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February 22, 2019

New Jersey Department of Environmental Protection
Bureau of Case Management
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P.O. Box 420
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Attn: Donna Gaffigan, Case Manager

Re: *Site-Wide Groundwater Progress Report*
Hoffmann-La Roche Inc. Site
340 Kingsland Street
Nutley, New Jersey
SRP PI #s 009949, 614465, and 625447
TRC Project No. 105009/198233

Dear Ms. Gaffigan:

On behalf of Hoffmann-La Roche Inc. (Roche), TRC Environmental Corp. (TRC) is submitting the attached Site-Wide Groundwater Progress Report, dated February 22, 2019. This report presents the results of activities conducted between August 2017 and April 2018 for semi-annual groundwater monitoring events and recent targeted Interim Remedial Measure (IRM) performance monitoring programs completed in selected areas. The focus of this GWPR is to monitor and document groundwater quality along the Site perimeter and in select interior areas of the Site over the reporting period.

The field programs reported herein, were performed in accordance with the NJDEP's Technical Requirements for Site Remediation (N.J.A.C. 7:26E) and applicable NJDEP Guidance, the approved Site-Wide Groundwater Sampling Plan – IRM Implementation Period (July 2015), and associated requests for Approval-Modification of the Site-Wide Groundwater Sampling Plan – IRM Implementation Period – July 2015 (February and May 2016), Roche Remediation Road Map (September 2012), and associated correspondence (NJDEP comments, Roche Response letters).

We look forward to meeting with you to discuss the contents of this report once you have had a chance to review it. In the interim, if you have any questions or need additional information, please feel free to contact Rebecca Hollender at 908-988-1710 or rhollender@trcsolutions.com, or Dan Nachman at 908-988-1637 or dnachman@trcsolutions.com.

Very truly yours,

Rebecca Hollender, LSRP (No. 585022)
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Cc: Chandra Patel, Roche

Site-Wide Groundwater Progress Report
for the
Hoffmann-La Roche Inc. Site
Nutley, New Jersey

Prepared For:

Hoffmann-La Roche Inc.
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PI ID #'s 009949, 614465, and 625447

Prepared By:
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February 22, 2019

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1.0 INTRODUCTION

On behalf of Hoffmann-La Roche Inc. (Roche), TRC Environmental Corporation (TRC) has prepared this Site-Wide Annual Groundwater Progress Report (GWPR) for the 120-acre former Roche facility (Site) located at 340 Kingsland Street, in the Township of Nutley, Essex County, New Jersey (Figure 1). The groundwater data covered in this reporting period (August 2017 through April 2018) includes results from two Site-wide semi-annual groundwater sampling events, and from recent targeted Interim Remedial Measures (IRM) performance monitoring programs completed in selected areas. This is the fifth GWPR being submitted to the New Jersey Department of Environmental Protection (NJDEP), and should be considered a supplement to the Site-wide Groundwater Remedial Investigation Report (GWRIR) dated April 2, 2014 (TRC, 2014) and the GWPRs submitted in January 2015, December 2015, August 2016 (a supplement to the December 2015 second GWPR), January 2017, and November 2017 (TRC, 2015a; 2015d; 2016c; 2017a; and 2017d). The focus of this GWPR is to monitor and document groundwater quality along the Site perimeter and in select interior areas of the Site over the reporting period.

In accordance with the NJDEP-approved Modification to the Site-Wide Groundwater Sampling Plan – Interim Remedial Measures (IRM) Implementation Period Rev. 1 (July 2015) dated November 2016 (TRC, 2016d), monitoring wells located within the plume fringe and in the vicinity of active IRM systems were sampled between August 2017 and April 2018 to monitor plume behavior during the IRM implementation or post-completion phase.[1] The sampling of monitoring and remedial wells during this reporting period helped to further refine the understanding of contaminant distribution within the aquifer system and document beneficial changes resulting from IRM activities.

These supplemental activities were conducted in accordance with the NJDEP's Technical Requirements for Site Remediation (TRSR) (N.J.A.C. 7:26E) and applicable guidance documents, the NJDEP's Field Sampling Procedures Manual (NJDEP, 2005), and the *Site-Wide Groundwater Sampling Plan – Interim Remedial Measures (IRM) Implementation Period Rev. 1* dated July 2015 (TRC, 2015b), and subsequent modifications (TRC, 2015c; 2016a; 2016b; 2016d).

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[1] The most recent IRM performance monitoring data (for IA-1, IA-1/IA-4, IA-2, IA-3/IA-7, IA-6, IA-11, and IA-12) are included with this report to fill in data gaps and provide the most comprehensive depiction of current groundwater conditions. Discussion of the IRM activities and evaluation of the IRM performance monitoring results will be submitted to the NJDEP in separate IRM progress reports in early 2019.

On January 29, 2018, Roche submitted to the NJDEP a Site-Wide Groundwater Conceptual Site Model Report (CSM Report) that redefined the vertical zonation of the groundwater flow system and movement of impacted groundwater (TRC and B. Kueper & Associates, Ltd., 2018). The CSM Report presented a detailed and thorough analysis of the large dataset that Roche has compiled over more than 2 decades and provided multiple lines of evidence for the origin and migration dynamics of several groundwater contaminant plumes. The CSM Report is discussed further in Section 3.0.

1.1 Document Organization

This document is organized into the following sections:

- Section 2.0 provides references to deliverables that summarize the most recent Site background information;
- Section 3.0 discusses CSM concepts and present a cross-section of the established model;
- Section 4.0 provides a brief overview of the Site's groundwater IRM programs;
- Section 5.0 provides a list of groundwater Contaminants of Concern (COCs) identified at the Site to date;
- Section 6.0 provides a technical overview (scope/methods) of the completed supplemental groundwater programs;
- Section 7.0 provides supplemental investigation findings for Investigative Area (IA)--specific investigations and Site-wide groundwater monitoring programs, and provides an evaluation of groundwater elevations and groundwater quality;
- Section 8.0 provides an update on the status of IRM and subsequent remedial activities; and,
- Section 9.0 provides a list of references.

Previous Site-Wide Groundwater Progress Reports provided an evaluation of contaminant trends over time, particularly for monitoring wells located at the downgradient edges of plumes. These previous evaluations determined that the plume margins are stable, and the plumes are not increasing in extent or severity. The data presented herein continue to support this conclusion.

2.0 SITE BACKGROUND AND GENERAL INFORMATION

2.1 Site Background and History

A comprehensive Site background (including Site description and history, physical setting, and historic regulatory compliance and deliverables) has been provided in the April 2014 Site-Wide GWRIR and subsequent GWPRs dated January 2015, December 2015, January 2017, and November 2017. Refer to the January 2018 CSM Report for the most updated Site background information (TRC and B. Kueper & Associates, Ltd., 2018). To manage the investigation of the large Site, Roche divided the Site into 15 IAs. The division of the Site into IAs is shown on Figure 2.

2.2 Current Ownership and Site Redevelopment

Roche officially ceased all business operations at the Nutley campus in December 2013. Roche sold the property in September 2016 to affiliates of Prism Capital Partners, LLC (Prism). Prism's land redevelopment project will transform the Site into a mixed-use development that includes a medical school, research facilities, retail stores, housing, a hotel, and other uses.

As shown on Figure 2, very few buildings remain at the Site.[2] Prism has remodeled existing Buildings 123 and 123A (located in IA-7) to accommodate the new Seton Hall-Hackensack Meridian Graduate School of Medicine. Areas surrounding these buildings, specifically in IAs 3, 11, and 13, were regraded and paved for the construction of parking lots and access roads. Similarly, a portion of IA-10 will be occupied by a new medical laboratory, with the northernmost portion of IA-10 being regraded for construction of a new parking deck.

The Site redevelopment activities prompted the sampling of select wells and required the decommissioning of others during this reporting period. Refer to Sections 6.2.1.2 and 6.3 for monitoring well sampling and well decommissioning details. Figure 2 provides the location of all former (including those demolished prior to September 2016) and existing buildings.

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[2] As documented in the previous GWPRs, Roche demolished many on-Site buildings as part of its Site divestment and repurposing strategy.

3.0 CONCEPTUAL SITE MODEL

In January 2018, Roche submitted the CSM Report, which redefined the groundwater flow system and contaminant fate and transport mechanisms, identified distinct groundwater plumes based on their chemical signatures, identified on- and off-Site sources of groundwater contamination, described the completed remedial activities and resulting improvements to on-Site groundwater quality, and discussed potential risk to receptors (TRC and B. Kueper & Associates, Ltd., 2018).

Prior to submission of the CSM Report, monitoring wells were classified into in one of seven, elevation-based groundwater zones (Zones S1 through S3 and D1 through D4). The CSM Report evaluated more than 5 years of groundwater and geologic Site data and concluded, among other things, that the Site's hydrogeology and contaminant distribution are governed by hydrogeologic units (HGUs), local drainage features, fault zones, and preferential pathways created by buried anthropogenic structures. The HGUs consist of thicknesses of dipping stratigraphic beds characterized by an interconnected network of bedding-plane and high-angle fractures. Figure 3 provides a schematic representation of the hydrogeological characteristics described in the CSM Report.

HGUs consist of sedimentary rocks of similar hydrogeological characteristics and behavior. An HGU in the layered, fractured sedimentary bedrock at the Site is a portion of the rock in the groundwater flow domain that has a network of well-interconnected bedding-plane and high-angle fractures. Groundwater within an HGU flows preferentially parallel to bedding due to the high transmissivity of the bedding-plane fractures. Similar, but not necessarily constant, hydraulic heads throughout a vertical interval of rock is characteristic of an HGU, reflecting the occurrence and extent of high-angle fractures connecting the transmissive bedding-plane fractures and facilitating the equalization of hydraulic head within the HGU. A total of five HGUs were established at the Site. Groundwater within the overburden, which varies in thickness from a few feet to as much as 50 feet, is monitored separately as hydraulic properties in unconsolidated material differs from the fractured bedrock system. Figures 4 and 5 provide depictions of potentiometric surfaces in the shallow groundwater and HGUs 1 through 5 for the reporting period covered in the GWPR.

As shown on Figure 3, the HGUs at the Site dip to the north-northwest and are displaced by the Clifton-Allwood Municipal Sewer (CAMS) Fault Zone in the center of the Site and by the Western Fault northwest of the Site. The HGUs are offset west and/or east of the CAMS Fault Zone and are labeled with a corresponding "W" or "E". The HGUs subcrop where the dipping strata intersect the overburden, and therefore not all HGUs are uniformly present beneath the Site. Subcrop lines show approximately where the bottom of the HGU intersects the overburden, except for HGUs 4W and 5W, which terminate at the western margin of the CAMS Fault Zone. HGU 1 is only present west of the CAMS Fault Zone (HGU 1W).

A total of 17 unique groundwater plumes were identified beneath the Site: six plumes originating from on-Site releases and attributable to on-Site activities (IA-9 Pipe Trench Area Plumes, IA-2 Tank Farm Area Plume, IA-6 Chlorobenzene Plume, IA-10 Building 104 Area Plume, IA-10 Building 70 Area Plume, and On-Site Dioxane Plume); four plumes originating from on-Site releases from the CAMS and not attributable to on-Site activities (CAMS IA-12 Plume, CAMS IA-3/IA-7 North Plume, CAMS IA-7 South Plume, and CAMS IA-11 Plume); and seven plumes originating off Site from upgradient sources (Off-Site CAMS North Plume, Off-Site Deluxe Plume, Off-Site Briad/North Plume, Off-Site Western Plume, Off-Site Sunoco Plume, Off-Site Eastern Plume, and Off-Site Nutley Windsor Sewer Plume). Maps from the CSM Report that identify and name the distinct plumes identified under and surrounding the Site are provided in Appendix A. Because development plans required the potential decommissioning of several monitoring wells, supplemental groundwater sampling activities were completed to document current plume conditions associated with individual plumes (refer to the first Quarter of 2018 (1Q 2018) Sampling Event in Section 6.2.1.2).

This report focuses on the overall extent and distribution of contaminants across the Site, and not on monitoring the individual plumes of on-Site or off-Site origin. However, the contaminant distribution maps presented on Figures 6 through 53 in this Progress Report are consistent with the conclusions presented in the CSM Report regarding the distribution of VOCs in groundwater at the Site.

4.0 GROUNDWATER INTERIM REMEDIAL MEASURE (IRM) PROGRAMS

Several remediation programs (e.g., soil and shallow bedrock excavations, groundwater IRMs) implemented by Roche have significantly improved groundwater quality at the Site. The groundwater IRM programs were initiated at the Site in 2015 and 2016 to remediate and reduce contaminant mass in the source areas of groundwater contaminant plumes and reduce further migration of contaminants in groundwater.

The groundwater IRMs targeted treatment of elevated PCE+ constituents (i.e., tetrachloroethene [PCE] and its associated degradation products of trichloroethene [TCE], cis-1,2-dichloroethene [cis-1,2-DCE], and vinyl chloride [VC]) in plumes emanating from the CAMS (CAMS IA-12 Plume, CAMS IA-3/IA-7 North Plume, CAMS IA-7 South Plume, and CAMS IA-11 Plume), as well as volatile organic compound (VOC) contamination in isolated on-Site plumes including: the IA-9 Pipe Trench Area Plumes (PCE+ and toluene), the IA-2 Tank Farm Area Plume (benzene, chloroform, and methylene chloride), the IA-6 Chlorobenzene Plume (chlorobenzene and PCE+), the IA-10 Building 104 Area Plume (PCE+), the IA-10 Building 70 Area Plume (benzene), and the on-Site Dioxane Plume in the IA-1/IA-4 area (1,4-dioxane [dioxane], benzene, and toluene).

IRM implementation activities and associated performance monitoring data have been documented in several groundwater IRM Progress Reports submitted to the NJDEP, dated February 2017, November 2017, and December 2017 (TRC, 2017b; 2017e; 2017f; 2017g; 2017h). Additional IRM Progress Reports will be submitted to the NJDEP in early 2019. As documented in these reports, all IRM programs have been completed in CAMS IA-12, CAMS IA-3/IA-7 North, CAMS IA-7 South, CAMS IA-11, IA-9, IA-2, IA-6, IA-10 Building 104, IA-10 Building 70, and IA-1/IA-4. The results of a monitoring event including wells in the area of the IA-10 Former Building 104 IRM and other portions of IA-10 are included in this GWPR to document groundwater quality conditions in the area (prior to well decommissioning). Contamination exceeding NJDEP's Ground Water Quality Standards (GWQS) after IRM completion will be addressed in a Site-Wide Groundwater Remedial Action Work Plan (RAWP) that will be submitted in February 2019.

Section 6.2.2 of this report details how IRM performance monitoring data were used to supplement data collected during the semi-annual monitoring events to create Figures 6 through 53, depicting groundwater quality conditions Site-wide for specific "snapshots" in time. Discussions of recent groundwater improvements within the IRM treatment areas are included in Section 7.2. Refer to the individual Groundwater IRM Progress Report (anticipated for submittal to NJDEP in early 2019) for recent data associated with the performance monitoring programs and detailed discussions of the IRM monitoring activities, results, and recommendations.

5.0 GROUNDWATER CONTAMINANTS OF CONCERN

During the 2013 remedial investigation (RI) and supplemental investigations (2014-2017), a total of 59 confirmed Site-specific COCs were identified in groundwater samples collected from monitoring wells installed at the Site. The list of Site-specific contaminants included numerous VOCs (primarily chlorinated VOCs), semi-volatile organic compounds (SVOCs), pesticides, and metals. The SVOC, pesticide, and metal exceedances were attributed to impacted historic fill material (HFM) placed throughout most of the Site and/or from naturally occurring conditions.

On March 20, 2017, the NJDEP issued a Classification Exception Area (CEA) for HFM, listing metals, pesticides, and select SVOCs (NJDEP, 2017). The approval excluded a short list of SVOCs (hexachlorobenzene, 2-methylnaphthalene, 2-methylphenol, 3&4-methylphenol, and pentachlorophenol) that are not generally considered HFM contaminants. In June and October 2017, Roche re-sampled the areas where the five SVOCs were detected above their respective GWQS to determine if the contamination persisted after the implementation of soil remedial actions and groundwater IRMs. The results, summarized in the April 2018 *Semi-Volatile Organic Compound Groundwater Sampling Report* (TRC, 2018a) and approved by the NJDEP in November 2018 (NJDEP, 2018), indicated that hexachlorobenzene, 2-methylnaphthalene, 2-methylphenol, 3&4-methylphenol, and pentachlorophenol are no longer present in Site groundwater at concentrations above the GWQS. As such, these contaminants will not be included in the Site groundwater CEA that will ultimately be proposed for the Site after implementation of the proposed groundwater RAWP.

The table below summarizes the current list of Site-specific groundwater COCs, which has been revised to exclude the remediated contaminants as well as those that have been included in the HFM CEA established by the NJDEP in March 2017 (NJDEP, 2017).

VOCs†	SVOCs‡	Pesticides‡	Metals‡
1,1,1-Trichloroethane (1,1,1-TCA)	Tentatively Identified Compounds (TICs)		
1,2,4-Trichlorobenzene			
1,1-Dichloroethane (1,1-DCA)			
1,1-Dichloroethene (1,1-DCE)			
1,2-Dichloroethane (1,2-DCA)			
2-Butanone (MEK)			
Acetone			

VOCs[†]	SVOCs[‡]	Pesticides[‡]	Metals[‡]
Benzene			
Bromodichloromethane			
Carbon disulfide			
Carbon tetrachloride			
Chlorobenzene			
Chloroethane			
Chloroform			
cis-1,2-DCE			
Cyclohexane			
Ethylbenzene			
Methyl Tert Butyl Ether (MTBE)			
Methylcyclohexane			
Methylene chloride			
PCE			
Toluene			
trans-1,2-Dichloroethene			
TCE			
VC			
Xylenes (total)			
Dioxane			
TICs			

[†] The following VOC constituents have only been detected above their respective GWQS once in a limited number of monitoring wells since the 2013 monitoring period: 1,1,2,2-tetrachloroethane, 1,2-dibromoethane, 1,2-dichloropropane, 1,3-dichloropropene (total), bromomethane, chloromethane, and dibromochloromethane. These compounds are, therefore, not considered Site-specific COCs and have been removed from the above table.

[‡] The groundwater contaminants captured under the HFM CEA have been removed from this table. Specifically the following polycyclic aromatic hydrocarbons (PAHs) were removed from the SVOC column: benzo(a)anthracene , benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene; as well as all identified metal exceedances including aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, iron, lead, manganese, nickel, sodium , thallium, and zinc; and exceeding pesticides dieldrin, lindane, and chlordane. Likewise, SVOCs no longer present after remediation of Site groundwater were also excluded from this table, namely hexachlorobenzene, 2-methylnaphthalene, 2-methylphenol, 3&4-methylphenol, and pentachlorophenol.

6.0 TECHNICAL OVERVIEW

This section provides a technical overview of the supplemental groundwater characterization activities completed at the Site between August 2017 and April 2018, specifically two semi-annual groundwater monitoring events and select area-specific investigative and remedial programs. Table 1 provides a sample collection summary (including the quality assurance [QA] and quality control [QC] samples) for this investigation period. The findings of these activities are presented in Section 7.0.

6.1 <u>Remediation Standards and Criteria</u>

Any chemical compound detected in groundwater with a concentration that exceeds the NJDEP GWQS for Class IIA Aquifers (N.J.A.C. 7:9C) is defined as a groundwater COC, or contaminant. In November 2015, the NJDEP revised the Interim Specific Ground Water Quality Criterion (ISGWQC) for dioxane[3], reducing the ISGWQC from 10 micrograms per liter (µg/L) to 0.4 µg/L. Laboratory analyses associated with the recent monitoring events achieved the lower contaminant detection limits for dioxane, which allowed for the detection of this compound at or below the established 0.4 µg/L ISGWQC. Effective January 16, 2018, the NJDEP adopted amendments to the GWQS rules (N.J.A.C. 7:9C). As part of this change, the dioxane 0.4 µg/L ISGWQC became a specific GWQS and is now listed in N.J.A.C. 7:9C Appendix Table 1.

6.2 <u>Groundwater Sampling Programs</u>

Between August 2017 and April 2018, several groundwater sampling programs were completed to monitor plume conditions at the Site perimeter and selected interior areas during IRM system operations, to further investigate areas displaying elevated contaminant concentrations in select on- and off-Site locations, and to further characterize upgradient sources of groundwater contamination.[4] The subsections below describe the completed programs, which include two semi-annual sampling events, namely the third quarter of 2017 (3Q 2017) and 1Q 2018 and supplemental IRM performance monitoring sampling in IA-1 Building 55, IA-1/IA-4, IA-2, IA-3/IA-7, IA-6, IA-10, IA-11, and IA-12.

6.2.1 Site-Wide Groundwater Monitoring Program

On December 21, 2016, the NJDEP approved Roche's request for the modification of the *Site-Wide Groundwater Sampling Plan – Interim Remedial Measures (IRM) Implementation Period –*

[3] Dioxane and VOCs are addressed separately in this report (even though dioxane is technically a VOC) because dioxane is an important standalone constituent for understanding and managing the Site. Dioxane and VOCs are also addressed separately because different analytical methods are currently used to measure dioxane as compared to VOCs. Specifically, a modified Method 8270 (SVOC) is used for dioxane, while Method 8260 is used for traditional VOCs.

[4] The IRM Performance Monitoring data included with this deliverable are presented in select tables and figures. Groundwater sampling in support of IRM programs will be discussed in detail in the upcoming Groundwater IRM Progress Reports.

July 13, 2015, submitted in November 2016 (TRC, 2016d). The revised groundwater sampling plan modified the sampling frequency from a quarterly to a semi-annual basis and reduced the list of sampled wells from all wells on-Site to a proposed list of 168 wells. The list of wells sampled has increased during the implementation of the revised plan to address data needs. Groundwater sampling events will be completed in March and September of each calendar year until a future groundwater monitoring program is defined in the forthcoming RAWP. A description of the implemented groundwater sampling methodologies and field activities is provided below. Table 2 provides a summary of well construction details. Table 3 lists the established HGUs and the total number of on- and off-Site monitoring wells associated with each of them. Monitoring well construction and other documentation is included in Appendix B. Refer to Figure 2 for the location of on- and off-Site monitoring wells.

6.2.1.1 Semi-Annual Fluid-Level Measurements

3Q 2017 and 1Q 2018

On September 26, 2017 and March 6, 2018, synoptic water-level measurements were collected from all accessible on-Site and off-Site wells (nearly 900 Roche-owned wells). The groundwater elevation measurements for these events are provided in Tables 4-1 and 4-2.

Prior to initial water-level measurements, the integrity of each well was inspected, and a photoionization detector (PID) was used to screen the well opening for the presence of volatile gases. A Solinst® oil-water interface probe was used to record depth-to-water measurements from established surveyed points and to assess for the potential presence of light/dense non-aqueous phase liquids (LNAPL/DNAPL) in each well. All pertinent observations and data were recorded on field sampling forms and in a field logbook.

Groundwater gauging was also conducted at the four Westbay multiport wells (DW-65, DW-69, DW-70, and DW-72) during the 3Q 2017 and 1Q 2018 Site-wide synoptic events. Groundwater gauging at these wells was completed using Westbay's proprietary pressure transducer system. The pressure transducer is lowered to the sample port, where it engages the sampling port, and seals with it. The sampling port is then opened, allowing the hydrostatic pressure at the sampling port to be directly measured and recorded. Following collection of the pressure measurement, the sample port is closed again. The measured hydrostatic pressure is subsequently converted to equivalent depth to water, correcting for atmospheric pressure at the time of the hydrostatic pressure measurement, and groundwater elevation values are then calculated. The calculated groundwater elevation measurements are included in Tables 4-1 and 4-2. The individual depth to water measurements collected at each port and the formulae used to calculate the potentiometric heads (from the measured hydrostatic pressures) within the monitored HGUs are presented in Tables 4-3 and 4-4.

Groundwater elevation contour maps for shallow groundwater and HGUs 1 through 5 are provided on Figure 4 (3Q 2017) and Figure 5 (1Q 2018). Shallow groundwater is considered as the upper 30 feet of the saturated zone; therefore, the shallow groundwater elevation contour maps (the upper-left panel of Figures 4 and 5) represent elevations of the water table, which is intercepted within the screened intervals of the selected wells. The water levels used for the HGU groundwater elevation contour maps were generally selected from monitoring wells screening the mid-section of the HGU. For HGU 5 (E and W), water levels were used from closer to the top of the unit owing to the undefined thickness of the unit. A discussion of the Site's groundwater flow regime is provided in Section 7.1.

6.2.1.2 Semi-Annual Groundwater Sampling

All sampling activities for both semi-annual sampling events were completed in accordance with the Roche Quality Assurance Project Plan (QAPP; TRC, 2013d), the NJDEP Field Sampling Procedures Manual (NJDEP, 2005), appropriate groundwater sampling standard operating procedures (SOPs), and the NJDEP-approved *Site-Wide Groundwater Sampling Plan – IRM Implementation Period - July 2015* and subsequent modifications.

Groundwater samples were collected using Passive Diffusion Bags (PDBs) for analysis of VOCs (SW-846 Method 8260) and Rigid Porous Polyethylene Samplers (RPPSs) for analysis of dioxane (SW-846 Method 8270 with selective ion monitoring [SIM]). The PDBs and RPPSs were filled with laboratory-grade deionized water and deployed at the 5-foot depth interval displaying the highest VOC concentrations during vertical screening the first time the wells were sampled. The PDBs and RPPSs were allowed to stay in the well (and equilibrate) for at least 14 days prior to removal and sample collection and transfer into laboratory glassware for analyses.

The 3Q 2017 and 1Q 2018 semi-annual sampling events included sampling of the four Westbay multiports (DW-65, DW-69, DW-70, and DW-72). Groundwater samples were collected using Westbay's proprietary sampling system, consisting of an evacuated (i.e., under vacuum) sealed stainless steel canister. This evacuated canister is lowered to the sample port, where it engages the sampling port, and seals with it. The canister and sampling port are then both opened, allowing groundwater to flow through the sample port and into the canister under negative (vacuum) pressure. Following sample collection, the canister and sample port are closed, the canister is retrieved from the multiport well, and the collected groundwater is transferred to laboratory glassware for analysis.

All groundwater samples were submitted to TestAmerica of Edison, New Jersey (TestAmerica) for analysis. Summary lists of groundwater samples collected during the semi-annual sampling events are provided in Table 1-1.[5] Analytical data from the 3Q 2017 and 1Q2018 sampling events are presented in Table 5. Field sampling forms are provided in Appendix C. The groundwater sampling results for the semi-annual sampling events are discussed in Section 7.2.

3Q 2017 Sampling Event

On September 27, 2017, TRC initiated sampling activities at the on- and off-Site multiports, collecting groundwater samples from a total of 84 sampling ports. On October 2, 2017, Groundwater & Environmental Services, Inc. (GES) initiated the deployment of PDBs and RPPSs in on- and off-Site monitoring wells. Between September 27 and November 1, 2017, groundwater samples (including duplicates) were collected from wells located along the perimeter of the Site and select wells located in close proximity to and/or downgradient of IRM treatment areas. DW-45A (northeast portion of IA-7) was inaccessible and could not be sampled during this sampling event. A summary list of groundwater samples collected during the semi-annual monitoring program is provided in Table 1-1.

1Q 2018 Sampling Event

On February 12, 2018, GES installed PDBs and RPPSs in on- and off-Site monitoring wells. On March 6, 2018, TRC initiated sampling activities at the on- and off-Site multiports, collecting groundwater samples from a total of 84 sampling ports. Between February 26 and March 29, 2018, groundwater samples (including duplicates) were collected from wells located along the perimeter of the Site and select wells located in close proximity to and/or downgradient of IRM treatment areas. DW-45A (northeast portion of IA-7) remained inaccessible and could not be sampled during this sampling event. A sample summary list of groundwater samples collected during the semi-annual monitoring program is provided in Table 1-1.

A groundwater sample and sample duplicate collected from monitoring well DW-38C were analyzed under the incorrect analytical method. The groundwater sample logged as DW-38C_RPPS531.8(A) was collected from an RPPS and was intended to be analyzed for dioxane; this sample was instead analyzed for VOCs. Likewise, the groundwater duplicate sample logged as DW-38C_PDB531.8(B) was collected from a PDB and intended to be analyzed for VOCs; this sample was instead analyzed for dioxane. The analytical data for these samples were rejected and listed as such in Table 1-1A.

6.2.2 Groundwater IRM Performance Monitoring Programs

In accordance with NJDEP-approved Permit-by-Rule applications, groundwater sampling within IRM treatment zones has been conducted prior to, during, and after completion of IRM system

[5] Except for the multiports, each groundwater sample collected in 3Q 2017 and 1Q 2018 is listed as two separate entries in Table 1-1 to individually track and more easily differentiate between samples collected via PDB and RPPS methods. This approach was taken as a quality control measure to reduce potential errors in the field (e.g., collecting samples, completing the chain-of-custody) and in the laboratory (e.g., running the sample for the correct analytical method).

implementation to monitor remedial system operations and to assess the effectiveness of each program. Groundwater IRM analytical data collected 1 or 2 months prior or subsequent to the semi-annual Site-wide groundwater sampling events (3Q 2017 and 1Q 2018) were incorporated into figures to provide the most comprehensive depiction of groundwater quality conditions at the Site for that time frame. The 3Q 2017 Site-wide semi-annual monitoring event was supplemented with IRM performance monitoring data collected between August and November 2017. The 1Q 2018 Site-wide semi-annual monitoring event was supplemented with IRM performance monitoring data collected between January and April 2018. Dioxane data collected during IRM performance monitoring events displaying laboratory method detection limits (MDLs) above the 0.4 µg/L GWQS for dioxane were not used to supplement the data sets for 3Q 2017 (Figures 42 through 47) and 1Q 2018 (Figures 48 through 53). Groundwater analytical data from 284 IRM wells were incorporated into the groundwater quality maps - Figures 6 through 53. The IRM performance monitoring samples were collected from IA-1 (Building 55 area), IA-1/IA-4, IA-2, IA-3/IA-7, IA-6, IA-10, IA-11, and IA-12 using the low-flow, PDB, and RPPS sampling methodologies and analyzed for VOCs (SW-846 Method 8260) and/or dioxane (SW-846 Method 8260 or SW-846 Method 8270 with SIM). A list of the IRM samples incorporated into this report is presented in Table 1-2. Refer to Table 1-2A for a list of dioxane samples rejected due to elevated MDLs.

The Electronic Data Deliverables/Electronic Data Submission (EDD/EDS), field sampling forms, and additional details associated with the IRM programs will be submitted to the NJDEP in the upcoming Groundwater IRM Progress Reports.

6.2.3 Off-Site Allwood Road Borehole Installation and Sampling

Groundwater contaminant contribution from off-Site upgradient sources (north of Route 3) has been documented by Roche in previous reports (TRC, 2015d; 2017a; TRC and B. Kueper & Associates, Ltd., 2018). A known contaminated site immediately north of Route 3 (i.e., the Briad property) is a source of PCE+, TCA+ (1,1,1-trichloroethane [1,1,1-TCA] and its associated degradation products 1,1-dichloroethene [1,1-DCE] and 1,1-dichloroethane [1,1-DCA]), dioxane, chlorobenzene, and dichlorobenzene contamination. Other unidentified entities north of Route 3 and west of the Site are also suspected of contributing to the on-Site groundwater plumes with similar contaminants.

6.2.3.1 <u>Borehole Installation</u>

Allwood Road (Passaic County Route 602) runs parallel to Route 3, approximately 150 to 1,200 feet north of the highway between Broad Street and Main Avenue in Clifton, New Jersey. During August and September 2017, Roche conducted a limited off-Site investigation along a 560-feet stretch of this road (between the railroad tracks and Book Court) to further correlate the off-Site and on-Site geology, hydrogeology and HGUs, and to evaluate the distribution of groundwater contaminants in areas upgradient of the Site. The field program included the installation of three bedrock boreholes (DW-73, DW-74, and DW-75) with subsequent geophysical logging, packer testing, and groundwater sampling. Data collected during the bedrock borehole advancement and packer testing are provided in Appendix D. All field activities described in the following sections were completed under TRC supervision and in accordance with the NJDEP-approved Site-specific QAPP (TRC, 2013d).

Since the completed borehole locations are within the right-of-way and paved roadway surface of Allwood Road, Roche obtained a road-opening permit issued by Passaic County, and coordinated traffic control plans with the Clifton Police Department and in accordance with requirements from the Passaic County Division of Roads.

Working hours within the Allwood Road right-of-way were restricted to the interval between 7:00 PM and 6:00 AM. All workers, equipment, and supporting materials were removed from the right-of-way at the end of each work day. Open boreholes were covered by steel construction plates by the driller at the end of each work shift to protect the boreholes, and to protect the public from potential physical hazards associated with the open boreholes.

Prior to drilling activities, the selected borehole locations were identified in the field and a private geophysical survey was completed to verify the absence of subsurface utilities in the planned drilling locations. In addition, as required by law, drilling contractors notified the New Jersey-One Call system prior to any drilling activities.

Between August 24, 2017 and October 1, 2017, boreholes DW-73, DW-74, and DW-75 were advanced by SGS North America of West Creek, New Jersey (SGS) to depths ranging from 180 to 245 feet below ground surface (bgs) in areas adjacent to or within the southernmost lane of Allwood Road (Figure 54). At each location, the driller used air knife clearing methods to a depth of 5 feet bgs, advanced a 10-inch borehole to at least 10 feet into competent bedrock via air rotary drilling, and grouted a 6-inch diameter steel casing into place to isolate the bedrock borehole from the overlying soil and overburden materials. After the grout curing period, the driller advanced the borehole (through the outer steel casing and cured grout) further into competent bedrock to the specified depths, predetermined to verify the stratigraphy at each location relative to a marker bed (specifically, a 40-foot thick sandstone unit between finer-grained units). All investigation-derived waste generated during the drilling activities (i.e., soil, rock cuttings, and groundwater) was containerized and staged at a Roche-designated staging location to await subsequent transport and off-Site disposal. Once the borehole drilling activities were completed, packer testing and sampling efforts were initiated.

6.2.3.2 Borehole Geophysical Logging

Following borehole advancement, each borehole was logged by ARM Geophysics of Hershey, Pennsylvania (ARM) using downhole geophysical equipment. The suite of downhole geophysical logging tools consisted of 3-arm caliper, fluid temperature, short and long normal resistivity, fluid conductivity, single point resistance, spontaneous potential, natural gamma, and heat-pulse flow meter techniques, in addition to optical televiewer (OTV) and acoustical televiewer (ATV) logging. These geophysical data were reviewed and used to define geologic stratigraphy, identify specific water-bearing fracture intervals, and to determine the fracture orientation and frequency in the bedrock. ARM's geophysical logs are provided in Appendix D.

6.2.3.3 Packer Testing and Sampling

Packer tests were conducted at each borehole in 10-foot intervals encompassing the top 60 to 80 percent of the borehole's total depth. The packer assembly was used to isolate different zones within the borehole to collect depth-discrete groundwater samples and gather screening-level hydraulic head measurements. Refer to Figure 54 and Appendix D for the packer zones, pumping rates, drawdown, as well as transmissivity and specific capacity estimates at DW-73, DW-74, and DW-75.

Following packer inflation in each interval, groundwater was allowed to stabilize (for a minimum of 5 minutes) and the packed borehole interval was gauged prior to pumping. The TRC field geologist monitored pressure transducer data (from pressure transducers located above the test interval, within the test interval, and below the test interval) and once the middle pressure transducer readings stabilized, the depth to groundwater (through the riser pipe connected to the packed interval) was manually gauged with an interface probe. Both the depth to water below the riser pipe and the height of the riser pipe above the surrounding roadway pavement were recorded (thus providing depth to water below ground surface).

For zones that responded slowly due to low yield, TRC's field geologist monitored conditions and collected measurements in 15-minute increments until water levels equilibrated or until 1.5 hours following packer inflation was achieved. In the event that groundwater levels did not equilibrate within the 1.5 hours of monitoring, pumping was subsequently initiated.

Following measurement of depth to groundwater, each packed interval was purged and sampled. A total of three packer interval volumes (plus one volume of the riser pipe) were purged during each test; however, for low-yielding zones (< 1 gallons per minute [gpm]), a minimum of one packer interval (plus one volume of the riser pipe) was purged when practical. In cases where purging was not possible at all, due to dry or very low-yielding intervals, the packers were deflated and re-set at the next planned packer test interval.

All purged intervals were sampled (by pump if practical, and by bailer if sampling by pump was not practical) and groundwater samples were submitted to SGS for VOC+15 (8260) and dioxane (8270 SIM) analyses on a 24-hour turn-around time.

6.3 Monitoring Well Decommissioning

On July 7, 2017, on behalf of Roche, TRC submitted a proposal for well modifications and decommissioning in portions of IA-3, IA-7, IA-11, and IA-13 to the NJDEP (TRC, 2017c). Prism notified Roche of their intentions to re-grade and pave portions of the Site to construct roadways and parking lots. On August 1, 2018, TRC submitted a revision of the July 7, 2017 proposal which reflects the NJDEP's consensus regarding the decommissioning of 90 monitoring and remedial wells (TRC, 2018b). These wells were no longer required for IRM or Site-wide monitoring. The decommissioning of these wells was completed in August 2017 by New Jersey-licensed drillers under TRC supervision. The NJDEP decommissioning reports are included in Appendix B. A table listing the decommissioned wells, along with their former general location and vertical investigation zone, and HGUs is provided below.

IA	Decommissioned Monitoring and Remedial Wells	Vertical Investigation Zone	HGU
IA-3	MW-10	Zone S1	2E
	MW-12, MW-35	Zone S1	3E
	MW-115	Zone S2	4E
	MW-116	Zone S3	3E
IA-7	IW-118A1, IW-118A2, IW-19, IW-20, IW-21, IW-22	Zone S1	overburden
	MW-288A, MW-289A, MW-293A, MW-399A, MW-399S, MW-400A, MW-401A, MW-401S, MW-402A, MW-402S, MW-403A, MW-403S, MW-405A, MW-406A, MW-406S, MW-407A, MW-407S, MW-408S, MW-409A, MW-412A, MW-42	Zone S1	2E
	MW-36	Zone S1	3E
	ART-16, ART-92, IW-118B, IW-14, IW-15, IW-16, IW-17, IW-18	Zone S2	--
	MW-204B	Zone S2	3E
	MW-378B	Zone S2	4E
	DW-56A	Zone D1	5E
IA-11	IA11-VP10, IA11-VP11, IA11-VP12, IA11-VP13,	Zone S1	overburden

IA	Decommissioned Monitoring and Remedial Wells	Vertical Investigation Zone	HGU
	IA11-VP14, IA11-VP15, IA11-VP16, IA11-VP17, IA11-VP18, IA11-VP19, IA11-VP22, IA11-VP23, IA11-VP24, IA11-VP25, IA11-VP26, IA11-VP27, IA11-VP28, IA11-VP29, IA11-VP5, IA11-VP6, IA11-VP7, IA11-VP8, IA11-VP9		
	MW-242, MW-25	Zone S1	2E
	MW-18, MW-65, MW-69	Zone S1	3E
	IW-162B, MW-327B, MW-332B	Zone S2	3E
	EW-26C	Zone S3	--
	IW-151C1, IW-151C2, IW-1C, IW-2C, IW-3C, IW-4C, IW-7C	Zone S3	3E
	MW-25C, MW-344C	Zone S3	4E
	DW-10B	Zone D1	4E
	DW-10C	Zone D2	5E
IA-13	IW-146C, IW-153C1, IW-153C2	Zone S3	--

6.4 <u>Data Reliability</u>

The analytical methods used for the semi-annual Site-wide groundwater sampling events are provided in the QAPP and the laboratory analytical reports. The laboratory data reports and EDD/EDS for the recent data are included on compact disc in Appendix E. Table 1 presents a summary of groundwater samples collected between August 2017 and April 2018.

Sample collection activities and laboratory analysis of groundwater samples obtained as part of the low-flow, PDB, and RPPS sampling program were performed in accordance with the TRSR, the NJDEP-approved groundwater RI Workplans for shallow and deep bedrock investigations (TRC 2012a; 2012b; 2013a; 2013b; 2013c; 2013e), the *Site-Wide Groundwater Sampling Plan - Interim Remedial Measures (IRM) Implementation Period Rev. 1 (July 2015)* (TRC, 2015b) and subsequent modifications, and the revised QAPP (TRC, 2013d).

On March 26, 2018, select samples collected at monitoring well DW-38C were requested for the wrong analytical method, as logged in the laboratory chain-of-custody. A groundwater sample collected via PDB (*DW-38C_PDB531.8(B)*) was analyzed for dioxane and a duplicate sample collected via RPPS (*DW-38C_RPPS531.8(A)*) was analyzed for VOCs. As a result, TestAmerica laboratory report 460152802 was revised to exclude these samples (460152802-1-9 and 460152802-1-10) from the report. A list of rejected samples can be found in Table 1-1A.

A QA review was performed on the laboratory analytical reports for all VOC samples collected as part of the Site-wide semi-annual monitoring program and supplemental investigations. The method-specific calibrations and quality control performance criteria were met for the data generated during this investigation, except as indicated in the conformance/non-conformance summaries provided in the laboratory reports. Laboratory sample analysis for dioxane was generally not requested via SW-846 Method 8270 with SIM during select IRM performance monitoring events. As a result, the non-detect concentrations that are reported in SW-846 Method 8260 analysis at MDLs exceeding the 0.4 μg/L GWQS for dioxane were rejected from the data set (Table 1-2A).

Based on a review of the laboratory reports, the overwhelming majority of the data were not qualified and are deemed useful for decision-making purposes.

6.5 <u>Factors Influencing Data</u>

The synoptic rounds of groundwater elevation measurements were completed in 1 day for each semi-annual sampling period (September 26, 2017 and March 6, 2018). No significant events or seasonal variations are known to have influenced the sampling procedures or the results of the sampling programs presented in this GWPR. As discussed in Section 4.0, groundwater IRMs have been implemented at selected IAs. Many of the IRMs have resulted in significant improvement in groundwater quality in specific areas.

6.6 Deviation from the Technical Requirements and Guidance

All field activities were conducted in compliance with the approved RI workplans, the *Site-Wide Groundwater Sampling Plan – Interim Remedial Measures (IRM) Implementation Period Rev. 1 (July 2015)* (TRC, 2015b) and subsequent modifications (TRC, 2015c; 2016a; 2016b; 2016d), the QAPP (TRC, 2013d), and the TRSR and applicable guidance documents.

Due to the large number of monitoring wells sampled via PDBs, NJDEP's PDB Data Checklist forms (documenting field activities associated with the deployment of PDBs at each well) were not completed. Instead, relevant data (e.g., monitoring well ID, time/installation depth/depth to water during deployment and retrieval, etc.) for the groundwater samples collected using PDBs and RPPSs are presented in a table format, which is included in Appendix C.

7.0 SUPPLEMENTAL INVESTIGATIVE FINDINGS

This section presents results from semi-annual groundwater monitoring events conducted between August 2017 and April 2018, IRM groundwater monitoring events conducted during this period, and an investigation program completed along a portion of Allwood Road (north of Route 3 and hydraulically upgradient of the Site).[6] The focus of this GWPR is to document current groundwater quality conditions along the Site perimeter and in select interior areas of the Site during the implementation phase of various IRM programs. The laboratory data packages and the EDDs associated with these investigative activities are included on compact disc(s) in Appendix E.

7.1 Groundwater Flow Regime

The semi-annual groundwater sampling program monitors groundwater elevations at the Site over time to assess temporal variability in the data (e.g., seasonal fluctuations) and to continue monitoring for any potential off-Site influences on the groundwater flow system. In addition, groundwater elevation data were evaluated to assess whether the operation of ongoing IRM systems (specifically in IA-1/IA-4) have resulted in changes to the Site's groundwater flow regime.

Figures 4 and 5 are six-panel maps that provide the potentiometric surfaces of the shallow groundwater (i.e., top of the water table) and HGUs 1 through 5. The groundwater elevation measurements were collected Site-wide in September 2017 and March 2018, respectively. Data collected during the monitoring well gauging events (including depth to water, groundwater elevation measurements, presence/absence of product [LNAPL/DNAPL], PID readings, etc.) are summarized in Tables 4-1 and 4-2 for September 2017 and March 2018, respectively. During the September 2017 gauging event, a saturated product sock was removed from HGU 2 well MW-237A[7] (in IA-12). Approximately 0.02 foot of LNAPL was measured in MW-237A during the 1Q 2018 event. LNAPL has not been detected in any other on- or off-Site well. DNAPL has not been detected in any monitoring well installed on- or off-Site. Monitoring wells MW-359B (IA-12) and MW-287A (IA-10) were noted as "dry" wells and could not be gauged during the September 2017 and March 2018 synoptic water-level measurement events.

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[6] The semi-annual groundwater data were supplemented with the most recent groundwater analytical results collected as part of IRM monitoring programs in IA-1, IA-2, IA-3, IA-4, IA-6, IA-7, IA-11, and IA-12. Detailed discussions of these IA-specific IRM monitoring events will be provided in future IRM progress reports.

[7] The presence of LNAPL (determined to be weathered gasoline) and associated groundwater impacts detected in monitoring well MW-237A (IA-12) have been attributed to an off-Site source, located north of Route 3 (a Sunoco service station). LNAPL was first detected at this location in IA-12 during the installation of a temporary well (TW-158A) and during gauging of a permanent monitoring well, in March 2014 (0.08 foot of LNAPL), June 2014 (0.12 foot of LNAPL), September 2016 (0.13 foot of LNAPL), and February 2017 (0.11 foot of LNAPL).

Figures 4 and 5 show that groundwater has a southerly flow component toward St. Paul's Brook. Shallow groundwater flow is convergent in the vicinity of the Valley Drain and St. Paul's Brook, which are local shallow groundwater discharge zones. Consistent with the regional topography, groundwater then flows to the southeast (parallel with St. Paul's Brook), to the Third River, and ultimately to the Passaic River (Figure 1).

As described in the CSM Report, a significant degree of anisotropy exists in the fractured bedrock system (TRC and B. Kueper & Associates, Ltd., 2018). In the presence of anisotropy, the direction of groundwater flow is orthogonal to the tangent of the intersection of the hydraulic gradient vector and an ellipse that represents the orientation and degree of anisotropy (refer to Appendix B of the CSM Report). Therefore, it is expected that in areas where the shallow groundwater is present in the overburden, which is expected to be relatively isotropic, the estimated groundwater flow directions are generally perpendicular to contoured water levels. In other areas, such as on the eastern portion of the Site and a smaller area west of the CAMS fault zone in IA-1, IA-4, and IA-12, the water table is present within the fractured bedrock (brown hatching shown in the "Shallow Groundwater" panel, Figures 4 and 5). As a result, the groundwater flow direction is typically oblique to the water-level contours due to anisotropy in hydraulic conductivity stemming from bedding plane fractures and high-angle fractures oriented along the strike of bedding, which is also consistent with results of pumping tests performed on-Site. This anisotropy in hydraulic conductivity tends to generate preferential flow from the north-northeast to the south-southwest.

Contours of groundwater elevation were not extended into most of the CAMS fault zone due to the disrupted positions and orientations of strata and HGUs, as well as the apparent offset of contours across much of the fault zone. The alignment of St. Paul's Brook has a controlling effect on the overall movement of groundwater in the region. In all HGUs, the hydraulic heads measured are lowest along the alignment of the brook. This northwest-southeast trending drainage feature is aligned parallel to a highly fractured zone. The groundwater flow in the drainage basin that includes the Site, flowing from the north and west, is funneled through a narrow band along the alignment of St. Paul's Brook as it exits the basin in a southeasterly direction toward Third River and the Passaic River. Refer to the CSM Report for detailed discussions of the bedrock hydraulic conductivity and anisotropy, preferential groundwater flow, and vertical hydraulic gradients.

Overall, there is minimal seasonal variability in the horizontal groundwater gradient and hydraulic heads measured in 3Q 2017 (September 26, 2017) and 1Q 2018 (March 6, 2018), as shown in Tables 4-1 and 4-2, and on Figures 4 and 5. From the consistency in flow patterns, it can also be concluded that groundwater flow across the Site is not significantly affected by any of the ongoing IRM activities or any off-Site pumping influences.

7.2 Site-Wide Groundwater Quality Assessment

In compliance with the approved *Site-Wide Groundwater Sampling Plan - Interim Remedial Measures (IRM) Implementation Period Rev. 1* (July 2015) and subsequent NJDEP-approved modifications (TRC, 2015c; 2016a; 2016b; 2016d), a minimum of 226 accessible on-Site and off-Site wells were sampled for VOCs and dioxane in 3Q 2017 and 1Q 2018. This dataset incorporates analytical results from 84 multiport wells sampled using Westbay's proprietary sampling system in 3Q 2017 and 1Q 2018. Data from an additional 284 wells sampled between August 2017 and April 2018 for performance monitoring of IRMs were incorporated into the Site-wide depiction of groundwater quality conditions. To further supplement the depiction of contaminant distribution in areas not recently sampled, the most recent sampling results were used for select wells last sampled between the first quarter of 2015 (1Q 2015) and 3Q 2017. Maps showing groundwater quality in areas where groundwater remediation has occurred or was ongoing (primarily the overburden, HGU 2, and HGU 3) exclude data collected in the treatment areas prior to the start of the particular groundwater IRM programs. In addition, groundwater quality data from off-Site properties were used for plume depiction in areas upgradient, sidegradient, and downgradient of the Site. Data shown at the Briad property (north of Route 3) were collected between January and December 2016, as reported in the April 2017 Ransom Environmental Remedial Investigation Report (Ransom Environmental, 2017). Deluxe wells located on Site (in IA-10) and off Site (at Deluxe property) were last sampled by Roche between July 2015 and June 2016. Nova wells were last sampled by Roche in June 2015. These data are shown on Figures 6 through 53.

This report (and previous GWPRs) uses the term "plume" to refer to areas where groundwater contaminants exceed the current GWQS, and to depict the overall extent of contaminant distribution at on- and off-Site locations for a specific group of chemicals. For instance, the PCE+ plumes shown on Figures 6 through 17 identify areas where PCE and its breakdown products have been detected at concentrations above groundwater remediation standards on a Site-wide basis, without distinguishing or depicting the separate and distinct plumes that have different chemicals in different proportions and that emanate from different potential sources. The CSM Report (TRC and B. Kueper & Associates, Ltd., 2018) identified groundwater plumes based on their chemical signature; i.e., the contaminants and ratios of those contaminants that comprise the plume. Unlike previous GWPRs, in this GWPR the groundwater plumes are shown using the HGU designations adopted in the CSM Report. Moreover, plume maps were prepared for the primary constituent groups. Figures 6 through 17 contour the total PCE+ concentrations (above the reported laboratory MDL) for the 3Q 2017 and 1Q 2018 events. Similarly, Figures 18 through 29 contour the TCA+ detections for the semi-annual events. Figures 30 through 41 contour the benzene and chlorobenzene concentrations; other VOC exceedances (i.e., excluding the PCE+, TCA+, and dioxane compounds) are identified on figure boxes at the bottom of each map. The dioxane concentrations that exceeded the 0.4 µg/L GWQS are contoured in Figures 42 through 53. The discussions presented in sections below are based on these maps.

7.2.1 PCE+ Groundwater Results – 3Q 2017 and 1Q 2018

As described in the CSM Report (TRC and B. Kueper & Associates, Ltd., 2018), the detection of PCE+ on Site has been attributed to several different source areas that caused several different plumes, including the on-Site CAMS plumes (in IA-12, IA-3/IA-7 North, IA-7 South, and IA-11), and off-Site plumes including the Deluxe Plume, the Western Plume, the Briad Plume, the CAMS North Plume, and the Eastern Plume (see Appendix A). The historical on-Site IA-9 Pipe Trench Plumes have been remediated, so the current PCE+ exceedances in the area of this plume are very low. As demonstrated in the CSM Report, the IA-9 Pipe Trench Plumes did not contribute to PCE+ impacts emanating from the CAMS or related to other off-Site plumes containing PCE+. There is a small, isolated area of PCE+ exceedances within the on-Site IA-6 Chlorobenzene Plume; other than this small area in IA-6, the small IA-10 B-104 Plume, and the small IA-9 Pipe Trench Plumes, all PCE+ impacts on and surrounding the Site emanate from CAMS releases or off-Site plumes. Some of the CAMS and off-Site plumes have a highly degraded signature (with abundant cis-1,2-DCE in addition to the parent PCE), while at least one off-Site plume, the Eastern Plume, has an almost pure PCE signature. The footprints of the individual plumes are discernable on the overburden and shallower HGU maps. In the deeper HGUs, the off-Site CAMS North and Eastern Plumes abut each other to form what appears to be a single large-scale PCE+ plume. The plume maps shown on Figures 6 through 17 do not distinguish between the different chemical signatures that define individual plumes, but rather simply contour the distribution of PCE+ concentrations, independent of its origin, chemical signature or incorporation of groundwater flow directions. To distinguish the impacts caused by the Off-Site CAMS North Plume and the Off-Site Eastern Plume, which have different ratios of PCE to degradation products, the boundary between these two plumes is shown on the PCE+ maps for HGUs 3, 4, and 5.

3Q 2017

As shown on Figures 6 through 11, the extent of PCE+ in groundwater is more widespread at depth, in HGUs 4 and 5, than in overburden or shallower HGUs. PCE+ plume migration from off-Site, upgradient areas toward the Site is apparent in the overburden and HGUs 1 through 5. The margins of the plume are similar in extent to what was reported in previous progress reports (TRC, 2015d; 2017a), and PCE+ concentrations at the outer edges of the plumes are similar to those detected earlier, indicating the PCE+ plumes are stable and not growing or increasing in concentration. During the 3Q 2017 sampling event, the highest PCE+ levels were detected in an HGU 1 well (MW-488A 2103 µg/L [Windsor Place]), select HGU 2 wells (MW-201B 1,910 µg/L [north of Route 3], IW-40A 4780 µg/L [IA-12], and IW-110A 1,183 µg/L [IA-6]) and HGU 4 wells (MW-271C 1,325 µg/L and MW-376C 1,315 µg/L [both in IA-12]).

In addition, a high TCE concentration (1,202 µg/L) was detected in well MW-479B. This well is in the Off-Site Nutley Windsor Sewer Plume, which is composed almost entirely of TCE. Because TCE is one of the compounds in the PCE+ suite, the Off-Site Nutley Windsor Sewer Plume is included in the contouring of the PCE+ plumes shown on Figures 6 through 17. However, this plume did not originate as a PCE release, but rather as a TCE release from the municipal sewer in Windsor Place.

Roche's groundwater IRM programs have significantly improved groundwater quality conditions in the overburden and HGUs 2 and 3. As depicted on Figure 6, insets 1 through 5, the historical maximum PCE+ concentrations exceeded 100,000 µg/L in IA-9 well MW-170 (145,790 µg/L), and were detected as high as 93,006 µg/L in the CAMS IA-12 area (MW-60). However, as a result of IRM activities, the 3Q 2017 analytical data shows that a low-concentration plume (of less than 10 µg/L) is observed in the area of the IA-9 Pipe Trench Plumes, reflecting a decline in PCE+ concentrations by four to five orders of magnitude, and the CAMS IA-12 Plume, which originally had PCE+ concentrations in excess of 100,000 µg/L, has been greatly reduced in concentration, by at least two orders of magnitude. Other IRM treatment areas exhibit one to two orders of magnitude decreases in overburden PCE+ concentrations, including the CAMS IA-3/IA-7 North Plume, CAMS IA-7 South Plume, and the IA-10 B104 Plume. The CAMS IA-11 Plume, which originally had PCE+ concentrations in excess of 50,000 µg/L, has been completely remediated in the overburden.

Similarly, comparisons between the historical maximum and 3Q 2017 analytical results in the shallow bedrock reveal significant reductions in contaminant concentrations and lateral distribution of PCE+ concentrations in groundwater constituents in IA-12, IA-3/IA-7 North, IA-7 South, and IA-11. As shown on Figure 8, no PCE+ concentrations greater than 5,000 µg/L were present in 3Q 2017 within any of the IRM treatment zones and the extent of the 10 and 100 µg/L contours have significantly decreased in IA-3/IA-7 North and IA-7 South. PCE+ impacts west of the HGU 2W subcrop boundary line are observed in IA-6, and upgradient of and along the northeastern portion of IA-10. As shown on Figure 9, PCE+ in HGU 3 is present primarily west of the railroad tracks (throughout IA-10) and along the entire length of the CAMS. The IA-11 IRM activities reduced historical maximum PCE+ concentrations in four HGU 3 wells (MW-413B, MW-62, MW-425B, and MW-325B) from over 10,000 µg/L to under 100 µg/L during the 3Q 2017 sampling event (Figure 9).

1Q 2018

Figures 12 through 17 present the PCE+ analytical results from the 1Q 2018 sampling event. The analytical data collected during this sampling program indicates an overall continued decrease in the vast majority of wells, with a few exceptions. In overburden, PCE+ concentrations increased from 15.09 µg/L to 158 µg/L in MW-259A (located within the IA-10 Building 104 IRM treatment area). In HGU 1, PCE+ concentrations increased from 698 μg/L to 1,118 μg/L in MW-375C (located in IA-12).

7.2.2 TCA+ Groundwater Results – 3Q 2017 and 1Q 2018

TCA+ is presented separately and contoured for the first time in this GWPR. In previous GWPRs, exceedances of TCA+ constituents were identified in data boxes on the PCE+ maps. As described in the CSM Report (TRC and B. Kueper & Associates, Ltd., 2018), the TCA+ impacts detected on and surrounding the Site have off-Site origins.

3Q 2017

As shown on Figures 18 through 23, the 3Q 2017 extent of TCA+ concentrations in groundwater is primarily limited to the western portion of the Site. The TCA+ plumes originate from an area north and hydraulically upgradient of IA-10 and the western portion of IA-12. The highest TCA+ concentrations were observed in a multiport well on the Briad property in HGU 1 (Br-MW-13-2 = 4,730 μg/L; Br-MW-13-3 = 2,660 μg/L; and Br-MW-13-4 = 5,100 μg/L) and HGU 2 (Br-MW-13-5 = 2,640 μg/L and Br-MW-13-6 = 2,670 μg/L). The HGU 1 map (Figure 19) shows off-Site TCA+ impacts north of Briad at multiport well DW-70 as high as 105 μg/L (DW-70-114-S3). The extent of TCA+ concentrations is larger in HGUs 2 and 3 than in overburden and HGU 1. In HGUs 2 and 3, TCA+ was detected in off-Site wells located on Allwood Road (DW-70-160-D1 = 104 μg/L [HGU 2], and DW-69-270-D2 = 4.4 μg/L and DW-70-174-D1 = 60.1 μg/L [HGU 3]) – Figures 20 and 21. Lower TCA+ concentrations are present in groundwater within HGUs 4 and 5. These impacts are found primarily in IA-10, but also in the western portion of IA-12, IA-1, IA-2, IA-6 and off-Site in Nichols Park. These TCA+ impacts to groundwater are attributable to one or more off-Site sources located north of the Site.

1Q 2018

Figures 24 through 29 summarize analytical results from the 1Q 2018 sampling event for the overburden and HGUs 1 through 5. Overall, the distribution and concentrations of TCA+ in groundwater observed during the 1Q 2018 are similar to the previous semi-annual sampling event (3Q 2017), particularly in HGUs 1, 3, 4, and 5. Slight decreases in total TCA+ concentrations were detected in a well located adjacent to Building 123 in IA-7 (MW-128) in the overburden (Figure 24), and an increase in TCA+ was detected in an IA-10 well (187RI-MW2) located within the former Building 70 footprint in HGU 2 (Figure 26).

7.2.3 Benzene, Chlorobenzene, and Other VOCs Groundwater Results – 3Q 2017 and 1Q 2018

3Q 2017

Figures 30 through 35 summarize the 3Q 2017 groundwater analytical results in the overburden and HGUs 1 through 5 for benzene, chlorobenzene, and other VOCs present at concentrations exceeding their respective GWQSs; benzene and chlorobenzene exceedances are contoured, and other exceedances are noted in data boxes. As contoured on these maps, benzene and/or chlorobenzene exceedances occur in the overburden and HGUs 2, 3, 4, and 5. There are no exceedances of either benzene or chlorobenzene in HGU 1. Benzene was detected at low concentrations in several localized areas in IA-2, IA-6, IA-1, IA-4, IA-10, IA-12, IA-7, IA-11, and IA-9. A large benzene plume emanates from the Sunoco site, an area upgradient of IA-12 (north of Route 3) in HGU 2. The effectiveness of the IRMs targeting benzene in IA-2 and IA-6 will be documented in IRM Progress Reports that will be submitted to the NJDEP in early 2019.

Prior to implementation of groundwater IRM programs, benzene concentrations in the former IA-2 Tank Farm and immediately downgradient northern IA-6 area exceeded 113,000 μg/L. In 3Q 2017, the highest benzene concentrations in groundwater persisted in the IA-2 and IA-6 areas within the overburden (MW-341A = 77 μg/L) and HGU 3 (ART-MW-6BR = 220 μg/L). HGU 3 monitoring well MW-244B showed a decrease in benzene concentration to 27 μg/L during the 3Q 2017 sampling program (Figure 33) when compared to pre-IRM sample data exceeding 10,000 μg/L (MW-244B = 24,000 μg/L in September 2014).

Prior to implementation of groundwater IRM programs, chlorobenzene concentrations in IA-6 exceeded 12,000 μg/L. In 3Q 2017, chlorobenzene was detected in IA-6 groundwater at concentrations above the GWQS in overburden well MW-346A (61 μg/L) and HGU 2 well IW-110 (380 μg/L) - Figures 30 and 32, respectively. Chlorobenzene was not detected at a concentration above the GWQS in any other well in IA-6.

Other VOCs (listed in the COC table of Section 5.0) were detected in groundwater at concentrations exceeding their respective GWQSs in one or more HGUs during the 3Q 2017 sampling event. These VOC exceedances are localized and limited to specific Site areas within a particular HGU. In the overburden (Figure 30 data boxes), the exceedances were restricted to areas adjacent to the CAMS in IA-12 (MW-60G and MW-60R; bromodichloromethane, dibromochloromethane, and bromoform) and in Windsor Place (MW-472S; carbon tetrachloride). In HGU 1 (Figure 31 data boxes), carbon tetrachloride was detected at concentrations exceeding its GWQS in five wells in the Nutley Windsor Sewer area (MW-472A, MW-474A, MW-487S, MW-487A, and MW-488A), and 1,2-DCA was detected at a concentration above the GWQS in off-Site multiport DW-70. In HGU 2, several wells near the CAMS in IA-12 showed exceedances of the GWQS for bromodichloromethane, bromoform, carbon tetrachloride, chloroform, dibromochloromethane, 1,2-DCA, MTBE, and/or TICs; a few wells contained MEK and MC exceedances in IA-7 and IA-4, respectively (Figure 32). While HGU 3 and HGU 5 wells exceeded for similar VOCs in IA-1, IA-4, and CAMS IA-3, respectively, the number of exceeding wells is significantly lower – see data box portion Figures 33 and 35. There were no exceedances of other VOCs in HGU 4 (Figure 34 data boxes).

1Q 2018

Figures 36 through 41 summarize analytical results from the 1Q 2018 sampling event for the overburden and HGUs 1 through 5. Overall, the distribution and concentrations of benzene and chlorobenzene in groundwater observed during the 1Q 2018 are similar to the previous semi-annual sampling event (3Q 2017), with some improvement. In IA-6, only one well, HGU 3 well MW-350B, had chlorobenzene above the GWQS in 1Q 2018, at a concentration of 58 μg/L. In 3Q2017, benzene was detected at concentrations slightly above the GWQS in HGU 2 well MW-494A (IA-7), HGU 3 well MW-393B (IA-1), and HGU 5 well DW-44B (IA-6); benzene concentrations decreased to values below the GWQS in these wells in 1Q 2018. Benzene concentrations decreased from 220 μg/L (3Q 2017) in ART-MW-6BR (HGU3 well in IA-2) to 55 μg/L in 1Q 2018. There were no exceedances of the respective GWQSs for benzene and chlorobenzene in HGU 1. There were no detections of chlorobenzene at concentrations above the GWQS in the overburden, HGU 4, and HGU 5. Benzene concentrations increased slightly in a few wells in HGU 2 (187RI-MW2, MW-394B) and HGU 3 (MW-394C). A more significant increase in benzene concentrations was observed from 3Q 2017 to 1Q2018 in HGU 3 IA-2 wells ART-MW-5BR (ND to 92 μg/L) and MW-186-2 (6.6 μg/L to 180 μg/L).

7.2.4 Dioxane Groundwater Results – 3Q 2017 and 1Q 2018

As described in the CSM Report, there is a dioxane plume of on-Site origin, emanating from a release area in IA-1 and IA-4. At least two off-Site plumes, the Western and Briad Plumes, also contain dioxane and contribute to dioxane occurrences in IA-10 and off-Site areas.

An on-Site source of dioxane was identified near the IA-1/IA-4 boundary, between former Buildings 56 and 44. An IRM for dioxane was initiated in July 2016 and operated until January 2019, and has significantly reduced dioxane concentrations in HGUs 2 and 3 in the source area. The performance of the IRM system targeting dioxane in IA-1/IA-4 will be described in detail in an IRM Progress Report that will be submitted in early 2019.

3Q 2017

As shown on Figure 42 through 47, the dioxane exceedances occur in the western portion of the Site. Figures 43 through 47 depict a background dioxane plume migrating toward the Site in HGUs 1 through 5. Background dioxane levels could not be accurately assessed using data from wells on the Briad property. Until recently, samples from the Briad wells were not analyzed with a method that could detect concentrations below 75 μg/L, and therefore many dioxane results are reported as non-detects due to the elevated laboratory MDLs. As shown on Figure 31, dioxane was detected at 110 μg/L in a Briad multiport (Br-MW-12-1) in early 2016.

The 3Q 2017 analytical data indicates that elevated dioxane concentrations (> 100 μg/L and < 1,000 μg/L) persist in IA-1 in an area between former Buildings 69 and 45 in HGU 2 (Figure 44), HGU 3 (Figure 45), HGU 4 (Figure 46), and HGU 5 (Figure 47). The highest dioxane concentrations detected in 3Q 2017 were observed in HGU 3 wells MW-392B with 670 µg/L and MW-393B with 540 µg/L. In HGU 2, there are additional dioxane exceedances in IA-6 (former Building 12) and in IA-10 (east of Windsor Place). While the dioxane contamination is of higher concentration in HGUs 2 and 3, the plume is more expansive and commingled in HGUs 4 and 5, extending into off-Site areas downgradient of Nichols Park.

As reported in the December 2015 GWPR, pre-IRM dioxane concentrations in the above-mentioned IA-1 wells were significantly higher. At that time, HGU 3 wells MW-392B and MW-393B displayed the highest on-Site dioxane concentrations with 3,550 µg/L and 1,300 µg/L, respectively. As a result of the IRM, dioxane concentrations in MW-393A and MW-256B dropped 1 order of magnitude, from more than 1,000 µg/L to current levels in the 100s µg/L.

The off-Site margins of the commingled dioxane plume are similar in extent to what was reported in previous progress reports (TRC, 2017a), and dioxane concentrations at the outer edges of the plumes are similar to those detected earlier, indicating the commingled dioxane plume is stable and not growing or increasing in concentration.

1Q 2018

Figures 48 through 53 present the dioxane analytical results from the 1Q 2018 sampling event for the overburden and HGUs 1 through 5. As shown on these maps, the overall extent and distribution of dioxane contamination across the Site did not significantly change between the 3Q 2017 and the 1Q 2018 sampling events, with the plumes in each HGU remaining stable. Decreases in dioxane concentrations were observed in the IA-1/IA-4 IRM treatment area for wells in HGU 2 and HGU 3. In HGU 2 (Figure 50), wells in the 100 to 1,000 µg/L plume area showed lower dioxane concentrations in wells MW387A (130 to 69 µg/L), MW-370A (300 to 79 µg/L), and MW-357A (210 to 1.90 µg/L). Dioxane concentrations also dropped in the IA-1/IA-4 treatment area for the following wells in HGU 3 (Figure 51): MW-388B (from 230 to 5.60 µg/L), MW-357-S2 (from 150 to 0.56 µg/L), MW-357-S3 (from 11 to 1.9 µg/L), and MW-371B (from 43 to 26 µg/L), and HGU 4 (Figure 52) MW-392C (200 to 48 µg/L). No significant changes in dioxane concentrations at individual wells were observed in the overburden, HGU 1, and HGU 5 (Figures 48, 49, and 53, respectively).

7.3 Supplemental Background Investigation at Allwood Road

As described in Section 6.2.3, in September and October 2017, a deep borehole investigation was conducted on a portion of Allwood Road (between the railroad tracks and Book Court) to correlate the off-Site stratigraphy to on-Site HGU boundaries and to obtain screening hydraulic head and groundwater quality data in areas upgradient of the Site (immediately north of the Briad property).

As shown on Figure 54, geologic data from the drilled boreholes (DW-73, DW-74, and DW-75) and multiport DW-70 (located approximately 350 feet west of DW-73) were used to define the established HGU boundaries along Allwood Road. HGUs 1, 2, and 3 were found to be of similar thicknesses in the three borings on Allwood Road as had been observed in the wells to the south on the Site. Similarly, the orientation of the strike and dip of the HGU boundaries and of the Marker Bed were found to be consistent with strike and dip of HGU boundaries and the Marker Bed in the wells to the south on the Site[8]. As shown on Figure 54, the bottom of HGU 1 is very shallow (10 to 40 feet bgs) and observed only in boreholes DW-73 and DW-74 (it is also found in multiport well DW-70 further west). HGU 2 appears to subcrop at borehole DW-75, and HGUs 3 through 5 extend further to the east.

Packer tests conducted during this investigation were limited to depths ranging between 20 and 190 feet bgs, primarily within HGUs 2 and 3. Groundwater quality data collected at DW-73, DW-74 and DW-75 identified low-level VOCs and/or dioxane concentrations, including the detection of the following compounds at concentrations above their respective GWQSs: PCE (1.1 to 3.6 μg/L), TCE (1.1 to 4.4 μg/L), 1,1-DCE (3.0 to 26.6 μg/L), 1,4-dichlorobenzene (1,4-DCB) (77.4 and 109 μg/L), and dioxane (0.98 to 3.64 μg/L), with the highest contaminant concentrations observed in DW-73. Contaminant concentrations were slightly lower in DW-74, and no exceedances were detected in borehole DW-75. Groundwater level measurements collected during packer test activities are provided in Appendix D. As detailed in the provided tables (Appendix D), the hydraulic head data indicate that a downward hydraulic gradient exists along Allwood Road, consistent with those observed in the northern portion of the Site. According to the results of the transmissivity and specific capacity calculations presented in Appendix D, the aquifer has higher transmissivity and specific capacity in HGU 3, as high as 1,245 gallons per day/foot (gpd/ft) and 1.47 gpm/ft (gallons per minute/foot), respectively, which are higher than those calculated for HGU 2.

[8] The Marker Bed is a laterally extensive sand layer that was a key element used for stratigraphic correlation, as described in the CSM Report (TRC and B. Kueper & Associates, Ltd., 2018).

8.0 SCHEDULE OF ACTIVE, COMPLETED, AND FUTURE GROUNDWATER MONITORING AND REMEDIAL ACTION ACTIVITIES

The active remedies implemented as IRMs described above have terminated. Individual IRM progress reports will be submitted to the NJDEP in early 2019 documenting the remediation accomplished in each on-Site source area. A Groundwater Remedial Action Work Plan (RAWP) will be submitted in February 2019 that will present a plan for remediation of the remaining exceedances in each IRM area.

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