

Introduction



Chris Ewers, P.E.
Principal Engineer
Ewers Engineering, Inc.
Tel. (916) 521-9696
chris@ewersengineering.com

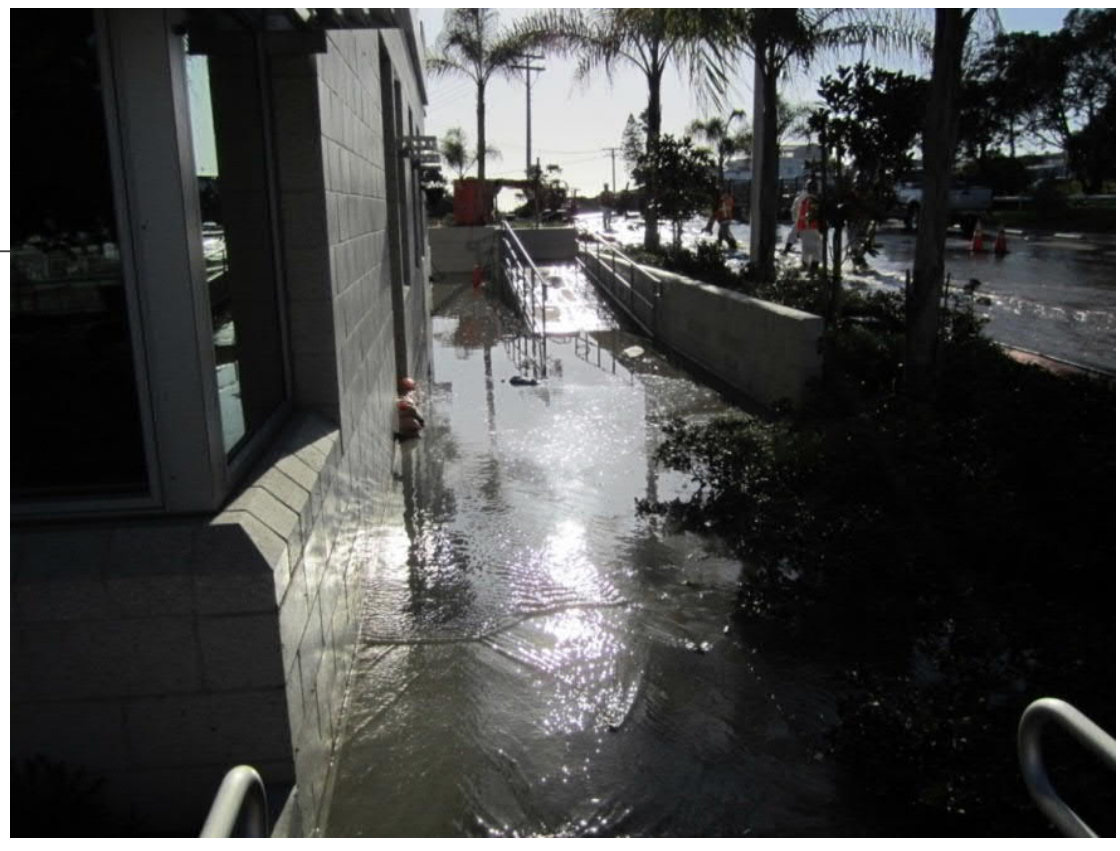
Ewers Engineering

Agenda

- **Why:** System changes, regulations, and professionalism
- **Factors:** What affects outage times
- **Calculating outage times:** Simple how-to
- **Bypasses:** Basic guidance for planning (as time permits)

Pump Station Outage Time

The maximum time a pump station can be out of service before an overflow occurs.



Definitions:

MAXIMUM

The longest time a pump station can be out of service before a spill occurs

ALLOWABLE

The outage duration that leaves time to respond if something goes wrong

Pump station outage times are needed when ...

- **Pump station repair:** replace the discharge ARV or valve
- **Emergency repairs:** treatment plant, force main, or relay pump station
- **Planned repairs:** treatment plant, force main, or relay pump station

The challenge: Optimal force main modifications*

Diameter	REPAIR	REHABILITATE	REPLACE
4-12 in.	2-4 hrs.	6-24 hrs.	6-8 hrs.
14-24 in.	4-6 hrs.	8-36 hrs.	8-12 hrs.
30-48 in.	8-16 hrs.	12-48 hrs.	12-24 hrs.

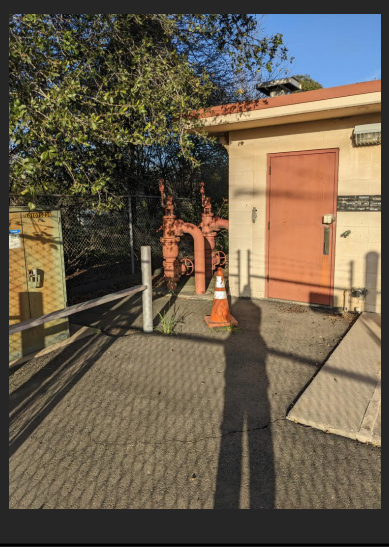
*Assumes optimal conditions for one or two sticks of pipe: Force main isolation and pumping ready, all critical parts and materials in hand and on site, excavation completed and cleared, and site fully staffed with trained and experienced maintenance crew/contractor crew.

Why not use the outage durations from a decade ago?

Systems change.

PUMP STATION OUTAGE DURATIONS CHANGE WITH THEM.

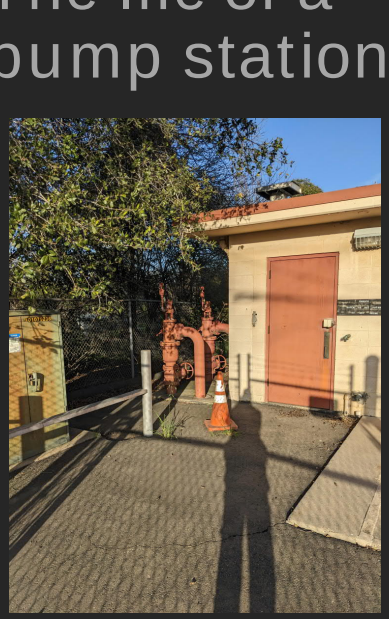
The life of a pump station



Facility changes

- Designed, built: 1978
- Relocated/rebuilt: 1983
- VFDs installed: 2006
- New pumps, motors with sewershed change: 2021

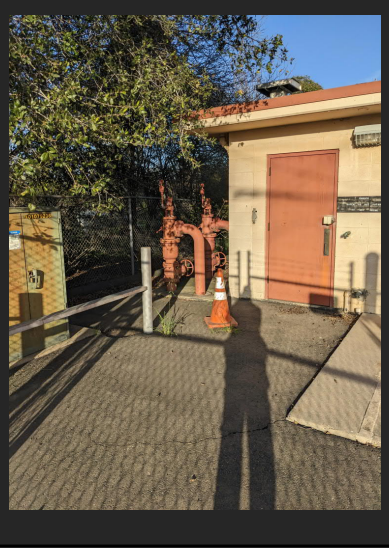
The life of a pump station



Sewershed changes

- Pump station site change: 1983
- Reduction in service area: 1997
- I&I reduction program: 2002-2006
- Added service area: 2021
- Industrial EDUs increase: 2022-2026

The life of a pump station



Would you trust an old outage duration from this pump station?

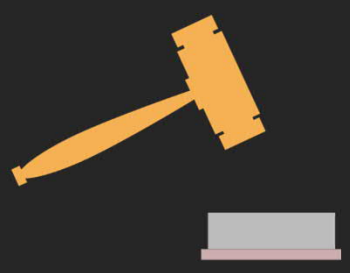
Regulation

WASTE DISCHARGE REQUIREMENTS
SECTION 5.6 AND ATTACHMENT D, SECTION 8.

Requirements

Waste Discharge Requirements §5.6 and Attachment D, § 8

Your plan must address ...



5.6. System Resilience

The Enrollee shall include and implement system-specific procedures in its Sewer System Management Plan to proactively prioritize: (1) operation and maintenance, (2) condition assessments, and (3) repair and rehabilitation, to address ongoing system resilience, as specified in Attachment D (Sewer System Management Plan – Required Elements) of this General Order.

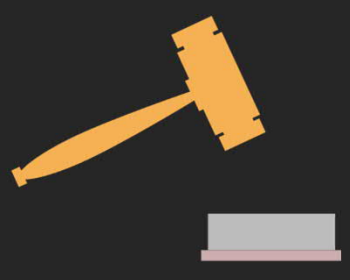
Attachment D, 8.1

• Prioritize the condition assessment of system areas that:
o Hold a high level of environmental consequences if vulnerable to collapse, failure, blockage, capacity issues, or other system deficiencies;
...
Identify system assets **vulnerable to direct and indirect impacts of climate change, including but not limited to: sea level rise; flooding and/or erosion due to increased storm volumes, frequency, and/or intensity;** wildfires; **and increased power disruptions.**

Requirements

Waste Discharge Requirements §5.6 and Attachment D, § 8

The short of it:



Make your collection system capable of taking disruptions without spilling.

Setting durations

FLOW, OUTAGE DURATION TESTING AND DOCUMENTATION

Prep: Know your system.



Checklist:

- ❑ **Upstream spillover** to another sewershed?
- ❑ **Upstream storage** in the gravity system?
- ❑ **Margin of safety,** wet well overflow
- ❑ **Wet well dimensions/volume**
- ❑ **Pump readiness**
- ❑ **Pump programming**
- ❑ **Overrides** (manual mode)
- ❑ **Collaborators and communication methods** (for example, get operations manager approval, warn treatment plant of surge, get recording help, have a backup pumping method available, etc.)

Prep: Know your goal.



How much time is available with the pumps shut down?

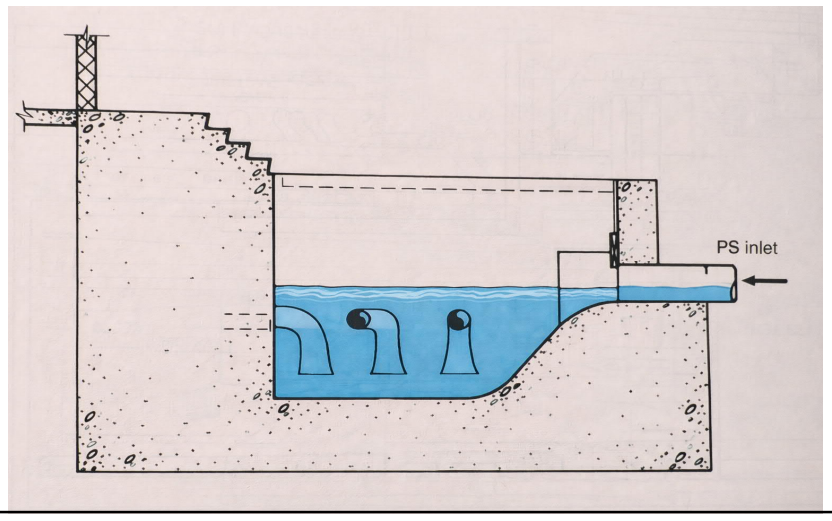
- Range of inflows: peak and low
- Think in hours, not minutes.
- Calculations can get tricky if flows are variable. Average them.

1. Test pump-down



Test pump-down time and volume

- Low-flow, low-demand period (Nighttime test)
- Allow wet well (and pipes?) to fill.
- Time pump-down to pump shutoff.
- Record flows.



1. Test pump-down



Calculate volume pumped

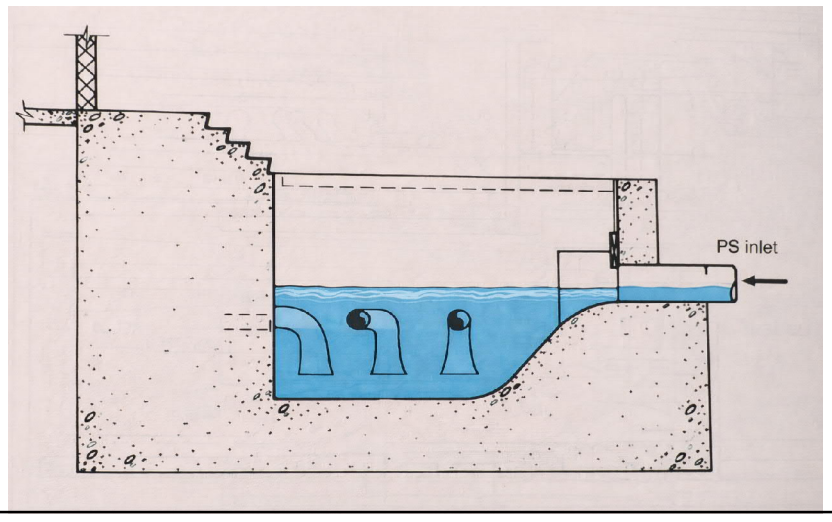
- $Net\ flow = Flow\ pumped\ - Flow\ in$
  ($Q_{net} = Q_{pump} - Q_{in}$)
- Volume = Flow/time
  ($V_{net} = \frac{Q_{net}}{time}$) (Best if Q_{in} =0)

2. Time peak-flow and dry weather-flow fill



Time peak-flow and low-flow filling

- Pump the wet well down. Turn off the pumps. [Check: Possible?]
- Time to fill to capacity. (Or half-full, calc.)
- [Turn the pumps back on.]



2. Time peak-flow and dry weather-flow fill



Calculate peak-flow and low-flow rates

$Q_{net} = Q_{pump} - Q_{in}$ and Q_{pump} = 0

So, $Q_{net} = Q_{in}$.

$$Q = \frac{V}{time}$$

3. Estimate outage duration



Calculate outage time

$T_{outage} = \frac{V_{fill}}{time_{fill}}$ at the inflow rate

Example wet well



Example wet well: pump-down time

Wet well is 15’ x 5’ x 12’ deep (operational).

$$V_{wet\ well} = 15'x5'x12' = 900\ ft^3 = 6{,}732\ gal.$$

$$Q_{pump} = 250\ gpm$$
$$Q_{in} = 100\ gpm$$

$$T_{empty} = \frac{V_{wet\ well}}{Q_{pump} - Q_{in}};\ T_{empty} = \frac{6{,}732\ gal.}{250\ gpm - 100\ gpm}$$

=45 minutes

Example wet well



Example wet well: Shutdown time

- 8 hrs. to make a repair (480 minutes)
- What is the max. inflow?

$$Q_{in} = \frac{V_{wet\ well}}{time_{fill}};\ Q_{in} = \frac{6{,}732\ gal.}{480\ minutes} = 14\ \text{gpm}^*$$

- How much prep time is needed?

$$T_{empty} = \frac{V_{wet\ well}}{Q_{pump} - Q_{in}};\ T_{empty} = \frac{6{,}732\ gal.}{250\ gpm - 14\ gpm}$$

= 29 minutes

*Thanks to the young lady in the audience who caught my math goof!

Set allowable time



Reaction time: The time it will take to arrange/switch to a bypass or alternative delivery system.

- *Pro tip:* Train to refine that time!

Questions?



Chris Ewers, P.E.
Principal Engineer
Ewers Engineering, Inc.
Tel. (916) 521-9696
chris@ewersengineering.com

Ewers Engineering

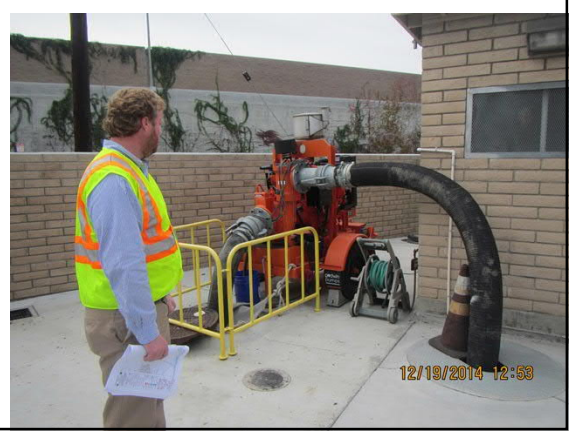
Bypassing

HOW, WHEN, AND WHY NOT

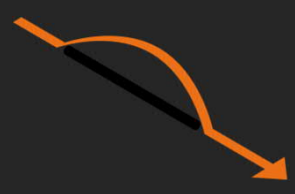
Bypass pumping

Flow Variables

- Total flow (peak dry weather)
- Partial flow
- Sewershed transfer



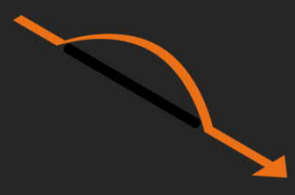
Bypass pumping



Alternatives

- Trucking
- Spills

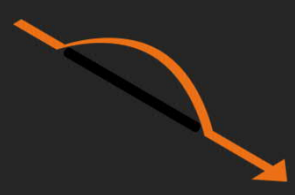
Bypass pumping



Time and Cost Considerations

- Traffic: Roadways and sidewalks/paths
- Availability of critical materials
- Long-term outages
- Setup time
- Cost

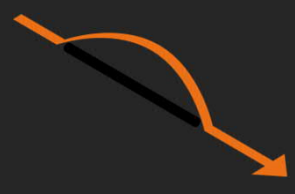
Bypass pumping



Force Main Considerations

- Single/redundant force main?
- Condition
- Operational capacity (ARVs, cleaning)
- Multiple pump stations pressurizing line

Bypass pumping

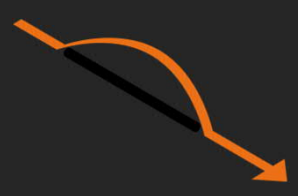


Cost Components

- Mobilization/demobilization
- Rental: k-rail, temp. pipe
- Traffic control
- Backfill buried lines, repave



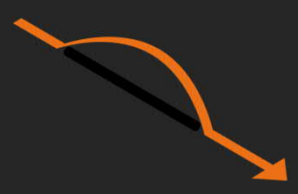
Bypass pumping
Costs



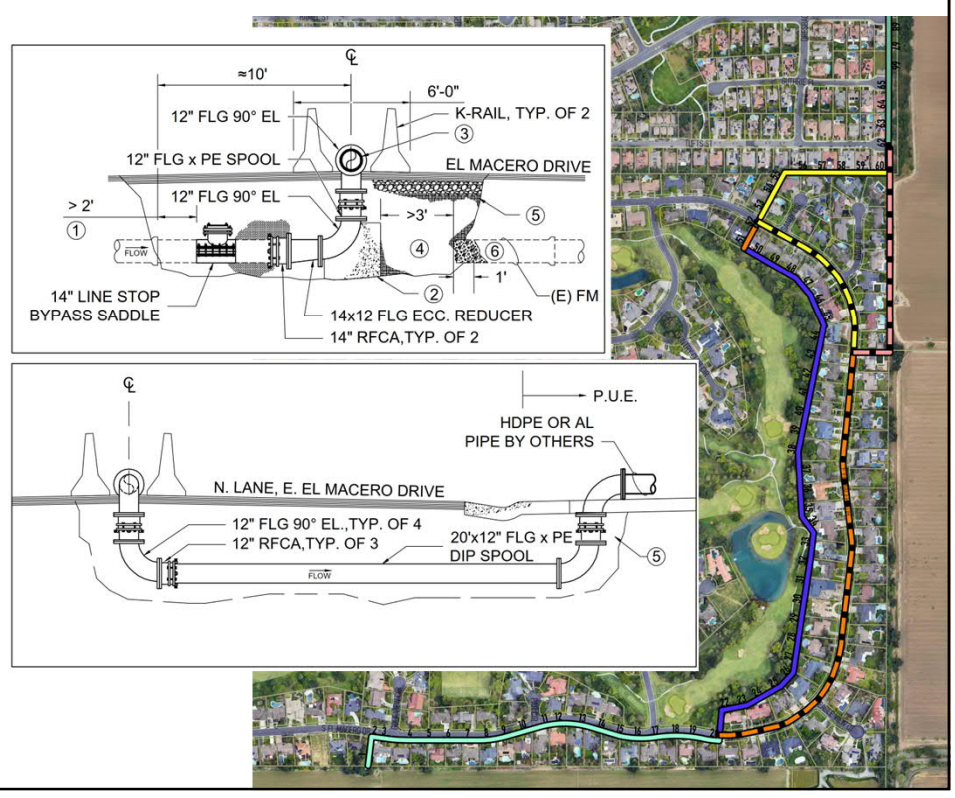
Example Project #1

- Peak flow: 1,400 gpm
- Length: 2,200-3,700 lf
  - Mix of unpaved and residential street locations
- Duration: 1 month – 2 years

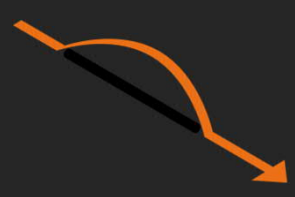
Bypass pumping
Costs



Example Project #1



Bypass pumping Costs

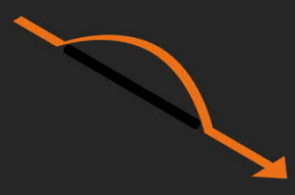


Example Project #1 *

- Long bypass: $146,100 1st month
  $34,100 ea. month after
  ($490,000/year)

* (2023 $) External labor and materials only. Cost for City crews to bury line, backfill, resurface/repave, then remove and repeat not included.

Bypass pumping Costs

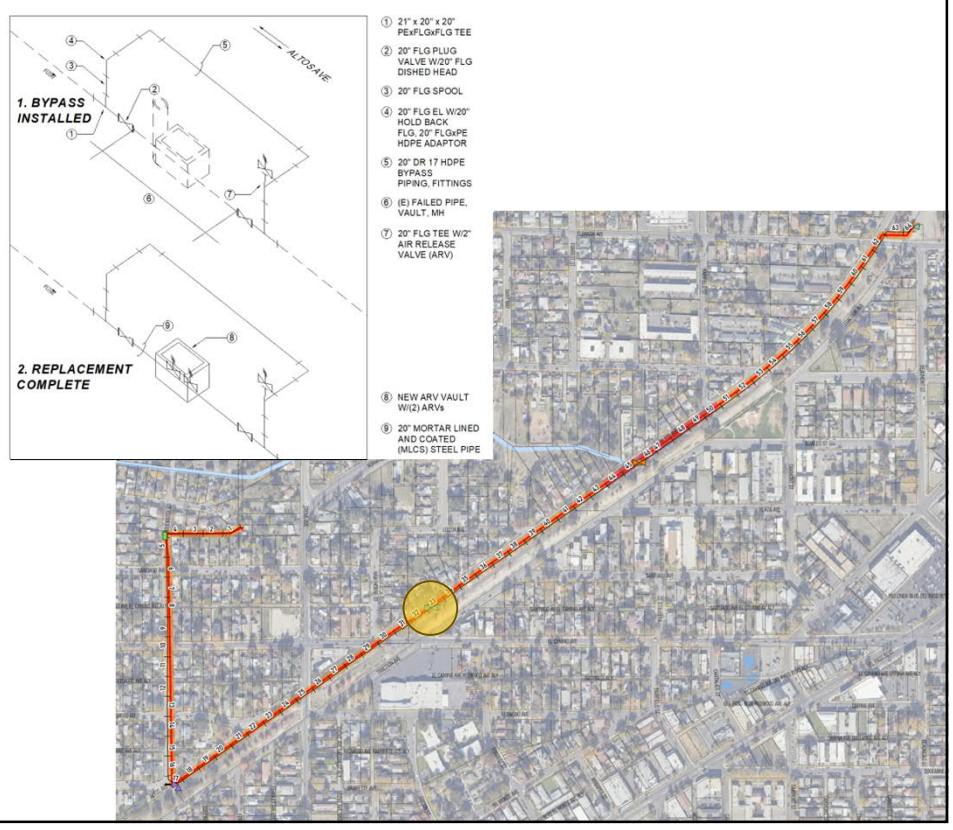


Example Project #2

- Diameter: 20 in.
- Length: 300 lf
  - Unpaved public access
- Duration: 2 years

Bypass pumping
Costs

Example Project #2



Bypass pumping
Costs

Example Project #2*

- Cleanup: $500,000
- Bypass: $1.53M
- Clean Water Act Lawsuit: $5.1M

* (2025 $) Contractor-completed bypass under emergency conditions (3x factor of planned work)