Pennsylvania Water Environment Federation
PennTEC Annual Technical Conference
June 4, 2013

Altoona Westerly Wastewater Treatment Facility BNR Conversion with Wet Weather Accommodation

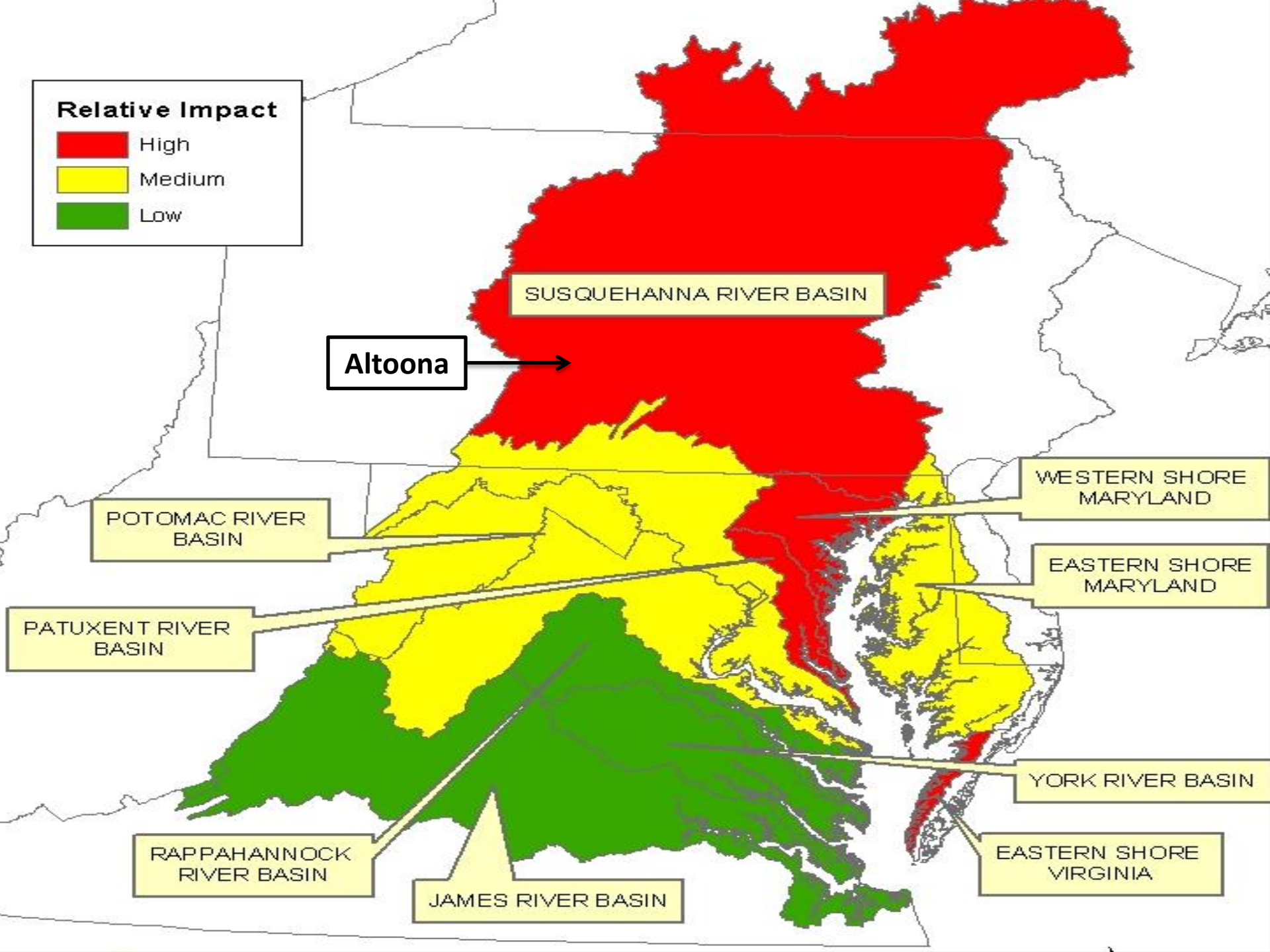
Presented by:
Jim Balliet, Secretary/Facilities Planning Director
GWIN, DOBSON & FOREMAN, INC.
Consulting Engineers

Westerly Treatment Facility

- Originally constructed in 1952
- Upstream 125 year old CSO System; “first flush” storage and pumping facility
- Upgraded in 1990
  - Coarse screening and aerated grit removal
  - Complete mix activated sludge, single stage nitrification
  - Final clarification and UV disinfection
  - Equalization storage
- Avg. Daily Flow – 10.8 mgd, Peak Flow – 60 mgd
- Altoona Water Authority – System Owner/Operator

The Chesapeake Bay Strategy

- PA Dept. of Environmental Protection issued new NPDES permits to Altoona with mass annual nutrient load limits
- Average effluent Nitrogen of 14.4 mg/l exceeds future cap load by 80,000 pounds, reduce N discharge by 45%
- Average effluent Phosphorus of 3.0 mg/l exceeds future cap load by 15,000 pounds, reduce P discharge by 55%
- Nutrient Cap Load Target Concentrations:
  - Effluent Nitrogen – 5.0 mg/l
  - Effluent Phosphorus – 0.67 mg/l


Relative Impact
High
Medium
Low
SUSQUEHANNA RIVER BASIN
Altoona
POTOMAC RIVER BASIN
WESTERN SHORE MARYLAND
EASTERN SHORE MARYLAND
PATUXENT RIVER BASIN
YORK RIVER BASIN
RAPPAHANNOCK RIVER BASIN
JAMES RIVER BASIN
EASTERN SHORE VIRGINIA

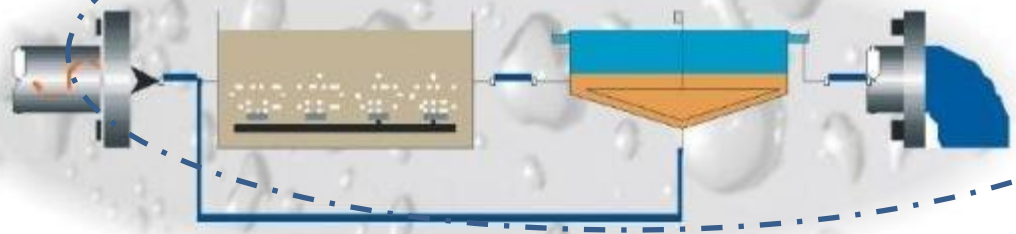
Project Goals

- **Reduce effluent nutrients levels** to ensure regulatory compliance
- **Treat wet weather CSO flows** while preventing washout of process nutrient biomass
- **Use sustainable design** by maximizing use of existing facilities; reduce chemical consumption/waste solids
- **Reduce energy consumption** using gravity flow, efficient NRT process
- **Reduce operating costs** by using energy-efficient equipment and process monitoring & control system
- **Generate nutrient credits** for sale on PA credit market

Evaluation of Alternatives

- Conducted extensive influent testing to characterize waste over full range of flows
- Evaluated existing treatment processes and conducted preliminary screening of various Nutrient Removal Technologies (NRT)
- BioWin process modeling of selected NRT processes with site-specific kinetic rates verified by High F/M testing
- Evaluate wet weather CSO treatment options
- Process evaluation by GDF and Bassett Engineering (process modeling and NRT consultant)

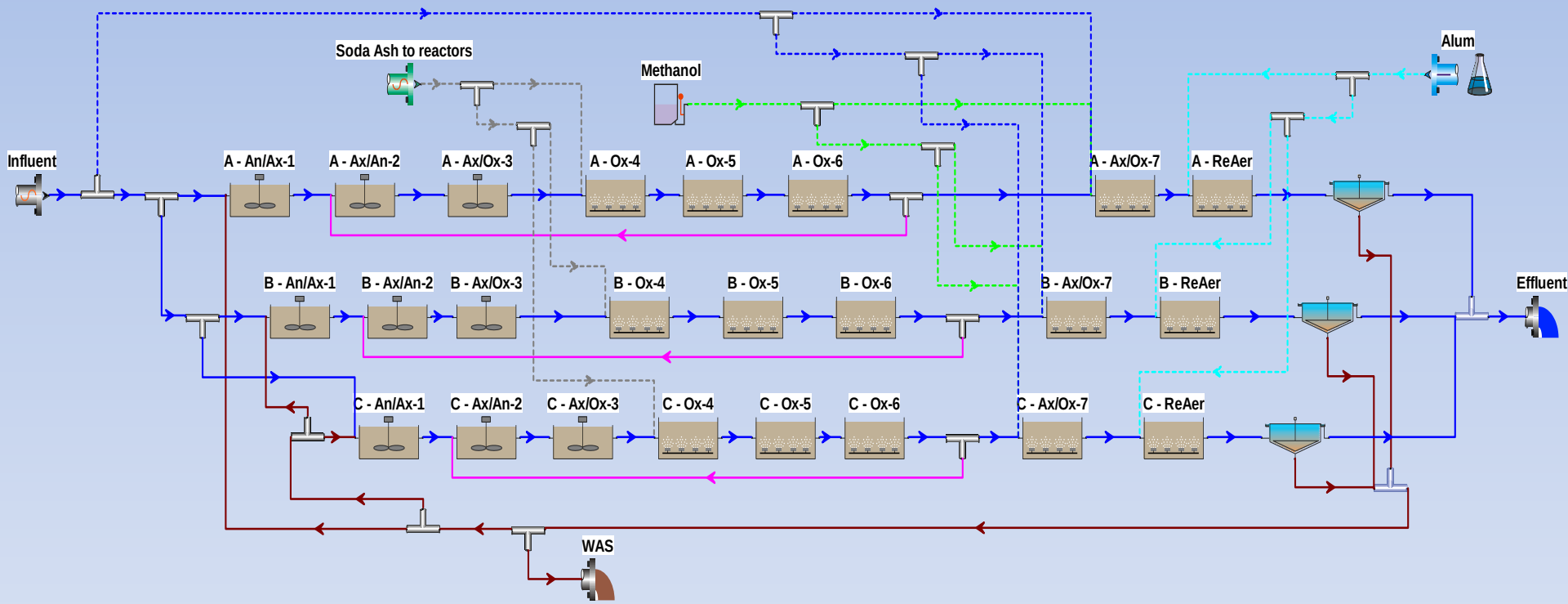
BioWin



Simulates biological processes of wastewater treatment plants

Developed By

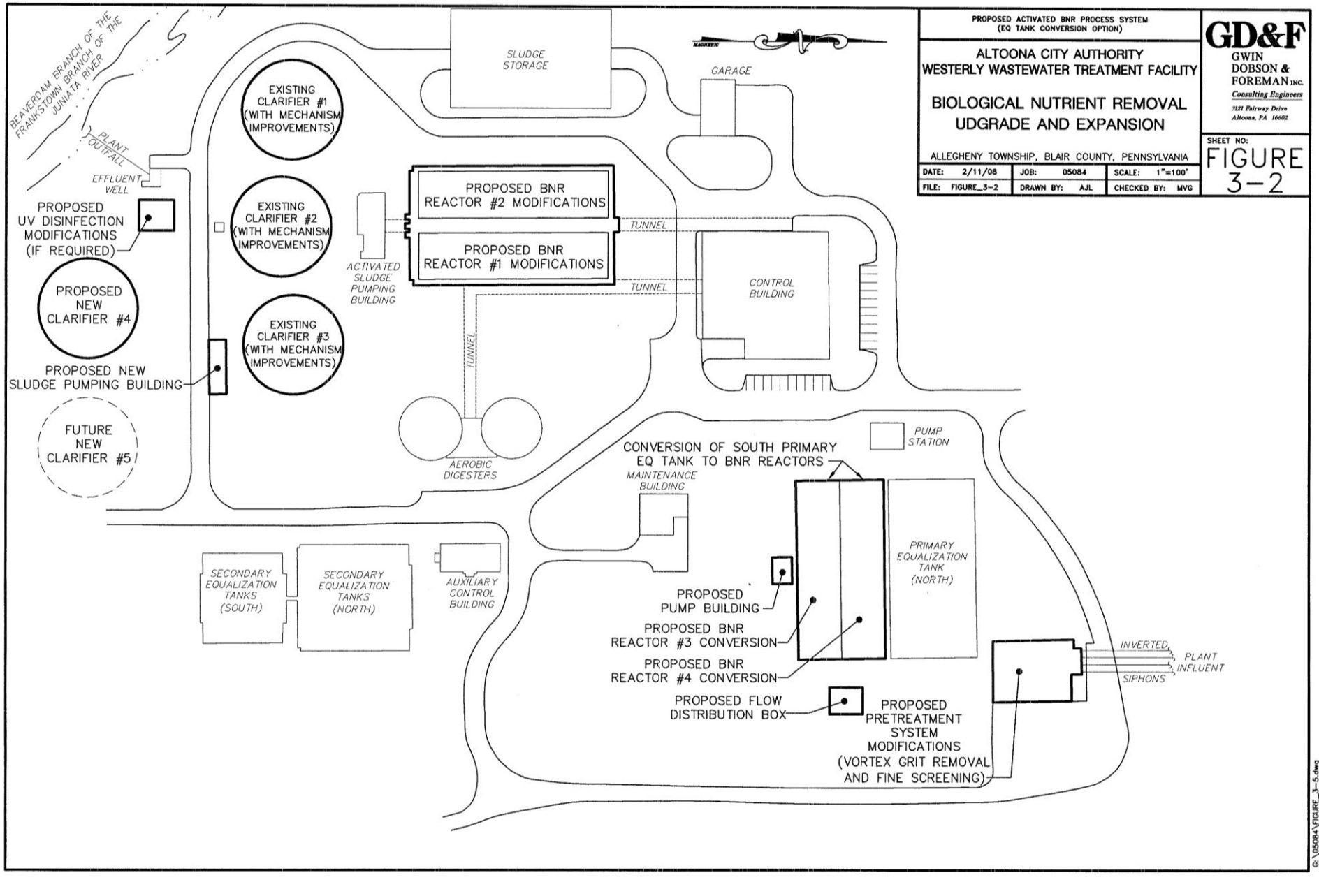
EnviroSim ASSOCIATES LTD.



BioWin Model for NRT Process

Selected Process

- Replace existing screens with fine screens.
- Replace aerated grit system with vortex grit separators
- Convert south EQ tank to two plug flow reactors.
- Convert existing aeration basins to two plug flow reactors.
- Construct fourth secondary clarifier.
- Provide chemical feed systems.
- Upgrade SCADA/instrumentation systems.


PROPOSED ACTIVATED BNR PROCESS SYSTEM
(EQ TANK CONVERSION OPTION)
ALTOONA CITY AUTHORITY
WESTERLY WASTEWATER TREATMENT FACILITY
BIOLOGICAL NUTRIENT REMOVAL
UDGRADE AND EXPANSION
ALLEGHENY TOWNSHIP, BLAIR COUNTY, PENNSYLVANIA
DATE: 2/11/08
JOB: 05084
SCALE: 1"=100'
FILE: FIGURE_3-2
DRAWN BY: AJL
CHECKED BY: MVG
GD&F
GWIN DOBSON & FOREMAN INC.
Consulting Engineers
3121 Fairway Drive
Altoona, PA 16602
SHEET NO:
FIGURE 3-2
BEAVERDAM BRANCH OF THE FRANKSTOWN BRANCH OF THE JUNIATA RIVER
PLANT OUTFALL
EFFLUENT WELL
PROPOSED UV DISINFECTION MODIFICATIONS (IF REQUIRED)
PROPOSED NEW CLARIFIER #4
PROPOSED NEW SLUDGE PUMPING BUILDING
FUTURE NEW CLARIFIER #5
EXISTING CLARIFIER #1 (WITH MECHANISM IMPROVEMENTS)
EXISTING CLARIFIER #2 (WITH MECHANISM IMPROVEMENTS)
EXISTING CLARIFIER #3 (WITH MECHANISM IMPROVEMENTS)
SLUDGE STORAGE
GARAGE
ACTIVATED SLUDGE PUMPING BUILDING
PROPOSED BNR REACTOR #2 MODIFICATIONS
PROPOSED BNR REACTOR #1 MODIFICATIONS
TUNNEL
TUNNEL
TUNNEL
CONTROL BUILDING
AEROBIC DIGESTERS
PUMP STATION
CONVERSION OF SOUTH PRIMARY EQ TANK TO BNR REACTORS
MAINTENANCE BUILDING
PRIMARY EQUALIZATION TANK (NORTH)
SECONDARY EQUALIZATION TANKS (SOUTH)
SECONDARY EQUALIZATION TANKS (NORTH)
AUXILIARY CONTROL BUILDING
PROPOSED PUMP BUILDING
PROPOSED BNR REACTOR #3 CONVERSION
PROPOSED BNR REACTOR #4 CONVERSION
PROPOSED FLOW DISTRIBUTION BOX
PROPOSED PRETREATMENT SYSTEM MODIFICATIONS (VORTEX GRIT REMOVAL AND FINE SCREENING)
INVERTED SIPHONS
PLANT INFLUENT
G:\05084\FIGURE_3-5.dwg

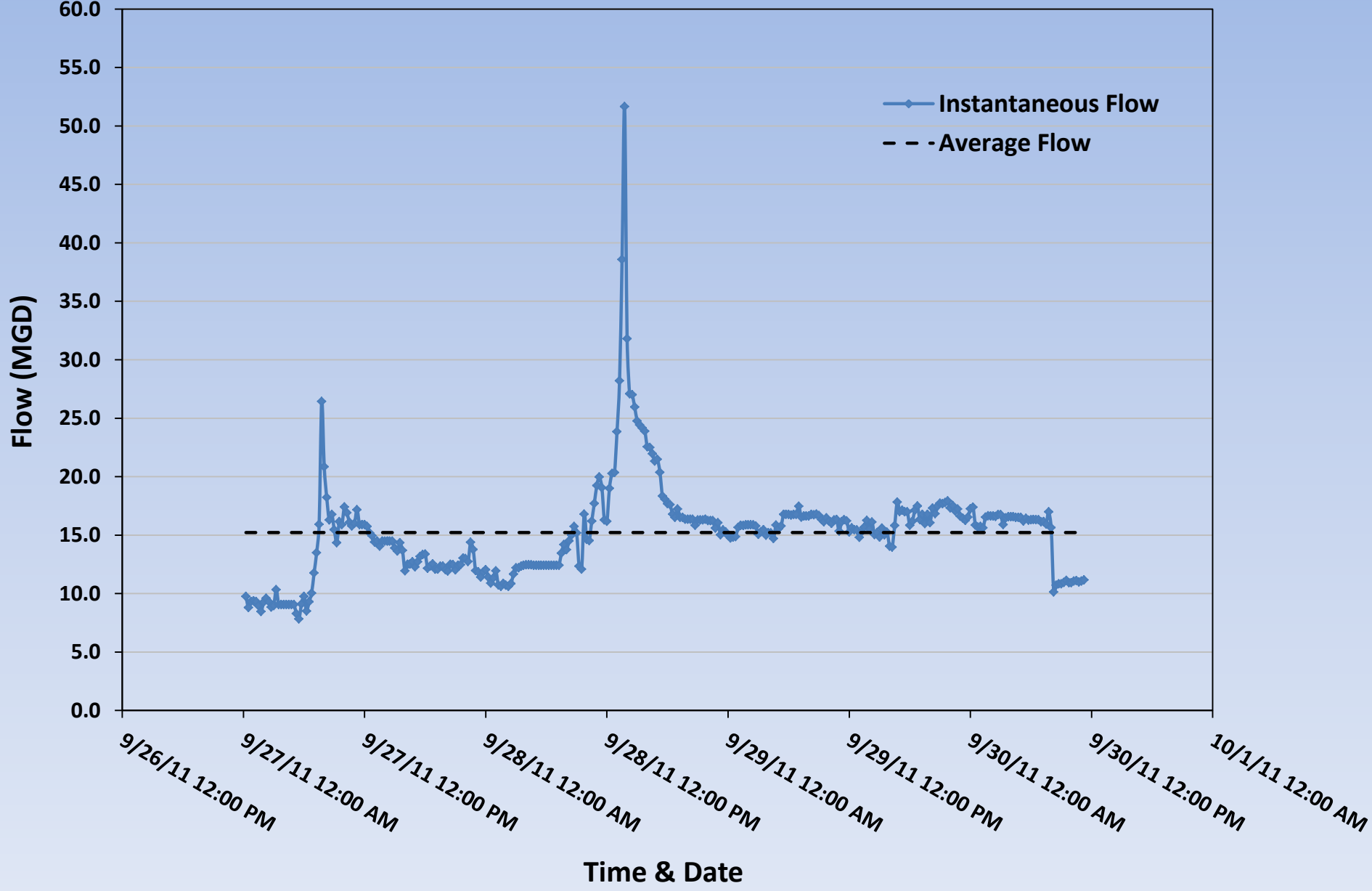
1) Headworks building, 2) Primary Equalization Tanks, 3) Secondary Equalization Tanks 4) BNR Reactors 1 & 2, 5) BNR Reactors 3 & 4, 6) Final Clarifiers, 7) UV Units, 8) Aerobic Digesters, 9) Digested Solids EQ/Feed Tank, 10) Control Building and Sludge Handling

Conversion of South Equalization Tank to NRT Reactors

Selected Process

- Provide nutrient removal using four plug NRT reactors.
- Operational flexibility to operate various nutrient removal processes including Bardenpho, MLE, VIP, A20 and Hybrid
- **Step feed high, diluted wet weather CSO flow to last oxic and swing zones to provide secondary (contact stabilization) treatment**

Westerly WWTF
Typical Peak Flow Event (September 27 - October 7, 2011)



Construction of Aeration Tanks Conversion, Distribution Box and Adjacent Step-Feed Channel

Existing Aeration Tanks Converted to NRT Reactors and Adjacent Step-Feed Channel to Last Oxic Zone

Hybrid BNR Feature

- Process combines the mixed liquor recycle feature from the VIP process with the Bardenpho process
- Mixed liquor from the final anoxic zone is recycled to the first anaerobic zone
- Lowers the oxidation/reduction potential (ORP) in the anaerobic zone
- Increases phosphorus release and enhances biological phosphorus removal
- Consistently meets P limits without chemical addition

NRT Reactor

Step Feed

- Diverts high wet weather CSO flow to last oxic zone
- Provides biological treatment of all CSO flows via contact stabilization (1-2 hour detention)
- Preserves treatment process sequence (anaerobic, anoxic and aerobic)
- Preserves nitrifiers and maintains N removal during and after high flow events
- Prevents elevated DO concentrations in process.
- Preserves solids washout in clarifiers

Sustainable Design

- Converted existing aeration tank into two plug flow NRT reactors
- Converted existing equalization basin into two plug flow NRT reactors
- Existing tanks were retrofitted with baffle walls to create anaerobic, anoxic and aerobic zones
- Constructed slightly submerged walls with underflow ports
- Located recycle pumps in existing pipe gallery
- Reused air distribution piping, existing flow distribution channels, RAS piping and effluent channels

Retrofitting of Existing Equalization Tank to NRT Reactor

Pipe Gallery Tunnel with Internal Recycle & Air Piping

Operational Flexibility

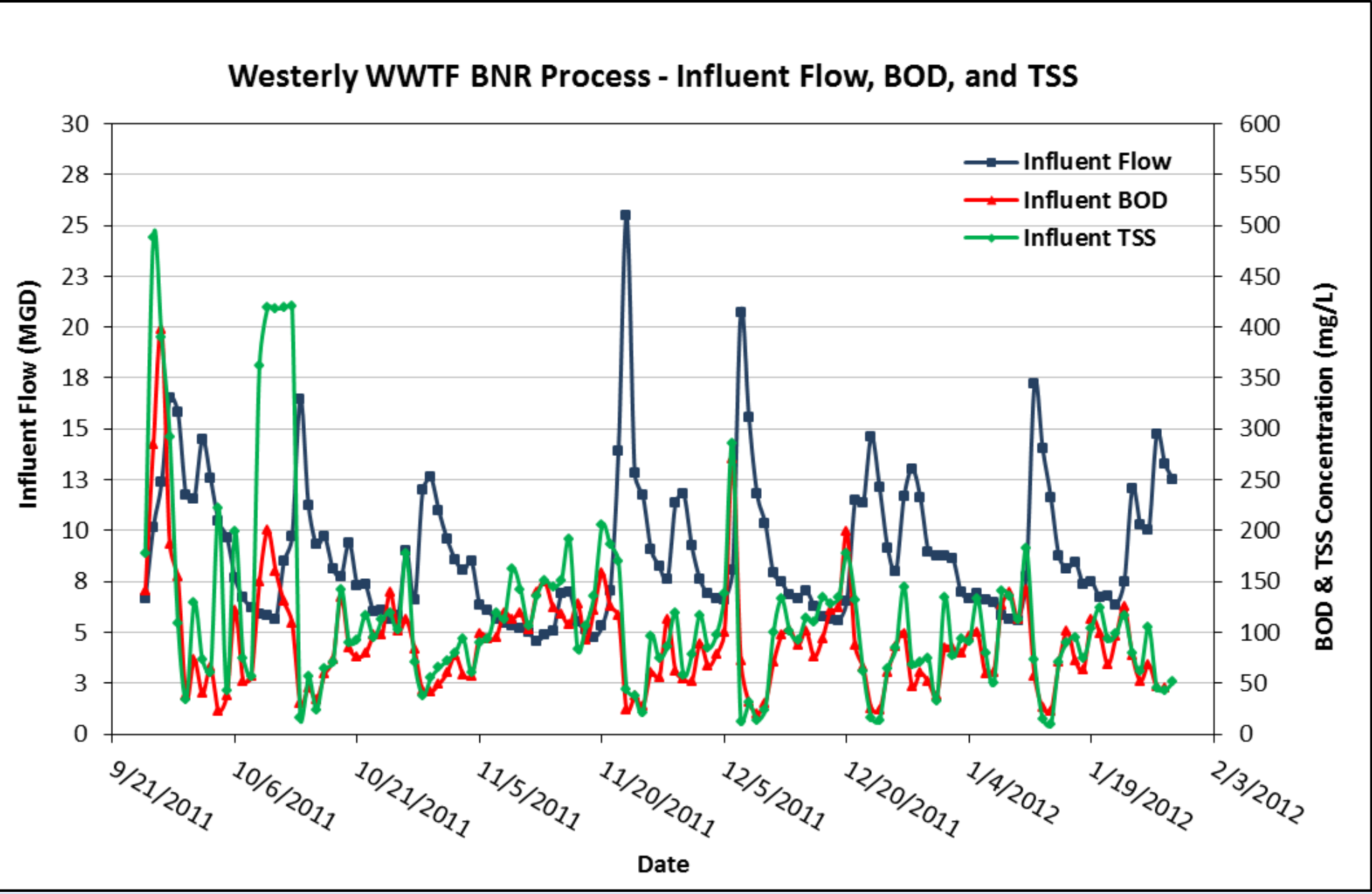
- Facility can operate in a variety of plug flow NRT removal modes (MLE, Stage 4/5 Bardenpho)
- **Current operation uses Virginia Initiative Plant (VIP) process for step feeding wet weather flow**
- Second anoxic zone is a switch zone (mixer and diffusers) and can operate as an oxic zone during step feed
- VIP process produces lower effluent N during cold weather without the second anoxic zone
- Internal RAS/MLSS/Nutrient recycle streams can draw and pump to multiple zones
- Wet weather CSO flow treated in contact stabilization mode in switch zone/last oxic zone

Switch Zone – Membrane Diffusers (oxic) & Submersible Mixers (anoxic)

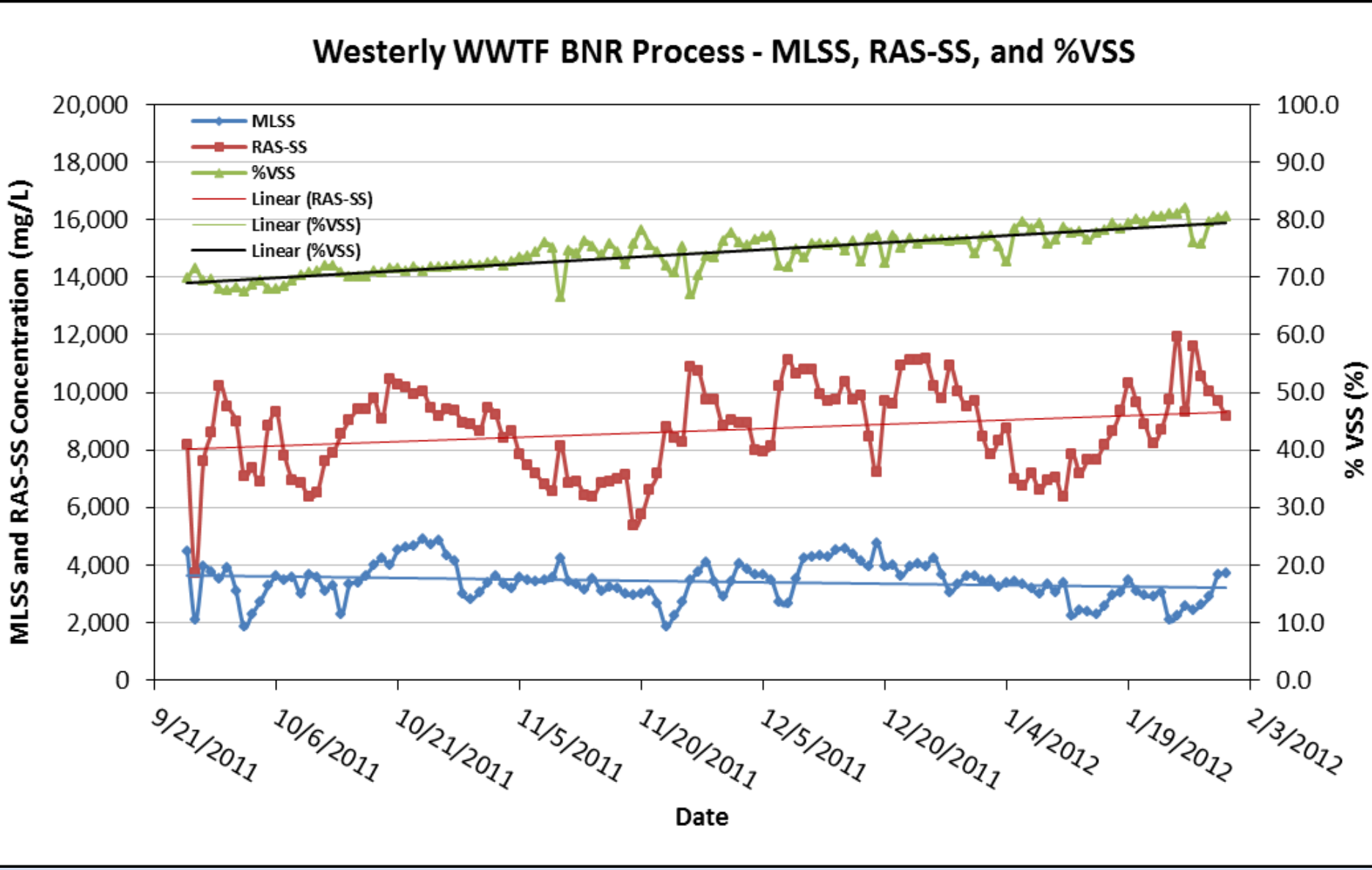
BNR Initial Process Parameters

September 2001 – February 2012

	SRT (Days)	WAS (MGD)	FM Ratio (per day)	MLSS (mg/L)	RAS (mg/L)	Total RAS (MGD)	NR (MGD)	MLR (MGD)
Minimum	2.25	0.07	0.04	1,835	3,700	2.60	1.60	0.90
Average	6.20	0.18	0.11	3,420	8,680	6.20	3.75	2.00
Maximum	14.50	0.34	0.33	4,880	11,950	8.30	4.70	2.50



VIP Process Operation During Wet Weather Flow



VIP Process Operation During Wet Weather Flow

Final Clarification

- Project included the addition of a fourth clarifier and upgrades to existing three clarifiers
- Surface overflow rate adequate for 60 mgd peak
- Employed rapid sludge removal via spiral blade sludge collectors
- Full radius skimmers
- Current density baffles (Stamford-type)
- Sludge blanket density meters

Final Clarifiers with Stamford Baffles

SCADA Process Control Features

- Step-feed process flow control
- Mixed liquor and nitrate recycle return rate
- RAS and WAS return rates
- DO control of air supply valves and blower speeds
- NO_4 control of nitrate recycle pumps and methanol
- RP control of mixed liquor recycle
- pH control of caustic soda feed
- NH_4 and PO_4 instruments provide process alarms

Other Facility Improvements

- Fine Screening
- Non-Aerated Vortex Grit Separation
- Final Clarifier Additions and Upgrades
- Ultraviolet Disinfection System
- Aerobic Digester System Upgrades
- Effluent Screw Lift Pumps

New Headworks Building

Headworks Fine Screening

Vortex Grit Separation System (preserve influent carbon)

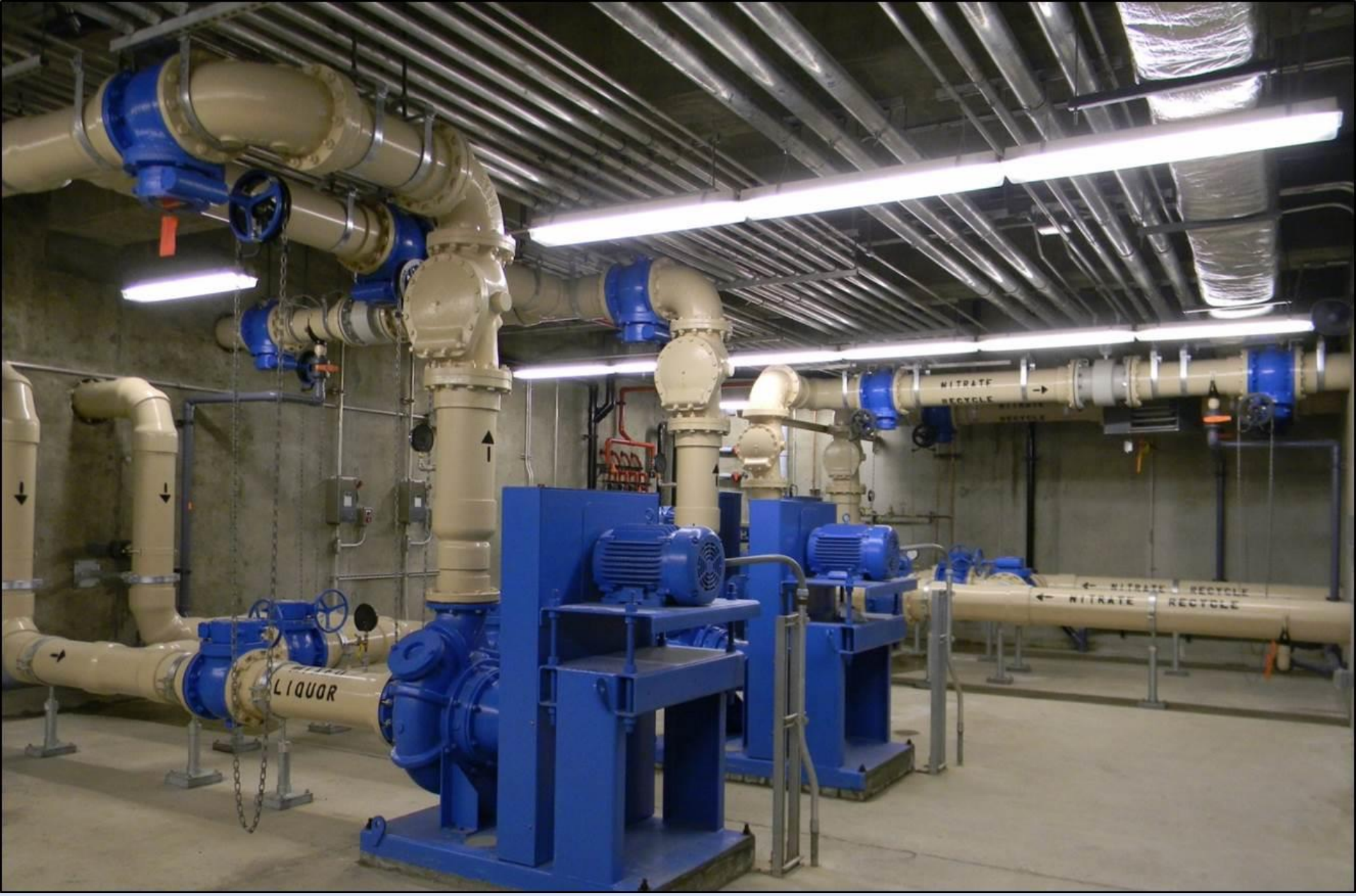
Ultraviolet Disinfection System

Centrifuge Sludge Dewatering System

60” Diameter Screw Lift Flood Pumps

Energy Efficient Turbo Blowers (high turndown capability)

Chemical Feed and Storage Facilities

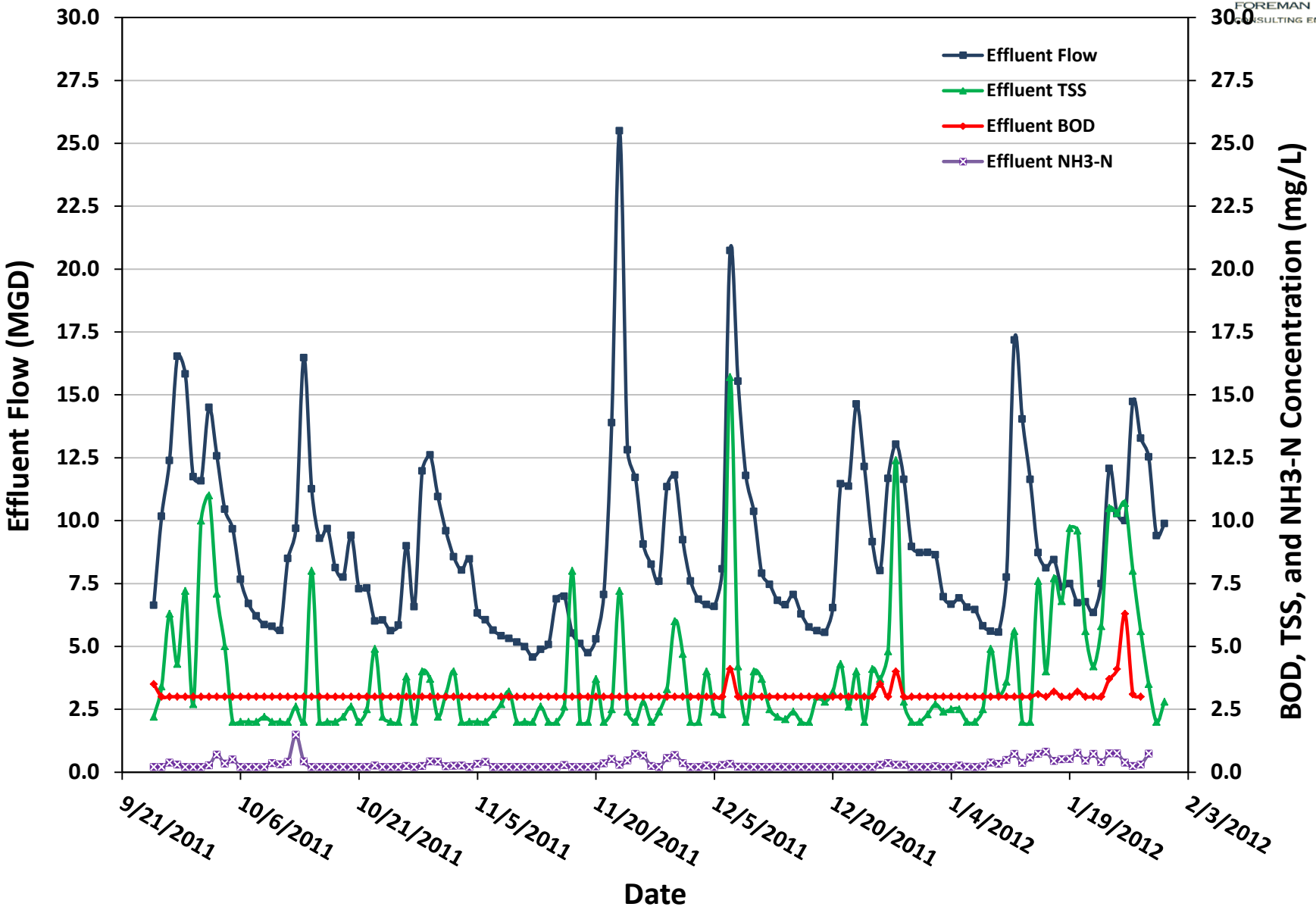


Internal Recycle Pumps – Mixed Liquor & Nitrate

BNR Process Results

- Process reduced effluent nitrogen concentration to near 3.0 mg/l with **NO CARBON ADDITION**
- Reduced annual N loading from 240,000 pounds to 70,000 pounds
- Biologically reduced annual P loading from 32,000 to 6,700 pounds with **NO CHEMICAL ADDITION**
- Generated $300,000 in nutrient credit revenue
- Processed **100% OF WET WEATHER FLOW WITHIN PERMIT LIMITS WITHOUT BNR PROCESS UPSET**
- Annual plant operating costs **REDUCED BY $110,000**

BNR Process - Effluent Flow, BOD, TSS, and Ammonia



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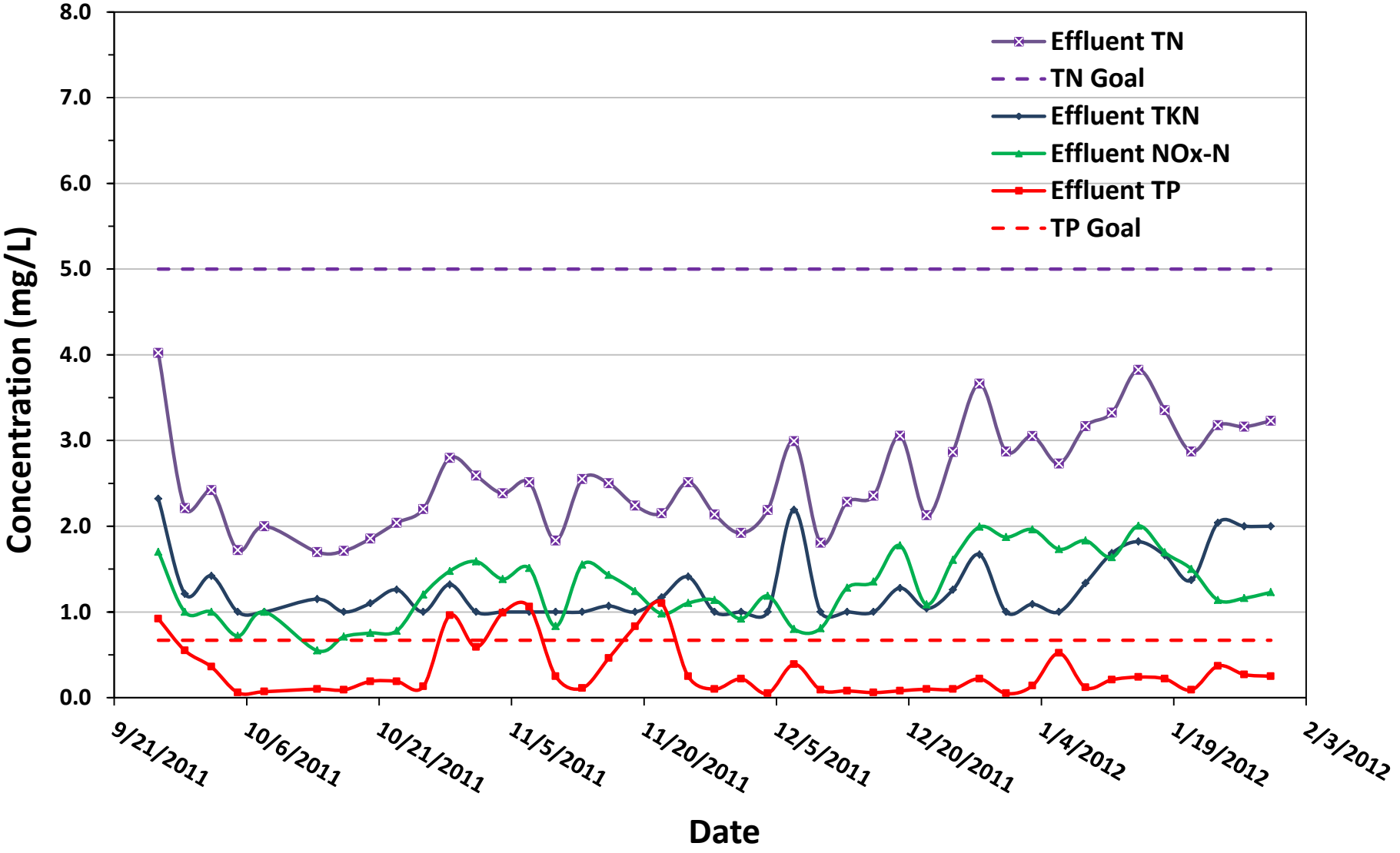
Westerly WWTF BNR Process - Effluent TKN, NOx-N, TN, and TP



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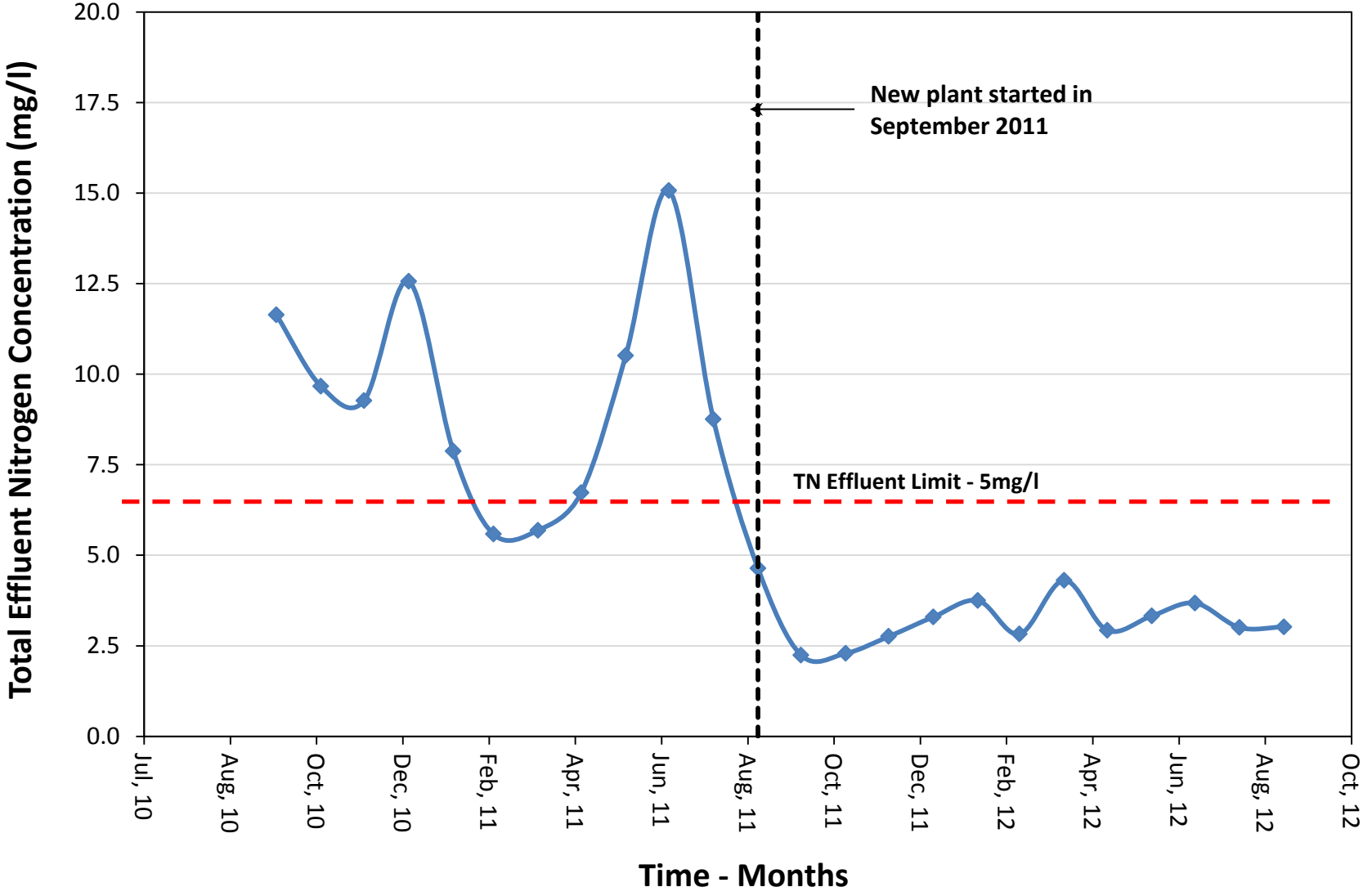
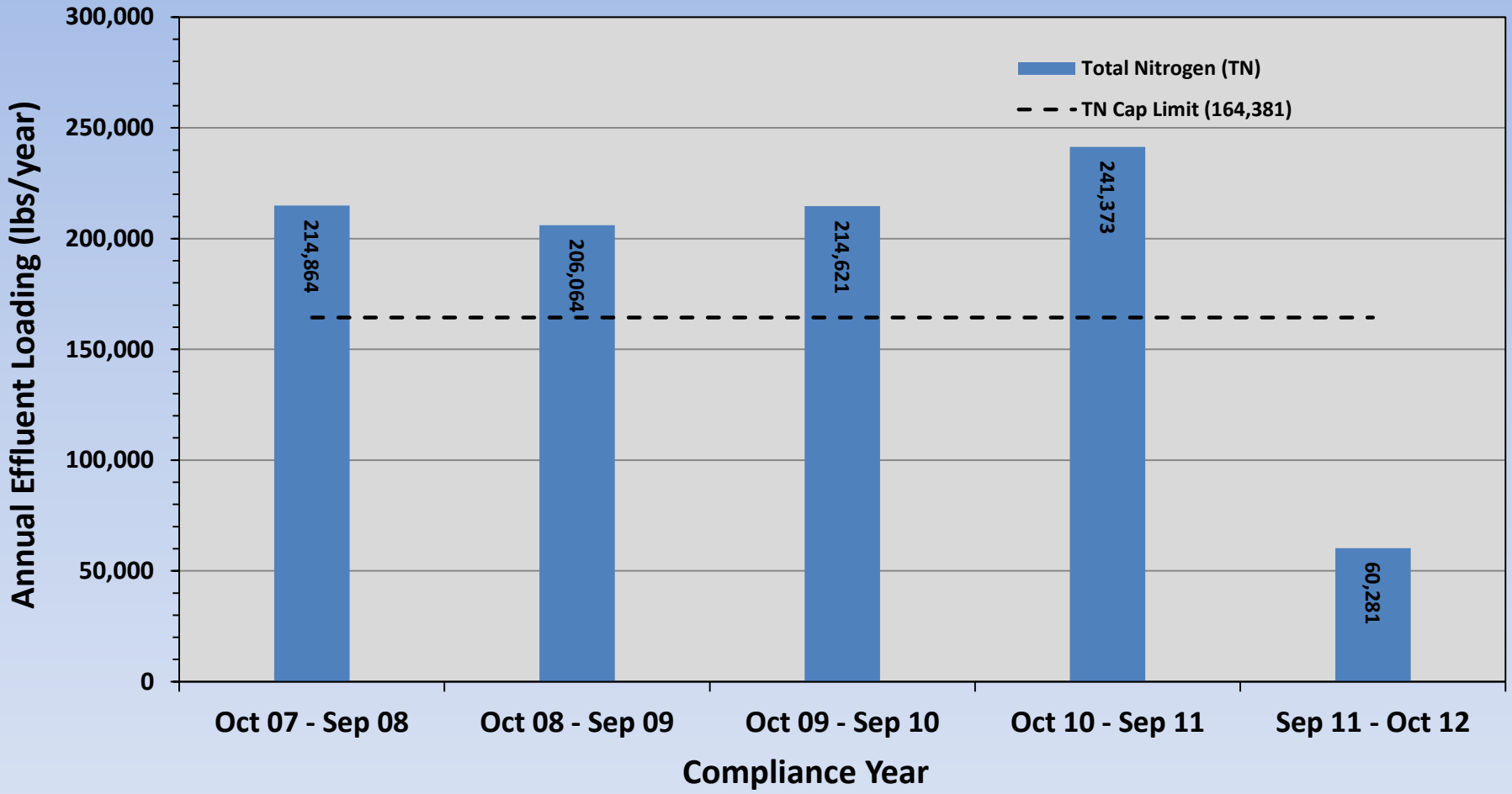
Total Effluent Nitrogen Concentration



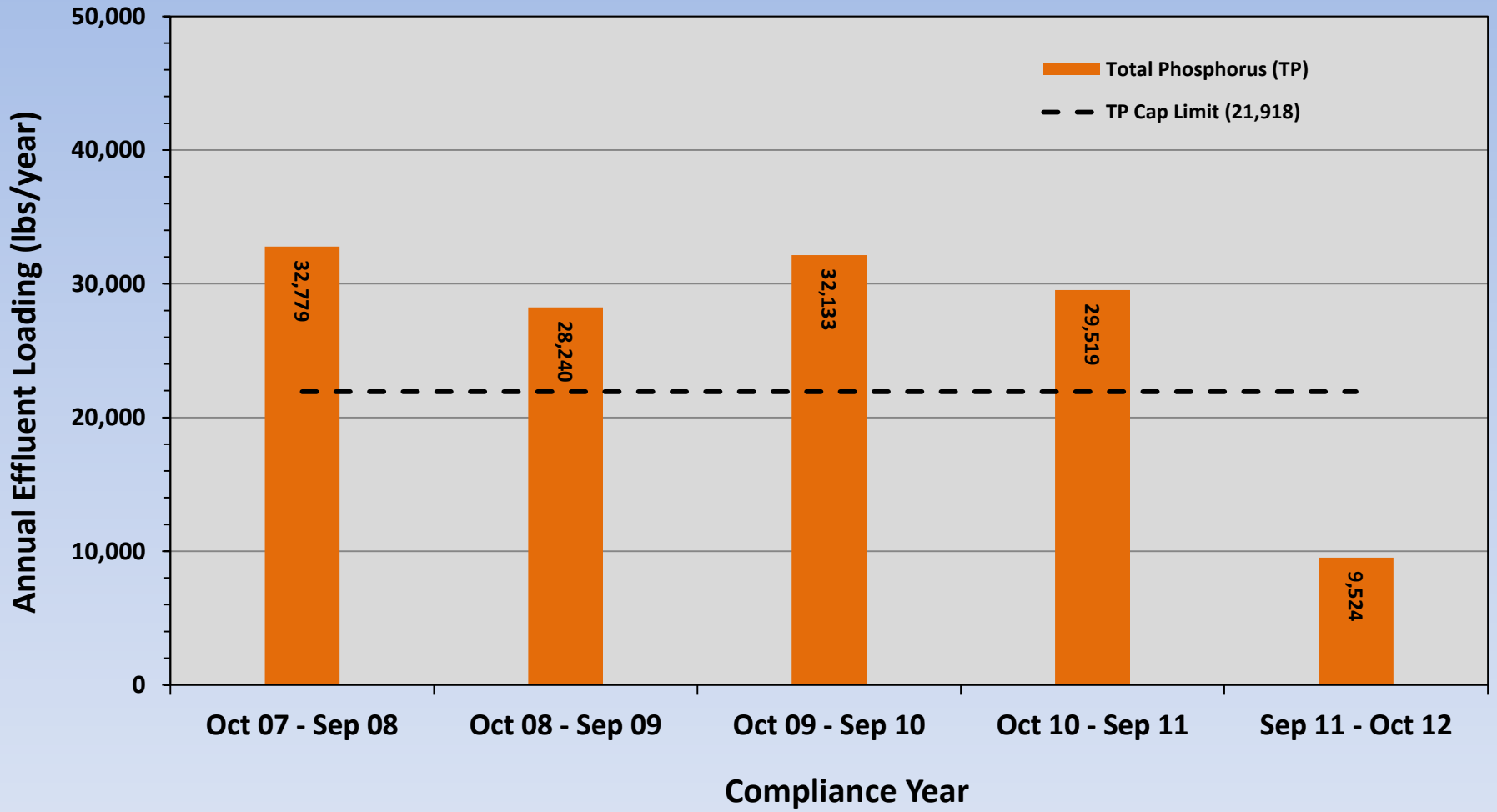
Monthly TN and TP Effluent Loadings: Actual Results and Permit Goals

Months	Total Nitrogen (TN)		Total Phosphorus (TP)	
	Actual Loading (lbs/mo)	Permit Goal (lbs/mo)	Actual Loading (lbs/mo)	Permit Goal (lbs/mo)
October, 2011	5,163	13,923	654	1,856
November, 2011	4,621	13,474	1,013	1,797
December, 2011	6,086	13,923	343	1,856
January, 2012	7,682	13,923	472	1,856
February, 2012	5,893	13,025	322	1,737
March, 2012	5,011	13,923	537	1,856
April, 2012	5,209	13,474	683	1,797
May, 2012	5,251	13,923	2,175	1,856
June, 2012	4,302	13,474	768	1,797
Total	49,218	123,062	6,967	16,408
Average	5,469	13,673	774	1,823
% Below the Goal	60%		58%	

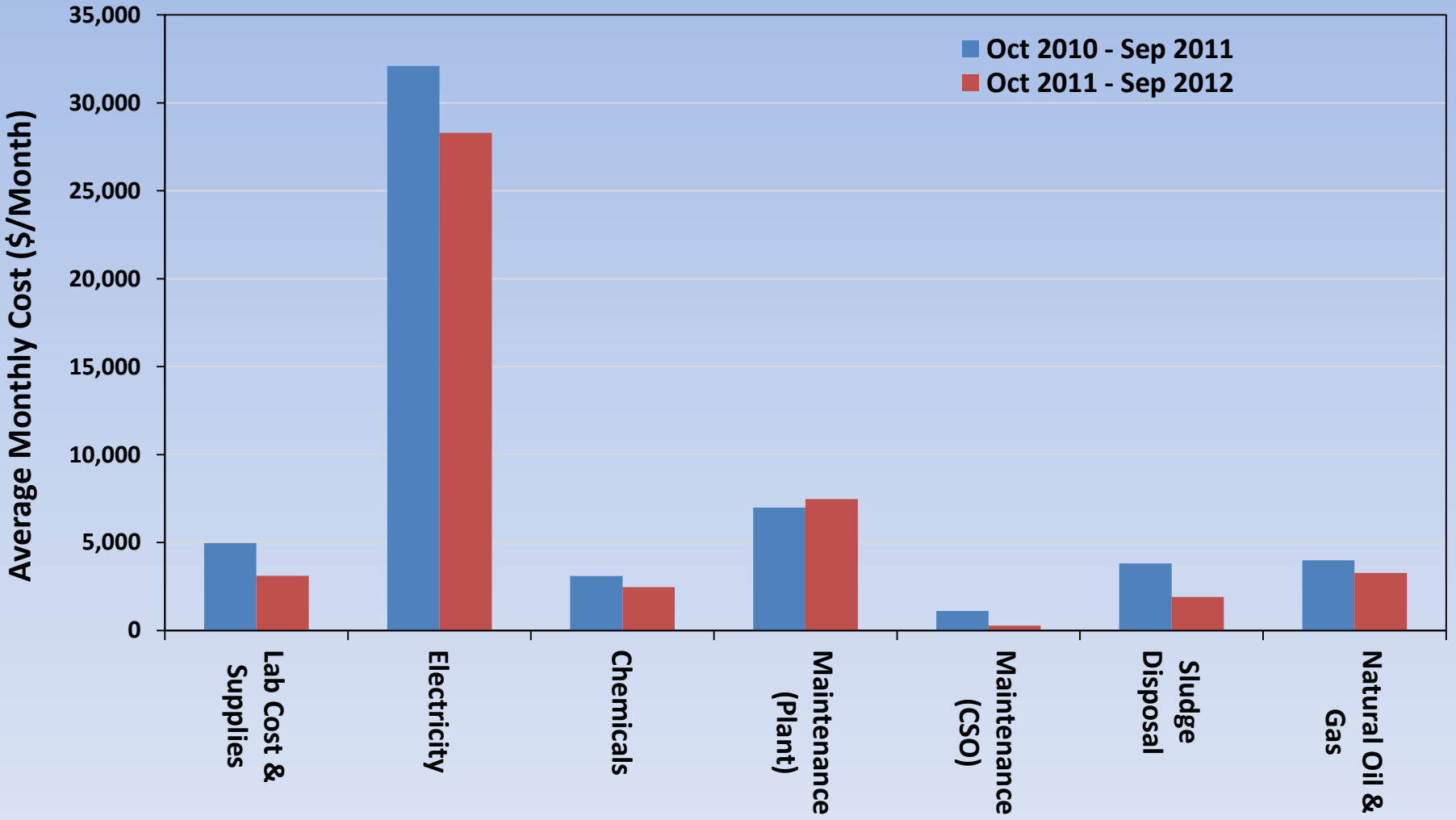
Annual Total Nitrogen Effluent Loading



Annual Total Phosphorus Effluent Loading



Westerly WWTF - Monthly Average O&M Costs



WESTERLY WASTEWATER TREATMENT FACILITY BNR UPGRADE

2013 Superior Achievement Award

AMERICAN ACADEMY OF ENVIRONMENTAL ENGINEERS & SCIENTISTS®

Questions/Discussion