SPDES Permit Modification Study
Brookhaven National Laboratory

Quantification and Removal Study
Mercury Minimization Study
Groundwater Recharge Evaluation

Brookhaven National Laboratory

Community Advisory Council Presentation

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BROOKHAVEN NATIONAL LABORATORY

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Office of Science
U.S. DEPARTMENT OF ENERGY

Background - Refresher

- In June 2009 NYSDEC modified BNL's SPDES permit
  - Past monitoring showed no appreciable evidence of contamination with radiological or volatile organic compounds.
  - Metals were targeted for reduction due to impacts on aquatic organisms. (Copper, Iron, Lead, Nickel, Mercury and Zinc)
  - Target Water Quality Based Effluent Limits (WQBELs) are extremely low due to BNL being the sole source of water to onsite portion of Peconic River during dry periods.
  - Required BNL to perform a Quantification and Removal Study and Mercury Minimization Program.
  - Permit modifications were presented to the CAC and BER in early 2009. Comments to the permit were submitted to NYSDEC by the CAC in May 2009.

Quantification and Removal Study/Mercury Minimization Program

Project Scope & Objectives

- Big Picture: Reduce metals discharges to Peconic River
  - To achieve Water Quality Based Effluent Limits
  - To reduce potential impacts on aquatic organisms

- Approach: Quantification & Removal Study and Mercury Minimization Program
  - An integrated study of options to reduce the discharge of metals to the Peconic River
    - Identify and measure sources of metals
    - Evaluate treatment options
    - Evaluate alternative disposal options
    - Recommend options to achieve goals

Field Activities

- BNL retained Dvirka and Bartilucci (D&B) in July 2009 and field work was performed between September 21 and December 30, 2009.
- Based upon NYSDEC recommendations and BNL knowledge of operations, certain processes and operations throughout the facility were selected for monitoring and evaluation in order to determine contributing sources of copper, iron, lead, nickel, zinc, and mercury to the STP.
- A total of 42 locations were sampled per sampling event.
- Samples collected on a weekly basis for a three month (i.e., 12-week) period.
- Flow measurements were made in order to estimate the mass contribution of each potential source to the STP.
- Draft reports were received by D&B on March 26, 2010.

Summary of Activities Evaluated During Q&R Study

Processes/Operations Descriptions	Location
Potable Water Supply	Finished Water: Bldg 624 Distribution System: 363, 490, 575 Filter Backwash: 488, 735 Water Softener Regeneration: 610 RO Retentate and Backwash: 555
Sanitary Only	Bldgs. 400, 460, Apartment Area
Cafeteria Operations	Bldg. 488
STP Sample Locations	Influent, Post aeration, Effluent, Digester Decant
Cooling Tower Blowdown and maintenance	Bldg. 488, 555, 600, 902
Boiler Blowdown, Boiler Wash, Condensate	Bldg. 610
Vehicle Cleaning	Bldg. 649
Laboratory Activities	Bldgs. 463, 480, 490, 510, 555, 735, 815
Process Waste Water	Magnet Cleaning/Flushing: Bldg 922 Printing Fountain Solutions: Bldg 197 Painting: Bldg. 422 Cage Wash: Bldg. 490 Once through cooling: Bldg 526 Printed Circuit Board Shop: Bldg. 535 CA Waste Water Sources:
Metal Cleaning	Bldg. 498

Summary of Effluent Limit Analysis

	Effluent Avg.	Former Limit		Interim Limit		Target Class C Limit	
	Value (µg/L)	Value (µg/L)	Probability	Value (µg/L)	Probability	Value (µg/L)	Probability
Copper	39.7	150	99.86%	150	99.86%	3.7	0.02%
Iron	345	370	97.65%	370	97.65%	300	92.30%
Lead	5.4	19	>99.99%	19	>99.99%	1.5	58.80%
Nickel	5	110	>99.99%	110	>99.99%	21	97.50%
Zinc	57	100	91.37%	100	91.37%	34	18.80%
Mercury	96 ng/L	800 ng/L	>99.99%	200 ng/L	98.60%	0.7 ng/L	3.60%
				50 ng/L (2012)	15.80%		

Notes:

1. Probability values reported represent the probability that the effluent concentration from the STP is less than or equal to the corresponding permit limit, without further treatment.
2. Probabilities are based upon STP effluent data from 2006 – July 2009.
3. Class C Limits are based upon protection of fish. Since BNL discharge is the sole source of water during dry periods the Class C standard is applied to this discharge.

Current STP Discharge profile for Mercury

Influent: 100-200 ppt

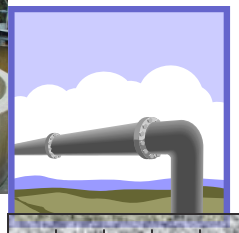
Rainwater: 5-9 ppt

Decant: 30 – 235 ppt

Aerobic Digester

Solids

Sewage Treatment Plant



Clarifier: 5-45 ppt

Sand Filter Beds

~80%

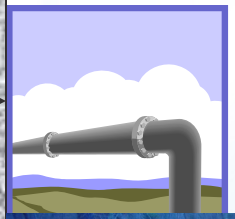
Under drain collection

~20%

Water table

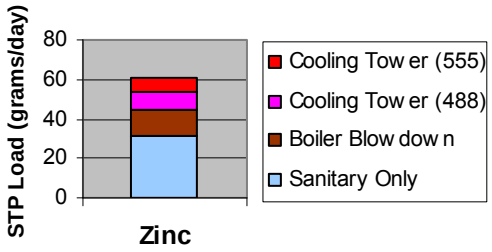
Aquifer

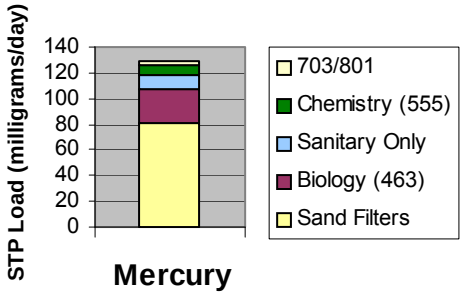
Groundwater: 2-9 ppt

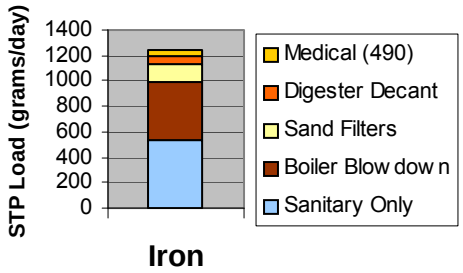


Discharge: 40-150 ppt

Major Sources of Metals

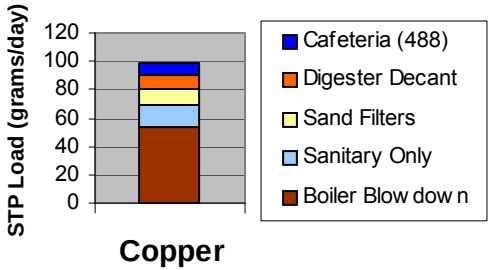


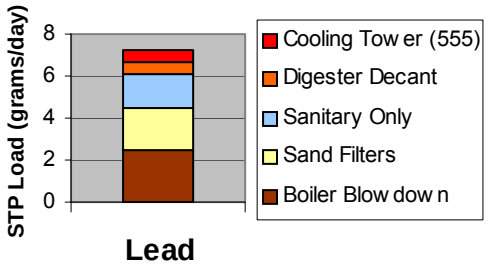


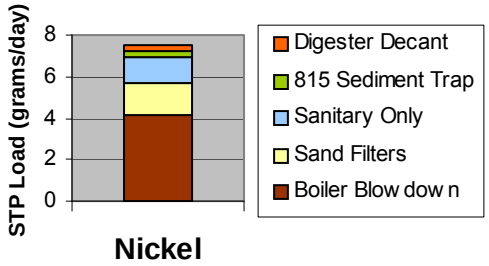


Major Sources of Metals to the STP

- Sanitary Only Sources
- Steam Plant: Boiler Blowdown
- STP Sand Filter Beds
- Sewage Treatment Plant: Digester Decant
- MH-100: Bldg. 490 Combined Sanitary/Laboratory
- MH-154: Bldg. 488 Cafeteria Operations







Source Control Strategies
(Copper, Lead, Zinc, Iron, and Nickel)

- Boiler blowdown and sanitary only sources were the largest sources of these metals to the STP.
  - Source control strategies for boiler blowdown were evaluated (adsorption, ion exchange, chemical precipitation) but not recommended due to high solids loading, metal concentrations, and overall cost to build systems and routine maintenance. — **No Further Consideration**
  - Elimination of direct electrical current sources by implementing a stray current evaluation. This could help reduce concentrations of copper, lead and zinc to the STP. — **To be Considered**
  - Improving the distribution system flushing program (e.g., adding hydrants or blow-offs and eliminating dead-ends) to remove iron. — **To be Considered**
- Source control for other significant sources (e.g., laboratory wastes) is not recommended since enhanced treatment of sanitary wastes is required. — **No Further Consideration**

Source Control Strategies (Mercury)

- Sand filter beds were determined to be the largest source of mercury at BNL followed by sanitary/laboratory wastewater sources: Biology (463), Chemistry (555), general laboratories (703), and Target Processing Labs (801), and sanitary only sources (Bldg. 400, 460 and the Apartments. A multi-phased approach recommended:

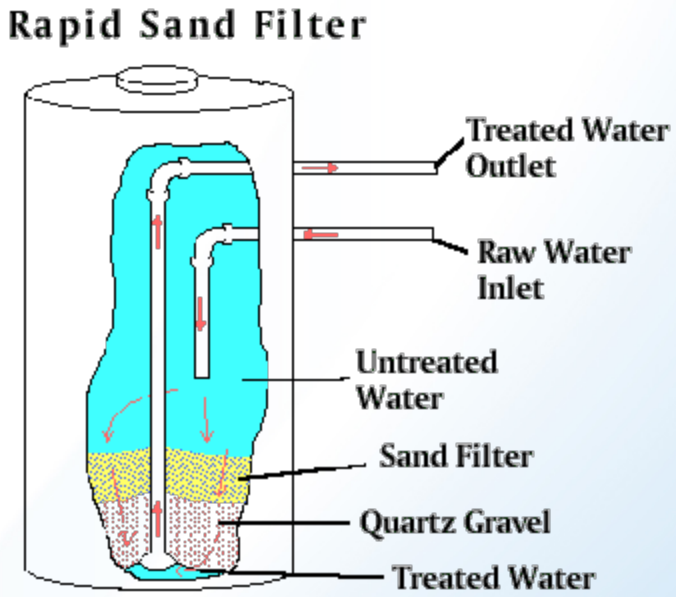
  - **Phase 1**
    - replace laboratory sink traps
  - **Phase 2**
    - decontaminate piping in buildings with mercury release compound
  - **Phase 3**
    - treat isolated laboratory wastewater streams using mercury absorbent/ion exchange; only applicable at Bldgs. 555 and 815 due to isolated piping systems.

Only if STP process is not upgraded

STP Disposal Options

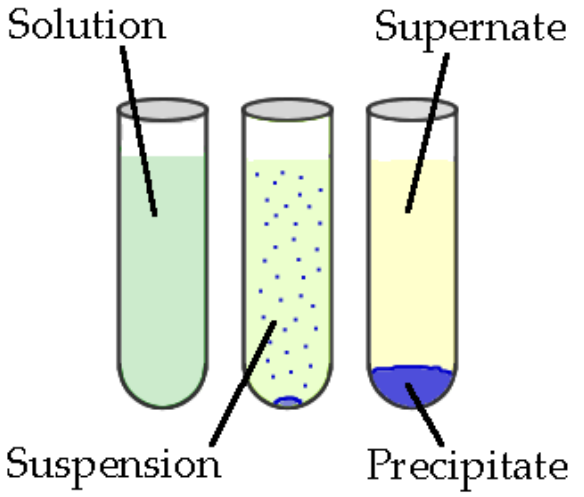
- Continue Discharge to Peconic
  - Improved treatment required to reduce metals concentrations (e.g., precipitation, carbon adsorption, ion exchange)
  - Replace sand filters with new rapid sand filters most likely required pending chosen technology.

- Redirect discharge and recharge to groundwater
  - New recharge basins will be required.



STP Treatment Options

- Chemical Precipitation – adding treatment reagents to bind with the metals so that they can be removed from solution.
  - Reagent would be added to the aeration tank using metering pump system;
  - Material will mix with the waste water stream and react with the dissolved metals and cause the metals to precipitate from solution;
  - Precipitated metals would be removed in the clarification stage and filtration step.
  - Pros:
    - Proven to remove some metals (e.g., mercury and copper) to low levels
  - Cons:
    - Testing required to determine effectiveness
    - Treatment reagents may be toxic to freshwater organisms



STP Treatment Options (cont.)

- Ion Exchange – pass the treated waste water through a bed of ion exchange media (usually a plastic resin) that removes the metals in solution
  - Ion exchange columns would be added after new rapid sand filters to polish the final waste water before discharge
  - Pros:
    - Can remove some metals to very low levels.
  - Cons:
    - Testing required to determine effectiveness
    - Requires “regeneration” of ion exchange columns and generates a significant waste stream
    - Water very low in ions is corrosive and “toxic” to aquatic organisms

STP Treatment Options (cont.)

- Chemical Adsorption
  - Activated Carbon: Pass the waste water through a bed of activated carbon for metals removal
    - Activated carbon vessel would be added after new sand filters to polish final waste water before discharge
    - Pros:
      - Very effective for removal of organic compounds
      - Shown promise for lead and mercury removal
    - Cons:
      - Testing required to determine effectiveness
      - Limited effectiveness for copper and zinc

STP Treatment Options (cont.)

- Other Adsorption Systems
  - BluePro: Pass the waste water through a bed of sand treated with ferric sulfate
    - Pros:
      - Good success demonstrated for mercury removal
    - Cons:
      - Testing required to determine effectiveness for other metals
      - Impacts of excess ferric sulfate not discussed
  - Siemens: Specialized ion exchange technology designed for mercury removal
    - Pros:
      - Lab tests show very effective for mercury removal to very low levels
    - Cons:
      - Testing required to determine effectiveness for other metals

D&B Recommended Alternative for STP Treatment Upgrade

- Polythiocarbonate precipitation and sand filter replacement:
  - Easiest to implement
  - Most cost effective
  - Proven for mercury and copper removal
  - Total Cost: $2.3M (order of magnitude)
  - Total Timeframe to Complete: 44 months

Considerations

- Ultimate fate of sulfur bearing compounds TBD.
- Toxicity of thiocarbonate may be higher than the metals (LC50 for minnows is ~ 16 ppm). Proposed treatment levels range from 5 – 20 ppm.
- Effectiveness of treatment and ability to achieve WQBELs to be determined during pilot testing.

Groundwater Discharge Alternative

- Abandon existing filters and discharge directly from secondary clarifiers to new recharge basins in area south and east of existing sand filters.
- Four basins required with no prefiltration (5 gals/day/sq. ft.), total land area required 100,000 sq. ft. Can be reduced by ½ if prefiltered.

	Effluent Avg.	Interim Limit	Groundwater Effluent Limit	Drinking Water Standard
Copper	39.7 µg/L	150 µg/L	1,000 µg/L	1,300 µg/L
Iron	345 µg/L	300 µg/L	600 µg/L	300 µg/L
Lead	5.4 µg/L	19 µg/L	50 µg/L	15 µg/L
Nickel	5 µg/L	110 µg/L	200 µg/L	NS
Zinc	57 µg/L	100 µg/L	5,000 µg/L	5,000 µg/L
Mercury	96 ng/L	200 ng/L	1,400 ng/L	200 ng/L
		50 ng/L (2012)		

NS – No Standard

Note: BNL would not request an increase in effluent limits under the groundwater discharge option and would suggest that existing limits remain.

Groundwater Discharge Alternative (cont.)

- Cost and Schedule:
  - Total Cost: $570,000.00
  - Total Timeframe to Complete: 31 months

Considerations

- Geotechnical borings and other soil characterization efforts will need to be performed to ensure the proposed areas are suitable for the construction of recharge basins.
- Potential environmental impact from removing discharge to river.

D&B's Final Recommendation

- Final Recommendation: Groundwater Discharge
  - Effluent will meet discharge standards without additional treatment.
  - Effectiveness of STP treatment alternatives not guaranteed and must be proven.
  - Impact of treatment reagents on toxicity of the effluent unknown.
  - Enhanced treatment is costly and labor intensive.

BNL Major Comments to Draft

- The draft report presumes that the WQBELs must be achieved. The permit process allows consideration of alternate limits based upon limits of detection, and feasibility (technical and cost) of achieving limits.
- Provide anticipated levels of treatment for the recommended technologies. What improvement is expected if just one of the options is added to the end of the STP process e.g., just replace existing filters with new filters?
- Due to the potential for accumulation of metals in the proposed recharge basins, BNL is uncomfortable with the proposed Final recommendation. Evaluate treatment alternatives prior to groundwater recharge (e.g., new filters, upgrade existing filters, treat via constructed wetland).
- Based upon past experience cost estimates are low, revisions will be made based on BNL operating experience.