The Reconstruction of the Port Jervis Wastewater Treatment Plant: Nitrogen Removal Technology

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Presenters: Rodrigo Pena-Lang, PE (D&B Engineers), Magdalena Gasior, PE (D&B Engineers) and Paul D. Smith, PE (NYCDEP)

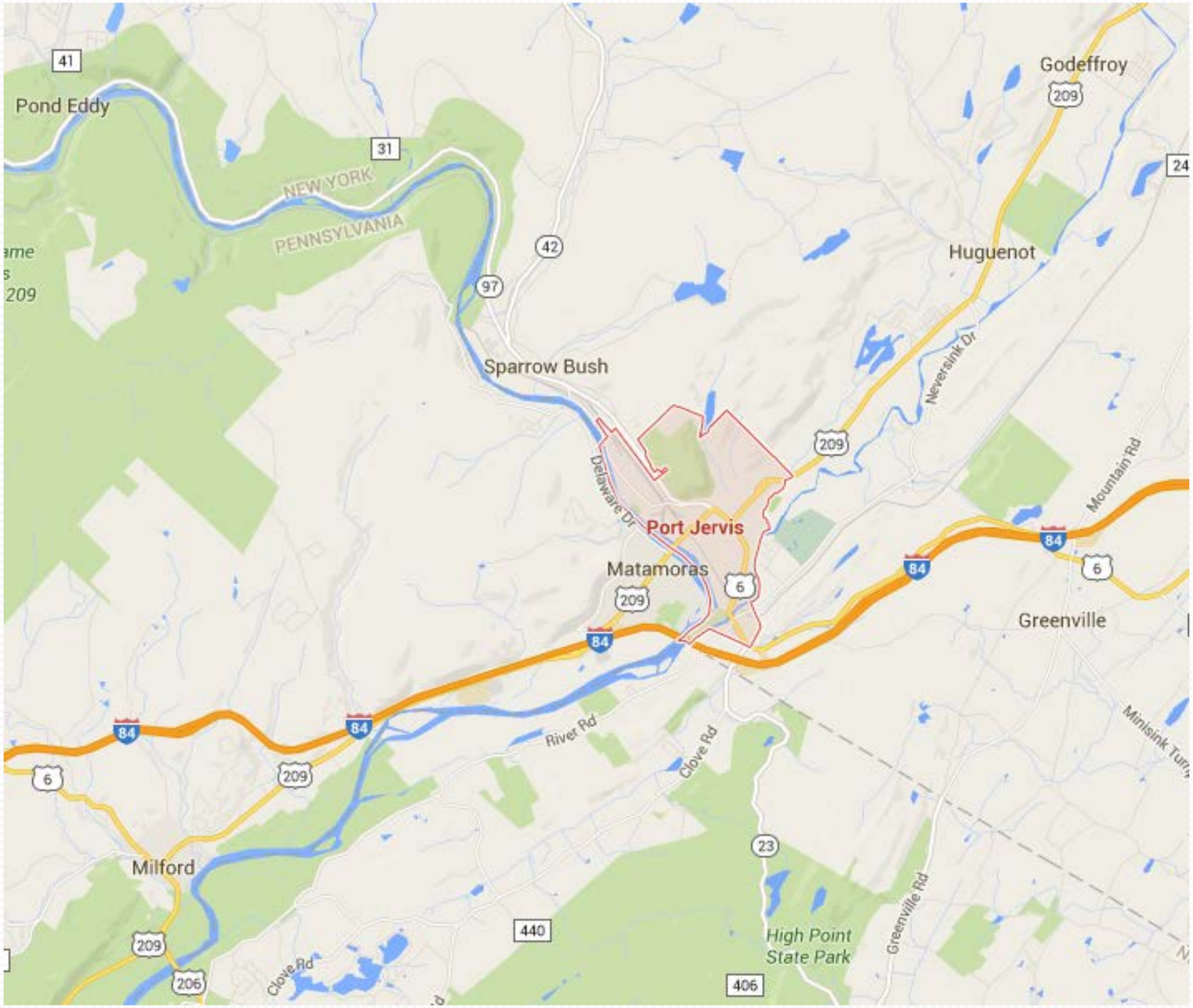
Overview

- Port Jervis WWTP History
- Division of Responsibilities
- Original Process Train at WWTP
- Subsequent Process Modifications
- DRBC rulings
- Nitrogen Removal Alternatives
- Alternatives
  - Biological Nitrogen Removal, Activated Sludge – Suspended Growth Systems
  - Combined System:
    - Biological Nitrogen Removal – Fixed Film Reactor and Post Denitrification System
- Nitrification
  - Rotating Biological Contactors (RBC) Vs. Deep Trickling Filters
- Denitrification:
  - Down Flow Deep Sand Filter
  - Up Flow Deep Sand Filter
  - MBBR
- Process Selection

Location

- PJWWTP is located in Orange County NY adjacent to Delaware River on corner of NY, PA and NJ.
- PJWWTP is in Delaware Watershed for NYC DEP drinking water source.
- Delaware River Basin Commission (DRBC) jurisdiction.

Location Map



Aerial Map

Delaware River
Neversink River
E Main St
OUTLINE OF NEW
BUILDING LOCATION
WITHIN SITE
Neversink River
Neversink River
Clove Brook

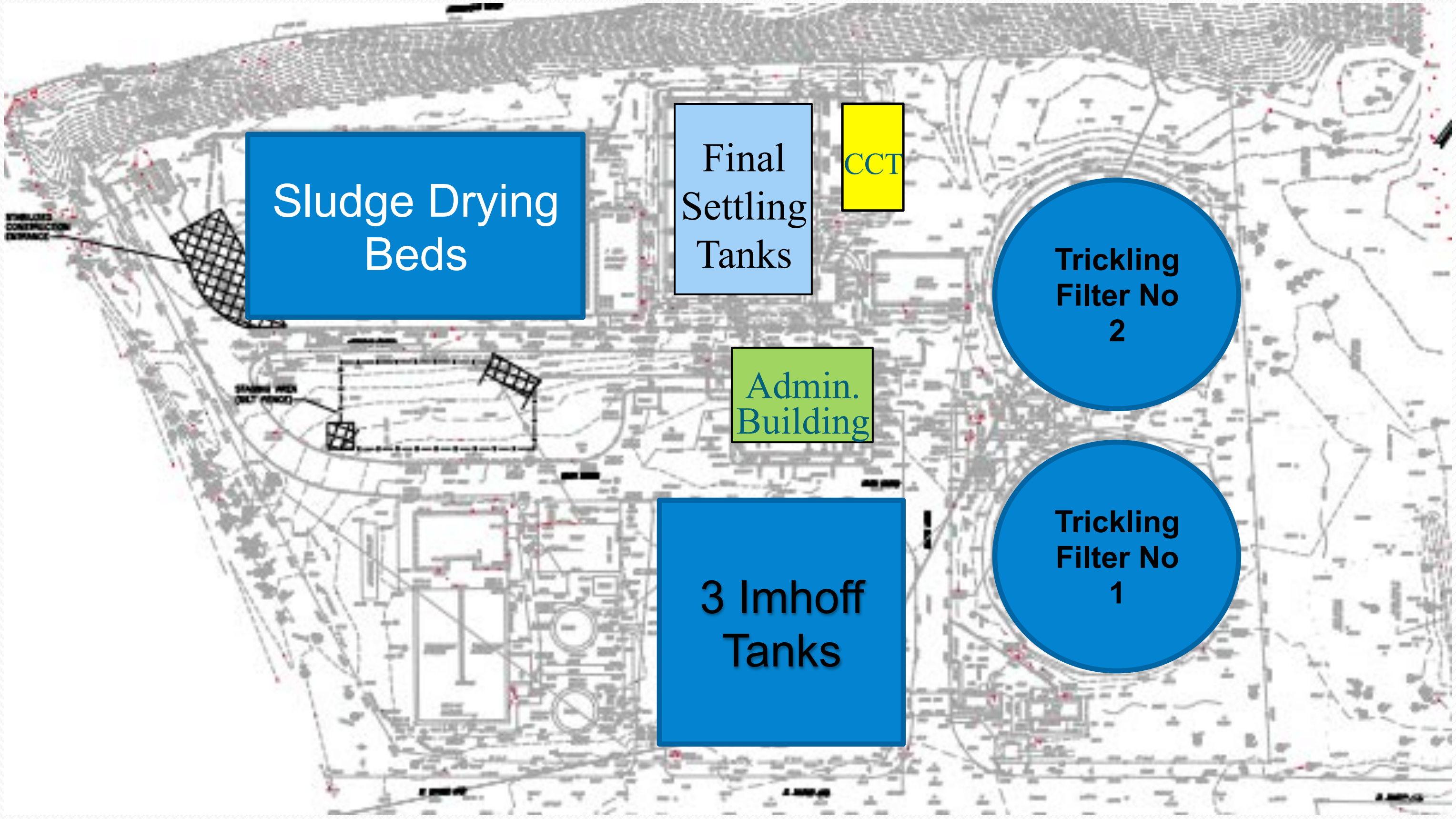
Port Jervis WWTP - History

- 1931 – Supreme Court decreed that if NYC DEP diverts water from Delaware River – it has to construct wastewater treatment plant for City of Port Jervis
- 1946 – an agreement between NYC and City of Port Jervis was reached and subsequently later amended twice in the 1950s.
- 1947 - Design for Port Jervis WWTP began.
  - The facilities were required to serve population of 12,500 plus flow from industrial facilities (equivalent population of 5,500).

Division of Responsibilities

- DEP constructed wastewater treatment plant, pump stations, interceptors and force mains.
- DEP maintains the wastewater treatment plant and the 3 pump stations.
- City of Port Jervis maintains the force mains and the interceptors.

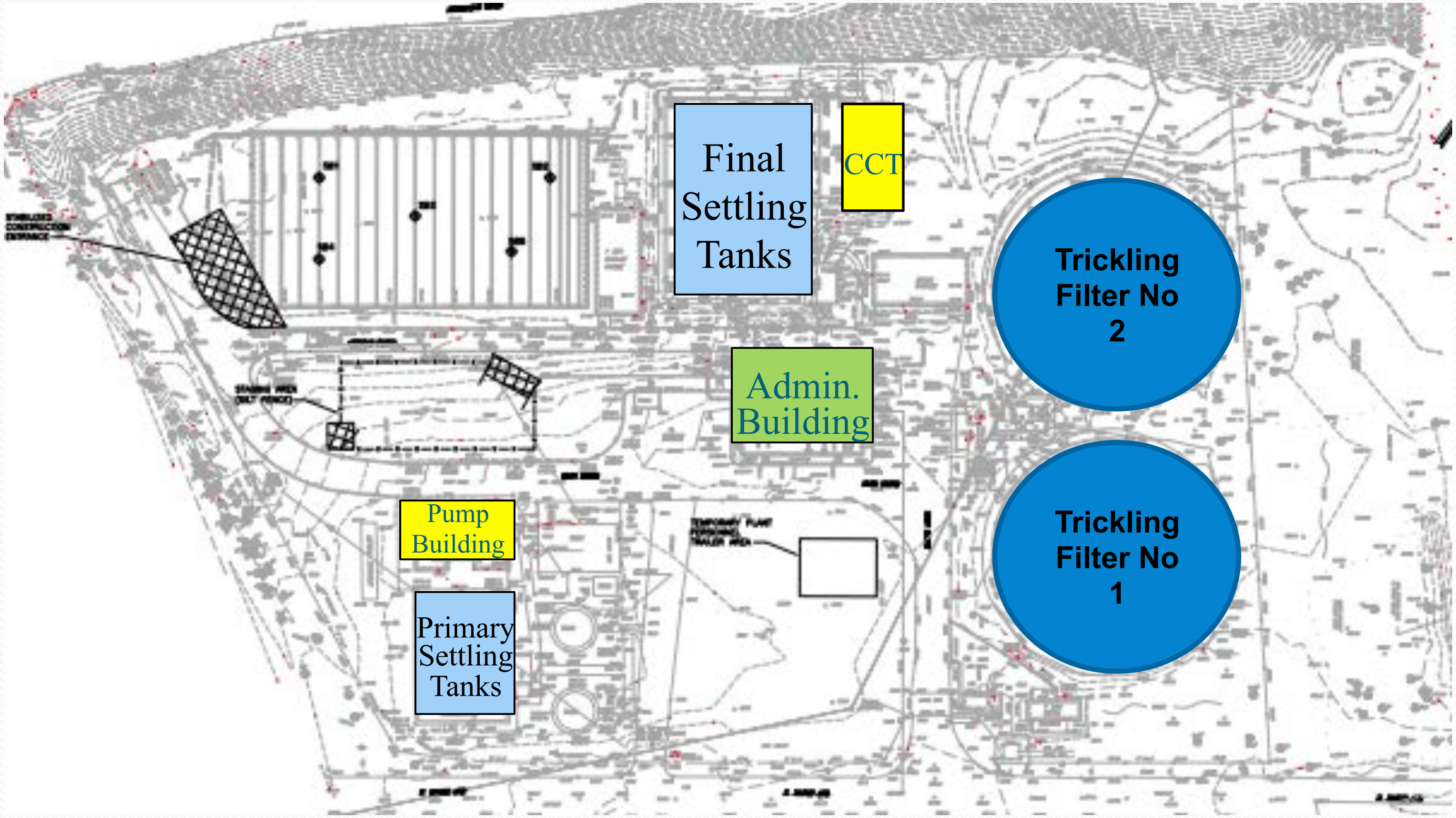
Original Process Train



Subsequent Process Modifications

- 1985 - Sludge drying beds were abandoned and replaced with centrifuge.
- 1990s - Centrifuge was abandoned as it was not performing and replaced with liquid sludge removal off site.
- 2006 – Imhoff tanks were removed, and primary settling tanks constructed.

Existing Site Plan



DRBC ruling/deadline

- 2004, DRBC issued more stringent ruling on the Nitrogen effluent limits
- 2006 – 1st Presentation to DRBC to dispute the ruling
- 2007 – 2nd Presentation to DRBC to dispute the ruling
- 2007 – Work stopped on the project
- 2009 – DRBC issued more stringent DRBC limits
- 2011 – City accepted more stringent DRBC limits
- September 2019 – Deadline to meet the new DRBC effluent limits

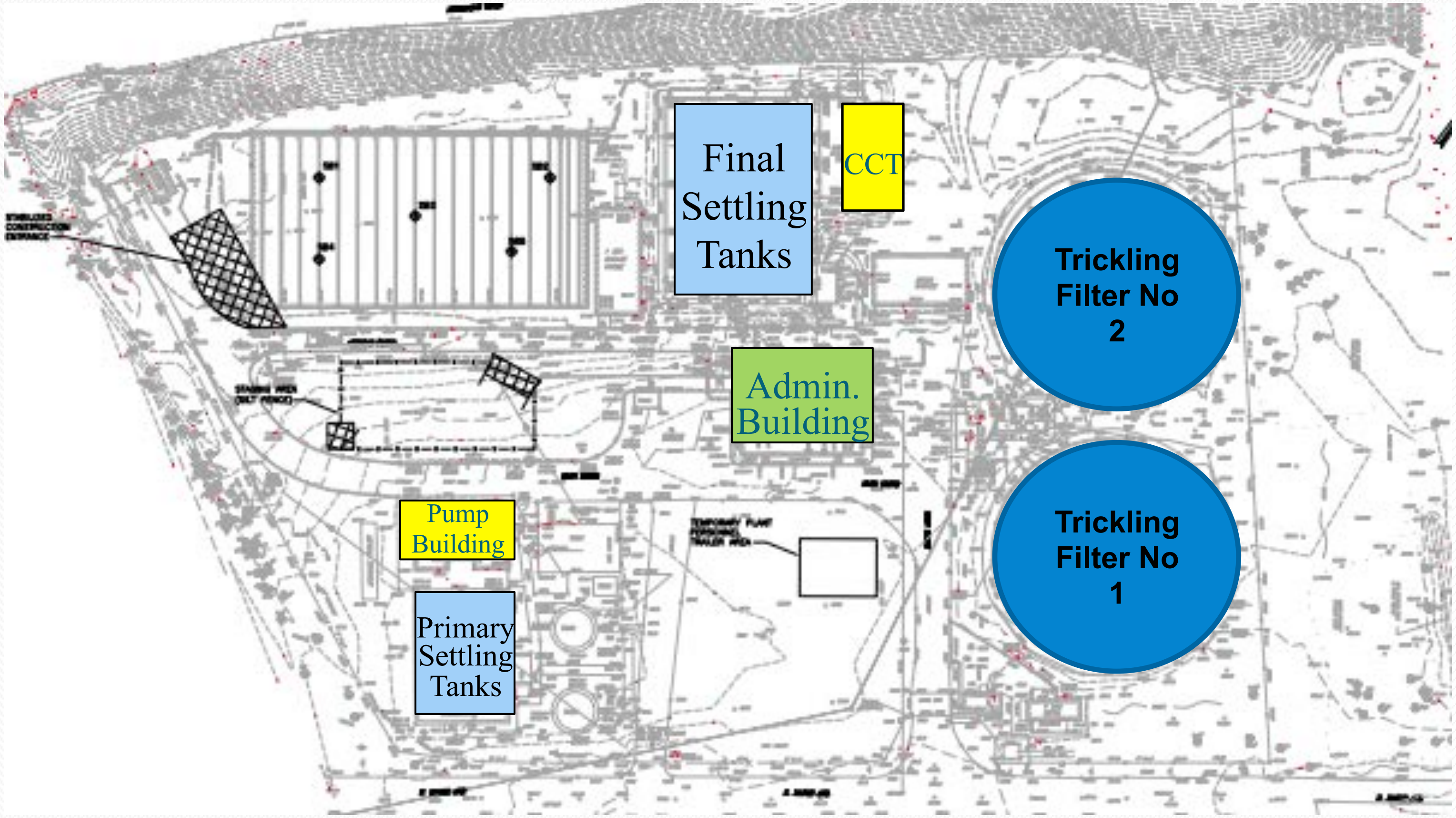
Why Remove Nitrogen From The Delaware River?

- The rising concentration of harmful nutrient compounds leads to **eutrophication** (nutrient enrichment due to human activities) in surface waters.

- Summer **algal blooms** are a familiar example of this eutrophication, and can present problems for ecosystems and people alike: low dissolved oxygen, fish kills, murky water, and depletion of desirable flora and fauna.

- Current process does not remove total nitrogen (TN) and total phosphorus (TP) to the extent needed to protect receiving waters.

Existing Site Plan



Process Criteria

- Port Jervis Wastewater Treatment Plant Influent Flow:

Actual Average Flow	1.2 MGD (from circular charts)
Design Flow	2.5 MGD (from SPDES)
Minimum Flow	0.5 MGD (from circular charts)
Peak Flow	7.4 MGD (from engineering analysis)

Existing Wastewater Characteristics

		2001-2006	2007-2012
Average Daily Flow	mgd	1.16	1.18
BOD	mg/l	174	160
TSS	mg/l	177	184
TKN	mg/l	26.5	21.8
Ammonia	mg/l	19.6	18

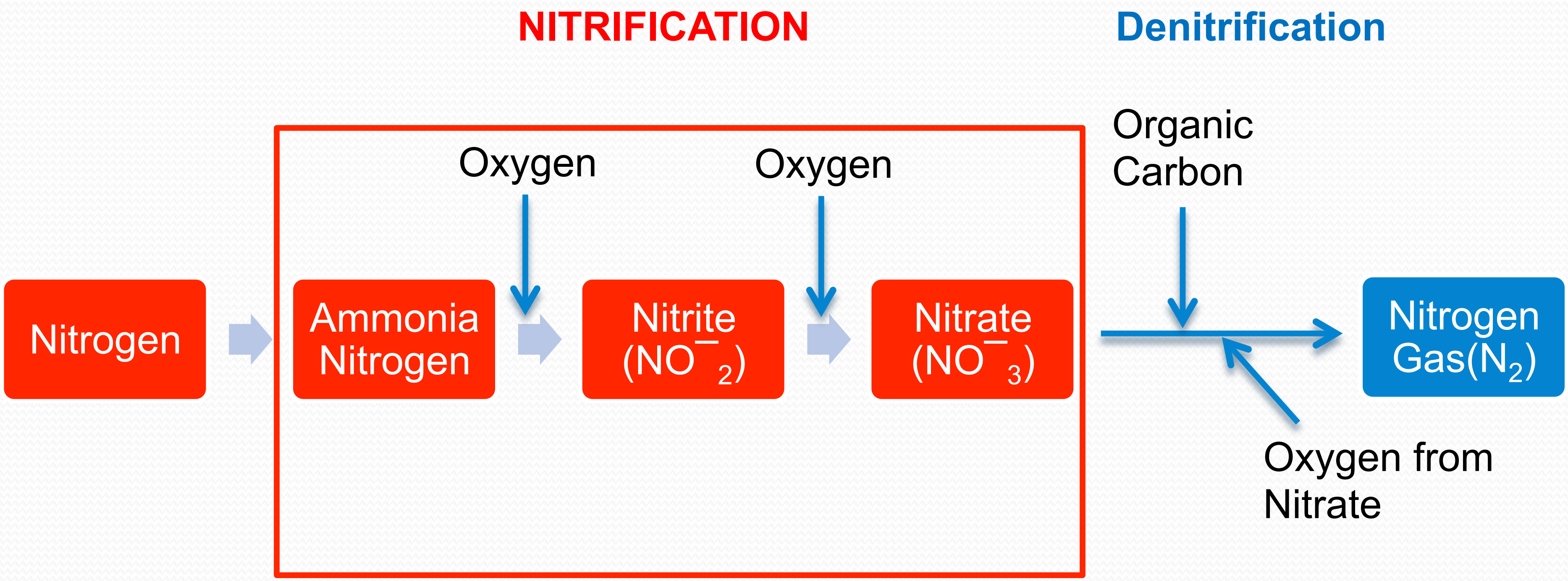
Review of Effluent Permit Limits

OUTFALL 001 (WWTP)			
Parameter	Current Limit	New Limit*	Concentration at 2.5 mgd **
pH (Standard Units)	6 to 9	6 to 9	-
Total Suspended Solids	30 mg/l	30 mg/l (364.3 lbs/day)	17.5 mg/l
Dissolved Oxygen	7.0 mg/l (min. at all times)	7.0 mg/l (min. at all times)	-
BOD (5-Day at 20C)	30 mg/l (85% min. removal)	30 mg/l (226.4 lbs/day) - 85% min. removal	11 mg/l
Fecal Coliform	200 colonies/100 ml as geo. avg.	50 colonies/100 ml as geo. avge.	-
Ammonia Nitrogen	Monitor and Report	98 lb/day (5/1 – 9/30). 147 lbs/day (10/1 – 4/30)	4.7 mg/l
Phosphorous	Monitor and Report	52.5 lbs/day	2.5 mg/l
Nitrate & Nitrite – N	Monitor and Report	101 lb/day (5/1 – 9/30). 151.5 lbs/day (10/1 – 4/30)	4.8 mg/l
Total Kjedhal Nitrogen	Monitor and Report	144.5 lb/day (5/1 – 9/30). 216.5 lbs/day (10/1 – 4/30)	6.9 mg/l
Total Dissolved Solids	-	1,000 mg/l	-

** Concentrations associated with loadings at full permitted discharge flow of 2.5 mgd:
[8.34 x Conc. (mg/l) x Flow (mgd) = Load (lb/day)]

Analysis of Alternatives

Biological Nitrification and Denitrification



Limitations/Design Parameters

- Extreme weather conditions; high summer and very low winter temperatures.
- Reduced staff availability. Only 4 people on a full-time basis.
- Personnel is not trained for advanced treatment operation.

Analysis of Alternatives

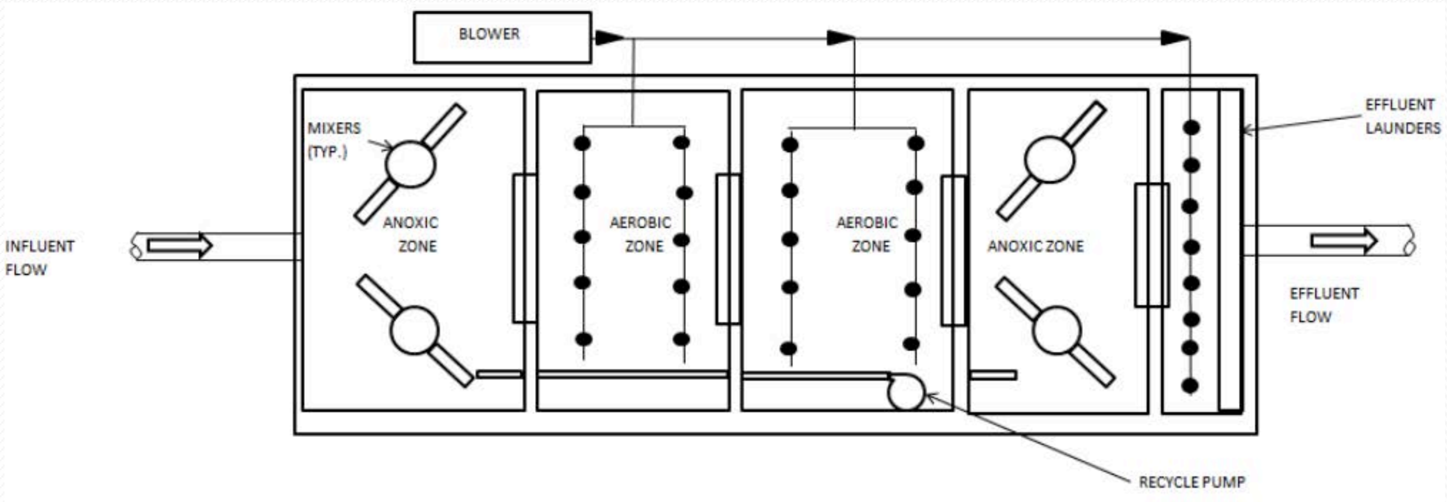
- Biological Nitrogen Removal:
  - Combination System (One Tank) - Suspended Growth System and Fixed Film (MBBR)

  - Combined System – Fixed Film Reactor and Post Denitrification

Moving Bed Bio Reactor

- How does it work?
  - Moving Bed Biofilm Reactor
    - 1st stage - Denitrification: anoxic tank.
    - 2nd stage – BOD and COD reduction: aerobic tank
    - 3rd stage – Nitrification and Oxygen depletion: aerobic tank

- Disadvantages
  - Higher level of training and education needed.
  - Higher demand of energy to run the system.
  - Existing Trickling Filter needed to be demolished.
  - Fairly new technology



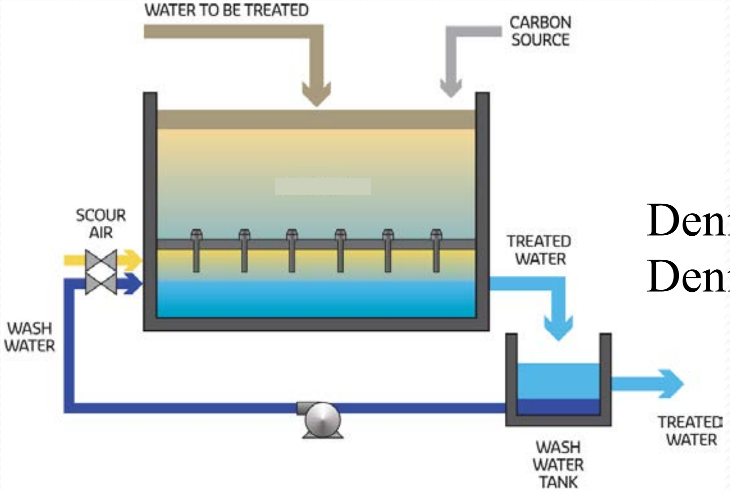
DIAGRAMMATIC VIEW OF A MBBR TANK

Fixed Film Reactor and Post Denitrification

- How does it work?
  - Nitrification is achieved in a fixed film reactor

Nitrification - in Trickling Filter

  - Nitrification is followed by denitrification at a different structure.



Denitrification – Deni Filter

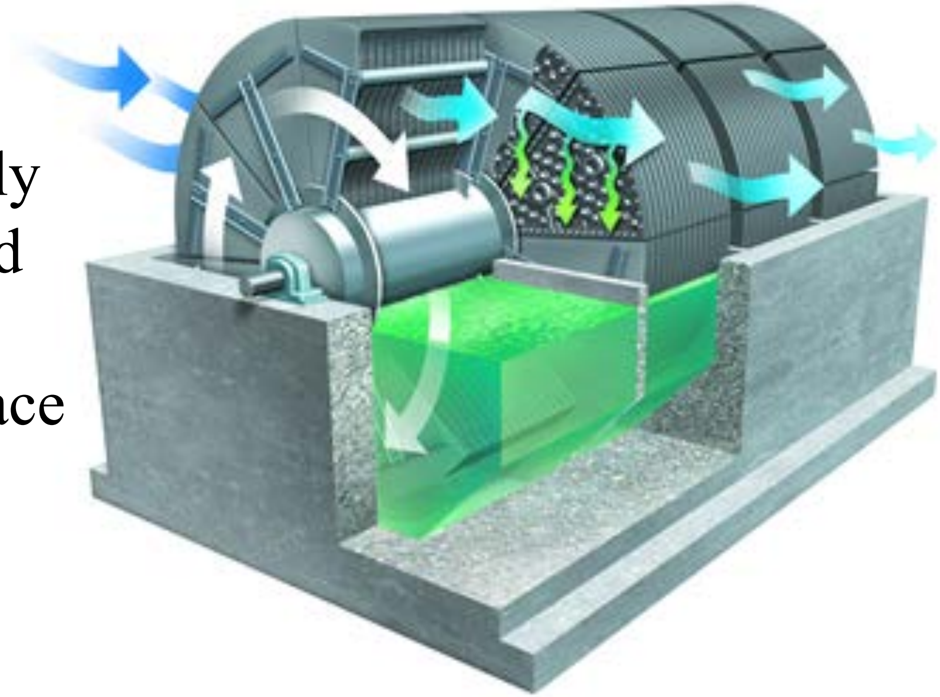
Fixed Film Reactor

- Fixed Film Reactor Alternatives:
  - Rotating Biological Contactors
  - Deep Trickling Filters

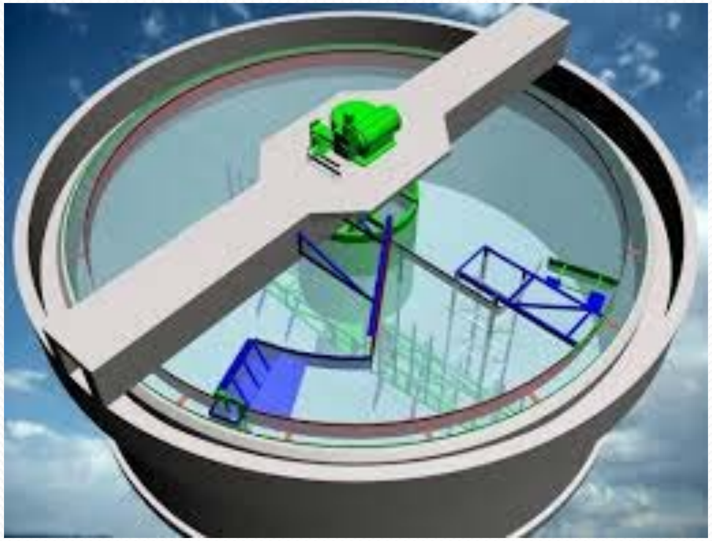
These processes are similar because both employ cultures of microorganisms that are attached to the surface of various media. For trickling filters the medium is stationary, whereas for rotary bio-contactors the medium, in the form of disks, rotates.

Rotating Biological Contactors

- A rotating biological contactor is a type of secondary treatment process.
- It consists of a series of closely spaced, parallel discs mounted on a rotating shaft which is supported just above the surface of the waste water.
- Microorganisms grow on the surface of the discs where biological degradation of the wastewater pollutants takes place.



Deeper Trickling Filters



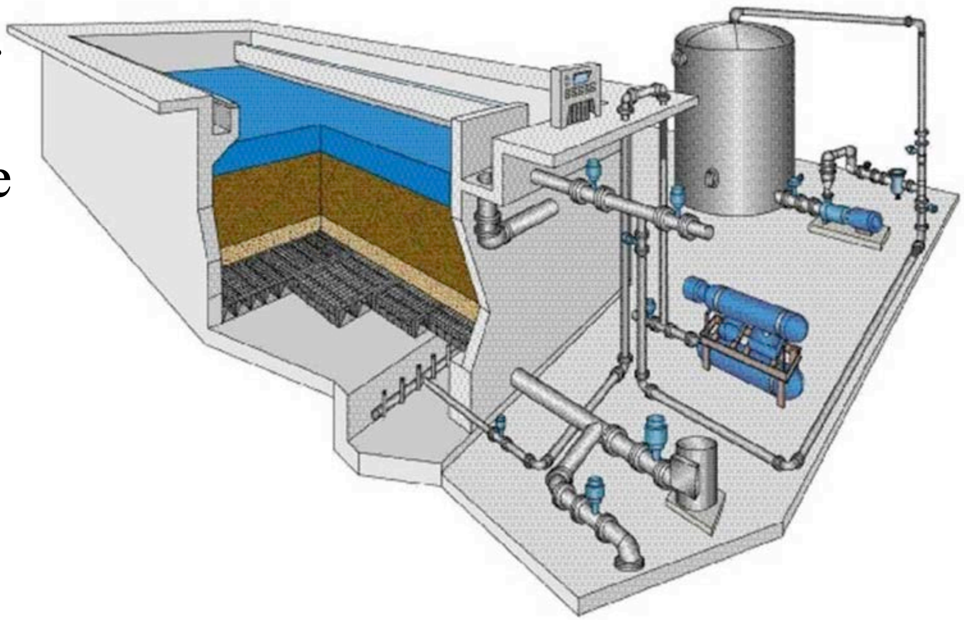
- Replace and increase the depth the media from stone to corrugated plastic 6 feet deep
- Enlarge the air plenum in the bottom of the filter for better air circulation.
- Upgrades to the trickling filter will provide the following as a minimum:
  - High Specific Surface Area
  - Wide Flow Passages
  - Improved Ventilation

Post Denitrification

- Systems alternatives for denitrification
  - Deep Sand Filters
    - Down-flow Mode
    - Up-flow mode

Down-Flow Sand Filters

- Deep-bed down-flow: attached growth microbiological units that provide filtration to remove solids from the wastewater and denitrification for tertiary treatment.

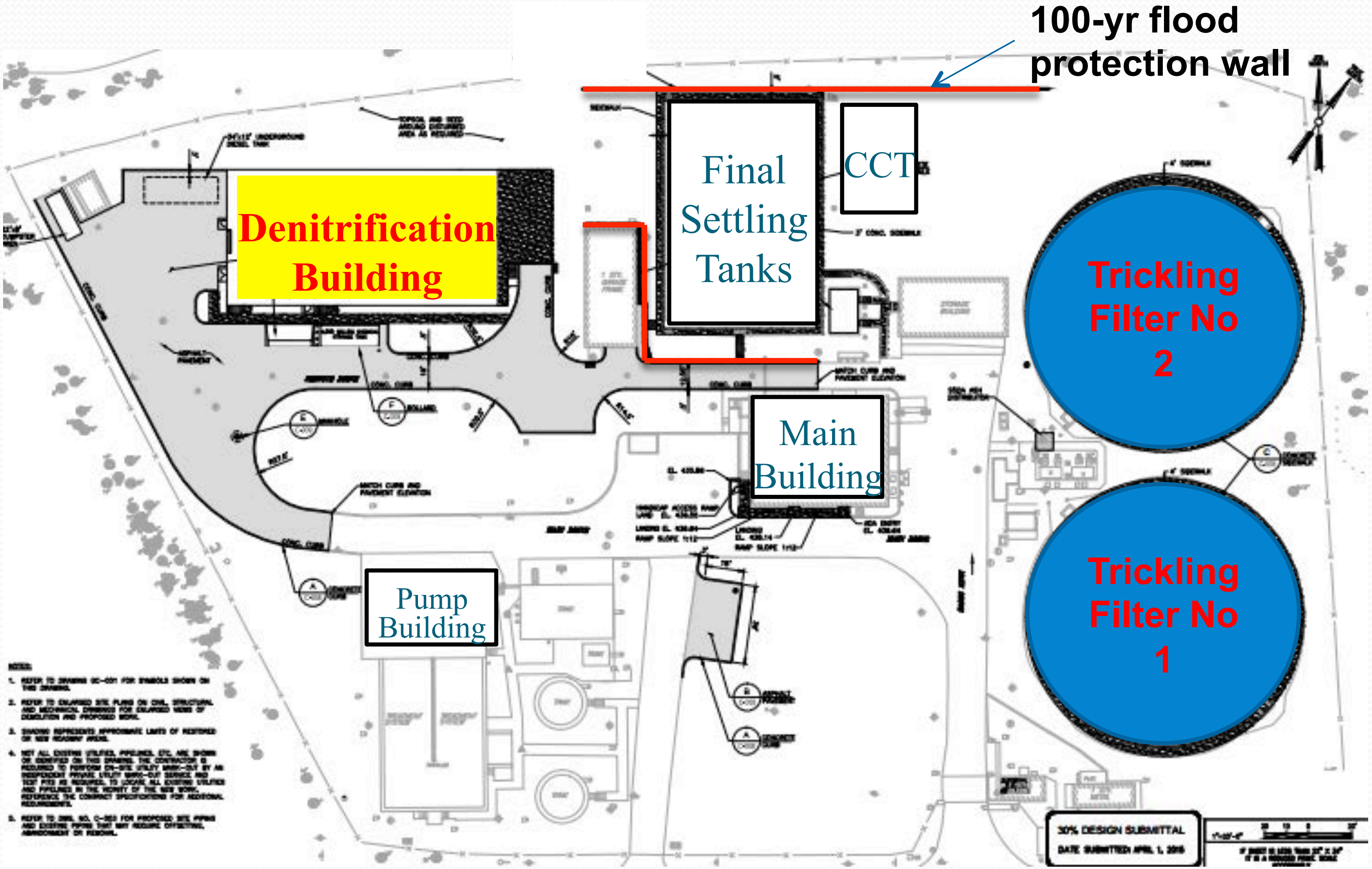


As the nitrified influent flow enters the filter tanks, denitrifying organisms attach and grow in the
filter media allowing the denitrifying process to take place. During the same process, suspended
solids are removed to less than 10 mg/l.

Up-Flow Sand Filters

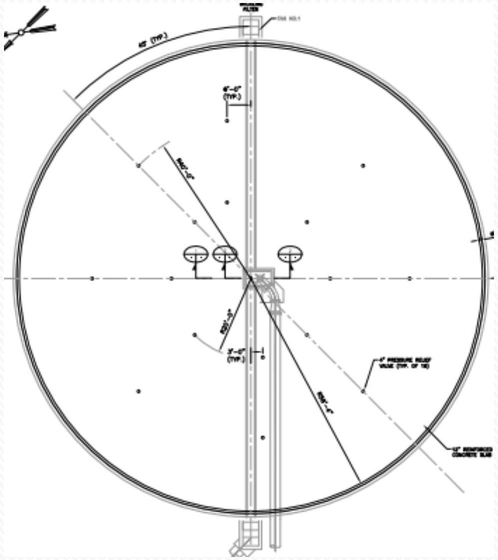
- Same technology as down-flow deep sand filter
- Disadvantages:
  - Very little to no backup testing.
  - Used with lower influent nitrite concentrations.
  - Studies with similar nitrite influent were performed in California only during the summer months, very different setting to Port Jervis's worse case scenario, winter months.
  - DO levels recommended to be above 6 mg/l in order to ensure proper working conditions. Expected DO in Port Jervis below 5 mg/l.

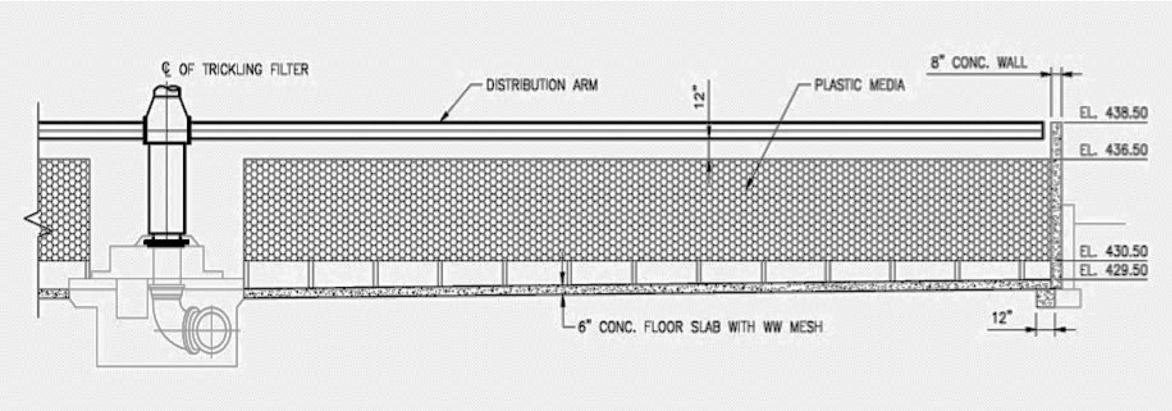
Process Selection



Process Selection

- Nitrification
  - Deep Trickling Filter

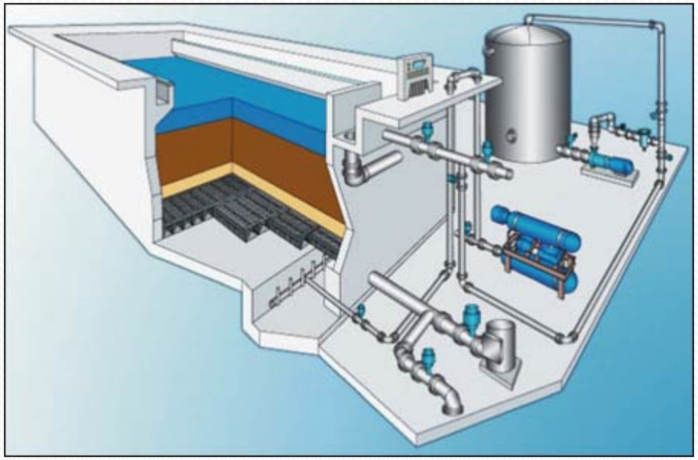




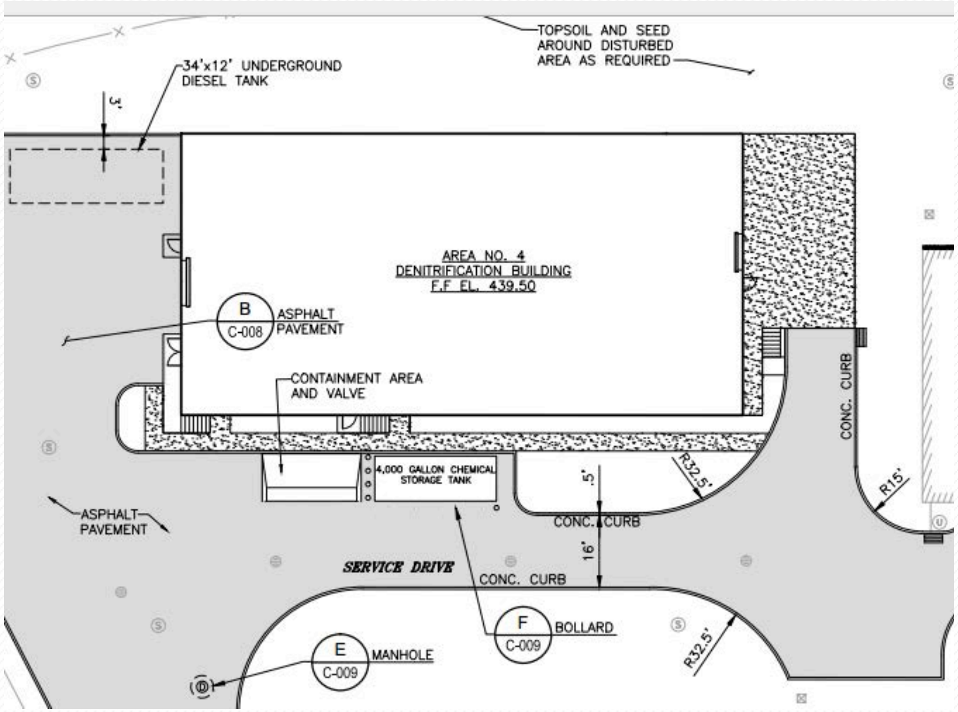
  - Mechanical Distributor Arms
  - Process Air
  - Alkalinity Adjustment

Process Selection

- Denitrification Filter

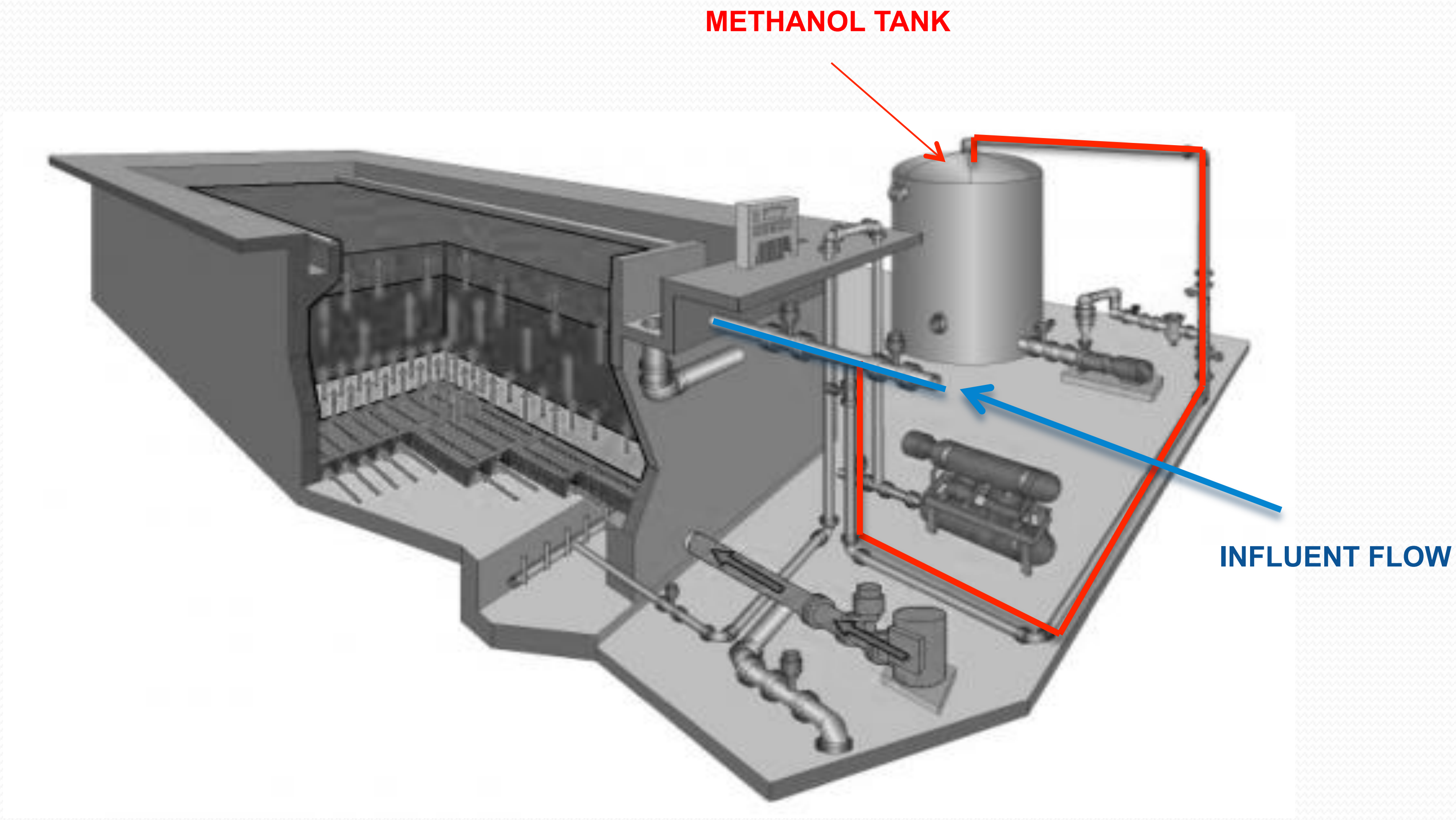


- Sizing the reactors
- Clearwell and Mudwell Tanks
- Carbon Source



Plan view

Chemical System - Methanol



Thank you

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  - Paul D. Smith, PE (Portfolio Manager)
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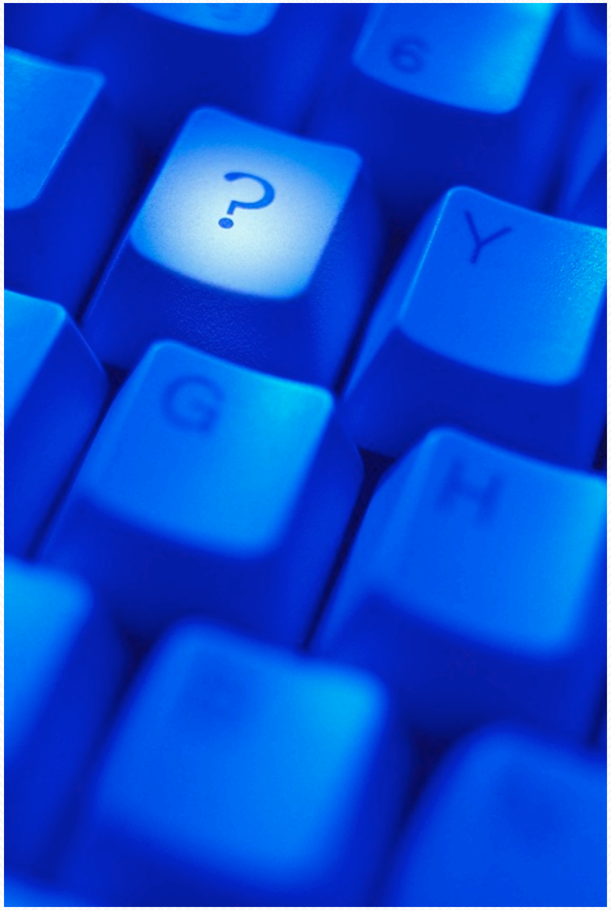
  - Daniel Baumgardner – Plant Operator
  - BWS Staff – Matt Burd, Jim Fitzimmons PE, and Phil Starks
  - D&B Design Team

Contact Information

Rodrigo Pena-Lang, PE

rplang@db-eng.com

Questions?



Original Process Train for WWTP

- The original process train for PJWWTP included:
  - 3 Imhoff tanks for primary settling, sludge digestion and sludge storage
  - 2 Trickling Filters for biological treatment
  - 2 final settling tanks
  - Sludge drying beds enclosed with greenhouses