INVENTUM ENGINEERING, PC

Corrective Measures Work Plan

Groundwater Treatment

Brownfield Cleanup Program Site #C915230

Buffalo Color Corporation Site

Area A

1337 South Park Avenue, Buffalo, NY

June 21, 2022

441 CARLISLE DRIVE
SUITE C
HERNDON, VA 20170
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1 Introduction

On behalf of HDC Holdings LLC (HDC) and South Buffalo Development LLC (SBD), Inventum Engineering, P.C. (Inventum) has prepared this Corrective Measures Work Plan (CM Work Plan) for Area A (Site) of the former Buffalo Color Corporation (BCC) property located at 1337 South Park Avenue in the City of Buffalo, County of Erie, New York. The Site is one of five areas that comprised the former BCC, which produced dyes and organic chemicals until it filed for bankruptcy protection in 2005. SBD entered into a Brownfield Cleanup Agreement (BCA, Index No. B9-0783-08-06) with the New York State Department of Environmental Conservation (NYSDEC) in April 2009 to investigate and remediate the 10.029-acre Area A Site (Site No. C915230).

Remedial investigation conducted in accordance with the BCA, determined that Site soil samples contained concentrations of certain metals and organic substances that exceeded the New York Commercial Soil Cleanup Objectives (SCOs). Shallow soil and groundwater samples collected from the southwestern portion of Area A were found to contain concentrations of volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) that exceeded applicable SCOs and groundwater standards. The approved RI concluded that no remedial action was necessary for deep aquifer groundwater.

In December 2013, following completion of remedial construction activities and the subsequent issuance of a certificate of completion (COC) from the NYSDEC, ownership of Area A was transferred to HDC. An agreement was executed between SBD and HDC establishing an environmental easement and granting SBD, and its contractors, indefinite access to the Site to perform continuing obligations and requirements under the NYSDEC approved Site Management Plan (SMP).

1.1 Site Description

Area A is situated on 10.029 acres and bounded by South Park Avenue to the north, the Buffalo River to the east, former/abandoned railroad tracks on an elevated embankment to the south, and active railroad lines to the west (Figure 1). The northeast corner of the Site is adjacent to a bridge abutment for the South Park Avenue bridge that extends over the Buffalo River. There are four buildings on the property; an unoccupied office building near South Park Avenue, two metal framed and sided warehouse structures used for dry storage, and the groundwater treatment plant structure.

The following is a summary of the Remedial Actions (RAs) performed at the Site:

- A vertical hydraulic barrier (VHB) consisting of slag, cement, and bentonite was installed using slurry trench and jet grout methods was constructed along the river.
- The pre-existing Area A groundwater extraction and treatment facility (GWTF), which was installed in 2006 as an Interim Corrective Measure (ICM), was repurposed to extract groundwater for treatment and to provide hydraulic control behind the VHB.
- The Area A riverbank was stabilized through closure of the former water intake structure, establishment of vegetation along segments of the riverbanks, and stabilization of existing concrete retaining walls to remain in place.
- Installation of an integrated Site-wide cover system to prevent human exposure to remaining soils containing compounds of concern at the Site.
- Abandonment/plugging of unused process sewers and installation of a new storm sewer conveyance system.
- Execution and recording of an environmental easement to restrict land use and address further exposure to any remaining contamination at the Site.

- Development and implementation of a SMP for longer term management of the site remedy.

The GWTF was initially constructed in 1996 to treat the groundwater recovered from the adjacent BCC Area D (NYSDEC Site No. 915012). Area A had five (5) existing extraction wells (EW-1 through EW-5) Figure 1, which had been installed in 2006 and were repurposed to provide hydraulic control of Area A. Upgrades to the GWTF were made under an agreement with the NYSDEC when the Area A extraction wells were connected to the existing treatment facility. Full-time pumping from the Area A extraction wells commenced in December 2007. The VHB was constructed between October 2012 and December 2013. Construction and connection of the Area A extraction system and VHB is documented in the December 2013 Final Engineering Report (FER)[1]. Operations and Maintenance procedures are documented in the March 2014 NYSDEC approved Operation, Maintenance and Monitoring (OM&M) manual[2] and performance metrics are reported in annual Periodic Review Reports (PRRs).

The extraction wells (EW-1 through EW-5) and the GWTF are currently operating, and treated waters are discharged to the Buffalo Sewer Authority (BSA) under BSA Permit No. 20-06-BU109.

1.2 Corrective Measure Recommendations

This CM Work Plan was prepared to address the recommended corrective measures to existing Engineering Controls (ECs) that were identified in the July 29, 2020 Periodic Review Report (PRR) for the reporting period of October 5, 2018 to October 5, 2019. Specifically, there is periodically an apparent outward gradient along the Buffalo River near the north end of Area A. Table 1 shows groundwater elevation monitoring data collected during the October 5, 2020 to October 5, 2021 reporting period from the six (6) observations well pairs installed on the interior and exterior of the VHB.

Inventum notes that while there may be a measured gradient at times, due to the presence of the VHB, it is unlikely the small and periodic outward gradient has induced any flow from the site to the river. A Corrective Measures Evaluation[3] was submitted to the NYSDEC on December 18, 2020 and was approved in a letter dated December 21, 2020. This evaluation included an updated assessment of corrective measure alternatives for the Site:

- Alternative A – Extraction and Treatment
- Alternative B – Hydraulic Barriers – VHB Extension and Capping
- Alternative C – Source Treatment, Capping, and Monitored Natural Attenuation

Inventum initially recommended proceeding with a series of ICMs to further evaluate the feasibility of implementing Alternative C, which included several temporary modifications to the existing groundwater extraction system. However, after discussions with the NYSDEC, SBD elected to proceed with Alternative A - Extraction and Treatment, which includes upgrades/updates to the GWTF to allow for long-term operation.

[1] Final Engineering Report. Buffalo Color Site – Area A/B. Erie County, New York. MACTEC Engineering and Consulting, P.C. December 2013

[2] Former Buffalo Corporation Color Sites Areas A and D Groundwater Extraction System OM&M Manual. Buffalo Color Areas A and D. Buffalo, New York. MACTEC Engineering and Consulting, P.C. Updated March 2015.

[3] Corrective Measures Evaluation, Brownfield Cleanup Site #C915230, Buffalo Color Corporation Site, Area A, 1337 South Park Avenue, Buffalo, New York, December 18, 2020.

1.3 Corrective Measure Objectives

The CM objective is to reestablish consistent hydraulic gradients along the Buffalo River. To achieve the CM objective, SBD is proposing to upgrade/update the GWTF to prepare for long-term operation and allow for a significant increase in the facilities treatment capacity.

Four (4) new extraction wells (EW-4A, EW-6, EW-7, and EW-8) were installed at the approximate locations shown on Figure 1 in May 2020. Operation of these four (4) new wells at pumping rates as low as 5 gallons per minute (gpm) combined with operation of two existing extraction wells (EW-1 and EW-2) at their current rates were shown in the Corrective Measures Evaluation to induce an inward gradient across the VHB. The groundwater pumping and conveyance system and GWTF will be designed for permanent operation at higher maximum flow rates to be capable of adapting to seasonal fluctuations.

The following sections of the Work Plan describe specifications for connecting the new extraction wells to the GWTF and modifications/upgrades to the GWTF.

2 CMS Hydraulic Control Measures Evaluation

2.1 New Extraction Wells

Four (4) additional extraction wells (EW-4A, EW-6, EW-7, and EW-8) were installed at the approximate locations shown on Figure 1 in May 2020. The wells were installed by Earth Dimensions, Inc. of Elma, New York. Each extraction well boring was completed using an 8.25-inch inside diameter hollow stem auger (12-inch outside diameter) and was keyed a minimum of 2-feet into the underlying clay formation. Each well was completed with a 4-inch diameter polyvinyl chloride (PVC) casing and screen. A 2-foot section of solid casing was installed at the bottom of each well and serves as a sump for the extraction pump. Twenty (20) feet of slotted screen (0.020 inch) was installed above the solid "sump" casing. A filter and sand pack were installed from one foot below the base of the screen to 5 foot above the top of the screened interval. A 2-foot-thick layer of bentonite was installed above the sand filter pack and the remaining annular space was filled with a bentonite-cement grout.

A summary of boring and well construction details for the new extraction wells is included on Table 2. Each of the new extraction wells were completed at the time of installation as above-grade stick-ups with approximately 3-feet of casing above ground surface to facilitate connection/incorporation into the GWTF.

Soil cuttings were screened with a photoionization detector (PID) equipped with a 10.6 eV lamp. The only indication of potentially impacted soil was in the boring for EW-7 where there was field screening (58 parts per million [ppm]) and olfactory evidence from approximately 25-feet to 27-feet. Additionally, there was light non-aqueous phase liquid (LNAPL) noted during the development and drilling of EW-7. However, there was not a sufficiently measurable amount of LNAPL present at EW-7 to be gauged by an oil-water interface meter either during well development, sampling, or during the pumping test. A temporary skid-mounted oil-water separator is proposed (Section 3) to account for any potential LNAPL from the connection of EW-7 to the GWTF.

2.2 Groundwater Sampling

Groundwater samples were collected from each of the new extraction wells two weeks following development (Table 3)[4]. Each well was purged prior to sampling with peristaltic pump and dedicated new high-density polyethylene (HDPE) tubing following low-flow sampling procedures. One sample was collected at EW-4A, EW-6, and EW-8 and analyzed for Target Compound List (TCL) Volatile Organic Compounds (VOCs) using EPA Method 8260, TCL Semi-Volatile Organic Compounds (SVOCs) using EPA Method 8270, and Target Analyte List (TAL) Metals using EPA Method 6010. Two (2) samples were collected from EW-7 where the globules of LNAPL were noted during development. One sample (A-EW-7A) from EW-7 was collected with the pump intake set at the bottom of the screen interval (approximately 30 feet bgs) and the second sample (A-EW-7B) was collected from the interval where PID and olfactory evidence was noted in the soil boring (approximately 25 feet bgs).

The extraction well water sample results (Table 3) show a suite of parameters detected at concentrations similar to those seen in the annual monitoring conducted of the Site monitoring and extraction wells under the SMP.

[4] Groundwater sampling logs and Laboratory Data Reports were included as appendices to the December 13, 2020 Corrective Measures Evaluation.

2.3 Shallow Aquifer Tests

A sequence of pumping tests and step test were conducted on the new extraction wells between June 23 and June 29, 2020.

Electric submersible pumps are utilized in the existing extraction wells and similar style pumps (Grundfos Redi-Flo 3" 22SQE07-140) were temporarily installed in each new extraction well for the tests. Temporary 1-inch HDPE tubing was used to connect the pump discharges to the GWTF. A 1-inch in-line digital flow meter was installed at each well head to monitor flow rate and total flows over the pumping tests. Pump control boxes with variable frequency drives (VFD) were connected to each submersible pump to provide power and adjust flow rates during the tests. Pressure transducers were installed in each of the adjacent interior observation wells (OW-A3I, OW-A4I, OW-A5I, and OW-A6I) and programmed to monitor and record changes in groundwater elevation at 1-minute intervals prior to (baseline) and during the tests.

2.3.1 Pumping Test

A series of pumping tests were conducted on June 24 and June 25, 2020 (Figure 2) to determine the pumping rates necessary to maintain consistent hydraulic gradient across the VHB. During each of the tests the new extraction wells were operated at pumping rates between 5 and 13 gpm and the response in the adjacent interior observation wells were monitored and recorded with the transducers. Manual groundwater level measurements were collected frequently during the pumping from the corresponding exterior observation wells (OW-A3E, OW-A4E, OW-A5E, and OW-A6E). Surface water levels from the Buffalo River were also recorded frequently.

Initially, the pumping tests were run with existing extraction wells EW-1 and EW-2 also operating at normal capacity; however, it became clear that the GWTF was not designed or capable of treating the additional maximum flow (up to 13 gpm each) from the four (4) new extraction wells with either EW-1 or EW-2 also operating. The pumps at EW-1 and EW-2 were shut off for the duration of each pumping test. Similarly, as the pumping rate was increased in new extraction wells EW-4A and EW-6 during the second test on June 25, 2020 (Figure 3) the GWTF could not treat the water when the flow rate at each well approached 12 to 14 gpm. As a result, these wells were operated at half the pump capacity (approximately 5 to 7 gpm) for the remainder of the test and the adjacent observation wells still showed a distinct and consistent inward gradient across the VHB.

The pumps in existing wells EW-3A, EW-4, and EW-5 were turned off during all the pumping tests. The pumps in all the existing wells were turned back on and were fully operating at the completion of each test.

Baseline groundwater level monitoring from the interior observation wells (OW-A3I, OW-A4I, OW-A5I, and OW-A6I) were monitored for a 24-hour period prior to starting the initial test. Similarly, groundwater recovery was monitored during the overnight period between the two tests from these observation wells.

2.3.2 Step Test

A step test was conducted at EW-6 on June 26, 2020 at pumping intervals of 7 gpm, 11 gpm, and 14 gpm. Each step was operated for approximately 60-minutes. The groundwater elevation in the extraction well was monitored frequently during each step of the test and during a 35-minute recovery period following completion of the test (Figure 3). Groundwater elevations were also monitored with transducers at nearby interior observation wells OW-A2I, OW-A3I, and OW-A4I. An estimated hydraulic conductivity of 18.9 feet per day ($6.6E^{-03}$ cm/sec) was calculated from the step test (Table 4). The new extraction wells are fully screened through the entire saturated interval and this value is within the range expected from the sand and gravel alluvium formation.

2.3.3 Buffalo River – Observation Well Response Monitoring

Transducers were installed in OW-A3I, OW-A3E, OW-A4I, and within the Buffalo River over a 63-hour period between June 26 and June 28, 2020. Transducers were programmed to monitor and record water levels at 5-minute intervals during that period (Figure 4). The goal of the monitoring was to observe the response of the exterior observation wells to fluctuations in river water levels as a guide to understanding the range of pumping rates that may be required to maintain long-term hydraulic control.

2.4 Evaluation and Findings

The pumping tests demonstrated that the temporary extraction wells (without existing extraction wells EW-3A, EW-4, and EW-5) as designed (fully screened through the saturated interval) are capable of withdrawing groundwater at rates that create an inward gradient across the VHB (Figure 2). Transducer data from the interior observation wells adjacent to the new extraction wells show an almost immediate response to pumping (Figure 2). The minimum pumping rate to affect a 0.5-foot differential across the VHB is estimated to be approximately 5 to 7 gpm per well under the conditions at the time of testing; however, the pumping and step test data also show that each new extraction well can yield over 15 gpm.

Figure 4 shows an immediate and proportioned response in exterior observation well OW-A3E with fluctuations in river water level. The river water level fluctuated over two feet (approximately 576.5 ft AMSL to 574 ft AMSL) over the monitoring period. There was an immediate but muted response on OW-A3E of approximately 2-feet (575.5 ft AMSL to 573.5 ft AMSL) over the same period. The corresponding interior observation well (OW-A3I) fluctuated between 574 ft AMSL and 574.25 ft AMSL.

3 Corrective Measures Work Plan

The existing groundwater extraction system for Area A is comprised of five (5) existing extraction wells (EW-1 through EW-5) all with independent discharge laterals to the GWTF (Figure 5). Control signal wiring connects a transducer from each well to the pump control panel in the GWTF. Each extraction well pump is operated by a VFD connected to the pump control panel which adjusts the pump motor based on a user defined set point in order to maintain the groundwater level within the extraction well.

The GWTF is comprised of two separate treatment streams (Figure 6). Extracted groundwater from EW-1, EW-2, EW-5, and periodically the Area D extractions wells are processed through one set of treatment controls (batch tank, bag filters, multi-media filter, and GAC) prior to discharge to a BSA manhole located on BCC Area B. Extracted groundwater from EW-3 and EW-4A are processed through a separate set of treatment controls (batch tank, bag filters, and GAC) prior to discharge via a separate lateral to the same manhole. The separation in treatment streams has been due to iron fouling which would cause severe operational issues if the two influent streams were combined.

The GWTF is currently operating at a capacity of approximately 402,000 gallons per month based on the Discharge Monitoring Report for the period October 1, 2021 through December 31, 2021.The BSA discharge permit allows a maximum daily discharge of 50,000 gallons per day (gpd) approximately 1.5 Million Gallons per Month.

An upgraded system designed for long-term operation will include pumps capable of higher maximum flow rates to be capable of adapting to seasonal fluctuations based on the pumping test and river/observation well data observed (Figure 2 and 4).

The upgraded system will include operation of extraction wells EW-1, EW-2, EW-4A, EW-6, EW-7, and EW-8 (Figure 1) at a total combined design flow rate of 42 gpm (minimum) to 100 gpm (maximum).

Inventum does not anticipate utilizing any of the existing treatment components within the upgraded system. The design and engineering process will include an evaluation on re-use of the existing groundwater treatment building or mobilization of a packaged system constructed offsite.

Conveyance piping from the existing extraction wells remaining in the upgraded system (EW-1 and EW-2) will remain in place; however, control wiring and other wellhead appurtenances (valves, electrical controls, etc..) may be replaced based on the final design. Preliminary conveyance piping layout and sizing for the upgraded system is shown on Figure 5.

3.1 Bench-Scale Treatability Testing

These existing primary treatment process/design (equalization, mechanical filtration, and carbon filtration) have been demonstrably successful over many years at meeting BSA discharge requirements and will be used as a starting point for design of the upgraded system (Figure 6). Inventum will initiate discussions with the BSA prior to conducting the treatability test to determine if any additional parameters or discharge limits may be required as part of the permit modifications.

The following additional treatment options will be evaluated based on recurring OM&M issues experienced in operation of the existing system and data generated over the course of the hydraulic evaluation (Section 2):

- Chemical Sequestration of Iron and Calcium at the extraction wellhead(s), treatment system influent, or within the treatment process; and
- Oil/Water Separation (OWS) to prevent premature plugging/fouling of filtration media and GAC from LNAPL globules that may be drawn into the system[5].

A bench-scale treatability study will be completed prior to full-scale system design to determine (1) a conceptual design that will handle flows from all extraction wells in a single treatment stream and (2) verify discharge criteria will be met with the conceptually designed treatment system.

A representative 1-gallon sample will initially be collected from each of the extraction wells (EW-1, EW-2, EW-4A, EW-6, EW-7, and EW-8). A representative 1-gallon sample will also be collected from the Area D (Site No. 915012) influent[6]. The wells not currently in operation (EW-4A, EW-6, EW-7, and EW-8) will be purged a minimum of three well volumes with a bailer or submersible pump to ensure collection of groundwater from the surrounding formation. Samples from extraction wells EW-1 and EW-2 will be collected directly from sample ports on the influent conveyance lines. Water quality readings of pH, temperature, oxidation-reduction potential (ORP), dissolved oxygen (DO), and turbidity will be collected and logged in a field notebook. Groundwater level measurements will be logged at the time of sample collection. The samples will be submitted to Ground/Water Treatment & Technology (GWTT) of Wharton, New Jersey for bench-scale treatability testing.

A representative sample will be created using equal volumes of the seven samples so that a characterization of the influent to the treatment system can be analyzed. The composite samples will be analyzed for:

- pH

[5] Although no measurable LNAPL was identified, globules were noted during development of EW-7.
[6] The Area D flow to the GWTF is periodic and represents approximately 0.5-percent of the total system flow. Independent bench tests (i.e., Area A only or Area D only) are not necessary for the system design.

- Total and Dissolved Metals – Calcium[7], Chromium, Copper, Iron[8], Lead, Mercury, Nickel, and Zinc
- Biological Oxygen Demand (BOD_5)
- Amenable Cyanide
- Polychlorinated Biphenyls (PCBs)
- VOCs (Method 624) and SVOCs (Method 625)
- Total Suspended Solids (TSS)
- Total Phenols
- Total Phosphates
- Oil and Grease

The analysis will be compared to historical system data to determine if any additional treatment components are necessary to meet BSA discharge criteria. Following the influent characterization analysis, the following unit operations will be tested to determine the efficacy of the conceptual design:

- Chemical Sequestering of Iron and Calcium – The efficacy will be evaluated through comparison of the pre- and post-treated samples to determine the ability of the sequestering agent to keep these metals in solution. Various sequestering agents will be added to aliquots of the composited sample and then analyzed with test kits to see where the iron/calcium come out. The sequestrant with the best response will then be added to a sample(s) run through the entire treatment system unit operations to see how the chemical reacts.
- Mechanical Filtration (varying micron ratings) – Aliquots of the composited sample will be processed through filters of varying micron ratings. Efficacy of mechanical filtration will be evaluated through comparison of percent removal between pre- and post-filtered samples via analysis of Total Suspended Solids.
- GAC Columns – The efficacy evaluated through reduction in influent concentrations to below BSA discharge limits.

Additional analysis may be conducted following the treatability testing through and within each unit operation to determine the efficacy of the process.

3.2 Extraction and Treatment System Design Report

Inventum will prepare a Corrective Measures Design Report for submittal to the NYSDEC prior to finalizing the treatment system mechanical, electrical, and construction specifications. The design report will include, at minimum:

- An analysis of the bench-scale treatability testing including laboratory data packages and a quality assurance assessment consistent with the components of a Level II data validation;
- Final system process design description(s) including unit operation sizing;
- Conceptual process and instrumentation diagram(s);
- Conceptual process logic and control diagram(s);
- Extraction well flow control architecture (ex. transducers, floats, etc..) and operational set points;
- Groundwater treatment and conveyance system design drawings including extraction well downhole and wellhead typical details;

[7] Required for chemical sequestration analysis.
[8] Required for chemical sequestration analysis.

- Extraction pump specifications and pump curves;
- Safety Data Sheets (SDS) for any proposed sequestering agents or any other recommended treatment process control additives;
- Intrusive site work specifications in accordance with the Site Excavation Work Plan (EWP), Health and Safety Plan (HASP), and Community Air Monitoring Plan (CAMP);
- Procedures and protocols for sampling and reporting during start-up; and
- Construction and start-up schedule.

Inventum does not anticipate utilizing any of the existing treatment components or controls within the upgraded system; however, re-use of the treatment system structure may be proposed dependent on, among other factors, final design of the upgraded system. Alternatively, a packaged treatment system may be constructed offsite and transported to the Site. If necessary, the design report will include specifications for the dismantling, removal, disposal/recycling, or demolition of any existing treatment components or related structures.

The design report will include a technical assessment of additional unit operations that may be required in the future for treatment of per- and polyfluoroalkyl substances (PFAS). Those unit operations will be taken into consideration through the conceptual and final system design when determining the size of the treatment enclosure and expansion ability of the logic control system. Influent and effluent sampling data for PFAS collected in October 2018, February 2021, and March 2021, which has been shared with both NYSDEC and BSA, will be utilized for the assessment. No additional sampling for PFAS is proposed at this time.

The design report and construction schedule will include estimates of any downtime of the existing GWTF operations during construction of the upgrades. The length of any downtime is primarily predicated on re-use of the existing treatment system structure versus construction of a packaged treatment system. The design report will include an analysis of the need for a temporary system during construction, and if deemed necessary, treatment and operational specifications for the temporary system.

The design report will also include procedures for performance testing that will be completed prior to full-time operation.

3.3 Permitting

The GWTF is currently operating, and treated waters are discharged to the BSA under Permit No. 20-06-BU109 which expires May 31, 2023. The current discharge permit allows a maximum daily discharge of 50,000 gpd and a new permit application will be submitted with the BSA to account for the production increase associated with the system upgrades. The permit application will request 150,000 gpd to allow for variation in the system pumping rates during low river stages.

3.4 Operations and Maintenance

The GWTF OM&M Plan will be revised after corrective measures are complete.

4 Corrective Measures Completion Report

Inventum will prepare a supplemental Final Engineering Report (FER) and Site Management Plan (SMP) documenting the upgrades to the treatment system. At minimum, the supplemental FER will include:

- A description of the groundwater extraction system treatment upgrades;

- Startup testing and observation well monitoring data;
- As-built reference drawings for the extraction wells, conveyance system, and treatment system; and
- Waste and material disposal documentation

5 Schedule

A schedule for implementation of the corrective measures is included in Figure 7. Discussions with the BSA on permit modifications will be initiated within 15-days of NYSDEC approval of this work plan. The collection of samples for the bench-scale treatability test(s) will be collected following consultation with the BSA on expected permit modification requirements. The FER and revised SMP will be submitted to the NYSDEC within 90-days of completing all corrective measure activities allowing time for evaluation of the full-scale operation of the upgraded extraction system.

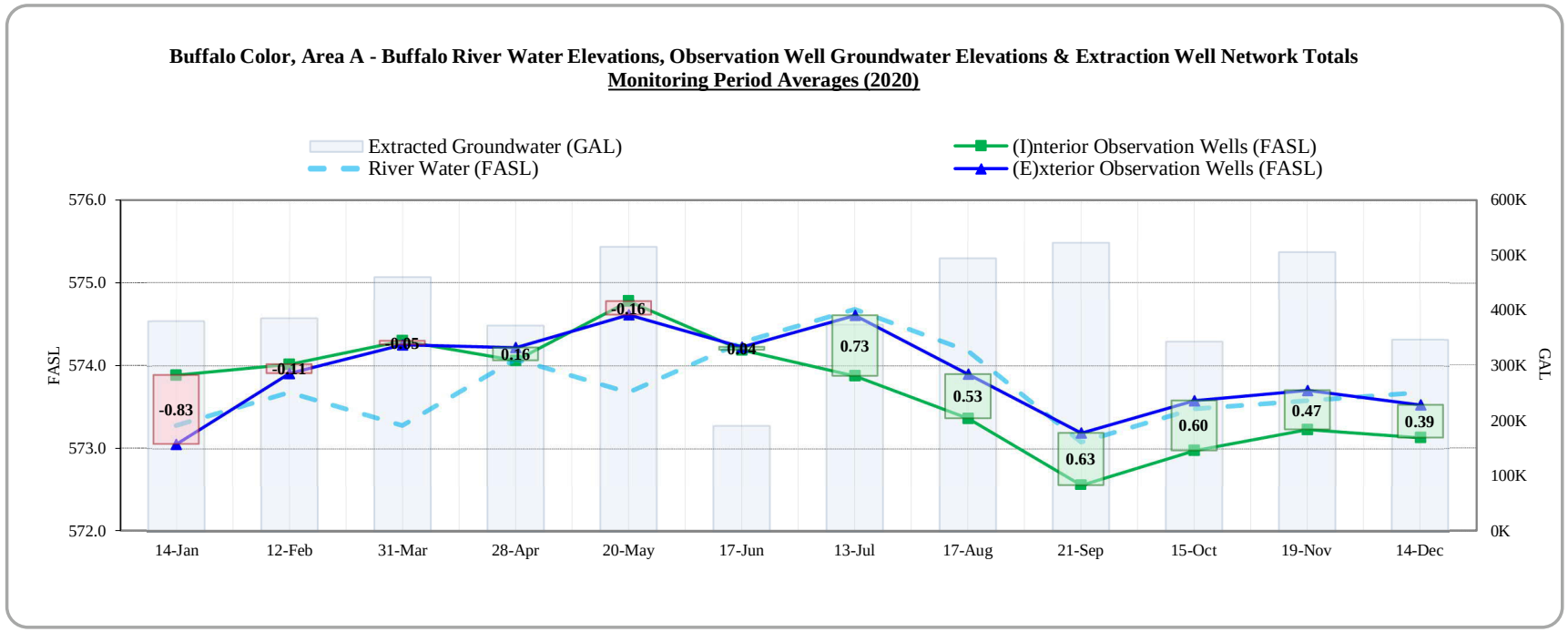
Tables

Table 1 - Area A Hydrographs

Buffalo Color, Area A - Buffalo River Water Elevations (FASL), Observation Well Groundwater Elevations (FASL), Elevation Differentials (FT) & Extraction Well Network Totals (GAL) (2020)

Abbreviations: River Stadia Rod (RSR), Observation Well (OW), Elevation Differential (ED), Extraction Well (EW)

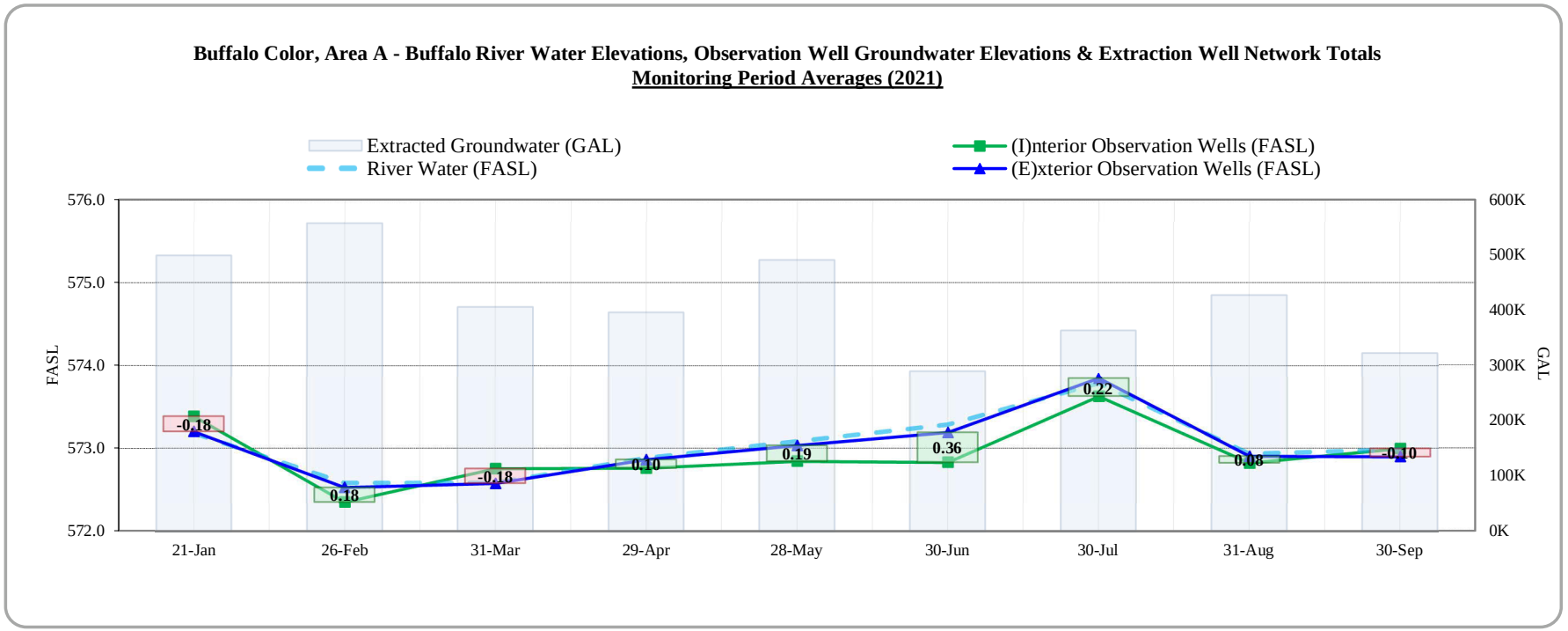
2020	RIVER	A-OW SET (1)			A-OW SET (2)			A-OW SET (3)			A-OW SET (4)			A-OW SET (5)			A-OW SET (6)			AVERAGES			A-EW					
Date	**RSR**	**1I**	**1E**	**1ED**	**2I**	**2E**	**2ED**	**3I**	**3E**	**3ED**	**4I**	**4E**	**4ED**	**5I**	**5E**	**5ED**	**6I**	**6E**	**6ED**	**I**	**E**	**ED**	**1**	**2**	**3A**	**4**	**5**	**TOTAL**
14-Jan	573.28	573.63	573.12	-0.52	572.84	572.78	-0.06	573.93	572.93	-1.00	574.44	573.00	-1.44	574.26	573.20	-1.06	574.22	573.32	-0.90	573.89	573.06	-0.83	301,982	21,509	24,102	9,339	23,559	380,491
12-Feb	573.68	573.71	574.07	0.35	573.04	573.96	0.92	574.00	573.97	-0.03	574.48	573.85	-0.63	574.43	573.71	-0.72	574.45	573.90	-0.55	574.02	573.91	-0.11	305,186	22,121	25,453	10,201	22,973	385,934
31-Mar	573.28	574.37	574.32	-0.06	573.59	574.23	0.64	574.46	574.22	-0.24	573.87	574.21	0.34	574.78	574.26	-0.52	574.74	574.30	-0.44	574.30	574.25	-0.05	369,456	26,753	23,253	10,864	29,598	459,924
28-Apr	574.08	573.75	574.16	0.40	573.14	574.56	1.42	574.10	574.18	0.08	574.47	574.18	-0.29	574.46	574.10	-0.36	574.46	574.16	-0.30	574.06	574.22	0.16	297,416	22,251	19,285	10,561	22,752	372,265
20-May	573.68	574.23	574.59	0.35	573.87	574.65	0.78	574.76	574.55	-0.21	575.38	574.50	-0.88	575.22	574.70	-0.52	575.20	574.71	-0.49	574.78	574.61	-0.16	413,376	29,685	25,258	15,864	30,103	514,286
17-Jun	574.28	573.97	574.27	0.29	573.31	574.56	1.25	574.20	574.10	-0.10	574.56	574.09	-0.47	574.55	574.15	-0.40	574.55	574.20	-0.35	574.19	574.23	0.04	153,566	10,870	9,293	6,530	10,976	191,235
13-Jul	574.68	573.46	574.55	1.08	573.02	574.61	1.59	573.91	574.65	0.74	574.15	574.65	0.50	574.34	574.65	0.31	574.39	574.55	0.16	573.88	574.61	0.73	283,032	19,422	18,295	34,208	19,011	373,968
17-Aug	574.18	572.81	573.79	0.97	572.47	573.91	1.44	573.42	573.88	0.46	573.70	573.88	0.18	573.89	574.01	0.12	573.90	573.94	0.04	573.36	573.90	0.53	353,892	23,692	18,500	73,548	23,714	493,346
21-Sep	573.08	571.91	573.05	1.13	571.67	573.14	1.47	572.66	573.17	0.51	572.88	573.21	0.33	573.10	573.35	0.25	573.15	573.24	0.09	572.56	573.19	0.63	398,292	24,588	16,984	55,467	25,961	521,292
15-Oct	573.48	572.25	573.57	1.31	572.15	573.76	1.61	573.13	573.65	0.52	573.30	573.54	0.24	573.50	573.45	-0.05	573.55	573.53	-0.02	572.98	573.58	0.60	263,236	15,771	11,415	36,353	16,642	343,417
19-Nov	573.58	572.67	573.67	0.99	572.36	573.71	1.35	573.34	573.71	0.37	573.56	573.74	0.18	573.71	573.75	0.04	573.75	573.66	-0.09	573.23	573.70	0.47	397,568	23,383	14,397	45,458	23,583	504,389
14-Dec	573.68	572.70	573.47	0.76	572.34	573.48	1.14	573.18	573.55	0.37	573.56	573.56	0.00	573.53	573.65	0.12	573.50	573.48	-0.02	573.13	573.53	0.39	277,076	16,213	10,148	27,589	16,206	347,232
Avg | Sum	***573.74***	***573.29***	***573.88***	***0.59***	***572.82***	***573.94***	***1.13***	***573.75***	***573.88***	***0.12***	***574.02***	***573.86***	***-0.16***	***574.15***	***573.91***	***-0.24***	***574.16***	***573.92***	***-0.24***	***573.70***	***573.90***	***0.20***	**3,814,078**	**256,258**	**216,383**	**335,982**	**265,078**	**4,887,779**



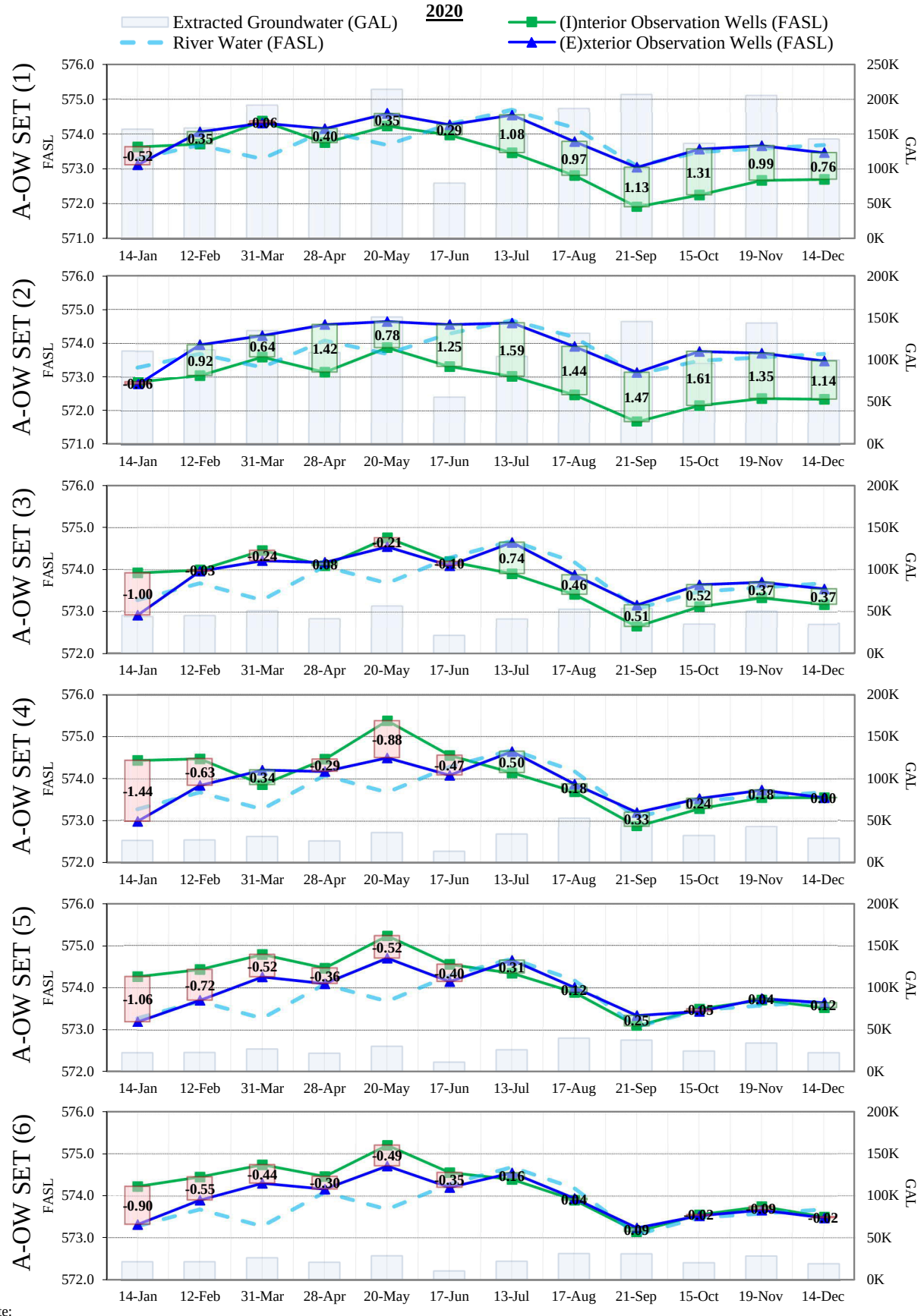
Buffalo Color, Area A - Buffalo River Water Elevations (FASL), Observation Well Groundwater Elevations (FASL), Elevation Differentials (FT) & Extraction Well Network Totals (GAL)

Abbreviations: River Stadia Rod (RSR), Observation Well (OW), Elevation Differential (ED), Extraction Well (EW)

2021	RIVER	A-OW SET (1)			A-OW SET (2)			A-OW SET (3)			A-OW SET (4)			A-OW SET (5)			A-OW SET (6)			AVERAGES			A-EW					
Date	**RSR**	**1I**	**1E**	**1ED**	**2I**	**2E**	**2ED**	**3I**	**3E**	**3ED**	**4I**	**4E**	**4ED**	**5I**	**5E**	**5ED**	**6I**	**6E**	**6ED**	**I**	**E**	**ED**	**1**	**2**	**3A**	**4**	**5**	**TOTAL**
21-Jan	573.18	572.89	573.37	0.47	572.62	573.31	0.69	573.54	573.24	-0.30	573.77	573.12	-0.65	573.72	572.99	-0.73	573.74	573.18	-0.56	573.38	573.20	-0.18	404,808	23,163	14,068	31,855	24,600	498,494
26-Feb	572.58	571.54	571.97	0.43	571.42	573.45	2.03	572.78	572.36	-0.42	572.73	572.38	-0.35	572.80	572.50	-0.30	572.82	572.50	-0.32	572.35	572.52	0.18	465,512	24,394	14,600	27,143	25,181	556,830
31-Mar	572.58	572.01	572.59	0.57	571.82	572.58	0.76	572.88	572.52	-0.36	573.20	572.50	-0.70	573.30	572.55	-0.75	573.30	572.72	-0.58	572.75	572.57	-0.18	341,164	16,818	10,135	17,392	20,450	405,959
29-Apr	572.88	572.07	572.83	0.75	571.92	572.80	0.88	572.98	572.86	-0.12	573.19	572.84	-0.35	573.19	572.93	-0.26	573.20	572.91	-0.29	572.76	572.86	0.10	328,324	16,246	9,822	19,224	22,344	395,960
28-May	573.08	572.19	572.97	0.77	571.96	573.00	1.04	572.98	573.00	0.02	573.26	573.03	-0.23	573.32	573.10	-0.22	573.34	573.09	-0.25	572.84	573.03	0.19	411,060	20,976	11,991	20,317	26,282	490,626
30-Jun	573.28	572.14	573.13	0.98	571.97	573.18	1.21	572.98	573.15	0.17	573.22	573.15	-0.07	573.31	573.27	-0.04	573.35	573.26	-0.09	572.83	573.19	0.36	241,792	12,300	7,252	12,777	15,973	290,094
30-Jul	573.78	573.01	574.47	1.45	572.84	573.61	0.77	573.72	573.70	-0.02	574.04	573.75	-0.29	574.05	573.82	-0.23	574.07	573.71	-0.36	573.62	573.84	0.22	304,676	17,094	10,035	20,578	11,207	363,590
31-Aug	572.93	572.01	572.92	0.90	571.92	572.91	0.99	572.96	572.93	-0.03	573.27	572.86	-0.41	573.39	572.85	-0.54	573.37	572.96	-0.41	572.82	572.90	0.08	351,304	18,763	11,488	18,858	26,549	426,962
30-Sep	572.98	572.12	572.87	0.74	572.14	572.81	0.67	573.15	572.85	-0.30	573.51	572.85	-0.66	573.52	573.00	-0.52	573.52	573.01	-0.51	572.99	572.90	-0.10	270,532	13,769	8,640	11,748	17,803	322,492
Avg | Sum	***573.03***	***572.22***	***573.01***	***0.79***	***572.07***	***573.07***	***1.00***	***573.10***	***572.95***	***-0.15***	***573.35***	***572.94***	***-0.41***	***573.40***	***573.00***	***-0.40***	***573.42***	***573.04***	***-0.38***	***572.93***	***573.00***	***0.07***	**3,119,172**	**163,523**	**98,031**	**179,892**	**190,389**	**3,751,007**

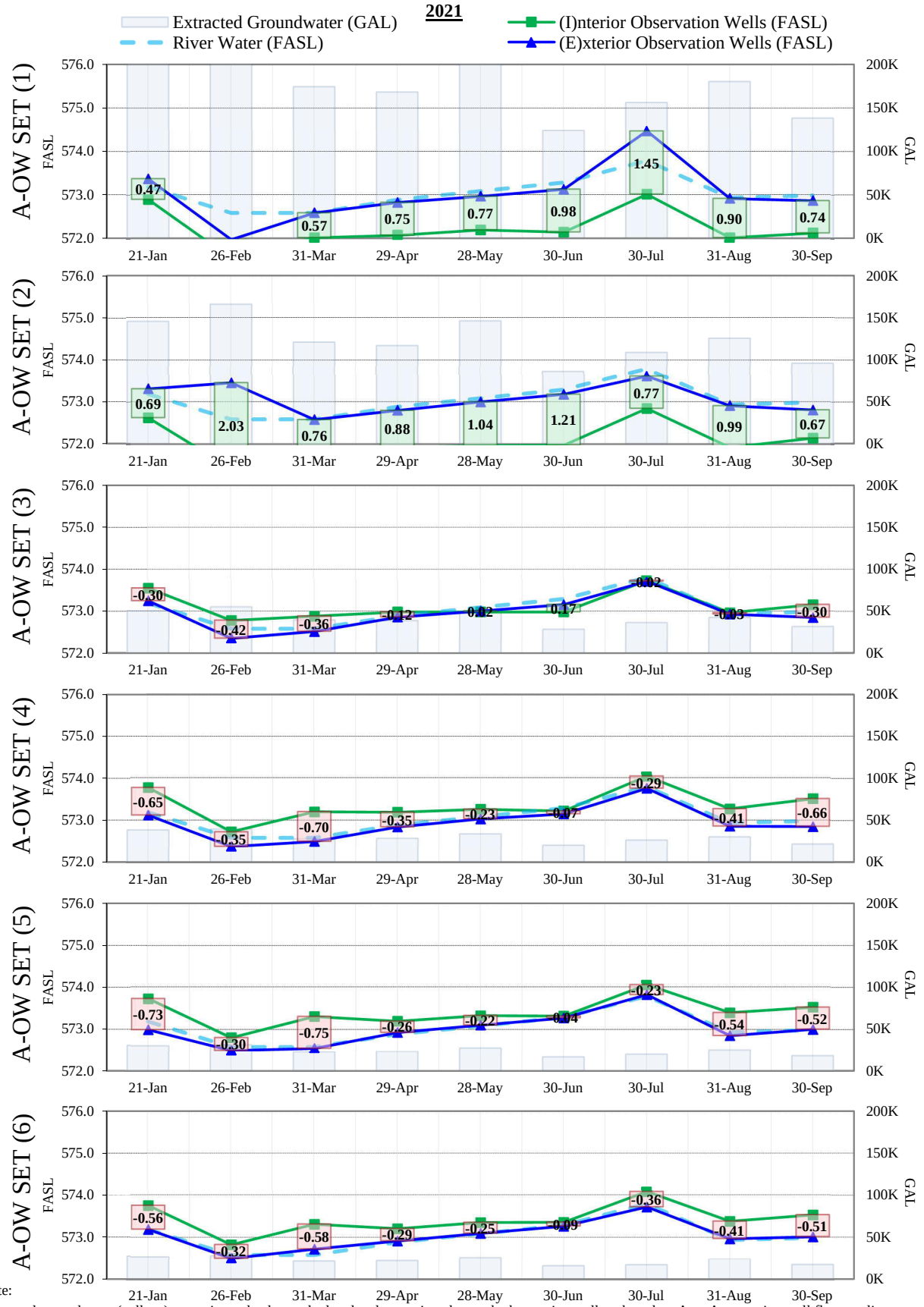


Buffalo Color, Area A - Buffalo River Water Elevations, Observation Well Groundwater Elevations & Extraction Well Network Allocations



Note:
Extracted groundwater (gallons) are estimated values calculated and apportioned to each observation well set based on Area A extraction well flow totalizers and the distance to the observation well pair.

Buffalo Color, Area A - Buffalo River Water Elevations, Observation Well Groundwater Elevations & Extraction Well Network Allocations



Note:
Extracted groundwater (gallons) are estimated values calculated and apportioned to each observation well set based on Area A extraction well flow totalizers and the distance to the observation well pair.

Table 2
Existing and New Extraction Well Construction Summary
South Buffalo Development - Area A

Existing Extraction Wells										
Well ID	Date Installed	Total Depth (ft. bgs)	Screen (ft. bgs)		Top of Casing Elevation (ft. AMSL)	Northing (a)	Easting (a)			
EW-1	Jun-06	32	22	27	582.49	1042883.93	1078036.05			
EW-2	Jun-06	34	24	29	582.64	1042989.17	1078144.74			
EW-3A	Jun-06	38	28	33	583.84	1043099.72	1078269.86			
EW-4	Jun-06	38	28	33	583.28	1043267.43	1078391.48			
EW-5	Jun-06	37	26.5	31.5	585.5	1043406.57	1078514.18			
New Extraction Wells										
Well ID (b)	Date Installed	Total Depth (ft. bgs)	First Water (ft. bgs)	Screen (ft. bgs)		Filter Pack (ft. bgs)		Sump (ft. bgs)		Static DTW (ft. bTOR)
EW-4A	May-20	34.5	10.5	13.5	33.5	8.5	34.5	33.5	34.5	11.4
EW-6	May-20	37.5	11	15.5	35.5	10.5	37.5	35.5	37.5	11.8
EW-7	May-20	34.5	12.5	13.5	33.5	8.5	34.5	33.5	34.5	10.5
EW-8	May-20	34	14	13	33	8	34	33	34	12

a/Coordinates referenced to NY State Plan (West Zone, US Survey Feet)
b/New extraction well survey to be completed if permanent installation completed.
ftbTOR: feet below top of riser

Table 3
South Buffalo Properties - Area A
New Extraction Wells
Groundwater Sample Results

Analytes	NY State Class GA Groundwater Standard/Guidance Value	Area A - Temporary New Extraction Wells (a,b) June 10, 2020				
		A-EW-4A	A-EW-6	A-EW-7A	A-EW-7B	A-EW-8
Metals (mg/L)						
Aluminum	NE	0.539	1.55	0.954	0.399	1.55
Arsenic	0.025	ND	0.043	ND	ND	ND
Barium	1	ND	0.137	ND	ND	ND
Cadmium	0.005	ND	ND	ND	ND	0.008
Calcium	NE	48.8	41.6	34.4	28.8	97.1
Chromium	0.05	0.01	ND	ND	ND	0.012
Copper	0.2	0.047	0.033	0.043	0.029	0.038
Iron	0.3	1.53	3.69	2.21	0.83	4.38
Lead	0.025	ND	0.027	0.026	0.016	ND
Magnesium	35	19.1	32	18.2	17.1	15.7
Manganese	0.3	0.024	0.111	0.037	ND	0.144
Potassium	NE	128	211	88	84	19.7
Sodium	20	135	522	187	210	100
Zinc	2	ND	0.102	0.086	ND	ND
SVOCs (µg/L)						
1,3-Dichlorobenzene	3	ND	ND	ND	ND	16.6
1,4-Dichlorobenzene	3	ND	ND	ND	ND	15.2
4-Chloroanaline	5	ND	763	ND	ND	ND
Acenapthene	20	ND	ND	148	135	15.9
Carbazole	NE	ND	ND	ND	94.6	ND
Dibenzofuran	NE	ND	ND	141	134	ND
Fluorene	50	ND	ND	112	101	ND
Naphthalene	10	ND	ND	1,060	414	ND
Phenanthrene	50	ND	ND	117	93.2	ND
VOCs (µg/L)						
1,2-Dichlorobenzene	3	ND	ND	ND	ND	7.21
1,3-Dichlorobenzene	3	ND	ND	ND	ND	27
1,4-Dichlorobenzene	3	ND	ND	ND	ND	25.3
Benzene	1	ND	1,500	ND	ND	ND
Chlorobenzene	5	ND	8,490	ND	ND	17
Toluene	5	ND	ND	ND	ND	2.48

a/Only analytes with detections in at least one sample are shown. Detection in Bold
b/Highlighted indicate exceedance of Class GA standard.
"NE" - Not Established

Table 4
EW-6 Step Test Analysis
South Buffalo Development - Area A

PROJECT INFORMATION:

Project Name:	Buffalo Color Area A	Client:	Inventum Engineering, PC
Project No.:	0006-001-010	Location:	Buffalo, NY

WELL DATA:

Static Water Level (fbTOR): 13.38 Prepared By: BCH

Total Depth (fbTOR): 40.50

STEP-DRAWDOWN DATA:

Step No.	Maximum DTW (fbTOR)	Q (gpm)	s (ft)	D s (ft)	Spcific Capacity Q/s (gpm/ft)	D s/Q (ft min/gal)
1	14.62	7.38	1.24	1.24	5.950	0.17
2	15.38	11.17	2.00	0.76	5.584	0.07
3	16.02	14.36	2.64	0.64	5.438	0.04
4						

DETERMINE THE AQUIFER TRANSMISSIVITY AND HYDRAULIC CONDUCTIVITY, T AND K:

$$T = \frac{2.25Q}{4p(h_o-h_1)}$$

$$K = \frac{T}{b}$$

T = Transmissivity, gal/day-ft

h_o-h_1 = Change in head over one logarithmic cycle, feet = 0.20

Q = Pumping rate from straight portion of curve, gal/day = 7.38

K = Hydraulic Conductivity (cm/sec) = (see below)

b = saturated thickness (feet) = 27.12

Equation of Best Fit Line (see attached Figure): y = 1.0217Ln(x) + 35.539

x_1 = 1: y_1 = 14.26 = h_1

x_0 = 10: y_0 = 14.47 = h_0

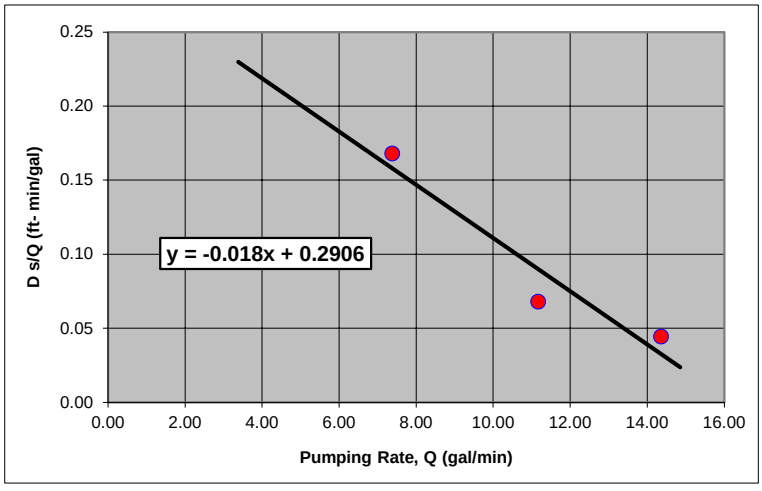
T = 3,821.66 gal/day-ft

T = 3.55E-01 ft^2/min

K = 1.31E-02 ft/min

K = 6.65E-03 cm/sec

DETERMINE HEAD LOSS COEFFICIENTS, B and C:



B = aquifer coefficient, measure of the head loss due to laminar flow

C = well coefficient, measure of the head loss due to turbulent flow in the well screen and pump inlet

L_p = ratio of laminar to total head losses, % percentage of the total head loss attributable to laminar flow

From the equation in the graph at the left:

C = -0.0180 $ft\text{-}min^2/gal^2$

B = 0.2906 ft-min/gal

$$L_p = \frac{BQ}{(BQ + CQ^2)} \times 100$$

L_p = 184.2%

TRUE WELL EFFICIENCY, E:

Theoretical Specific Capacity = $\frac{Q}{s} = \frac{T}{1500}$

= 2.55 gpm/ft

Actual Specific Capacity = $\frac{Q}{s}$ = 5.95 gpm/ft

$$E = \frac{\text{theoretical}}{\text{actual}} = 42.8\%$$

Figures

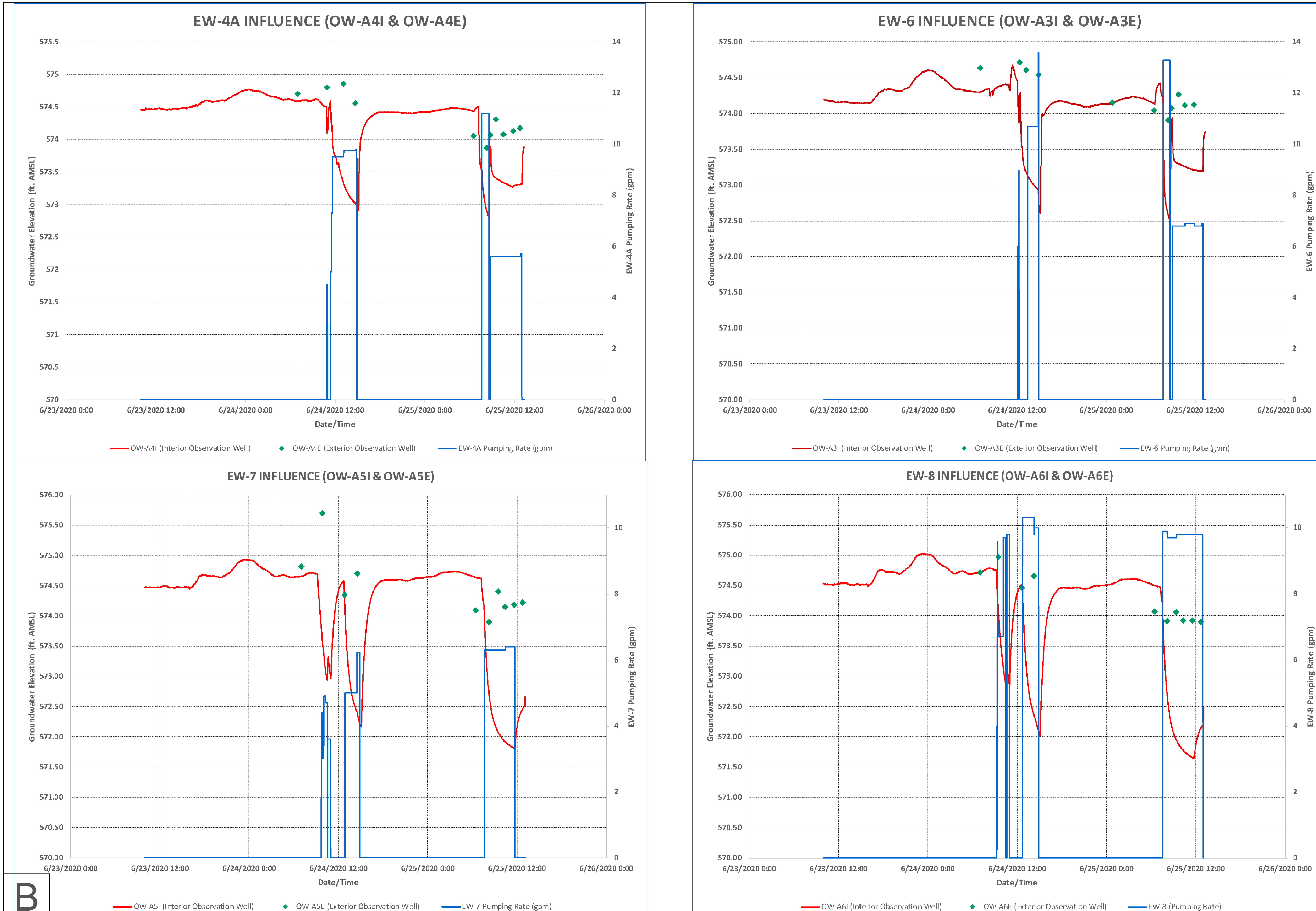
INVENTUM ENGINEERING
441 CARLISLE DRIVE
SUITE C
HERNDON, VIRGINIA 20170
www.InventumEng.com

SITE LAYOUT
Area A
Former Buffalo Color Corporation Site (C915230)

DRAWING BY	
CHECKED	
APPROVED	

FIGURE 1

DRAWING NUMBER



B

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FIGURE 2

CORRECTIVE MEASURES PUMPING TEST EVALUATION

SOUTH BUFFALO DEVELOPMENT - AREA A

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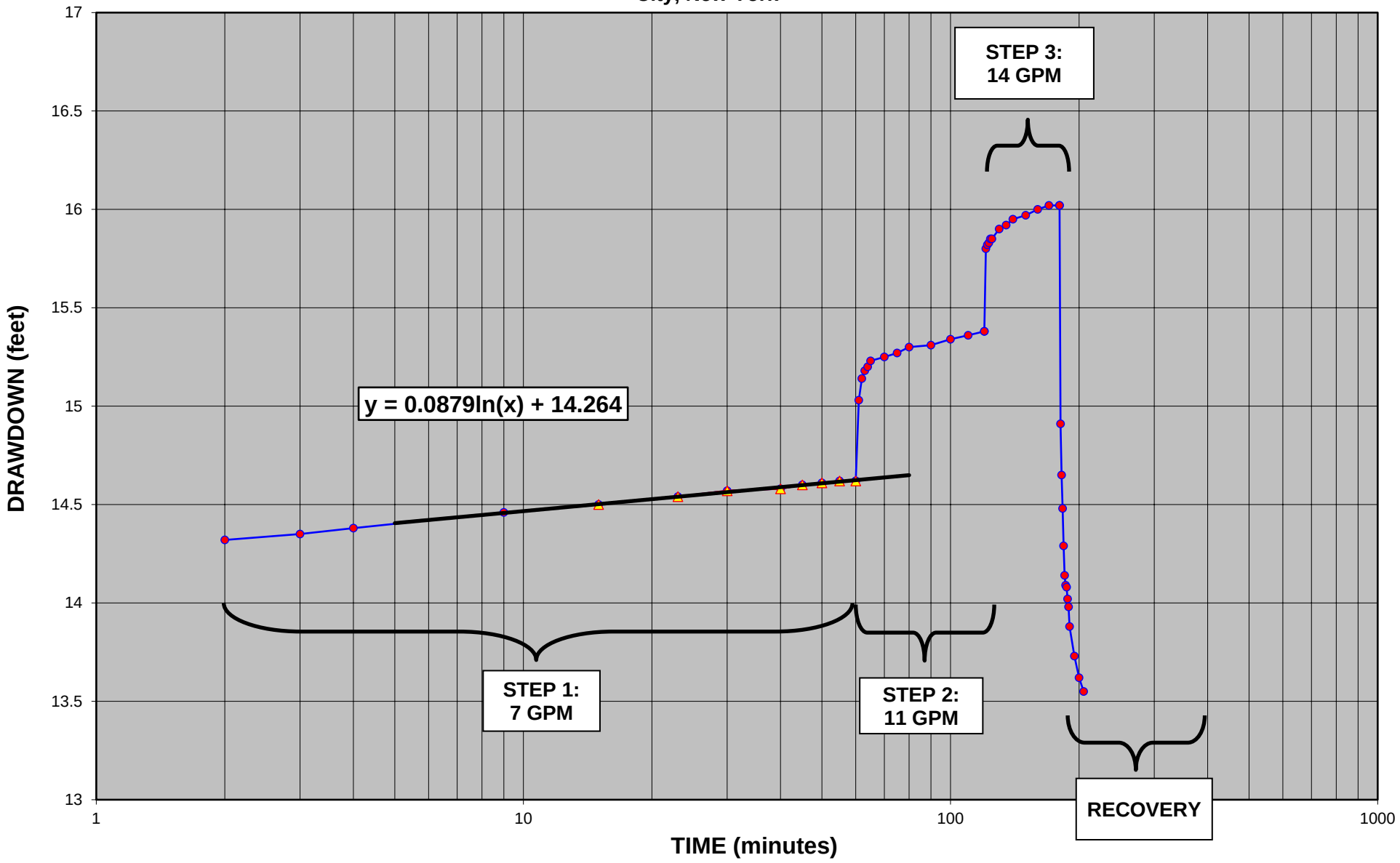
FIGURE 1

Figure 3
[EW-6]
STEP-DRAWDOWN TEST (SEMI-LOG)

Buffalo Color Area A
Inventum Engineering, PC
City, New York



Buffalo River - Groundwater Elevation Influence
June 25th (4PM) - June 28th (7AM)

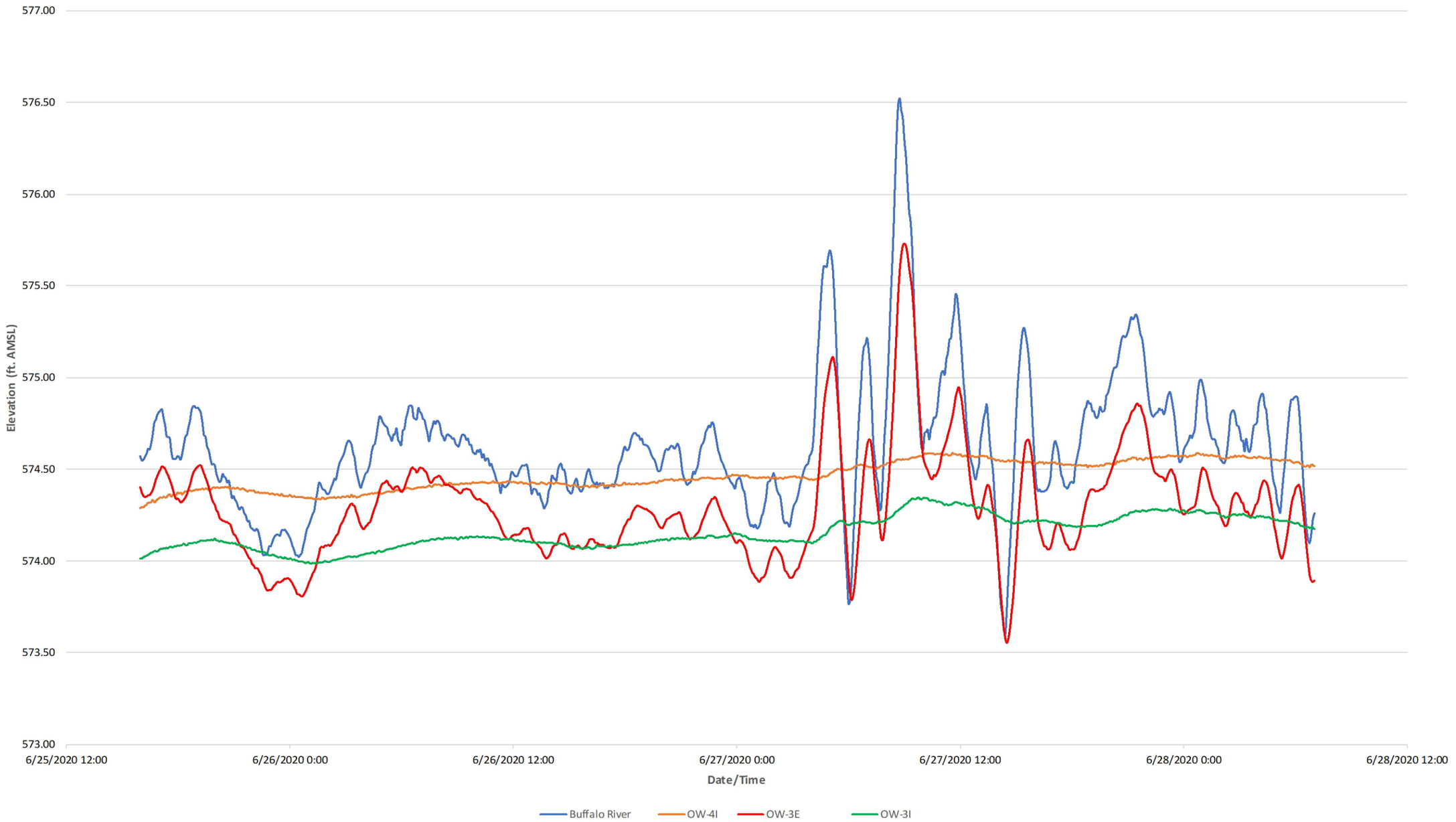


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FIGURE 4
BUFFALO RIVER TRANSDUCER MONITORING SUMMARY
SOUTH BUFFALO DEVELOPMENT-AREA A

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FIGURE 4

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FIGURE 5

CM WORK PLAN
PRELIMINARY CONVEYANCE LAYOUT

SOUTH BUFFALO DEVELOPMENT, LLC
AREA A

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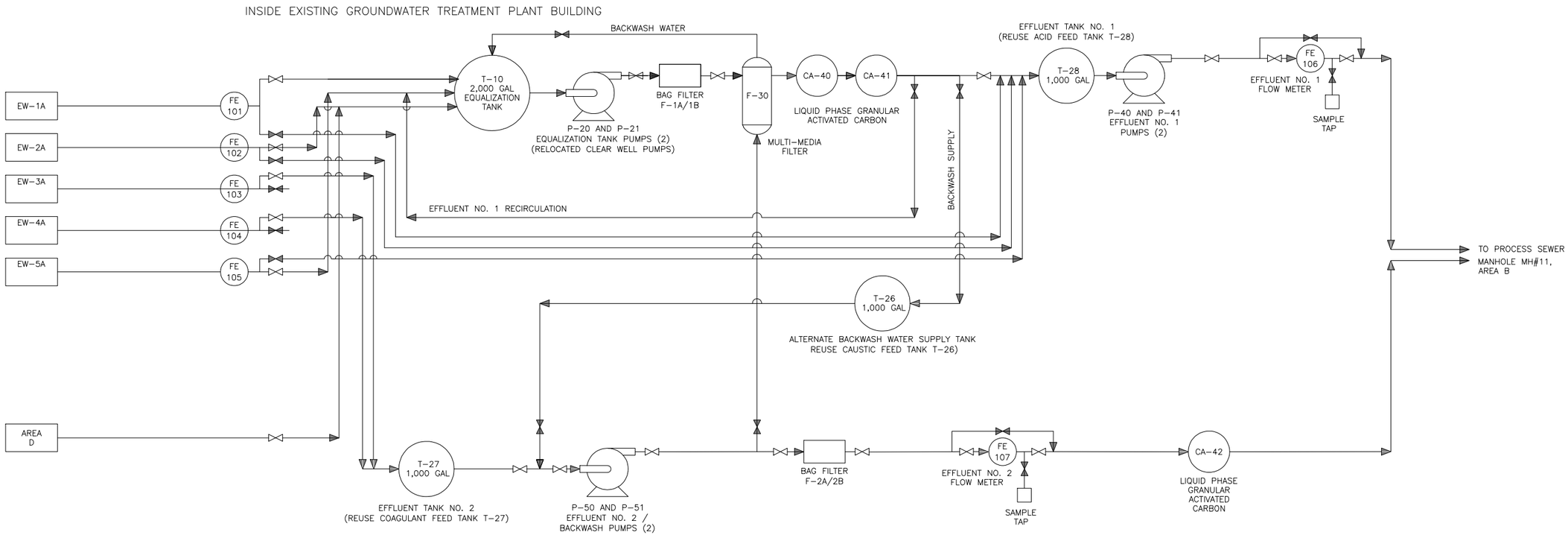
FIGURE 5



NOTES:

1. GENERAL PROCESS FLOW SHOWN ONLY. NOT ALL PIPING IS SHOWN.

B

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FIGURE 6
CM WORK PLAN
EXISTING GWTF LAYOUT
SOUTH BUFFALO DEVELOPMENT, LLC
AREA A

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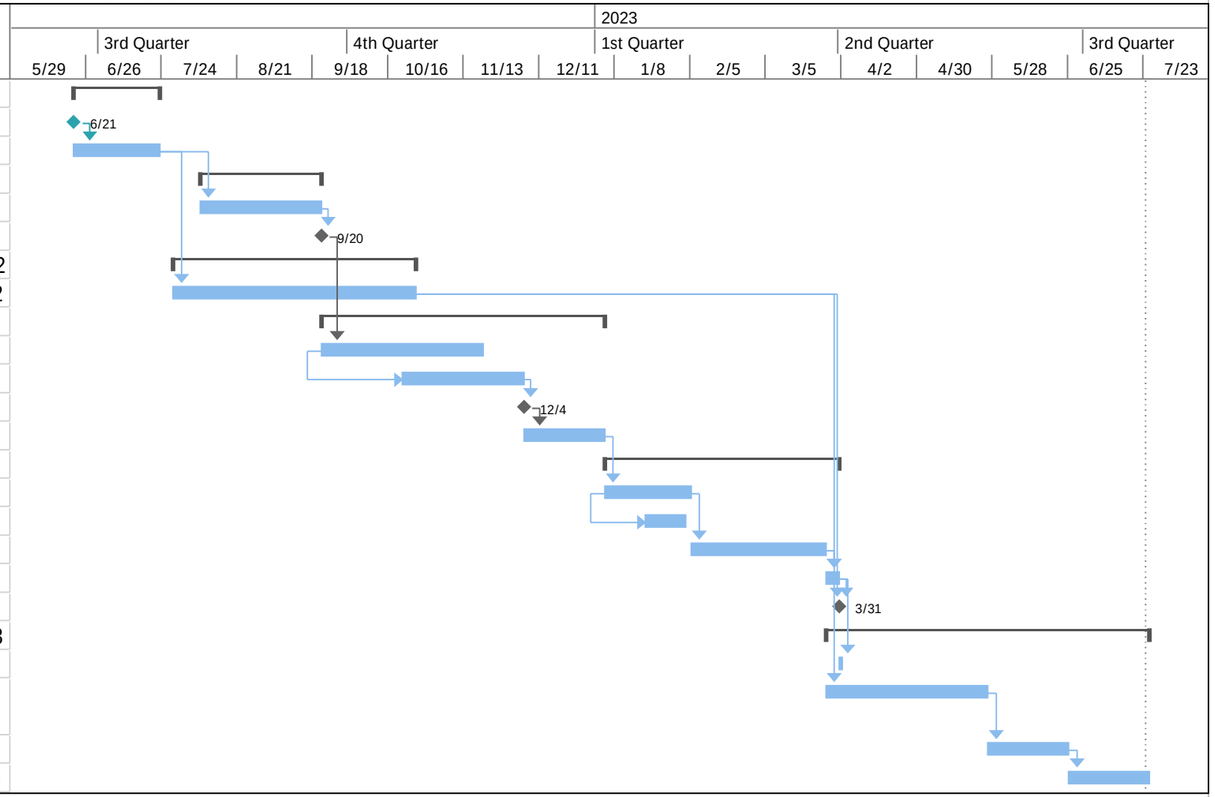
FIGURE 6

NOT TO SCALE

Figure 7
Corrective Measures Schedule
Groundwater Treatment Facility Upgrades
Former Color Corporation Site - Area A
NYSDEC Site No. C915230

	Task Name	Duration	Start	Finish
1	Corrective Measures (CM) Groundwater Treatment Work Plan	32 days	Tue 6/21/22	Fri 7/22/22
2	Groundwater Treatment Work Plan Submittal	0 days	Tue 6/21/22	Tue 6/21/22
3	NYSDEC Review and Approval	32 days	Tue 6/21/22	Fri 7/22/22
4	Bench-Scale Treatability Testing	45 days	Sun 8/7/22	Tue 9/20/22
5	Sample Collection and Analysis	45 days	Sun 8/7/22	Tue 9/20/22
6	Total Systems Analysis Reporting (Internal)	0 days	Tue 9/20/22	Tue 9/20/22
7	Permitting	90 days	Thu 7/28/22	Tue 10/25/22
8	Buffalo Sewer Authority	90 days	Thu 7/28/22	Tue 10/25/22
9	Groundwater Extraction and Treatment System Design	105 days	Wed 9/21/22	Tue 1/3/23
10	System Design and Engineering	60 days	Wed 9/21/22	Sat 11/19/22
11	Corrective Measures Design Report Preparation	45 days	Fri 10/21/22	Sun 12/4/22
12	Corrective Measures Design Report Submittal	0 days	Sun 12/4/22	Sun 12/4/22
13	NYSDEC Review and Approval	30 days	Mon 12/5/22	Tue 1/3/23
14	Corrective Measures Implementation	87 days	Wed 1/4/23	Fri 3/31/23
15	Final Mechanical/Electrical/Controls/Logic Design	32 days	Wed 1/4/23	Sat 2/4/23
16	Extraction Wellhead and Conveyance System Site Work	15 days	Thu 1/19/23	Thu 2/2/23
17	Treatment System Construction/Installation	50 days	Sun 2/5/23	Sun 3/26/23
18	System Startup and Testing	5 days	Mon 3/27/23	Fri 3/31/23
19	Full Operation	0 days	Fri 3/31/23	Fri 3/31/23
20	Corrective Measures Completion Report	120 days?	Mon 3/27/23	Mon 7/24/23
21	Extraction Well Survey	1 day?	Sat 4/1/23	Sat 4/1/23
22	Draft Completion Report and OM&M Plan Preparation and Submittal	60 days	Mon 3/27/23	Thu 5/25/23
23	NYSDEC Review and Comment	30 days	Fri 5/26/23	Sat 6/24/23
24	Completion Report and OM&M Plan Final Submittal	30 days	Sun 6/25/23	Mon 7/24/23



Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	