CHPRC-02625
Revision 0

Compilation of Information Regarding Extraction and Injection Wells of the 100 Areas Pump and Treat (P&T) Systems

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

P.O. Box 1600
Richland, Washington 99352

Approved for Public Release;
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TECHNICAL MEMORANDUM

Compilation of Information Regarding Extraction and Injection Wells of the 100 Areas Pump and Treat (P&T) Systems

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1 Introduction

This technical memorandum presents information on a compilation of information regarding the extraction and injection wells of the 100 Areas pump and treat (P&T) systems.

2 Background and Scope

Five P&T systems are currently operational in the Hanford 100 Areas to reduce the footprint of groundwater contamination and to prevent various contaminants of concern from discharging into the Columbia River. Table 1 lists the number of extraction and injection wells in each P&T system.

Table 1. Number of Extraction and Injection Wells by P&T System

100 Area P&T System Name	Number of Extraction Wells	Number of Injection Wells
HX	31	15
DX	44	14
KX	18	9
KR4	12	5
KW	11	4

Information regarding these pumping wells is compiled in an Excel Spreadsheet titled "*CHPRC-02625_Rev0_100AreasPumpingWellsInformation.xlsx*". This compilation includes well type, remediation objective, location, construction, and stratigraphy information for each pumping well. Additionally, aquifer and well parameters estimated from well development and operational data are presented. This compilation will be used to gauge the effectiveness of each pumping well, support the

remedial investigation/feasibility study needs for each 100 Area operable unit, and assist in developing remedial designs. This technical memorandum, which is intended as a companion guide to the spreadsheet, describes the various data fields (and associated data sources) found in the spreadsheet.

3 Compilation Description

The compilation spreadsheet contains several worksheets. The "*Master*" worksheet presents the compilation of data and various analyses regarding the pumping wells. The remaining worksheets furnish data to the "*Master*" worksheet. A brief summary of the contents of each worksheet follows:

- *Source:* This worksheet contains an indexed list of various data sources.
- *AvgWL:* This worksheet contains the average water levels in each pumping well for the 2012-2014 period.
- *Stratigraphy:* This worksheet contains the stratigraphic elevations at each pumping well.
- *OpenAreaCalcs:* This worksheet contains calculations related to open well screen area.

Table 2 describes the data fields in the *Master* worksheet and their associated data sources. Note that compiled information in the spreadsheet is subject to change as the analyses and underlying data sets are updated.

Table 2. Descriptions of Data Fields in the Compilation

Group	Column Name	Column Description	Data Source
Well Info	Well	Name of the well.	Hanford Environmental Information System (HEIS) database
	System ID	System identification of the well.	HEIS database
	Well Type (EW, IW)	The well type is indicated by a two letter code. EW is used for extraction wells; IW is used for injection wells.	HEIS database
Status	CY2014 Cr(VI) Concentration (mg/l)	Hexavalent chromium concentration (mg/l) at the well location based on the fall calendar year (CY) 2014 plume.	The fall CY 2014 plume is shown in DOE/RL-2015-07, *Hanford Site Groundwater Monitoring Report for 2014*.
	Remediation Objective (RP, MR, AR)	Based on the location of the well, each well is assigned a two letter code that indicates its remediation objective. RP = River Protection, MR = Mass Recovery, AR = Aquifer Restoration.	SSP&A after discussion with CHPRC.
	Scheduled for Redevelopment (Y/N)	Indicates whether the well is scheduled to be redeveloped. Y=Yes and N = No.	SSP&A after discussion with CHPRC.
Location	Groundwater Operable Unit	Operable unit in which the well is located.	HEIS database.
	P&T System	Names the P&T system to which the well is connected.	HEIS database.
	Easting	Easting coordinate (NAD1983_StatePlane_Washington_South_FIPS_4602, meters).	HEIS database.
	Northing	Northing coordinate (NAD1983_StatePlane_Washington_South_FIPS_4602, meters).	HEIS database.
	Ground Surface Elevation (m)	Ground surface elevation (NAVD88, *North American Vertical Datum*, m) at the well.	Well construction spreadsheets (CHPRC).
	100AGWM Model Row	Indicates the row number of the 100 Area Groundwater Model (100AGWM) in which the well is located.	The 100AGWM is documented in SGW-46279, *Conceptual Framework and Numerical Implementation of 100 Areas Groundwater Flow and Transport Model*.
	100AGWM Model Column	Indicates the column number of the 100 Area Groundwater Model (100AGWM) in which the well is located.	The 100AGWM is documented in SGW-46279.
	Distance From River Shoreline (m)	Distance in m from the well to the river shoreline. The low river shoreline shapefile was digitized using piecewise-linear segments. From each well, the perpendicular distance to this redigitized shapefile was calculated and reported as the distance to the river.	Calculated by SSP&A based on the method detailed in the preceding column.
Stratigraphy (Elevations in m)	Top of Hanford	Top of the Hanford formation at the location of the well (NAVD88, m).	Calculated by SSP&A based on geology information obtained from ECF-Hanford-13-0020, *Process for Constructing a Three-dimensional Geologic Framework Model of the Hanford Site's 100 Area*. Basalt elevations were obtained from Intera Inc. in the file *basalt Ellensburg top_20l0update m.ascii*.
	Top of Reworked Ringold E	Top of the Reworked Ringold E formation at the location of the well (NAVD88, m). A code of -99999 is used to indicate that the formation is not present at the well.	
	Top of Ringold E	Top of the Ringold E formation at the location of the well (NAVD88, m). A code of -99999 is used to indicate that the formation is not present at the well.	
	Top of Reworked RUM	Top of the Reworked Ringold Upper Mud (RUM) formation at the location of the well (NAVD88, m). A code of -99999 is used to indicate that the formation is not present at the well.	
	Bottom of Aquifer Elev	Bottom of the unconfined aquifer (NAVD88, m). The elevation is set to the top elevation of the RUM formation where it is present and to the top elevation of the Basalt formation where the RUM is absent.	
	Stratigraphy in Well Screen (Sand/Silt/Gravel)	Indicates whether the dominant stratigraphy in the well screen is sand, silt, or gravel.	Borelogs from HEIS database.

Table 2. Descriptions of Data Fields in the Compilation

Group	Column Name	Column Description	Data Source
Construction	Construction Date	Date on which the well was constructed.	Well construction spreadsheets (CHPRC).
	TOS Elev (m)	Elevation (NAVD88, m) of the top of well screen.	HEIS database.
	BOS Elev (m)	Elevation (NAVD88, m) of the bottom of well screen.	HEIS database.
	Typical WL Elev (m)	Typical water level elevation (NAVD88, m) at the well; average of the measured water level in the 2012-2014 period.	Water levels from the HEIS database.
	Typical Free Head (m)	Indicates the depth to water table from the ground surface.	Calculated by SSP&A using the equation "*Ground Surface Elevation(m)*" *minus* "*Typical WL Elev*".
	Typical Wetted Screen Length (m)	Typical length (m) of the wetted screen.	Calculated by SSP&A using the following conditional evaluation: If "*Typical WL Elev*" > "*TOS Elev*": "*TOS Elev*" *minus* "*BOS Elev*" Else: "*Typical WL Elev*" *minus* "*BOS Elev*".
	Typical Wetted Screen (%)	Typical wetted screen length as a percentage of the total screen length.	Calculated by SSP&A using the equation 100.0 × "*Typical Wetted Screen Length (m)*"/ ("*TOS Elev*" minus "*BOS Elev*").
	Screen Diameter (in.)	Diameter (in.) of the well screen.	HEIS database.
	Filter Pack	Indicates the material forming the filter pack.	Well construction spreadsheets (CHPRC) and HEIS database.
	Slot Size (Thousandths of an in.)	Indicates the slot size (thousandths of in.) in the well screen.	Well construction spreadsheets (CHPRC) and HEIS database.
	Typical Wetted Open Area (in.^{2}/ft)	Open area (in.^{2}) per unit length of wetted screen.	http://www.groundwatersupply.net/images/Stainless_Steel_Well_Screens_and_Accessories_-_North_America.pdf®
	Typical Wetted Open Area (in.^{2})	Typical open area (in.^{2}) of the wetted screen.	Calculated by SSP&A using the equation "*Typical Wetted Open Area (in^2/ft)*" × "*Typical Wetted Screen Length*".
	Wetted Open Area Percent Rank	Percentage rank of the wetted open area. A high rank indicates that the well screen has a lot of open area.	Calculated by SSP&A by sorting the data in the column "*Typical Wetted Open Area (in.^{2})*" in ascending order, assigning a rank from low to high and then dividing the rank with the total number of wells.
Well Development Results	Date of Well Development	Date on which the well development was conducted.	Well development spreadsheets provided by CHPRC.
	Duration of Pumping during the test that was analyzed (min)	Duration of the pumping test in minutes.	Well development spreadsheets provided by CHPRC.
	Pumping Rate (gpm)	Pumping rate in gallons per minute (gpm).	Well development spreadsheets provided by CHPRC.
	Maximum Drawdown (m)	Measured drawdown in m.	Well development spreadsheets provided by CHPRC.
	Drawdown as a % of Typical Saturated Thickness	Measured drawdown expressed as a percentage of the typical saturated thickness.	Calculated by SSP&A based on the equation: "*Maximum Drawdown (m)*"/"*Typical Wetted Screen Length (m)*".
	Estimated SC (gpm/m)	Estimated specific capacity (SC) in gpm/m.	Calculated by SSP&A based on the equation: "*Pumping Rate (gpm)*"/"*Maximum Drawdown (m)*"
	Estimated SC (gpm/ft)	Estimated SC in gpm/ft.	Calculated by SSP&A based on the equation: "*Estimated SC (gpm/m)*"/3.28084.
	Aquifer T from SC (m^2/day)	Aquifer transmissivity estimated from SC in m^2/day.	Calculated by SSP&A based on the methodology described in Appendix A of ECF-Hanford-15-0040, *Analysis of Well Development Data in the 100 Areas*, using the equation: 1.3 × "*Estimated SC (gpm/m)*" × 5.45099.
	Drawdown-Estimated T (m^2/day)	Aquifer transmissivity estimated from drawdown data in m^2/day.	Estimated by SSP&A in ECF-Hanford-15-0040.
	Recovery-Estimated T (m^2/day)	Aquifer transmissivity estimated from recovery data in m^2/day.	Estimated by SSP&A in ECF-Hanford-15-0040.
	Aquifer T from SC (ft^2/day)	Aquifer transmissivity estimated from SC in ft^2/day.	Calculated by SSP&A using the equation: "*Aquifer T from SC (m^2/day)*" × 3.28084^2.
	Drawdown-Estimated T (ft^2/day)	Aquifer transmissivity estimated from drawdown data in ft^2/day.	Calculated by SSP&A using the equation: "*Drawdown-Estimated T (m^2/day)*" × 3.28084^2.
	Recovery-Estimated T (ft^2/day)	Aquifer transmissivity estimated from recovery data in ft^2/day.	Calculated by SSP&A using the equation: "*Recovery-Estimated T (m^2/day)*" × 3.28084^2.

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Table 2. Descriptions of Data Fields in the Compilation

Group	Column Name		Column Description	Data Source
Streamlined Hydraulic Model	Conveyance System	Pipe Length (ft)	Length of pipe from wells to transfer/treatment building in ft.	Appendix A. Input Data from CHPRC-02626, *Description of Hydraulic Calculations for the 100-D, H and K Groundwater Pump-and-Treat [P&T] Conveyance Systems*.
		Pipe Inner Diameter (in.)	Inner diameter of pipe in inches.	Appendix A. Input Data from CHPRC-02626.
		Pump Model	Pump model number used to obtain capacity curves.	Appendix A. Input Data from CHPRC 02626.
		Head Gain from Pump (ft)	Head Gain from Pump, h_p, calculated from pump capacity curves in ft using Equation 2-3 from pg. 3.	Appendix D. Steady Flow Head from CHPRC-02626.
	Calculations for Pump Extraction Limit (PEL)	Elevation Change (ft)	Difference in elevation between 2 ft above well transducer to 5 ft above transfer/treatment building slab elevation, Δz, in ft, example in Section 4.1.2 pg. 9.	Appendix D. Steady Flow Head from CHPRC-02626.
		Pipe Friction (ft)	Head loss due to pipe friction, h_f calculated using Darcy-Weisbach equation in ft presented as Equation 2-6 pg. 4.	Appendix D. Steady Flow Energy from CHPRC-02626.
	Calculations for Pump Extraction Limit (PEL)	Filter (ft)	Head losses due to filter, h_f, calculated as 80% of maximum allowable pressure difference in ft, example shown in Section 4.1.5 pg. 13.	Appendix D. Steady Flow Head from CHPRC-02626.
		Minor (ft)	Minor head losses, h_m, due to bends and valves calculated using a uniform K value of 30 ft with Equation 2-11 pg. 6.	Appendix D. Steady Flow Head from CHPRC-02626.
		Pump Extraction Limit (PEL, GPM)	Maximum extraction limit based upon head gained from pump being equal to all calculated head losses in gallons/minute based on Equation 2-2 pg. 2.	Appendix E. Head Balance Extraction Rates from CHPRC-02626.
		% Increase PEL/10 ft H2O well	Increase gained in the pump extraction limit rate if the water level is assumed to be 12 ft above transducer instead of 2 ft as a percentage.	Calculated by SSPA using Equation 2.2 pg. 2 with a 10 ft reduction in elevation change.
	Demonstrative Example: Nov 2014	Nov-14 Rate as % of PEL	November 2014 average extraction rate as a percentage of the pump extraction limit (PEL).	Calculated by SSPA using the equation "N0V-14 Rate/PEL Rate × 100%" Appendix E. Head Balance Extraction Rates from CHPRC-02626.
		Primary Control (F=Flow, L=Level)	Primary mechanism in which the flow was controlled in November 2014 for selected wells.	Provided to SSPA in screen captures from D. Neshem at CHPRC in an email on Nov. 17, 2014.
		Limited by Pump?	If the November 2014 extraction rate is likely limited by the head provided by the pump.	Calculated by SSPA assuming the extraction rate is limited by the pump if the Nov-14 Rate as % of PEL >= 90%.
P&T Operation Data	Data Period Assessed		Indicates the data period of the operational data that was assessed to estimate aquifer and well properties.	HEIS database.
	Water Level Control		Indicates if the pumping was controlled by water level.	SSP&A.
	Linear Tool	Estimated SC (gpm/m)	SC estimated using linear tool in gpm/m.	Estimated by SSP&A using the linear tool.
		Estimated SC (gpm/ft)	SC estimated using linear tool in gpm/ft.	Calculated by SSP&A using the equation: "*Estimated SC (gpm/m)*"/3.28084.
		Estimated Aquifer T (m^2/day)	Aquifer transmissivity estimated using linear tool in m^2/day.	Estimated by SSP&A using the linear tool.
		Estimated Aquifer T (ft^2/day)	Aquifer transmissivity estimated using linear tool in ft^2/day.	Calculated by SSP&A using the equation: "*Estimated Aquifer T (m^2/day)*" × 3.28084^2.
		Confidence Level (H/M/L)	Confidence (high/medium/low) in the estimate.	Assigned by SSP&A.
	Convolution Tool	Estimated Aquifer T (m^2/day)	Aquifer transmissivity estimated using convolution tool in m^2/day.	Estimated by SSP&A using convolution tool in Table 7-1 (ECF-Hanford-15-0062, *Estimation and Tracking of Well Efficiency with Application to the 100 Areas Pump-and-Treat (P&T) Systems*).
		Estimated Aquifer T (ft^2/day)	Aquifer transmissivity estimated using convolution tool in ft^2/day.	Calculated by SSP&A using the equation "*Estimated Aquifer T (m^2/day)*" × 3.28084^2.
		Initial Efficiency	Initial well efficiency estimated using convolution tool.	Estimated by SSP&A using convolution tool in Table 7-1 (ECF-Hanford-15-0062).
		Final Efficiency	Final well efficiency estimated using convolution tool.	Estimated by SSP&A using convolution tool in Table 7-1 (ECF-Hanford-15-0062).

Table 2. Descriptions of Data Fields in the Compilation

Group	Column Name	Column Description	Data Source
TTIM	Estimated Aquifer T (m^2/day)	Aquifer transmissivity estimated using TTIM model (m^2/day).	Estimated by SSP&A using TTIM model.
	Estimated Aquifer T (ft^2/day)	Aquifer transmissivity estimated using TTIM model (ft^2/day).	Calculated by SSP&A using the equation "*Estimated Aquifer T (m^2/day)*" × 3.28084^2.
Summary	Best Est. Aquifer T (m^2/day)	Best estimate of T in m^2/day.	Geometric mean of transmissivity estimated using the well-development data (SC based, drawdown based, recovery based), operational data (linear tool, Convolution tool), and TTIM models.
	Best Est. Aquifer T (ft^2/day)	Best estimate of T in ft^2/day.	Calculated by SSP&A using the equation "*Best Est. Aquifer T (m^2/day)*" × 3.28084^2.
100AGWM	Current Aquifer T (m^2/day)	Aquifer transmissivity (m^2/day) in 100AGWM in the model cell where the well is located.	Calculated by SSP&A based on 100AGWM documented in SGW-46279.
	Current Aquifer T (ft^2/day)	Aquifer transmissivity (ft^2/day) in 100AGWM in the model cell where the well is located.	Calculated by SSP&A based on 100AGWM documented in SGW-46279.
Well-Specific Evaluation	Usability	Good/moderate/poor ranking.	Based on findings of the aquifer, well, pump, pipes, and other factors.
	Long-Term Effectiveness	Good/moderate/poor ranking.	
	Capability	Good/moderate/poor ranking.	

4 References

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