Detailed Facility Planning for Impending TN Limits

January 25, 2023

Michael R. Theriault, PE

Town of Hanover New Hampshire Incorporated 1761

NEWEA Working for Water Quality

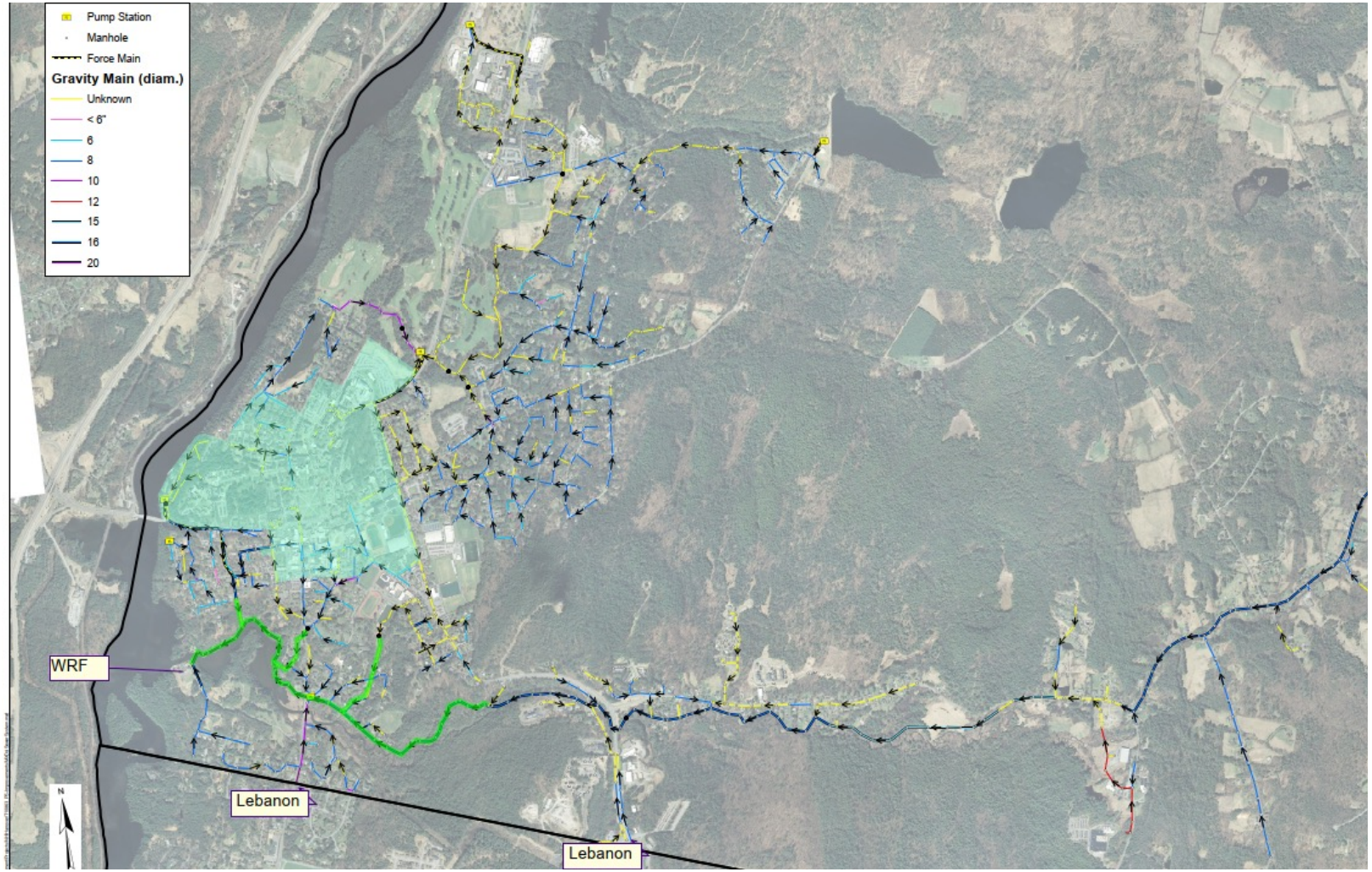
Wright-Pierce Engineering a Better Environment

Presentation Objectives

Background: Water Reclamation Facility

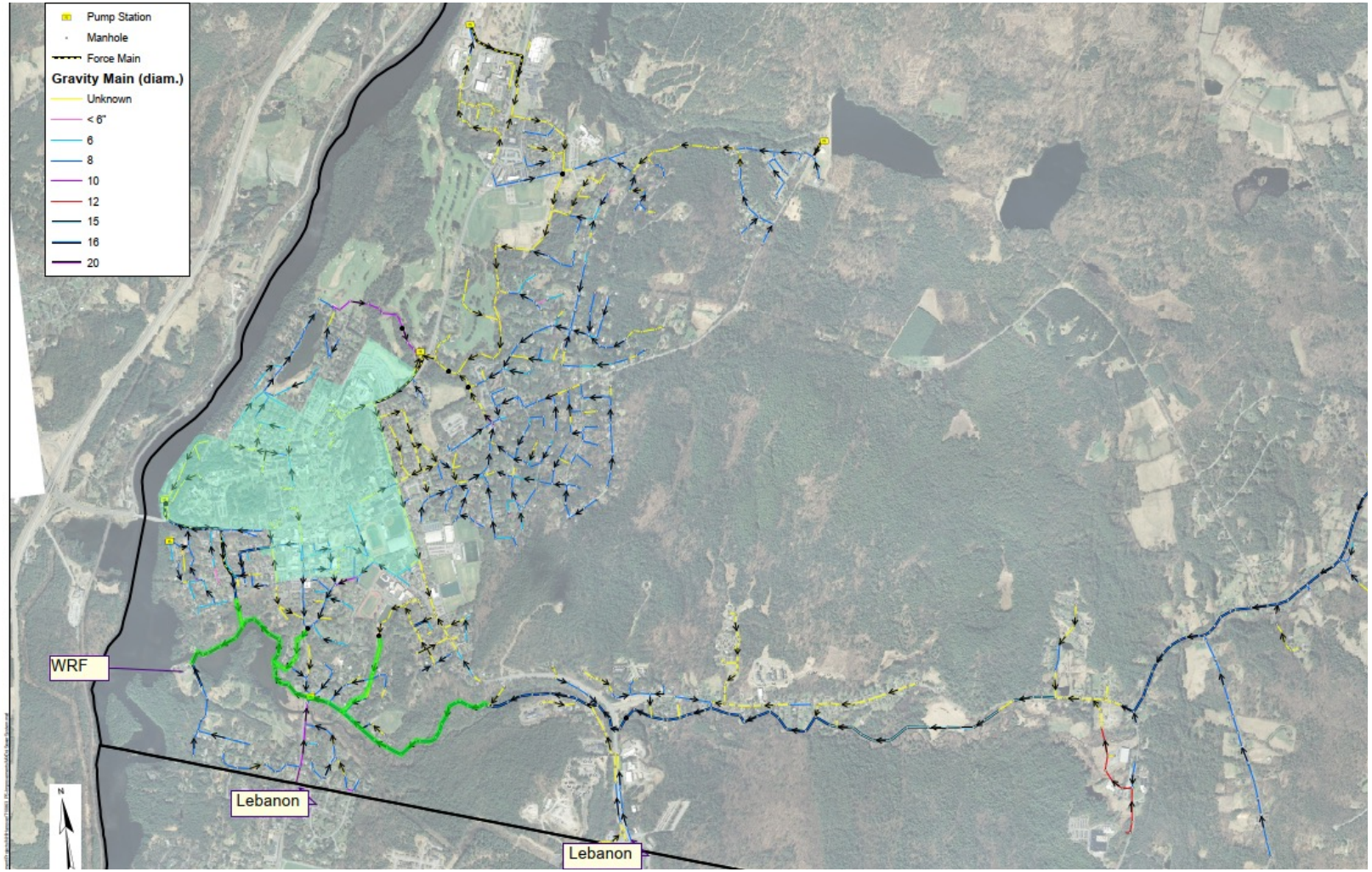
- 1963 Primary Treatment
- 1985 Secondary Treatment
  - UV Disinfection
  - Digesters
- 2005 Chlor./Dechlor.
- 2006 Outfall Extension
- 2008 Secondary Clarif
- 2010 Aeration, Blowers
- 2012 Solids Handling

Background: Town of Hanover



- Population 11,900
  - 11,300 sewered total
- 4 Town pump stations, 1 private
- ~45 miles 6”-20” sewer
- ~3 miles force main
- Water Reclamation Facility
  - 2.3 MGD AADF
- Dartmouth College
- Lebanon
  - 0.65 MGD IMA
  - Dartmouth Hitchcock Medical Center

Background: Town of Hanover

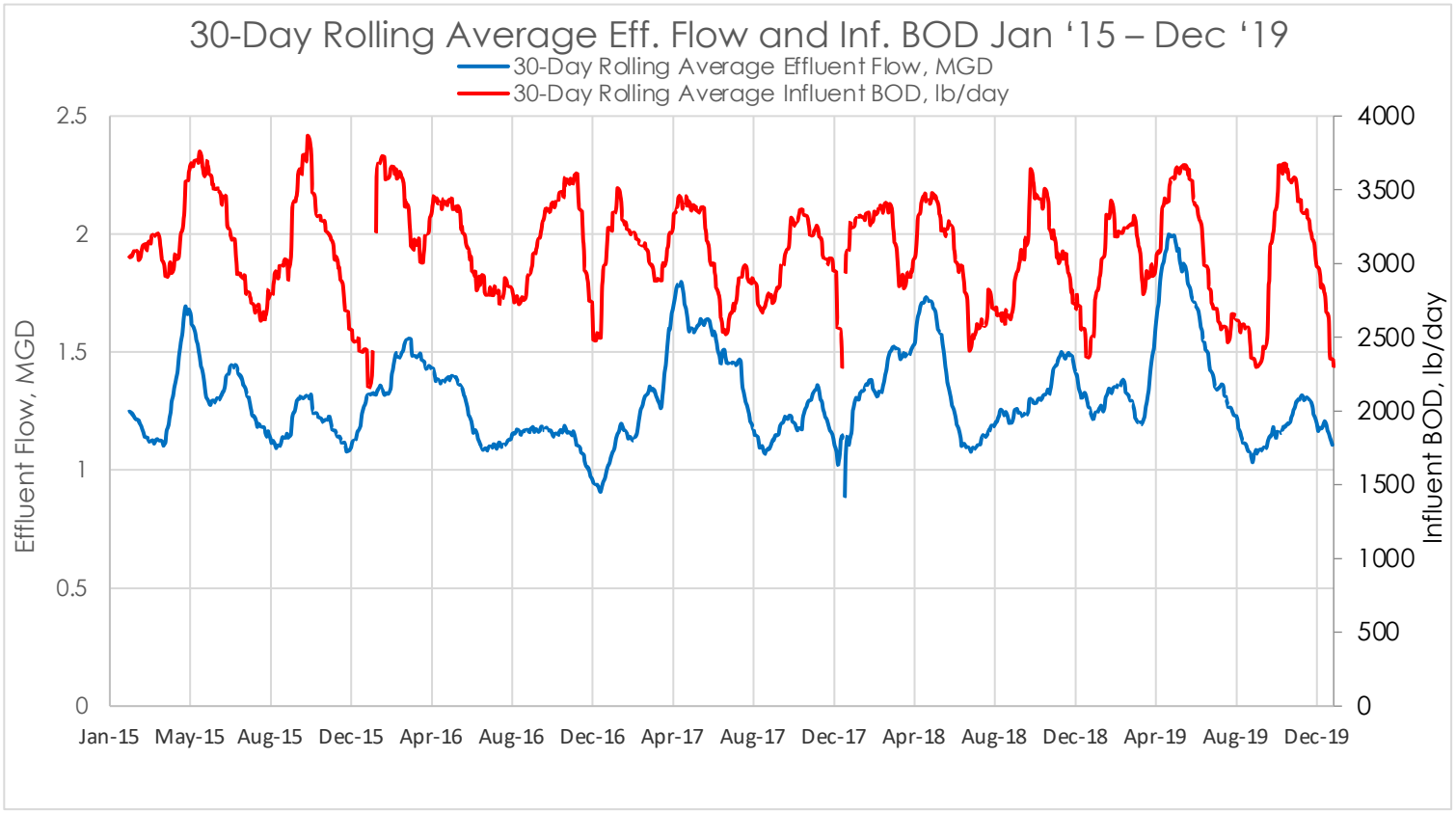


- WRF flows decreasing
- 0.5% annual growth since 2010
- Growth areas
  - Dartmouth College
  - West Wheellock Street Redevelopment, Zoning
  - Opportunity areas to North
  - Lebanon
    - Within existing IMA
    - Beyond IMA
      - Dartmouth Hitchcock Expansions, Surrounding Campus
      - Route 120 – Mixed use commercial

Population, Growth

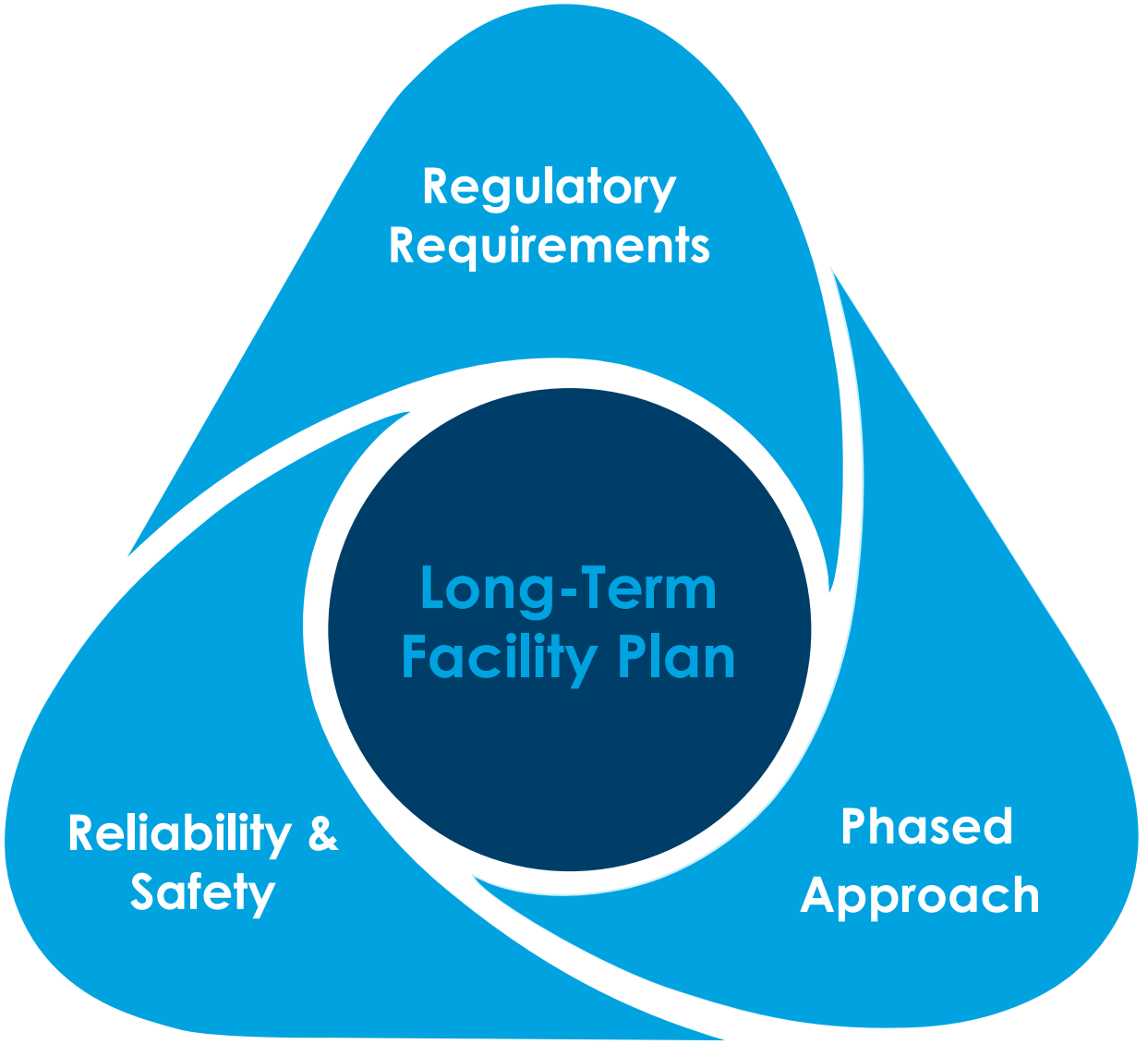
- Workshops with Town
- Likelihood of Development
  - 100%
  - 70%
  - 50%
- 0.46 MGD
  - 35% Flow and Load Increase
  - Assumes Lebanon within IMA limit

Key Issue – Irregular Flows and Loads

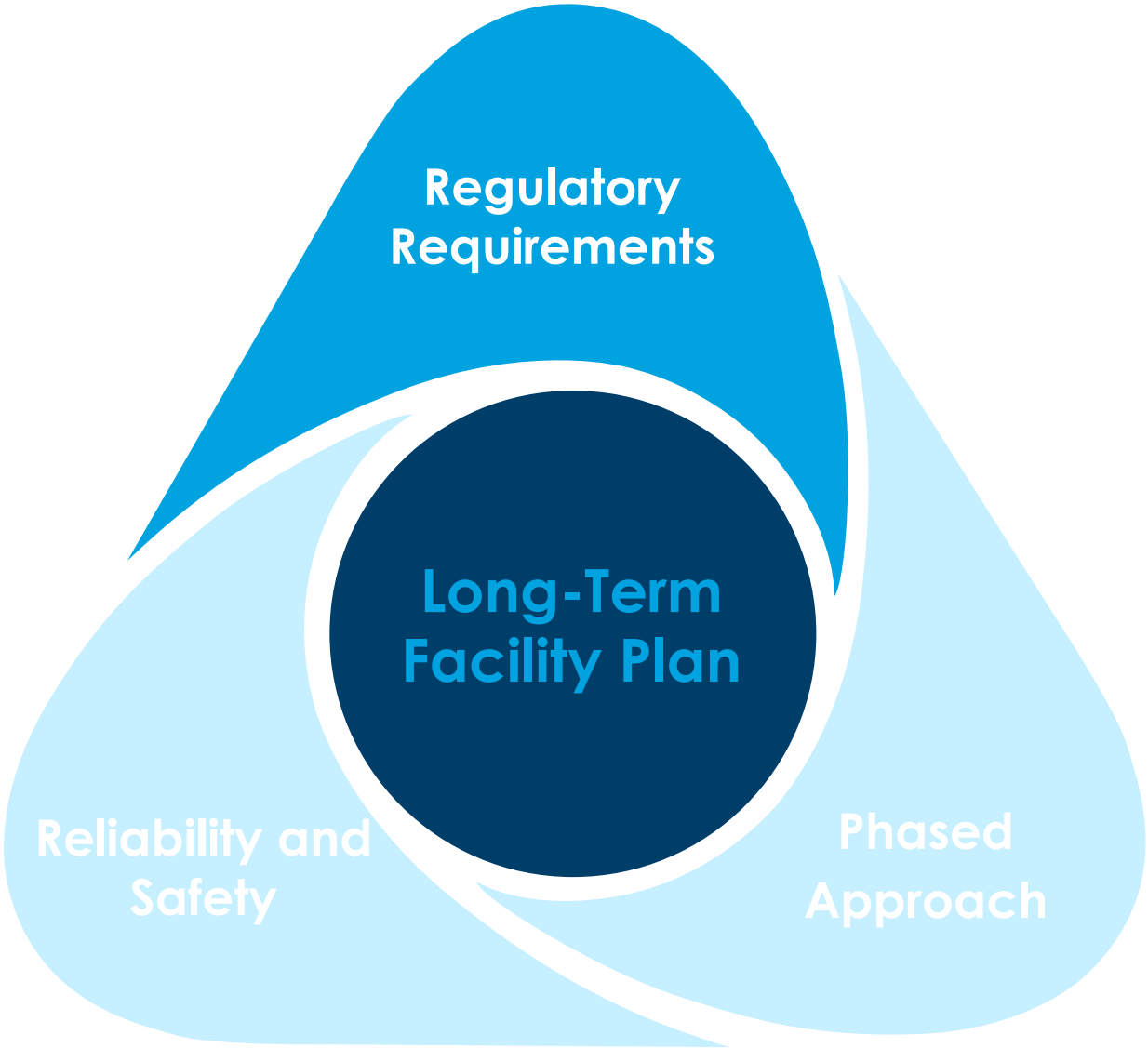


- **WRF**
  - **2.3 MGD ADF, Conventional Activated Sludge**
  - **7.6 MGD Peak**
- **Current**
  - **1.3 MGD AADF**
  - **2.6 MGD Max Day**
  - **4.1 MGD Peak**
  - **Lebanon 0.27 MGD AADF**
- **Nutrient removal process susceptible to irregular flows/ loads**
- **Need robust solution to account for variations**

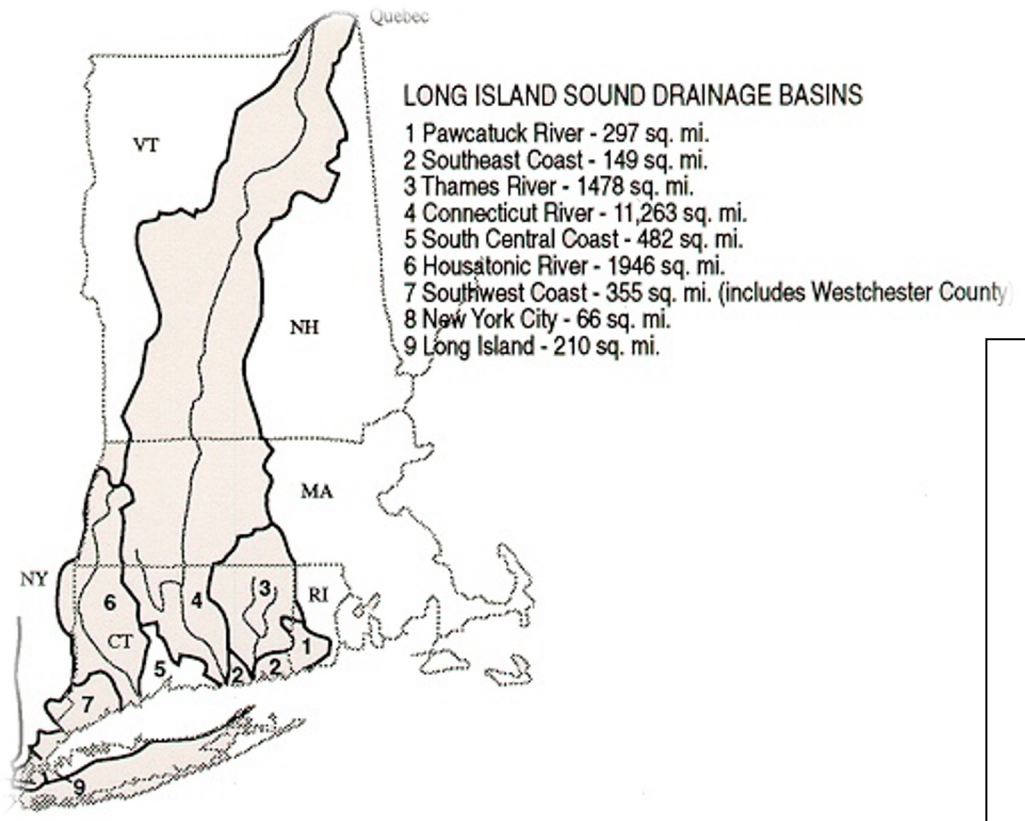
Background: Project Drivers



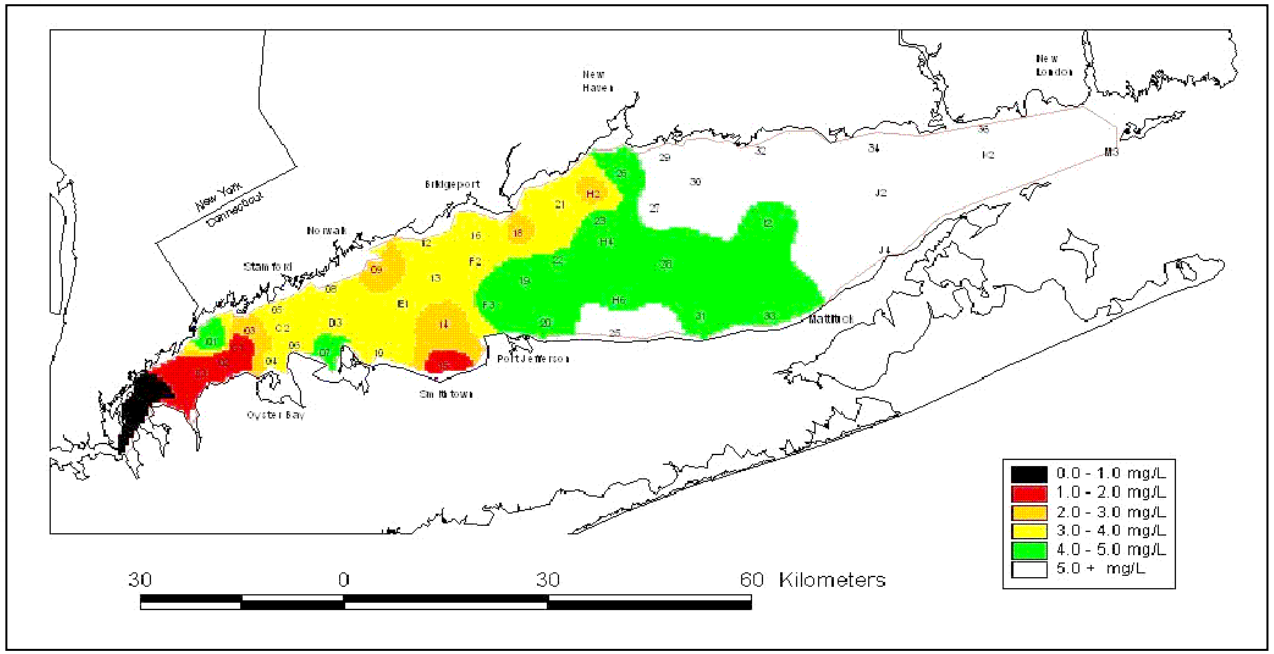
Background: Project Drivers



Regulatory Drivers



- **Watershed: 16,246 sq miles**
- **Population: 8 million people**

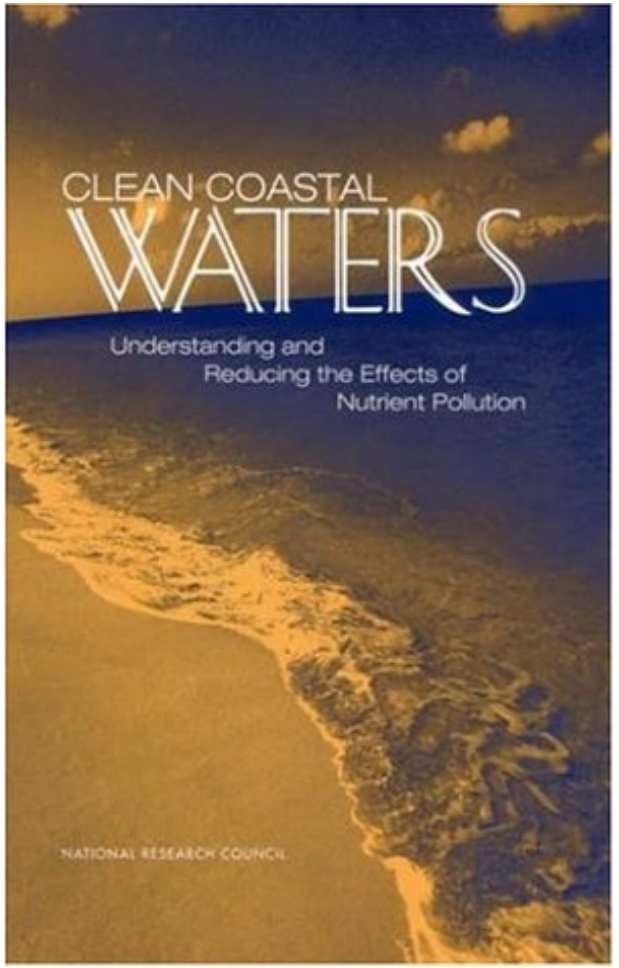


Long Island Sound Bottom Waters, Aug 5-8, 1999
from Long Island Sound Study, 2000

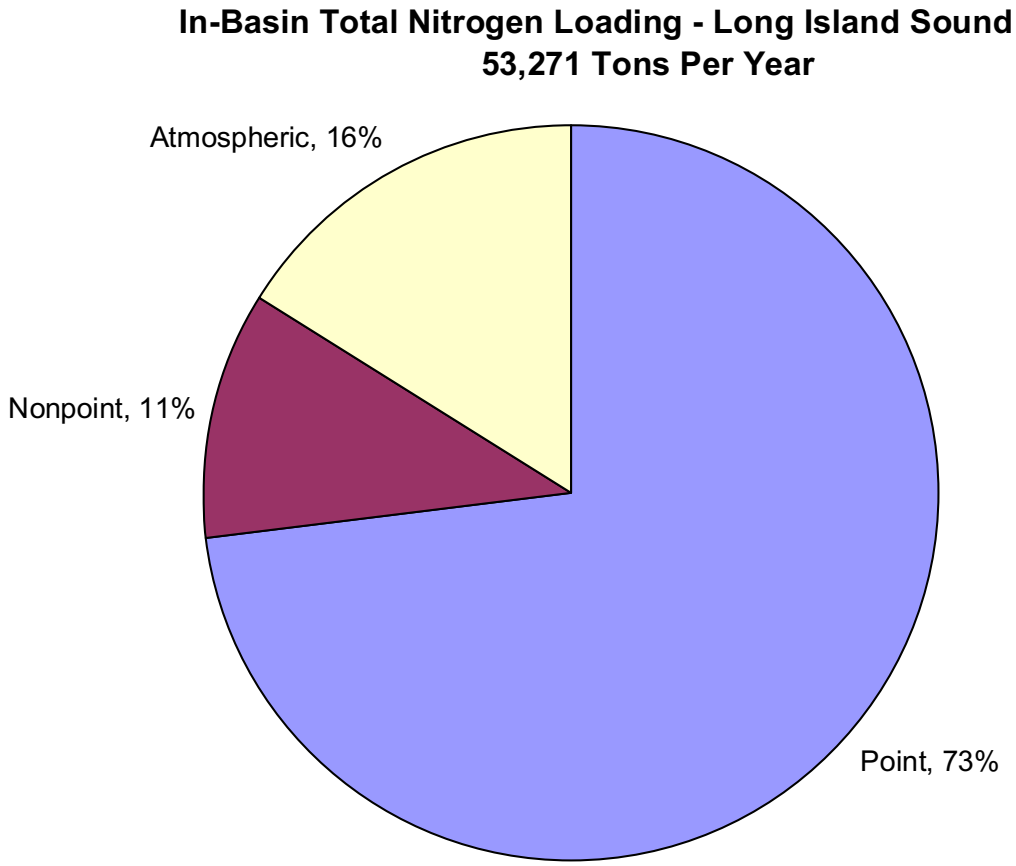
Regulatory Drivers

NRC 2000

- Nitrogen is now the largest pollution problem in the coastal waters of the United States
- Two thirds of coastal rivers and bays are moderately to severely degraded from nitrogen pollution.

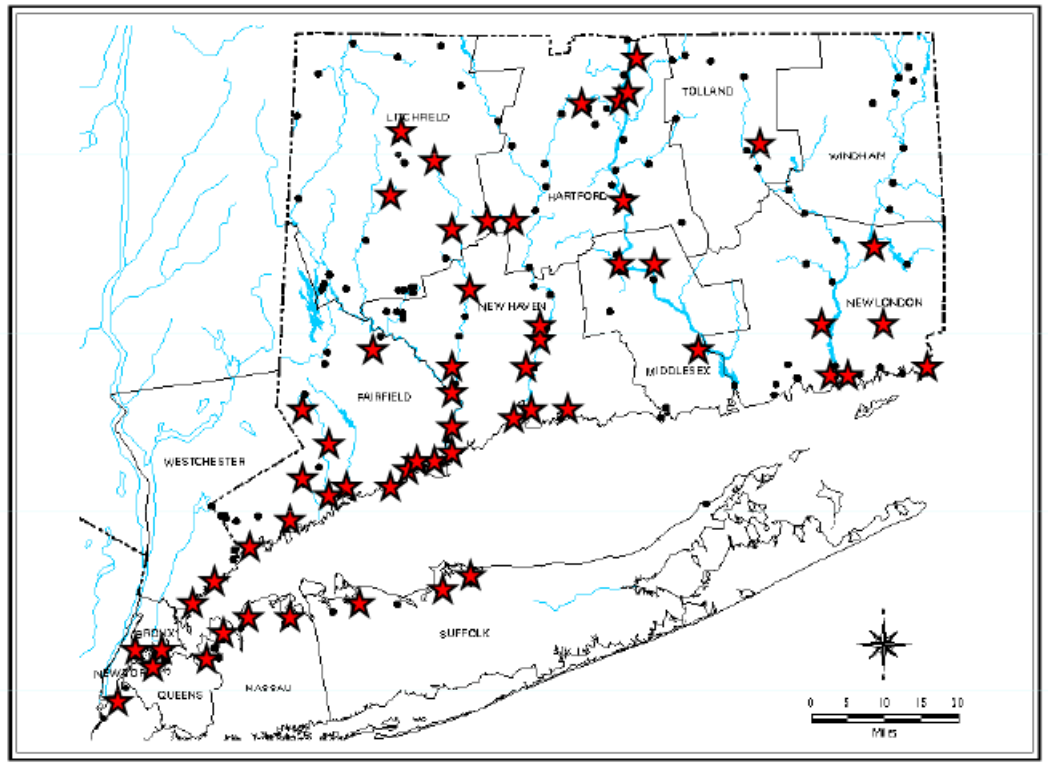


Regulatory Drivers



from Long Island Sound TMDL for Dissolved Oxygen, December 2000

Regulatory Drivers

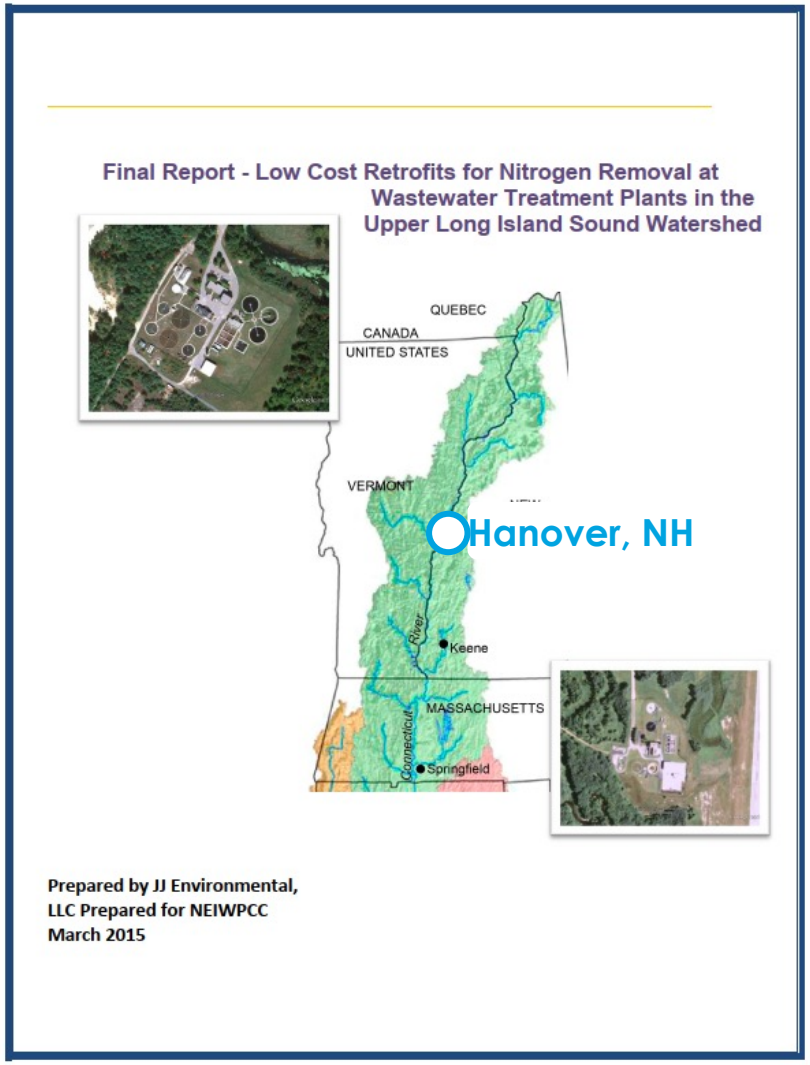


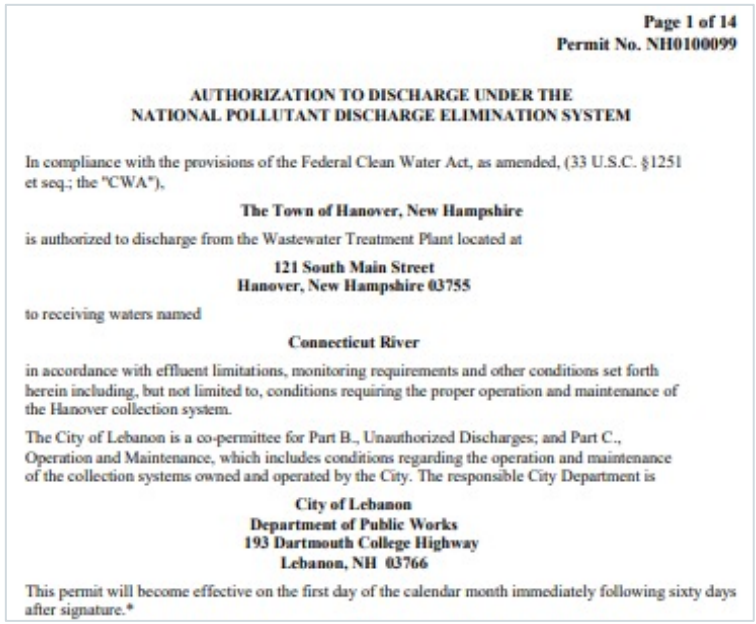
CT DEP/ NYSDEC (2006)

Sewage Treatment Plants
★ STPs with ANR
● STPs without ANR

- Long Island Sound was one of the first estuaries to be subject to nutrient criteria (TMDL 2000)
- CT and NY far into their implementation plan…hundreds of millions of dollars in WWTP improvements
- As of 2006, 46 plants have been modified for advanced nutrient removal
- Connecticut has implemented a nitrogen credit trading program

EPA: Connecticut River Valley





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Permit No. NH0100099

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Clean Water Act, as amended, (33 U.S.C. §1251 et seq.; the "CWA"),

The Town of Hanover, New Hampshire

is authorized to discharge from the Wastewater Treatment Plant located at

121 South Main Street
Hanover, New Hampshire 03755

to receiving waters named

Connecticut River

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein including, but not limited to, conditions requiring the proper operation and maintenance of the Hanover collection system.

The City of Lebanon is a co-permittee for Part B., Unauthorized Discharges; and Part C., Operation and Maintenance, which includes conditions regarding the operation and maintenance of the collection systems owned and operated by the City. The responsible City Department is

City of Lebanon
Department of Public Works
193 Dartmouth College Highway
Lebanon, NH 03766

This permit will become effective on the first day of the calendar month immediately following sixty days after signature.*

- 2000-2001 Long Island Sound Study, TMDL
- 2007-2015 WWTF Optimization Study
- 2015 Hanover NPDES Permit
  - Current Nitrogen Optimization Goal
  - Future Nitrogen "Optimization" Limit

EPA: Connecticut River Valley

#2 NH Loading

Summary of New Hampshire Out-Of-Basin Wastewater Treatment Plant and Industrial Discharger Total Nitrogen Effluent Data

Permit #	Name	Type	Design Flow (MGD)	2014-2018 Avg Flow (MGD)	2014 Average Load (lb/day)	2015 Average Load (lb/day)	2016 Average Load (lb/day)	2017 Average Load (lb/day)	2018 Average Load (lb/day)	2014-2018 Avg Load (lb/day)
Total New Hampshire Out-of-Basin Load			**31.5**	**18.6**	**1,662**	**1,457**	**1,370**	**1,555**	**1,154**	**1,440**
NH0000621	BERLIN STATE FISH HATCHERY	IND	6.1	6.30	8.8	13	13	15	8.7	12
NH0000744	NH DES (TWIN MTN STATE FISH HATCHERY)	IND	1.0	0.78	2.0	5.8	6.2	5.5	5.1	4.9
NH0100099	HANOVER WWTF	POTW	2.3	1.30	*341*	*341*	313	350	361	341
NH0100145	LANCASTER WWTF	POTW	1.2	0.79	84	78	45	72	63	68
NH0100153	LITTLETON WWTP	POTW	1.5	0.69	32	36	24	31	45	34
NH0100200	NEWPORT WWTF	POTW	1.3	0.59	97	63	80	80	79	80
NH0100366	LEBANON WWTF	POTW	3.2	1.49	*136*	*136*	132	127	152	137
NH0100382	HINSDALE WWTP	POTW	0.3	0.19	*18*	17	11	20	16	16
NH0100510	WHITEFIELD WWTF	POTW	0.2	0.08	35	22	15	18	24	23
NH0100544	SUNAPEE WWTF	POTW	0.6	0.40	*32*	*32*	*32*	50	33	35
NH0100765	CHARLESTOWN WWTP	POTW	1.1	0.28	22	13	12	19	22	17
NH0100790	KEENE WWTF	POTW	6.0	2.89	*533*	*397*	*394*	*452*	40	363
NH0101052	TROY WWTF	POTW	0.3	0.08	23	15	12	13	25	18
NH0101150	WEST SWANZEY WWTP	POTW	0.2	0.07	6.1	6.4	7.8	7.8	15	8.7
NH0101168	MERIDEN VILLAGE WATER DISTRICT	POTW	0.1	0.03	0.53	2.5	1.4	2.9	1.3	1.7
NH0101257	CLAREMONT WWTF	POTW	3.9	1.51	*161*	*161*	*161*	163	146	158
NH0101392	BETHLEHEM VILLAGE WWTP (1)	POTW	0.3	0.21	25	26	25	29	25	26
NHG580226	GROVETON WWTP	POTW	0.4	0.12	18	13	10	12	14	13
NHG580315	COLEBROOK WWTP	POTW	0.5	0.22	26	23	21	31	31	26
NHG580391	CHESHIRE COUNTY MAPLEWOOD NURSING HOME	POTW	0.040	0.02	2.1	1.6	1.3	1.5	1.3	1.5
NHG580404	WINCHESTER WWTP	POTW	0.28	0.14	6.1	11	3.9	13	8.3	8.3
NHG580421	LISBON WWTF	POTW	0.3	0.12	26	23	19	17	17	20
NHG580536	STRATFORD VILLAGE SYSTEM	POTW	0.1	0.01	2.2	1.9	3.9	2.5	2.8	2.7
NHG580978	WOODSVILLE WWTF	POTW	0.3	0.19	22	15	19	19	13	18
NHG581206	NORTHUMBERLAND VILLAGE WPCF	POTW	0.1	0.04	2.7	3.3	3.5	2.6	3.1	3.0
NHG581214	STRATFORD-MILL HOUSE	POTW	0.0	0.01	1.4	1.5	2.2	1.8	2.3	1.8
NHG581249	LANCASTER GRANGE WWTP	POTW	0.0	0.00	0.45	0.53	0.45	0.49	0.44	0.47

EPA: Connecticut River Valley

- 2021 Town & EPA Meeting
  - Spring 2023 Permit Issuance Likely
  - Nitrogen Limit likely:

    10 mg/L, 192 lbs/day
    - Keene (2021)
    - Small General Permit NH (2021)
- 2015-2019 Hanover TN Effluent:
  - 29 mg/L TN avg
  - 332 lbs/day TN avg
  - 576 lbs/day TN peak month

- 2021 Small General Permit

Table 1 - Annual Average Total Nitrogen Limits for Massachusetts WWTF Dischargers to the Long Island Sound Watershed

Facility Design Flow, Q_D (MGD)	Annual Average TN Limit (lb/day)
$Q_D > 10$	Q_D (MGD) * 5 mg/L * 8.34 + optimize
$5 < Q_D \leq 10$	Q_D (MGD) * 8 mg/L * 8.34 + optimize
$1 \leq Q_D \leq 5$	Q_D (MGD) * 10 mg/L * 8.34 + optimize
$0.1 \leq Q_D < 1$	Optimize
$Q_D < 0.1$	TN monitoring only

Table 2 - Annual Average Total Nitrogen Limits for New Hampshire WWTF Dischargers to the Long Island Sound Watershed

Facility Design Flow, Q_D (MGD)	Annual Average TN Limit (lb/day)
$1.5 \leq Q_D$	Q_D (MGD) * 10 mg/L * 8.34 + optimize
$0.1 \leq Q_D < 1.5$	Optimize
$Q_D < 0.1$	TN monitoring only

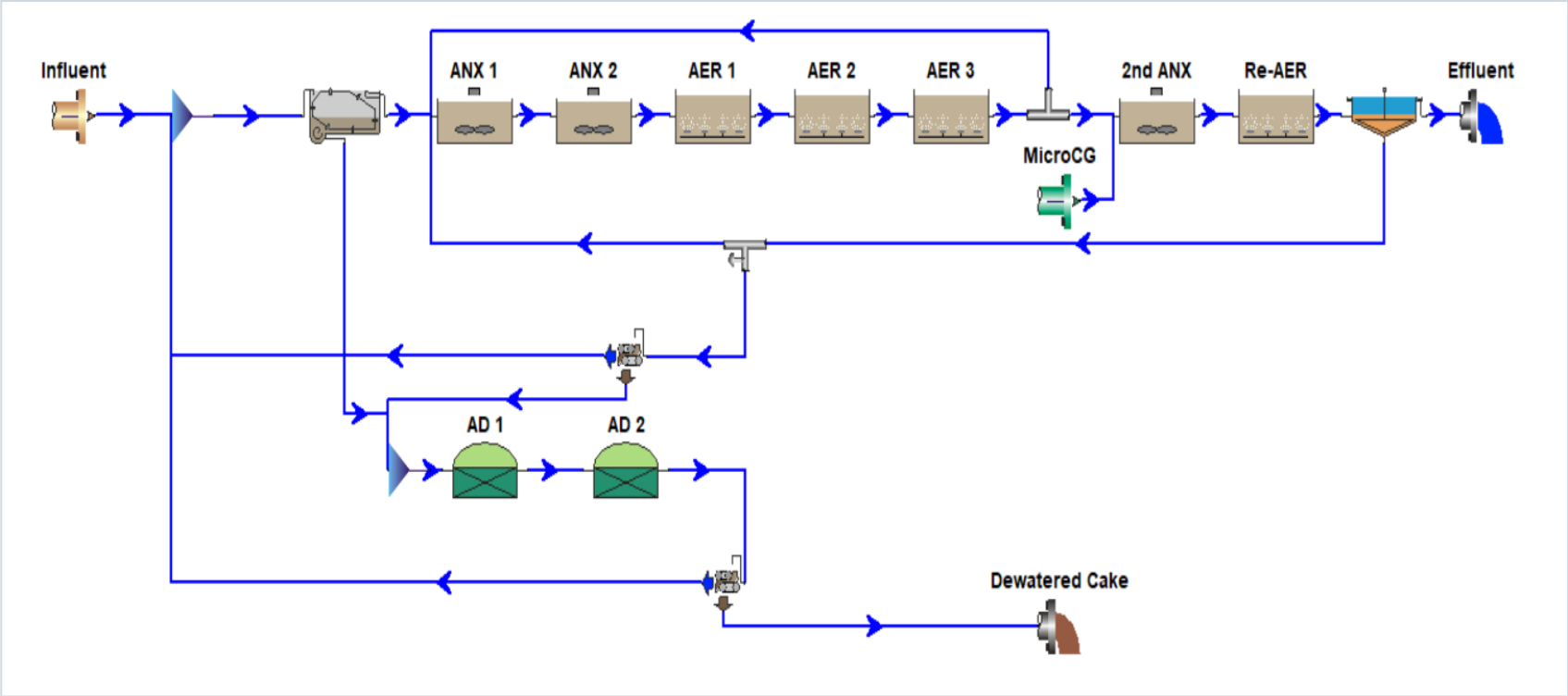
CURRENT FACILITY CANNOT RELIABLY MEET FUTURE TOTAL NITROGEN LIMIT WITHOUT A SIGNIFICANT UPGRADE

REDUCTION OF MORE THAN 2/3 NITROGEN NEEDS TO BE ACHEIVED

Total Nitrogen Removal: Technology Screening

Biological Nitrogen Removal Processes		
Typical Effluent TN		
6-10 mg/l	**5-8 mg/l**	**3-5 mg/l [1]**
Modified Ludzack Ettinger (MLE)	Cyclic Aeration	Sequencing Batch Reactor (SBR)
Bidenitro	Simultaneous Nit-Denit (SND)	Four-Stage Bardenpho
Schreiber	Step-Feed	Tertiary Biologically Active Filter
Side Stream Treatment	---	Moving Bed Bioreactor

Secondary Treatment Process Evaluation



- Existing conditions
- Evaluate treatment capacity
  - BNR reactors, secondary clarifiers
  - Establish min. SRT for complete nitrification
- TN removal, existing tankage
  - Internal recirculation
  - Anoxic zone in existing tankage
- More stringent TN removal, additional tankage
  - Additional reactor volume, post anoxic zone

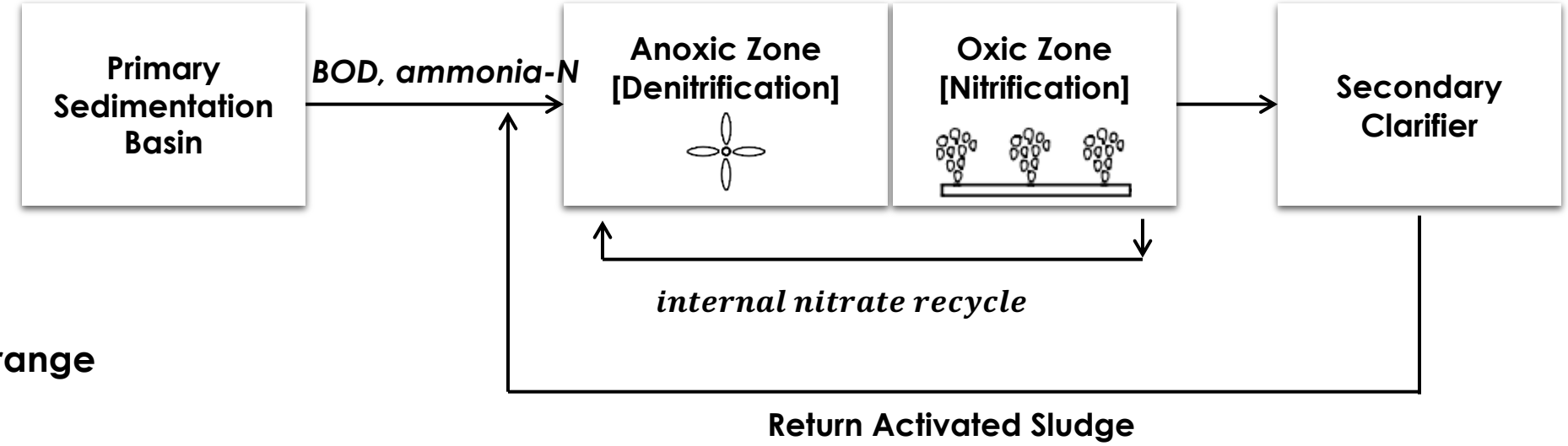
Total Nitrogen Removal: Modified Ludzack-Ettinger

$$\text{ammonia-N} + O_2 \rightarrow (\text{nitrifiers}) \rightarrow H^+ + H_2O + NO_2 + \text{energy}$$
$$NO_2 + O_2 \rightarrow (\text{nitrifiers}) \rightarrow NO_3 + \text{energy}$$

$$\begin{array}{l} \textit{organic carbon} \\ \downarrow \\ NO_3 \rightarrow N_2\ (+\textit{ammonia nitrogen}) \end{array}$$

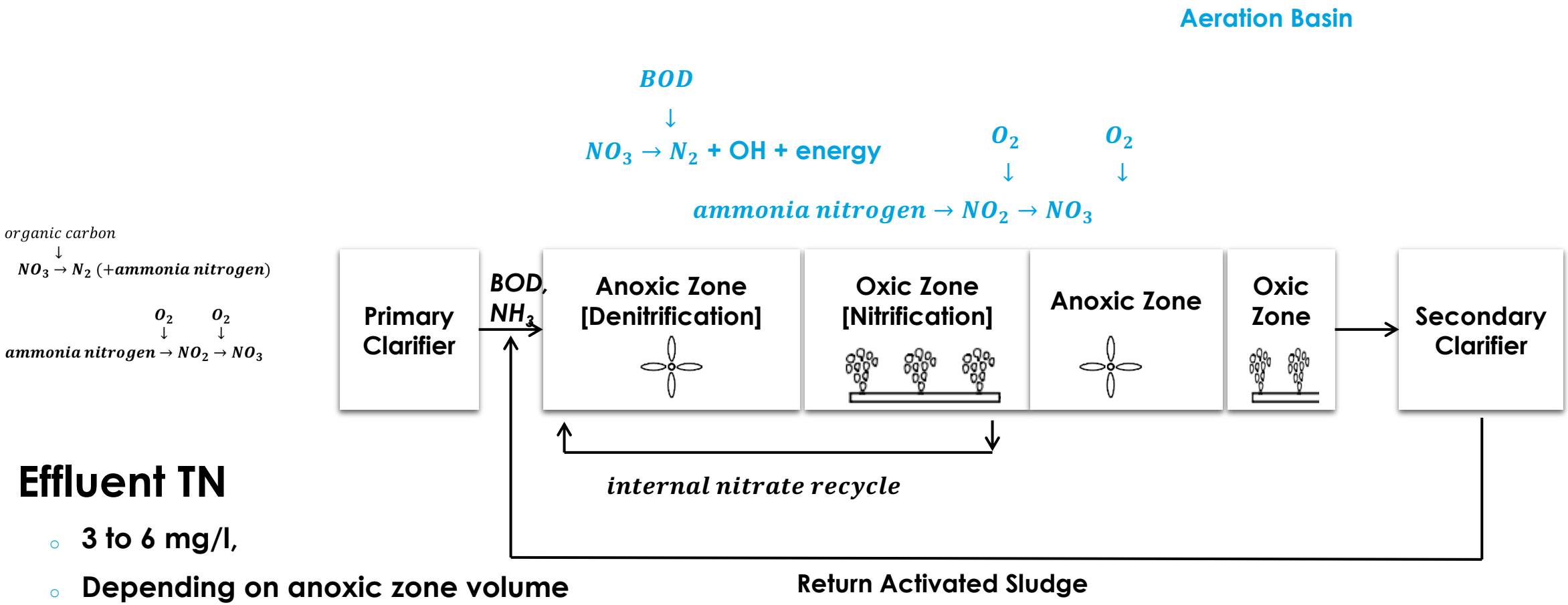
$$\begin{array}{ccc} & O_2 & O_2 \\ & \downarrow & \downarrow \\ \textit{ammonia nitrogen} & \rightarrow & NO_2 \rightarrow NO_3 \end{array}$$

$$BOD + NO_3 \rightarrow (\text{dentrifiers}) \rightarrow N_2 + OH^- + \text{energy}$$



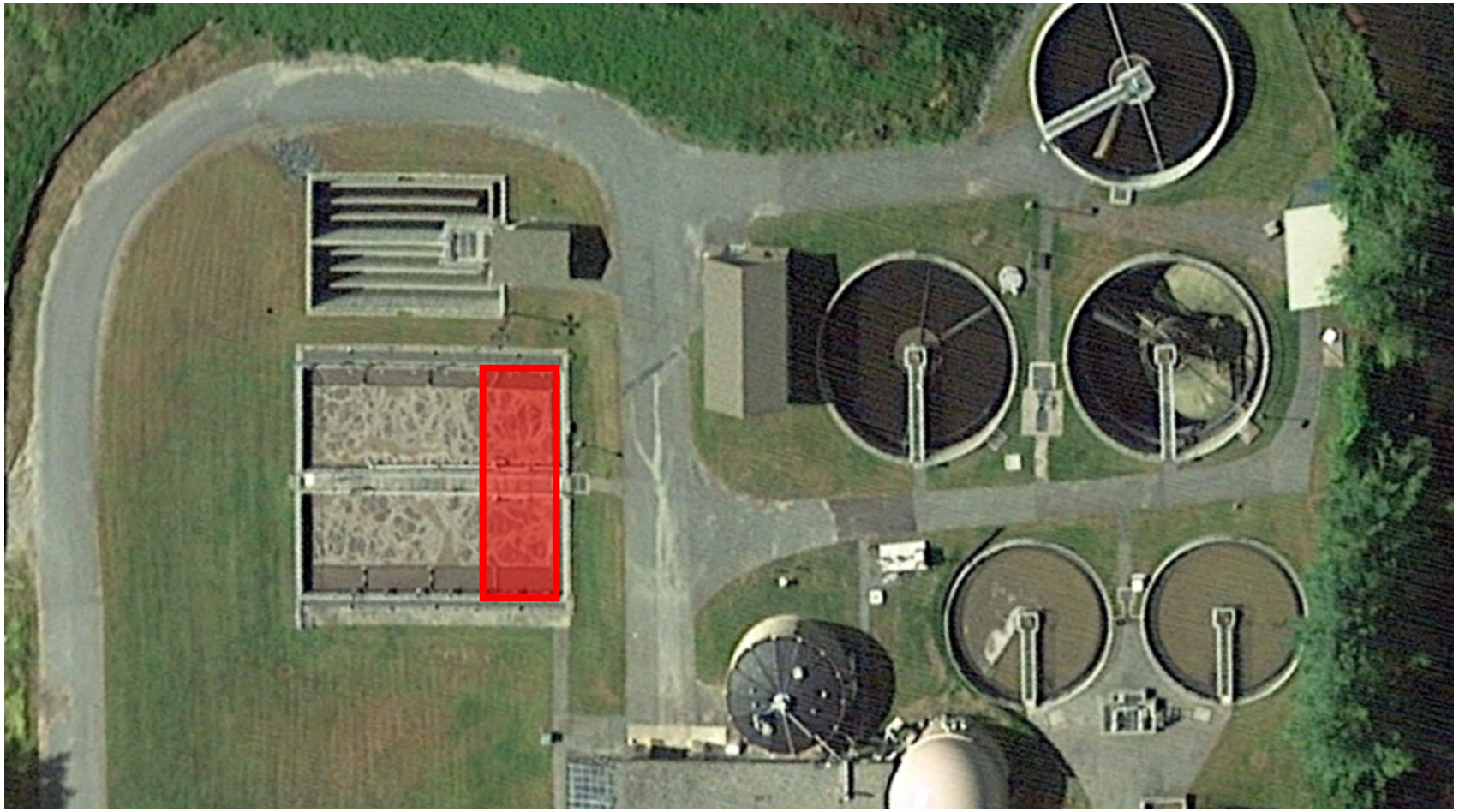
- **Effluent TN**
  - 6 to 10 mg/l range

Total Nitrogen Removal: 4-Stage Bardenpho



- **Effluent TN**
  - 3 to 6 mg/l,
  - Depending on anoxic zone volume and carbon addition levels

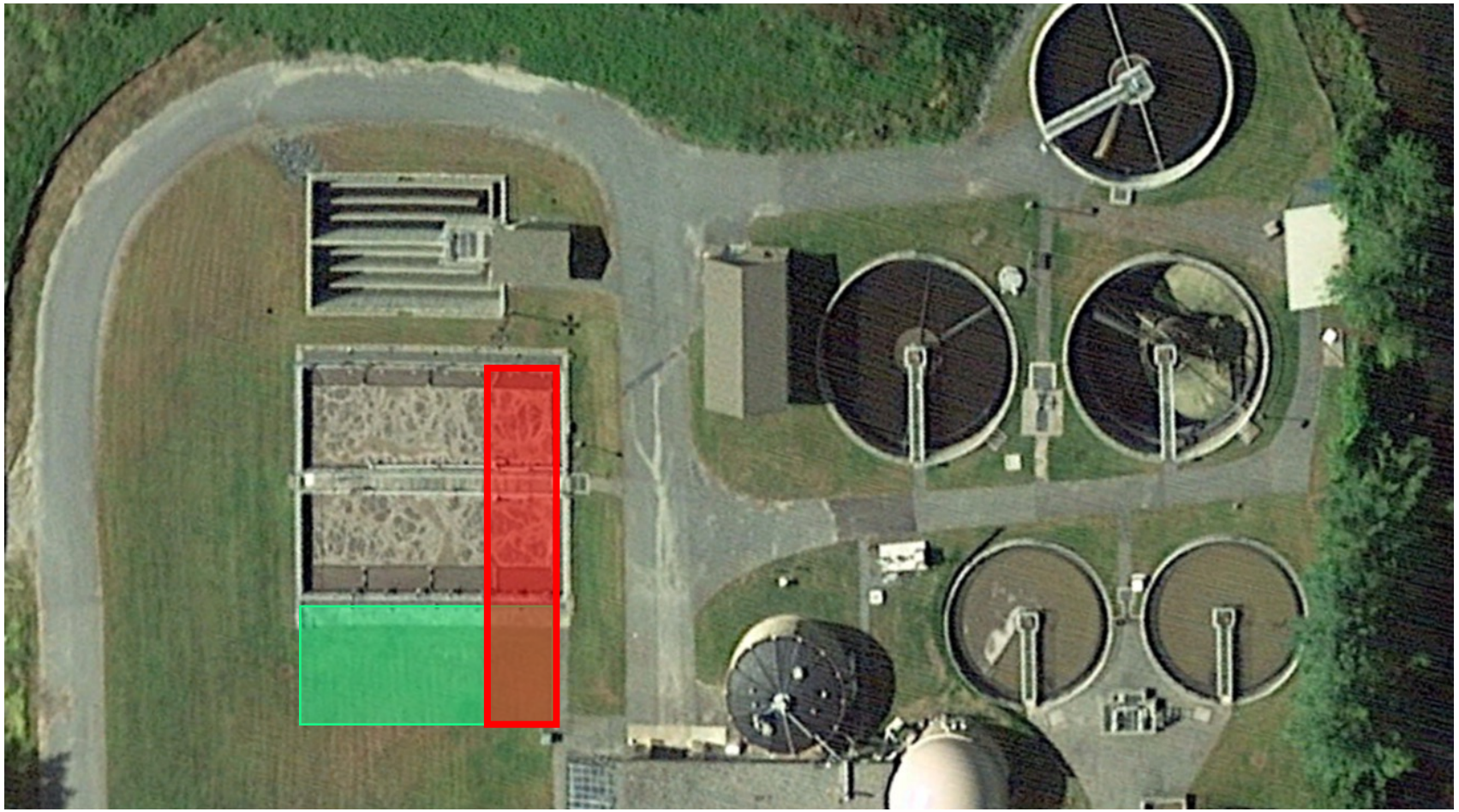
Total Nitrogen Removal: Modified Ludzack-Ettinger



Key Considerations

- Treatment capacity with current volume
- Consider expansion needs
- Potential TN removal performance
  - Anaerobic digestion impacts

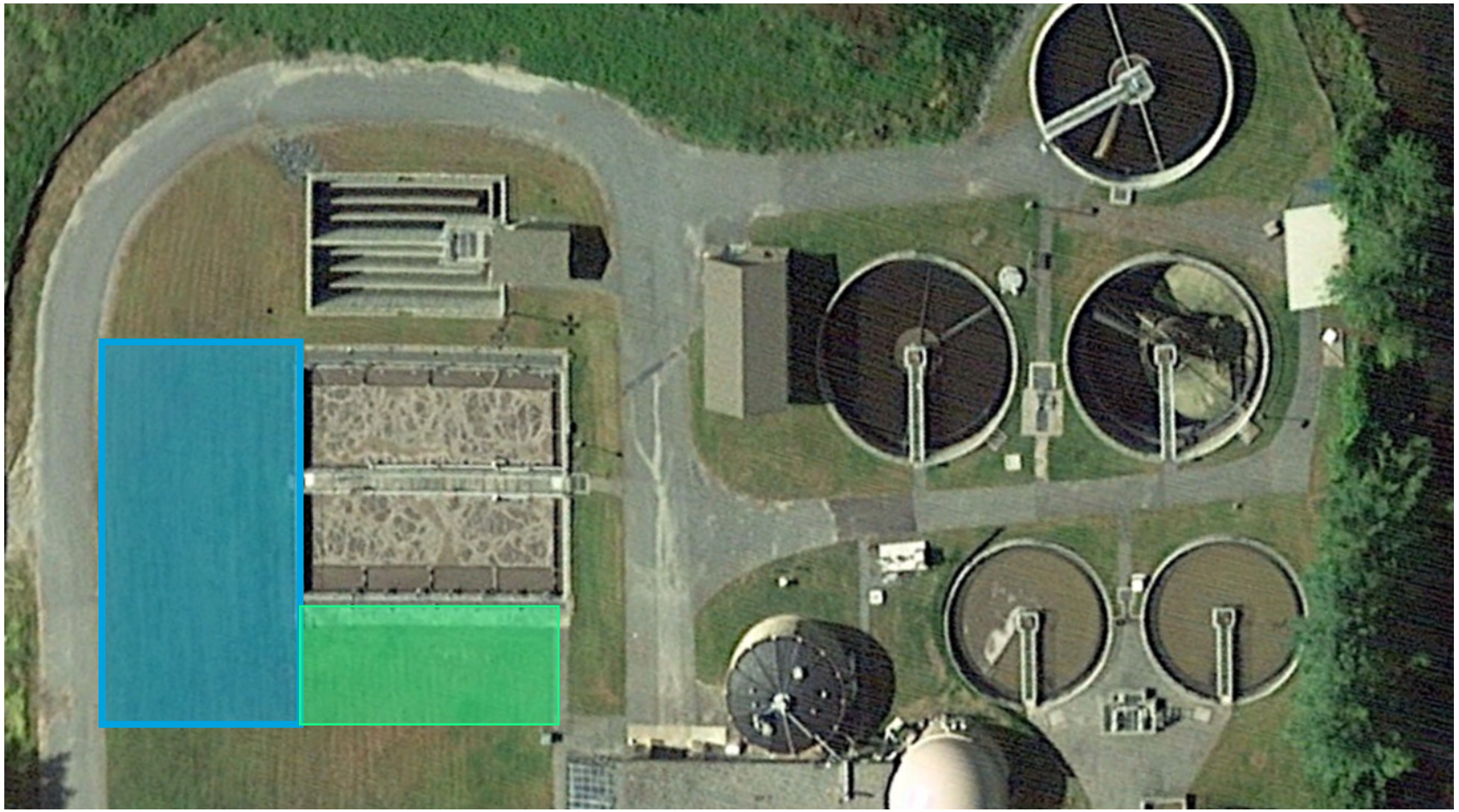
Total Nitrogen Removal: Modified Ludzack-Ettinger



Key Considerations

- **Expansion required**
  - 3 Trains
- **Supplemental carbon needs**
- **Potential TN removal performance**
  - Anaerobic digestion impacts

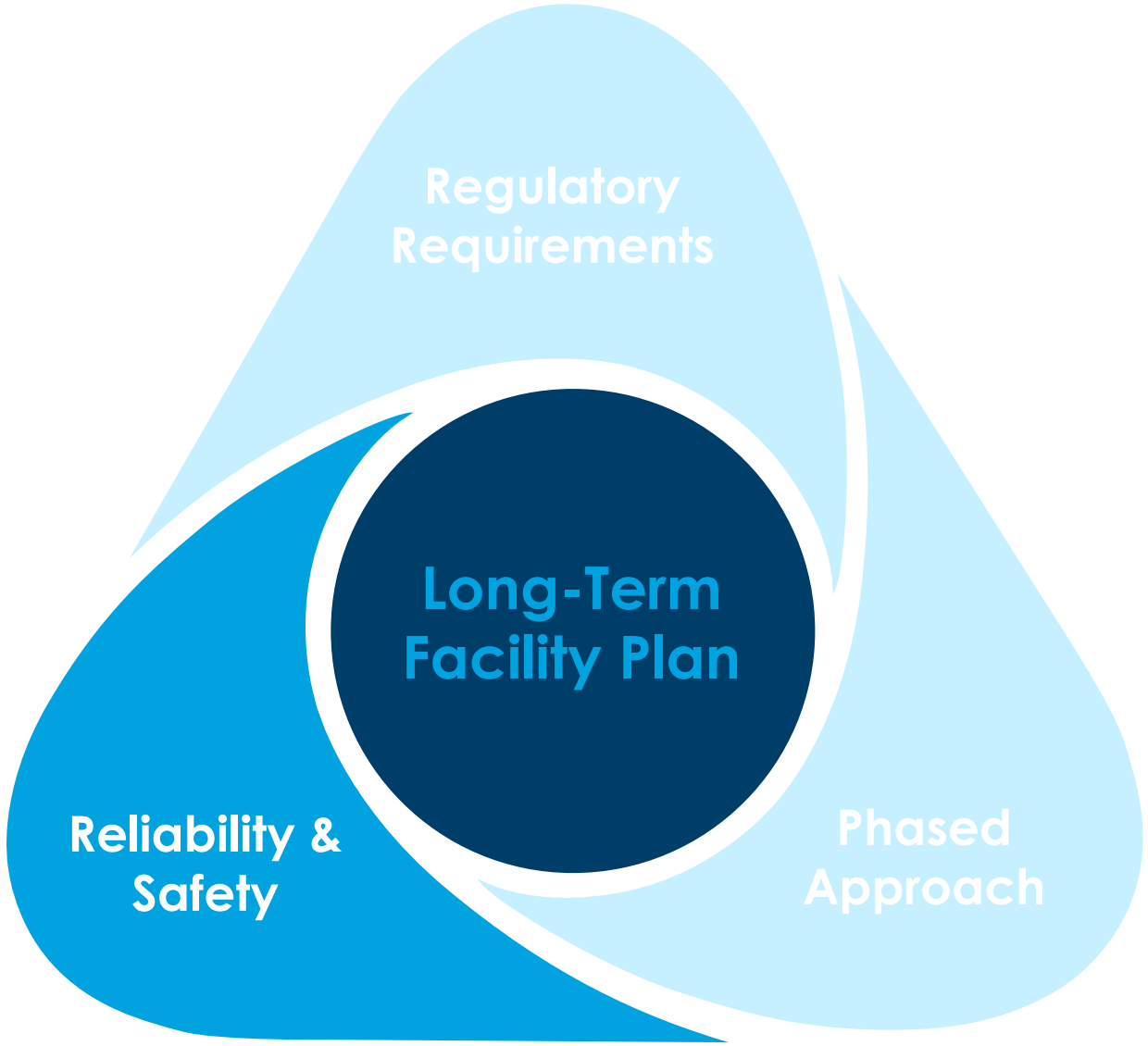
Total Nitrogen Removal: 4-Stage Bardenpho



Key Considerations

- Expansion required
- Supplemental carbon needs
- Potential TN removal performance
  - Anaerobic digestion impacts

Project Foundations



Reliability and Safety

Leftover Projects from 2002-2011

Reliability and Safety

Replace Temporary Projects, Aeration Selectors

Reliability and Safety

Headworks Building (1988)

Reliability and Safety

Headworks Building (1988)

Reliability and Safety

Septage Receiving (1988)

Reliability and Safety

Treatment: Secondary Clarifiers (1988)

Reliability and Safety

Sludge Thickening (1988) and Influent Screening

Reliability and Safety

Safety and Access

Reliability and Safety

Yard Electrical Distribution

Reliability and Safety

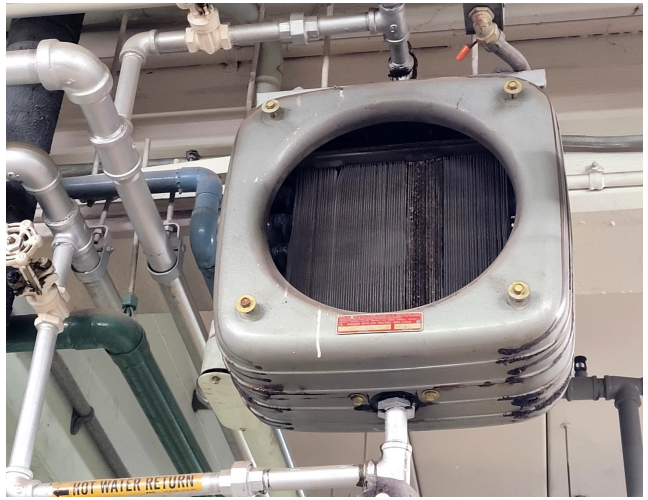
Motor Control Center (1988)

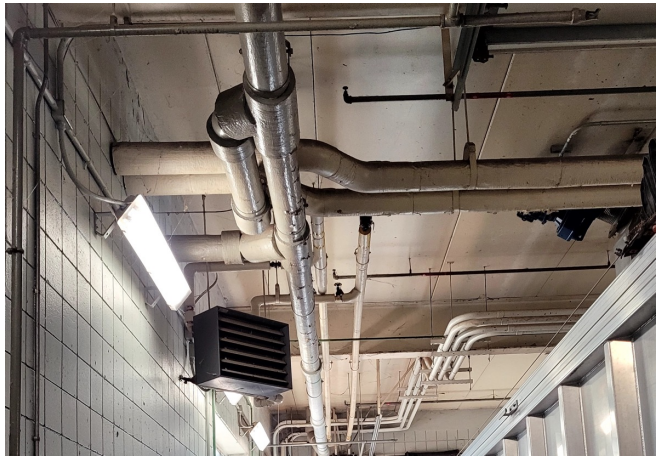
Reliability and Safety

HVAC Systems

Reliability and Safety

HVAC Systems



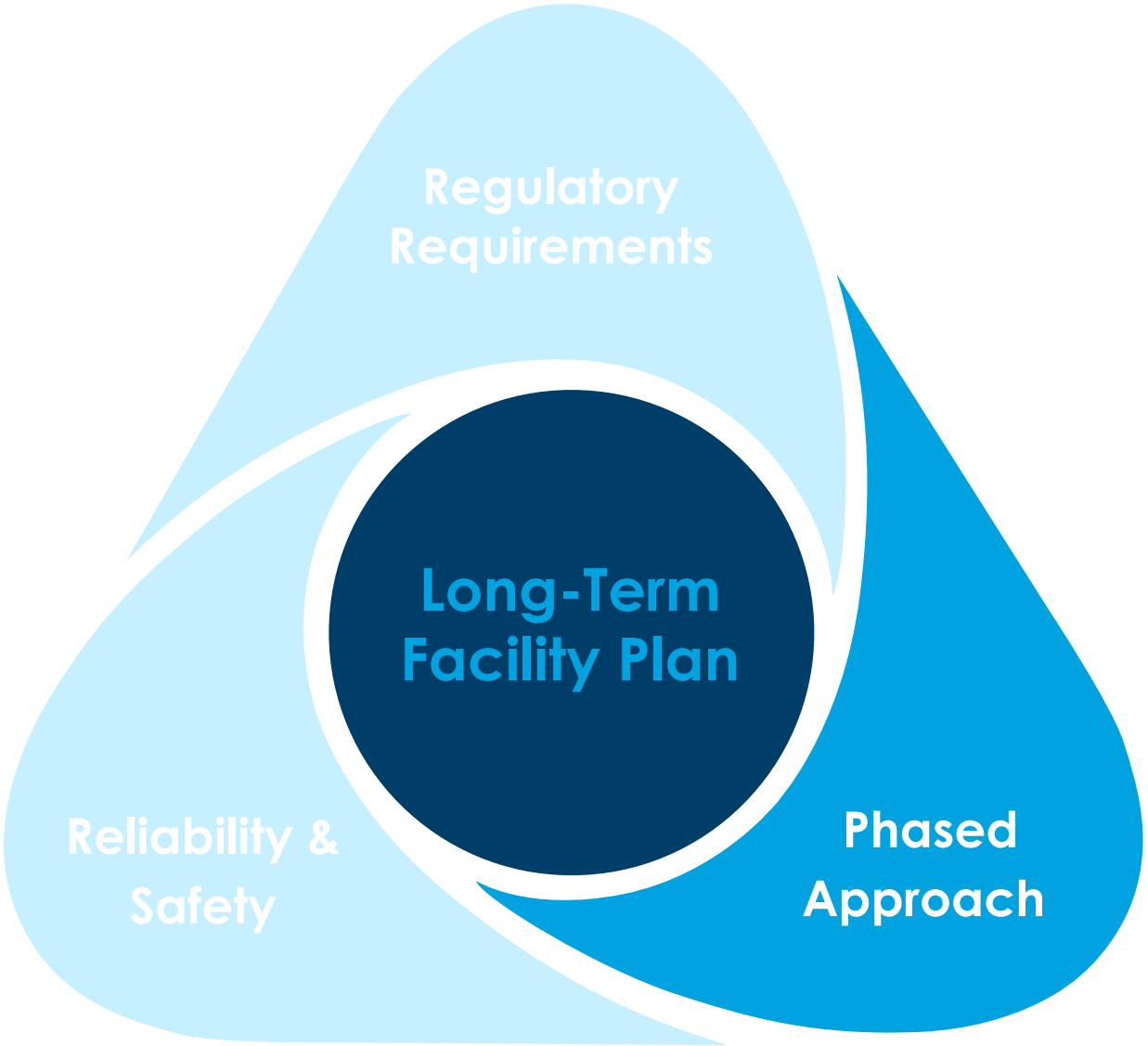


Reliability and Safety

Operations Building

Architectural, Plumbing, HVAC, Electrical

Project Foundations

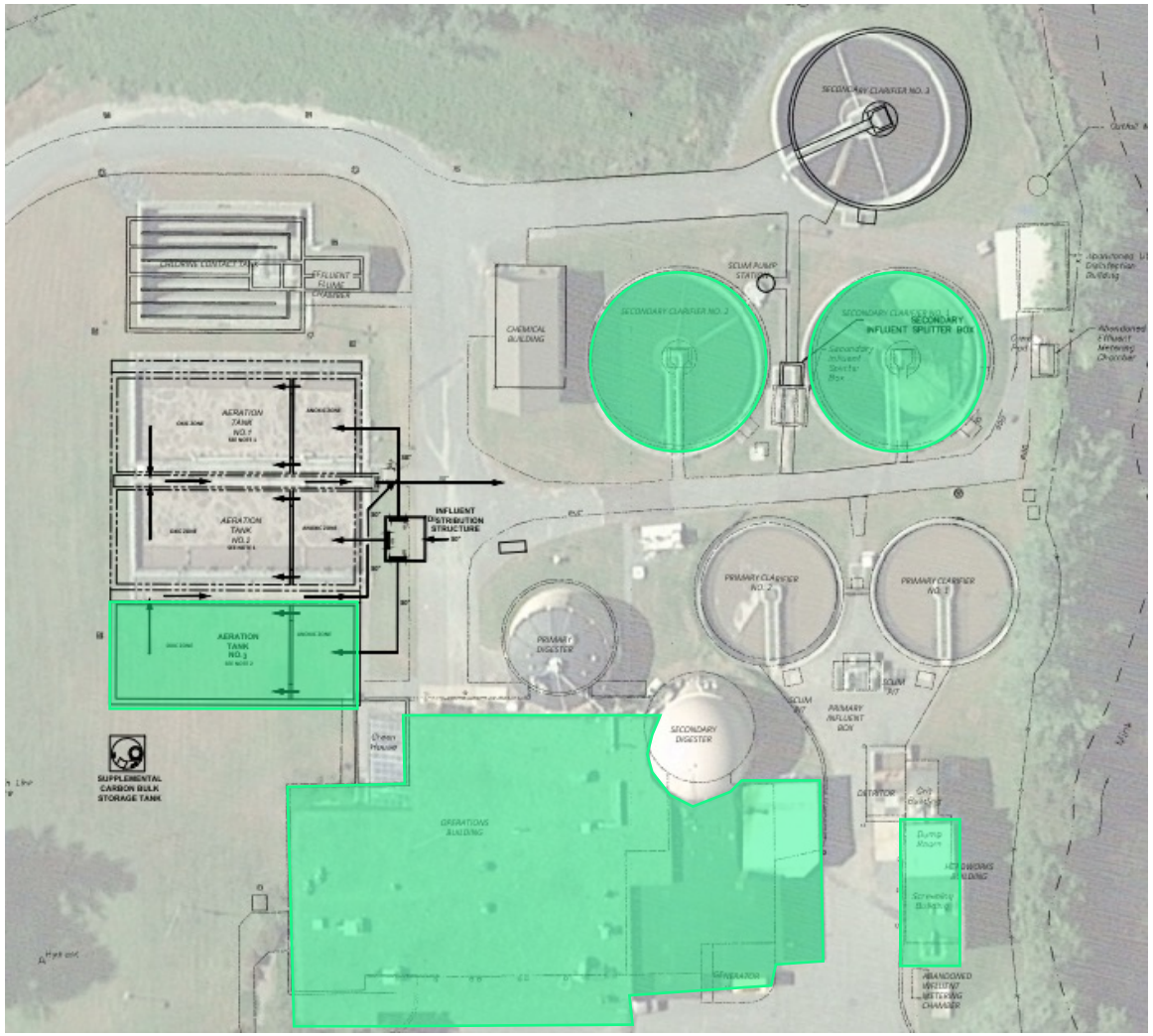


Current Project and Future Needs

- **Current Project – 2023 - $22M**
  - **Highest Priority**
  - **2023 NPDES Permit Requirements**
  - **Criticality & Risk of Failing Equipment**
  - **Safety**
  - **Operations Building**

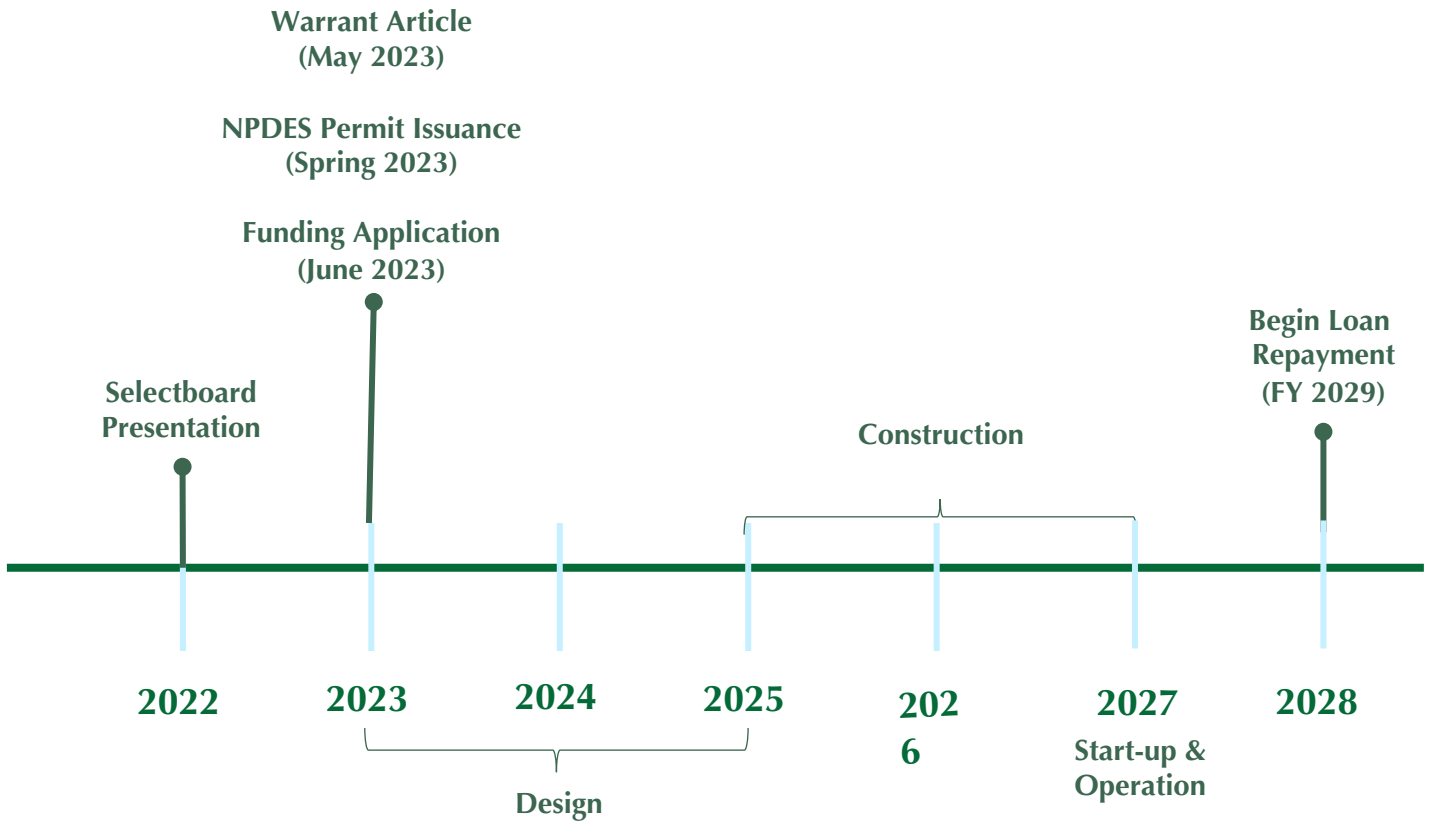
- **Future Projects**
  - 2033 - $16M
    - Critical Equipment Replacement
  - 2043 - $17M
    - Facility expansion
    - More stringent NPDES Permit

Proposed Project:



- Aeration Tank Expansion
  - 3 Trains
- Secondary Clarifiers
- Headworks Building
- Operations Building
  - Equipment
  - Building Systems:
    - Architectural
    - Electrical
    - Plumbing, HVAC
- Site: Electrical

Proposed Project: Project Schedule



WRIGHT-PIERCE
Engineering a Better Environment

Proposed Project: Cost

Priority	Capital Upgrade Item	Total Project Cost
1	Three-Train Modified Ludzack-Ettinger (MLE) Process Nutrient Removal Upgrade	$7.30 M
2	Aged Wastewater Equipment Replacement	$4.55 M
3	Operations Building – Administration Area Improvements	$1.26 M
4	Purchase Spare Parts for Redundancy and Purchase/Replace Sodium Bisulfite Submersible Mixer	$0.25 M
5	Electrical and Instrumentation WRF Site Improvements	$0.47 M
6	Modify Influent Flow Meter Vault and Install Magnetic Flow Meter	$0.12 M
7	Headworks Building Upgrades	$4.17 M
8	Operations Building – Process Equipment Areas, Garage, Maintenance Shop Space Improvements (Critical Needs)	$1.73 M
9	Pipe Thickness Testing and Valve Replacement for Solids Piping	$0.09 M
	Contingency	$2.09 M
	TOTAL PHASE I	**$22 M**

Funding

- **NHDES State Revolving Loan Fund**
  - 2022 Priority List
    - 15 projects offered funding as of August 2022
  - $22M Total Project Cost
  - $2.2 M Principal Forgiveness (10%)
  - SRF rates 2.536% interest for 20 year loan
- **NHDES State Aid Grant eligible**
  - $4.4M
  - (deferred grant funding)

Proposed Project: Existing Debt

Loans	Principal	Interest	Total	Matures	FY
2008 SRF $2.9 M	$148,198	$36,184	$189,551	12/1/2027	2028
2013 ARRA Ln $1.7 M	$63,393	$11,718	$74,111	12/1/2026	2027
2013 SRF $4.235 M	$287,827	$55,479	$343,305	7/1/2026	2027

- With current tax rate-repayment-retiring approx. $7.4 M in loans by Fiscal 2028

Proposed Project: Proposed Debt

Loans	Principal	Int. Rate	Yearly Payment	Matures
2023 SRF $22 M	$19.8 M	2.536%	~$1.268 M	2048

- 10% principal forgiveness

- **Potential Rate Impact Scenario – For this project only**

	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Rate Increase from FY 2023	0%	3.8%	7.6%	11.4%	15.2%	19.0%	22.8%
Average Domestic User (185 gal/day)	$475.00	$493.07	$511.14	$529.20	$547.27	$565.34	$583.41

THANK YOU

Proposed Project: Future Project Cost (2033)

Capital Upgrade Item	Total Project Cost
WRF Electric Service	$1.87 M
Dewatering Feed Pumps, Centrifuges, and Conveyors Replacement	$3.6 M
Secondary Clarifier No. 3 Mechanism and Secondary Scum Pump (With Mixing Valve) Replacement	$1.41 M
Pump Replacement and Select Pipe and Valve Replacement – Grit Pump, Plant Water Pumps and Equipment, Primary Sludge Pumps and Motor Actuators/Valves, TWAS Pump, RAS & WAS Pumps, and Primary Sludge/RAS/WAS Piping and Valves	$1.86 M
Disinfection Chemical Feed Storage Tanks Replacement	$0.25 M
PLC/SCADA System Upgrade	$1.21 M
Operations Building – Process Equipment Areas, Garage, and Maintenance Shop Space Electrical and HVAC Improvements (items not upgraded in Phase I)	$1.02 M
WRF Generator Replacement	$0.76 M
Anaerobic Digester Conversion to Sludge Storage Tanks and Demolition of TWAS Storage Tank	$2.32 M
Chemical Building HVAC Improvements	$0.34 M
Contingency	$1.45 M
TOTAL PHASE II	**$16 M**

Proposed Project: Future Project Cost (2043)

Capital Upgrade Item	Total Project Cost
Four-Stage Bardenpho Process Nutrient Removal Upgrade	$9.37 M
Grit System Replacement[1]	$2.02 M
Primary Clarifier No. 1 and No. 2 Mechanism Replacement [2]	$2.86 M
Secondary Clarifier Influent Splitter Box Structure Gate Replacement	$0.11 M
Chlorine Contact Tanks Gate Replacement	$0.11 M
Electrical Improvements in Chemical Building	$0.95 M
Contingency	$1.58 M
TOTAL PHASE II	**$17 M**

Resources

- Assessment of existing infrastructure
- Short-list potential solutions to address WRF needs
- Detailed alternative analysis
- Capital, O&M and 20-year life-cycle costs
- Recommended solutions
- Implementation plan/schedule
- Involve public/stakeholders

Proposed Project: Existing Conditions