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November 15, 2017

New Jersey Department of Environmental Protection
Bureau of Case Management
Mail Code 401-05F
P.O. Box 420
Trenton, NJ 08625-0420

Attn: Donna Gaffigan, Case Manager

Re: *Site-Wide Groundwater Progress Report*
Former 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 November 15, 2017. This report presents the results of semi-annual groundwater monitoring events (September 2016 and March 2017), and other groundwater characterization activities conducted in and upgradient of the northern Site perimeter (multiport wells) and in the IA-10/Windsor Place area. An evaluation of the Site's groundwater flow regime and contaminant distribution over time was conducted in support of future remedial programs.

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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Daniel Nachman
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Cc: Chandra Patel, Roche

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Site-Wide Groundwater

Progress Report

For the

Former Hoffmann-La Roche Inc. Facility

Nutley, New Jersey

Prepared For:

Hoffmann-La Roche Inc.
800 Bloomfield Avenue, Suite 127
Nutley, NJ 07110-1199
PI ID #'s 009949, 614465, and 625447

Prepared By:

TRC Environmental Corporation
41 Spring Street, Suite 102
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November 15, 2017

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1.0 INTRODUCTION

On behalf of Hoffmann-La Roche Inc. (Roche), TRC Environmental Corporation (TRC) has prepared this Site-Wide Groundwater Progress Report (GWPR) to summarize supplemental groundwater characterization activities conducted at 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 2016 through July 2017[1]) includes results from Site-wide semi-annual groundwater sampling events, and from targeted programs completed in selected areas, to assess groundwater contaminant concentration trends over time and further characterize groundwater contaminant conditions. This is the fourth 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 and the GWPRs submitted in January 2015, December 2015, and January 2017. The focus of this GWPR is to monitor and document groundwater quality and contaminant concentration trends along the Site perimeter and in select interior areas of the Site during the implementation phase of various interim remedial measure (IRM) programs.

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, monitoring wells located within the plume fringe and in the vicinity of active IRM systems were sampled in September 2016[2] and March 2017 to monitor plume behavior during the IRM implementation phase. This report also includes findings from investigations completed in Investigative Area (IA) 10 (IA-10) and an adjacent section of Windsor Place (an off-Site public road), and multiport well installations in IA-12 and in areas upgradient of the Site (i.e., north of Route 3).[3]

The monitoring and remedial wells installed during this reporting period helped to further refine the understanding of contaminant distribution within the aquifer system and support ongoing IRM activities. The data collected during the groundwater monitoring programs described herein may be used to assist future remedial decisions and will be used to support the development of a revised Conceptual Site Model (CSM), detailed in a separate document. This GWPR report provides data collected from August 2016 through July 2017; conclusions derived from these (and previous) data will be presented in the CSM.

[1] An SVOC re-sampling event conducted in July 2017 will be reported under separate deliverables.

[2] The groundwater sampling event referred herein as "September 2016" was completed between October 3 and 19, 2016.

[3] The most recent IRM performance monitoring data (for IAs 2, 6, 3/7, 11, and 12) are included with this report to fill in data gaps and provide the most comprehensive depiction of current groundwater conditions. A discussion of the IRM activities and evaluation of the IRM performance monitoring results will be submitted to the NJDEP in a separate deliverable.

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 (2005), and the *Site-Wide Groundwater Sampling Plan – Interim Remedial Measures (IRM) Implementation Period Rev. 1* (July 2015), and subsequent modifications.

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 provides a technical overview (scope/methods) of the completed supplemental groundwater programs;

- Section 4.0 provides a list of groundwater Contaminants of Concern (COCs) identified at the Site to date, and discusses a pending update to the Site-wide Groundwater Classification Exception Area (CEA);

- Section 5.0 provides supplemental investigation findings for IA-specific investigations and Site-wide groundwater monitoring programs, and provides a time-series evaluation of groundwater elevations and water quality;

- Section 6.0 provides a schedule of future activities; and,

- Section 7.0 provides a list of references.

2.0 SITE BACKGROUND

A comprehensive Site background (including Site description and history, physical setting, and historic regulatory compliance and deliverables) has been provided with the April 2014 Site-Wide GWRIR and subsequent GWPRs dated January 2015, December 2015, August 2016, and January 2017. Refer to the January 2017 GWPR for the most updated Site background information.

3.0 TECHNICAL OVERVIEW

This section provides a technical overview of the supplemental groundwater characterization activities completed at the Site between August 2016 and July 2017, specifically 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 5.0.

3.1 Remediation Standards and Criteria

Any chemical compound detected in groundwater with a concentration that exceeds the New Jersey Ground Water Quality Standards for Class IIA Aquifers [GWQS] (N.J.A.C. 7:9C) is defined as a groundwater constituent of concern (COC, or contaminant). In November 2015, the NJDEP revised the Interim Ground Water Quality Criterion (IGWQC) for 1,4-dioxane, reducing the IGWQC 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 1,4-dioxane, which allowed for the detection of this compound at or below the established 0.4 µg/L IGWQC.

3.2 Groundwater Sampling Programs

Between August 2016 and July 2017, multiple 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 (September 2016 and March 2017), supplemental remedial investigations at IA-10/Windsor Place, and multiport well installations in IA-12 and north of Route 3.

3.2.1 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 – July 13, 2015,* submitted in November 2016. The revised groundwater sampling plan modified the sampling frequency from a quarterly to a semi-annual basis and increased the list of

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

monitoring wells sampled from approximately 168 perimeter and select interior wells to 179 wells in September 2016 and 227 wells in March 2017. Groundwater sampling events will be completed in March and September of each calendar year until a future groundwater monitoring program is defined in the anticipated Site-Wide Remedial Action Workplan (RAW) for Groundwater. 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 vertical investigation zones and the total number of on- and off-Site monitoring wells associated with them. Monitoring well construction and other documentation is included in Appendix A. Refer to Figure 2 for the location of on- and off-Site monitoring wells.

3.2.1.1 Semi-Annual Fluid-Level Measurements

September 2016 and March 2017

On September 28, 2016 and February 28, 2017, synoptic water-level measurements were collected from all accessible on-Site and off-Site wells. The synoptic water-level measurements were collected from over 900 Roche-owned wells located in on-Site and off-Site areas. 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.

The water-level measurements were used to generate groundwater contour maps (Figures 3 and 4). NJDEP contour map reporting forms are included in Appendix B. A discussion on the Site's groundwater flow regime is provided in Section 5.2.

3.2.1.2 Semi-Annual Groundwater Sampling

All sampling for both semi-annual sampling events were completed in accordance with the Roche Quality Assurance Project Plan (QAPP), the NJDEP Field Sampling Procedures Manual (August 2005), and the groundwater sampling standard operating procedures (SOPs). The groundwater sampling results for the semi-annual sampling events are discussed in Section 5.3.1. The Passive Diffusion Bag (PDB) and Rigid Porous Polyethylene Sampler (RPPS) sampling forms are provided in Appendix C.

September 2016 Sampling Event

On September 14, 2016, Groundwater & Environmental Services, Inc. (GES) initiated the deployment of PDB and RPPS in 179 on- and off-Site monitoring wells. The PDB and RPPS samplers were filled with laboratory-grade deionized water and deployed within the wells every 5 feet of saturated well screen or open borehole (for newly-installed monitoring wells) or at the 5-foot depth interval displaying the highest volatile organic compound (VOC) concentrations (for previously sampled monitoring wells). The PDBs and RPPSs were allowed to stay in the well (and equilibrate) for at least 14 days prior to removal and sample collection. Between October 3 and 19, 2016, 192 groundwater samples (including eight duplicates) were collected from the PDBs and RPPSs and submitted to TestAmerica of Edison, New Jersey (TestAmerica) for the analysis of VOCs (SW-846 Method 8260C) and 1,4-dioxane (SW-846 Method 8270C with selective ion monitoring [SIM]). A summary list of groundwater samples collected during the semi-annual monitoring program is provided in Table 1-1.

March 2017 Sampling Event

Between February 20, 2017 and March 9, 2017, GES installed PDBs and RPPSs in 227 on- and off-Site monitoring wells. The PDB and RPPS samplers were filled with laboratory-grade deionized water and deployed within the wells every 5 feet of saturated well screen or open borehole (for newly-installed monitoring wells), or at the 5-foot depth interval displaying the highest VOC concentrations (for previously sampled monitoring wells). The PDBs and RPPSs were allowed to stay in the well (and equilibrate) for at least 14 days prior to removal and sample collection. Between March 8, 2017 and April 3, 2017, 245 groundwater samples (including 14 duplicates) were collected from the PDBs and RPPSs and submitted to TestAmerica for the analysis of VOCs (SW-846 Method 8260C) and 1,4-dioxane (SW-846 Method 8270C with SIM). Samples collected from 48 (out of 225) monitoring wells were analyzed outside of the required holding times for VOCs and 1,4-dioxane. Re-sampling of these wells was conducted between March 29, 2017 and April 4, 2017 using the same passive sampling methods. A sample summary list of groundwater samples collected during the semi-annual monitoring program is provided in Table 1-1. See Table 1-1A for a list of the "out-of-hold" samples.[5] Groundwater samples were also collected from one on-Site and three off-Site multiport wells during the March 2017 sampling effort. Refer to Section 3.2.2 for a summary of completed multiport well field activities.

[5] The groundwater dataset submitted with this report does not include the out-of-hold groundwater sample results (i.e., not included in the EDDs, summary tables and figures).

3.2.2 Multiport Wells Installation and Sampling (Off-Site and On-Site)

Groundwater contaminant contribution from off-Site upgradient sources (north of Route 3) has been documented by Roche in previous groundwater reports. These off-Site contaminant plumes, in particular the chlorinated volatile organic compounds (CVOC)[6] and 1,4-dioxane plumes, appear to migrate toward the Site from the north along the Clifton-Allwood Municipal Sewer (CAMS), from the northeast ("eastern plume"), and from the northwest proximal to the Norfolk-Southern Conrail railway tracks.[7] To further investigate off-Site source areas north of Route 3, Roche installed four multiport wells (three off-Site and one on-Site at the northern boundary of the property in IA-12) screening groundwater zones between 26 and 376 feet below ground surface (bgs). After evaluation of available multiport technologies, the Westbay multi-level monitoring system was selected to profile the vertical distribution of dissolved-phase contaminants and to provide discrete hydraulic head profiles (from multiple zones) at each of the four multiport well locations. Multiport well construction diagrams are provided in Appendix D. The sections below detail the activities completed during this program which included multiport installation, transmissivity and geophysical profiling, gauging, and sampling.

3.2.2.1 <u>Subsurface Utility Clearance</u>

Prior to drilling activities, the selected multiport well 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.

3.2.2.2 <u>Bedrock Borehole Advancement</u>

Between August and December 2016, four bedrock boreholes (on-Site well location DW-65 and off-Site well locations DW-69, DW-70, and DW-72) were advanced via air rotary methods by HRS Drilling of Netcong, New Jersey (HRS) to depths ranging from 350 to 376 feet bgs. The on-Site location DW-65 was advanced to investigate the quality of groundwater entering the Site from the northwest. Off-Site locations DW-69, DW-70, and DW-72, were advanced to investigate groundwater quality upgradient (i.e., to the north-northeast and northwest) of the Site. The locations of these boreholes are shown on Figure 2. At each location, an initial borehole

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[6] CVOCs are a large family of chemical compounds widely used in industrial and commercial products for their effective degreasing properties. CVOCs are the most prevalent groundwater contaminants at the Site, particularly tetrachloroethene (PCE), trichloroethene (TCE) and their degradation products (cis-1,2-dichloroethene [cis-1,2-DCE] and vinyl chloride [VC]). To a lesser extent 1,1,1-trichloroethane (1,1,1,-TCA), and its breakdown products 1,1-dichloroethene (1,1-DCE), and 1,1-dichloroethane (1,1-DCA) have also been detected.

[7] An additional off-Site source(s) of groundwater contamination (1,1,1-TCA and breakdown products, methyl tertiary butyl ether [MTBE], and 1,4-dioxane) has been identified in an area upgradient (north) of western IA-12 and IA-10.

was advanced at least 10 feet into competent bedrock, and an outer steel casing was installed (i.e., grouted into bedrock) to isolate the bedrock borehole from the overlying soil. After the grout cured, a bedrock borehole was drilled deeper (inside the grouted steel casings) to the targeted bedrock depth at each location.

During borehole advancement activities, drill cuttings were logged by a TRC geologist to document major lithologic changes, water-bearing fractures, and drilling properties of the rock. Following borehole advancement, each open bedrock borehole was developed to remove drill cuttings, and temporarily sealed with a blank FLUTe™ to prevent vertical groundwater movement prior to well construction. Monitoring well logs and well documentation are provided in Appendix A.

3.2.2.3 FLUTe™ Transmissivity Profiling

As discussed above, following borehole advancement and development activities, FLUTe™ field technicians installed a blank FLUTe™ borehole liner into each borehole. During liner installation (i.e., eversion, the technical term for the opposite process of inversion), the advancing liner displaces the groundwater present in the borehole into transmissive features present in the surrounding formation (i.e., permeable fractures). Using a FLUTe™ proprietary process, FLUTe™ field technicians actively monitored and recorded the liner eversion velocity, the hydraulic head within the advancing liner, and the vertical position of the advancing face of the everting liner, to produce a transmissivity profile depicting the vertical location and estimated transmissivity of transmissive features intersected by the borehole during its advancement. Following field activities, FLUTe™ provided these data in spreadsheet format to TRC, for TRC's evaluation during well design (as described below).

3.2.2.4 Borehole Geophysical Logging

Following borehole advancement, each borehole was logged using downhole geophysical equipment. Geophysical logging of these boreholes was completed by ARM Geophysics of Hershey, Pennsylvania (ARM), and 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, to support well design (as described below). ARM's summary reports are provided in Appendix E.

3.2.2.5 Westbay Multiport Well Design, Construction, Development, and Survey

Well log observations, FLUTe™ transmissivity profiling data, and borehole geophysical survey data were evaluated to identify and select zones to be isolated for potentiometric head monitoring, and for sampling to monitor groundwater quality. Following the identification of these zones of interest, well design for each borehole was finalized with technical assistance from Westbay. Each well location was constructed as a Westbay multiport well by Earth Data Northeast of Exton, Pennsylvania (EDN) (Westbay's regional distributor), under TRC and New Jersey-licensed driller oversight. Each well was constructed of polyvinyl chloride (PVC), consisted of sampling ports (for groundwater sample collection and potentiometric head measurements), purging ports (where possible, based on space constraints), riser piping, and hydraulic packers (to isolate each zone from the surrounding borehole). Each multiport well was constructed with 19 to 24 discrete sampling ports. The four Westbay multiport wells were completed with water-tight protective, flush-mounted steel covers. Well construction details are summarized in Table 2. EDN's summary well construction reports are provided in Appendix D.

Multiport Well Installation Program = Four Multiport Wells			
IA-12	DW-65	(0) Zone S1 Ports	N/A
		(4) Zone S2 Ports	DW-65-60-S2, DW-65-66-S2, DW-65-73-S2, and DW-65-84-S2.
		(6) Zone S3 Ports	DW-65-91-S3, DW-65-96-S3, DW-65-105-S3, DW-65-119-S3, DW-65-126-S3, and DW-65-136-S3.
		(8) Zone D1 Ports	DW-65-145-D1, DW-65-154-D1, DW-65-167-D1, DW-65-176-D1, DW-65-185-D1, DW-65-199-D1, DW-65-211-D1, and DW-65-221-D1.
		(6) Zone D2 Ports	DW-65-239-D2, DW-65-249-D2, DW-65-262-D2, DW-65-302-D2, DW-65-331-D2, and DW-65-350-D2.
Off-Site (Allwood Rd.)	DW-69	(0) Zone S1 Ports	N/A
		(2) Zone S2 Ports	DW-69-70-S2 and DW-69-86-S2.
		(4) Zone S3 Ports	DW-69-104-S3, DW-69-114-S3, DW-69-134-S3, and DW-69-142-S3.
		(8) Zone D1 Ports	DW-69-150-D1, DW-69-160-D1, DW-69-171-D1, DW-69-186-D1, DW-69-195-D1, DW-69-213-D1, DW-69-224-D1, and DW-69-234-D1.
		(6) Zone D2 Ports	DW-69-246-D2, DW-69-260-D2, DW-69-270-D2, DW-69-283-D2, DW-69-303-D2, and DW-69-375-D2.

Multiport Well Installation Program = Four Multiport Wells			
Off-Site (Allwood Rd	DW-70	(0) Zone S1 Ports	N/A
		(1) Zone S2 Ports	DW-70-53-S2.
		(4) Zone S3 Ports	DW-70-72-S3, DW-70-83-S3, DW-70-94-S3, and DW-70-114-S3.
		(9) Zone D1 Ports	DW-70-123-D1, DW-70-131-D1, DW-70-140-D1, DW-70-150-D1, DW-70-160-D1, DW-70-174-D1, DW-70-189-D1, DW-70-205-D1, and DW-70-219-D1.
		(5) Zone D2 Ports	DW-70-231-D2, DW-70-241-D2, DW-70-261-D2, DW-70-285-D2, and DW-70-350-D2.
Off-Site (Allwood Rd)	DW-72	(1) Zone S1 Ports	DW-72-63-S1.
		(2) Zone S2 Ports	DW-72-84-S2 and DW-72-99-S2.
		(4) Zone S3 Ports	DW-72-113-S3, DW-72-120-S3, DW-72-136-S3, and DW-72-146-S3.
		(7) Zone D1 Ports	DW-72-167-D1, DW-72-176-D1, DW-72-202-D1, DW-72-217-D1, DW-72-224-D1, DW-72-237-D1, and DW-72-246-D1.
		(7) Zone D2 Ports	DW-72-263-D2, DW-72-276-D2, DW-72-288-D2, DW-72-299-D2, DW-72-316-D2, DW-72-330-D2, and DW-72-375-D2.

Following installation, each zone equipped with a purge port was developed by EDN using a submersible pump until a turbid-free discharge was achieved. The elevation and horizontal locations of the monitoring wells were surveyed by a Roche-contracted, New Jersey-licensed land surveyor. Monitoring well documentation forms are provided in Appendix A.

3.2.2.6 Westbay Multiport Well Gauging and Sampling

Groundwater gauging and/or sampling were completed at the newly-installed Westbay multiport wells in December 2016 (DW-65 only), and in February, March, April, and May 2017 (DW-65, DW-69, DW-70, and DW-72). Groundwater gauging 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. Resulting depth to water and groundwater elevation measurements are summarized in Table 4-2, and the formulae used to calculate these values from the measured hydrostatic pressures are presented in Appendix D.

Groundwater sampling was completed 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 in the canister, the canister and sample port are closed, the cylinder is retrieved from the multiport well, and the collected groundwater is transferred to laboratory glassware for off-Site laboratory analysis. Groundwater samples were submitted to SGS Accutest (formerly Accutest)[8] for the analysis of VOCs (SW-846 Method 8260C) and 1,4-dioxane (SW-846 Method 8260C with SIM). A sample summary list of groundwater samples collected at on- and off-Site multiport wells is provided in Table 1-2.

3.2.3 IA-10 / Windsor Place Zone S2 Investigation

Investigations of soil and groundwater have been completed in the southern portion of IA-10 and an adjacent section of Windsor Place (off-Site) to locate the source of elevated trichloroethene (TCE) contamination in shallow groundwater. In November 2016, TRC sampled MW-479B (for VOCs) along with five upgradient Zone S1 wells to further assess the elevated TCE concentrations in area. 1,4-Dioxane analyses was not conducted.

Between January and July 2017, supplemental investigations were completed in the IA-10/Windsor Place area to further characterize groundwater and evaluate potential sources of the TCE exceedances detected in on-Site well MW-479B. These field programs included the installation of Zone S1 and Zone S2 monitoring wells in Windsor Place and IA-10 (former B110), as well as one comprehensive groundwater sampling program of 37 shallow monitoring wells (Zone S1, S2, and S3) completed in January 2017 (VOCs and 1,4-dioxane), and two small-scale sampling events of 6 shallow wells (Zone S1 and S2) completed in June and July 2017 (VOCs).

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[8] Accutest (headquartered in Dayton, New Jersey) was acquired by SGS Laboratories in January 2016. Presently, SGS Accutest is contracted to analyze Site samples for select limited-scope programs.

3.2.3.1 Monitoring Well Installation and Initial Sampling

On January 4 and 5, 2017, four Zone S2 monitoring wells were installed upgradient of MW-479B to further investigate the extent of dissolved TCE contamination in the area. Three monitoring wells (MW-474B, MW-487B, and MW-488B) were installed off-Site in Windsor Place and one well (MW-501B) was installed on-Site in IA-10, upgradient (west) of Windsor Place. The drilling of these wells was completed in two stages. During the first stage, a 6-inch borehole was advanced via water rotary to competent bedrock (approximately 30 feet bgs), and left as an open-hole for field screening grab sampling. Grab samples were collected from the 30-foot open-hole to determine if the borehole should be further advanced to screen a deeper depth interval. During the second stage, all four Zone S2 wells were advanced to 40 feet bgs (based on screening grab data) and installed as flush-mounts with 6-inch steel outer casing and 2-inch inner PVC casing with 10 feet of 0.010 slot PVC screen.

On January 13, 2017, the newly-installed monitoring wells (MW-474B, MW-487B, MW-488B, and MW-501B) were developed and sampled via the low-flow method at 5-foot intervals along the screen to characterize groundwater conditions within the screened interval and establish the sampling depth for future monitoring events. The samples were submitted to SGS Accutest and analyzed for VOCs (including 1,4-dioxane). A comprehensive sampling of these and other monitoring wells in the area was conducted two weeks after well development (see Section 3.2.3.3).

Between June 5 and 6, 2017, two Zone S1 monitoring wells (MW-479S and MW-479A) were installed in IA-10, adjacent to MW-479B, to determine if the elevated TCE levels in Zone S2 originate from a shallow on-Site source. The shallow wells were completed in the overburden/weathered bedrock interface or shallow bedrock at 10 feet bgs (MW-479S) and 20 feet bgs (MW-479A). Immediately after the well installation and development, grab samples were collected via bailer and submitted to SGS Accutest for VOC analysis. Additional sampling was conducted at two weeks and four weeks post-development (see Section 3.2.3.3). The table below lists the monitoring wells installed in IA-10 and Windsor Place during the current reporting period.

IA-10 / Windsor Place = 6 Monitoring Wells		
IA-10	(2) Zone S1	MW-479S and MW-479A
	(1) Zone S2	MW-501B
Off-Site - *Windsor Place*	(3) Zone S2	MW-474B, MW-487B, and MW-488B

Refer to Table 2 for additional well construction details. A summary of all Site-wide monitoring wells installed by Roche is presented in Table 3. Groundwater sampling measurements and calculations are provided in Appendix C. Monitoring well documentation (including well logs, permits, records, NJDEP Forms A & B, etc.) is included in Appendix A.

3.2.3.2 Fluid Level Measurements

On January 23, 2017, synoptic water-level measurements were collected from 71 on-Site and off-Site wells located in the southern portion of IA-10 and Windsor Place. Groundwater elevation data from the Zone S1, S2, and S3 wells were collected to refine the groundwater flow conditions after the installation of supplemental Zone S2 wells in the IA-10/Windsor Place area.

Prior to initial water-level measurements, the integrity of each well was inspected, and a 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 the potential for the presence of LNAPL/DNAPL in each well. All pertinent observations and data were recorded on field sampling forms and in a field logbook. The water-level measurements were used to generate groundwater contour maps (Figures 5, 6, and 7). A summary of the gauging data collected for these wells is provided in Table 4-3. NJDEP contour map reporting forms are included in Appendix B. Refer to Section 5.2.3 for a brief discussion of groundwater gauging results.

3.2.3.3 Groundwater Sampling

Between January 24 and 27, 2017, TRC collected 43 groundwater samples using the low-flow sampling method from 37 wells (Zones S1, S2, and S3) in southern IA-10 and off-Site along Windsor Place. On June 20, 2017 and July 7, 2017, small-scale groundwater sampling programs were conducted on the two newly-installed Zone S1 monitoring wells located in IA-10 (MW-479S and MW-479A) and four other Zone S2 wells located on-Site (MW-479B) and off-Site (MW-747B, MW-487B, and MW-488B).

The samples were submitted to SGS Accutest for analysis of VOCs (SW-846 Method 8260C) and 1,4-dioxane (SW-846 Method 8260C with SIM). During well purging activities, water quality measurements (temperature, pH, oxidation-reduction potential [ORP], turbidity, specific conductivity, salinity and dissolved oxygen [DO]) were collected using a field-calibrated water quality meter. As per the NJDEP Field Sampling Procedures Manual, groundwater samples were collected subsequent to stabilization of the water quality parameters.

A summary list of groundwater samples collected in the IA-10/Windsor Place area is provided in Table 1-3. Groundwater sampling measurements and calculations are provided on the Field Sampling Sheets in Appendix C. Refer to Section 5.4.2 for a brief discussion of groundwater analytical results.

3.2.4 Groundwater IRM Implementation and Performance Monitoring

IRM programs were initiated at the Site in 2015 to remediate, contain, or stabilize areas of elevated groundwater contamination and prevent further spreading of contaminants in groundwater. Remaining contamination after IRM completion will be addressed via a Site-wide Groundwater RAW. A schedule of active IRM programs for selected IAs is provided in Section 6.1.

3.2.4.1 Recently Completed Remedial Action (RA) and IRM Activities

Several remediation programs (soil excavations, groundwater IRMs, etc.) have been implemented at the Site (i.e., IA-2, IA-1/IA-4, IA-3/IA-7, IA-6, IA-10, IA-11, and IA-12); some of these have resulted in significant improvement of groundwater quality conditions at the Site. A compilation of several groundwater IRM Progress Reports was submitted to the NJDEP in February 2017, providing a detailed description of IRM start up and progress in the areas described below. Additional IRM Progress Reports will be submitted in late 2017 and early 2018. The following Remedial Action (RA) and IRM activities were recently completed:

- In-Well Air Stripping (IWAS) and Ozone injection activities were initiated in the IA-1/4 IRM area in August 2015 and remain in operation to the present. Ozone injections were temporarily suspended between July 2016 and November 2016 (due to leakage in the supply lines) and reinitiated in December 2016 upon equipment repair.
- The IA-2 *in-situ* thermal treatment (ISTT) operations were completed in early 2016. The VOC plume south of the IA-2 Tank Farm, which had migrated into the northern portion of IA-6, was successfully remediated with an IWAS system (99.9% VOC reduction); consequently, the IA-2 IWAS wells (located in the southern portion of the IA-2 Tank Farm and northern area of IA-6) were idled in December 2016. Groundwater monitoring is currently ongoing. In December 2016, an area of VOC-contaminated groundwater in the southeast corner of the IA-2 ISTT treatment zone (beneath the thermal treatment zone) was further treated via the installation and operation of two IWAS wells; operation of those wells is ongoing.
- IWAS and Enhanced *In-Situ* Bioremediation (EISB) amendment injection equipment was installed in the IA-3/7 IRM area between December 2016 and March 2017. Operation of the IA-3/7 IRM treatment systems and the initial round of EISB amendment injection

commenced in April 2017, and a second round was completed in July 2017. Additional injections will be performed if needed, and monitoring is ongoing.

- In November 2016, Roche submitted a Groundwater Investigation Report for the IA-4 Area of Concern (AOC) 105 - Building 61 Pump House and Piping (No. 6 Fuel Oil Release Area) to the NJDEP. This report documented the excavation of non-aqueous phase liquid (NAPL)-impacted soils (to top of bedrock) conducted in September 2015, described the groundwater monitoring program that demonstrated oil was not migrating in groundwater from beneath the building, and proposed no further action for the IA-4 AOC 105 groundwater. The NJDEP approved that report and agreed to no further action for the IA-4 AOC 105 groundwater in June 2017.
- The IA-6 IWAS/*In-Situ* Chemical Oxidation (ISCO) IRM system began operation in April 2016 and continues to the present. Successful removal of chlorobenzene in the target treatment zone was achieved in January 2017. Remediation (IWAS) of residual chlorobenzene and CVOC concentrations continued through July 2017.
- In 2015, two IRMs consisting of one-time bioamendment injections into shallow (overburden) groundwater were completed in IA-10 near former Building 70 and Building 104. Post-IRM groundwater monitoring was completed.
- Roche completed the excavation of tetrachloroethene (PCE)-contaminated weathered bedrock from beneath the abandoned CAMS manhole in IA-11 to a depth of 26 feet bgs between January and March 2017 and backfilled the excavation with gravel containing bioamendment to encourage reductive dechlorination of residual CVOCs in local groundwater. Groundwater monitoring demonstrated that the source zone has been successfully remediated.
- The IA-12 IWAS/ISCO system targeting the CVOC plume where breaches in the CAMS were found began operation in late June 2016 and is ongoing.

3.2.4.2 Supplemental Wells in Support of IRM Design and Implementation

By June 2016, more than 650 remedial wells (biosparge, extraction, injection, IWAS, recovery, soil vapor extraction [SVE], vapor points, etc.) were installed by Roche to support the operation of the IRM systems.

Between July 2016 and February 2017, an additional 29 monitoring and remedial wells (including injection and vapor points) were installed at on- and off-Site locations as part of recent pilot studies or IRM programs. Figure 2 provides the location of the new monitoring wells. Appendix A provides the well construction documentation for the supplemental wells installed during the reporting period.

The table below lists the wells completed at the Site during the current reporting period under the various IRM programs. Tables 2-1 and 2-2 provides a summary of well construction details. Table 3 provides a summary of the vertical investigation zones and the total number of on- and off-Site monitoring wells associated with them. Additional wells may be installed as part of ongoing or upcoming IRM or supplemental investigative programs. Future well installation activities will be documented in subsequent GWPRs.

IRM Programs = 29 Monitoring and Remedial Wells		
IA-1/4 IRM	(1) Zone S1	MW-500A
IA-2 IWAS	(2) Zone S3	ART-99, ART-100
IA-3/IA-7/CAMS IRM	(2) Zone S1	MW-139A, MW-502A
	(3) Zone S2	ART-103, ART-104, MW-502B
	(1) Zone S3	MW-503C
IA-11 West IRM	(1) Zone S1	IW-180AR
	(1) Zone S2	MW-413BR
IA-12 IWAS/ISCO	(8) Zone S1	IW-181A, IW-182A, IW-183A, IW-184A, IW-185A, IW-186A, VE-1210-1, VE-1210-2
	(10) Zone S2	ART-101, ART-102, IW-181B2, IW-181B3, IW-182B2, IW-182B3, IW-183B2, IW-183B3, IW-185B, IW-186B

3.2.4.3 Groundwater IRM Performance Monitoring Programs

IA-specific groundwater monitoring programs are being conducted prior to, during, and after completion of IRM system implementation to monitor remedial system operations and assess the effectiveness of each program. A *Compilation of Interim Remedial Measure Progress Reports* was submitted to the NJDEP on February 2, 2017. The IRM progress reports documented completed activities while summarizing and evaluating system performance data.

The most recent IRM performance groundwater data for IA-2, IA-12, IA-11, IA-6, and IA-3/IA-7 are included with this report, in that they have been incorporated into the March 2017 data maps (Table 1-4). IRM progress reports evaluating these and additional data sets will be submitted to the NJDEP in 2017.

3.2.5 Groundwater Data Quality Assessment in Support of Laboratory Switch

As of March 2017, TestAmerica became Roche’s primary laboratory, contracted to analyze the majority of groundwater samples and other Site media. Data reported during and since the recent Site RI (September 2013) had been consistently analyzed by SGS Accutest.

On June 23, 2016, a targeted groundwater sampling event was conducted at the Site to evaluate the representativeness of the Site groundwater data generated by the two different laboratories. Groundwater samples were collected from 36 monitoring wells and split between the two laboratories for the analysis of 1,4-dioxane (via method SW846 8260C-SIM) and VOCs (via method SW846 8260C). The monitoring wells selected for the evaluation have historically displayed 1,4-dioxane and VOC concentrations ranging from high (> 100 μg/L) to medium (10 to 100 μg/L) to low (non-detect to 10 μg/L), so as to be representative of groundwater plume conditions at on- and off-Site locations.

Refer to Section 5.1 and Appendix F for findings on the analytical data quality evaluation between the two laboratories (TestAmerica and SGS Accutest).

3.3 Monitoring Well Abandonment and Repair

Since the last progress report submission, Roche completed repairs and/or decommissioning of monitoring wells previously identified as damaged as a result of Site redevelopment (e.g., building demolition, changes in Site topographical grade) or remedial (i.e., soil excavations, IRM system installation) activities.

3.3.1 Monitoring Well Abandonment

In a letter dated July 29, 2016, NJDEP approved the abandonment of 19 monitoring wells that were considered to no longer be needed for ongoing IRM or long-term groundwater monitoring activities. As documented in the January 2017 GWPR, the abandonment of these wells was completed in the Fall of 2016 by a New Jersey-licensed driller under TRC supervision. Well decommissioning reports not available during submittal of the January 2017 GWPR are included with this deliverable in Appendix A. A table listing the abandoned wells along with their former general location and vertical investigation zone is provided below.

IA	Abandoned Monitoring Wells	Vertical Investigation Zone
IA-1	MW-4A, MW-256A, MW-357-SBR, MW-369A, and MW-369-SBR	Zone S1
IA-4	MW-177	Zone S1
IA-6	MW-157	Zone S1
	MW-86 and RW-51	Zone S3
IA-7	MW-125 and MW-198	Zone S1
IA-10	22RI-MW1, 53RI-MW4, 66RI-MW5, 186RI-MW3, 186RI-MW4, and MW-30	Zone S1
Off-Site	MW-5G and MW-213A	Zone S1

3.3.2 Monitoring Well Repairs

Between June and December 2016, approximately 135 monitoring wells were repaired at the Site. These wells had been noted to have damaged casings (risers), obstructions, missing or damaged manways or pads, and/or had been buried under a shallow gravel cover (< 1 foot) or significantly buried during building demolition/Site excavation/grade modification activities (> 10 feet). Monitoring well repairs that resulted in altered casings (i.e., measuring point elevation) were resurveyed by a New Jersey-licensed surveyor. Six additional wells (26RI-MW1, IW-5C, MW-139, MW-386A, MW-413B, & MW-425B) were decommissioned, generally to facilitate remedial excavation activities (IA-11) or to address damages sustained during earlier excavation/grade modification activities.

3.4 <u>Remediation-Derived Waste – IRM System Installation</u>

Between August 2016 and July 2017, Roche disposed of non-hazardous waste material generated at the Site during the implementation of recent remedial activities, specifically:

- IA-11 bedrock excavation (soil and rock),
- IA-10 Northern Portion excavation (sediments accumulated in excavation dewatering FRAC tanks),
- IRM monitoring well installations (drill cuttings), and
- IA-12 Electrical Resistance Heating (ERH) electrode abandonment effort (soil, graphite shot, wires, sand, etc.).

Waste characterization and disposal were completed in accordance with State and Federal regulations, and disposal facility permit requirements.[9] Copies of fully executed waste manifests or bills of lading will be submitted to the NJDEP with the corresponding IA-specific deliverable.

3.5 <u>Data Reliability</u>

The analytical methods used for the quarterly Site-wide groundwater sampling events are provided in the QAPP and the laboratory analytical reports. The laboratory data reports and electronic data deliverables/Electronic Data Submission (EDD/EDS) for the recent data are

[9] Waste profiling included sample analysis of Target Compound List (TCL) VOCs, Target Analyte List (TAL) metals, TCL polychlorinated biphenyls (PCBs), pesticides, and herbicides, Resource Conservation & Recovery Act (RCRA) characteristics, total petroleum hydrocarbons (TPH), full Toxicity Characteristic Leaching Procedure (TCLP), paint filter and Form U constituents.

included on compact disc in Appendix G. Table 1 presents a summary of groundwater samples collected between August 2016 and July 2017.

In September 2016, field implementation of the groundwater sampling programs were transferred from TRC to GES.[10] While Roche has subcontracted GES to conduct Site-wide and IA-specific sampling events, TRC continues to develop investigative, remedial, and/or monitoring programs under Licensed Site Remediation Professional (LSRP) direction and with approval from the NJDEP. TRC assisted Roche with training GES to familiarize them with the Site and to ensure that the same field SOPs were followed.

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 (2012 and 2013), the *Site-Wide Groundwater Sampling Plan - Interim Remedial Measures (IRM) Implementation Period Rev. 1 (July 2015)* and subsequent modifications, and the revised QAPP (2013).

Roche subcontracted TestAmerica as the primary laboratory to conduct analysis of the majority of Site samples while SGS Accutest continues to analyze Site samples for select limited-scope programs. The analytical data presented in this report were analyzed by one of these two laboratories.[11] In the 3Q 2016, Roche conducted a data quality assessment to evaluate potential data variability between the two laboratories (TestAmerica vs. SGS Accutest). As discussed in Appendix F, the data quality assessment indicated that using the two laboratories provides data that are comparable and can be relied upon to make remedial decisions.

As detailed above, during the March 2017 semi-annual groundwater sampling event, TestAmerica analyzed select groundwater samples past the established holding time for select VOCs. Therefore, TestAmerica laboratory reports 460-129624-1 and 460-129737-1 were revised and the out-of-hold data were excluded from these reports. The 48 monitoring wells in question were re-sampled and then analyzed by TestAmerica for VOCs and/or 1,4-dioxane, and included in laboratory reports 460-130860-1, 460-130768-1, 460-13-642-1, and 460-130538-1. 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

[10] TRC continues to assist with sampling activities on an as-needed basis.

[11] SGS Accutest conducted analysis of groundwater samples during the September 2016, March 2017 multiport sampling, and select IRM monitoring programs. TestAmerica analyzed the Site-wide groundwater samples in March 2017 and supplemental IRM monitoring programs.

method-specific calibrations and QC 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.

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

3.6 Factors Influencing Data

The synoptic rounds of groundwater elevation measurements were completed in one day for each semi-annual sampling period (September 28, 2016 and February 28, 2017). Overall, data generated from these events were consistent with measurements collected prior to and after the one-day gauging events (exceptions were indicated, where applicable). Multiple building dewatering systems or building basement sumps were in operation at the Site during the entire monitoring period. It is possible that these dewatering systems could have influenced local shallow groundwater elevations in the immediate vicinity of the sumps.

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 3.2.4.1, groundwater IRMs have been implemented at selected IAs. Many of them have resulted in significant improvement in groundwater quality in specific areas.

3.7 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)* and subsequent modifications (February 2016, May 2016, and November 2016), the QAPP, and the TRSR and applicable guidance documents. As such, there were no sampling methods or procedures that deviated from the approved workplan, TRSR, and applicable guidance.

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 collected PDB and RPPS samples are presented in a table format, which is included in Appendix C.

4.0 GROUNDWATER CONTAMINANTS OF CONCERN (COC)

During the 2013 RI and supplemental investigations (2014-2017), a total of 59 confirmed Site-specific groundwater COCs were identified in groundwater samples collected from monitoring wells installed at the Site. The table below summarizes the Site-specific groundwater COCs.

VOCs†	Semi-Volatile Organic Compounds (SVOCs)	Pesticides	Metals
1,1,1-Trichloroethane (1,1,1-TCA)	1,4-Dioxane	Dieldrin	Aluminum
1,2,4-Trichlorobenzene	2-Methylnaphthalene	Lindane	Antimony
1,1-Dichloroethane (1,1-DCA)	2-Methylphenol	Chlordane	Arsenic
1,1-Dichloroethene (1,1-DCE)	3&4-Methylphenol		Barium
1,2-Dichloroethane (1,2-DCA)	bis(2-Ethylhexyl)phthalate		Beryllium
2-Butanone (MEK)	Benzo(a)anthracene		Cadmium
Acetone	Benzo(a)pyrene		Chromium
Benzene	Benzo(b)fluoranthene		Cobalt
Bromodichloromethane	Benzo(k)fluoranthene		Iron
Carbon disulfide	Dibenzo(a,h)anthracene		Lead
Carbon tetrachloride	Hexachlorobenzene		Manganese
Chlorobenzene	Indeno(1,2,3-cd)pyrene		Nickel
Chloroethane	Pentachlorophenol		Sodium
Chloroform	TICs		Thallium
cis-1,2-dichloroethene (cis-1,2-DCE)			Zinc
Cyclohexane			
Ethylbenzene			
Methyl Tert Butyl Ether (MTBE)			
Methylcyclohexane			
Methylene chloride			
PCE			
Toluene			
trans-1,2-Dichloroethene			
TCE			
Vinyl Chloride (VC)			
Xylenes (total)			
Tentatively Identified Compounds (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.

4.1 Updates to Groundwater Classification Exception Area (CEA)

The April 2014 GWRIR included supporting documentation for the future establishment of a CEA[12]. A CEA for VOCs was proposed for PCE, TCE and their daughter products (i.e., cis-1,2-DCE and VC), 1,2-dichloropropane, 1,2-dichloroethane, 1,1,1-TCA, chlorobenzene, benzene, chloroform, toluene, and methylene chloride. Some VOCs emanating from historic on-Site releases have been attributed to non-Roche sources (e.g., CAMS). In addition, as the remedial investigation (RI) and subsequent investigations have progressed, evidence has been collected that indicates that some of the VOCs detected in groundwater have originated off-Site and have migrated under the Site with groundwater flow.

A separate non-VOC CEA, also referred to as the historic fill CEA, was proposed for historic-fill related SVOCs, pesticides, and metal constituents exceeding their respective GWQS. At the time, it was determined that these contaminants emanated from historic fill and/or naturally occurring conditions, and were not a result of former Roche operations. However, five of the 14 SVOCs listed above (specifically 2-methylnaphthalene, 2-methylphenol, 3&4-methylphenol, hexachlorobenzene, and pentachlorophenol) were determined to not be associated with historic fill. Roche will re-evaluate the distribution of these five SVOCs in groundwater (after completion of various RA programs at the Site) with a targeted sampling event in 2017. A separate report will be submitted to the NJDEP that will include the methodology, the rationale behind the selected wells, and the findings.

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[12] CEAs are established to provide notice that the constituent standards for a given aquifer classification are not or will not be met in a localized area due to natural water quality or anthropogenic influences, and that designated aquifer uses are suspended in the affected area for the term of the CEA. The intent of this action is to ensure that the uses of the aquifer are restricted until standards are achieved.

5.0 SUPPLEMENTAL INVESTIGATIVE FINDINGS

This section presents the findings of the supplemental groundwater characterization activities, specifically results from semi-annual groundwater monitoring events (conducted between August 2016 and July 2017), and other investigative programs completed in IA-10/Windsor Place, and select areas upgradient of the Site (north of Route 3).[13] Additionally, findings from a comparative assessment of analytical data quality between Roche's contracted laboratories (Accutest and TestAmerica) are summarized below. The focus of this GWPR is to document groundwater quality and concentration trends over time along the Site perimeter and in select interior areas of the Site during the implementation phase of various IRM programs. The methods and procedures employed during the various field activities are presented in Section 3.0 (Technical Overview). The laboratory data packages and the EDDs associated with these investigative activities are included on compact disc(s) in Appendix G.

5.1 Comparison of Groundwater Analytical Data between Laboratories

Groundwater samples collected from 36 monitoring wells were split and sent to SGS Accutest and TestAmerica for analysis of VOCs and 1,4-dioxane. The objective of this program was to determine if there were significant differences in analytical results between the two laboratories and determine if results obtained from the newly-contracted laboratory (TestAmerica) demonstrated satisfactory agreement with results from the previous laboratory. As further discussed in Appendix F, the laboratory comparison analysis concluded that the data reported by TestAmerica are reliable, consistent with previous analyses (completed by SGS Accutest), and suitable for the project's monitoring and remedial objectives.

5.2 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. During this reporting period, recent monitoring well installations allowed for greater definition of the Site's groundwater flow regime in areas north of the Site and in the IA-10/Windsor Place area. Groundwater elevation data were evaluated to assess whether the installation and/or operation of IRM systems (e.g., IWAS, amendment injections, soil/bedrock excavations, etc.) in multiple Site IAs resulted in changes to the Site's groundwater flow regime.

[13] The semi-annual groundwater data were supplemented with the most recent groundwater analytical results collected as part of IRM monitoring programs in IA-2, IA-3/7, IA-6, IA-11, and IA-12. Findings from these IA-specific IRM monitoring events are not discussed in this report.

Figures 3 and 4 are six-panel maps that provide the potentiometric surfaces of Zones S1 through S3 and Zones D1 through D3 measured on a Site-wide scale in September 2016 and February 2017, respectively. The February 2017 gauging event includes groundwater head data from four multiport wells installed at the northern boundary of IA-12 or off-Site along Allwood Road (Figure 4). Data collected during the January 2017 groundwater gauging event, which targeted Zone S1, S2, and S3 wells in Windsor Place and the southern portion of IA-10, are depicted in the potentiometric surface maps included as Figures 5 through 7.[14] The Site stratigraphic and geophysical data are being examined for CSM development. Based on that evaluation, the vertical zonation (Zones S1 through S3 and D1 through D4) of the groundwater flow system may be redefined, in which case the water-level data will be reorganized accordingly.

5.2.1 Synoptic Well Gauging Events - September 2016 and February 2017

Overall, the highest groundwater elevations are found in the northern portions of the Site (IA-12 and IA-10). The lowest groundwater elevations are in the southern portions of the Site (IA-14 and IA-15). As shown on Figures 3 and 4, the general direction of groundwater flow in all zones appears to be from northwest to southeast. Four monitoring wells (DW-16C, DW-31B, DW-31C, and DW-33C) show anomalously low water levels (between 20.10 feet above msl and -207.58 feet below msl). These wells are low-yielding; i.e., monitoring wells where recovery to static groundwater head conditions has required numerous months, or has not yet occurred. The majority of these wells are located in the western portion of the Site, and are generally in Zone D3. It is likely that the cause of their poor response to aquifer conditions is related to lower fracture interconnectivity. Therefore, the groundwater elevation data collected from these wells were not used, as they were not deemed to be representative of aquifer conditions.

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 2016 and February 2017, respectively. During the September 2016 and February 2017 gauging events, approximately 0.13 foot and 0.11 foot of LNAPL was recorded in Zone S1 well MW-237A[15] (in IA-12), respectively. 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.

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[14] In homogeneous, isotropic systems, groundwater flow directions meet the equipotential lines at a right angle. In anisotropic and heterogeneous systems, such as the Site, groundwater can flow in a direction oblique to the equipotential lines. Therefore, to avoid possible misrepresentation of the true groundwater flow directions beneath the Site, groundwater flow lines are not included on the potentiometric maps.

[15] 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), and subsequently in June 2014 (0.12 foot of LNAPL).

As shown on Figures 3 and 4, areas of relatively higher potentiometric heads remain apparent in an area surrounding the pond in Nichols Park (Zone S1), in the central part of IA-3/IA-7 (Zones S1 and S3), and in IA-12 along the CAMS (Zone S3); possible reasons for these elevated water levels have been presented in previous GWPRs. Anomalously low water levels in two Zone S2 wells in the northeastern corner of the Site (IA-12) suggest northeast flow in Zone S2, which is inconsistent with the hydraulic gradients noted in Zones S1 and S3 in this part of the Site. Groundwater elevation data collected from the Westbay multiport wells confirms that groundwater is flowing from the north toward the Site (Figure 4) in Zones S1 through D2. Therefore, the groundwater elevation data collected from wells MW-271B and MW-61B are not representative of aquifer conditions in this part of the Site.

Steeper lateral hydraulic gradients (closely-spaced contours, indicative of less fractured and less permeable bedrock) are observed in the southeastern and eastern portions of the Site (IA-14 and IA-15, and eastern IA-3 and IA-7), while most of the Site's fractured bedrock aquifer is relatively permeable, as evidenced by flatter gradients (widely-spaced contours) particularly in Zones S3, D1, D2, and D3 (Figures 3 and 4). Vertical hydraulic gradients were calculated[16] for up to 373 well clusters (screening different zones) to evaluate the vertical groundwater gradient between Zones S1 through D4 (Table 5-1). As shown in Tables 5-1A and 5-1B, the vertical hydraulic gradients ranged between -1.638 to +0.189 in September 2016 and -1.611 to +0.241 in March 2017 (downward and upward, respectively). Overall, the well clusters displayed downward vertical gradients, with a predominantly upward vertical gradient observed from Zone S3 to S1 in a narrow area parallel to St. Paul's Brook in the southeastern portion of the Site (IA-11, IA-15, and Nichols Park).

Overall, there is minimal seasonal variability in the horizontal groundwater gradient and hydraulic heads measured in September 2016 and February 2017, as shown in Tables 4-1 and 4-2, and on Figures 3 and 4. Therefore, it can be concluded that groundwater flow across the Site is not significantly affected by any of the ongoing IRM activities or off-Site pumping influences.

5.2.2 Multiport Well Gauging Event – Westbay – December 2016 and March 2017

Between December 2016 and February 2017, Westbay collected hydraulic head data at on-Site (DW-65) and off-Site (DW-69, DW-70, and DW-72) multiport wells. The measured hydrostatic pressures collected by Westbay were subsequently converted to equivalent depth to water and groundwater elevation values, correcting for atmospheric pressure at the time of the hydrostatic pressure measurement. A table showing the formula used in the calculations is included in Appendix D. The resulting depth to water readings are listed in Table 4-2. As shown on Figure

[16] Water levels measured at the well clusters (screening different zones) throughout the Site were used to calculate the vertical hydraulic gradient. The vertical gradient was derived by using the difference in hydraulic head divided by the vertical distance between the middle of the well screens in each pair of wells.

4, closely spaced groundwater elevation contour lines (indicative of a less permeable bedrock) are evident downgradient of the on-Site multiport (DW-65) in Zone S1, and the off-Site multiport wells in Zone S3 (DW-69, DW-70, and DW-72). Groundwater elevation data collected from the off-Site multiport wells located northwest of the Site (DW-69 and DW-70) were generally 4 to 10 feet higher than groundwater levels recorded in the closest on-Site wells. The multiport located northeast of the Site (DW-72) displayed groundwater elevations approximately 2 to 4 feet higher than values recorded in the closest on-Site wells.

5.2.3 Targeted Well Gauging Event – IA-10 / Windsor Place – January 2017

As shown on the Site-wide potentiometric surface maps (Figures 3 and 4), the depicted groundwater contours in Zones S1 through S3 in the vicinity of the IA-10/Windsor Place indicate groundwater flows to this area from off-Site properties located in the west-northwest (alongside and west of Kenzel Avenue) as well as other portions of IA-10 to the northwest (former Buildings 103 & 104). The recent groundwater elevation data collected from 71 wells in and around IA-10 and Windsor Place indicate that water levels are lower in Zone S1 around a portion of the Nutley Municipal Sewer traversing Windsor Place (Figure 5), suggesting a portion of the sewer is acting as a drain. Lower potentiometric heads were not observed in this area in Zones S2 or S3 (Figures 6 and 7, respectively). Groundwater elevation data collected during the January 2017 gauging event are shown in Table 4-3. Results from vertical gradient calculations (Table 5-2) show that in IA-10, west and east of Windsor Place, a downward hydraulic gradient exists in the shallow zones (Zones S1, S2, and S3), and that an upward vertical gradient is occurring in Windsor Place, along a portion of the Nutley Municipal Sewer.

5.3 <u>Site-Wide Groundwater Quality Assessment</u>

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 (February 2016, March 2016, and November 2016), a minimum of 179 accessible on-Site and off-Site wells were sampled for VOCs and 1,4-dioxane using either the low-flow or PDB/RPPS methods between August 2016 and July 2017. Discussion of the results obtained from semi-annual sampling events as well as area-specific supplemental investigations or monitoring is provided in the sections below.

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 CVOC plumes shown on Figures 8 and 9 identify any area where PCE and its breakdown products (PCE+) have been detected 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. In the forthcoming CSM report, distinct groundwater plumes will be defined based on their chemical signature; i.e., the contaminants and ratios of those contaminants that comprise the plume. Future GWPRs will depict the groundwater plumes consistent with the CSM plume designations.

5.3.1 Comprehensive Semi-Annual Sampling Events (September 2016 and March 2017)

Multiple VOC plumes have been identified throughout the Site and upgradient locations in Zones S1 through D4.[17] PCE+ and 1,4-dioxane are the primary and most widespread contaminants detected in groundwater (on- and off-Site).

In compliance with the NJDEP-approved *Modification of the Site-Wide Groundwater Sampling – Interim Remedial Measures (IRM) Implementation Period - July 2015*, dated November 2, 2016, groundwater samples were collected from equilibrated PDB/RPPS during semi-annual events (September 2016 and March 2017) from a minimum of 179 monitoring wells located around the outer boundary of the combined Site-wide CVOC and 1,4-dioxane plumes and the outer perimeter of IRM areas. The list of wells sampled in the semi-annual monitoring events (Table 1-1) were selected to focus on areas downgradient of and in between IRM boundaries, as well as areas outside of known groundwater impacts to document plume stability/absence of receptor impact (sentinel wells). The March 2017 sampling program included samples from monitoring wells located within the footprint of IRM areas in IAs 7, 9, and 11 to monitor for potential contaminant rebound conditions subsequent to IRM implementation programs. In addition, the Site-wide March 2017 dataset includes VOCs and 1,4-dioxane results from newly-installed on-Site and off-Site multiport wells, and was further supplemented with data collected during IRM performance monitoring activities.

All samples were analyzed for TCL VOCs and 1,4-dioxane by TestAmerica, except the multiport samples, which were analyzed by SGS Accutest. Figure 2 provides a map depicting the location of all monitoring wells on- and off-Site (through July 2017). Figures 8 and 9 provide a comparative seven-panel view of VOC distribution across the Site for Zones S1 through D4. The figures listed above depict isoconcentrations for the total of PCE+ at concentrations in excess of their respective GWQS (i.e., the total sum of the highest chlorinated VOC constituents; the total excludes contaminant concentrations that do not exceed their respective GWQS)[18]. Similarly, Figures 10 and 11 depict a comparative seven-panel view of 1,4-dioxane distribution across the Site for Zones S1 through D4. These maps support discussions presented in sections below.

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[17] Not all identified groundwater plumes are attributable to Roche sources. A discussion of Site plumes and source origin will be presented in the upcoming CSM Report.

[18] While the VOC figures depict contaminant isoconcentrations of the sum of PCE and its breakdown products (or PCE+) exceeding the GWQS, all VOC constituents above the GWQS are shown in the figure data boxes.

The required sample duplicates, field blanks, and trip blanks were collected during each sampling phase/event for the same analytical parameters to assess and validate the quality of the data generated.[19] Duplicate sample data are presented with the analytical results of the corresponding September 2016 and March 2017 samples. Tables 6-1 and 6-2 summarize VOC results from September 2016 and March 2017, respectively. Field blank and trip blank sample results associated with both VOC datasets are presented in Table 6-3. 1,4-Dioxane VOC results (including field and trip blanks) are tabulated in Table 6-4. Table 6-5 summarizes supplemental VOC and 1,4-dioxane data (including field and trip blanks) collected during IRM monitoring programs. Appendix G provides the laboratory reports and EDDs for the analyses performed.

5.3.1.1 CVOCs Along the Site Perimeter (South & Southeastern) and in the Vicinity of Interior IRM Areas

Figures 8 and 9 depict the extent of the PCE+ impacts exceeding their respective GWQS in Zones S1 through S3 and D1 through D4 for September 2016 and March 2017, respectively. Figure 8 (September 2016) does not include data from wells located within or in the vicinity of IRM boundaries; this figure portrays some plume configurations based on data collected during a previous (pre-IRM) monitoring event for visual aid purposes. Figure 9 (March 2017) provides the most current and comprehensive depiction of CVOC distribution in groundwater, including supplemental data collected in and around select IRM areas.

In March 2017, elevated CVOC concentrations were detected off-Site, west of IA-11 and IA-15, with PCE results above 100 µg/L in Zone S1 (MW-171A =320 µg/L), Zone S2 (MW-171B = 330 µg/L, MW-257B = 210 µg/L, MW-304B = 290 µg/L), Zone S3 (MW-171C = 380 µg/L, MW-304C = 560 µg/L, and Zone D1 (DW-47A = 140 µg/L) – see Figure 9. In the IA-10/Windsor Place area, the highest TCE concentrations detected in March 2017 in Zones S1 and S2 were 7,900 µg/L (MW-488A) and 1,300 µg/L (MW-479B), respectively. As shown on Figure 9, a dissolved CVOC plume (with approximate concentrations between 1 and 10 µg/L) is observed along most of the southern perimeter of the Site and downgradient (off-Site) areas.

Overall, the areal footprint of the total CVOC impacts has remained relatively stable. However, a few monitoring wells located within the outer boundary had a decrease/increase in contaminant concentrations (up to +/- 1 order of magnitude) over the last 6 months of sampling (Figures 8 and 9). The monitoring wells where the decrease in contaminant levels was observed are located off-Site, hydraulically downgradient of IA-11 in Zones S1 and S2. The wells displaying higher contaminant concentrations in March 2017 are located in the southern portion of, and west of, IA-10 (Zones S1, S2, and D2) or off-Site, west of IA-15 (Zone S3 PCE impacts. Evaluation of

[19] TRC reviewed the data for the corresponding analytical laboratory reports and concluded that all TCL VOC (including 1,4-dioxane) data are useable for the intended purposes, with the exceptions noted in Section 3.5.

all contaminant concentrations over time for these and other wells is further discussed in Section 5.5.

The paragraphs below provide brief discussions that summarize the changes in groundwater conditions in IA-7, IA-9, and IA-11. An upcoming IRM Groundwater Progress Report will provide detailed discussions on recent IRM work and evaluate performance monitoring data associated with these systems.

IA-7 – Southwest

In June 2015, total CVOC levels in the southwestern portion of IA-7 (proximal to the former CAMS) were detected > 10 μg/L in Zone S1 and > 100 μg/L in Zone S2. An EISB pilot test (under a Discharge to Ground Water [DGW] Permit-by-Rule [PBR] authorization) was implemented between February 23, 2015 and September 6, 2015. As shown on Figure 9, results from the March 2017 sampling event indicate total CVOC concentrations in Zone S1 and Zone S2 have decreased to < 10 μg/L.

IA-9 – Vicinity of Former B73

In March 2014, groundwater sample results from monitoring wells MW-152R, MW-170R, and MW-170AR exceeded 100,000 μg/L in total CVOCs. Hot spot areas were excavated in June 2014, and the entire building (including pipe trench and surrounding walls) was excavated in June 2015. The March 2017 results indicate that CVOCs in IA-9 shallow groundwater (Zone S1) have been reduced to levels below applicable GWQS.

IA-11 – West

In June 2015, total CVOC concentrations were observed in Zone S1 > 10 μg/L and Zone S2 > 10,000 μg/L. Between December 20, 2016 and January 17, 2017, weathered bedrock with CVOC source material was excavated in the western portion of IA-11 to a maximum depth of 26 feet bgs. Post-IRM groundwater results (March 2017 – Figure 9) indicate that CVOCs were not detected above applicable GWQS in Zone S1 and have significantly decreased in Zone S2 to less than 5 μg/L.

5.3.1.2 1,4-Dioxane along the Site Perimeter (South & Southeastern) and in the Vicinity of Interior IRM Areas

Figures 10 and 11 depict the extent of the 1,4-dioxane impacts exceeding 0.4 μg/L (the revised IGWQC promulgated in November 2015) in Zones S1 through S3 and D1 through D4 for September 2016 and March 2017, respectively. Figure 10 (September 2016) does not include data from wells located within or in the vicinity of IRM boundaries; this figure portrays some plume configurations based on data collected during a previous (pre-IRM) monitoring event for visual aid purposes. Figure 11 (March 2017) provides the most current and comprehensive depiction of 1,4-dioxane distribution in groundwater.

As shown on Figure 11, the highest 1,4-dioxane concentrations (>1,000 μg/L) have been consistently located on-Site in the eastern portion of IA-1 (near former B44, B45, and B56). Plume areas exceeding 100 μg/L are noted in monitoring wells located in Zones S1, S2, S3, and D1 in IA-1, IA-6, IA-10, and IA-12. 1,4-Dioxane concentrations exceeding 10 μg/L have been primarily identified in the western portion of the Site, between the Norfolk Southern Railroad tracks and First Avenue.

Overall, the areal footprint of the 1,4-dioxane plume has remained relatively stable, with minor adjustments in the low-level isoconcentration lines 0.4, 1, and 10 μg/L in some areas. An IWAS/ISCO IRM was initiated in IA-1/IA-4 in August 2015. Recent 1,4-dioxane data (Figure 11) show considerable decreases in concentrations within some IRM areas when compared to previous monitoring events (Figure 10), specifically two areas displaying 1,4-dioxane concentrations >1,000 μg/L in IA-1 were reduced to < 1,000 μg/L. Similarly, a small >100 μg/L 1,4-dioxane plume was reduced by one order of magnitude.

As shown on Figure 11, low-level 1,4-dioxane exceedances, between 0.4 and 10 μg/L, extend downgradient of the Site property boundary in all zones, with a greater extent observed in Zone S3 and a lesser extent observed in Zone D2. The most downgradient impacts are observed south-southeast of the Site, in Zone S3 wells MW-214C (7.5 μg/L), MW-209C (18 μg/L), MW-104C (41.0 μg/L), MW-236C (0.6 μg/L), MW-171C (1.5 μg/L), MW-216C (1.1 μg/L), MW-146C (0.8 μg/L) and MW-258C (0.8 μg/L). The outer extent of the 1,4-dioxane impacts has been sufficiently delineated laterally and vertically. Tables 6-4 provide the groundwater analytical results for 1,4-dioxane for the September 2016 and March 2017 sampling events.

5.4 Supplemental Groundwater Characterization and Background Investigation

Groundwater characterization activities completed at the Site since 2013 identified groundwater impacts associated with off-Site sources. Sufficient evidence exists to support that VOCs and 1,4-dioxane are migrating toward the Site from areas north and west of the Site and/or have been released on-Site from breaches in the CAMS.

In the northern portion of the Site (IA-12), total CVOC levels in groundwater along the CAMS have been historically detected above 10,000 μg/L. A separate plume (i.e., "eastern plume"), comprised primarily of PCE (>1,000 μg/L), has been identified in the northeastern portion of IA-

12, which originates north of Route 3 and has been documented to travel south along the eastern perimeter of the Site.

In IA-10, a more recent discovery identified a source of elevated TCE concentrations (>5,000 µg/L) associated with a municipal sewer in Windsor Place (off-Site road).

Between November 2016 and March 2017, supplemental groundwater investigations were conducted on- and off-Site to further characterize the quality of groundwater migrating toward the Site. These investigations included the installation of multiport wells at on-Site (IA-12) and off-Site (Allwood Road) locations, and installation of additional monitoring wells at Windsor Place. The sections below present a summary of the groundwater analytical results from these new wells.

As discussed in the next subsection (5.4.1), recent data collected at off-Site multiport wells (i.e., DW-69 and DW-70) confirmed contaminant contributions from these upgradient areas to the Site-wide 1,4-dioxane plume at levels ranging from 0.5 to 47 µg/L in Zones S2, S3, D1, or D2 (Figure 11).

5.4.1 Multiport Wells Sampling Events (January, March, April, and May 2017)

Between December 18, 2016 and February 2, 2017, multiport wells were installed on-Site at the northern boundary of IA-12 (DW-65), at two off-Site locations north-northwest of IA-10 and IA-12 (DW-69 and DW-70), and one off-Site location northeast of IA-12 (DW-72). These wells, screening groundwater at 19 to 24 discrete depth intervals in Zones S1, S2, S3, D1, and D2, were completed to provide more detailed vertical discretization of hydraulic head values, evaluate background groundwater conditions, and identify potential plumes migrating toward the Site. The on-Site multiport well DW-65 was sampled in January 2017, approximately 1 month after installation. All the multiport wells were sampled during the March 2017 Site-wide monitoring program and subsequently in April 2017 and May 2017. Figures 12 through 15 depict the vertical profiles for the individual multiport wells and include analytical data summary boxes (January, March, April, and May 2017 events) as well as the recorded hydraulic head data collected during well installation and sampling activities. In addition, multiport groundwater analytical data are summarized on the Site-wide CVOC and 1,4-dioxane plume figures for the March 2017 sampling event (Figures 9 and 11, respectively). The VOC and 1,4-dioxane data are also presented in Tables 6-6A and 6-7A. Refer to Tables 6-6B and 6-7B for analytical results of corresponding field blanks and trip blanks.

VOCs

VOC results from the four DW-65 sampling events include exceedances of PCE (1.1 – 4.9 µg/L), TCE (1.1 – 18.3 µg/L), benzene (1.2 – 5.4 µg/L), MTBE (83.6 – 255 µg/L), 1,1-DCE (1.2 – 37.2 µg/L), 1,2-DCA (2.2 – 25.1 µg/L), and VC (1.3 – 3 µg/L). As shown on the DW-65 vertical profile (Figure 12), benzene, MTBE, and/or VC were detected above GWQS levels in both sampling events in Zone S2 and S3 ports (at approximately 60 to 90 feet bgs). PCE and TCE exceedances were primarily detected in Zones D1 and D2 (between 176 and 350 feet bgs), and 1,2-DCA exceedances were detected in Zone D2 (between 239 and 350 feet bgs). The highest TCE concentrations (>10 and <100 µg/L) were detected between 239 and 262 feet bgs (approximately -90 feet and -120 feet mean sea level [MSL]). As shown on Figure 9, the total CVOC concentrations detected in DW-65 are similar to or slightly below total CVOC levels observed in the northern portion of IA-10.

As shown on the Site-wide CVOC plume map (Figure 9), there is minimal contaminant contribution from well DW-69 (located approximately 1,500 feet north-northwest of IA-10/IA-12), with TCE exceedances detected between 1.1 and 5.8 µg/L (Zones S3, D1, and D2), and a maximum 1,1-DCE exceedance of 5.2 µg/L (Zone D2). The vertical profile for DW-69 (Figure 13) shows little to no impact in Zones S2 and S3, and very slight exceedances of the 1 µg/L GWQS for TCE between 142 and 375 feet bgs (equivalent to 0 feet and -235 feet MSL).

Groundwater samples collected from multiport well DW-70 (located approximately 920 feet north-northeast of IA-10 and northwest of IA-12) exceeds the GWQS for PCE (1.1 – 22.7 µg/L), TCE (1.6 – 78.6 µg/L), 1,1-DCE (3.1 – 80.2 µg/L), and 1,2-DCA (2.3 – 5.8 µg/L) – Figure 14. As shown on this figure, PCE and TCE concentrations were generally slightly above the 1 µg/L QWQS established for each constituent. These minor exceedances of PCE and TCE were in the majority of the ports (Zones S2 through D2), with the highest PCE and TCE concentrations (maximum of 22.7 µg/L and 78.6 µg/L for PCE and TCE, respectively) detected in port DW-70-114-S3 and additional TCE detections slightly above 10 µg/L in ports DW-70-83-S3 (14.7 µg/L), DW-70-123-D1 (13.8 µg/L), and DW-70-261-D2 (18 µg/L). 1,1-DCE was also detected above the 1 µg/L GWQS in all the samples collected in Zone S3, D1, and D2. The highest 1,1-DCE levels (between 10 and 100 µg/L) were observed between DW-70-83-S3 and DW-70-189-D1. As shown on the Site-wide CVOC plume map (Figure 9), total CVOC concentrations detected in multiport well DW-70 are comparable to exceeding contaminant levels observed on-Site in IA-10 and IA-12 (> 1 and < 10 µg/L in Zones S2, and > 10 and < 100 µg/L in Zones S3, D1, and D2).

Multiport well DW-72 (located 615 feet north-northeast of IA-12) displayed the highest CVOC concentrations among all the off-Site multiport wells (Figure 15). PCE is the primary exceeding constituent in DW-72; the detected TCE exceedances were sporadic and insignificant in comparison. As shown on Figures 9 and 15, the highest PCE concentrations were observed in Zone S3 (DW-72-136-S3) with 297 µg/L of PCE detected in March 2017; however, contaminant levels are generally lower than those detected in downgradient wells MW-353C (off-Site, north of Route 3) and MW-271C (northern boundary of IA-12). In Zones D1 and D2, DW-72 also displayed PCE concentrations >1 and <100 µg/L, similar to contaminant concentrations recorded in wells hydraulically downgradient of the area [DW-64A (off-Site, north of Route 3), DW-28A (IA-12), and DW-28B (IA-12)]. While there have been no exceedances of a GWQS for VOCs in Zones S1 and S2 in the northeastern boundary of IA-12, a slight PCE exceedance (1.1 µg/L) was detected in a Zone S2 port (DW-72-99-S2) during the March 2017 sampling event.

1,4-Dioxane

Previous groundwater investigations determined that while a source of 1,4-dioxane contamination was located on-Site, there appears to be contribution to the Site-wide 1,4-dioxane plume from upgradient areas (north of Route 3) in Zones S2, S3, D1, D2, and D3.[20] As shown on the most recent Site-wide 1,4-dioxane plume configuration (Figure 11), the 1,4-dioxane impacts are generally observed in the western portion of the Site (along the railroad tracks), with the most predominant lateral plume dispersion occurring in Zones S2 and S3. The multiport program detected 1,4-dioxane in off-Site wells DW-69, DW-70, and DW-72 and the on-Site well DW-65. As shown on the multiport data profiles, Figures 12 through 15, 1,4-dioxane exceedances, above the 0.4 µg/L IGWQC, are continuous (i.e., detected in most, if not all, ports) at DW-70 and DW-65. Multiport wells DW-69 and DW-72 display isolated low-level concentrations of this constituent (ranging between 0.44 and 1.5 µg/L of 1,4-dioxane), with no exceedances or detections in the majority of sample ports.

5.4.2 IA-10 / Windsor Place Sampling Events (November 2016 and January, June, and July 2017)

Elevated TCE concentrations detected in IA-10 Zone S2 well MW-479B (13,200 µg/L of TCE) in September 2016 prompted Roche to undertake an investigation of shallow groundwater in the IA-10/Windsor Place area. In November 2016, a confirmatory sampling event was conducted to assess the validity of the >10,000 µg/L of TCE in well MW-479B. The objective of the supplemental investigations, conducted in January, June, and July 2017, was to further characterize shallow groundwater conditions in the area and potentially locate the origin of the elevated TCE concentrations in the on-Site well (MW-479B).

[20] Monitoring wells installed in Zone S1 in the northern Site perimeter (IAs 10 and 12) do not exceed the 0.4 µg/L Interim Ground Water Quality Criterion (IGWQC) for 1,4-dioxane, with the exception of well MW-237A (1.3 µg/L of 1,4-dioxane). Impacts at this shallow well (MW-237A) have been attributed to a source north of Route 3 (i.e., Sunoco).

The sections below discuss results associated with the November 2016 and January, June and July 2017 sampling efforts. The VOC and 1,4-dioxane groundwater data from November 2016 and January 2017 are summarized on Figures 16 through 19 and in Tables 6-8A and 6-9A. The VOC data from the June and July 2017 groundwater sampling events are summarized on Figure 20 and in Table 6-8B. Field blank and trip blank results are included in Tables 6-8C and 6-9B.

November 2016

In November 2016, monitoring well MW-479B was re-sampled (via PDB) along with five other Zone S1 wells (MW-474A, MW-487A, MW-488A, MW-496A, and MW-472A) located in Windsor Place (sampled via low-flow). As shown on the table below, TCE levels in MW-479B were detected at 8,310 µg/L. In the shallow Zone S1 wells, TCE levels ranged between 7.5 µg/L (on-Site well MW-474A) and 4,510 µg/L (off-Site well MW-487A). A summary of all analytical results is presented in Table 6-8A.

January 2017

Since the confirmatory event resulted in >8,000 µg/L of TCE in well MW-479B, a comprehensive groundwater sampling program was conducted in the IA-10 and Windsor Place area in January 2017. The field effort involved sampling 37 monitoring wells in Zones S1, S2, and S3 for VOCs and 1,4-dioxane with the objective of identifying a source area for the elevated TCE concentrations in IA-10 (MW-479B).

VOCs

In January 2017, three Zone S2 monitoring wells (MW-474B, MW-487B, and MW-488B) were installed upgradient of MW-479B in Windsor Place and one Zone S2 well (MW-501B) was installed in IA-10 proximal to former Building 110. The new wells, along with 33 other wells screening Zones S1, S2, and S3 wells in the area, were sampled for VOCs (including 1,4-dioxane). As summarized in Table 6-8A and on Figures 16 through 19, elevated TCE concentrations (>1,000 µg/L) were detected in off-Site Zone S1 wells MW-487A (2,000 µg/L), MW-488A (5,120 µg/L) and an on-Site Zone S2 well MW-479B (6,500 µg/L). While there are no Zone S3 wells in Windsor Place, the groundwater quality for Zone S3 on-Site indicate TCE is not detected or is significantly below the 10 µg/L of TCE in the immediate vicinity of Windsor Place.

As shown in the table below, a review of monitoring well data with elevated TCE results (>1,000 µg/L) in the IA-10/Windsor Place area reveals that TCE concentrations fluctuate over time. Analytical data associated with the March 2017 semi-annual sampling event are also included for reference. Hydrographs for these wells were also prepared to assess potential correlation between TCE levels and changes in water table (Appendix H).

Summary of Elevated TCE Concentrations Detected in IA-10/Windsor Place Monitoring Wells

	Sample Date:	Sep-15	Dec-15	Mar-16	Jun-16	Sep-16	Nov-16	Jan-17	Mar-17
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Sample Method:	*Low-Flow /Grab*	*Low-Flow*	*Low-Flow*	*Low-Flow*	*PDB*	*PDB*	*Low-Flow*	*PDB*
	Laboratory:	*SGS*	*SGS*	*SGS*	*SGS*	*TA*	*TA*	*TA*	*TA*
Zone S1 IA-10 (B112)	MW-472A	**2,210**	**1,410**	*NS*	*NS*	*NS*	422	211	*NS*
	MW-476A	**1,000**	764	*NS*	*NS*	*NS*	*NS*	15	*NS*
Zone S1 Windsor Place (Off-Site)	MW-474A	**1,570**	**1,490**	*NS*	*NS*	*NS*	7.5	164	310
	MW-487A	**9,120**	**7,920**	*NS*	*NS*	*NS*	**4,510**	**2,000**	**1,600**
	MW-488A	167	**2,290**	*NS*	*NS*	*NS*	497	**5,120**	**7,900**
Zone S2 IA-10 (B112)	MW-479B	**1,650**	**1,030**	*NS*	**1,060**	**13,200**	**8,310**	**6,540**	**1,300**

Based on the data tabulated above and graphed in Appendix H, there is no apparent correlation between fluctuating TCE concentrations in the wells, sampling methodology, the laboratory conducting sample analysis, and/or changes in groundwater elevation.

1,4-Dioxane

The majority of 1,4-dioxane impacts detected in monitoring wells located in Windsor Place and the southern portion of IA-10 correspond to the fringes of a dissolved plume (> 0.4 and < 10 µg/L) that is migrating from the west (Zone S1), northwest, north, and/or northeast (Zone S2, D1, D2, and D3) – Figure 11 and Table 6-9A. In Zone S3, however, a monitoring well located in IA-10 near former B112 displays 1,4-dioxane concentrations above 100 µg/L (MW-479C = 160 µg/L). As shown on the Site-wide 1,4-dioxane plume map (Figure 11 – Zone S3 panel), this plume travels to the southeast, where 1,4-dioxane levels are within the same order of magnitude or slightly lower (MW-208C = 120 µg/L; MW-275C = 97 µg/L; and MW-126C = 110 µg/L) than what has been observed in MW-479C.

June and July 2017

In June and July 2017, the groundwater investigation continued in the area with the installation and sampling of two IA-10 Zone S1 wells (proximal to the location of elevated TCE in groundwater), and the sampling of MW-479B and other Zone S2 wells in Windsor Place.

As shown on Figure 20 and Table 6-8B, TCE did not exceed 4 µg/L in the shallow overburden (MW-479S) and 15 µg/L in the shallow bedrock (MW-479A). MW-479B results were once again elevated for TCE, with 5,600 µg/L detected in June 2017 and 6,200 µg/L detected in July 2017. The highest TCE concentrations detected in Windsor Place Zone S2 were recorded for well MW-488B (100 µg/L in June 2017 and 170 µg/L in July 2017).

5.5 Temporal Groundwater Concentration Trends

Time-series plots of groundwater elevation and COC concentrations were prepared for select wells located along the Site boundary to assess for notable trends in contaminant concentrations over the monitoring period (Appendix I). In addition, this report presents statistical data tables that identify the wells where an increase in contaminant trend is evident (Appendix I). 1,4-Dioxane was not evaluated due to the limited number of sampling events for this compound.

As shown in Appendix I, the trend lines for these graphs depict a stable, decreasing, or slight increase in contaminant levels. Twelve out of the 54 outer perimeter wells (DW-13-D2, DW-44A, DW-44B, MW-104B, MW-105B, MW-144A, MW-209C, MW-214A, MW-214C, MW-216C, MW-257B and MW-258C) evaluated showed a slight increase (within an order of magnitude) in contaminant concentrations over time for at least one or more COCs; these wells showing a slight increase are generally characterized by an increase in daughter products and a decrease in parent products, with the exception of wells MW-105B, MW-216C, MW-257B, and MW-258C. These four wells show an increasing trend of either PCE or TCE; these wells are screened in Zone S2 and deeper along the southern Site perimeter. However, overall trends indicate the margins of the plume are stable.

6.0 SCHEDULE OF FUTURE GROUNDWATER INVESTIGATION AND REMEDIAL ACTION ACTIVITIES

The sections below present various schedules of RA field activities that are planned for completion in the near future.

6.1 RI/RA Field Programs

The table below lists the IRM programs selected for implementation in Site IAs where contaminant mass reduction and/or control was warranted, as well as supplemental groundwater sampling programs designed to monitor groundwater quality during the IRM implementation period and/or gather supplemental data for potential natural attenuation applicability. Rows shaded gray indicate IRMs that have been completed.

RI/RA Field Programs							
IA & RI/RA Program	**Targeted COCs**	**Status**	**Treatment Zone**	**Anticipated Technology**	**NJDEP Permit**	**Anticipated Start Date**	**Duration**
Site-Wide GWSP - IRM Implementation Period	VOCs, 1,4-dioxane	Ongoing	N/A	MNA	N/A	Ongoing (began 3Q 2015)	TBD[1]
IA-1/IA-4 IRM	toluene, benzene, 1,4-dioxane	Design & installation completed; operation ongoing	Groundwater in overburden and bedrock	IWAS/ART, ISCO	Air discharge for off-gas; PBR for injections	Ongoing (began 2Q 2016)	2 - 3 years
IA-2 IRM	benzene, chloroform, methylene chloride	Design & installation completed; ISTT operation completed; most IWAS wells idled	Groundwater in overburden and bedrock	Thermal Treatment (ERH)	Air discharge for off-gas; PBR for electrode drip	Completed (1Q 2016)	6 – 8 months *Completed*
				IWAS	Air discharge for off-gas	Idled; monitoring for completeness determination	2 - 3 years
IA-3/IA-7/ CAMS IRM	PCE+	PDI & pilot test completed; design & installation completed; operation ongoing	Groundwater in overburden and bedrock	IWAS/ART EISB	Air discharge for off-gas; PBR for injected amendment	Ongoing (began 1Q 2017)	1 - 2 years

RI/RA Field Programs							
IA & RI/RA Program	**Targeted COCs**	**Status**	**Treatment Zone**	**Anticipated Technology**	**NJDEP Permit**	**Anticipated Start Date**	**Duration**
IA-6 IRM	chlorobenzene	Design & installation completed; operation ongoing	Groundwater in overburden and bedrock	IWAS/ART, ISCO	Air discharge for off-gas; PBR for injections	Ongoing (began 2Q 2016)	1 – 2 years
IA-9 IRM	toluene & PCE+	PDI and IRM completed	Unsaturated and saturated overburden	Excavation and EISB	PBR for backfilled amendment	Excavation completed. Amendment placed July 2015	1 year *Completed*
IA-10 IRM (B70)	benzene	Completed	Groundwater in overburden	EISB (with no recirculation)	PBR for injected amendment (submitted 8/1/2014)	Monitoring completed (injections completed 1Q 2015)	2 years *Completed*
IA-10 IRM (B104)	PCE, TCE and breakdown products	Completed	Groundwater in overburden	EISB (with no recirculation)	PBR for injected amendment	Monitoring completed (injections completed 2Q 2015)	2 years *Completed*
IA-11 IRM Bedrock	PCE+	PDI, pumping test, & pilot test completed; excavation and treatment of source zone completed	Groundwater in bedrock (Zones S1 and S2)	Excavation of source residuals in weathered bedrock; EISB (with no recirculation)	PBR for injected amendment	Excavated in 1Q 2017	4 years *Completed*
IA-12 IRM Bedrock	PCE+	PDI, pumping test. & pilot test completed; Phase I ERH completed; IWAS/ISCO ongoing	Groundwater in bedrock	Thermal Treatment (ERH)	Air discharge for off-gas; PBR for electrode drip	Completed (3Q 2015)	6 - 9 months *Completed*
				IWAS/ART, ISCO	Air discharge for off-gas; PBR for injections	Ongoing (began 2Q 2016)	2 years

Notes:

1. A minimum of 1 year of monitoring was proposed in the Site-Wide GWRP – IRM Implementation Period (September 2015). This sampling plan provided flexibility to adjust the frequency, number of wells and parameters after 4 sampling quarters. A proposal to modify the plan was submitted to the NJDEP in November 2016 to change the sampling frequency to semi-annual. The NJDEP has approved this change.
2. Completed IRM programs are shown in gray.
3. ERH = Electrical Resistance Heating.
4. MNA = Monitored Natural Attenuation.
5. N/A = Not Applicable.

6. PBR = Permit-by-Rule.
7. TBD = To Be Determined.
8. IWAS = In-Well Air Stripping.
9. ART = Accelerated Remediation Technologies.
10. ISCO = *in-situ* chemical oxidation.
11. EISB = Enhanced *in-situ* bioremediation.

6.2 **IRM Performance Monitoring**

An IRM Progress Report documenting recent IRM activities and summarizing available performance monitoring data will be submitted to the NJDEP in late 2017/early 2018 under separate cover.

7.0 REFERENCES

TRC, Hoffmann-La Roche Inc., Nutley Facility, Site-Wide Ground Water Remedial Investigation Report, April 2014.

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