Technical Memorandum

To:	Steve Wall, City of Camas
From:	Dawn Chapel and Dan Matlock, Pacific Groundwater Group
Re:	Updated Environmental Review for Select Facilities at the Port of Camas-Washougal Industrial Park
Date:	August 6, 2015

An updated environmental review was conducted for select facilities at the Port of Camas-Washougal Industrial Park to evaluate environmental conditions, cleanup activities, and potential water quality threats to groundwater supplies being considered for development by the City of Camas and Washougal near the Steigerwald Wildlife Refuge. A previous environmental review of the Industrial Park was conducted in 2007 (PGG, 2007). Since completion of the 2007 environmental review, three sites at the Industrial Park continue to be of concern as a potential threat to future groundwater supplies in the area. These sites include:

1. Exterior Wood
2. TrueGuard, LLC (formerly Allweather Wood Treaters, Inc.)
3. Philip Services Corporation (formerly Burlington Environmental)

The location of these facilities in relation to the future groundwater supply is shown in Figure 1. The Industrial Park is bounded by the Steigerwald Wildlife Refuge to the west, the Gibbons Creek Remnant Channel to the north and east, and the Columbia River to the south. The Gibbons Creek Remnant Channel flows east to west and terminates at a pump station on the west side of the Exterior Wood parcel where a pump station operates to discharge the water to the Columbia River.

A conceptualized hydrogeologic cross-section of the area is presented in Figure 2. The Industrial Park and proposed future groundwater supply are located on the floodplain of the Columbia River. This area is underlain by recent alluvial floodplain deposits up to 40 feet thick or more. The recent alluvial sediments are broken into two subunits, an upper subunit consisting of organic rich silt and clay followed by a lower subunit consisting of predominantly fine sand. The Pleistocene Alluvial Aquifer (PAA) occurs beneath the recent alluvium and it forms the most productive aquifer in the area, consisting of coarse-grained sand, gravel and cobbles. Sediments dredged from the Columbia River were used to elevate the floodplain for construction of the Industrial Park. These fill sediments occur above the silt subunit of the recent alluvium in the Industrial Park area. Figure 2 shows the general flow directions in each unit.

Although there are documented environmental releases at the above three sites, the migration and mobility of contaminants from these properties is extremely limited. The extent of groundwater impacts have been well characterized at each site and investigative results show impacts are limited to shallow depths within the fine-grained recent alluvial deposits (generally less than 40 feet) with minimal lateral migration (impacts are largely confined to within the footprint of the facility parcels). Given the 20 to 30 years since the first documented releases at the PSC and Exterior Wood sites, it is apparent that significant attenuation processes must be acting to limit the migration and mobility of contaminants from these sites. Without attenuation, groundwater contaminants should have migrated 0.5 to 1 mile from these sites over the past 20 to 30 years based on groundwater velocities of about 0.4 ft/day in the recent alluvium, and this has not been observed at these sites.

The proposed wellfield lies approximately 1.5 miles southeast of the environmental sites. The wellfield will withdraw water from the deeper Pleistocene Alluvial Aquifer (PAA) with completion depths well over 100 feet below the fine-grained silt, clay, and silty sand of the recent alluvial deposits (see Figure 2). Operation of the Steigerwald wellfield is not expected to change contaminant mobility and migration on these sites. All three sites are listed as confirmed contaminated sites with the Department of Ecology, measures to correct sources of contamination are ongoing, and with time the sites will be remediated.

The following section provides a brief summary of findings for each site. Subsequent sections provide more detail.

SUMMARY OF FINDINGS

The contaminants of concern at **Exterior Wood** are arsenic, chromium, and copper in soil and groundwater. A release to the environment with subsequent corrective measures was originally documented in 1995. Routine groundwater monitoring since then indicates concentrations above MTCA groundwater cleanup levels are limited to onsite shallow groundwater (20 feet depth or less) in the immediate vicinity of the drip pad where the releases occurred. There was a reported low level detection of copper (presumably below cleanup levels) in the facility's process water well (115 feet depth) back in 1995 suggesting some diffuse vertical migration may have occurred at this location in the past. In a 2011 report, it was recommended that the water well be resampled; however, resampling results were not found in Ecology's files. PGG is currently in contact with Ecology to ensure that future investigation address the potential for vertical migration at the site.

Shallow groundwater gradients at the Exterior Wood site are towards the north discharging to the Gibbons Creek Remnant Channel. Concentrations above MTCA levels do not appear to be migrating offsite in shallow groundwater. Where impacted, the concentrations in shallow groundwater display seasonal variability suggesting residual contaminants in overlying soils may continue to be a source to groundwater in the future.

Some slow increasing trends in contaminant concentrations occur in shallow groundwater at the Exterior Wood site. A slow increasing trend in arsenic occurs in onsite well MW-1

(most recent concentration in March 2011 was 67 ug/L) and a slow increasing trend in chromium occurs in onsite well MW-6 (most recent concentration in March 2011 was 149 ug/L) – see Attachment A for well locations. These concentrations are above MTCA Method-A groundwater cleanup levels (5 ug/L for arsenic and 100 ug/L for chromium). There was also a recent elevated detection of copper and chromium in downgradient well MW-9 and a recent elevated detection of copper in MW-1; however, these recent detections are below MTCA cleanup levels and it is not clear if these represent new trends or natural variability. All other wells display relatively stable or decreasing concentrations (but with some seasonal variability). The current status with Ecology is to conduct a site hazardous assessment to determine if further action is required to characterize contamination and/or perform additional remedies at this site (possibly occurring in the next couple years).

The contaminants of concern at **TrueGuard** are arsenic and other priority metals in soil and groundwater, although arsenic in shallow groundwater is the main cleanup driver at this site. Dioxin and dibenzofuran compounds are also listed as suspected (but not confirmed) in soil and groundwater. High levels of arsenic are documented in shallow groundwater near the central portion of the property with concentrations ranging from 600 to 6,400 ug/L (Attachment B). Concentrations decrease to 5 to 75 ug/L at the property boundaries (Attachment B). The general direction of shallow groundwater flow at the TrueGuard site is from northwest to the east-southeast towards Steigerwald Marsh (Figure 2).

TrueGuard is located adjacent (south) of the PSC site. Arsenic in shallow groundwater is also a contaminant of concern at the PSC site and the two plumes appear to be comingled at the property boundary (Attachment B). Both sites have developed site background concentrations for arsenic, which is currently under review by Ecology. Various cleanup technologies have been tested at the TrueGuard site. Pilot testing has shown substantial reduction of arsenic concentrations using air sparging technology. The most current document received by Ecology in 2010 was a work plan for full implementation of air sparging at this site. The air sparging system has been in operation since June of 2011. Ecology is planning to meet with Exterior Wood on August 18, 2015 and should be receiving an update on the site status. PGG will continue discussions with Ecology to obtain updated site information as it becomes available.

The **PSC facility** continues to undergo corrective actions. A recent remedial investigation and feasibility study (RI/FS) was completed in 2013 under the State's MTCA rule. The FS report is currently being reviewed by Ecology. The RI/FS will likely go to public review by the spring of 2016 and a cleanup action plan developed by the fall of 2016. The main contaminants of concern driving cleanup at the PSC site are chlorinated ethenes, 1,4-dioxane, and arsenic in two aquifers (the shallow aquifer within the dredged fill sediments and a lower aquifer within the recent alluvium directly below the silt layer) and the silt aquitard that separates the two aquifers (Figure 2). The depth of impact appears to be limited to the upper 46 feet. Residual contaminants above cleanup levels remain in onsite shallow soils beneath Building 1 (Attachment C), which continue to leach contaminants to the shallow aquifer. Residual contaminants also remain in the underlying silt

layer beneath the former tank farm (Attachment C) and continue to release contaminants to the lower aquifer. The greatest impact to the shallow aquifer occurs east of Building 1 and extends slightly offsite to the east towards the Steigerwald Marsh. The greatest impact to the lower aquifer occurs onsite below the former tank farm and just north of the former tank farm. Impacts to the lower aquifer are largely confined to onsite. The groundwater flow direction in the shallow aquifer is eastward towards Steigerwald Marsh and the lower aquifer is predominantly southward towards the Columbia River (Figure 2). Concentrations in the shallow aquifer are either relatively stable or decreasing; however increasing trends in some chlorinated ethenes (cis-1,2-dichloroethene and vinyl chloride) occur in the lower aquifer beneath the former tank farm. The increasing trends in the lower aquifer may be in part due to the natural breakdown of the higher chlorinated ethenes (PCE and TCE)

The preferred remedy identified in the FS for the PSC site includes enhanced anaerobic bioremediation in the former tank farm area to address chlorinated ethenes leaching from the silt layer and in-situ chemical oxidation of 1,4-dioxane in the shallow aquifer east of Building 1. The predicted restoration time frame at the conditional point of compliance (property boundary) is 20 to 30 years for the lower aquifer and 10 years or less for the shallow aquifer. Groundwater concentrations onsite in the vicinity of the source areas will likely have contaminants above cleanup levels for a much longer period of time.

EXTERIOR WOOD

Exterior Wood is a wood treatment facility that has been in operation at this site since 1977. Before 2001, the facility used chromated copper arsenic (CCA) solution for treating raw lumber and plywood in pressurized retorts. Except for minimal use in agricultural applications, CCA is no longer used at the facility (Saga Environmental and Engineering, Inc. 2011). The site is listed with Ecology's Toxic Cleanup Program as having confirmed arsenic, chromium, and copper in soil and groundwater (Facility ID 33568379)

A contaminant release to the environment from this site was documented in 1995. Information about the release and subsequent corrective actions was found in a Written Notice and Plan of Action letter report to Exterior Wood from AGRA Earth and Environmental (AGRA) dated August 24, 1995 and a Status Letter Report to Chuck Clarke of EPA Region 10 from Exterior Wood, Inc. dated September 15, 1995.

During a site visit by AGRA, structural failures were identified on portions of the drip pad, described as hexagonal or alligator skin-like patterned cracks in the asphalt. It is unknown how long the drip pad was in this condition prior to 1995. Subsequent investigative work performed in 1995 found detectable concentrations of arsenic, chromium, and copper in subsurface soils around the drip pad and underlying shallow groundwater (20-ft deep or less). Low levels of copper were also detected in the facility's process water well during this time, presumably below MTCA cleanup levels, suggesting some diffuse vertical migration may have occurred at this location in the past. Actual concentrations are not reported in these 1995 documents. A well log for Exterior Wood obtained from Ecology's on-line database describes a 115-ft deep well completed in sand and

gravel in 1977 for industrial water supply. The Exterior Wood supply well is likely drawing water from the Pleistocene Alluvial Aquifer (PAA) beneath the recent alluvium. In a 2011 Technical Memorandum (see below), it was recommended that the supply well be resampled; however, resampling results were not found in Ecology's files. PGG is currently in contact with Ecology to address investigation of potential vertical migration during their on-going negotiations with this site.

Corrective Actions undertaken in 1995 included excavation of 200 cubic yards of CCA-impacted soils and asphalt and repair of the failed drip pad asphalt. Some soils with elevated CCA were left in place where removal was not feasible due to the presence of structural features and in places where testing showed groundwater was not impacted (Exterior Wood, 1995). Detailed investigative reports of the 1995 activities were not found in Ecology's files. It is unknown what concentrations of CCA were originally observed in the underlying soils, their lateral extent, or to what extent impacted soils remain. The Plan of Action letter did however note impacted soils were primarily confined to a zone one foot below the drip pad surface and that post excavation testing indicated removal was generally successful except in those areas where excavation was not feasible (Exterior Wood, 1995).

A more recent document summarizing site groundwater monitoring is provided in a Technical Memorandum from Brag Berggren of Saga Environmental and Engineering, Inc. (Saga) dated May 26, 2011. The Saga report provides a summary of groundwater monitoring conducted up until March 2011. Reports on groundwater monitoring after March 2011 were not available in Ecology's files.

The 2011 Saga reports that nine groundwater monitoring wells are installed on the site (Attachment A) primarily around the drip pad (upgradient and downgradient wells) and that groundwater monitoring for arsenic, chromium, and copper has been conducted on a quarterly to semi-annual basis at the site since 1995. Well logs for Exterior Wood monitoring wells obtained from Ecology's on-line database show these wells are 20-ft deep or less. Sediments encountered at depth below the 1-ft gravel base are characteristic of marsh and recent alluvial deposits variably described in the logs as silty sand to silty clay. Based on the well log for the facility supply well, the thickness of the recent alluvium is about 34-ft thick at this location.

The depth to groundwater onsite ranges from approximately 1 to 12 feet below ground surface. The general gradient is towards the north (away from the Columbia River) with discharge towards the Gibbons Creek Remnant Channel. The estimated horizontal groundwater velocity at the site is 2.5 to 50 ft/yr. A lower than expected groundwater level has been observed in upgradient well MW-6 which is located near the facility's water supply well and may be influenced by pumping from the supply well.

The 2011 Saga report compared groundwater data to MTCA groundwater cleanup levels:

- Arsenic = 5 ug/L (Method-A)
- Chromium = 100 ug/L (Method-A)

- Copper = 100 ug/L (Method-B)[1]

See Attachment A for location of wells discussed in the following summary.

Groundwater concentrations in onsite wells *downgradient* of the drip pad (towards the north) have remained relatively stable since monitoring first began and are either non-detected or at concentrations below MTCA (MW-3, MW-8, and MW-10). A recent elevated detection of chromium and copper (9.23 ug/L and 30.6 ug/L respectively) was reported in downgradient well MW-9 during the March 2011 sampling event; however, these elevated detections are still below MTCA cleanup levels. Previous concentrations of chromium and copper (since 1997) in well MW-9 are generally less than 2 ug/L. It is unknown if the March 2011 results are indicative of a new increasing trend in this well.

Elevated concentrations of arsenic, chromium, and copper are generally observed in one or more onsite wells immediately *upgradient* of the drip pad (MW-4 and MW-11) and along the east side of the property (MW-1 and MW-6). MW-6 is located adjacent to a portion of the drip pad where some of the highest chromium concentrations in soil were observed prior to excavation. Concentrations and trends observed in these wells are as follows:

- MW-4: Historically arsenic exceeded MTCA Method-A in this well with concentrations as high as 63.6 ug/L (1999); however concentrations have generally *decreased* since 2000 and since 2009 have been below MTCA Method-A. The most recent arsenic concentration in March 2011 was 1.11 ug/L. Concentrations of chromium and copper have been somewhat variable in this well but always below MTCA values. The most recent chromium and copper concentrations were < 2 ug/L (undetected) and 5.84 ug/L respectively.
- MW-11: Arsenic has exceeded MTCA Method-A in this well since 1997, with relatively stable concentrations (though somewhat variable between sampling events). A maximum concentration of 83.9 ug/L was observed in September 2009 and the most recent concentration in March 2011 was 45 ug/L. Concentrations of chromium and copper are much lower (typically less than 2 ug/L).
- MW-1: Arsenic concentrations have generally *increased* in this well over time and have consistently exceeded the MTCA Method-A level since 2005. The most recent arsenic concentration in March 2011 was 67 ug/L. Chromium concentrations are generally less than 5 ug/L, except for a single elevated concentration of 33.8 ug/L in March 2010. Copper concentrations are typically less than 10 ug/L, but more recent concentrations in 2010 and 2011 have been higher (as high as 26.9 ug/L in March 2010). It is not clear if the recent 2010 and 2011 elevated copper results are indicative of a new increasing trend in this well.
- MW-6: Chromium concentrations in this well have *increased* from values typically less than 5 ug/L prior to 2005 to a maximum of 149 ug/L recently measured in March 2011 (above MTCA Method-A). Chromium concentrations in this well display sig-

[1] Copper does not have an established Method-A level. Method-B is shown for comparison.

nificant variability from one sampling event to the next. For example the concentration of chromium measured in September 2009, December 2009, March 2010 and June 2010 was < 2 ug/L, 112 ug/L, 7.26 ug/L and 88.5 ug/L respectively. The large variability in chromium concentrations from one sampling event to the next suggests fluctuating groundwater elevations may be remobilizing residual contaminants in site soils; although changes in redox conditions may also play a role in mobilizing metals. As mentioned above, MW-6 is located adjacent to a portion of the drip pad where some of the highest chromium concentrations in soil were observed prior to excavation. Arsenic and copper concentrations in this well are typically less than 5 ug/L (below MTCA levels) and have been somewhat more stable over time.

Along the northeast corner of the property (downgradient of MW-1 and MW-6) the concentrations of arsenic, chromium, and copper are relatively low (generally less than 2 ug/L) and well below MTCA levels.

Recommendations in the Saga 2011 report was to continue monitoring of arsenic and chromium on a quarterly basis for the next year to evaluate trends over time, after which the frequency of monitoring would be reassessed. It was recommended that the frequency of copper analysis be reduced to annual events. The Saga 2011 report also recommended that the facility's water supply well be sampled during the next sampling event. Sampling results were not found in Ecology's files; however, PGG is currently in contact with Ecology to address investigation of potential vertical migration during their ongoing negotiations with this site.

The above observations suggest impacted groundwater is generally limited to onsite shallow groundwater in the immediate vicinity of the drip pad where the original release occurred with limited lateral and vertical mobility. Corrective measures taken in 1995 have removed most of the release and although residual contaminated soils may remain, ongoing groundwater monitoring indicates no contaminant migration away from this site.

The Department of Ecology sent Exterior Wood an Early Notice letter on January 4, 2012 indicating the site has been listed as a State Cleanup Site and in the future Ecology may conduct a Site Hazard Assessment to determine if further action is needed. According to conversations with Kirsten Alvarez at the Department of Ecology on 7/15/2015 there have been no reports or actions through Ecology on this site since 2012. The next step is a Site Hazardous Assessment to determine if further action is required to characterize contamination and/or perform additional remedies at this site (possibly occurring in the next couple years).

TRUEGUARD, LLC (ALLWEATHER WOOD TREATERS, INC.)

TureGuard, LLC (formerly known as Allweather Wood Treaters, Inc. before 2007) is a wood preserving facility located adjacent to (south) of the Philip Service Corporation (PSC) Site. Lumber is pressure treated with ACQ (alkaline copper quaternary), borates, and CCA (chromium copper arsenate). The facility has been in operation since 1985 and operates with an NPDES permit for discharge to the Gibbons Creek Remnant Channel,

which flow westward to a pump station near the Exterior Wood parcel which pumps the water to the Columbia River. A review of NPDES documents show elevated levels of copper above NPDES discharge limits have occurred on several occasions. Elevated levels of hexavalent chromium have also occurred a few times.

The site was recently registered with Ecology through the Voluntary Cleanup Program in 2007 due to confirmed contamination of arsenic and other priority metals above cleanup levels in soil and groundwater. According to documents reviewed by PGG, the source of arsenic in groundwater was from a cracked foundation under the main retort. The cracked foundation was repaired in 2007. Dioxin and dibenzofuran compounds are also listed as suspected (but not confirmed) in soil and groundwater.

PGG contacted the Ecology site manager to learn the status of the site (phone conversation with Tom Middleton 7/23/15). The site is currently undergoing voluntary cleanup and Ecology receives periodic updates. The main contaminant of concern is arsenic in shallow groundwater (3 to 20 feet below ground surface). Various cleanup technologies have been attempted in the past. The most recent documents received by Ecology was for an air sparging work plan submitted in 2010 and a technical memorandum submitted in 2014 for developing site background arsenic concentrations. Both these documents were obtained by PGG through a public records request. The following summary is based on review of these two documents and review of investigative and remedial work performed between 2007 and 2009 by Maul Foster Alongi (MFA) as summarized by AMEC in the recent RI/FS completed for the adjacent PSC site (see below). PGG has contacted MFA to request copies of past investigative reports. We have also contacted Ecology to request copies of submitted older site status reports. To date we have not received copies of all documents but will provide additional documentation once it has been received.

MFA's investigative work identified arsenic in shallow groundwater at concentrations ranging from about 600 to 6,400 ug/L in the central portion of the property (Attachment B). Concentrations decrease to values ranging from about 5 to 75 ug/L at the property boundaries (Attachment B). Iron, manganese, copper, and chromium are also detected at concentrations above preliminary cleanup up levels. Shallow groundwater at the site flows generally from northwest to the east-southeast towards Steigerwald Marsh, which is consistent with findings on the adjacent PSC property (see below).

Arsenic concentrations are naturally elevated in the shallow aquifer due to a highly reducing aquifer environment. A site background arsenic concentration in shallow groundwater for the TrueGuard site was recently calculated to be 18.6 ug/L, which is above the MTCA Method-A cleanup level (5 ug/L). Site background arsenic concentrations were also calculated for the adjacent PSC site (22.84 ug/L for shallow groundwater and 1.42 for the lower aquifer). If adopted, these background concentrations could become cleanup levels at these sites. Ecology is still reviewing calculated arsenic background concentrations for both the TrueGuard and PSC sites.

Starting in 2008, a series of pilot studies were conducted at the TrueGuard site to identify appropriate in-situ remediation technologies for reducing arsenic. Initial studies focused

on injection of Adventus EHC-M (in 2008) and activated red mud and persulfate (in 2009). Both studies showed marginal improvements and did not support full scale implementation. A field pilot test of air sparging in 2010 showed substantial improvements in arsenic concentrations. A work plan for implementing full scale air sparging remediation at the site was submitted in August 2010. The air sparging system has been in operation since June of 2011. Ecology is planning to meet with Exterior Wood on August 18, 2015 and should be receiving an update on the site status at that time. PGG will continue to be in touch with Ecology regarding this site and provide updated information as it becomes available.

PHILIPS SERVICES CORPORATION (PSC)

The Philip Service Corporation (PSC) facility in Washougal continues to undergo corrective actions under the facility's Resource Conservation and Recovery Act (RCRA) Part B permit. A recent Remedial Investigation and Feasibility Study (RI/FS) was completed in 2013 according to the State's Model Toxic Control Act (MTCA) regulations to characterize the nature and extent of contamination and to evaluate potential cleanup options. The following section provides a brief summary of site history and earlier investigations. This earlier work was previously summarized by PGG in 2007. Subsequent sections summarized the more recent RI/FS work.

PSC SITE HISTORY AND PREVIOUS INVESTIGATIONS

The PSC site was constructed in 1978 and originally owned and operated by McClary Columbia Corporation (MCC) for production of phenolic resins, and later defoamers and water treatment chemicals for the paper industry. Phenolic production ceased in 1979 and the facility was operated as a waste oil recovery for boiler fuel. In 1985 the site was purchased by Chemical Processors, Inc. and that same year a drum storage building was constructed and in 1986 a tank farm was installed. The contents stored in the tanks included industrial defoamers, detergents, and recycled solvents (the tank farm was dismantled in 1995). In 1992, Burlington Environmental, Inc. (BEI) purchased the property and in 1993, PSC (Formerly Philip Environmental Inc.) purchased BEI.

Early investigative work occurred in 1985 and 1986 in response to compliance inspections by the Department of Ecology and reports of illegal discharge of product and waste by former MCC employees. In 1986 a recovery well was installed in the vicinity of the tank farm to recover DNAPL. The primary constituents detected in DNAPL included 1,1,1-TCA, trichlorotrifluoroethane, TCE, PCE, toluene and xylene. The recovery well was screened 1.5 to 8 feet below ground surface with the bottom of the well about 2 feet into the silt layer. Approximately 60 gallons of dark colored solvent mixture and 18,000 gallons of contaminated groundwater were removed. A 1988 post-closure RCRA 3008(h) order was issued for further investigative and corrective action work. PSC continued investigative work through the 1990's. In 1995 the tank farm was removed and in 1996 a Silt Investigation was conducted to evaluate the continuity of the silt later below the facility and collect soil samples for chemical analysis.

In 1997 all soil and asphalt beneath the former tank farm was excavated and sampled to the silt layer. High levels of chlorinated solvents were detected in excavated soils. During the excavation a "dry well" was discovered consisting of a series of plastic 5-gallon buckets connected together with the bottom bucket perforated (total depth was about 6 feet). Post excavation sampling indicated some residual contamination above MTCA Method-B cleanup levels remained east of the tank farm near the office building (Building 1) where excavation was infeasible.

A Draft RI and Supplemental RI were submitted in 2000 and 2002. In 2007, an RI Work Plan was submitted to address remaining data gaps. Data gap investigative work was conducted between 2007 and 2011 and the final RI was completed in 2013 (see below). Regular groundwater monitoring has been conducted on the site since 2000.

PSC REMEDIAL INVESTIGATION AND FEASIBILITY STUDY (2013)

The following sections describe the main findings in the 2013 RI/FS (AMEC, 2013).

HYDROGEOLOGY

Investigative work at the facility has focused on depths less than 46-feet within the recent alluvium and overlying dredge sand fill. Two aquifers (shallow and lower) and one aquitard (confining layer) have been characterized (Figure 2).

Sand Fill (Shallow Aquifer)

Sand dredged from the Columbia River and emplaced over the floodplain silts in the Industrial Area comprises the shallow aquifer. The depth to water in the shallow aquifer varies from 4 to 6 feet below ground surface (bgs) during the dry season and 1 to 4 feet bgs during the wet season. Monitoring since 1994 indicates a consistent horizontal flow direction towards the east discharging to the Steigerwald Marsh with an average gradient of 0.011 ft/ft and an average linear groundwater velocity of 0.4 ft/day. No hydraulic relationship has been observed between Columbia River stages and groundwater levels in the shallow aquifer. A fairly strong tidal response; however, was observed in the underlying lower aquifer (see below). These relationships suggest that the intervening silt confining layer acts to limit the hydraulic connections between the shallow and lower aquifers. The saturated thickness in the shallow aquifer decreases towards the east such that groundwater discharging to the marsh east of the site is mainly derived from groundwater in the underlying Silt Layer (see below).

Silt Layer (Aquitard)

The silt layer is laterally continuous beneath the site and represents the former floodplain beneath the sand fill. The unit is characterized as dark greenish gray to black silt and clay with high organic content. Groundwater in the silt layer exhibits a highly reducing environment and forms a relatively low permeable unit between the shallow and lower aquifers. The thickness of the silt layer beneath the facility varies from about 5 to 20-ft. Both

upward and downward vertical hydraulic gradients have been measured across the silt layer generally due to fluctuating elevations of the Columbia River.

Gravel Unit and Deeper Units (Lower Aquifer)

Only the upper 40 feet of the lower aquifer has been investigated at the site. The unit is characterized as discontinuous gravel and silty sand. The lower aquifer is confined by the overlying silt layer and groundwater levels fluctuate seasonally by about 6-ft.

The dominant flow direction in the lower aquifer is southward towards the Columbia River; however during brief high tides and high discharge events in the Columbia River there are short-term northward flow directions observed towards the Gibbons Creek Remnant Channel. A 2-week continuous water level monitoring study conducted in December 1990 shows a strong correlation between Columbia River Stage and groundwater elevations in the lower aquifer. The magnitude of the groundwater response was about 1/3 of the river stage with about a 4 hour lag.

NATURE AND EXTENT OF CONTAMINATION

The primary contaminants of concern (COCs) in groundwater at the PSC site are chlorinated ethenes, 1,4-dioxane, petroleum compounds, and select metals. Mobilized metals in groundwater appear to be correlated to reducing conditions attributed to the marsh sediments and natural degradation of the organic COCs.

The main source of contamination at the site is associated with the former tank farm and dry well; although various other spills have reportedly occurred onsite. High levels of contaminants remain in the shallow soils immediately east of the former tank farm beneath Building 1 (where excavation was infeasible) and in the underlying silt layer beneath the former tank farm. Organic COCs (chlorinated ethenes, benzene, ethylbenzene, and m,p-xylenes) and inorganic COCs (cyanide, arsenic, vanadium, copper, and zinc) exceed preliminary soil cleanup levels in several areas beneath the site.

The greatest impact to the ***shallow aquifer*** occurs east of Building 1 near South 32nd Street and extends eastward offsite towards Steigerwald Marsh (wells MC-14, MC-20 and MC-123 in Attachment C); however, a preferential northward flow path may also occur within permeable fill around a utility line that runs along South 32nd Street. Leaching of residual contaminants in shallow soils beneath Building 1 likely continues to contribute to high concentrations in the shallow aquifer at this location. COC concentrations in the shallow aquifer are either steady or slowly decreasing over time; although seasonal variability is apparent with fluctuating water levels, suggesting remobilization of soil contaminants may be ongoing.

The greatest impact to the ***lower aquifer*** occurs onsite below the former tank farm (MC-24D and MW-25D) and about 40 feet north of the former tank farm (MW-118D) - See Attachment C for well locations. Leaching of residual contaminants in the overlying silt layer continues to contribute to high concentrations of COCs in the lower aquifer at this

location. The concentrations of some chlorinated ethenes have increased over time (with seasonal variability) in the lower aquifer near the former tank farm. Vinyl chloride has slowly increased in monitoring wells MC-24D, MC-25D and MC-118D and cis-1,2-dichlroethene has slowly increased in MC-24D and MC-25D. The increasing trend may be partly related to on-going degradation of tetrachloroethene and trichloroethene. The concentration of 1,4-dioxane in MW-24D and MW-25D may also be slowly increasing; although the trend is much less discernible.

The highest concentrations of detected organic contaminants in groundwater measured most recently (between September 2011 and June 2012) are as follows, preliminary groundwater cleanup levels identified in the RI are provided for comparison (see Attachment C for well locations):

Tetrachloroethene (PCE) – Preliminary cleanup level = 0.69 ug/L

- Shallow Aquifer = 4.02 ug/L (Onsite MC-21 east of Building 1)
- Silt Layer = 24 ug/L (Onsite GP-118 beneath former tank farm)
- Lower Aquifer = 29.4 ug/L (Onsite MC-118D north of former tank farm)

Trichloroethene (TCE) – Preliminary cleanup level = 0.54 ug/L

- Shallow Aquifer = 0.95 ug/L (Offsite MC-20 east of South 32nd Street)
- Silt Layer = 2.4 ug/L (Onsite GP-116 near former tank farm)
- Lower Aquifer = 3.4 ug/L (Onsite MC-25D beneath former tank farm)

1,2-cis-Dichloroethene – Preliminary cleanup level = 16 ug/L

- Shallow Aquifer = 92.4 ug/L (Onsite MC-14 east of Building 1)
- Silt Layer = 16,000 ug/L (Onsite GP-118 beneath former tank farm)
- Lower Aquifer = 2,400 ug/L (Onsite MC-25D beneath former tank farm)

Vinyl Chloride – Preliminary cleanup level = 0.025 ug/L

- Shallow Aquifer = 1.4 ug/L (Onsite MC-14 east of Building 1)
- Silt Layer = 21 ug/L (Onsite GP-118 beneath former tank farm)
- Lower Aquifer = 84 ug/L (Onsite MC-25D beneath former tank farm)

1,4-Dioxane – Preliminary cleanup level = 1 ug/L

- Shallow Aquifer = 140 ug/L (Onsite MC-14 east of Building 1)
- Silt Layer = 78 ug/L (Onsite GP-122 beneath former tank farm)
- Lower Aquifer = 11 ug/L (Onsite MW-24D beneath former tank farm)

The concentration of organic contaminants migrating offsite are considerably lower than the above, though some contaminants migrating offsite are still above preliminary clean-up levels.

HRC PILOT TEST - INTERIM ACTION

In 2000, PSC conducted a pilot test to evaluate treatment of shallow groundwater in the vicinity of MW-14 to reduce the amount of contamination migrating across South 32nd Street toward Steigerwald Marsh. The pilot test consisted of injecting hydrogen-releasing compound (HRC) into 12 direct-push borings upgradient of MW-14. Post pilot testing monitoring showed somewhat lower concentrations compared to pre-pilot testing. However lower concentrations were also observed in up-gradient and cross-gradient wells - thus the observed lower concentrations may be the result of previous source removal in 1997 and natural degradation. The study concluded that use of HRC may have some benefit but not a significant one.

PREFERRED CLEANUP PLAN

The preferred cleanup alternative identified in the Feasibility Study (Alternative A-2) includes the following measures:

- Continued IPIM under Building 1 (inhalation pathway interim measure)
- Augmentation of surface cover by paving over targeted contaminated areas
- Long-term monitoring and maintenance of surface cover
- Grouting of utility trench along South 32nd Street
- Enhanced anaerobic bioremediation with carbohydrate injection in tank farm area and near MW-118D to address chlorinated ethenes in silt layer and shallow soils
- In-situ chemical oxidation of elevated 1,4-dioxane in area around MC-14
- Monitored natural attenuation of groundwater downgradient of remediation areas
- Groundwater monitoring for at least 20 years
- Institutional controls (including deed restrictions)

The main disadvantage of the preferred remedy is the uncertainty in enhanced bioremediation effectiveness in the underlying silt layer. Given the low permeability of the silt layer it may not be possible to adequately distribute the injection solution. There is also a potential for vinyl chloride to increase during the break down of parent chlorinated ethenes. Full degradation of vinyl chloride with this technology may or may not be possible.

The predicted restoration time frame at the conditional point of compliance (parcel boundary) is 20 to 30 years in the lower aquifer and 10 years or less in the shallow aquifer. Groundwater concentrations onsite in the vicinity of the source area will likely have COC's above cleanup levels for a much longer period of time.

PGG contacted the Ecology site manager Kaia Petersen to learn the status of the site since completion of the RI/FS (phone conversation 7/28/15). The FS report is currently being review by Ecology. No more remedial investigative work is anticipated for the site. The RI/FS will likely go out for public review by the spring of 2016 and Ecology hopes to have a Cleanup Action Plan (CAP) completed by the fall of 2016. All site undergoing cleanup actions under MTCA require 5 year reviews to assess the effectiveness of the remedy. If conditions are not improving as anticipated, additional remedies/contingencies may be considered.

Site specific background concentrations for arsenic were developed in the RI (22.84 ug/L for shallow groundwater and 1.42 for the lower aquifer). If adopted, these background concentrations could become cleanup levels at these sites. Ecology is still considering site-specific background concentrations for arsenic at this site. Upgradient arsenic concentrations outside the contaminated source area are elevated due to other offsite sources and natural background.

FIGURES

Figure 1: Study Area

Figure 2: Conceptualized Hydrogeologic Cross Section through Steigerwald Marsh Area

ATTACHMENTS

Attachment A: Scanned Figure showing Exterior Wood Monitoring Wells

Attachment B: Scanned Figure showing TrueGuard Monitoring Wells

Attachment C: Scanned Figure showing PSC Monitoring Wells

REFERENCES

AGRA Earth and Environmental, 1995. Letter dated August 24, 1995 to Steve Hogan (general manager at Exterior Wood) regarding Written Notice and Plan of Action Exterior Wood, Inc. Facility Drip Pad Washougal, Washington.

AMEC Environmental and Infrastructure, Inc., 2013. Final Remedial Investigation Report, PSC Washougal Facility – Washougal, Washington.

AMEC Environmental and Infrastructure, Inc., 2013. Final Feasibility Study Report, PSC Washougal Facility – Washougal, Washington.

Exterior Wood, Inc. 1995. Letter from Steve Hogan (general manager at Exterior Wood) to Mr. Chuck Clarke of the U.S. EPA region 10 regarding 10-Day Written Notice and Plan of Action.

Maul Foster Alongi, 2010. Letter dated August 18, 2010 from James Peale, LG and Ted Wall, PE to Tom Middleton LHG of Department of Ecology regarding Horizontal Air Sparging Work Plan.

Maul Foster Alongi, 2014. Letter dated November 13, 2014 from Tony Silva, RG to Tom Middleton of Department of Ecology regarding Arsenic Background Groundwater Evaluation

Pacific Groundwater Group, 2007. Steigerwald Area Exploration and Testing Program Draft Report. Consultant's report prepared for City of Camas May 2007.

Saga Environmental and Engineering, Inc. 2011. Technical memorandum from Brad Berggren, PE, LHG regarding Exterior Wood Groundwater Monitoring Review.

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① Philip Services Corporation (formerly Burlington Environmental)

② Exterior Wood Parcels

③ TrueGuard LCC (Formerly Allweather Wood Treaters, Inc.)

Steigerwald Wellfield Parcel

Test Wells

N

0 Feet 1,000

Figure 1
Study Area

PgG

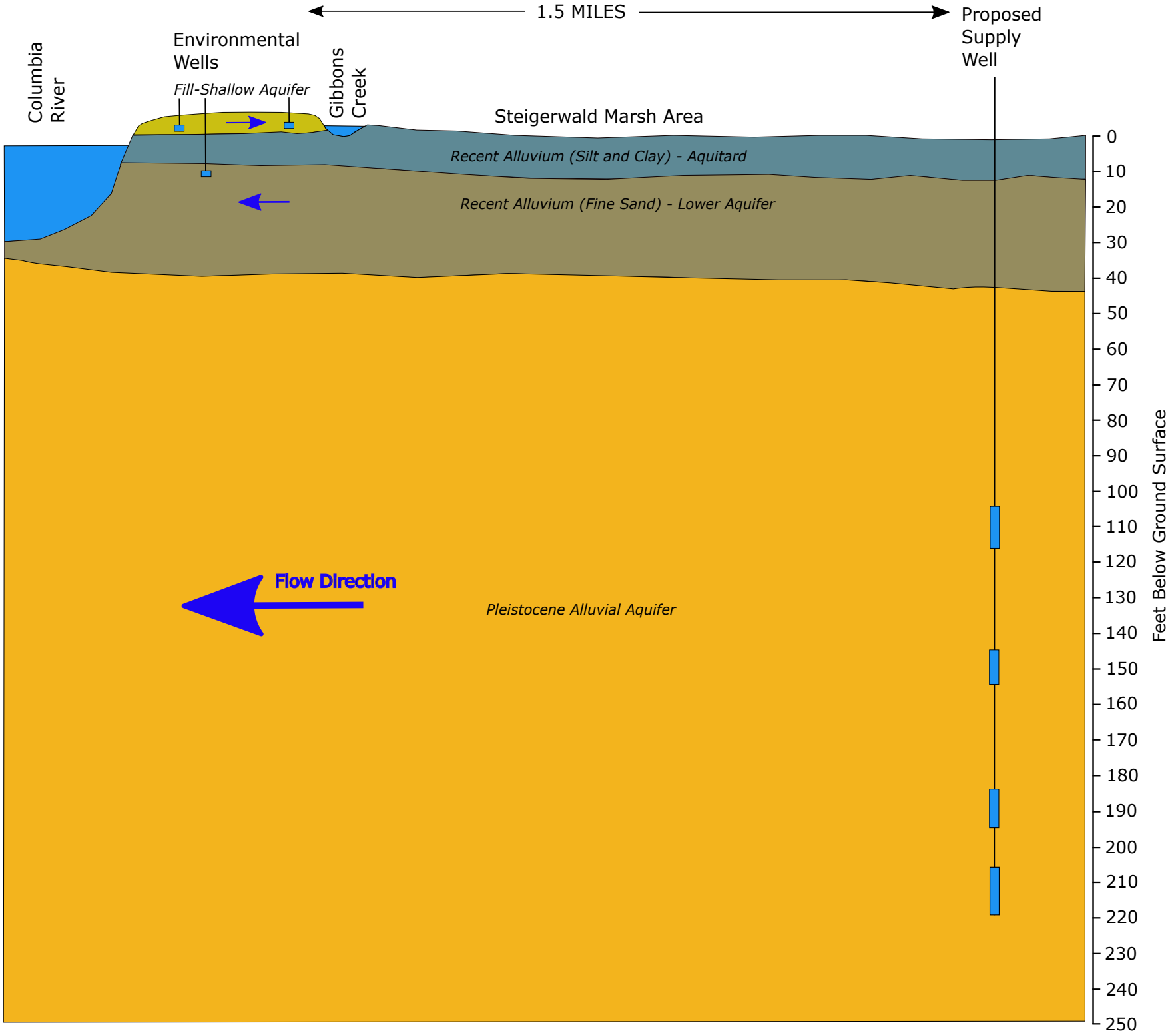
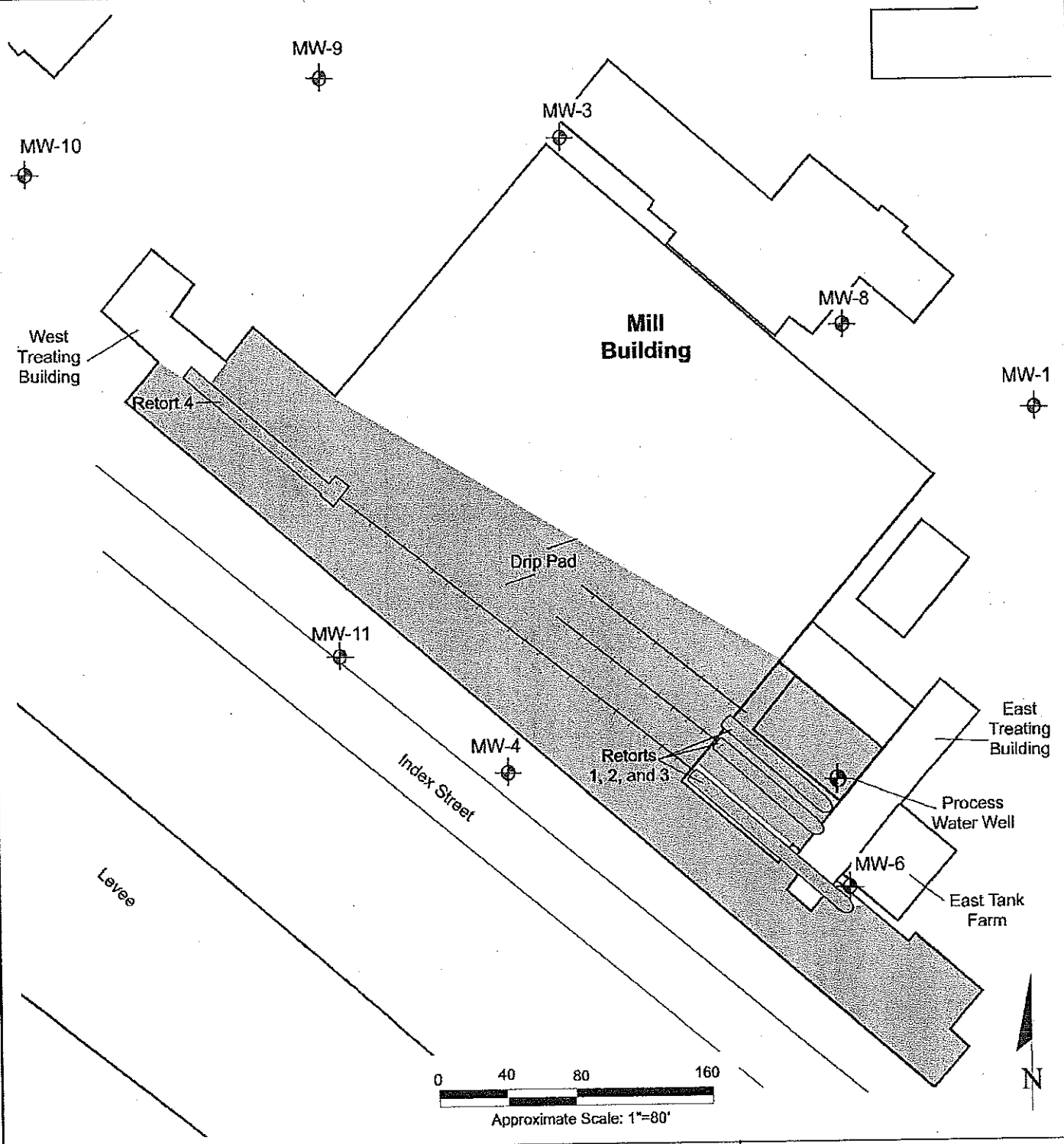


Figure 2. Conceptualized Hydrogeologic Cross Section through Steigerwald Marsh Area

ATTACHMENT A



LEGEND

- Structure
- Retort
- Drip Pad
- Tram Track
- Approximate Monitoring Well Location
- Approximate Process Water Supply Well Location

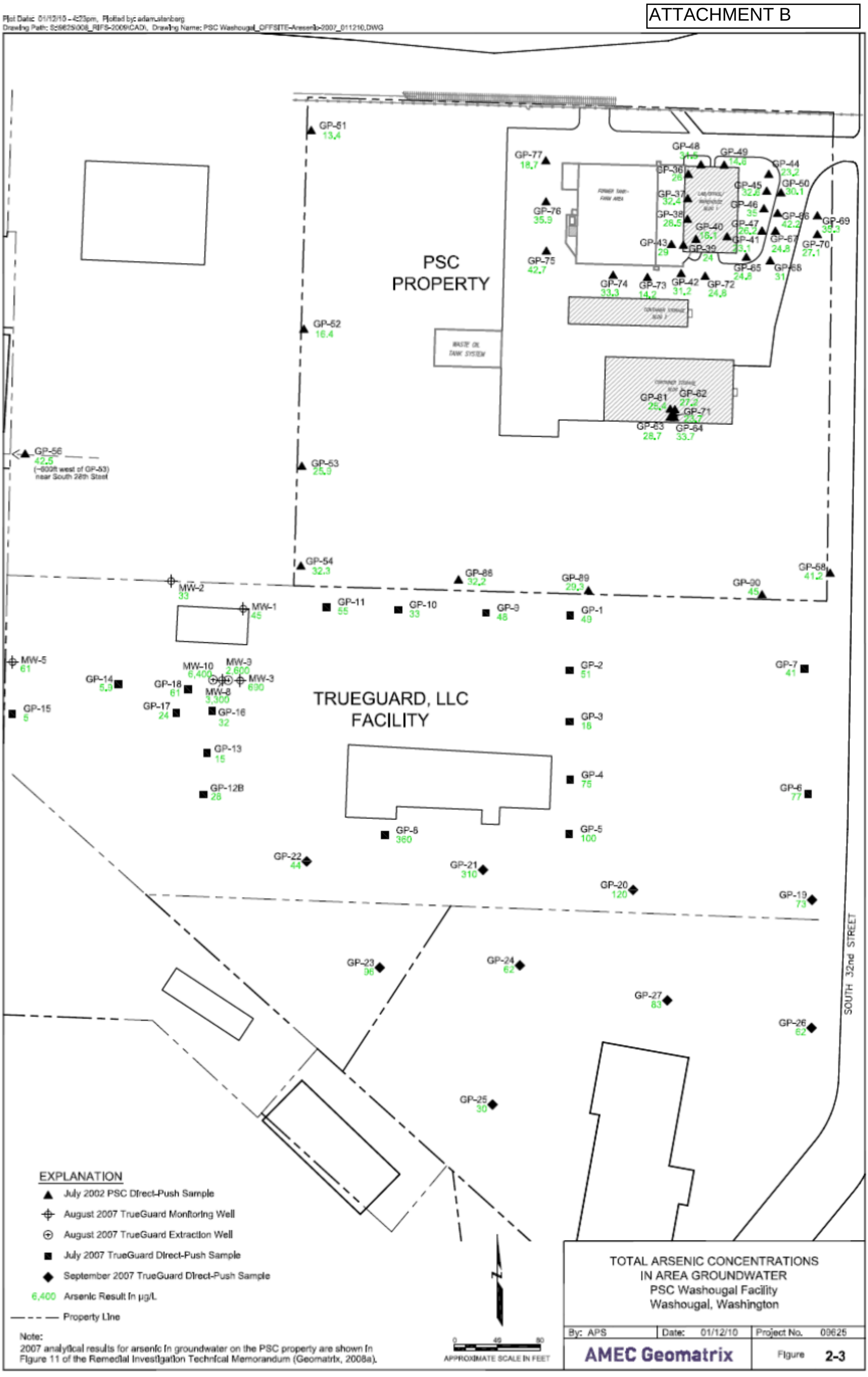
Sources:
- Exterior Wood 2009
- Google Earth 2009
- GeoEngineers 2011

Figure 1
Drip Pad and Monitoring Well Locations

Exterior Wood
2685 Index Street
Washougal, Washington

Project No. 098301.00 May 2011

ATTACHMENT B



ATTACHMENT C