Hydraulic Bottlenecks at Treatment Plants Causes and Cures

Cheeney Creek WWTP
Fishers, IN
-
Rock River Water Reclamation District
Rockford, IL

74th Annual IWEA Conference
November 16, 2010
Andrea Bretl, PE

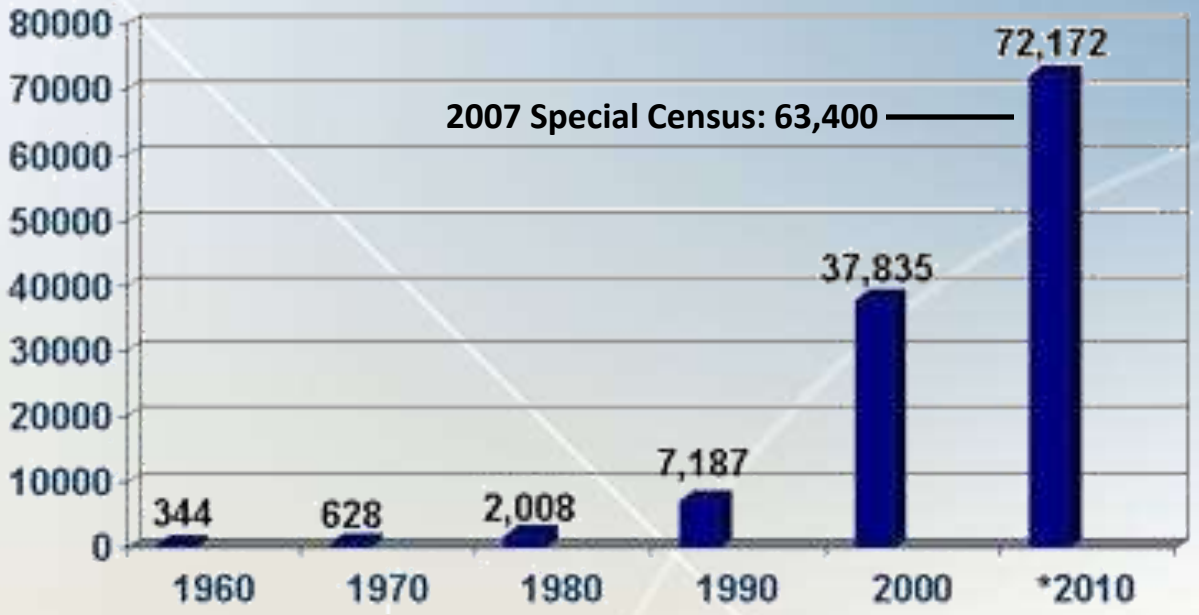
Clark Dietz
ENGINEERS

Hydraulic Bottlenecks at Treatment Plants

Cheeney Creek WWTP
Fishers, IN

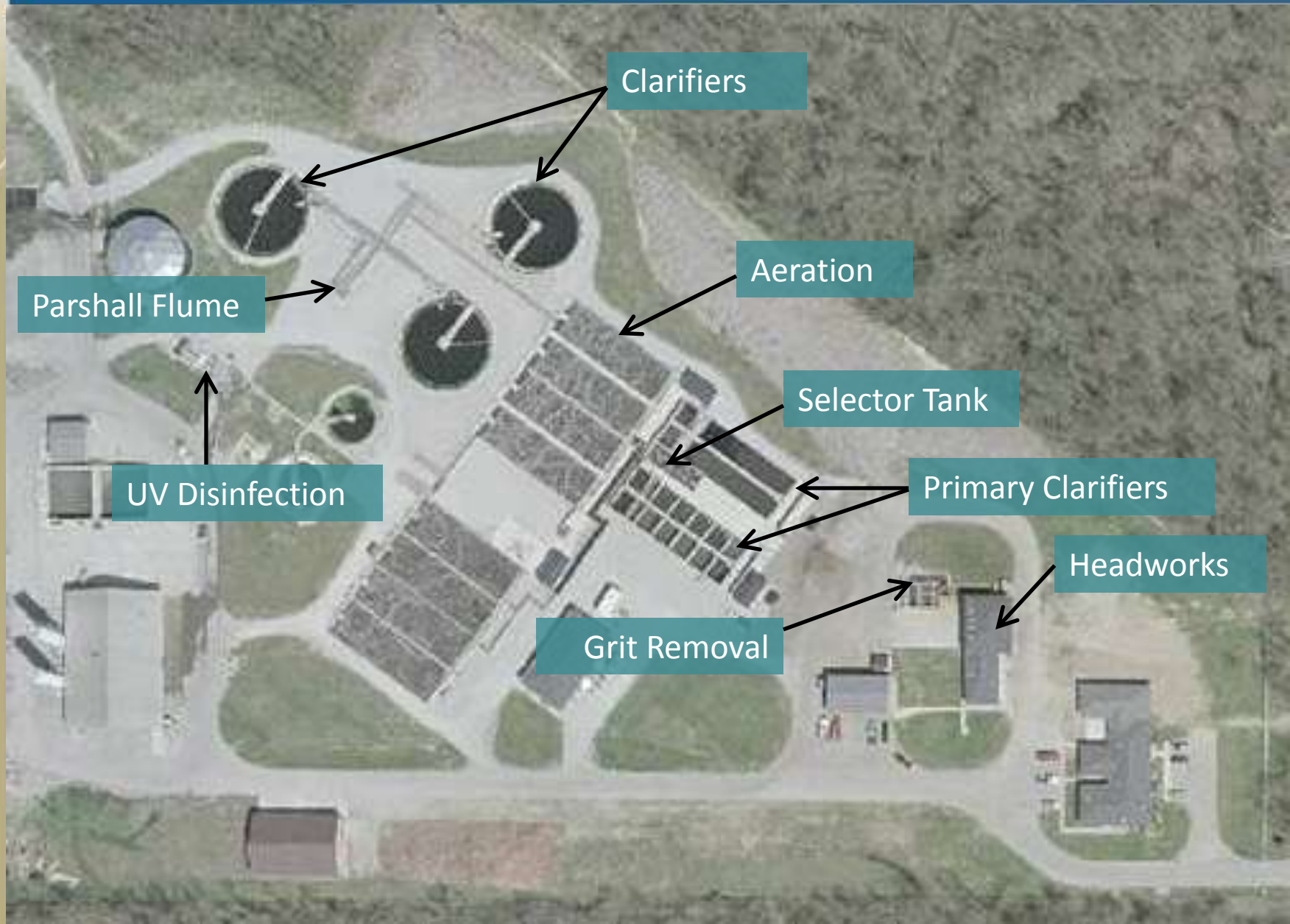
Cheeney Creek WWTP

- The Town has experienced rapid growth over the last 20 years

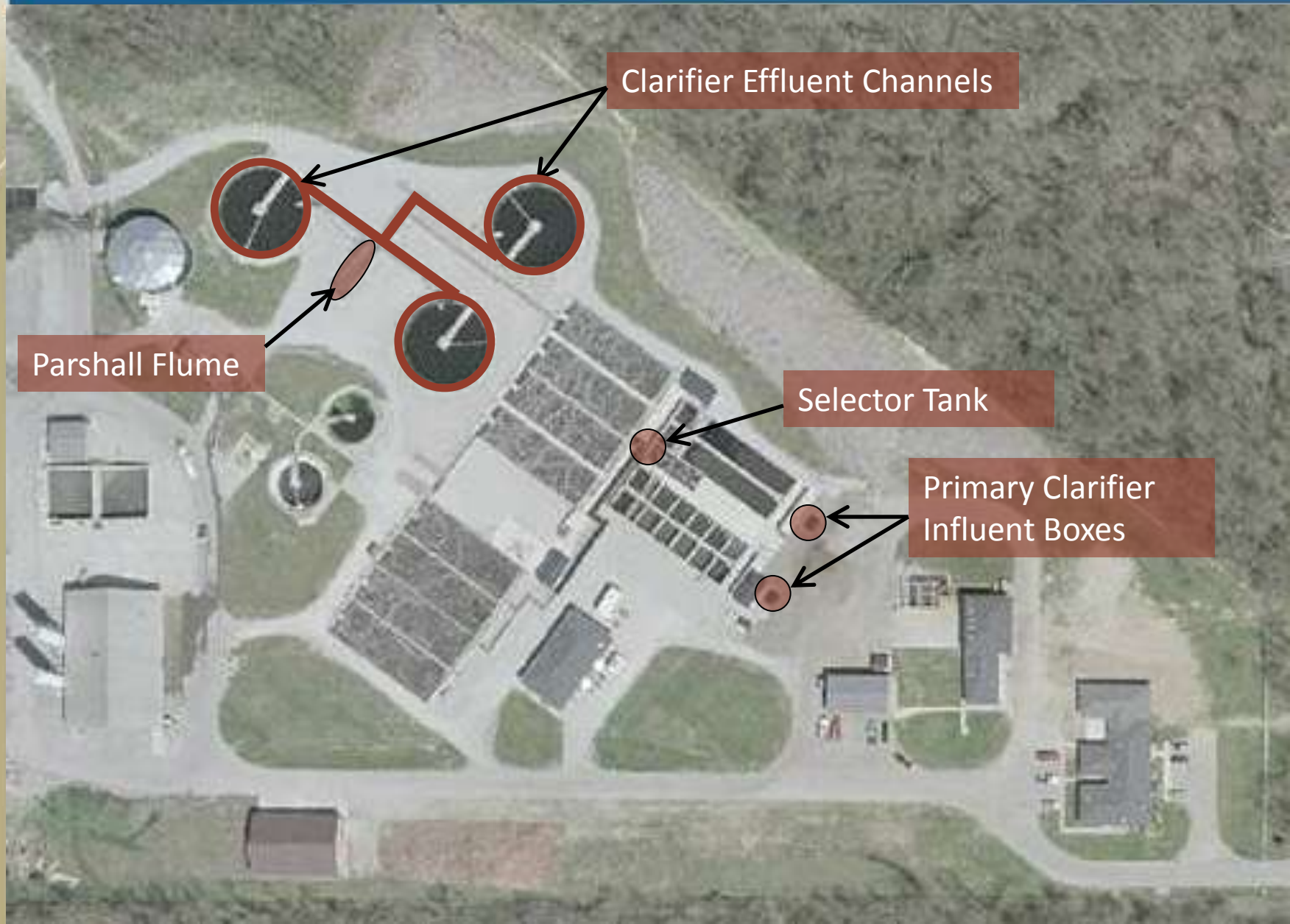


- Rated Design Flow: 8 mgd
- Rated Peak Flow: 16 mgd

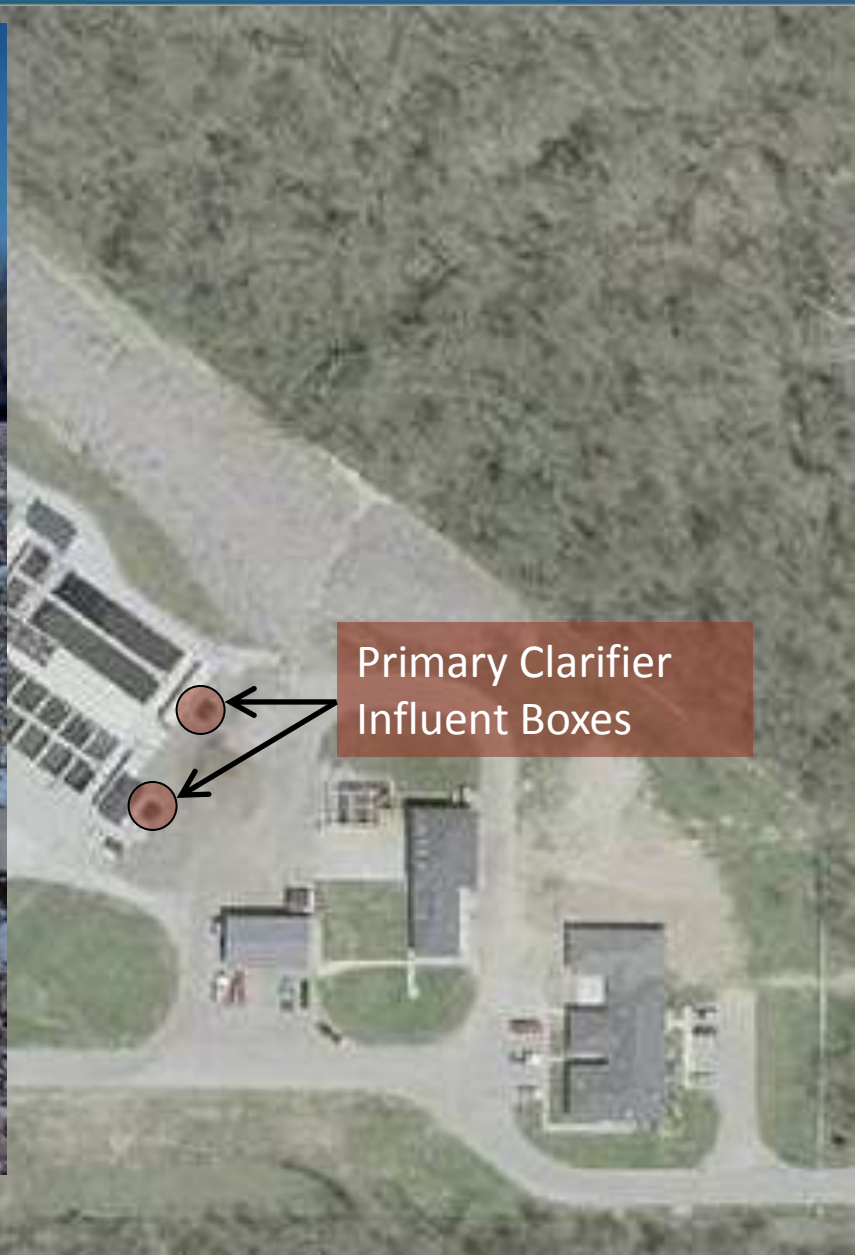
Cheeney Creek WWTP



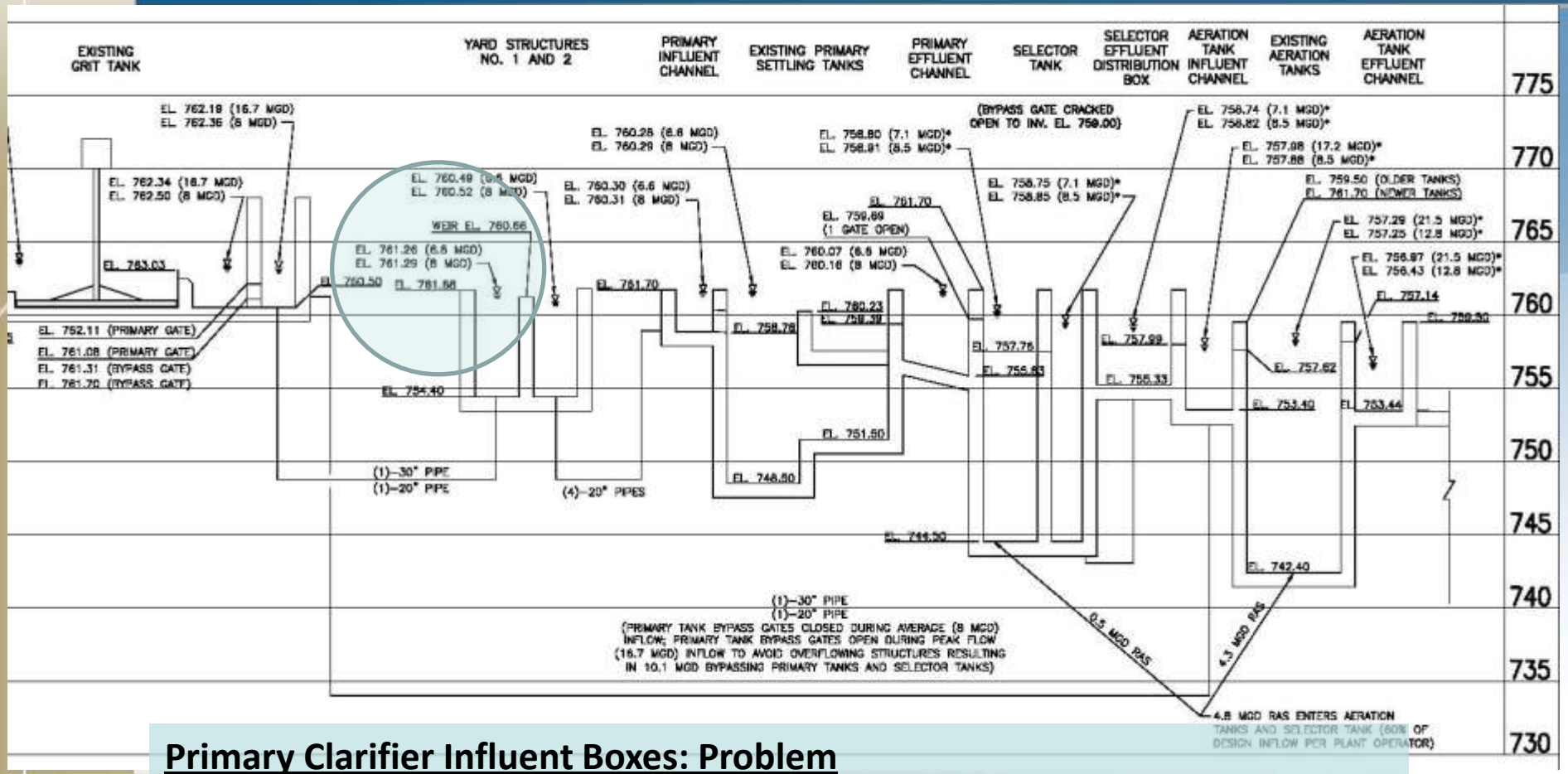
Cheeney Creek Existing Hydraulic Issues



Primary Clarifier Influent Boxes



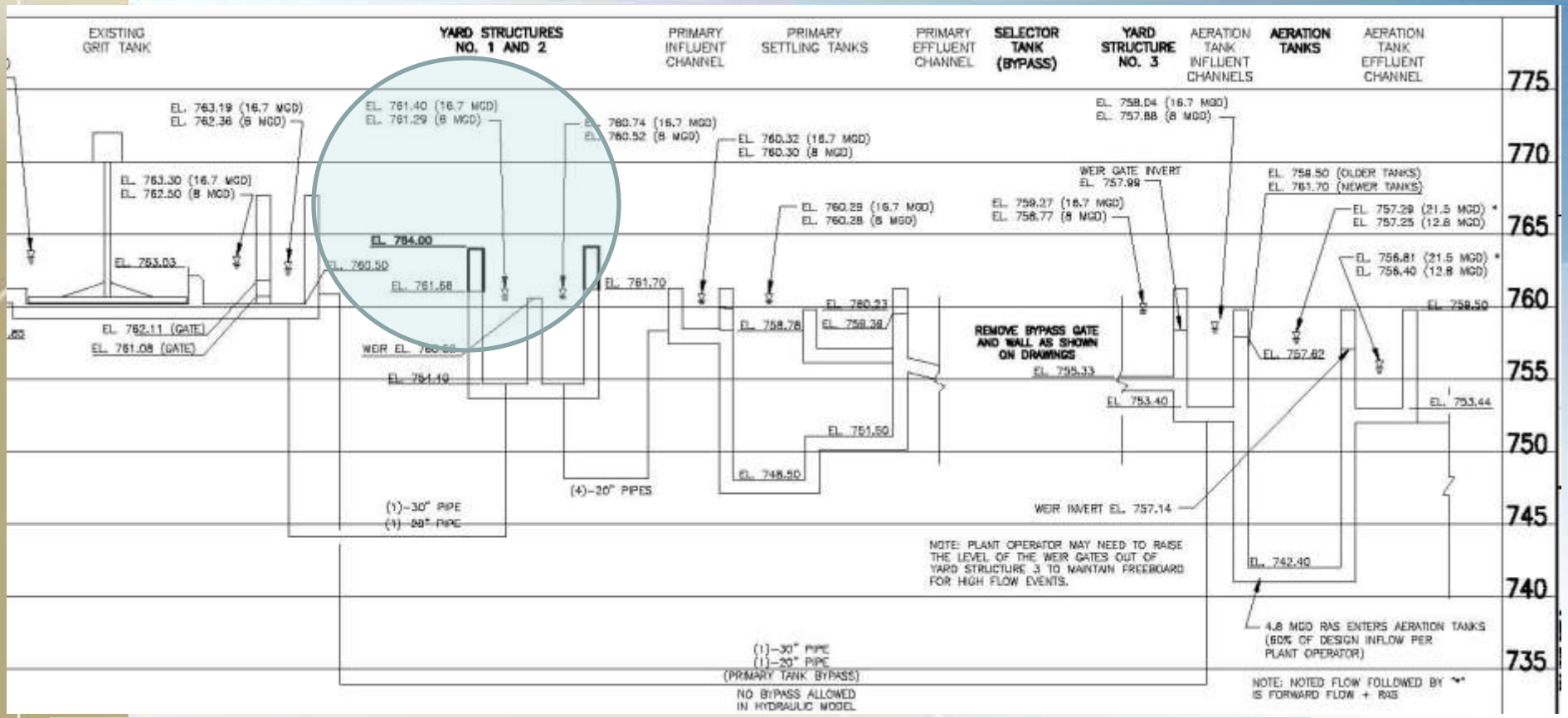
Primary Clarifier Influent Boxes



Primary Clarifier Influent Boxes: Problem

- Approximately 1.0-ft of separation between the weir elevation and the exterior wall.
- Design flow: water elevation within 0.4-ft of exterior wall
- Primary clarifiers partially bypassed during high flows to prevent overtopping at the influent box.

Primary Clarifier Influent Boxes



Primary Clarifier Influent Boxes: Solution

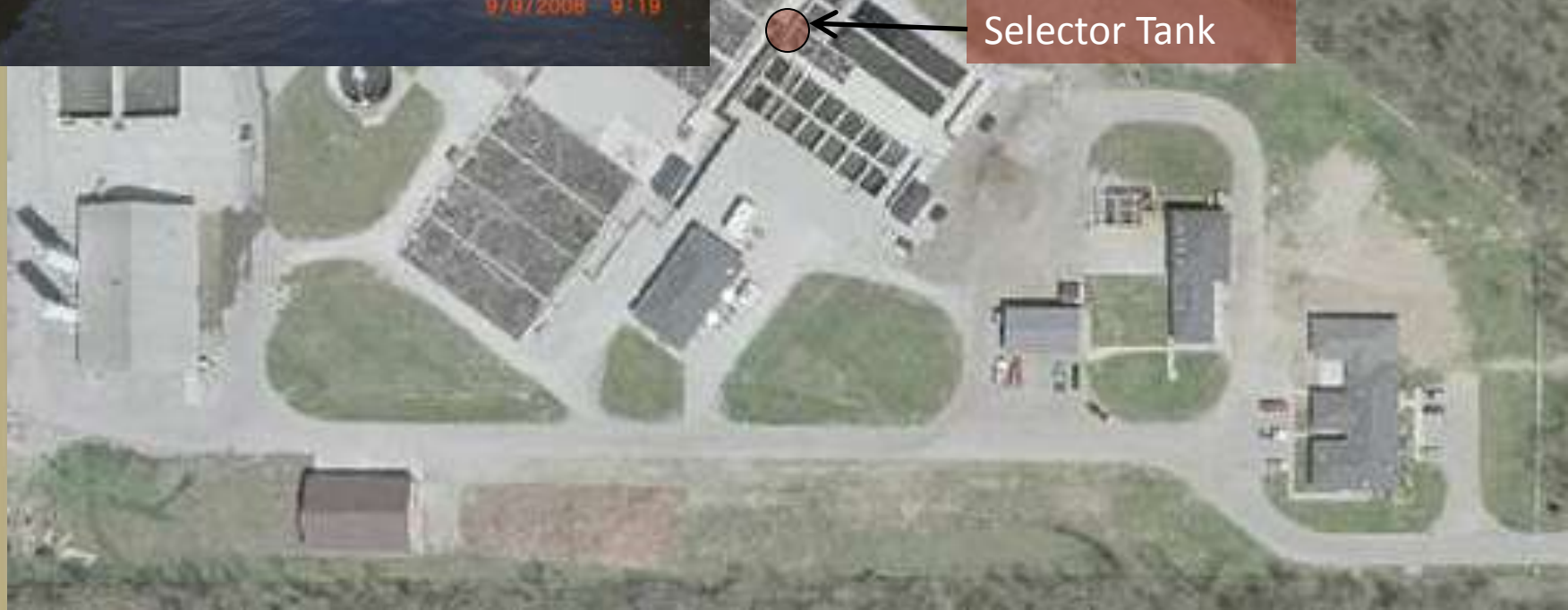
- Raise Primary Clarifier walls 2.3-ft.
- Also added inverted slide gates to allow flow to isolated at each tank.

Result

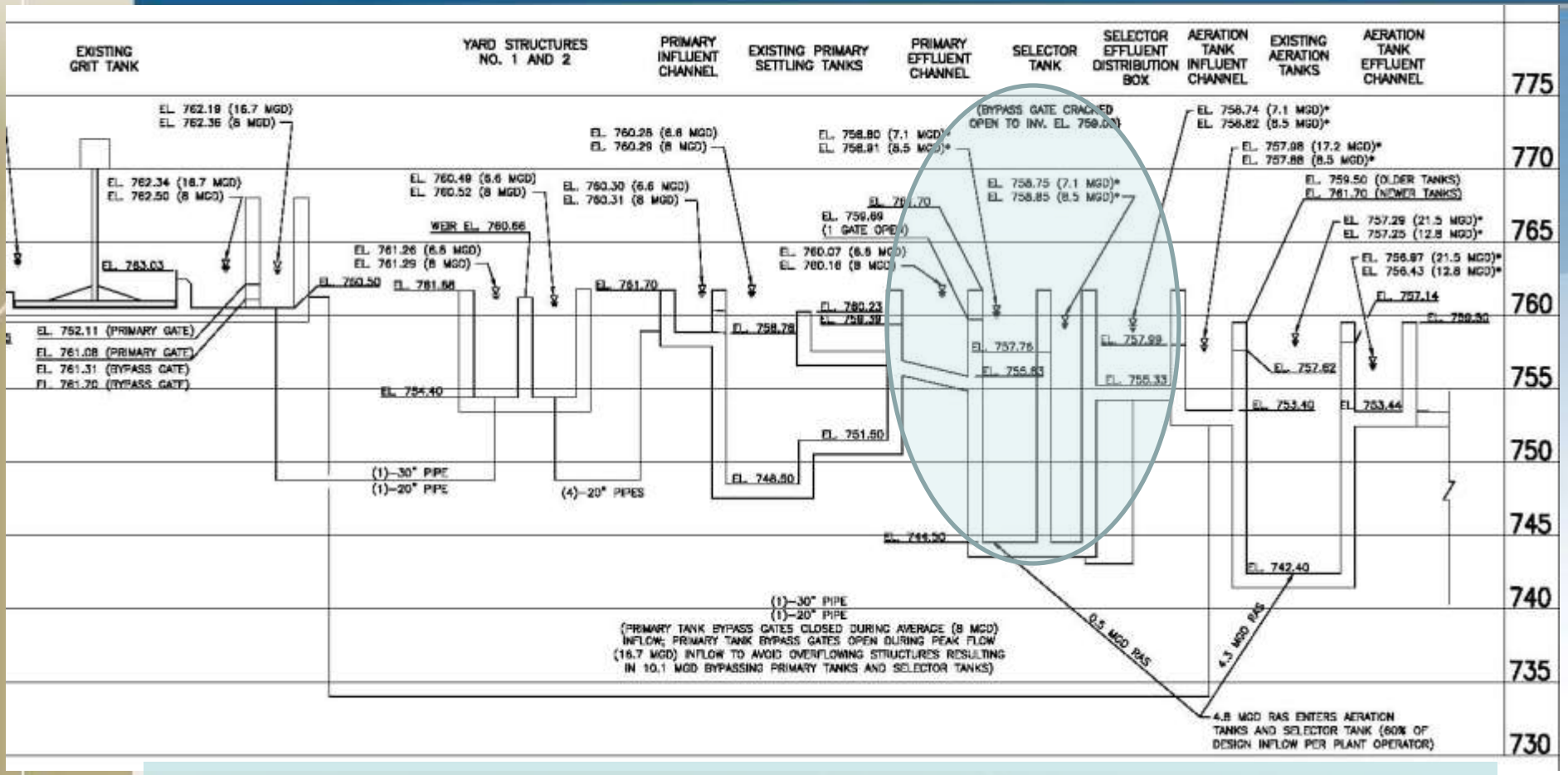
- Primary clarifiers no longer need to be bypassed during any design flows.

A freeboard of 2.6-ft maintained at all flows.

Selector Tank



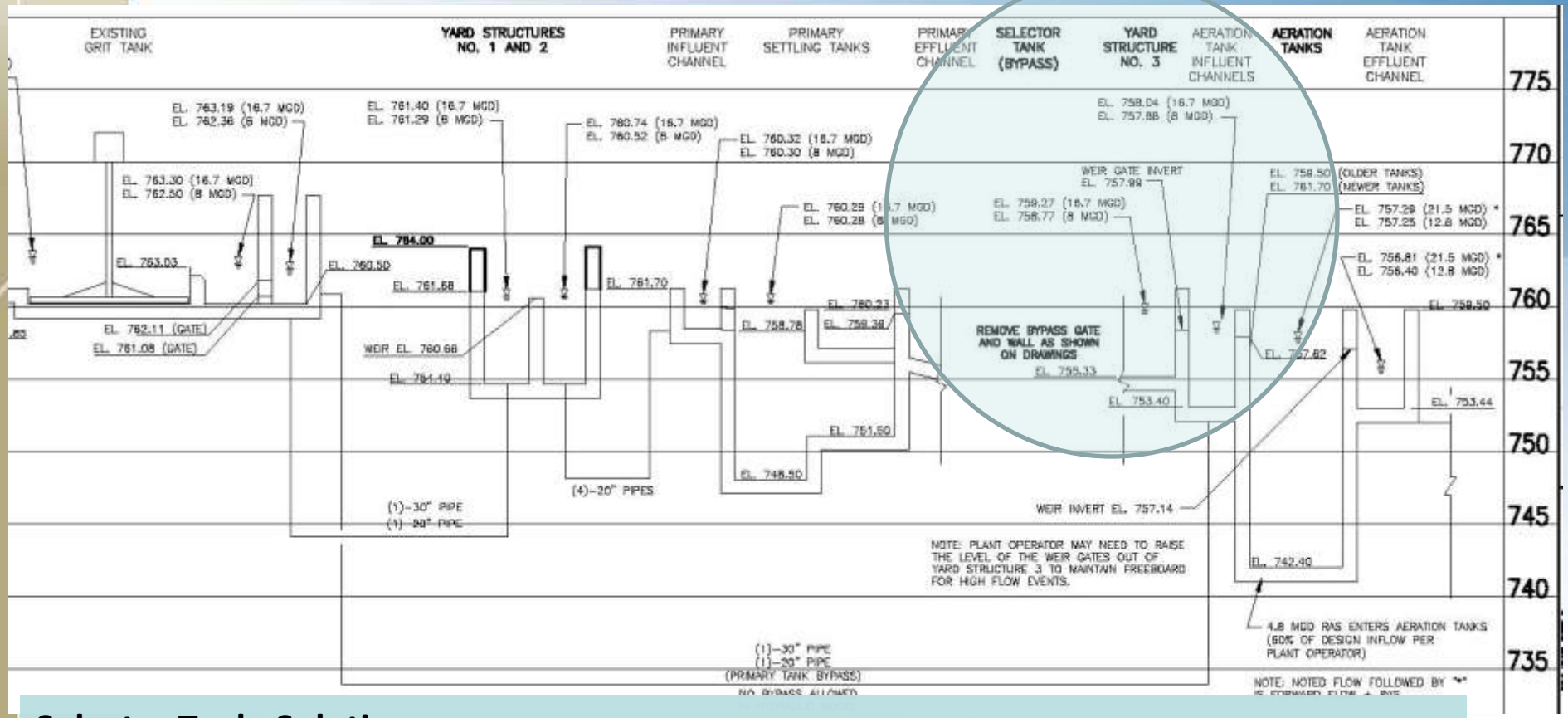
Selector Tank



Selector Tank: Problem

- Bypass gate must be fully open to get design and peak flows passed.
- When bypass gate is open flow to the selector is very low (1 mgd)
- To keep in service, the weirs would need to be lowered. That would allow more flow through (4.3 mgd). Bypass gate still needs to be fully open.

Selector Tank



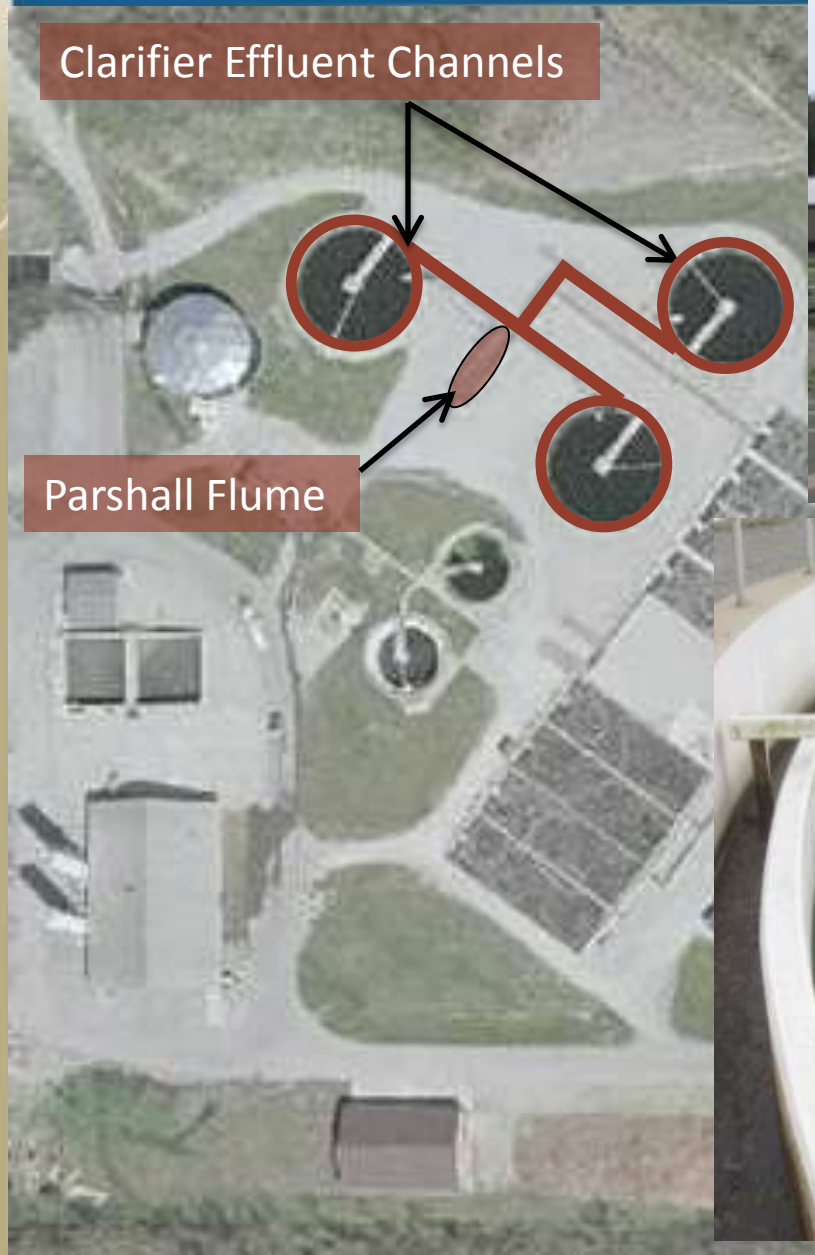
Selector Tank: Solution

- Remove selector tank from service.
- Remove wall between primary tank effluent channel and aeration tank diversion box.

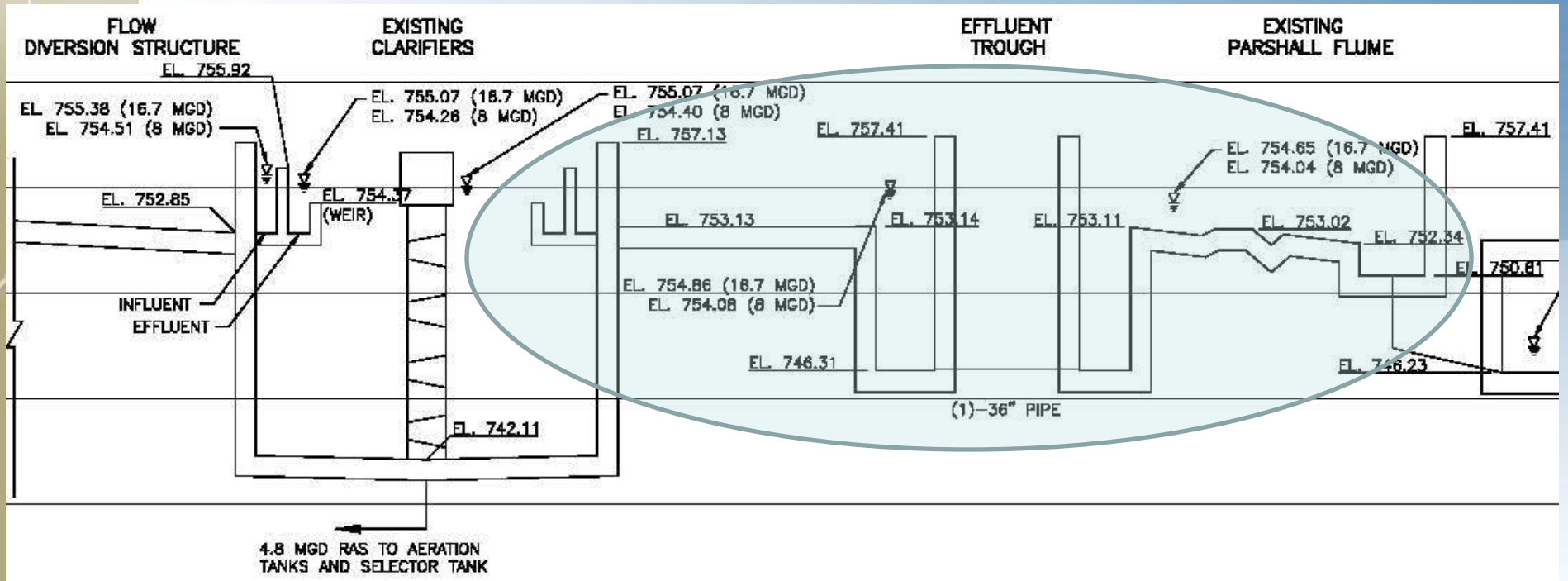
Result

- Water level in the aeration tank influent channel is lowered though the flow is increased (primary tanks no longer bypassed).

Clarifier Effluent Channels and Flume



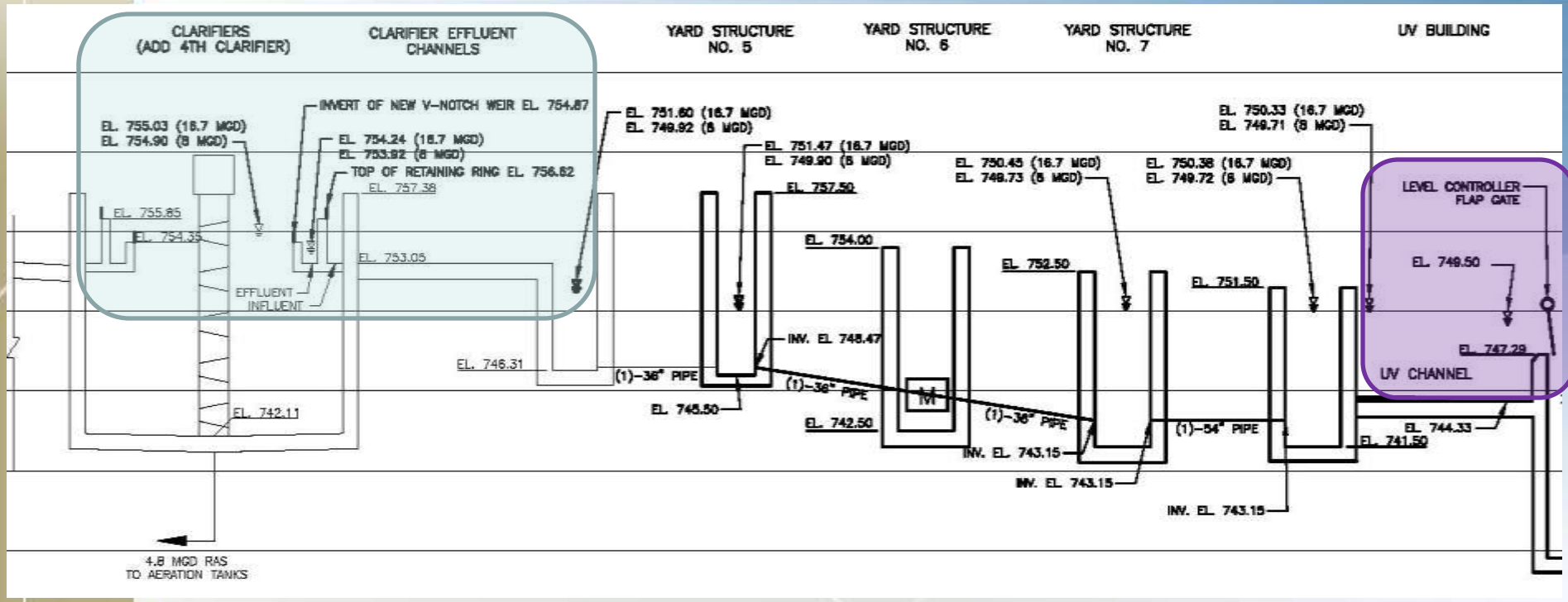
Clarifier Effluent Channels and Flume



Final Clarifiers: Problem

- The invert elevation of the clarifier effluent channels and effluent troughs are at the same elevation and the invert elevation of the Parshall flume is 1-inch lower than the clarifier effluent channels/troughs.
- The clarifier effluent weirs are partially submerged during normal flows.
- When flow reached 11 or 12 mgd the effluent weirs were completely submerged.
- Hydraulics were so constrained that clarifiers could not be taken down for maintenance and cleaning.

Clarifier Effluent Channels and Flume



Final Clarifiers: Solution

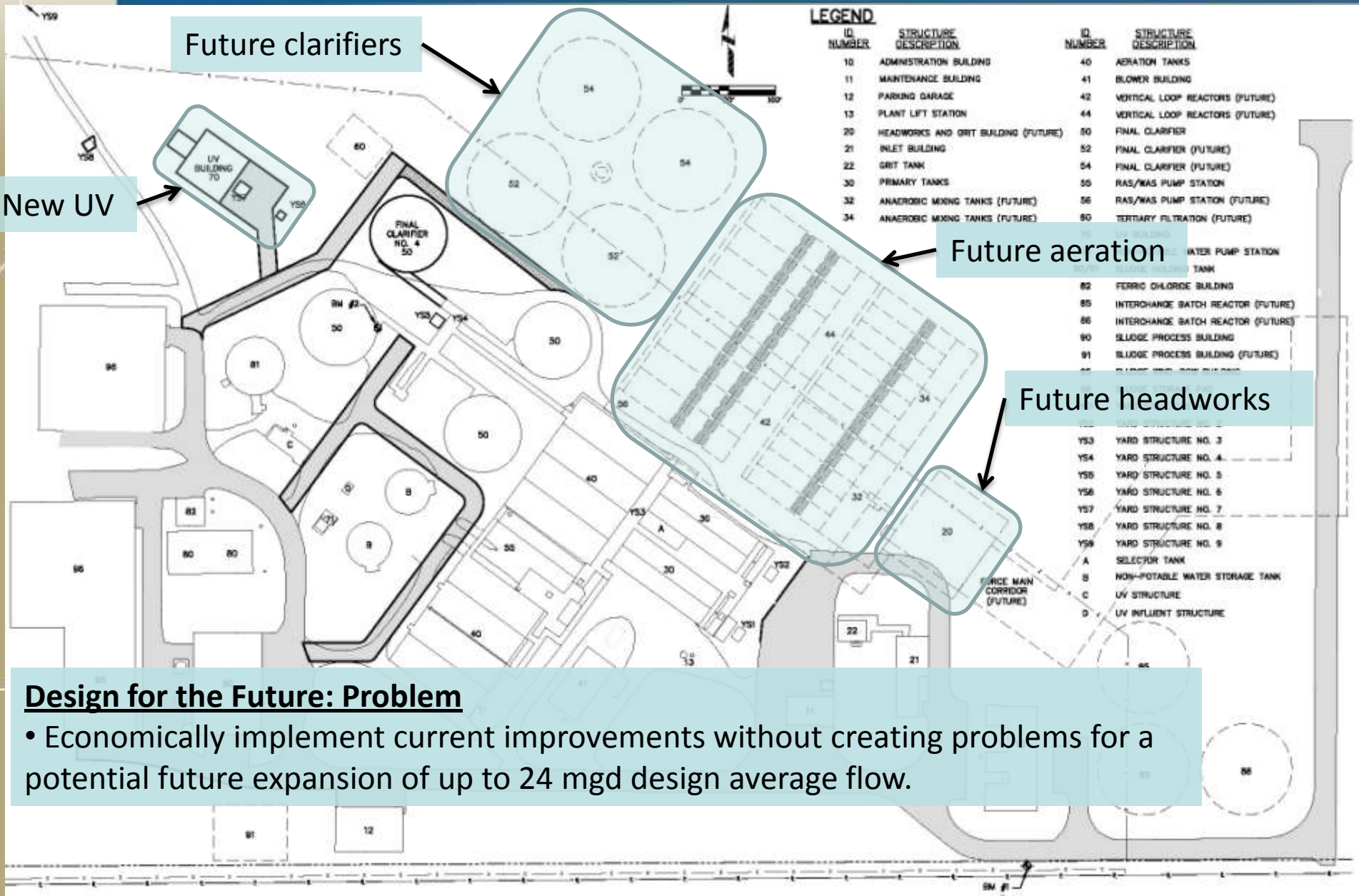
- Add 4th clarifier for operational flexibility
- Raise the effluent weirs
- Modify effluent metering to lower hydrualic grade line in clarifier effluent channels.

Result

- Clarifier weirs no longer submerged and can pass 16 mgd.

Fishers Current Improvements

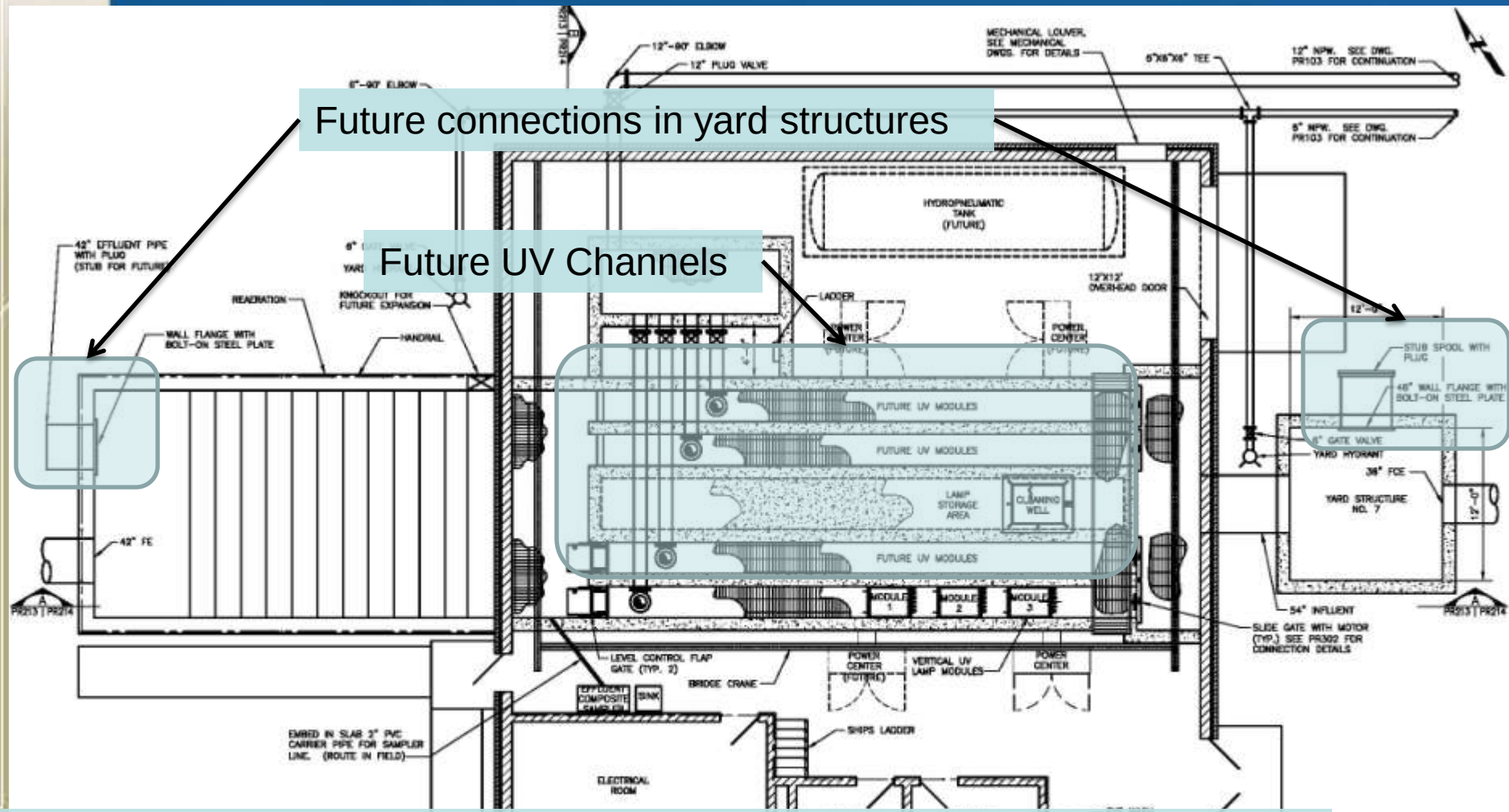
Current Improvements with Future Plans



Design for the Future: Problem

- Economically implement current improvements without creating problems for a potential future expansion of up to 24 mgd design average flow.

Current Improvements with Future Plans



Design for the Future: Solution

- Add additional UV channel in building to accommodate future 24 mgd DAF and 60 mgd peak flows.
- Add spool pieces in the yard structures for future connections.

Calculations

Two methods

- First pass: XPSWMM
- Second pass and QA/QC: hand calculations working backwards through the plant

Calculations

Hand calculations: Outfall to cascade aerator

- Pressure pipe (Hazen-Williams) for submerged conditions when the river is high and the outfall is flooded
- Open channel (Manning's) flow when the outfall is not flooded

Calculations

Hand calculations: UV Channel

- Height calculated to achieve required effluent DO
- Headloss on top broad step calculated as broad crested weir
- Nappe trajectory checked using equation of motion

Calculations

Hand calculations: UV Channels

- Effluent level control flap gates: a hydraulic control point
- Channels: Mannings open channel flow and UV manufacturer information through bulbs
- Channel entrances: checked critical slope, channel entrance equation

Calculations

Hand calculations: Yard structures and flow meter

- Pressure pipe (Hazen Williams)

Calculations

Hand calculations: Clarifier effluent channels and weirs

- Open channel flow (Mannings)
- V-notch weirs (now a hydraulic control point)
- Within clarifier (influent losses) from manufacturer and double checked using orifice equations.

Calculations

Hand calculations: Aeration effluent channels, effluent weirs, tanks, influent, influent channels

- Open channel flow (Mannings)
- Sharp crested weirs (a hydraulic control point)
- Channel entrance calculation

Calculations

Hand calculations: Selector tank, primary clarifiers, primary clarifier influent structures

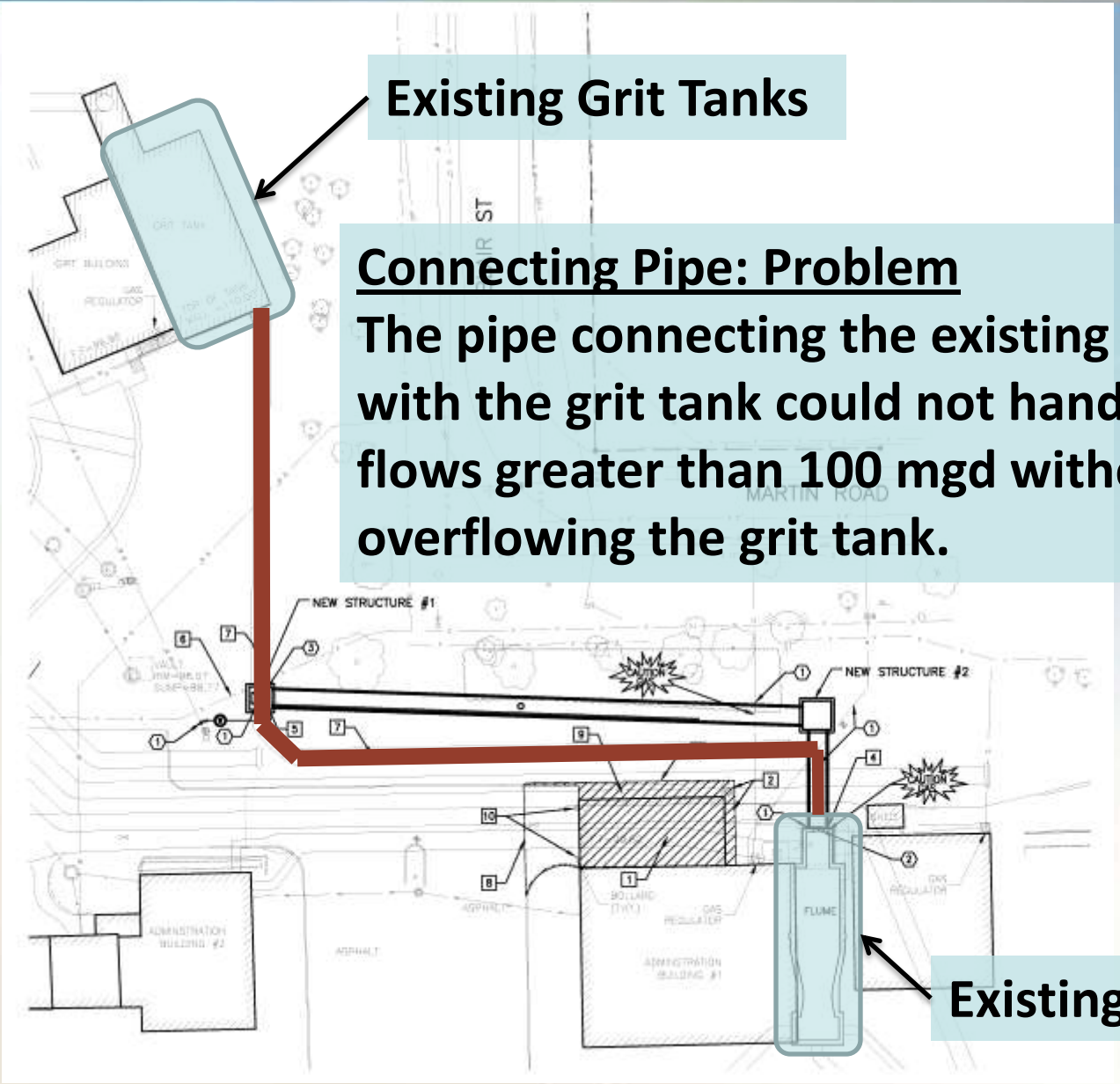
- Open channel flow (Mannings)
- Sharp and broad crested weirs
- Channel entrance calculation
- Hazen Williams

Hydraulic Bottlenecks at Treatment Plants

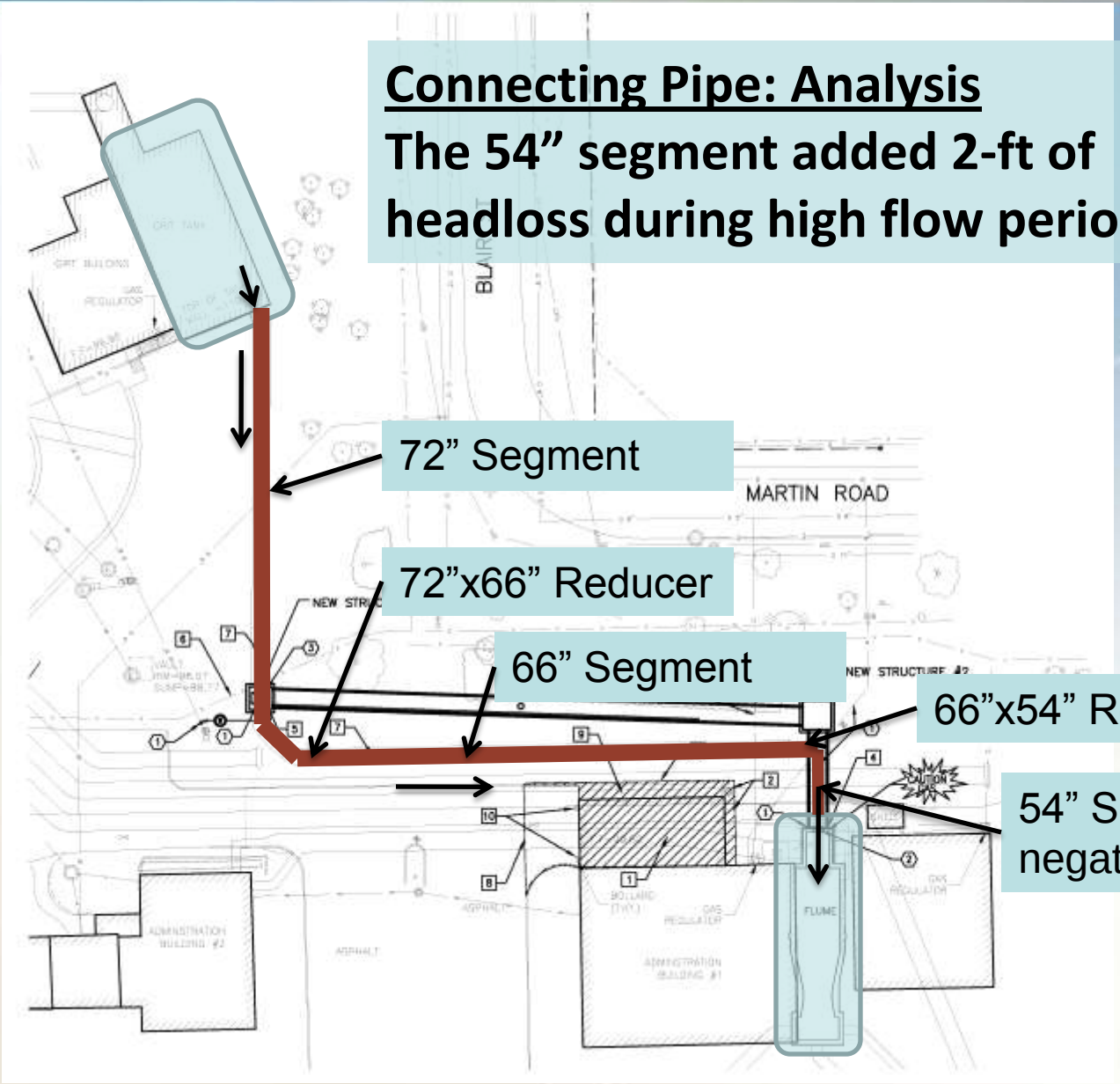
Rock River Water Reclamation District
Rockford, IL

Rock River WRD

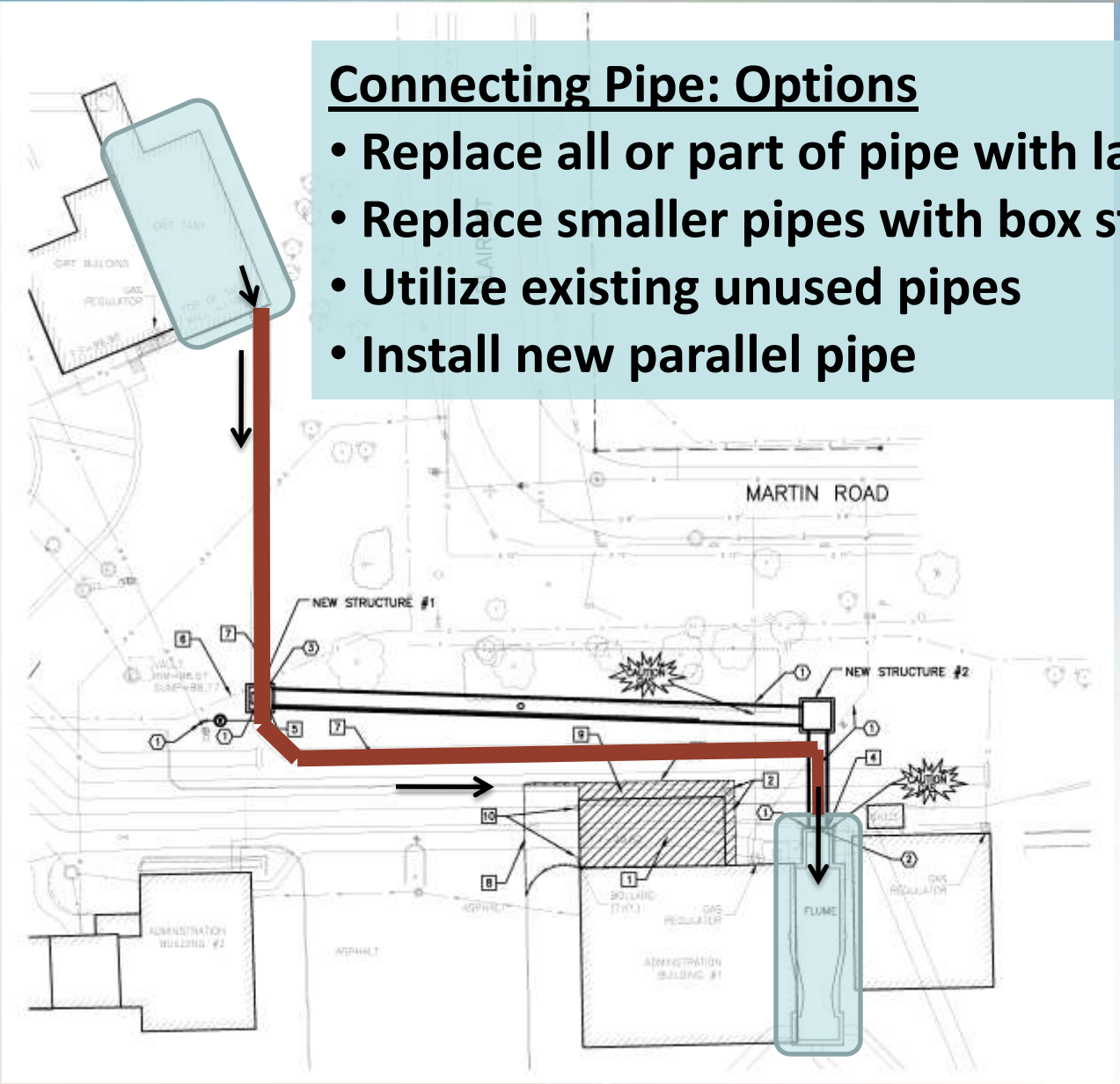
Average dry weather flow: 30 mgd
Required peak flow: 129 mgd



Rock River WRD



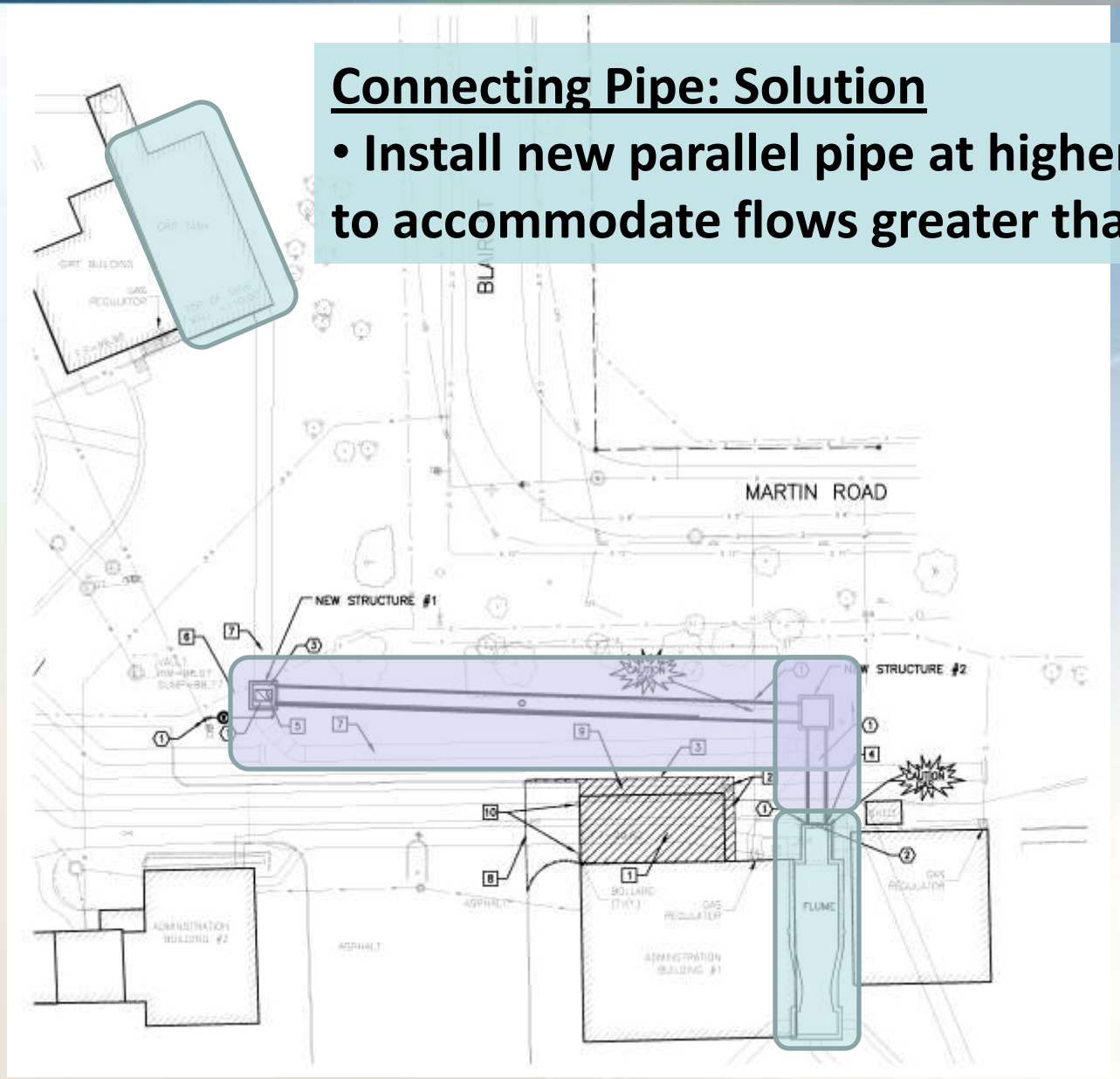
Rock River WRD



Connecting Pipe: Options

- **Replace all or part of pipe with larger pipes**
- **Replace smaller pipes with box structures**
- **Utilize existing unused pipes**
- **Install new parallel pipe**

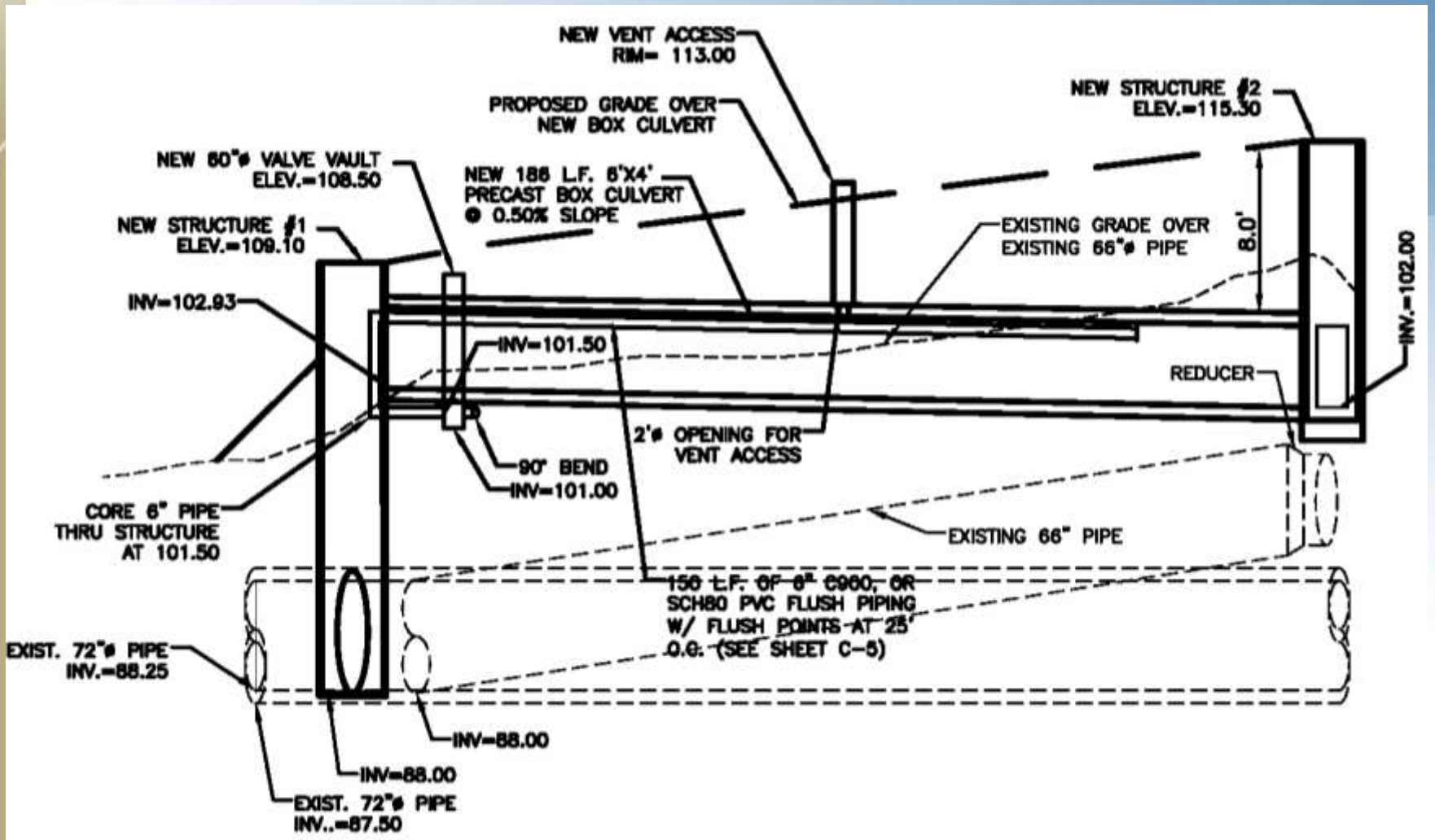
Rock River WRD



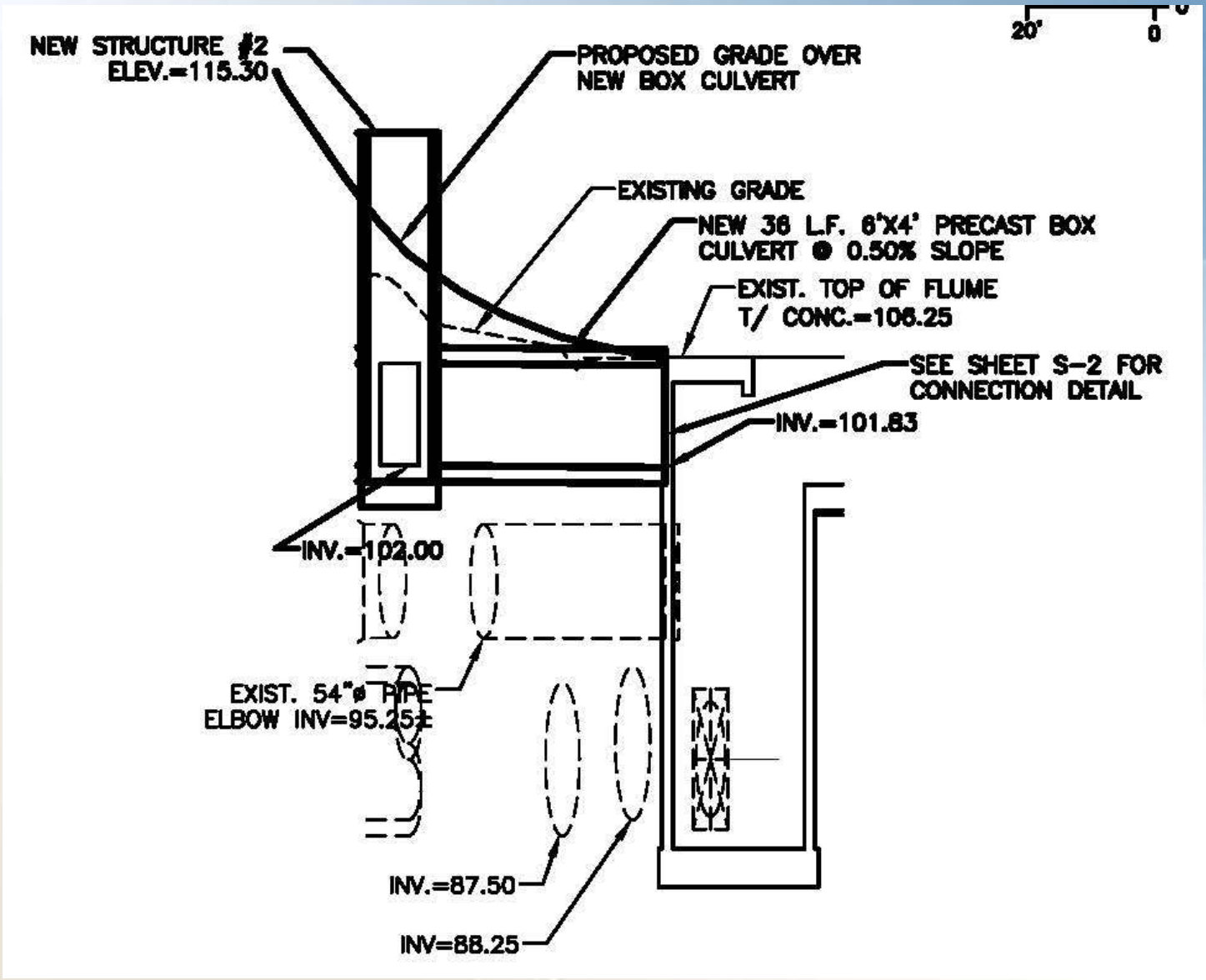
Connecting Pipe: Solution

- **Install new parallel pipe at higher elevation to accommodate flows greater than 45 mgd.**

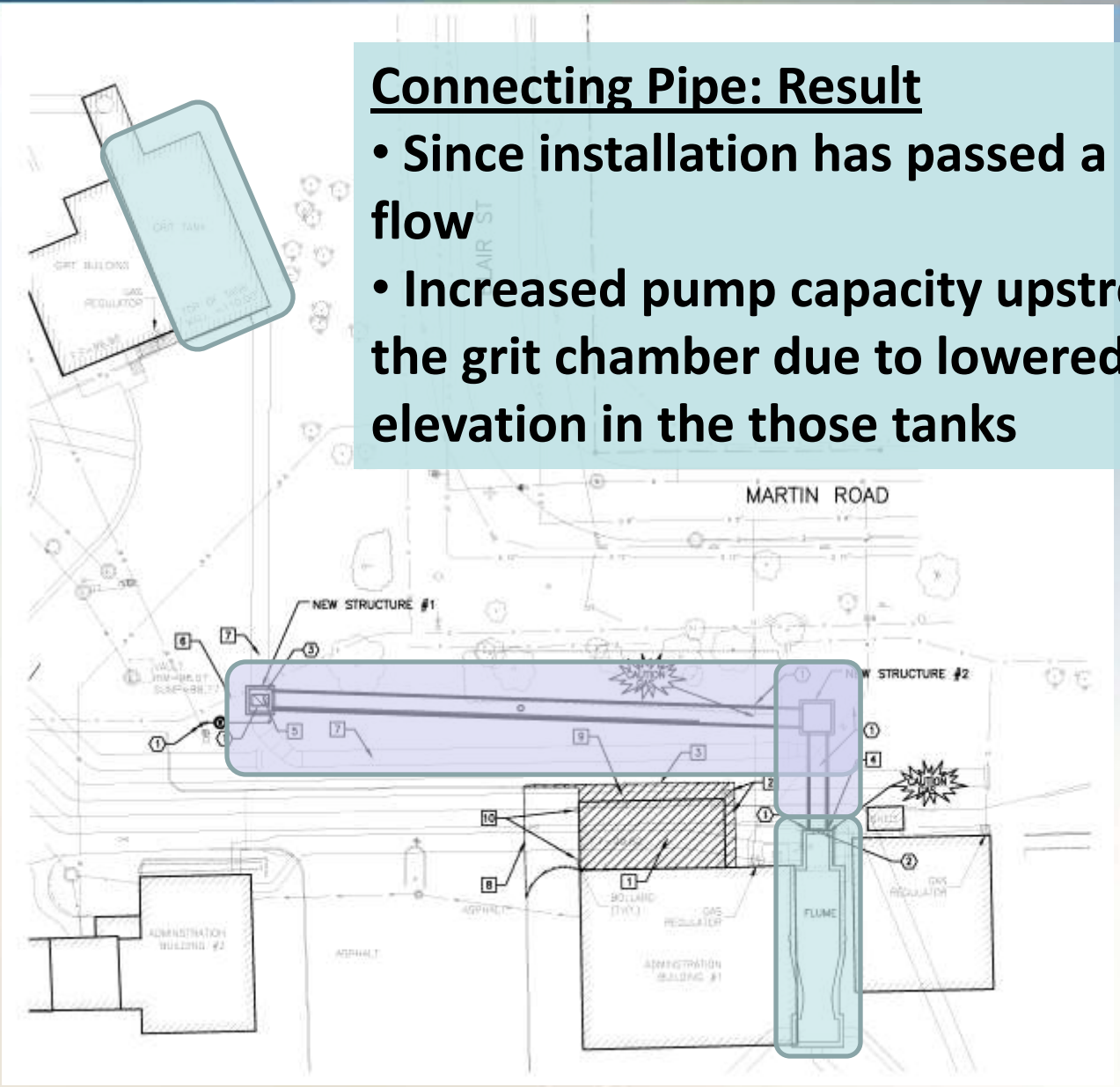
Rock River WRD



Rock River WRD



Rock River WRD



Connecting Pipe: Result

- **Since installation has passed a 135 mgd flow**
- **Increased pump capacity upstream of the grit chamber due to lowered water elevation in the those tanks**