Meeting Multiple Treatment Objectives:
The Case Study of a Successful Groundwater Well Treatment System for the Removal of Hydrogen Sulfide, Manganese, and VOC Contaminants.

Jonathan Morris, P.E.
GHD

Art Saunders, P.E.
SUEZ
SUEZ INTRODUCTION
WHO IS SUEZ?

- **150 years in the US water market**

- **Key Highlights**
  - 1869-Founded as Hackensack Water Company
  - 1890-Listed on the New York Stock Exchange
  - 1994-Merger with General Water Works Corp. (United Water)
  - 2000-Acquisition by Suez of General Water Works Corp. (United Water)
  - 2002-Acquisition of US Water
  - 2007-Acquisition of Aquarion Water Company of New York
  - 2007-Acquisition of AOS Operating Company
  - 2008-Acquisition of Earth Tech (NACO)
  - 2008-Acquisition of Utility Service Company
  - 2009-SUEZ merge with GDF to form GDF SUEZ
  - 2009-SUEZ Environnment formed as subsidiary to GDF SUEZ
  - 2010-SENA formed as subsidiary to Suez Environnment
  - 2016 - Suez Environnment became SUEZ, all SUEZ owned companies worldwide name changed to SUEZ.
  - 2017 – Acquisition of GE Water

- **8,100 employees serving over 7 million people in 26 states**

- **Operator of 240 municipal water systems**

- **Owner of 20 regulated water utilities**
SUEZ WATER PENNSYLVANIA

SWPA Facts

- Over 90 employees
- Over 60,000 customers
- 40 municipalities
- Approximately 4.7 billion gallons of water delivered to customers annually
- Five surface water treatment plants
- Eight well systems with a total of 28 wells
SUEZ WATER PENNSYLVANIA – DALLAS OPERATIONS
SHAVERTOWN WATER SYSTEM

- CONSISTS OF TWO WELLS
  - HASSOLD
  - SALLA

- BOTH WELLS HAVE Mn LEVELS GREATER THAN SECONDARY MCL
  - Mn Secondary MCL – 0.05 mg/L
  - Salla Well Mn – 0.18 mg/L
  - Hassold Well Mn – 0.43 mg/L

- BOTH WELLS HAVE H₂S
  - Salla Well – 1.32 mg/L
  - Hassold Well – 0.28 mg/L

- HASSOLD WELL HAS VOC’S

- TREATMENT FOR BOTH WELLS CONSISTED OF SEQUESTERING, CHLORINATION, AND AIR STRIPPERS.
HASSOLD WELL

- Permitted at 100 gpm
- Porous plate air stripper for VOC removal
- Had to be run at 70 gpm or greater to avoid VOC concentration build up.
- Mn clogged porous plate air stripper
SALLA WELL

- Permitted at 200 gpm
- Air stripper for H₂S removal
- Sulfur odor from stripper permeated neighborhood even though odor retardants were used.
Mn ISSUES

- CUSTOMER COMPLAINTS DUE TO DISCOLORED WATER, DIRTY/STAINED LAUNDRY, STAINED FIXTURES
- BLACK Mn SLIME BUILD UP IN PIPES, PUMPS, INSTRUMENTATION, CUSTOMER SERVICE LINES, METERS, AND STORAGE TANKS
- REQUIRED FREQUENT FLUSHING OF DISTRIBUTION SYSTEM AND CLEANING OF INSTRUMENTATION, METERS, ETC.
- NEW CUSTOMER MOVING INTO THE AREA WERE MORE SENSITIVE TO THE WATER DISCOLORATION.
Mn TREATMENT SOLUTION

- SEVERAL TREATMENT OPTIONS WERE INVESTIGATED
- SEQUESTATION WAS TRIED WITHOUT SUCCESS
- GREEN SAND WAS CONSIDERED BUT NOT PERSUED DO TO LAND AVAILABILITY AND WASTE HANDLING REQUIREMENTS
- AN ELECTRO MEDIA SYSTEM WAS SELECTED.
  - FIT INTO THE LAND FOOTPRINT AVAILABLE
  - MEDIA CLEANING/REGENERATION ONLY REQUIRED BACKWASH WITH FINISHED WATER
  - REALTIVELY SMALL AMOUNT OF WASTEWATER
  - FORGIVABLE TREATMENT PROCESS
  - EASILY MONITORED/OPERATED REMOTELY THROUGH SCADA SYSTEM
SHAVERTOWN Mn WATER TREATMENT PLANT PLAN

- ONE TREATMENT POINT FOR BOTH WELLS AT THE SALLA WELL SITE
  - LARGEST SUEZ OWNED SITE AVAILABLE, POSSIBLE TO PURCHASE ADDITIONAL LAND IF REQUIRED
  - EASIEST SITE TO ACCESS FOR CONSTRUCTION EQUIPMENT
  - CLOSE PROXIMITY TO SANITARY SEWER FOR WASTEWATER DISPOSAL
  - CLOSE PROXIMITY TO EXISTING WATER DISTRIBUTION SYSTEM FOR SECONDARY DISCHARGE FOR INCREASED FLOWS AND REDUNDANCY

- REQUIRED INSTALLATION OF APPROXIMATELY 3,500 FEET OF CONNECTING PIPE BETWEEN THE HASSOLD WELL SITE AND THE SALLA WELL SITE.
SHAVERTOWN Mn WATER TREATMENT PLANT PLAN

- RAW WATER MAIN BETWEEN WELL SITES
SHAVER TOWN Mn WATER TREATMENT PLANT PLAN

- SALLA WELL SITE
PROJECT MILESTONES:

- RFP FOR CONSULTANT TO SELECT TREATMENT PROCESS AND DESIGN TREATMENT SYSTEM ISSUED OCTOBER 2014
- RFP REQUIRED THREE PHASES:
  1. TREATMENT RECOMMENDATION
  2. DESIGN AND PERMITTING OF RECOMMENDED TREATMENT
  3. CONSTRUCTION SERVICES
- NOTICE TO PROCEED TO CONSULTANT ISSUED FEB. 2015
- RFQ FOR CONSTRUCTION ISSUED AUGUST 2015
- NOTICE TO PROCEED ISSUED OCTOBER 2015
- PROJECT IN SERVICE JUNE 2016
GHD DESIGN SCHEDULE:

- **Phase I: Preliminary Design**
  - GHD’s Notice To Proceed (Phase 1): February 17, 2015
  - Recommended Treatment Technologies: April 3, 2015

- **Phase II: Design and Permitting Phase**
  - GHD’s Notice To Proceed (Phase 2): April 6, 2015
  - 60% Deliverables to Client: June 19, 2015
  - 90% Deliverables to Client: July 17, 2015
  - 90% Progress Meeting with Client: July 22, 2015
  - 100% Deliverables to Client: July 28, 2015
  - Bid Documents to Invited Bidders: August 3, 2015
  - Pre-Bid Meeting: August 13, 2015
  - Bids Received: August 26, 2015
  - Award to Contractor: September 25, 2015
PROJECT OBJECTIVES:

- Project Objectives:
  - Eliminate the need to keep Hassold Well in operation at all times.
  - Eliminate the possibility of known VOC(s) creating any violations now or in the immediate future.
  - Reduce concentrations of iron, manganese and hydrogen sulfide to meet MCLs and minimize customer complaints.
  - Combine treatment at one location with one entry point for two wells.
    - Increases Salla Well Station flow from 200 gpm to 300 gpm.
    - Increase in flow requires existing booster stations to be replaced.
    - Increase in flow impacts Salla Well Station 4-Log removal.
Manganese In Groundwater

- The extent to which manganese is dissolved in groundwater depends on the amount of oxygen in water, and to a lesser extent, upon its degree of acidity.
- If the groundwater is oxygen poor, manganese will dissolve more readily, particularly if the pH is on the low side (which was not the case with either well site).
- Dissolved oxygen content is typically low in deep aquifers, particularly if the aquifer contains organic matter. Decomposition of the organic matter depletes the oxygen in the water and dissolves the manganese.
- Under those conditions, the dissolved metal is often accompanied by hydrogen sulfide (rotten egg smell).
- When this water is pumped to the surface, the dissolved metals react with the oxygen in the atmosphere, resulting in oxidized metals and in the case of manganese, form blackish particulates in the water and similar colored stains on fixtures.
- State requirements allow a combined Fe and Mn concentration up to 1.0 mg/l before actual removal is required.
PROCESS DESIGN:

- **Manganese Treatment Alternatives**
  - **Sequestration**
    - At low concentrations, manganese can be controlled by sequestration, which involves adding a polyphosphate chemical to the water.
  - **Oxidation/Filtration**
    - Manganese removal usually involves oxidation followed by filtration.
    - If non-oxidizing filter media is used then a stronger oxidant, such as ozone or potassium permanganate is used for oxidization upstream of the filters. The use of non-oxidizing filter media will often times also require pH adjustment upstream of the filters to reduce the oxidation reaction time.
  - **Oxidizing Media Filters**
    - With oxidizing media filters, oxidizing occurs to a large degree at the filter media/water interface.
    - The advantage of using oxidizing media filters are three-fold: strong oxidant is not required; pH adjustment not required as long as pH is near neutral or higher, and oxidation contact time is not required as the reaction occurs in the media/water interface.
Hydrogen Sulfide (H₂S) In Groundwater

- H₂S can be generated in the groundwater and/or by sulfur reducing bacteria in the well bore.
- Rotten egg smell
- Sulfate reduction is accompanied by an increase in alkalinity and pH. Because the raw water in both wells had a relatively high pH of 7.7 or greater, there was some justification for saying that the H₂S has a local source, perhaps from bacterial slime in the well.
- Hydrogen sulfide is not directly regulated under the Safe Drinking Water Act, but it is indirectly regulated through the Secondary Standards (SMCLs) for odor. The “Threshold Odor Number” (TON) for H₂S is 3.
PROCESS DESIGN:

○ H₂S Treatment Alternatives
   ○ Aeration (with and without pH Adjustment)
     - Aeration only removes H₂S portion and not bilsufide (HS⁻). With normal pH of wells, only 50% exist as H₂S. Thus, unless H₂S levels were very low, aeration without pH adjustment would not be effective.
     - pH of water needs to be lowered to allow aeration to achieve 100% removal.
   ○ Oxidation
     - H₂S is destroyed by a sufficient concentration of oxidant; however, other sulfur compounds are formed which can subsequently cause other problems.
     - The most common problem is the formation of colloidal sulfur which increases turbidity and water coloration.
   ○ Oxidizing Media Filters
     - Process converts H₂S to elemental sulfur and removes the sulfur via filtration.
     - Oxidation contact time is not required as the reaction occurs in the media/water interface.
     - H₂S can be removed with simple chlorination, followed by filtration and the process does leave suspended sulfur (and potential turbidity) as other processes
PROCESS DESIGN:

- **Volatile Organic Compounds (VOCs)**
  - Volatile organic chemicals (VOCs) are carbon-containing compounds that evaporate easily from water into air at normal room temperatures (which is why the distinctive odor of gasoline and many solvents can easily be detected).
  - VOCs are contained in a wide variety of commercial, industrial and residential products, including fuel oils, gasoline, solvents, cleaners and degreasers, paints, inks, dyes, refrigerants, and pesticides.
  - One sample from Hassold Well site had a VOC detected in the form of 1/1 – Dichloromethane of 2.4 ug/L (pre-stripper).
    - 1/1 Dichloromethane has an EPA MCL of 0.007 mg/L or 7.0 ug/L. This contaminant appears to be controlled by constant use of the well, and based on available records, did not exceed the MCL.

- **Typical Treatment for VOCs**
  - Activated carbon filtration – eliminated due to high maintenance and capital costs.
  - Aeration
RECOMMENDED TREATMENT PROCESSES:

- **Manganese and H2S Treatment**
  - AdEdge Oxidizing Media Filters.
    - Three (3) 54-inch diameter filters with
    - Chlorine (NaOCl) injected upstream of filters as the oxidant.
    - Backwash provided from distribution supply and booster pumps.
  - Backwash waste handling addressed by installation of two backwash basins and pumps. Backwash pumped to sanitary sewer.

- **VOC Treatment**
  - Carbonair Low Profile Air Stripper
    - Six (6) trays with 25 HP Blower
    - Air Stripper located downstream of Filter Skid

- **SUEZ pre-purchased filter and air stripper equipment to save on project costs.**
RECOMMENDED TREATMENT PROCESSES:

- **4-Log Removal of Viruses**
  - Existing Salla Well Station include a clearwell and contact pipe for 4-Log removal; however it is sized for 200 gpm.
  - Under the project, a new contact pipe was installed to achieve 4-Log removal at the combined well flow of 300 gpm.

- **Booster Pumps**
  - Existing Salla Well Station include a vertical turbine pump which pumped water from clearwell to distribution system.
  - Project provided two, new vertical turbine pumps rated for new station well flow.

- **New Chemical Feed Systems:**
  - NaOCL feed system installed for filter media oxidant and disinfection.
  - Phosphate feed system for possible sequestering and corrosion control.

- **New Electrical and SCADA systems**
EXISTING WELL STATION:
EXISTING WELL STATION:
SITE DESIGN:
NEW TREATMENT FACILITY:
NEW TREATMENT FACILITY:
PROCESS DESIGN:
NEW TREATMENT FACILITY:
NEW TREATMENT FACILITY:
REQUIRED PERMITS AND SCHEDULE:

- **Project Schedule:**
  - SUEZ issued Design/Permitting (Phase 2) NTP to GHD on April 6, 2015
  - Project scheduled to bid in August 2015
  - Construction scheduled to begin in early Fall 2015

- **Permitting required for Project:**
  - PADEP Public Water Supply Construction Permit
  - PADEP Chapter 105 General Permit GP-5
  - Luzerne County Conservation District E&S Control Approval
  - Dallas Township Zoning Approval
  - Dallas Township Street Cut Permit
PERMITTING PROCESS:

- **Luzerne County Conservation District E&S Control Approval**
  - CD comments received June 29, 2015.
  - Received approval during bidding process and issued to bidders via Addendum.

- **PADEP Chapter 105 General Permit GP-5**
  - Application submitted June 8, 2015.
  - Received during bidding process and issued to bidders via Addendum.

- **PADEP Public Water Supply Construction Permit**
  - DEP comments received and GHD provided response to DEP on August 26, 2015.
  - Secured permit following receipt of bids on September 15, 2015 and issued to Contractor at pre-construction meeting.
  - No changes to Contract Documents.
PERMITTING PROCESS:

- **Dallas Township Street Cut Permit**
  - Issued to SUEZ on August 19, 2015.

- **Dallas Township Zoning Approval**
  - Zoning Hearing attended by SUEZ and GHD on June 8, 2015.
  - Filed variances for Front Yard and Toby Creek setbacks.
  - Zoning was granted with conditions that E&S and DEP approvals be provided.
  - Secured shortly following receipt of bids once all permits were received.

- **Dallas Township Building Permit**
  - Zoning approval was required for issuance.
  - Permit was issued on September 18, 2015 and issued to Contractor at September 24, 2015 pre-construction meeting.

Goal Met: All permits in hand by the construction start date.
CONCLUSION
CONCLUSION

- PROJECT WAS SUCCESSFUL

- WATER QUALITY
  - Mn – NON DETECT
  - H₂S – NON DETECT

- OPERATOR FEED BACK
  - SATISFIED WITH SYSTEM
  - REDUCED CUSTOMER COMPLAINTS ABOUT DISCOLORED WATER OR ODOR

- CUSTOMERS
  - THE EXPECTED RESULTS OF THE PROJECT WAS COMMUNICATED TO THE CUSTOMERS AND LOCAL OFFICIALS DURING THE PROJECT
  - SUEZ DELIVERED THE EXPECTED RESULTS
  - CUSTOMERS ARE SATISFIED WITH THE NEW TREATMENT PROCESS.