the Merced Pump Sta.		
Mobile 60 KW Generator	Needs voltage selector switch.		
Electric Arc Welder	Only adequate for the Sylvan Circle Pump Sta.		
Rented Generators	May take some time to rent and may be in short supply during an areawide power failure.		
City Vactor Trucks (2) Approx. 65 GPM average flow.	May not be available to the WPCP during an areawide emergency. Probably available for local failures.		
Rented Vactor Trucks (Roto-Rooter)	Main office is in San Leandro. Three vactor trucks available. One hour maximum response time.		

STANDBY OPTIONS FOR EACH PS

January 31, 1996

TABLE 4-2

STANDBY ALTERNATIVES FOR EACH PUMP STATION

Standby Unit	Major Pump Stations						Minor Pump Stations						
	Bermuda		Merced		Neptune		Wicks Extension	Bene-dict	Blue Dolphin	Cata-lina	San Rafael	Sylvan Circle	Tea-garden
	Peak Flow	Average Flow	Peak Flow	Average Flow	Peak Flow	Average Flow	Peak Flow	Average Flow					
Alternatives for Widespread Pump Station Failures													
Deutz Mobile Pump		X		X		X	X	X	X	X	X	X	X
Lister Mobile Pump							X	X	X	X	X	X	X
Deutz and Lister Pumps	X	X		X		X	X	X	X	X	X	X	X
Electric Mobile Pump (+ Gen)								X	X	X	X	X	X
Teel Trash Pump								X	X	X	X	X	X
Edison Diaphragm Pump								X	X	X	X	X	X
Wilden Diaphragm w Air Comp.								X	X	X	X	X	X
Ebarra Elec. Submers. (+Gen)									X	X	2?	X	X
Rented Engine Driven Pumps	X	X	X	X	X	X	X	X	X	X	X	X	X
Stationary Generators			X	X					X				
60 KW Mobile Generator		X		X	X	X	X	X	X	X	X	X	X
Electric Arc Welder												X	
Rented Generators	X	X	X	X	X	X	X	X	X	X	X	X	X
City Vector Trucks									X	X	X	X	X
Private Vector Trucks (Roto-Rooter)									X	X	X	X	X
Additional Alternatives for Local Pump Station Failures													
City Spare Pumps				X			X	X					
Rented Spare Pumps	X	X	X	X	X	X	X	X	X	X	X	X	X
Gravity Bypass								Proposed		X			

An "X" in a column means that this unit can provide standby support for this pump station.
 Bolded and underlined cells are the recommended standby alternatives in a total power failure. See Table 5-1.

DEPLOYMENT PLAN

TABLE 5-1

STANDBY EQUIPMENT DEPLOYMENT PLAN

FOR A CITY-WIDE POWER OUTAGE

Pump Station	Standby Resource to be Deployed
MAJOR PUMP STATIONS	
Bermuda	Deutz pump.
Merced	On-site stationary generator.
Neptune	60 KW mobile generator.
Wicks Extension	Gravity bypass. (To be installed). Or: Lister pump.
MINOR PUMP STATIONS	
Benedict	Connected to hospital standby power system.
Blue Dolphin	Gravity bypass.
Catalina	Wilden diaphragm pump.
San Rafael	Teel trash pump.
Sylvan Circle	48 hour storage. Electric arc welder for power. Probably easier to use the vactor truck.
Teagarden	Edison diaphragm pump.
UNASSIGNED STANDBY RESOURCES	
	Lister pump. (If not needed at Wicks Extension).
	First City vactor truck.
	Second City vactor truck.
	Electric driven mobile pump. (Requires a generator).
	Ebarra electric submersibles. (Require generators).
	Rented pumps.
	Rented generators.
	Rented vactor trucks. (One hour maximum response time).

DESIRABLE FEATURES -- 1

- Plastic lined wet wells (PVC or HDPE)
- Access to the force main. (With splitters?)
- Float backup for the analog level sensing system
- Manual override pump control. HOA switch.

FORCE MAIN QUICK CONNECT



DESIRABLE FEATURES -- 2

- Variable frequency drives (VFDs)
- Bypass starters on VFDs
- 480, 3 phase electrical power
- Junction and transition electrical box near the wet well
- Everything above flood level
- Drainage back to the wet well (?). Increasingly required. The great leap backwards.

JUNCTION AND TRANSITION BOX NEAR WET WELL, SECLINE PUMP STA.



DESIRABLE FEATURES -- 3

- Pressure gauges, pointed upward.
- Wiggle room in the piping
- Air release valves
- Eccentric plug valves, plug on top when open
- Safety grate on hatch of wet well
- Magnetic flow meter

PRESSURE GAUGE, VICTAULIC, ARV, HORIZONTAL PLUG VALVE



WET WELL SAFETY GRATE, SECLINE PUMP STATION, NORTH LAKE TAHOE



MAGNETIC FLOW METER, SECLINE PUMP STATION, NORTH LAKE TAHOE



DESIRABLE FEATURES -- 4

- Restrained joints. No thrust blocks
- Surge valve.
- Valves outside the wet well
- No check valve in vertical piping

DESIRABLE FEATURES -- 5

- P-trap rather than a flap gate on the valve vault drain
- Odor control port
- Soil bed scrubber
- SCADA (Supervisory Control And Data Acquisition) (As a minimum, remote alarms)

ODOR CONTROL PORT, SECLINE PUMP STATION, NORTH LAKE TAHOE



CARBON CANISTER ODOR SCRUBBER, SECLINE PUMP STATION



THE FUTURE???

- Crystal ball
- Ouija board
- Cast bones with Queequeg

FUTURE TRENDS IN PUMP STATION DESIGN--1

- Larger fines for spills. More emphasis on reliability.
-
- Mostly submersible type
-
- More use of dry pit submersible pumps for existing dry pit pump stations so pumps and motors are not destroyed by flooding.
-
- More pumps for more redundancy
-
- Dual force mains

FUTURE TRENDS IN PUMP STATION DESIGN -- 2

- More backup
-
- Flow meters
-
- Safety grates on wet wells
-
- Arc flash electrical equipment
-
- More SCADA

NUMBER OF PUMPS

- Capacity is with one of the largest pumps out of service.
-
- (For wastewater. Maybe not for potable water or stormwater).
-
- Maximum turndown with a VFD is around 50%
-
- On/off can affect treatment
-
- On/off can flood small sewers

NUMBER OF PUMPS FOR SMALLER PUMP STATIONS

- "Small" = 500 GPM, 5 -10 HP
-
- On/off operation
-
- Two pumps
-
- Each 100 % of peak flow

NUMBER OF PUMPS FOR LARGER PUMP STATIONS

- You want to handle average flow plus a little with a single pump
-
- Three or four typical
-
- More for very large flows and/or extreme peaking factors
-
- Different sized pumps for large peaking factors

NUMBER OF PUMPS TABLE

No. of Pumps	% of Peak Flow	Peaking Factor	Average Flow As % Of Peak Flow
1	No Spare	1	100
2	100	2	50
3	50	3	33
4	33	4	25
5	25	5	20
6	20	6	16

CASE HISTORY

- Large pump station with two generators
-
- One generator new and tested
-
- Four pumps
-
- Spill of 175,000 gallons into Lake Tahoe
-
- How could this happen?
-
- Common point of failure
-
- Three 10 amp fuel pumps on a single 20 amp circuit