

The background is a light blue gradient with several realistic water droplets of various sizes scattered across the surface. The droplets have highlights and shadows, giving them a three-dimensional appearance.

TOWN OF CASTINE, MAINE WATER SUPPLY CHALLENGES AND SOLUTIONS

CLIMATE & WEATHER INFORMATION FOR NEW ENGLAND WATER
UTILITIES & STORMWATER MANAGERS

BY: ANNALEIS HAFFORD P.E., VICE PRESIDENT, OLVER ASSOCIATES INC.

MANAGER OF UTILITY OPERATIONS

INTRODUCTIONS

- OLVER ASSOCIATES INC. IS A 60 EMPLOYEE FIRM LOCATED IN WINTERPORT, MAINE
- WE ARE A CIVIL AND ENVIRONMENTAL ENGINEERING FIRM AND DESIGN UPGRADES TO WATER AND WASTEWATER INFRASTRUCTURE AS WELL AS DESIGN NEW FACILITIES.
- WE ALSO ASSIST OUR CLIENTS WITH OBTAINING FUNDING AND OVERSEE CONSTRUCTION SERVICES AS IMPROVEMENTS ARE MADE.
- ONE OF OUR OTHER SERVICES IS TO MANAGE SMALL UTILITIES. THIS SERVICE HAS GROWN OVER THE YEARS. WE NOW HAVE 20 SMALL WATER AND WASTEWATER UTILITIES THAT WE OPERATE. THEY RANGE IN SIZE FROM ONLY 17 CUSTOMERS UP TO 1 600 CUSTOMERS.

UTILITY BACKGROUND

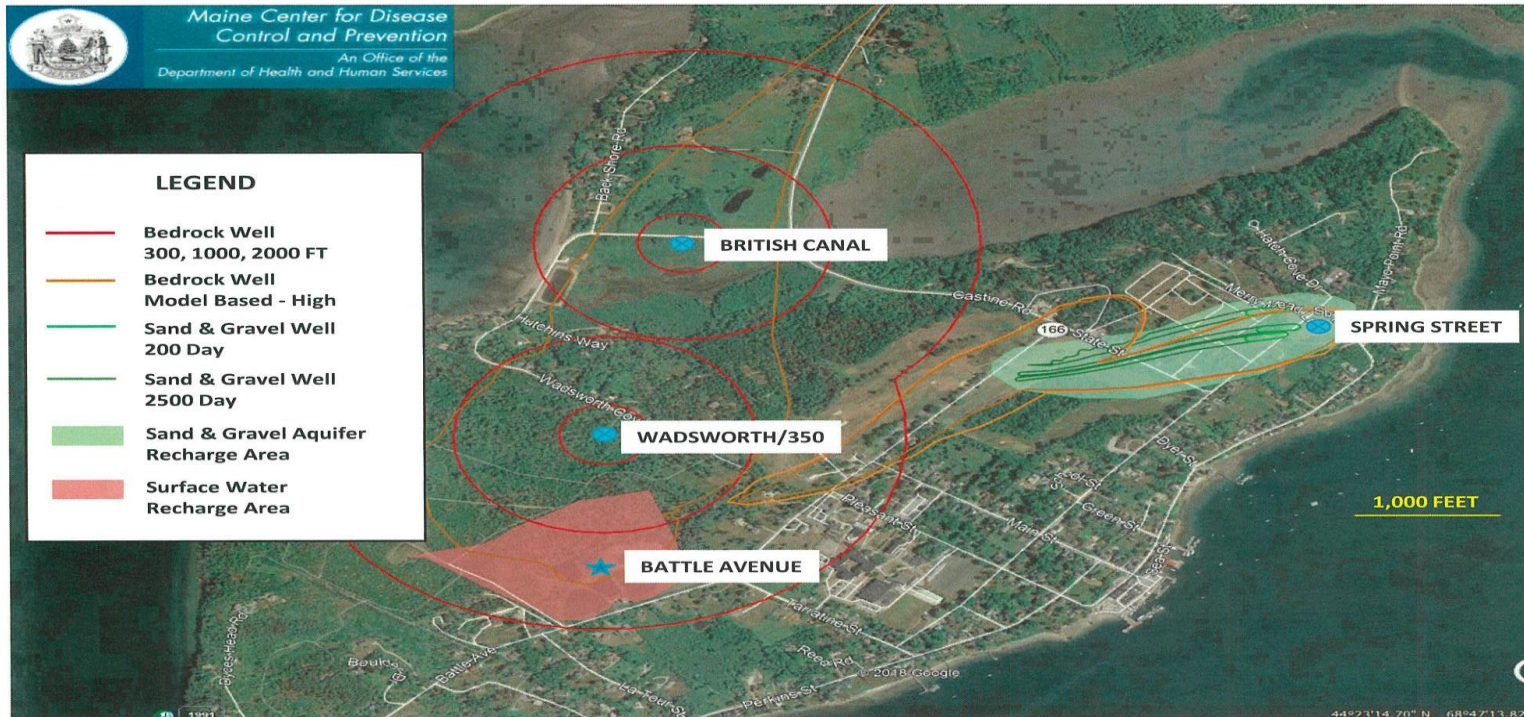
- THE TOWN OF CASTINE WATER DEPARTMENT PROVIDES WATER SERVICE TO ABOUT 380 CONNECTED CUSTOMERS.
- THE SYSTEM IS SMALL BUT COMPLICATED WITH VARIOUS SUPPLY SOURCES WITH VARYING CHEMISTRY AND TREATMENT REQUIREMENTS.
- YEARLY DEMAND IN 2018 WAS 21.885 MGD AND IN 2019 WAS 21.523 MGD.
- IN TYPICAL YEARS, THE PEAK WATER USE IS JULY THROUGH OCTOBER.
- THE BIGGEST INFLUENCE ON THE TOWN'S WATER DEMAND IS ITS INFLUX OF OUT OF STATE SUMMER POPULATION AND MAINE MARITIME ACADEMY.

WATER SOURCE CHALLENGES

- THE TOWN OF CASTINE HAS HAD WATER SUPPLY CHALLENGES FOR MANY YEARS. IT'S KEY SOURCES HAVE BEEN SIGNIFICANTLY IMPACTED BY DROUGHT CONDITIONS.
- THE TOWN IS SURROUNDED BY SALT WATER EXCEPT FOR A NARROW "NECK" THAT LEADS TO THE TOWN.
- THE TOWN HAS HAD MANY VARYING SOURCES OF WATER SUPPLY OVER THE YEARS AND VARIOUS SOURCES HAVE BEEN DISCONTINUED DUE TO ISSUES WITH WATER QUALITY WITH SOME OF THE DEEPER BEDROCK WELLS.
- THE PAST ULTRAFILTRATION SYSTEM AT BATTLE AVENUE FAILED CAUSING THE TOWN TO HAVE SIGNIFICANT SHORTCOMINGS DURING DROUGHT AND BUSY SUMMER MONTHS WITH THE NEED TO RELY ON TRUCKING WATER FROM OUTSIDE SOURCES.
- IN SUMMARY, A LOT OF MONEY HAS BEEN SPENT OVER THE YEARS ON INVESTIGATING POSSIBLE ADDITIONAL SOURCES OF WATER AND A PRIOR FAILED SURFACE WATER TREATMENT SYSTEM.

LOCATION OF SUPPLY WELLS AND RECHARGE AREAS

CASTINE WATER DEPARTMENT - SOURCE WATER PROTECTION AREAS



GEOLOGY OF CASTINE WELLS

- CASTINE NECK IS A ROCKY PENINSULA CAPPED BY A THIN SAND SPIT DEPOSITED AS SEA LEVELS RETREATED ABOUT 12,000 YEARS AGO.
- THIS SAND HAS BEEN TAPPED FOR GROUNDWATER SUPPLY IN TWO VERY DIFFERENT TYPES OF SOURCE WATER SUPPLIES THAT HAVE BEEN KEY TO THE IMPROVEMENTS IN THE TOWN'S WATER SUPPLY.
- IN ADDITION TO THESE VALUABLE SAND AQUIFERS, THE TOWN HAS TWO BEDROCK WELLS THAT ARE KEY TO ITS PRESENT WATER SUPPLY.

EXISTING SOURCES OF WATER SUPPLY

- SPRING STREET WELL – THIS IS THE TOWN’S HIGHEST QUALITY AND LEAST COSTLY SOURCE OF WATER, HOWEVER THE AQUIFER DRIES UP IN THE SUMMER MONTHS.
 - TREATMENT – AERATION AND PHOSPHATE SEQUESTERING FOR LEAD AND COPPER CONTROL, AS WELL AS LOW LEVELS OF CHLORINATION.
 - THIS IS OUR “GO TO WELL”, HOWEVER, DURING DROUGHT CONDITIONS, SUPPLY DROPS SIGNIFICANTLY.
 - THIS SHALLOW WELL SUPPLIES ON AVERAGE ABOUT 27 TO 32 PERCENT OF THE TOWN’S WATER SUPPLY.
 - SUPPLY DURING DROUGHT CONDITIONS CAN BE AS LOW AS 16 PERCENT FROM THIS SOURCE.
- IMPROVEMENTS – THE SPRING STREET WELLFIELD WAS ORIGINALLY TAPPED BY FOUR DRIVEN POINT WELLS THAT WERE REPLACED IN 2012 BY ONE GRAVEL PACKED WELL HAVING A SUMP SET INTO THE CLAY BELOW THE SCREEN. THIS UNUSUAL DESIGN ALLOWS FOR CONSIDERABLY GREATER WITHDRAWAL VOLUMES WITH LESS MAINTENANCE THAN THE FOUR ABANDONED WELLS. THIS ALLOWED THE TOWN TO INSTALL AERATION TO STRIP CO₂ AND IMPROVE ALKALINITY FOR LEAD AND COPPER CONTROL. PHOSPHATE SEQUESTERING WAS ALSO ADDED FOR CONTROL OF LEAD AND COPPER.

EXISTING SOURCES OF WATER SUPPLY, CONT.

- BRITISH CANAL WELL (BC) – THIS WELL WAS INSTALLED IN 1999, IS DRILLED INTO BEDROCK AND IS THE NEXT CLEANEST WELL. THIS WELL IS PUMPED TO THE WADSWORTH COVE WELL TREATMENT BUILDING .
 - TREATMENT – CHLORINATION AND SEQUESTERING WITH PHOSPHATE FOR LEAD AND COPPER CONTROL.
 - THIS WELL IS ALSO INFLUENCED BY DRY WEATHER AND ITS YIELD IS LIMITED DUE TO TIDAL INFLUENCE.
 - THE WELL HAS TO BE CONTROLLED TO A CERTAIN DRAWDOWN TO PREVENT THIS INFLUENCE AND IN THE SUMMER MONTHS DURING DROUGHT, WE HAVE TO MONITOR WATER QUALITY AND WELL LEVELS TO ENSURE THAT THE TIDE IS NOT INFLUENCING THE WELL.
 - THIS BEDROCK WELL SUPPLIES ON AVERAGE ABOUT 32 TO 35 PERCENT OF THE TOWN'S WATER SUPPLY, HOWEVER, DROPS TO AROUND 25 PERCENT DURING DROUGHT CONDITIONS.
- IMPROVEMENTS – INSTALLED NEW TRANSDUCER, INITIATED REGULAR MONITORING FOR SODIUM AND IMPROVED SECURITY OF THE SITE. PHOSPHATE SEQUESTERING WAS ALSO ADDED FOR THE CONTROL OF LEAD AND COPPER.

EXISTING SOURCES OF WATER SUPPLY, CONT.

- WADSWORTH COVE WELL – 350 WELL – THIS WELL IS A BEDROCK WELL WITH THE HIGHEST AND MOST CONSISTENT YIELD OF ALL THE WELLS, HOWEVER, IT IS THE MOST EXPENSIVE TO OPERATE DUE TO THE ARSENIC REMOVAL PROCESS.
 - TREATMENT – ARSENIC REMOVAL, PHOSPHATE SEQUESTERING FOR LEAD AND COPPER CONTROL AS WELL AS CHLORINATION.
 - THIS WELL IS PUSHED TO ITS CAPACITY DURING MOST PEAK FLOW MONTHS TO MAINTAIN PRODUCTION.
 - THIS WELL IS SLIGHTLY INFLUENCED BY DRY WEATHER WHICH IMPACTS ITS YIELD IN THE SUMMERTIME.
 - THIS BEDROCK WELL SUPPLIES ON AVERAGE ABOUT 26 TO 31 PERCENT OF THE TOWN'S WATER SUPPLY, HOWEVER, IN THE PEAK FLOW MONTHS, THE SUPPLY FROM THIS WELL IS ABOUT 42 PERCENT.
- IMPROVEMENTS – BACK IN 2006, THE TOWN HAD TO INSTALL THE ARSENIC REMOVAL SYSTEM DUE TO CHANGES IN THE ALLOWABLE LEVEL OF ARSENIC IN GROUNDWATER. THE SYSTEM WORKS VERY WELL WITH BUT IS MUCH MORE EXPENSIVE TO USE THAN IN THE PAST. PHOSPHATE SEQUESTERING WAS ADDED FOR THE CONTROL OF LEAD AND COPPER.

EXISTING SOURCES OF WATER SUPPLY, BATTLE AVENUE

- BATTLE AVENUE SITE

- HISTORY – PRIOR TO THE DRINKING WATER RULES, THE TOWN USED THE BATTLE AVENUE PONDS FOR ITS PRIMARY WATER SOURCE. IN 2002, THE TOWN WAS REQUIRED TO COMPLY WITH THE SURFACE WATER TREATMENT RULES AND INSTALLED ULTRAFILTRATION TO AUGMENT THE WELLS WHEN THEY BECAME OVERTAXED. THIS SYSTEM OPERATED POORLY FROM THE START DUE TO EXCESSIVE FOULING OF THE ULTRAFILTRATION FILTERS. AFTER A SHORT PERIOD, THE SYSTEM WAS BASICALLY SHUT DOWN AND HARDLY UTILIZED.
- THE TOWN'S GROUNDWATER SOURCES COULD NOT RELIABLY KEEP UP WITH SYSTEM DEMAND DURING THE MONTHS OF AUGUST, SEPTEMBER AND OCTOBER. ONGOING WATER CONSERVATION EFFORTS AND BULK WATER HAULING HAS BEEN REQUIRED.
- THE BATTLE AVENUE SITE USED TO CONSIST OF 5 PONDS BUT NOW CONSISTS OF 4 SURFACE WATER PONDS WHICH ARE FED FROM GROUNDWATER FROM UPGRADIENT TERRAIN.

EXISTING SOURCES OF WATER SUPPLY, BATTLE AVENUE – STUDY PHASE

- THE TOWN CONTACTED OUR FIRM TO REQUEST ASSISTANCE IN UNDERSTANDING HOW THE WATER DEPARTMENT COULD USE THE EXCESS WATER THAT WAS OBSERVED ROUTINELY OVERFLOWING FROM THE BATTLE AVENUE PONDS. THIS STUDY WAS FUNDED THROUGH THE MAINE DWP'S CAPACITY DEVELOPMENT GRANT PROGRAM IN COORDINATION WITH OUR FIRM, THE TOWN AND PETER GARRET, THE TOWN'S LONG STANDING HYDROGEOLOGIST.
- THIS STUDY DEVELOPED IN THREE KEY PHASES:
 - PHASE 1 – DIRECT FILTRATION OF POND WATER THROUGH A TRIAL CARTRIDGE FILTRATION SYSTEM.
 - PHASE 2 – INSTALLATION OF A HORIZONTAL TEST WELL AND TESTING FOR MICRO-PARTICULATE ANALYSIS WHICH CONFIRMED IT WAS UNDER THE INFLUENCE OF SURFACE WATER DUE TO ALGAE.
 - PHASE 3 – FILTRATION OF THE HORIZONTAL WELL WATER THROUGH TRIAL CARTRIDGE FILTRATION SYSTEM.
- ONCE THE TRIAL WORK WAS DONE, WE PREPARED A REPORT WHICH EVALUATED CARTRIDGE FILTRATION AND FOUND IT TO BE A FEASIBLE OPTION FOR CASTINE.

EXISTING SOURCES OF WATER SUPPLY, BATTLE AVENUE – CONSTRUCTION PHASE

- THE CONSTRUCTION OF THIS SYSTEM WAS DONE IN TWO PROJECT PHASES :
 - THE PROJECT FIRST INCLUDED INSTALLATION OF A NEW 6-INCH HORIZONTAL PRODUCTION WELL INCLUDING A CONCRETE MANHOLE OR COLLECTION STRUCTURE.
 - GRAVITY PIPING FROM THE COLLECTION STRUCTURE TO TWO WELL CASINGS WITH A CENTER WELL FOR A TRANSDUCER, ALONG WITH A FUTURE FORCEMAIN FOR RECHARGE WERE INSTALLED.
- FOLLOWING THE INSTALLATION OF THE NEW HORIZONTAL WELL THE OLD TREATMENT SYSTEM WAS DEMOLISHED AND A NEW SYSTEM WAS CONSTRUCTED INCLUDING:
 - ONE TRAIN CARTRIDGE FILTRATION SYSTEM WITH TWO FILTERS (HARMSCO WITH A 1 MICRON FILTER FOLLOWED BY A 1 MICRON ABSOLUTE FILTER)
 - SODIUM HYPOCHLORITE ADDITION PACED TO FLOW FOLLOWED BY STATIC MIXING, ONLINE CHLORINE MONITORING, CHLORINE CONTACT LOOP, AND POST CT ONLINE CHLORINE MONITORING.
 - SODA ASH AND PHOSPHATE ADDITION, PACED TO FLOW FOLLOWED BY STATIC MIXING AND ONLINE PH. MONITORING.
 - NEW BUILDING TO HOUSE THE EQUIPMENT WITH SANITARY FACILITIES AND SITE WORK.

EXISTING SOURCES OF WATER SUPPLY, BATTLE AVENUE – SUMMARY OF RESULTS

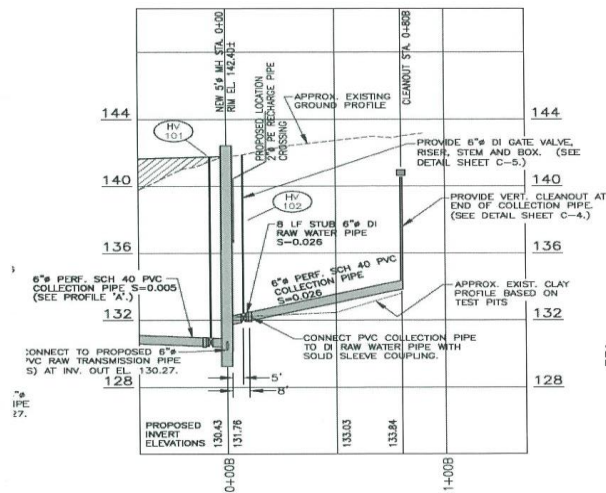
- THIS IS THE SECOND MOST COSTLY WATER SOURCE TO OPERATE, MAINLY DUE TO THE CARTRIDGES REQUIRED FOR SURFACE WATER FILTRATION.
- THIS SITE HAS BEEN INSTRUMENTAL WITH SUPPLYING THE ADDED WATER NEEDED TO PREVENT MANDATORY CONSERVATION MEASURES AND BULK WATER HAULING.
- IN 2017, AT FULL SCALE OPERATION WE WERE ABLE TO PRODUCE ABOUT 12.5 PERCENT IN OCTOBER.
- IN 2018, WE WERE ABLE TO PRODUCE UP TO 17 PERCENT DURING AUGUST WHEN THE SPRING STREET AND BC WELLS STARTED TO DECLINE IN PRODUCTIVITY.
- IN 2019, WE DID NOT NEED TO RUN THE SITE AGGRESSIVELY BECAUSE OF THE WET SUMMER WITH A PEAK OF ONLY 12 PERCENT USED IN OCTOBER.
- RECENTLY, IN 2020, WE EXPERIENCED DROUGHT LIKE CONDITIONS IN JUNE WHICH IS VERY UNUSUAL FOR MAINE. THIS RESULTED IN A 28 PERCENT SUPPLY FROM THIS SITE. THE SYSTEM IS OPERATING EXCELLENT AND PRODUCING HIGH QUALITY WATER.

EXISTING SOURCES OF WATER SUPPLY, BATTLE AVENUE

- SINCE THE ORIGINAL DESIGN WE HAVE MADE THE FOLLOWING IN-HOUSE IMPROVEMENTS:
 - INSTALLED A SECOND WELL PUMP SO WE HAVE BACKUP IF THE ORIGINAL PUMP FAILS.
 - THE NEW SUPERINTENDENT HAS INSTALLED A SECOND TRAIN JUST LIKE THE FIRST TO IMPROVE THROUGHPUT AND IMPROVE IRON CLOGGING. THIS HAS DOUBLED THE PRODUCTION OF THIS SOURCE.
 - OBTAINED APPROVAL FOR ARTIFICIAL RECHARGE OPERATIONS AND WATER SUPERINTENDENT AND STAFF INSTALLED SYSTEM.
 - SHUTDOWN THE LONGER WEST SIDE COLLECTOR WHERE IRON PRESENTED ITSELF AND ARE ONLY USING THE SHORT EAST COLLECTOR.
 - WATER SUPERINTENDENT AND STAFF HAS OPTIMIZED OPERATIONS SO THE SYSTEM IS NOW ABLE TO RUN AUTOMATICALLY WITH NO ISSUES. THERE ARE FAIL SAFE CONTROLS TO SHUT THE SYSTEM DOWN AUTOMATICALLY.

PROFILE SHOWING HORIZONTAL WELL'S CONNECTION TO COLLECTION MANHOLE

The manhole

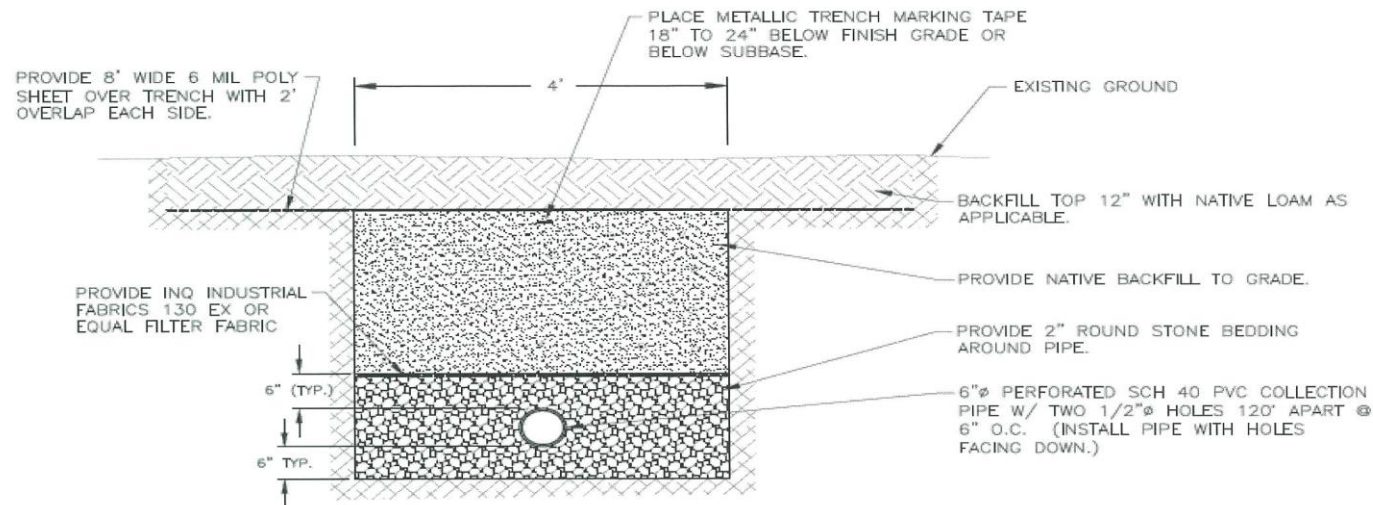


PROFILE B — PROPOSED 6"Ø PERFORATED PVC COLLECTION PIPE (FAST) TO PROPOSED COLLECTION MH



SECTION OF HORIZONTAL WELL INSTALLATION

Production Well Specifications



COLLECTION PIPE TRENCH DETAIL

GRAVITY COLLECTION MANHOLE AND DOWNSTREAM WELLS AND TRANSDUCER HOUSING



CARTRIDGE SYSTEM SHOWING THE SINGLE TRAIN INITIALLY INSTALLED IN 2016 AND THE SECOND TRAIN INSTALLED IN FEBRUARY, 2020



DUAL TRAIN CARTRIDGE FILTRATION SYSTEM



FUTURE STUDIES AND IMPROVEMENTS FOR DROUGHT OPERATIONS – ARTIFICIAL RECHARGE



BASIC LAYOUT OF ARTIFICIAL RECHARGE SYSTEM

