Infrastructure Audit and Data Accessibility Report
Nevada Environmental Response Trust Site
Henderson, Nevada

Prepared for:

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ACRONYM LIST

AWF	Athens Road Well Field
bgs	Below ground surface
BMI	Black Mountain Industrial
COP	Continuous Optimization Program
ETI	Envirogen Technologies, Inc.
EQ	Equalization
FBR	Fluidized bed reactor
gph	Gallons per hour
gpm	Gallons per minute
GWETS	Groundwater Extraction and Treatment System
GWTP	Groundwater Treatment Plant
HDPE	High-density polyethylene
HMI	Human-machine interface
hp	Horsepower
HTML5	HyperText Markup Language 5
IC	Instrumentation and controls
I/O	Input/output
IWF	Interceptor Well Field
kb/s	Kilobit per second
LS1	Lift Station 1
LS2	Lift Station 2
LS3	Lift Station 3
MGD	Million gallons per day
mg/L	Milligram per liter
mm	Millimeter
NDEP	Nevada Department of Environmental Protection
NERT	Nevada Environmental Response Trust
NPDES	National Pollutant Discharge Elimination System
OPC	Open Platform Communications
PLC	Programmable logic controller
psi	Pound per square inch
PVC	Polyvinyl chloride
RI/FS	Remedial Investigation/Feasibility Study
SCADA	Supervisory control and data acquisition
SLMW	Stabilized Lake Mead Water
SQL	Structured Query Language
SWF	Seep Well Field
UI	User interface
USEPA	United States Environmental Protection Agency
VFD	Variable frequency drive

CERTIFICATION

I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been prepared in a manner consistent with the current standards of the profession, and to the best of my knowledge, comply with all applicable federal, state, and local statutes, regulations, and ordinances.

Description of Services Provided: Infrastructure Audit and Data Accessibility Report, Nevada Environmental Trust Site, Henderson, Nevada.

August 25, 2015
Date

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Nevada CEM Certificate Number: 2167
Nevada CEM Expiration Date: September 18, 2016

EXECUTIVE SUMMARY

At the direction of the Nevada Division of Environmental Protection, Tetra Tech, Inc. (Tetra Tech), on behalf of the Nevada Environmental Response Trust (NERT or the Trust), has prepared this Infrastructure Audit and Data Accessibility Report for the Groundwater Extraction and Treatment System (GWETS). The GWETS operates within and down gradient of the NERT portion of the Black Mountain Industrial (BMI) Complex in unincorporated Clark County, Nevada. The BMI Complex is surrounded by the City of Henderson, Nevada (Figures 1-1 and 1-2).

This report serves as one of several components of a system baseline assessment and is specific to the physical infrastructure of the GWETS. Other studies which are currently being performed as part of the Trust's Continuous Optimization Program (COP) include assessments of subsurface conditions and hydrogeology, groundwater flow and transport modeling, and well field optimization. The COP is an integral part of the ongoing Remedial Investigation/Feasibility Study (RI/FS), because the data acquired during the COP will be used to guide the evaluation of potential remedial alternatives.

Through the evaluation of the GWETS infrastructure, the following elements were identified as most likely to limit NERT's ability to utilize the full capacity of the GWETS:

- The effluent pipeline, which may be restricted,
- The existing National Pollutant Discharge Elimination System (NPDES) and air emissions permit flow limits,
- The Lift Station 1 (LS1) pumping capacity,
- The fluidized bed reactor (FBR) treatment plant effluent pipeline flow capacity, and
- The Groundwater Treatment Plant (GWTP) hydraulic and mass loading capacity.

Acknowledging the fact that the GWETS will be required to effectively perform for at least the next eight years and almost certainly longer as a component of the Trust's final remedy, Tetra Tech provides the following recommendations to optimize the current system to enable NERT to confidently utilize the full capacity of the GWETS.

Recommendations for Near-Term Implementation

- A maintenance program to verify well pump models and pump conditions in all extraction wells should be implemented to develop accurate records for pumping infrastructure.

- The backup pump at LS2 is a submersible pump that is reportedly undersized and cannot serve as a full backup for the primary pump. As a result, the operation of the SWF and AWF are dependent on a single pump. Tetra Tech recommends that an appropriately-sized backup pump be installed at LS2.

- Effluent pipeline flow is currently limited to 1,000 gpm, apparently by a restriction in the pipeline. Additional study of the effluent pump and pipeline system is recommended to further evaluate whether a restriction may be present. This study may include performance testing of the effluent pump and pipeline system.

- Additional flow meters should be installed to improve measurements of inflows to the GW-11 Pond.

- A stilling well with a pressure transducer should be installed at the GW-11 Pond to facilitate more accurate and consistent measurements of the pond level year-round.
- Network infrastructure to allow operational data to be bridged to the web should be installed to allow the Trust to more effectively monitor the GWETS. A system which provides detailed access to flow rates, totalizer values, process pressures, pump status and flow, data trending, and mass removal information is recommended.

Other GWETS Facility Analyses

Well Field Equipment

- The existing well pumps have adequate reserve pumping capacity to allow for increasing pumping rates and mass extraction from the existing wells. Well pump variable frequency drives (VFDs) have a long payback period if only power cost savings are taken in consideration. However, the use of VFDs could enhance the operational capabilities of the GWETS and increase overall GWETS flexibility.

Lift Station Pumps, Effluent Pump Station, and Pipelines

- The existing transfer pumps in LS1, Lift Station 2 (LS2), and Lift Station 3 (LS3), and the effluent pump station are operating below their hydraulic capacity, and have moderate reserve capacity to allow for variability in discharge rates from the well fields and operational flexibility at the FBR treatment plant and GWTP. The need for lift station pump retrofits will depend on how the COP is implemented and where additional pumping capacity is required.
- The installation of VFDs at LS1, LS2, and LS3 would not be cost-effective in the short term based on power savings. However, VFDs may provide other benefits, including reducing the volume required for flow equalization. Installation of VFDs is not recommended for the existing lift station pumps at this time, but should be considered if pump retrofits are performed.
- The existing influent pipelines can accommodate large increases in flow. Infrastructure modifications to the influent pipelines are not recommended at this time.

Groundwater Treatment Plant and FBR Treatment Plant

- The GWTP has sufficient reserve capacity to handle increased flow or increased hexavalent chromium mass loading up to 29 percent greater than current values. If implementation of the COP at the Interceptor Well Field (IWF) will significantly increase flow or hexavalent chromium mass loading to the GWTP, it will likely require upgrades or replacement.
- Three alternatives for the GWTP were developed and analyzed, including one bypass alternative, and two upgrade or replacement alternatives. Upgrading or replacing the GWTP offer the increased hydraulic and mass loading capacity that may be required during implementation of the COP.
- The FBR treatment plant is currently limited to an effluent flow of approximately 1,000 gpm by the NPDES and air emissions permits. Additional evaluation of the hydraulic and mass loading capacity of the FBR treatment plant is recommended.

1.0 INTRODUCTION

Groundwater extraction has been implemented at the Site as a removal action to address impacts to groundwater resulting from releases of perchlorate and hexavalent chromium, among other contaminants. Collectively, the entire system of extraction wells, water conveyances, and treatment plants is referred to as the Groundwater Extraction and Treatment System (GWETS). The GWETS is comprised of the following components:

- Three groundwater extraction well fields, one located on-site and two located off-site;
- Pipelines and lift stations conveying groundwater from the off-site well fields to the Site;
- The Treatment Plant, which is located at the Site and includes the following:
    - The Groundwater Treatment Plant (GWTP), which treats hexavalent chromium in groundwater from the on-site well field;
    - The fluidized bed reactor (FBR) treatment plant, which treats perchlorate in groundwater from all of the well fields;
    - The GW-11 Pond, which is used for water storage and equalization;
    - The Equalization Area, which includes equalization tanks and a granular activated carbon pretreatment system;
    - Other miscellaneous conveyances and tanks; and
- The effluent pump station and pipeline, which convey treated effluent from the FBR treatment plant to an outfall at Las Vegas Wash.

The primary components of the GWETS are shown on Figures 1-3, 2-1, and 2-7.

This report serves as one of several components of a system baseline assessment and is specific to the physical infrastructure of the GWETS. Other studies which are currently being performed as part of the Trust's Continuous Optimization Program (COP) include assessments of subsurface conditions and hydrogeology, groundwater flow and transport modeling, and well field optimization. The COP is an integral part of the ongoing Remedial Investigation/Feasibility Study (RI/FS), because the data acquired during the COP will be used to guide the evaluation of potential remedial alternatives.

1.1 Objective

The overall objective of the Infrastructure Audit and is to provide a baseline evaluation of the hydraulic and mass loading capacities of the various elements of the GWETS as they currently exist and to facilitate the development of strategies for implementing the COP.

Acknowledging the fact that the GWETS will be required to effectively perform for at least the next eight years and almost certainly longer as a component of the Trust's final remedy, Tetra Tech prepared this report to discuss and recommend facility modifications to optimize the current system to enable NERT to confidently utilize the full capacity of the GWETS.

The scope of work to accomplish these objectives included the following:

- Assembling available information on the GWETS infrastructure.

- Evaluating the capacity (hydraulic or mass loading) of the various components of the GWETS to provide a baseline for future optimization efforts under the COP.
- Identifying infrastructure-related restrictions, potential points of failure, or other factors which limit overall system capacity.
- Developing alternatives to increase the GWETS capacity, reliability, or operational flexibility.
- Identifying methods to provide better access and ability to monitor GWETS operating data.
- Providing recommendations for potential implementation by NERT.

NERT has also initiated an Enhanced Operational Metrics Project, which is designed to collect and report additional operational data for the GWETS. This evaluation considered the Enhanced Operational Metrics Project and integrated the planned system modifications into the engineering analyses. In addition, an evaluation of potential modifications to improve the calculation of the water balance for the GW-11 Pond is included here.

1.2 Scope Limitations

The following items are specifically excluded from this scope:

- An engineering evaluation of the FBR treatment plant capacity. Evaluation of the FBR treatment plant will be performed by Envirogen Technologies, Inc. (ETI), the Treatment Plant operator, under a separate scope. Only summary-level information on the FBR treatment plant provided by ETI is provided here.
- Hydrogeologic evaluation of extraction well yields. This evaluation only considers the GWETS infrastructure; hydrogeologic evaluations will be performed under a separate scope.
- Evaluation of infrastructure elements which are proposed or not currently in use. For example, construction of an ion exchange treatment system is being considered by NERT to handle a portion of the effluent from one of the off-site well fields; such a system is not considered in this evaluation.

1.3 Report Organization

This report is organized as follows:

- **Introduction (Section 1)**: Describes the objectives of the infrastructure audit and the organization of this report.
- **GWETS Existing Conditions (Section 2)**: Provides an overview of the construction details of the existing GWETS infrastructure and key operational information.
- **GWETS Current Capacity Evaluation (Section 3)**: Presents an analysis of the hydraulic or mass loading capacities of the primary GWETS infrastructure components, and identifies elements of the infrastructure that limit the overall capacity of the GWETS.
- **Potential GWETS Modifications (Section 4)**: Presents an overview of potential strategies for achieving the overall goal of optimizing the GWETS by more effectively using the available capacity of the system and presents recommendations for

modifications to elements of the GWETS that may help achieve that goal. Section 4 also provides a summary of approximate relative costs associated with the recommended GWETS modifications. The costs are developed at a conceptual level and are intended only to allow comparison between the alternatives presented.

- **GWETS Performance Monitoring and Data Accessibility (Section 5)**: Presents an analysis of options for real-time external access to key GWETS performance metrics. Section 5 also provides a summary of approximate costs developed at a conceptual level, which are intended only to allow comparison between the alternatives presented.
- **Summary and Conclusions (Section 6)**: Presents a summary of the infrastructure audit results and conclusions based on those results.

2.0 GWETS EXISTING INFRASTRUCTURE

The components of the GWETS evaluated in this study are the three extraction well fields, three lift stations and associated pipelines, and the GWTP. A general layout of the GWETS is presented on Figure 2-1. The following subsections briefly describe the existing GWETS infrastructure. A brief description of the FBR treatment plant, based on information provided by ETI, is also included.

2.1 Well Fields

Groundwater supplied to the GWETS is derived from three extraction well fields: the Seep Well Field (SWF), Athens Road Well Field (AWF), and Interceptor Well Field (IWF). The well field locations are shown on Figure 2-1. Additional details for the SWF, AWF and IWF are presented below. Well and pump information was obtained from the All Wells Database maintained by NDEP. The well pumps were not removed for inspection during the audit; recommendations for performing well pump inspections to verify the information provided in this report are provided in Section 6.

2.1.1 Seep Well Field

The SWF is located approximately 3 miles north of the Treatment Plant and is the northernmost (most down-gradient) well field. The primary purpose of the SWF is to extract perchlorate-contaminated groundwater prior to discharge into Las Vegas Wash. The SWF consists of 10 active extraction wells installed between 2001 and 2004. Two of the wells (PC-99R2 and PC-99R3) are manifolded together and act as a single well. Well construction details for SWF wells are provided in Table 2-1. Well depths range from 38 feet to 55 feet below ground surface (bgs), and casing diameters range from 4 to 8 inches. The wells are completed at the surface with above-grade concrete vaults. An electrical panel is located in each well vault. Available pump information is provided in Table 2-1. Pump curves obtained from the manufacturer are provided in Appendix A.

Average monthly pumping rates for individual SWF wells for the period from January 2013 to June 2015 are summarized in Table 2-2; time series plots of well discharge are provided in Figure 2-2. The majority of the flow from the well field (over 99 percent) is extracted from six wells. The average discharge for these six wells ranged from approximately 62 to 128 gallons per minute (gpm). The average combined discharge for the entire SWF for the period from January 2013 to June 2015 was approximately 532 gpm. The peak discharge was approximately 596 gpm in February 2015.

The well pumps are controlled by current sensors, which shut down the pumps if they run dry and restart the pumps after a timed delay. All SWF well pumps are shut down at a high level alarm signal from Lift Station 1 (LS1).

2.1.2 Athens Road Well Field

The AWF is located approximately 2 miles north of the Treatment Plant (Figure 1-2), and extracts groundwater from the central portion of the perchlorate plume. The AWF consists of a total of 18 extraction wells. All but two of the wells are manifolded in pairs or groups of three. The well pairs or groups are interlocked so that only one well can operate at a time, with one well serving as an extraction well and the other well serving as a monitoring well and backup extraction well that switches on if the primary well goes down. As of June 2015, eight wells in the AWF area were active. The installation dates of these wells are provided in Table 2-1. Well construction details for the AWF wells are provided in Table 2-1. Well depths range from 30 feet to 58 feet bgs, and casing diameters are either 6 or 8 inches. Available pump information is also provided in Table 2-1. All of the pumps are reportedly Grundfos SP submersible pumps. Pump curves obtained from the manufacturer are provided in Appendix A.

The average monthly pumping rates for the AWF wells for the period from January 2013 to June 2015 are summarized in Table 2-3; time series plots of well discharge are provided as Figure 2-3. The average discharge for individual AWF wells ranged from 3.5 to 62 gpm. The average combined discharge for the entire AWF from January 2013 to June 2015 was approximately 282 gpm. The peak combined discharge during this time period was 293 gpm in September 2014.

The well pumps are controlled by current sensors, which shut down the pumps if they run dry and restart the pumps after a timed delay. All AWF well pumps are shut down at a high level alarm signal from Lift Station 3 (LS3).

2.1.3 Interceptor Well Field

The IWF is located adjacent to the Treatment Plant and extracts contaminants immediately down-gradient from the on-site source areas. The IWF consists of 31 wells, 27 of which are currently active (as of June 2015). The wells were installed in 1986 (10 wells), 1993 (4 wells), between 1998 and 2000 (11 wells), 2003 (1 well), and between 2007 and 2010 (4 wells). Well construction details for the IWF are provided in Table 2-1. Well depths range from 35 feet to 51 feet bgs. All of the IWF wells have 6-inch diameter casings, with the exception of well I-AR, which has an 18-inch diameter casing. Available pump information is also provided in Table 2-1. All of the IWF pumps are reportedly Grundfos SP submersible pumps. Pump curves obtained from the manufacturer are provided in Appendix A.

Average monthly pumping rates for the individual IWF wells for the period from January 2013 to June 2015 are summarized in Table 2-4; time series plots of well discharge are provided as Figures 2-4a through 2-4c. The average discharge for individual IWF wells ranged from 0.4 to 5.4 gpm. The average combined discharge for the entire IWF from January 2013 to June 2015 was approximately 69 gpm, and the peak combined discharge during this time period was approximately 78 gpm in June 2014.

The well pumps are controlled by current sensors, which shut down the pumps if they run dry and restart the pumps after a timed delay. All IWF well pumps are shut down at a high level alarm signal from the GWTP.

2.2 Lift Stations

Extracted groundwater from the SWF and AWF is conveyed to the Treatment Plant with a system of lift stations and pipelines. The layout of the lift stations and pipelines is shown on Figure 2-1. Groundwater extracted from the SWF is pumped to LS1, and groundwater from the AWF is pumped to LS3. Both LS1 and LS3 discharge to Lift Station 2 (LS2), which pumps the combined flow to the Treatment Plant. All three lift stations have two pumps. Table 2-5 summarizes the lift station details; Table 2-6 and Figure 2-5 present lift station pumping rates from January 2013 to June 2015.

2.2.1 Lift Station 1 – SWF Lift Station

LS1 is located on a dirt road extension of Pabco Road near Las Vegas Wash, and serves the SWF wells. LS1 has a concrete wet well measuring approximately 32 feet by 14 feet by 7 feet, with a capacity of approximately 24,000 gallons. It was observed during the field audit that LS1 has two Quadna vertical turbine pumps. LS1 had an average flow of 580 gpm between January 2013 and June 2015, as shown in Table 2-6. This water is pumped through a 10-inch diameter high-density polyethylene (HDPE) pipe to LS2. Flow is controlled with a throttling valve. The GWETS operators report that the valve is approximately 50 percent open during regular operation.

Pump nameplate information was provided to Quadna, the pump manufacturer, to identify the specifications of the vertical turbine pumps. However, the pump impeller size could not be determined; therefore, an exact pump curve could not be obtained. Tetra Tech evaluated curves for these pumps based on the range of potential impeller sizes.

The transfer pumps in LS1 are turned on and off by the signals from high and low liquid level switches in the wet well. When the liquid level in LS1 reaches a high level alarm, all well pumps in the SWF area are shut down.

2.2.2 Lift Station 3 – AWF Lift Station

LS3 is located on Galleria Drive near the City of Henderson wastewater treatment plant and serves the AWF wells. LS3 has a wet well measuring approximately 8 feet by 25 feet by 8 feet, with a capacity of approximately 12,000 gallons. It was observed during the field audit that LS3 has two Myers submersible pumps. LS3 had an average flow of 282 gpm between January 2013 and June 2015, as shown in Table 2-6. Water is pumped through an 8-inch diameter HDPE pipe to LS2. Flow is controlled with a throttling valve, which the GWETS operators noted was normally “between 60 and 75 percent;” interpreted as percent closed based on subsequent hydraulic calculations.

Pump nameplate information was provided to Myers, the pump manufacturer, to identify the specifications of the submersible pumps. Myers was unable to provide the rated capacity and rated head values due to recording errors at the Myers facility, but was able to provide a potential range of pump curves. The Myers submersible pump impeller diameter was identified as 8 inches.

The transfer pumps in LS3 are turned on and off by the signals from high and low liquid level switches. When the liquid level in LS3 reaches a high level alarm, all well pumps in the AWF area are turned off.

2.2.3 Lift Station 2 – Combination of SWF and AWF

LS2, located at 6542 Pabco Road, has a wet well measuring approximately 21 feet by 22 feet by 14 feet, with a capacity of approximately 48,000 gallons. LS2 has one Quadna vertical turbine pump and one submersible pump used for backup purposes.

Pump nameplate information was provided to Quadna to identify the vertical turbine pump specifications. It was determined that the pump has a rated capacity of 1,200 gpm at 231 feet of head with an impeller diameter of 8.06 inches. No data could be found for the submersible pump. ETI has reported that the submersible pump cannot serve as a full backup to meet the required flow. Section 6.2 outlines recommendations to address this limitation.

LS2 had an average flow of 805 gpm between January 2013 and June 2015, as shown in Table 2-6. Water is pumped through a 12-inch diameter HDPE pipe to the Treatment Plant and flow is controlled with a throttling valve. The GWETS operators report that the valve is approximately 49 percent open during regular operations.

The transfer pumps in LS2 are turned on and off by the signals from high and low liquid level switches. When the liquid level in LS2 reaches a high level alarm, the pumps in LS1 are turned off. If the liquid level stays at the alarm level, the pumps in LS3 are turned off. When discharging to the EQ tanks, a high level alarm in the EQ tanks turns off the pumps in LS2. Currently, the LS2 discharge is directed to the GW-11 Pond, thereby bypassing the EQ tanks.

2.2.4 Effluent Pump Station

The effluent pump station is located adjacent to the FBR treatment plant and discharges through a 12-inch diameter HDPE pipe to an outfall at Las Vegas Wash. The effluent pumps are Corcoran horizontal centrifugal pumps. Flow rates from the Treatment Plant to Las Vegas Wash from January 2013 to June 2015 are presented in Table 2-7 and on Figure 2-6. Discharge rates over this period ranged from approximately 766 to 971 gpm, and averaged approximately 891 gpm.

Pump nameplate information was provided to Corcoran to identify the pump specifications. It was determined that the pump has a rated capacity of 1,000 gpm at 197 feet of head with an impeller diameter of 14.38 inches. The pump motor is driven by a VFD which is proportionally controlled based on discharge tank level.

2.3 Pipelines

Groundwater is conveyed from the well fields to the Treatment Plant and from the Treatment Plant to the outfall at Las Vegas Wash via a system of pipelines. The influent pipelines from the lift stations to the Treatment Plant are approximately 4 miles long, not including the piping from the individual wells to the lift stations. The record drawings for the influent and effluent piping are provided in Appendix B. A recent study by ETI (GWETS Influent/Effluent Pipeline Survey Report, 1373-REP-001 REV A, June 2015) provides additional information on the locations of the pipelines and appurtenances.

The influent piping consists of the piping from the individual extraction wells to the well field lift stations or GWTP, from well field lift stations LS1 and LS3 to the common lift station (LS2), and from LS2 to the Treatment Plant. Table 2-8 presents a summary of the influent piping. All influent piping material is HDPE, and the diameter of the piping from the lift stations to the Treatment Plant varies from 8 to 12 inches. The IWF piping that directly feeds the GWTP is either 4 or 6 inches in diameter, depending on whether the wells are west or east of the GWTP, respectively.

The effluent pipeline conveys treated effluent from the Treatment Plant to an outfall at Las Vegas Wash. The effluent pipeline is constructed from 12-inch diameter HDPE pipe.

2.4 GWTP

Chromium-impacted groundwater extracted from the IWF is treated at the GWTP, which chemically reduces hexavalent chromium and removes the resulting trivalent chromium through chemical precipitation. The equipment associated with the GWTP is located on a 30-foot by 50-foot concrete pad, and an overhead canopy is installed over the concrete pad to protect the equipment from sun and rainfall. Ferrous sulfate solution is stored in a holding tank located approximately 40 feet southwest of the GWTP equipment pad. The current GWETS and a process flow diagram of the chromium treatment process are shown on Figures 2-7 and 2-8, respectively.

Tetra Tech requested copies of drawings or other available documentation for the GWTP from ETI and Ramboll Environ. Both ETI and Ramboll Environ responded that they did not have copies of drawings or other documentation for the GWTP. Tetra Tech also searched the on-site file storage for GWTP drawings or other records, but no records were found. The chromium treatment process flow diagram (Figure 2-8) was therefore developed based on an inspection of the GWTP performed in May 2015, and consists of the following:

- Groundwater from the IWF wells enters the common manifold and influent holding tank T-1 (estimated volume of 4,000 gallons).
- From influent holding tank T-1, groundwater is pumped by transfer pump P-1A (electrical centrifugal pump) to the former degassing tank T-2 (estimated volume of 5,000 gallons). Backup transfer pump P-1B is not functional.
- Ferrous sulfate is metered into the influent line of transfer pump P-1A (degassing tank T-2 influent) using metering pump MP-1 at a current feed rate of approximately 1.5 gallons per hour (gph). Ferrous sulfate solution is stored in dedicated storage tank T-3 (estimated volume of 8,000 gallons). Tank T-2 acts as a reaction tank where soluble hexavalent chromium is reduced to non-soluble trivalent chromium by reaction with the ferrous sulfate.
- The effluent from tank T-2 flows by gravity into clarifier C-1 (calculated flow capacity of 110 gpm), where precipitated solids are settled. The clarifier, converted from earlier equipment, uses seven AccuPac IFR 6036 tube settling media blocks. The dimensions of the tube settling media blocks are 36 inches high by 12 inches wide by 84 inches long.
- Polymer solution is metered into the clarifier C-1 influent line using metering pump MP-2. Polymer solution is prepared from dry polymer and stored in polymer feed tank T-4.
- The treated groundwater effluent from the clarifier flows by gravity into effluent tank T-5 (estimated volume of 4,000 gallons).
- From effluent tank T-5, groundwater is pumped by either transfer pump P-4A or P-4B (electrical centrifugal pumps) to either the GW-11 Pond or the EQ tanks. The second transfer pump (P-4b) is a back-up.
- Settled solids from the bottom of the clarifier are pumped periodically by solids transfer pump P-2 (compressed air-driven double-diaphragm pump) into sludge settling tank T-6 (estimated volume of 4,000 gallons). Lime is added manually into the sludge settling tank to aid in the dewatering process.
- Low-solids content sludge from the bottom of the sludge tank is pumped periodically by sludge pump P-3 (compressed air-driven double-diaphragm pump) into filter press FP-1, which has a nominal capacity 5 cubic feet, filter plate size of 630 millimeters (mm), 17 filter plates, model number of JWI 630G32-17-5DA.
- Filtered liquid is recycled back to influent tank T-1. When the filter cycle is finished, the final sludge cake is removed and loaded into a roll-off container for periodic off-site disposal.

During the GWTP inspection, Tetra Tech noted that back-up transfer pump P-1B was not functional and informed ETI. In general, few backups or redundancies were noted at the GWTP. Further discussion of the GWTP is provided in Section 4.4.

2.5 FBR Treatment Plant

The FBR treatment plant uses an anaerobic biological processed to treat perchlorate in groundwater extracted from all three well fields using an anaerobic biological process. The plant consists of several subsystems, including the following:

- EQ system, including equalization tanks, granular activated carbon columns, and filters. According to ETI, the equalization tanks are usually bypassed and equalization is performed in the GW-11 Pond;
- Fluidized bed reactors, including five first-stage reactors and four second-stage reactors. According to ETI, two first-stage reactors and two second-stage reactors are currently off-line, but can be brought back into service as needed to meet the COP objective;
- Dissolved air flotation separators;
- Solids handling system, including thickeners and filter presses;
- Aeration and biofilter systems;
- Effluent disinfection system;
- Effluent pumping system;
- Chemical feed systems;
- Process control system; and
- Utility systems, including compressed air, service water, electrical, and equipment pad sumps.

3.0 CURRENT GWETS CAPACITY EVALUATION

This section presents the evaluation of maximum performance capacity for the GWETS components described in Section 2.0, including the well fields, lift stations, pipelines and GWTP. This evaluation was performed assuming that the existing equipment and infrastructure elements are allowed to operate at full capacity. A brief discussion of the performance capacity of the FBR treatment plant, based on information provided by ETI, is also included.

3.1 Well Field Pumping Capacities

The parameters needed to evaluate the maximum pumping capacity of an extraction well include well yield at maximum stress (minimum water level), a pump curve, and approximate hydraulic losses in the discharge piping. This evaluation only considered the infrastructure elements; the hydraulic properties of the aquifer were not included in the evaluation. The reader is cautioned that groundwater extraction is usually limited by well yield, which is a function of the hydraulic properties of the aquifer and the well, not the pumping and conveyance infrastructure. Thus, the estimates of reserve pumping capacity noted below do not necessarily indicate that it will be possible to increase groundwater extraction rates in a well field to the maximum capacity of the infrastructure. Well yields will be evaluated under a separate scope.

The estimated maximum pumping capacities for each individual well pump are summarized in Table 3-1. These estimated maximum pumping capacities were compared to pumping rates measured between January 2013 and June 2015 to evaluate reserve pumping capacity.

Seep Well Field

As shown in Table 3-1, the calculations indicate a substantial reserve in pumping capacity for the existing well pumps in the SWF area. The total calculated maximum well pump capacity for all SWF wells combined is approximately 1,200 gpm, and the actual peak discharge was approximately 596 gpm in February 2015; therefore, the existing well pumps could accommodate an increase in flow of up to 100 percent compared with current operation.

Athens Road Well Field

For the existing well pumps in the AWF area, the calculations indicate a moderate reserve in pumping capacity (Table 3-1). The total calculated maximum well pump capacity for all AWF wells combined is approximately 500 gpm, and the actual peak discharge was 293 gpm in September 2014; therefore, the existing well pumps could accommodate an increase in flow of up to 70 percent compared with current operation.

Interceptor Well Field

For the existing well pumps in the IWF area, the calculations indicate a significant reserve in pumping capacity (Table 3-1). The total calculated maximum well pump capacity for all IWF wells combined is approximately 200 gpm, and the actual peak discharge was approximately 78 gpm in June 2014; therefore, the existing well pumps could accommodate an increase in flow of up to 160 percent compared with current operation. As noted above, this conclusion only considers the pumping infrastructure, without taking well yield into account.

Summary

Overall, it appears that the existing well pumps and associated infrastructure are not a limitation to meeting the COP objective.

3.2 Lift Station Hydraulic Capacities

Maximum hydraulic capacities for the lift stations were calculated assuming that the existing pumps are operated at full capacity (without any restrictions or throttling), and are pumping through the existing pipelines. For each lift station, a pipeline curve was developed based on information obtained from the pipeline record drawings. Maximum current capacity (flow and discharge pressure) was then estimated using the pipeline curve and a pump curve.

The lift station information is summarized in Table 2-5, which includes the current, known, or assumed pump manufacturers, rated pump capacities and head values, pipe sizes, average flow rates, and wet well dimensions and volumes. The flows for the lift stations are summarized in Table 2-6.

Lift Station 1

As stated in Section 2.2, LS1 has an average flow of 580 gpm, flows through a 10-inch diameter HDPE pipe to LS2, and has a throttling valve currently set at approximately 50 percent open during regular operations. The pump impeller size is unknown. Tetra Tech therefore estimated an impeller diameter, which allowed a range to be determined for the maximum LS1 operating capacity using the estimated impeller diameter (Quadna 6.62-inch impeller) and the system curve while considering a fully open throttling valve. The current maximum operating capacity of the pump, if operated in a fully open scenario, is estimated to be between 650 and 736 gpm at 160 feet to 212 feet of head, respectively, as shown on Figure 3-1. The estimated reserve pumping capacity for LS1, compared with actual average flow, is 12 to 27 percent.

Lift Station 2

As stated in Section 2.2, LS2 has an average flow of 805 gpm, flows through a 12-inch diameter HDPE pipe to the Treatment Plant, and has a throttling valve currently set at approximately 49 percent open during regular operations. Tetra Tech evaluated the maximum operating capacity of the pump at LS2 by applying the system curve while considering a fully open throttling valve. The current maximum operating capacity of the pump, if operated in a fully open scenario, is estimated to be 1,170 gpm at 256 feet of head, as shown on Figure 3-2. The estimated reserve pumping capacity for LS2, compared with actual average flow, is approximately 45 percent.

Lift Station 3

As stated in Section 2.2, LS3 has an average flow of 282 gpm, flows through an 8-inch diameter HDPE pipe to LS2, and has a throttling valve currently set at approximately 30 percent open during regular operations. Tetra Tech evaluated the maximum operating capacity of the pump at LS3 by applying the system curve while considering a fully open throttling valve. The current maximum operating capacity of the pump, if operated in a fully open scenario, is estimated to be 547 gpm at 37 feet of head, as shown on Figure 3-3.

To develop a low-end estimate for the maximum capacity of the pump at LS3, Tetra Tech applied a calibration factor of two to the system curve while considering a fully open throttling valve. With the calibrated system curve, the maximum operating capacity of the pump is estimated to be 378 gpm at 44 feet to 37 feet of head, respectively, as shown on Figure 3-3. The estimated reserve pumping capacity for LS3, compared with actual average flow, is 34 to 94 percent.

Summary

Overall, all of the lift stations have reserve capacity to support the COP objective. LS1 has the least reserve capacity, approximately 12 to 27 percent compared with current average flow.

Flow through LS2 could be increased by 45 percent compared with the current average, and flow through LS3 could be increased by at least 34 percent compared with the current average flow.

3.3 Effluent Pump Station Hydraulic Capacity

The effluent pump station has an average flow of 890 gpm (Table 2-7), and flows through a 12-inch diameter HDPE pipe to Las Vegas Wash. In performing the effluent pipeline hydraulic calculations, Tetra Tech found that additional head equivalent to an orifice plate or throttling valve set at 30 percent open must be added to the system to achieve calibration. However, no restriction device was noted on the pipeline record drawings. This situation was discussed in detail with ETI. During normal FBR treatment plant operations, ETI has observed that flow through the effluent pipeline is limited to approximately 1,000 gpm. Based on the behavior of the pump VFD near the flow limit, ETI believes that flow may be restricted by an air pocket located at a high point in the effluent pipeline. Restriction of the pipeline is consistent with Tetra Tech's hydraulic calculation results.

Tetra Tech evaluated the maximum capacity of the pump and effluent pipeline by applying the system curve while considering an unrestricted pipeline (*i.e.*, with no potential restriction). The current maximum operating capacity of the pump in this scenario would be approximately 1,185 gpm at 182 feet of head, as shown on Figure 3-4. The estimated reserve pumping capacity for the effluent pump station assuming an unrestricted pipeline, compared with actual average flow, is 33 percent.

Summary

The hydraulic capacity of the effluent pump station may be impaired by a restriction in the effluent pipeline. The restriction limits the effluent current pump station capacity to approximately 1,000 gpm, or 84 percent of the maximum capacity of 1,185 gpm.

Determining whether a restriction is present in the effluent pipeline, and if so, removing the restriction would allow the effluent pump station to operate at full capacity. Recommendations for further investigation of the effluent pipeline are provided in Section 6.

3.4 Pipeline Capacities

Maximum pipeline capacities were estimated assuming that the capacities of the pipelines are limited only by the mechanical strength of the pipe, without consideration of the capacity of the pumping equipment. This analysis focuses on the existing pipeline infrastructure, including pipe diameter, length, fittings and valves, maximum working pressure, and material of construction. Tetra Tech used a maximum pipe operating pressure of 130 pounds per square inch (psi), which equals 300 feet of head for each lift station. This pressure is based on a pressure rating of 200 psi for the HDPE pipe with a Standard Dimension Ratio of 9, after applying a safety factor of approximately 50 percent. The use of a 50 percent safety factor, as well as very conservative coefficients for calculating pipe friction losses, takes into account the age and condition of the pipeline. The maximum capacity calculation for each pipeline was performed by developing a pipeline curve and using the value of flow at a discharge head of 300 feet.

Lift Station 1 to Lift Station 2 Pipeline

Assuming 300 feet of head, the maximum hydraulic capacity of the LS1 to LS2 pipeline could reach 975 gpm.

Lift Station 2 to Treatment Plant Pipeline

Assuming 300 feet of head, the maximum hydraulic capacity of the LS2 to the Treatment Plant pipeline could reach 1,340 gpm.

Lift Station 3 to Lift Station 2 Pipeline

For the LS3 to LS2 pipeline, Tetra Tech used a more conservative discharge head estimate of 62 feet, based on the smaller elevation change between LS3 and LS2. Assuming 62 feet of head, the maximum hydraulic capacity of the LS3 to LS2 pipeline could reach 750 gpm.

Effluent Pipeline

Assuming 300 feet of head, the maximum hydraulic capacity of the effluent pipeline from the FBR treatment plant to Las Vegas Wash could reach 1,425 gpm at 300 feet of head. This calculation assumes an unrestricted pipeline.

Well to Lift Station Pipelines

For the pipelines from the individual wells to the lift stations, maximum hydraulic capacities were conservatively estimated using the longest pipe run for each well field. The results of these calculations, as presented in Table 3-2, suggest that all individual pipelines from the pumping wells have ample hydraulic capacity. The capacities of the individual pipelines significantly exceed the maximum pumping rates of the pumps (Table 3-1); therefore, these pipelines are not an infrastructure limitation.

Summary

The existing pipeline system, considered apart from the pumps, has ample capacity to support the COP.

3.5 GWTP Capacity

This section of the report presents the evaluation of the GWTP.

3.5.1 Capacity Estimates

Historical data demonstrate that the GWTP has sufficient capacity to treat chromium at the concentrations present in IWF groundwater at flow rates up to 75 gpm with an acceptable chromium removal efficiency. The design treatment capacity of the GWTP is not known, but is constrained by the sizing and performance of the existing equipment. The maximum capacity of the key GWTP equipment is summarized below:

- **Existing fluid transfer pump capacity**: Existing pumps P-1A, P-4A, and P-4B shown on Figure 2-8 are centrifugal pumps. The maximum capacity for pump P-1A is estimated to be approximately 190 gpm, and maximum capacities for pumps P-4A and P-4B are both estimated to be approximately 140 gpm. Therefore, the existing GWTP maximum hydraulic capacity, as limited by fluid transfer pumps P-4A and P-4B, is approximately 140 gpm. A summary of maximum hydraulic capacities for the GWTP pumps is presented in Table 3-3.
- **Existing filter press capacity**: The existing filter press, FP-1, is JWI model 630G32-17-5DA, which has a nominal capacity of 5 cubic feet, filter plate size of 630 mm, and a number of filter plates. The maximum GWTP hydraulic capacity as limited by the current filter press is calculated to be approximately 90 gpm based on nominal capacity, actual dry filter cake volumes generated at a flow rate of 70 gpm, filter cake density and solids content (common values assumed), and number of daily cycles (conservatively assumed

as two per day). The maximum GWTP flow as limited by the filter press is presented in Table 3-4.

The existing filter press also limits the mass loading capacity of the GWTP, because the volume of solids produced by the treatment process is proportional to mass loading. Thus, the existing filter press has the capacity to handle a 29 percent increase in flow at current concentrations, or a 29 percent increase in mass loading at the current flow rate, but not both.

- **Existing clarifier capacity**: Based on information for existing clarifier C-1 and clarifier media manufacturer performance data, the clarifier hydraulic capacity is calculated as approximately 110 gpm (see Table 3-5). However, this calculated capacity is for general solids retention and not specifically for precipitated chromium removal; therefore, the actual flow rate when chromium carryover from the clarifier exceeds the required treatment criteria is not precisely known.

The maximum GWTP hydraulic capacity can also be evaluated by considering the relationship between GWTP inflow and effluent chromium concentrations from 2010 to 2014. Figure 3-5 shows a general trend of increasing effluent total chromium concentrations with increased flow, suggesting that carryover of precipitated solids past the clarifier is the cause of the higher effluent concentrations. For purposes of evaluating the capacity of the GWTP, Tetra Tech chose the original effluent limit established when the plant was constructed (specified in a 1986 Consent Order with Kerr-McGee). Using a concentration of one-half of the total chromium effluent limit of 1.7 mg/L as a criterion for evaluating when capacity is exceeded, Figure 3-5 suggests that the GWTP has a treatment capacity of 93 gpm.

Based on the GWTP infrastructure limitations identified above, the filter press is the most critical performance limitation, and would likely limit the maximum GWTP treatment capacity to slightly less than 90 gpm at the current influent chromium concentrations. This is a 29 percent increase over the current flow rate of 70 gpm. Similarly, the filter press would also limit increases in mass loading to 29 percent at the current influent flow rate of 70 gpm. However, the flow limitations imposed by the clarifier (110 gpm) and by the predicted chromium effluent concentrations (93 gpm) are also important constraints which would limit GWTP capacity even if the filter press were replaced.

3.5.2 Potential for Bypassing the GWTP

An alternative to continued operation of the GWTP is treatment of chromium by the FBR treatment plant. The FBR treatment plant is operated under reducing conditions, has systems for handling solids, and based on current influent concentrations and flow rates, is currently treating up to 1.3 pounds per day of chromium (500 pounds per year). It is therefore possible that the GWTP could be bypassed, allowing the entire chromium load to be treated by the FBR treatment plant. Without the GWTP, the FBR treatment plant chromium loading would be approximately 11 times greater than the typical chromium loading during the past several years of operation, as calculated based on average values from 2007 to 2014. It is not known whether the FBRs can handle the entire chromium load and still reliably meet the National Pollutant Discharge Elimination System (NPDES) permit discharge limits of 0.01 mg/L for hexavalent chromium and 0.1 mg/L for total chromium. Other concerns include the effects of chromium toxicity on the FBR treatment plant biomass, and the potential for affecting the disposal status of is the waste biosolids. A pilot test would be necessary to evaluate these uncertainties.

3.6 FBR Treatment Plant Capacity

Perchlorate treatment is performed by the FBR treatment plant. The overview of the FBR treatment plant capacity presented in the following subsections is based on a review of applicable permits, the Operations Manual for the plant, and information provided by ETI. A more complete review of the FBR treatment plan will be prepared by ETI under a separate scope.

3.6.1 Permit Limits

The 30-day average effluent flow limit stated in the fact sheet for NPDES permit No. NV0023060 is 1.45 million gallons per day (MGD), with a daily maximum limit of 1.75 MGD. The 30-day average effluent flow limit in the NPDES permit corresponds to a flow rate of 1,007 gpm (rounded here to 1,000 gpm), while the daily maximum limit corresponds to a flow rate of 1,215 gpm. In addition, Clark County Department of Air Quality Minor Source Permit #17249, which covers eight emissions units in the FBR treatment plant, limits the maximum operating capacity of the FBR treatment plant to 1.44 MGD, or 1,000 gpm.

3.6.2 Infrastructure Limits

According to the Operations Manual for the FBR treatment plant, the design influent water quality specifications for the FBR treatment plant are an annual average flow of 950 gpm, with a 30-day maximum of 1,000 gpm. According to ETI, the major subsystems of the FBR treatment plant are actually designed for flow rates well in excess of 1,000 gpm. However, the internal piping systems may limit hydraulic capacity to somewhat lower values. ETI also noted that at present, the effluent pipeline limits the hydraulic capacity of the FBR treatment plant.

3.6.3 Mass Loading Capacity

The mass loading capacity of the FBR treatment plant is a function of the concentrations of all electron acceptors in the influent, including nitrate and chlorate as well as perchlorate, because all of these electron acceptors must be utilized by the bacteria during treatment. According to ETI, the mass loading capacity for the FBR treatment plant, as currently configured (with two first-stage and two second-stage reactors off-line), is calculated using the equivalent loading function as follows:

$$[(0.90 \times NO_3\ as\ N) + (0.17 \times ClO_3) + (0.18 \times ClO_4)] \times flow \times \left(\frac{1440 \times 8.34}{10^6}\right) < 1{,}133\ lbs/day$$

where:

> NO_3 as N is the influent nitrate (as nitrogen) concentration in mg/L
> ClO_3 is the influent chlorate concentration in mg/L
> ClO_4 is the influent perchlorate concentration in mg/L
> Flow is the influent flow rate in gpm
> 1,133 pounds per day is the equivalent loading capacity of the plant as currently configured with two first-stage and two second-stage reactors off-line.

When all reactors (five first-stage and four second-stage) are activated, the equivalent loading capacity is increased to 1,514 lbs/day, again calculated using the equivalent loading function. According to ETI, three of the off-line reactors are ready to be reactivated; the fourth is currently being refurbished and will be ready for reactivation shortly after refurbishment is completed.

The mass loading capacity for perchlorate was estimated from the equivalent loading function by assuming that the FBR treatment plant is operated at maximum hydraulic capacity (1,000 gpm) and that the nitrate/perchlorate and chlorate/perchlorate concentration ratios in the influent are constant and equal to the average ratios observed for the period from January 2013 to June 2015 (0.087 and 1.75, respectively). Based on these assumptions, the maximum perchlorate mass loading is approximately 2,000 pounds per day with two first-stage and two second-stage reactors off-line, and is approximately 2,700 pounds per day when all reactors are activated. ETI has indicated that the FBR treatment plant should be operated at approximately 85 percent of these mass loading limits to allow for operational flexibility. The available perchlorate mass loading capacity is thus 1,700 pounds per day under current conditions, and 2,300 pounds per day with all reactors activated. The objective of the COP is to utilize this available capacity.

3.7 Summary

The capacity estimates for the various components of the GWETS are summarized in Table 3-6. At present, all of the major elements of the GWETS infrastructure are operating below maximum hydraulic or mass loading capacity, and there is moderate headroom to allow for variability in discharge rates from the well fields and operation flexibility at the FBR treatment plant and GWTP.

Factors which could limit future increases in mass extraction during implementation of the COP include the following:

- **Effluent pipeline**: Although the hydraulic capacity of the effluent pipeline appears to be adequate, a restriction appears to be present which limits flow to approximately 1,000 gpm. Because all treated groundwater is discharged through the effluent pipeline, this infrastructure issue could potentially affect future optimization of all of the well fields, particularly the AWF and SWF.
- **Permit limits**: The existing NPDES and air emissions permits limit total effluent discharge from the GWETS to approximately 1,000 gpm. Like the effluent pipeline, these limits could affect optimization of all of the well fields, but the permits could potentially be modified to increase the allowable discharge.
- **Lift Station 1**: LS1 may have as little as 12 percent reserve capacity, which has the potential to limit increases in pumping from the SWF.
- **FBR Treatment Plant**: Although the actual hydraulic capacity of the FBR treatment plant is not currently known, it is likely to have substantial reserve hydraulic capacity. The primary limitation on the FBR treatment plant is the effluent pipeline. The FBR treatment plant also has substantial reserve mass loading capacity.
- **GWTP**: The hydraulic and mass loading capacity of the GWTP could limit increases in groundwater extraction or influent total chromium concentrations in the IWF. Increasing mass extraction by increasing groundwater extraction from the IWF could become limited by the hydraulic and/or mass loading capacity of the GWTP.

The hydraulic capacity of LS2 has been thought to be a factor which may limit increases in pumping by the GWETS. The results of the analysis presented in this report indicate that the hydraulic capacity of LS2, which conveys most of the untreated water to the FBR treatment plant, and the hydraulic capacity of the effluent pump station, which conveys all treated water from the FBR treatment plant, are very similar. This observation suggests that the hydraulic capacity of LS2 alone is unlikely to limit the capacity of the GWETS.

4.0 POTENTIAL GWETS MODIFICATIONS

This section discusses potential modifications to optimize the GWETS and provide increased operational flexibility. Estimated costs for the modifications are also presented. Note that these costs are based on a conceptual level design and therefore the level of accuracy is consistent with the limited design detail currently available. Capital cost and other budget amounts presented within this report have been developed to support a relative cost comparison between alternatives. More accurate cost budget data should be developed after design efforts are advanced. Specifically, the following potential modifications and upgrades were developed:

- Well pumping equipment (benefits and costs of using VFDs in extraction wells);
- Lift stations transfer pumps (larger capacity pumps and use of VFDs in lift stations); and
- GWTP upgrades (three alternatives, including GWTP bypass).

This section also presents recommendations based on Tetra Tech's understanding of NERT's priorities and goals.

4.1 Evaluation Criteria

The following subsections reiterate the objective of the COP and review other competing demands on GWETS capacity.

4.1.1 COP Objective

The objective of the COP is to more effectively utilize the available capacity of the GWETS. The COP is a long-term program that will be implemented through final remedy selection, which is anticipated to be up to eight years in the future.

4.1.2 Other Potential Demands on GWETS Treatment Capacity

Besides the GWETS, other demands on perchlorate treatment capacity prior to remedy selection include the following:

- AP-5 Pond Closure: This project includes removal of approximately 600 to 900 tons of residual perchlorate salts currently present in the AP-5 pond, as well as closure of the pond itself. This project envisions that perchlorate would be treated at the FBR treatment plant. The availability of reserve treatment capacity is a crucial element of this project.
- Soil Flushing Pilot Test: A soil flushing pilot test is currently being implemented in the area up-gradient of the IWF and barrier wall. Implementation of the planned pilot test is not expected to significantly impact treatment capacity. However, an expanded soil flushing program could use substantial portions of the available GWETS treatment capacity.

4.2 Well Field Equipment

This section discusses potential modifications to well pumping equipment, including well pumps and VFDs.

4.2.1 Well Pumps

Current extraction well pump capacities were evaluated in Section 3.1. The results of this evaluation suggest that, in general, the existing well pumps provide ample pumping capacity for optimization of the GWETS and increasing mass extraction. Note that this evaluation focused on evaluating the maximum capacities of the well pumps and infrastructure without consideration of well yields. If the intention is to increase the well yields, then a hydrogeologic evaluation is needed in combination with the pump capacity evaluation.

4.2.2 Use of Variable Frequency Drives

Tetra Tech evaluated the use of VFDs with the existing extraction well pumps. The primary cost benefit of VFDs would be a reduction in power cost, because the pumps would not have to be restricted or “throttled back” to obtain the desired flow rates. Estimated VFD installation costs for IWF, AWF, and SWF are summarized in Table 4-1 and Appendix C. Evaluations of potential power cost savings for the IWF, AWF, and SWF are also provided in Appendix C.

Based on power cost savings considerations, installation of VFDs would not be cost effective. This is especially true for the AWF and IWF, where estimated payback periods for the power savings obtained with the VFDs are unreasonably high (over 50 years). However, the VFDs could be interfaced with pressure transducers (to be installed under the Enhanced Operational Metrics project) to maintain a constant liquid level set point in a well. The set points would allow drawdown to be adjusted to reflect seasonal changes in water levels or changes in contaminant concentrations in a particular well. This functionality would significantly improve system flexibility. Tetra Tech recommends further investigation of the potential costs and benefits of using VFDs in combination with the new pressure transducers.

4.3 Water Conveyance

This section discusses potential modifications for the lift stations and pipelines.

4.3.1 Lift Station Pumps

As described in Section 3, the capacity of the LS1 pump is a potential infrastructure limitation on increasing groundwater extraction from the SWF. Large increases in groundwater extraction from the AWF could result in the LS3 and LS2 pumps also becoming an infrastructure limitation. Tetra Tech evaluated options for retrofitting the lift stations and effluent pump station with pumps capable of increasing flow to the maximum capacity of the pipelines. The actual need for pump retrofits will depend on the pumping scenario and whether additional pumping capacity is actually required. The recommended pumps are as follows:

- LS1: Goulds Vertical Industrial Turbine pump, model VIT – CATM and size 12CHC-4 stages. The rated capacity for this pump is 975 gpm at 306 feet of head.
- LS2: Goulds Vertical Industrial Turbine pump, model VIT – CFTM and size 12CHC-5 stages. The rated capacity for this pump is 1,340 gpm at 311 feet of head.
- LS3: Myers submersible pump, model 4VCX. The rated capacity for this pump is 850 gpm at 62 feet of head.
- Effluent pump station: Goulds pump, model 3196 Lti and size 4x6-10G. The rated capacity for this pump is 1,425 gpm at 300 feet of head.

Pump curves and specifications for the proposed pumps are provided in Appendix D. The costs are summarized in Table 4-1 and Appendix C.

An additional consideration in upgrading pumps is the existing electrical service. The current allowable running horsepower (hp) values for the lift stations are 100 hp at LS1, 200 hp at LS2, and 20 hp at LS3. The current lift station configuration allows both pumps to operate simultaneously. If this system is maintained, the electrical service at all three lift stations would also need to be upgraded at a cost of approximately $150,000 per station. If the controls were modified to ensure that both pumps could not run at the same time, only the electrical service at LS2 would need to be upgraded. As noted above, the need for electrical service upgrades will depend on the pumping scenario and whether additional pumping capacity is actually required.

4.3.2 Use of VFDs

Tetra Tech evaluated VFDs for use with the lift stations pumps. The main cost benefit of lift station pump VFDs would be a reduction in power costs because the pumps would not have to be throttled to obtain the desired flow. An evaluation of estimated VFD installation costs compared with potential power cost savings for LS1, LS2, and LS3 is provided in Appendix C. Based on the power cost considerations, the estimated VFD payback period for the existing pumps is approximately 15 years, but would be somewhat shorter for the larger pumps recommended above. Although VFDs are not considered to be cost-effective in the short term, they may provide other benefits, including reducing the volume required for flow equalization. Installation of VFDs is not recommended for the existing lift station pumps, but should be considered if pump retrofits are performed.

4.3.3 Lift Station Pipelines

The evaluation of the existing influent pipeline infrastructure presented in Section 3.4 found that pipeline capacities would not limit groundwater extraction from the SWF and AWF. Pipeline infrastructure modifications are not recommended at this time.

4.3.4 Effluent Pipeline

The evaluation of the effluent pump station presented in Section 3.3 suggests that the effluent pipeline may be restricted, limiting flow to about 1,000 gpm. Tetra Tech recommends further study of the effluent pump and pipeline system to determine whether a restriction may be present. This study may include detailed performance testing of the effluent pump and pipeline system.

4.4 GWTP Modification Alternatives

The existing Consulting, Operations, and Maintenance Agreement between ETI and NERT requires that ETI operate and maintain the GWTP to meet contractual effluent specifications for chromium removal (i.e., effluent hexavalent chromium concentrations less than 0.01 mg/L, and effluent total chromium concentrations less 0.1 mg/L). Influent specifications under the contract are average annual influent total chromium concentrations of 9.4 to 11.5 mg/kg, and an average annual influent flow rate of 70 gpm. If future optimization efforts performed under the COP do not result in material exceedances of the influent specifications, no modifications to the GWTP will be necessary, as a contractual maintenance obligation for the GWTP currently exists.

Tetra Tech's inspection of the GWTP in May 2015 found that the following equipment would likely need refurbishment or replacement:

- Existing filter press;
- Backup pump P-1B
- Ferrous sulfate metering feed pump and associated tubing; and
- Air compressor for double-diaphragm pumps.

Since the inspection was performed, the filter press has been refurbished by ETI. Tetra Tech has advised ETI of the other items that are in need of repair or replacement.

If GWETS optimization implemented under the COP or other projects could result in significant increases in either the average annual flow or total chromium concentrations from the IWF, modifications to the GWTP would be necessary. Tetra Tech developed three alternatives for upgrading the GWTP, as described in the following subsections.

4.4.1 Alternative #1: Bypass GWTP and Update Ferrous Sulfate Feed

Under this alternative, the current GWTP would be bypassed, and the effluent would be directed to the FBR treatment plant, but the ferrous sulfate feed system would continue to be operated to reduce hexavalent chromium concentrations. The precipitated chromium would be removed by the existing FBR treatment plant sludge handling system. It is recognized that placing the ferrous sulfate feed at this location could potentially cause chromium to settle out in the GW-11 Pond or cause issues with the strainers or granular activated carbon system in the EQ Area. The existing ferrous sulfate feed pump and associated lines would be replaced by a new electronic metering pump capable of adjusting the feed rate automatically depending on flow from the wells in the IWF area (6 gph sized for 250 gpm influent flow rate). A new 250 gpm capacity electronic flowmeter would also be installed. A flow diagram for Alternative #1 is presented as Figure 4-1. The upgraded treatment system maximum flow rate would be limited by the ferrous sulfate feed pump capacity, which is sized for a maximum 250 gpm influent flow rate. However, the actual treatment capacity may be limited by the ability of the FBR treatment plant to handle the increased chromium load. A pilot test is necessary prior to implementation of this alternative to assess whether the FBR treatment plant can accommodate this load.

The estimated capital cost for Alternative #1 is approximately $60,000 (Table 4-1 and Appendix C), the lowest of the three alternatives. However, implementation of this alternative would require an evaluation of the existing NPDES permit effluent limits, input from ETI with respect to potential disruptions to the FBR treatment plant, and likely an amendment to the existing Consulting, Operations, and Maintenance agreement between ETI and NERT.

4.4.2 Alternative #2: Key Equipment Upgrade

Under this alternative, several major equipment items that are most important for GWTP treatment capacity and/or treatment efficiency would be replaced. This alternative would increase the existing treatment capacity and extend the service life of the GWTP at a moderate cost. The following changes would be made to the existing GWTP under this alternative (see Figure 4-2):

- Replacement of the existing clarifier with a new 200 gpm capacity inclined plate clarifier. This replacement would include installation of an integral flash mix tank with slow mixer and flocculation tank with rapid mixer. The existing polymer blending system would also be replaced with a new higher capacity polymer blending system.

- Replacement of the existing filter press with a 10 cubic foot automated filter press. The associated double-diaphragm pumps and piping would also be replaced.
- Replacement of the existing ferrous sulfate feed pump and associated tubing with a new higher capacity electronic metering pump feed (6 gph sized for 250 gpm inflow). The associated feed tubing would also be replaced.
- Replacement of the existing air compressor with a new unit with increased capacity (15-HP, 50-standard cubic feet per minute, two-stage, 120-gallon tank).
- Replacement of the four existing transfer pumps (P-1A, P-1B, P-4A, and P-4B) with new pumps. New pumps P-1A and P-1B would have capacities of 200 gpm at 30 feet of head, and new pumps P-1A and P-1B would have capacities of 200 gpm at 60 feet of head.
- Replacement of electrical components (e.g., motor starters and wiring) as needed.
- Upgrades to piping as needed.
- Replacement of field instrumentation (e.g., pressure gauges, switches, and sensors) to allow improved system monitoring.

The estimated capital cost for Alternative #2 is approximately $370,000 (Table 4-1 and Appendix C). Under this alternative, all key equipment items that determine the GWTP treatment capacity or are at risk of failure would be replaced, but the existing GWTP control system and control logic would be retained. The following non-motorized items such as tanks and piping deemed to be in good condition would be retained for continued use:

- Influent tank (T-1);
- Former degassing tank (T-2, acting as a reaction tank);
- Ferrous sulfate storage tank (T-3);
- Effluent tank (T-5);
- Sludge tank (T-6); and
- Piping and valves determined to be in good condition.

Implementation of Alternative #2 would significantly increase the capacity and extend the operational life of the GWTP. The chromium treatment capacity and overall functionality of Alternative #2 would be similar to Alternative #3 (Entire GWTP Replacement), but Alternative #2 would offer less automation and flexibility compared to Alternative #3.

4.4.3 Alternative #3: GWTP Replacement

Under this alternative, all existing GWTP equipment located on the 30-foot by 50-foot concrete pad would be removed, and a new 200-gpm-capacity chromium removal system would be installed. The overall existing treatment approach (chromium reduction via ferrous sulfate and precipitation) and general process sequence would be retained because the existing system has proven to be reliable and easily maintained under site-specific conditions. The GWTP chromium treatment process that would be implemented under Alternative #3, as shown on Figure 4-3, is summarized as follows:

- Groundwater from the IWF wells would enter the common manifold and influent holding tank T-1 (4,000 gallons).
- From influent tank T-1, groundwater would be pumped via transfer pump P-1A (3 HP, 200 gpm at 30 feet of head) to the reaction tank T-2 (5,000 gallons). Pump P-1B is an automatic back-up for P-1A, and both pumps have a capacity of 200 gpm at 30 feet of head (close-coupled pump with 3 hp motor).
- A pre-selected constant water level would be maintained in tank T-1 using a submersible pressure transmitter (SPT-1) and VFDs (VFD-1 and VFD-2) for pumps P-1A and P-1B. This would allow for a continuous nearly constant flow (eliminating on/off cycling) through the entire treatment system and would eliminate peak loading from clarifier C-1, which would in turn increase overall chromium removal efficiency.
- Ferrous sulfate would be metered into the influent line of reaction tank T-2 using metering pump MP-1, which would maintain the proper ferrous sulfate feed rate automatically depending on the inflow from the wells using the flow signal from flowmeter FM-1.
- Ferrous sulfate solution would be stored in the existing dedicated storage tank (T-3, estimated volume 8,000 gallons). Soluble hexavalent chromium would be reduced to non-soluble trivalent chromium by ferrous sulfate in reaction tank T-2.
- The effluent from reaction tank T-2 would flow by gravity into the inclined plate clarifier (C-1,200-gpm capacity) where solids would be precipitated.
- A polymer solution would be metered into the clarifier C-1 influent line using metering pump MP-2. A 55-gallon plastic drum would be used as a polymer feed tank (T-4).
- The treated groundwater effluent from clarifier C-1 would flow by gravity into effluent tank T-5 (4,000 gallons, HDPE).
- From effluent tank T-5, groundwater would be pumped via transfer pump P-4A to the GW-11 Pond, or to the EQ tanks. Pump P-4B is an automatic back-up for P4-A, and both pumps have a capacity of 200 gpm at 60 feet of head (close-coupled pump with 5 hp motor).
- Settled solids from the bottom of the clarifier would be pumped periodically by solids transfer pump P-2 (compressed air-driven double-diaphragm pump) into the cone-bottom sludge settling tank T-6 (2,500 gallons).
- Lime would be added into the sludge settling tank to aid in the precipitation process using a volumetric screw feeder with an adjustable rate (5 cubic foot hopper, 304 stainless steel construction, and feed rate of 0.028 to 2.8 cubic feet per hour).
- Low-solids-content sludge from the bottom of the sludge tank would be pumped periodically by sludge pump P-3 (compressed air-driven double-diaphragm pump) into the filter press FP-1 (10 cubic foot capacity).
- Filtered liquid would be transferred back into influent tank T-1, and after the filter cycle, the final sludge cake would be removed and loaded into the on-site roll-off container for periodic off-site disposal.
- The entire treatment process would be controlled by a programmable logic controller (PLC) with a touch screen human-machine interface (HMI). The control system would allow remote access for monitoring and control via the internet.

The estimated capital cost for Alternative #3 is approximately $690,000 (Table 4-1 and Appendix C). The existing ferrous sulfate storage tank (T-3) would be retained for the use in the new GWTP. Alternative #3 would offer significant additional capacity compared to the current GWTP while extending the life of the GWTP for at least 30 years. The chromium treatment capacity and overall functionality of Alternative #3 would be similar to Alternative #2 (Key Equipment Upgrade), but it would offer a greater degree of automation and flexibility compared to Alternative #2.

4.4.4 GWTP Upgrade Recommendations

The lowest cost option is Alternative #1 (Bypass GWTP and Update Ferrous Sulfate Feed), as discussed in in Section 4.4.1. This alternative would require pilot testing to determine whether the FBR treatment plant can accommodate the additional chromium loading without causing NPDES permit violations. Other uncertainties associated with this alternative include the effects of chromium toxicity on the FBR treatment plant biomass, and the potential for elevated chromium levels to affect the disposal status of the waste biosolids. Until these risks are better understood, Alternative #1 is not recommended.

If GWETS optimization implemented under the COP or other projects could result in significant increases in average annual flow or influent chromium concentrations from the IWF, Tetra Tech recommends implementation of either Alternative #2 (Key Equipment Upgrade) or Alternative #3 (Entire GWTP Replacement). Alternatives #2 and #3 offer similar treatment capacities, while Alternative #2 offers a lower cost compared to increased operational flexibility of Alternative #3. Both of these alternatives offer increased hydraulic and mass loading capacity that may be required during implementation of the COP. Management preferences and financial considerations are the key factors in selecting between these alternatives.

Tetra Tech also considered a potential diversion (GWTP bypass) of the flow from the extraction wells with relatively low chromium concentrations and directing this flow directly to the GW-11 Pond for treatment by the FBR treatment plant. Six wells in the IWF area have average chromium concentrations less than 2 mg/L, representing approximately 3 percent of the GWTP chromium loading. The average flow from these wells was approximately 15 gpm, and if diverted to the GW-11 Pond, would result in approximately 90 pounds per year of additional chromium loading to the FBR treatment plant. Overall, it appears that the potential benefit of diverting this flow would be small (a 15-gpm flow reduction to the GWTP). The cost of the piping upgrades required for this flow diversion would be relatively minor, likely less than $40,000.

4.5 GW-11 Pond Water Balance Instrumentation

One of the uses for the additional data collected from the instrumentation and controls implemented under the Enhanced Operational Metrics project is to improve the data used in determining the water balance for GW-11 Pond. During the evaluation of infrastructure presented in this report, it was determined that there are still some inputs for the GW-11 Pond water balance that are either estimated or have inaccuracies due to the method of monitoring and reporting. These areas include the effluent diversion flow into the GW-11 Pond, the flow from sumps in the D-1 Building and FBR pad, and the water level in the GW-11 Pond.

The effluent diversion flow is calculated using totalizer readings from the effluent flow meter located on the effluent line at the D-1 building. This flow meter measures all effluent flow, whether or not it is directed to Las Vegas Wash or diverted to the GW-11 Pond. The totalizer readings at the start and end of a diversion are manually documented by the operators to calculate the quantity of effluent diverted, and that amount is subtracted from the effluent flow to determine the amount that actually is discharged to Las Vegas Wash. If the operators are either late or forget to record the totalizer reading, the two flows are not accurate. It is recommended that two new flow meters be installed in the effluent after the two flows split in the EQ Area, one in the effluent pipe that goes to Las Vegas Wash and one in diversion pipe that goes to the GW-11 Pond.

The D-1 Building sump (P-1202) also receives flow from the FBR pad sumps (P-1101 and P-1102). The flow from P-1202 combines with the D-1 Building PDM sump (P-1203) and flows through a single pipe to the GW-11 Pond. This sump flow has been estimated based on the quantity of Stabilized Lake Mead Water (SLMW) used in the area of the FBR process minus what would enter the process flow stream and not reach the sump. There is limited confidence in the number used to estimate SLMW entering the process. By installing a flow meter on the combined discharge line from the sumps, this input to the GW-11 Pond would be more accurate and improve the water balance calculation.

The water level in GW-11 Pond is currently measured manually by the operators using a tape measure and a designated measuring point marked at the top of the pond liner. This method of measurement is greatly impacted by weather and wind. During wind and storm events, operators have difficulty taking an accurate reading from the pond level measuring device. This inaccuracy results in unreliable pond volume calculations and subsequently impacts the GW-11 Pond water balance. A difference of 1 inch in the level measurement represents over 100,000 gallons in pond volume. Current accuracy is likely not within 1 inch even when the pond surface is calm. The accuracy of the level measurement and therefore the pond volume can be improved by installing a stilling well and pressure transducer.

It should be understood that even with these recommended improvements to various inputs to the GW-11 Pond water balance calculation, the various pond inflows and outflows will not always balance. The flow meters and level measuring devices will have some level of error, even when installed properly and calibrated on an ongoing basis. This is most evident when the sum of two flows from the flow meter does not equal the flow from another flow meter that is measuring the combined flow. Although magnetic flow meters have a reported accuracy of 0.5 percent of flow (some report a higher accuracy), these are under optimum flow conditions and a perfectly calibrated system. Accuracies for individual flow meters in the range of 1 to 5 percent are likely. Therefore, if two flow meters are reading low by 5 percent and the flow meter with the combined flow is reading high by 5 percent, the difference is 10 percent. Therefore, if the balance of inflows to outflows is within 5 to 10 percent, it should be considered that they are within accuracy for balanced flows.

4.5.1 Effluent Flow to Las Vegas Wash

A magnetic flow meter should be installed in the 8-inch diameter effluent pipe at the EQ Area following the motorized isolation valve that is closed to divert water to GW-11 Pond. Power to the flow meter should be provided from the power panel in the EQ Area with conduit and conductors routed from the panel to the flow meter. The control signal from the flow meter should be routed to the input/output (I/O) panel located at the EQ Area. There is sufficient I/O available in this panel. The cable provided with the flow meter should be routed through new conduit to the panel. The existing PLC should will be programmed to collect, display, and record data from this flow meter.

4.5.2 Effluent Diversion Flow

A magnetic flow meter should be installed in the 8-inch diameter effluent diversion pipe at the EQ Area following the motorized isolation valve that is opened to divert water to the GW-11 Pond. Power to the flow meter should be provided from the power panel in the EQ Area with conduit and conductors routed from the panel to the flow meter. The control signal from the flow meter should be routed to the I/O panel located at the EQ Area. There is sufficient I/O available in this panel. The cable provided with the flow meter should be routed through new conduit to the panel. The existing PLC should be programmed to collect, display, and record data from this flow meter.

4.5.3 D-1 Building and FBR Sump Flow

A magnetic flow meter should be installed in the 4-inch diameter sump discharge pipe after the tee where flows from the D-1 Building sump, which also receives flow from the FBR pad sumps, and from the D-1 Building PDM sump combine. Power to the flow meter should be provided from the power panel in the motor control center room in the D-1 Building with conduit and conductors routed from the panel to the flow meter. The control signal from the flow meter should be routed to the PLC panel that will be installed under the Enhanced Operational Metrics project and located in the control room. There is sufficient I/O available in this panel. The cable provided with the flow meter should be routed through new conduit to the panel. The PLC should be programmed to collect, display, and record data from this flow meter.

4.5.4 GW-11 Pond Water Level

To facilitate more consistent readings year-round, Tetra Tech recommends that a stilling well with pressure transducer be installed at the GW-11 Pond to measure the pond level. This will reduce the effects of wind on measurement accuracy and the possibility of human error. The stilling well should include a 3-inch diameter polyvinyl chloride (PVC) pipe installed along the surface of the GW-11 Pond liner reaching to the pond bottom with a pressure transducer placed at the bottom of the pipe. The pressure transducer should be the same as the transducers used in the extraction wells. The stilling well should be located near the outlet pipe near the EQ Area. Power to the pressure transducer should be provided from the power panel in the EQ Area with conduit and conductors routed from the panel to transmitter junction box at the stilling well. The control signal from the pressure transducer should be routed to the I/O panel located at the EQ Area. There is sufficient I/O available in this panel. The cable provided with the pressure transducer should be routed to the junction box and connected to control wiring carried in conduit to the I/O panel. The existing PLC should be programmed to collect, display, and record level data.

4.5.5 Estimated Costs for GW-11 Pond Water Balance Instrumentation

The estimated cost for the design and installation of the three flow meters and for the stilling well and pressure transducer, including modifications to the PLC system and displays, is presented in Table 4-1 and Appendix C. The estimated cost for GW-11 Pond water level monitoring is $290,000.

5.0 GWETS PERFORMANCE MONITORING AND DATA ACCESSIBILITY

The following subsections describe options and recommendations for providing external access to GWETS operational data.

5.1 Summary

The GWETS is a complex network of various components, and much of the monitoring of the system is currently conducted manually. This is a time-consuming and labor intensive process. As a of result of the large system size, overall footprint, and complexity, it is currently not possible to gather all of the information needed for effective performance monitoring in near real time. Therefore, it is difficult to make site management decisions and identify necessary modifications to system operational parameters. This is further complicated by the fact that NERT must request data from the system operator. It is good practice for NERT management to have direct, unrestricted access to the information in order to confirm operations are functioning normally. Equally important, the overall system performance is likely to improve if the system can be monitored and optimization decisions made in near real time. Currently, upgrades to GWETS process equipment and instrumentation are underway as part of the Enhanced Operational Metrics project, and one of the upgrades includes installation of an instrumentation and controls (IC) system that will provide a complex network of I/Os of operational data from the wells and lift stations (real-time and historical data). Allowing remote access to these I/Os and I/Os from the Treatment Plant via the internet would facilitate remote monitoring and inspection of process operations directly by the Trust, and by others as directed by the Trust, from off-site locations. In addition to providing access to the I/Os, a system would be required to convert this information into a usable format and allow it to be easily understood. In this section, the networking infrastructure elements required to allow real-time external access to key GWETS operational data by bridging supervisory control and data acquisition (SCADA) to the web are identified and evaluated. Extracting a sufficient amount of system operational information for NERT management is important; therefore, this section provides tiered scenarios involving increasing sophistication for the proposed remote system monitoring interface.

5.2 Networking Infrastructure

Installation of various network equipment and services, as shown on Figure 5-1, would be required for remote real-time GWETS operations monitoring. The proposed networking infrastructure is based on the assumption that internet access to the GWETS SCADA unit is permissible. The infrastructure described below includes both software and hardware. As illustrated on Figure 5-1, hardware will be located both on-site and off-site at secure locations. Access to the GWETS control room SCADA/Open Platform Communications (OPC), laboratory data, and data collected and stored for historical inquiries (using software referred to as iHistorian), would be obtained by installing a web-service software on a server located within the control room. It is important to note that this is a conceptual design at this stage. It was agreed that Tetra Tech will work closely with ETI to determine the best location of the proposed hardware and integration with the GWETS SCADA system. The iHistorian stores GWETS data over long periods of time that can be retrieved to show historical trends. A remote web server with a data collection application known as a daemon would be used to periodically collect OPC, laboratory data, and historical data (from iHistorian), and the data would be extracted from the control room web service over an internet data connection. It is anticipated that the hardware will most likely be housed at a secure location in the Henderson or Las Vegas area. The specific location will be determined during the design phase. It was identified by the NERT team (including ETI) that the existing internet connection is slow, and this would be a limitation to the implementation of this system. To circumvent this, the NERT is currently evaluating other connectivity options available at the Site. The data extracted by the daemon would be stored on a Structured Query Language (SQL) database server. A second web service program, installed within the remote web server, would provide the user interface (UI) for remote user access of select GWETS performance monitoring metrics to hand-held devices and desktop and/or laptop computers with HyperText Markup Language 5 (HTML5) capable web browsers. Because users would access GWETS data residing on the remote web server, which yields much faster internet connection speeds, restrictions or “bottlenecks” would be eliminated, and the overall user experience would be improved. User connections to the remote server web service would be through a secure log-in, and the entire performance monitoring UI would be developed for viewing in a read-only format. The cost to integrate the networking infrastructure would be the same for each scenario evaluated in the subsequent sections, with variations in tiers based on the level of programming required to develop the UI and to modify the web services and data collection daemon. The cost for development, installation, and integration of the networking infrastructure is estimated to be approximately $150,000 (Table 5-1).

5.3 Real-Time GWETS Performance Monitoring

Following installation of the instrumentation and infrastructure required for implementation of the Enhanced Operational Metrics project, a total of 340 I/Os will be available for data logging. A select group of these I/Os were evaluated in terms of data value and benefit for remotely viewing via an HTML5 web-based GWETS performance monitoring dashboard interface. The quantity of I/Os to be included in the dashboard interface depends on the level of I/O detail, the process “zoom-in” capability desired, and the complexity of the web-based interface.

The web interface can be uploaded at whatever frequency is required by NERT stakeholders. The frequency of upload for field information (e.g., pump operations, rates, etc.) is likely to be between 1 and 60 minute intervals, whereas analytical data will be uploaded as it is entered into the database. The frequency of the upload will not affect the cost and can be adjusted, as needed, depending on specific data requirements.

As communicated by NERT, the GWETS data accessibility platform will be rolled out in phases. At Phase 1, only monitoring or “read-only” data will be provided. Subsequent phases and upgrades to this platform can be rolled out as required by NERT. These subsequent phases will be defined at a later time and may include provisions for remote operation and controls. All hardware, software and infrastructure established in Phase 1 will be designed with future upgradability in mind. Three options for Phase 1 are presented below. The options are presented in “tiers,” with each tier representing an increasingly higher level of detail and sophistication.

5.3.1 Tier 1 Remote Performance Monitoring

Tier 1 remote performance monitoring will provide a general snapshot of overall process conditions from each lift station, the extraction well fields, and groundwater treatment. This tier represents the simplest of tiers evaluated in terms of implementation and data visualization. Within Tier 1, main GWETS process flows, totalizer values, process pressures, sampling data, and mass removal data would be viewable. Figure 5-2 provides a conceptual portrayal of the Tier 1 level of detail and I/Os, and Table 5-2 summarizes the 10 I/Os selected for visualization. Flow rates and totalizer values in total gallons and gallons per year to date (or other customizable date references) would be displayed for LS1, LS2, LS3, IWF (GWTP intake), and

FBR treatment plant discharge. Process pressures would be viewable at LS1, LS2, LS3, IWF, and FBR treatment plant discharge (process pressures for LS2 and the FBR treatment plant discharge would utilize additional I/Os that are not included in the Enhanced Operational Metrics project I/O list).

Through upload of perchlorate and hexavalent chromium laboratory electronic data deliverables, the contaminant mass between sampling events would be calculated via a built-in algorithm using, for example, the average concentration value of the two most recent samples and the volume of water pumped between the two sample collection events. Perchlorate and hexavalent chromium mass would be presented in tons-to-date and pounds between collection of the two samples. Additionally, the estimated current total mass removal would be calculated based on current recovery volumes and the most recent sample analyzed. In this scenario, perchlorate and hexavalent chromium mass removal data would be viewable via data tables and historical time-series bar chart plots.

Provided the infrastructure for networking to the GWETS and FBR treatment plant control rooms is in place, the components identified in Section 5.2 would be capable of providing a data extraction platform for implementation of Tier 1. The local web services at the GWETS and FBR treatment plant control room and remote server web service would allow devices to view the dashboard interface via secure log-in using an HTML5-compatible web browser. The cost to implement Tier 1 would be approximately $330,000, including the infrastructure discussed in Section 5.2, as shown in Table 5-1.

5.3.2 Tier 2 Remote Performance Monitoring

Building from Tier 1, Tier 2 would provide a snapshot of overall process conditions identical to that provided by Tier 1. However, Tier 2 would also include GW-11 Pond flow and totalizer monitoring and additional drill-down capability (on a separate screen) to view the operating status (i.e., on/off) of each individual pump within the SWF, AWF, and IWF. Figures 5-3 and 5-4 provide conceptual portrayals of the Tier 2 level of detail and I/Os, and Table 5-3 summarizes the Enhanced Operational Metrics I/Os selected for visualization. Additionally, gauges, bar scales, or other graphics would visualize a limited set of critical parameters, such as flow from each lift station and FBR treatment plant discharge. Mass calculations and visual output display would be identical to that described for Tier 1. The cost to implement Tier 2 would be approximately $360,000, including the infrastructure discussed in Section 5.2 (Table 5-1).

5.3.3 Tier 3 Remote Performance Monitoring

Tier 3 is the most complex of the visualization scenarios illustrated, where further details are provided in auxiliary sub-level visuals. Each of the sub-levels would be selected by the user by clicking on the appropriate text box. Figures 5-5 through 5-8 provide a conceptual portrayal of the Tier 3 level of detail and I/Os, and Table 5-4 summarizes the 169 Enhanced Operational Metrics I/Os selected for visualization. Within the main screen, the following would be displayed:

- Flow rates and totalizer values for LS1 (SWF), LS2, LS3 (AWF), IWF, GW-11 Pond, and FBR treatment plant discharge;
- Process pressures for LS1, LS2, LS3, IWF, GW-11 Pond, and FBR treatment plant discharge;
- VFD operating frequency (in hertz), if ultimately required, and on/off status for pumps 1 and 2 at LS1, LS2, and LS3;

- Bar, gauge, or other graphic displays for flow at LS1 (SWF), LS2, LS3 (AWF), IWF, GW-11 Pond, and FBF; and
- Access buttons for sub-screens specific to IWF, SWF, and AWF pumping data, data trending, and mass removal.

Well-specific data and pump status information would be accessed via the main screen, where individual pump flow rates and well water levels could be viewed by well field. Additionally, a column for design flow rate could be added for comparison of actual versus design operating conditions. Following the well field pump overview screens, trending data could be viewed in Tier 3 in greater detail than in Tier 1 and Tier 2. Conceptual trending visualizations could include overall and well field-specific perchlorate and hexavalent chromium removal and well field-specific extraction rates. The refinement of the trending data to be visualized can be discussed with NERT if this scenario is selected for implementation. Lastly, mass removal data tables would present mass and volume recovery data by total and well field-specific perchlorate and hexavalent chromium removal, with a tabular format similar to that described for Tier 1.

An additional "query tool" is anticipated be included in Tier 3. This query tool would allow the user to enter certain parameters via the system and receive specified information back in both tabular and graphical form. For example, the user could query for all chromium results for the past year or extraction rates from a given well field over the past year. This historical information would be extracted as defined above.

The cost to implement Tier 3 would be approximately $440,000, including the infrastructure discussed in Section 5.2 (Table 5-1).

5.3.4 Benefits, Cost Evaluation, and Recommended Technology Platform

The tiers described above would offer differing benefits, with cost and implementation complexity increasing from Tier 1 (lowest cost; simplest implementation) to Tier 3 (highest cost; most complex implementation). A qualitative evaluation of the UI tiers is provided in Table 5-5, and the following discussion summarizes the benefits and limitations for each tier. It is important to note that each person with access to this system presumably will have an account that is password protected. Therefore, it is possible to assign each user access to different levels of information, based upon the direction of the NERT leadership.

Tier 1 was developed to provide a high-level summary of GWETS process operations while also providing data needed to gain an increased understanding of overall perchlorate and hexavalent chromium mass removal. Although it would not provide the capability of viewing the operations of each specific well in a well field, this option would provide a streamlined UI and would present general data within one screen. If overall lift station flows or other operating parameters appear unusual compared with normal operating conditions, the plant operator could then inspect the local SCADA HMI to initiate troubleshooting and diagnosis. Based on the lowest bandwidth requirement of the tiers, the data polling intervals could be increased more than the other tiers. In summary, Tier 1 would provide the simplest, lowest cost, and easiest implementation of the three tiers, with the limitation of viewing a reduced set of process I/Os.

Tier 2 would provide a moderate level of detail, such that GWETS process operations and individual recovery well pump on/off status could be monitored remotely. The streamlined UI would be maintained for Tier 2, as discussed for Tier 1, and the additional 56 I/Os would be required to provide a pump on/off status for each well pump. Remotely monitoring pump status would allow a quick and simplified approach to deploying maintenance personnel and maintaining pumps in an expedited manner. Tier 2 is a mid-range option, including mid-range costs and ease of implementation. The cost-benefit of Tier 2 over Tier 1 includes the additional capability of viewing recovery well pump status for a small incremental cost increase.

The greatest level of detail would be offered in Tier 3, where a main screen would provide an overview of overall GWETS operations, and auxiliary screens would allow for a focused view of well-specific pump status and flow rates, operational trending, and detailed mass removal summaries. The multiple screen layout would offer various benefits. For example, the well-specific pump status and flow rate data would allow personnel to determine when a pump may be operating outside of a pump curve and if a possible restriction or mechanical issue is present. Additionally, by monitoring flow to each lift station, well field flow rates could be calculated by summing individual flow rates. For Tier 1 and Tier 2, the flow rates viewed would be the discharges from the pumps at each lift station to the conveyance pipelines. More detailed trend visualization would assist in optimization of pumping strategies such that mass removal could be maximized while maintaining performance objectives. Similarly, detailed interpretation of mass removal could be used to modify pumping approaches. Overall, Tier 3 represents the most complex scenario with the greatest cost. However, the cost difference between Tier 3 and the other tiers is relatively low, and Tier 3 offers the benefits of monitoring operational parameters remotely with a high level of detail. As an initial UI platform, Tier 3 would offer the largest amount of customization and resulting optimization that could be conducted in near-real time. Because the large amount of available information could be unnecessary for select stakeholders, separate log-in credentials could be created for viewing only the main screen and for viewing the auxiliary pages.

Based on the information provided in Section 5, implementation of Tier 3 is recommended, and polling interval testing is recommended to determine the most efficient data refresh rate for the UI.

6.0 SUMMARY AND CONCLUSIONS

The following subsections briefly summarize the elements of the GWETS infrastructure which are most likely to impact the COP objective and present Tetra Tech's recommendations.

6.1 Summary

Acknowledging the fact that the GWETS will be required to effectively perform for at least the next eight years and almost certainly longer as a component of the Trust's final remedy, Tetra Tech provides the following recommendations to optimize the current system to enable NERT to confidently utilize the full capacity of the GWETS.

- **Effluent pipeline**: Although the hydraulic capacity of the effluent pipeline appears to be adequate, a restriction may be present which limits flow to approximately 1,000 gpm Because all treated groundwater is discharged through the effluent pipeline, this infrastructure issue could potentially affect future optimization of all of the well fields, particularly the AWF and SWF.
- **Permit limits**: The existing NPDES and air emissions permits limit total effluent discharge from the GWETS to approximately 1,000 gpm. Like the effluent pipeline, these limits could affect optimization of all of the well fields; however, with regulatory concurrence, the permits could potentially be modified to increase the allowable discharge flow rate.
- **Lift Station 1**: LS1 may have as little as 12 percent reserve capacity, which has the potential to limit increases in pumping from the SWF.
- **FBR Treatment Plant**: Although the actual hydraulic capacity of the FBR treatment plant is not currently known, according to ETI, it is likely to have substantial reserve hydraulic capacity. The primary limitation on the FBR treatment plan is the effluent pipeline. The FBR treatment plant has substantial reserve mass loading capacity.
- **GWTP**: The hydraulic and mass loading capacity of the GWTP could potentially limit increases in mass extraction from the IWF.

The hydraulic capacity of LS2 has been thought to be a factor which may limit increases in pumping from the SWF and AWF. The results of the analysis presented in this report indicates that the hydraulic capacity of LS2, which delivers water to the FBR treatment plant, and the effluent pump station, which conveys water from the FBR treatment plant, are very similar. This suggests that the hydraulic capacity of LS2 is unlikely to limit the hydraulic capacity of the GWETS.

6.2 Recommendations

Based on the data and analyses presented in this report, Tetra Tech presents the following recommendations for consideration by the Trust.

6.2.1 Recommendations for Near-Term Implementation

Based on consultation with the Trust, Tetra Tech makes the following recommendations for implementation in the near-term:

Well Field Equipment

- A maintenance program to verify well pump models and pump conditions in all extraction wells should be implemented. These inspections could be conducted whenever a pump is removed for routine servicing or well redevelopment.

Lift Stations and Effluent Pump Station

- The backup pump at LS2 is a submersible pump that is reportedly undersized and cannot serve as a full backup for the primary pump. As a result, the operation of the SWF and AWF are dependent on a single pump. Tetra Tech recommends that an appropriately-sized backup pump be installed at LS2.

Pipelines

- Effluent pipeline flow is currently limited to 1,000 gpm, apparently by a restriction in the pipeline. Additional study of the effluent pump and pipeline system is recommended to further evaluate whether a restriction may be present. This study may include performance testing of the effluent pump and pipeline system.

GW-11 Pond Water Balance Instrumentation

- Additional flow meters should be installed at the following locations to improve measurements of inflows to the GW-11 Pond: (i) in the 8-inch diameter effluent pipe at the EQ Area following the motorized isolation valve that is closed to divert water to GW-11 Pond; (ii) in the 8-inch diameter effluent diversion pipe at the EQ Area following the motorized isolation valve that is opened to divert water to the GW-11 Pond; (iii) and in the 4-inch diameter sump discharge pipe after the tee where flows from the D-1 Building sump, which also receives flow from the FBR pad sumps, and from the D-1 Building PDM sump, are combined.
- A stilling well with a pressure transducer should be installed at the GW-11 Pond to facilitate more accurate and consistent measurements of the pond level year-round.

Performance Monitoring and Data Accessibility

- Network infrastructure to allow GWETS operational data to be bridged to the web should be installed to allow the Trust to more effectively monitor the GWETS. A system which provides detailed access to flow rates, totalizer values, process pressures, pump status and flow, data trending, and mass removal information is recommended. The system would be implemented in a read-only environment, but would be designed to be readily upgraded. Control over level of access to data could be implemented through a password-protected account system.

6.2.2 Other GWETS Facility Analyses

Based on consultation with the Trust, Tetra Tech notes the following for potential long-term optimization activities:

Well Field Equipment

- The existing well pumps have adequate reserve pumping capacity to allow for increasing pumping rates and mass extraction from the existing wells. Wholesale replacement of the existing well pumps is not considered to be necessary at this time. However, individual pumps may need to be upgraded, depending on the optimization strategy chosen for implementing the COP.

- Well pump VFDs have a long payback period if only power cost savings are taken in consideration. However, the use of VFDs could enhance the operational capabilities of the GWETS and increase overall GWETS flexibility. This value should be reviewed after the Enhanced Operational Metrics project is complete and additional information on potential optimization strategies is available. If it is determined that variable pumping rates are required to optimize mass extraction, then the payback period for VFDs may become less important.

Lift Stations and Effluent Pump Station

- The existing transfer pumps in LS1, LS2, LS3, and the effluent pump station are operating below their hydraulic capacity, and have moderate reserve capacity to allow for variability in discharge rates from the well fields and operational flexibility at the FBR treatment plant and GWTP. However, the pump at LS1 may have as little as 12 percent reserve capacity, and could potentially limit increased pumping and mass extraction from the SWF. In addition, large increases in groundwater pumping and mass extraction from the AWF could exceed the hydraulic capacity of the LS2 and LS3 pumps. The need for lift station pump retrofits will depend on how the COP is implemented and where additional pumping capacity is required.
- The installation of VFDs at LS1, LS2, and LS3 would not be cost-effective in the short term based on power savings. However, VFDs may provide other benefits, including reducing the volume required for flow equalization. Installation of VFDs is not recommended for the existing lift station pumps at this time, but should be considered if pump retrofits are performed.

Pipelines

- The existing influent pipelines can accommodate large increases in flow. Infrastructure modifications to the influent pipelines are not recommended at this time.

GWTP

- The GWTP has sufficient reserve capacity to handle increased flow or increased hexavalent chromium mass loading up to 29 percent greater than current values. If implementation of the COP at the IWF will significantly increase flow or hexavalent chromium mass loading to the GWTP, it will likely require upgrades or replacement.
- Three alternatives for the GWTP were developed and analyzed, including one bypass alternative, and two alternatives to upgrade or replace the GWTP. Upgrading or replacing the GWTP both offer the increased hydraulic and mass loading capacity that may be required during implementation of the COP. Management preferences and financial considerations are the key factors in selecting between these alternatives.

FBR Treatment Plant

- The FBR treatment plant is currently limited to an effluent flow of approximately 1,000 gpm by the NPDES and air emissions permits. According to ETI, the major subsystems of the FBR treatment plant are actually designed for flow rates well in excess of 1,000 gpm. However, the internal piping systems may limit hydraulic capacity to somewhat lower values. ETI also noted that at present, the effluent pipeline limits the hydraulic capacity of the FBR treatment plant. Additional evaluation of the hydraulic and mass loading capacity of the FBR treatment plant is recommended.

TABLES

Table 2-1. Well Field Well Construction Details and Pump Information

Well ID	Installation Date	Status	Casing	Top of Casing Elevation (ft amsl)	Ground Elevation (ft amsl)	Muddy Creek Elevation (ft amsl)	Depth to Qal/UMCf Contact (feet)	Total Borehole Depth (ft bgs)	Total Well Depth (ft bgs)	Well Stickup (feet)	Screened Interval (ft bgs)	Filter Interval (feet)	Screen Size	Water-Bearing Zone	Lithology	Pump Model Number	Manu-facturer	Pump Power (hp)	Flow Rate[1] (gpm)
Seep Well Field																			
PC-115	06/01/01	P&A	6-Inch PVC	NR	1553.62	1505.00	49	55.3	55.3	NR	10 to 50	8 to 55.3	0.04	Shallow	Qal	NA	NA	NA	NA
PC-115R	07/01/01	Active	8-Inch PVC	1554.71	1554.79	1504.79	50	58	55.5	-0.09	10 to 50	8 to 55.5	0.04	Shallow	Qal	NA	Grundfos	5	91.5
PC-116	06/01/01	P&A	6-Inch PVC	NR	1551.64	1505.50	47	55	52.3	NR	12 to 47	10 to 55	0.04	Shallow	Qal	NA	NA	NA	NA
PC-116R	07/01/01	Active	8-Inch PVC	1552.10	1552.04	1503.04	49	58	55.5	0.06	10 to 50	8 to 58	0.04	Shallow	Qal	150S200-11	Grundfos	7.5	124.8
PC-117	02/01/03	Active	8-Inch PVC/SS	1552.26	1551.23	1500.23	51	57.5	53	1.03	11 to 51	9 to 57.5	0.04	Shallow	Qal	85S50-3	Grundfos	5	92.6
PC-118	02/01/03	Active	8-Inch PVC/SS	1554.53	1553.65	1504.15	49.5	52	51	0.88	9 to 49	7 to 52	0.04	Shallow	Qal	85S50-3	Grundfos	5	76.3
PC-119	02/01/03	Active	8-Inch PVC/SS	1554.66	1554.34	1507.34	47	49	47	0.32	15 to 45	11 to 49	0.04	Shallow	Qal	85S50-3	Grundfos	5	65.0
PC-120	02/01/03	Active	8-Inch PVC/SS	1554.64	1554.41	1509.41	45	48	47	0.23	15 to 45	11 to 48	0.04	Shallow	Qal	85S50-3	Grundfos	5	0.0
PC-121	02/01/03	Active	8-Inch PVC/SS	1554.10	1554.70	NR	NR	40.5	38.5	-0.60	6.5 to 36.5	4.5 to 40.5	0.04	Shallow	Qal	85S50-3	Grundfos	5	0.0
PC-133	12/01/04	Active	4-Inch PVC	1553.00	1551.84	1513.84	38	40.2	40.2	1.16	5 to 40	3 to 40.2	0.02	Shallow	Qal/xMCf/ UMCf	NA	Grundfos	1.5	2.2
PC-99R2[2]	05/01/01	Active	6-Inch PVC	1552.55	1552.18	1500.18	52	55.3	55.3	0.38	10 to 50	8 to 55.3	0.04	Shallow	Qal	150S200-11	Grundfos	20	58.0
PC-99R3[2]	07/01/01	Active	8-Inch PVC	1552.48	1551.90	1499.90	52	58	55.5	0.58	10 to 50	8 to 58	0.04	Shallow	Qal	150S200-11	Grundfos	5	
Athens Road Well Field																			
ART-1	10/01/01	Active	6-Inch PVC/SS	1614.47	1615.57	1562.57	53	58	56	-1.11	14 to 54	11 to 58	0.04	Shallow	Qal	40S20-7	Grundfos	2	33.0
ART-1A	03/01/03	Active	8-Inch PVC/SS	1614.40	1615.80	1561.80	54	58	56	-1.40	19 to 54	16 to 57	0.04	Shallow	Qal	NA	NA	NA	NA
ART-2	10/01/01	Active	6-Inch PVC/SS	1617.10	1617.42	1562.42	55	57	56	-0.32	19 to 54	16 to 57	0.04	Shallow	Qal	60S30-5	Grundfos	3	71.0
ART-2A	03/01/03	Active	8-Inch PVC/SS	1616.81	1618.33	1561.33	57	58	58	-1.52	21 to 56	9 to 58	0.04	Shallow	Qal	NA	NA	NA	NA
ART-3	10/01/01	Active	6-Inch PVC/SS	1617.93	1618.91	NR	NR	48.5	47	-0.98	15 to 45	13 to 48.5	0.04	Shallow	Qal	40S20-7	Grundfos	3	NA
ART-3A	03/01/03	Active	8-Inch PVC/SS	1617.60	1619.14	1566.14	53	58	55	-1.54	18 to 53	9 to 58	0.04	Shallow	Qal	40S20-7	NA	1.5	54.0
ART-4	10/01/01	Active	6-Inch PVC/SS	1617.39	1618.29	1573.91	44.4	48.4	46.4	-0.90	19.4 to 44.4	14.4 to 48.4	0.02	Shallow	Qal	40S20-7	Grundfos	NA	NA
ART-4A	02/01/03	Active	8-Inch PVC/SS	1617.46	1618.29	1574.91	43.4	47.4	45.4	-0.83	18.4 to 43.4	7.4 to 45.4	0.04	Shallow	Qal	NA	NA	1.5	10.0
ART-5[3]	10/01/01	Active	6-Inch PVC/SS	1614.06	1617.76	1589.18	28.6	31.6	30.6	-3.70	18.6 to 28.6	15.6 to 30.6	0.04	Shallow	Qal	NA	NA	NA	NA
ART-6	10/01/01	Active	6-Inch PVC/SS	1615.31	1620.13	1582.25	37.9	41.9	39.9	-4.82	17.9 to 37.9	13.5 to 39.9	0.04	Shallow	Qal	25S07-5	Grundfos	NA	NA
ART-6A	03/01/03	Active	8-Inch PVC/SS	1614.71	1619.96	1582.26	37.7	41.7	39.7	-5.25	22.7 to 37.7	10.7 to 39.7	0.04	Shallow	Qal	NA	NA	NA	NA
ART-7	10/01/01	Active	6-Inch PVC/SS	1615.37	1617.98	NR	NR	41.7	41.0	-2.61	19 to 39	13.5 to 41	0.04	Shallow	Qal	25S07-5	Grundfos	0.75	32.0

Table 2-1. Well Field Well Construction Details and Pump Information (continued)

Well ID	Installation Date	Status	Casing	Top of Casing Elevation (ft amsl)	Ground Elevation (ft amsl)	Muddy Creek Elevation (ft amsl)	Depth to Qal/UMCf Contact (feet)	Total Borehole Depth (ft bgs)	Total Well Depth (ft bgs)	Well Stickup (feet)	Screened Interval (ft bgs)	Filter Interval (feet)	Screen Size	Water-Bearing Zone	Lithology	Pump Model Number	Manu-facturer	Pump Power (hp)	Flow Rate (gpm)
Athens Road Well Field (continued)																			
ART-7A	03/01/03	Active	8-Inch PVC/SS	1614.78	1618.02	NR	NR	42.7	41.7	-3.24	19.7 to 39.7	9.7 to 41.7	0.04	Shallow	Qal	NA	NA	NA	NA
ART-7B	06/28/10	Active	8-Inch PVC/SS	1619.62	1618.06	1573.06	45	50	50	1.56	29.5 to 44.5	25 to 50	0.04	Shallow	Qal	NA	NA	NA	30.0
ART-8	01/01/02	Active	6-Inch PVC/SS	1617.69	1618.54	1567.54	51	54	50.5	-0.85	18 to 48	15 to 54	0.02	Shallow	Qal	40S15-5	Grundfos	5	85.0
ART-8A	03/01/03	Active	8-Inch PVC/SS	1617.10	1618.53	1566.53	52	58	54	-1.43	22 to 52	9 to 58	0.04	Shallow	Qal	NA	NA	NA	NA
ART-9	05/01/06	Active	8-Inch PVC/SS	1614.90	1618.68	1576.18	42.5	47.5	45.5	-3.78	23 to 43	15 to 45.5	0.04	Shallow	Qal	NA	NA	0.75	47.0
PC-150	6/30/10	Active	6-Inch PVC	1619.09	1618.36	1579.36	39	45	45	0.72	19.5 to 39.5	15 to 45	0.02	Shallow	Qal	NA	NA	NA	4.0
Interceptor Well Field																			
I-A	12/01/86	P&A	6-Inch PVC	1753.20	1750.10	1732.10	18	42.5	41	3.10	21.2 to 40.5	6 to 42.5	0.02	Shallow	UMCf (fg)	NA	NA	NA	NA
I-AA	12/04/07	Active	6-Inch PVC	1753.93	1751.08	1721.08	30	47	46	2.86	23.7 to 43.7	18 to 47	0.02	Shallow	UMCf (fg)	5S05-13	Grundfos	0.5	1.5
I-AB	08/14/09	Active	6-Inch PVC	1753.89	1750.57	1723.39	30.5	51	51	3.32	25 to 45	20 to 51	0.02	Shallow	Qal/UMCf (fg)	5S05-13	Grundfos	0.5	0.2
I-AC	06/15/10	Active	6-Inch PVC	1752.76	1750.12	1717.12	33	50	50	2.64	24.5 to 44.5	20 to 50	0.02	Shallow	Qal/UMCf (fg)	5S05-13	Grundfos	0.5	NA
I-AD	06/16/10	Active	6-Inch PVC	1755.39	1752.94	1721.94	31	50	50	2.45	24.5 to 44.5	20 to 50	0.02	Shallow	Qal/UMCf	5S05-13	Grundfos	0.5	0.2
I-AR	04/01/00	Active	18-Inch Galv Steel	1758.35	1758.02	1731.02	27	45	45	0.33	25 to 45	20 to 45	NR	Shallow	UMCf	NA	NA	0.5	1.0
I-B	10/01/86	Active	6-Inch PVC	1752.70	1750.00	1723.00	27	46	43	2.70	17.8 to 42.5	14.3 to 46	0.02	Shallow	Qal/xMCf/ UMCf (fg)	NA	Grundfos	0.5	1.5
I-C	12/01/86	Active	6-Inch PVC	1752.80	1752.00	1724.50	27.5	44.5	43	0.80	13.2 to 42.5	10.4 to 44.5	0.02	Shallow	UMCf	NA	Grundfos	0.5	6.0
I-D	10/01/86	Active	6-Inch PVC	1752.70	1750.00	1721.00	29	47	45	2.70	16 to 44.5	10.7 to 47	0.02	Shallow	Qal/xMCf/ UMCf (fg)	NA	Grundfos	0.5	2.0
I-E	12/01/86	Active	6-Inch PVC	1752.40	1750.00	1723.00	27	49	44	2.40	21.5 to 43.5	10.2 to 49	0.02	Shallow	UMCf	5S05-13	Grundfos	0.5	1.5
I-F	09/01/86	Active	6-Inch PVC	1749.70	1747.70	1717.70	30	50	43.8	2.00	11.8 to 43.3	11 to 50	0.02	Shallow	Qal/xMCf/ UMCf	NA	Grundfos	0.5	5.7
I-G	12/01/86	Active	6-Inch PVC	1752.50	1749.20	1721.20	28	43.5	39.3	3.30	9.5 to 38.3	7 to 43.5	0.02	Shallow	Qal/xMCf/ UMCf (fg)	NA	Grundfos	0.5	0.5
I-H	09/01/86	Active	6-Inch PVC	1753.20	1750.30	1721.80	28.5	47	43.6	2.90	13.6 to 43.1	11.6 to 47	0.02	Shallow	UMCf	NA	Grundfos	0.5	1.2
I-I	12/01/86	Active	6-Inch PVC	1745.50	1742.30	1715.80	26.5	45	41	3.20	11.3 to 40.5	8.5 to 45	0.02	Shallow	Qal/xMCf/ UMCf	NA	Grundfos	0.5	5.0
I-J	12/01/86	Active	6-Inch PVC	1750.09	1746.59	1718.59	28	45	41	3.50	11.2 to 40.5	8.7 to 45	0.02	Shallow	Qal/xMCf/ UMCf (fg)	NA	Grundfos	0.5	8.0
I-K	12/01/86	Active	6-Inch PVC	1746.04	1743.80	1719.30	24.5	43	35.8	2.24	7 to 35.2	6 to 43	0.02	Shallow	UMCf	NA	Grundfos	0.5	4.0
I-L	10/01/93	Active	6-Inch PVC	1751.70	1748.30	1720.30	28	45	40	3.40	9 to 39	7 to 45	0.02	Shallow	Qal/xMCf/ UMCf	NA	Grundfos	0.5	2.5
I-M	10/01/93	Active	6-Inch PVC	1752.90	1749.20	1719.20	30	45	40	3.70	9 to 39	7 to 40	0.02	Shallow	Qal/xMCf/ UMCf	NA	Grundfos	0.5	2.6

Table 2-1. Well Field Well Construction Details and Pump Information (continued)

Well ID	Installation Date	Status	Casing	Top of Casing Elevation (ft amsl)	Ground Elevation (ft amsl)	Muddy Creek Elevation (ft amsl)	Depth to Qal/UMCf Contact (feet)	Total Borehole Depth (ft bgs)	Total Well Depth (ft bgs)	Well Stickup (feet)	Screened Interval (ft bgs)	Filter Interval (feet)	Screen Size	Water-Bearing Zone	Lithology	Pump Model Number	Manu-facturer	Pump Power (hp)	Flow Rate (gpm)
Interceptor Well Field (continued)																			
I-N	10/01/93	Active	6-Inch PVC	1751.40	1747.80	1713.80	34	45	38	3.60	7 to 37	5 to 38	0.02	Shallow	Qal/xMCf/ UMCf	5S05-13	Grundfos	0.5	3.5
I-O	10/01/93	Active	6-Inch PVC	1752.80	1749.00	1719.00	30	40	40	3.80	9 to 39	7 to 40	0.02	Shallow	Qal/xMCf/ UMCf	5S05-13	Grundfos	0.5	2.5
I-P	03/01/98	Active	6-Inch PVC	1751.70	1749.20	1716.20	33	45	44.5	2.50	14 to 44	12 to 45	0.02	Shallow	Qal/xMCf/ UMCf	5S05-13	Grundfos	0.5	3
I-Q	03/01/98	Active	6-Inch PVC	1753.10	1749.40	1721.40	28	40	40	3.70	9.6 to 39.6	7 to 40	0.02	Shallow	Qal/xMCf/ UMCf	NA	Grundfos	0.5	2.5
I-R	02/01/99	Active	6-Inch PVC	1751.35	1749.06	1721.56	27.5	45	43	2.29	9.8 to 39.8	7.8 to 43	0.02	Shallow	Qal/xMCf/ UMCf	NA	Grundfos	0.5	2.5
I-S	02/01/99	Active	6-Inch PVC	1750.03	1747.57	1721.07	26.5	45.2	45.2	2.46	12 to 42	9.5 to 45.2	0.02	Shallow	Qal/xMCf/ UMCf	NA	Grundfos	0.5	5
I-T	02/01/99	Active	6-Inch PVC	1751.66	1749.03	1718.03	31	60	45.2	2.63	12 to 42	10 to 45.2	0.02	Shallow	Qal/xMCf/ UMCf	NA	Grundfos	0.5	0.4
I-U	02/01/99	Active	6-Inch PVC	1752.17	1749.54	1721.04	28.5	45	45	2.63	12 to 42	9.5 to 45	0.02	Shallow	Qal/xMCf/ UMCf	NA	Grundfos	0.5	0.8
I-V	02/01/99	Active	6-Inch PVC	1752.13	1749.46	1716.96	32.5	55	45	2.67	12 to 42	9.5 to 45	0.02	Shallow	Qal/xMCf/ UMCf	NA	Grundfos	0.5	4.8
I-W	09/01/00	Active	6-Inch PVC	1751.50	1749.12	1727.12	33	51	50.5	2.38	20 to 50	14 to 51	0.02	Shallow	Qal/xMCf/ UMCf	5S05-13	Grundfos	NA	NA
I-X	09/01/00	Active	6-Inch PVC	1748.60	1746.22	1713.22	33	51	50.5	2.38	20 to 50	14 to 51	0.02	Shallow	Qal/xMCf/ UMCf	5S05-13	Grundfos	NA	NA
I-Y	09/01/00	Active	6-Inch PVC	1751.40	1748.89	1720.89	28	50.5	50.5	2.51	20 to 50	14 to 50.5	0.02	Shallow	Qal/xMCf/ UMCf	5S05-13	Grundfos	NA	NA
I-Z	06/01/03	Active	6-Inch PVC	1743.78	1742.19	1718.78	25	40	35	1.59	15 to 35	10 to 35	0.02	Shallow	Qal/xMCf/ UMCf	NA	Grundfos	0.5	8.0

All data are from the All Wells Database maintained by the Nevada Environmental Response Trust and other Black Mountain Industrial Complex property owners.

1 Seep Well Field flow rates are average flow rates; Athens Road Well Field and Interceptor Well Field flow rates are maximum sustainalbe flow rates.

2 Wells PC-99R2 and PC-99R3 are connected and operate as a single pumping well.

3 Well ART-5 has been dry since February 2006.

fg - Fine grained.

ft amsl - Feet above mean sea level.

ft bgs - Feet below ground surface.

gpm - Gallons per minute.

hp - Horsepower.

NA - Not available.

NR - Not recorded.

P&A - Plugged and abandoned.

PVC - Polyvinyl chloride.

Qal - Quaternary Alluvium.

SS - Stainless steel.

UMCf = Upper Muddy Creek Formation.

xUMCf = transitional Upper Muddy Creek Formation.

Table 2-2. Seep Well Field Pumping Rates

Date	PC99R2/ 99R3 (gpm)	PC-115R (gpm)	PC-116R (gpm)	PC-117 (gpm)	PC-118 (gpm)	PC-119 (gpm)	PC-120 (gpm)	PC-121 (gpm)	PC-133 (gpm)
Jan-13	55.9	91.6	124.9	124.9	93.7	93.0	0.1	1.3	4.2
Feb-13	55.3	90.5	124.9	125.0	93.7	93.0	0.0	0.0	4.7
Mar-13	54.4	89.7	124.2	124.4	91.2	89.5	1.1	0.0	4.2
Apr-13	56.0	90.4	124.9	124.9	93.7	76.8	0.0	0.0	4.2
May-13	55.9	93.5	123.7	123.8	92.8	74.8	0.0	0.0	4.2
Jun-13	38.3	96.9	124.8	124.8	93.6	75.6	0.0	0.0	4.3
Jul-13	55.9	96.0	123.2	123.3	92.7	74.7	0.0	0.0	4.4
Aug-13	57.2	89.9	124.7	113.6	84.3	70.8	0.0	0.0	4.7
Sep-13	62.4	96.2	124.9	93.7	65.0	62.5	0.0	0.0	4.2
Oct-13	62.1	94.8	124.4	93.3	61.3	62.2	5.0	0.0	4.3
Nov-13	60.3	76.9	120.7	90.6	63.6	60.3	0.0	0.0	4.2
Dec-13	62.1	65.9	124.6	93.5	64.9	62.3	0.0	0.0	4.2
Jan-14	62.2	92.4	124.4	93.5	64.0	62.4	0.0	0.0	4.2
Feb-14	62.4	99.5	124.9	93.7	63.7	62.5	0.0	0.0	4.2
Mar-14	60.8	98.0	121.6	91.4	62.0	60.9	0.0	0.0	4.2
Apr-14	62.2	89.2	124.4	93.6	63.6	62.4	0.0	0.0	4.3
May-14	65.6	83.2	124.4	93.5	62.7	62.3	0.0	0.0	4.2
Jun-14	60.1	85.3	120.3	90.3	60.6	60.2	0.0	0.0	4.2
Jul-14	62.4	89.7	124.8	91.6	70.8	62.9	0.0	0.0	4.2
Aug-14	62.0	96.0	124.0	93.1	77.6	62.1	0.0	0.0	4.2
Sep-14	62.3	98.9	124.8	93.6	78.0	62.4	0.0	0.0	4.2
Oct-14	62.2	92.4	124.5	93.6	77.8	62.3	0.0	0.0	4.2
Nov-14	62.5	98.7	125.1	93.8	78.1	62.5	0.0	0.0	4.2
Dec-14	62.5	95.4	124.9	93.7	78.0	62.5	0.0	0.0	4.1
Jan-15	62.5	96.2	124.5	94.3	75.6	62.2	0.0	0.2	4.1
Feb-15	87.8	105.1	150.8	119.9	78.0	50.0	0.0	0.0	4.2
Mar-15	85.9	100.8	153.3	121.2	77.5	47.1	0.2	0.0	4.2
Apr-15	64.9	102.9	147.8	115.3	76.2	47.8	0.0	0.0	4.2
May-15	62.5	88.1	137.2	94.1	77.0	62.9	0.0	0.0	4.2
Jun-15	62.4	88.5	143.4	93.7	78.1	62.5	0.0	0.0	4.3
Minimum	38.3	65.9	120.3	90.3	60.6	47.1	0.0	0.0	4.1
Maximum	87.8	105.1	153.3	125.0	93.7	93.0	5.0	1.3	4.7
Average	61.6	92.4	127.8	103.7	76.3	65.8	0.2	0.1	4.2

Source: Envirogen Technologies, Inc., GWETS Field Sheets updated on a weekly basis.

gpm - Gallons per minute averaged during the month.

Monthly gpm values are averages of flow values during that month.

Minimum, maximum, and average values are from January 2013 to June 2015.

Table 2-3. Athens Road Well Pumping Rates

Date	ART-1/1A (gpm)	ART-2/2A (gpm)	ART-3/3A (gpm)	ART-4/4A (gpm)	ART-5 (gpm)	ART 7/7A/7B (gpm)	ART-8/8A (gpm)	ART 9/6/6A (gpm)	PC-150 (gpm)
Jan-13	23.4	62.4	46.8	8.0	0.0	31.2	62.4	53.8	NA
Feb-13	23.4	62.5	46.9	8.0	0.0	31.3	62.5	48.3	NA
Mar-13	23.4	62.4	46.8	7.9	0.0	31.2	62.4	46.8	NA
Apr-13	23.4	62.5	46.9	7.9	0.0	31.3	62.5	46.9	NA
May-13	23.4	61.5	46.2	7.9	0.0	30.7	54.3	46.1	NA
Jun-13	23.4	62.5	46.9	8.0	0.0	31.2	61.7	46.9	NA
Jul-13	23.5	60.8	45.9	7.8	0.0	30.5	60.8	45.5	NA
Aug-13	23.5	61.9	47.6	8.3	0.0	31.0	56.6	48.2	NA
Sep-13	23.4	62.4	48.0	9.2	0.0	31.2	46.8	53.0	NA
Oct-13	23.6	61.7	48.6	9.9	0.0	30.9	60.8	48.3	NA
Nov-13	23.2	59.7	47.5	10.3	0.0	29.9	59.7	43.9	NA
Dec-13	23.4	62.3	49.2	11.6	0.0	31.1	62.3	45.3	NA
Jan-14	23.4	62.1	47.3	11.5	0.0	30.2	62.6	46.0	NA
Feb-14	23.4	62.5	46.9	11.1	0.0	31.2	62.5	45.3	NA
Mar-14	23.4	61.0	47.7	8.3	0.0	31.7	62.1	42.2	NA
Apr-14	23.4	62.4	46.9	5.0	0.0	31.2	62.4	46.8	NA
May-14	23.4	62.5	46.8	11.4	0.0	31.2	62.5	46.8	NA
Jun-14	23.4	62.5	46.8	12.2	0.0	31.2	62.5	46.9	NA
Jul-14	23.4	61.0	43.3	11.5	0.0	30.5	66.4	45.4	NA
Aug-14	23.4	62.0	46.3	15.4	0.0	31.0	62.0	47.9	NA
Sep-14	23.6	62.5	46.6	15.6	0.0	31.3	62.5	50.8	NA
Oct-14	23.1	62.3	43.6	15.8	0.0	30.9	62.9	50.6	NA
Nov-14	20.9	52.2	45.0	15.6	0.0	30.2	65.0	45.7	4.5
Dec-14	11.7	57.9	45.6	15.6	0.0	31.0	62.3	55.0	4.5
Jan-15	8.5	62.2	42.8	15.5	0.0	29.7	71.2	49.1	4.5
Feb-15	8.6	62.0	43.4	13.2	0.0	31.0	62.5	58.8	4.5
Mar-15	7.8	62.0	44.7	15.1	0.0	30.3	62.0	60.9	4.5
Apr-15	7.8	62.5	44.4	15.4	0.0	29.7	62.5	60.5	4.5
May-15	7.8	62.4	43.8	15.6	0.0	29.3	62.4	59.9	4.5
Jun-15	7.8	62.5	43.4	15.7	0.0	28.4	62.4	62.4	4.5
Minimum	7.8	52.2	42.8	5.0	0.0	28.4	46.8	42.2	4.5
Maximum	23.6	62.5	49.2	15.8	0.0	31.7	71.2	62.4	4.5
Average	19.9	61.6	46.1	11.5	0.0	30.7	61.7	49.8	4.5

Source: Envirogen Technologies, Inc., GWETS Field Sheets updated on a weekly basis.

Well ART-5 has been dry since February 2006.

NA - Not available.

gpm - Gallons per minute averaged during the month.

Monthly gpm values are averages of flow values during that month.

Minimum, maximum, and average values are from January 2013 to June 2015.

Table 2-4. Interceptor Well Field Pumping Rates

Date	I-AR (gpm)	I-AA (gpm)	I-AB (gpm)	I-AC (gpm)	I-AD (gpm)	I-B (gpm)	I-C (gpm)	I-D (gpm)	I-E (gpm)	I-F (gpm)	I-G (gpm)	I-H (gpm)	I-I (gpm)	I-J (gpm)	I-K (gpm)	I-L (gpm)	I-M (gpm)	I-N (gpm)	I-O (gpm)	I-P (gpm)	I-Q (gpm)	I-R (gpm)	I-S (gpm)	I-T (gpm)	I-U (gpm)	I-V (gpm)	I-W (gpm)	I-X (gpm)	I-Y (gpm)	I-Z (gpm)
Jan-13	1.4	NA	NA	NA	NA	1.7	5.9	1.7	2.3	3.9	0.6	1.0	4.5	5.5	3.0	2.1	5.0	2.7	3.2	4.1	0.2	3.2	2.8	0.6	1.1	5.3	NA	NA	NA	8.8
Feb-13	1.5	NA	NA	NA	NA	1.4	6.4	1.8	2.4	3.9	0.7	1.0	4.9	5.9	2.8	2.6	4.5	2.3	3.3	4.1	0.2	2.5	3.1	0.4	1.1	5.4	NA	NA	NA	8.4
Mar-13	1.4	NA	NA	NA	NA	1.5	5.4	1.7	2.5	3.8	0.8	1.0	4.8	6.1	3.1	1.6	4.7	1.3	3.4	4.2	0.2	2.3	3.2	0.2	1.3	5.4	NA	NA	NA	8.4
Apr-13	1.4	NA	NA	NA	NA	1.5	5.6	1.8	2.6	3.4	0.8	1.0	4.9	5.8	1.9	1.6	4.3	1.3	3.6	4.5	0.4	2.4	4.4	0.2	1.5	5.4	NA	NA	NA	8.2
May-13	1.1	NA	NA	NA	NA	1.4	4.7	1.8	2.6	4.5	0.9	1.0	4.8	5.0	2.1	1.5	4.3	1.2	3.4	5.0	0.2	2.3	3.7	0.1	0.4	5.4	NA	NA	NA	8.0
Jun-13	1.0	NA	NA	NA	NA	1.4	4.4	1.8	2.7	4.7	0.9	0.9	4.9	6.6	4.0	1.4	2.3	1.2	2.9	5.3	0.2	2.4	3.8	0.1	0.2	5.5	NA	NA	NA	7.8
Jul-13	0.9	NA	NA	NA	NA	1.4	4.4	1.8	2.6	4.7	0.9	1.0	4.8	6.5	3.9	1.4	2.2	1.2	2.9	5.1	0.2	2.5	3.8	0.3	0.6	5.6	NA	NA	NA	7.6
Aug-13	0.8	NA	NA	NA	NA	1.5	3.4	1.7	2.7	4.7	0.8	1.0	4.9	6.5	3.8	1.4	2.2	1.1	2.8	4.8	0.2	2.6	3.9	0.5	1.0	5.6	NA	NA	NA	7.7
Sep-13	0.6	NA	NA	NA	NA	1.7	5.3	1.6	2.8	4.7	0.9	0.8	4.9	6.6	4.0	1.3	2.2	1.1	1.1	5.5	0.2	2.7	3.9	0.4	1.0	5.6	NA	NA	NA	7.9
Oct-13	0.4	NA	NA	NA	NA	1.7	5.6	1.6	2.8	4.7	1.1	0.6	4.9	6.8	4.0	1.4	2.1	1.2	0.4	6.2	0.1	2.2	3.9	0.3	1.1	5.6	NA	NA	NA	8.0
Nov-13	1.6	NA	NA	NA	NA	0.8	5.4	1.4	2.7	4.5	1.1	0.6	4.8	6.7	3.9	1.3	2.0	1.0	0.5	6.0	0.8	2.8	3.8	0.2	1.1	5.5	NA	NA	NA	7.8
Dec-13	1.6	NA	NA	NA	NA	1.6	5.9	1.9	2.8	4.7	0.9	0.6	4.9	6.9	4.0	1.2	2.1	1.0	0.6	6.1	1.1	3.7	4.3	0.5	1.1	5.7	NA	NA	NA	7.9
Jan-14	1.5	NA	NA	NA	NA	1.5	6.1	1.9	2.9	4.8	1.0	0.6	4.9	6.8	3.9	1.2	2.1	1.0	0.7	6.1	0.9	3.9	4.3	0.7	1.1	5.8	NA	NA	NA	8.0
Feb-14	1.4	NA	NA	NA	NA	1.6	4.8	2.2	2.8	4.8	0.9	0.6	4.9	7.0	4.1	1.2	2.1	2.3	0.6	5.8	0.9	3.9	4.1	0.6	1.1	5.8	NA	NA	NA	8.0
Mar-14	1.3	NA	NA	NA	NA	1.5	5.8	2.2	2.6	4.7	0.7	0.6	4.9	7.0	4.2	1.1	2.1	3.2	1.3	5.2	1.0	3.9	4.4	0.4	1.1	5.9	NA	NA	NA	7.9
Apr-14	1.2	0.0	0.0	0.0	0.0	1.7	5.9	2.3	2.6	4.7	0.8	0.5	4.7	6.8	4.2	1.2	2.0	2.8	2.1	4.4	0.9	3.8	3.7	0.3	1.0	5.8	0.0	0.0	0.0	7.7
May-14	1.2	0.4	0.4	0.1	0.4	1.8	6.2	2.2	2.4	4.6	0.7	0.6	4.7	6.7	4.0	2.3	1.9	2.2	2.0	3.3	0.8	3.8	3.2	0.3	0.9	5.7	0.7	2.7	0.2	7.1
Jun-14	1.1	0.5	0.0	0.0	0.0	1.5	7.0	3.3	2.2	4.6	0.4	1.3	4.8	4.8	4.4	2.6	4.0	2.4	2.5	3.3	0.9	3.2	5.2	0.5	0.9	5.9	0.5	3.9	1.5	5.0
Jul-14	1.0	0.3	0.0	0.0	0.0	1.4	6.7	2.6	1.6	4.4	0.2	1.3	4.5	2.5	4.7	2.9	3.1	3.1	2.5	3.5	0.6	2.9	5.0	0.5	0.8	5.6	0.9	4.3	1.4	3.7
Aug-14	0.9	0.9	0.0	0.0	0.0	1.3	5.8	1.9	1.4	4.4	0.2	1.4	4.8	2.6	5.0	2.4	2.9	3.1	2.5	3.8	0.5	2.7	4.9	0.4	0.8	5.7	0.9	3.4	1.4	2.7
Sep-14	0.8	1.4	0.0	0.0	0.0	1.1	5.9	1.9	1.3	4.1	0.2	1.4	4.7	2.6	5.1	2.2	2.7	3.0	2.6	3.9	0.5	2.6	5.1	0.5	0.9	5.7	1.1	3.1	1.4	2.7
Oct-14	0.8	1.4	0.0	0.0	0.1	1.1	5.7	1.9	1.3	4.0	0.2	1.4	4.6	2.6	5.3	2.2	2.5	3.0	2.8	3.9	0.5	2.6	5.2	0.5	0.9	5.6	1.1	3.1	1.4	2.8
Nov-14	0.8	1.3	0.0	0.0	0.0	1.1	5.5	1.8	1.2	4.2	0.2	1.5	4.7	2.6	5.3	2.4	2.5	2.5	2.9	4.0	0.5	2.6	5.1	0.5	0.9	5.6	1.0	3.2	1.5	2.7
Dec-14	0.7	1.2	0.0	0.0	0.0	1.0	6.1	1.8	0.9	4.5	0.1	1.3	4.7	5.6	4.8	2.4	2.4	1.9	2.5	3.1	0.5	2.3	5.0	0.4	0.9	5.2	1.0	3.3	1.3	6.0
Jan-15	0.7	1.3	0.0	0.0	0.0	1.1	6.0	1.8	1.1	4.4	0.2	1.1	4.8	6.7	4.3	2.6	2.4	1.8	1.7	2.2	0.4	2.3	5.2	0.4	1.0	5.0	1.0	3.3	1.5	7.3
Feb-15	0.7	0.8	0.0	0.0	0.0	1.1	5.4	1.8	1.2	4.6	0.2	1.0	4.8	6.4	4.2	2.9	2.3	1.5	1.7	2.2	0.5	2.4	5.0	0.3	0.9	5.0	0.8	3.4	1.6	7.4
Mar-15	0.7	0.8	0.0	0.0	0.0	1.2	4.7	1.8	1.2	4.1	0.2	0.9	4.8	6.6	4.1	3.3	2.3	2.4	1.5	2.0	0.4	2.5	4.3	0.4	0.9	4.8	0.7	3.2	1.6	7.1
Apr-15	0.7	0.9	0.0	0.0	0.0	1.1	4.6	1.7	1.1	3.6	0.2	0.9	4.6	6.4	3.9	3.3	2.3	2.6	1.5	1.9	0.4	2.3	4.4	0.4	0.9	4.5	0.4	2.9	1.6	6.9
May-15	0.7	1.3	0.0	0.0	0.0	1.0	5.3	1.7	1.1	4.2	0.2	0.8	4.8	6.5	4.0	3.2	2.4	2.9	1.3	1.8	0.4	2.4	4.6	0.4	1.0	4.6	0.4	1.5	1.5	6.9
Jun-15	0.7	0.6	0.0	0.0	0.0	1.0	5.2	1.6	1.2	4.0	0.1	0.8	4.9	6.5	3.9	3.2	2.4	2.8	1.5	1.7	0.4	2.4	4.7	0.4	0.9	3.8	0.4	1.7	1.2	6.8
Minimum	0.4	0.0	0.0	0.0	0.0	0.8	3.4	1.4	0.9	3.4	0.1	0.5	4.5	2.5	1.9	1.1	1.9	1.0	0.4	1.7	0.1	2.2	2.8	0.1	0.2	3.8	0.0	0.0	0.0	2.7
Maximum	1.6	1.4	0.4	0.1	0.4	1.8	7.0	3.3	2.9	4.8	1.1	1.5	4.9	7.0	5.3	3.3	5.0	3.2	3.6	6.2	1.1	3.9	5.2	0.7	1.5	5.9	1.1	4.3	1.6	8.8
Average	1.0	0.9	0.0	0.0	0.0	1.4	5.5	1.9	2.1	4.4	0.6	1.0	4.8	5.7	4.0	2.1	2.7	2.0	2.1	4.1	0.5	2.8	4.3	0.4	1.0	5.4	0.7	2.9	1.3	6.8

Source: Envirogen Technologies, Inc., GWETS Field Sheets updated on a weekly basis.

NA - Not available.

gpm - Gallons per minute averaged during the month.

Monthly gpm values are averages of flow values during that month.

Minimum, maximum, and average values are from January 2013 to June 2015.

Table 2-5. Lift Station Details

Location		Manufacturer	Rated Capacity (gpm)	Rated Head (feet)	Pipe Diameter (inches)	Average Flow (gpm)	Wet Well Dimensions (feet)	Wet Well Volume (gallons)
Lift Station #1	Pump 1	Quadna	525	253	10	621	32 x 14 x 7	24000
	Pump 2	Fairbanks or Quadna	NA	NA	10	621	--	--
Lift Station #2	Pump 1	Quadna (Vertical Turbine)	1200	231	12	860	21 x 22 x 14	48000
	Pump 2	Myers (Submersible)	NA	NA	12	250	--	--
Lift Station #3	Pump 1	Myers (Submersible)	NA	NA	8	250	8 x 25 x 8	12000
	Pump 2	Goulds	NA	NA	8	250	--	--
Effluent (Las Vegas Wash)	Pump 1	Corcoran	1000	197.5	10	900	--	--

gpm - Gallons per minute.

NA - Not available; pump nameplate was unavailable.

-- Pump capacity information was unavailable due to unknown specifications.

Table 2-6. Lift Station Pump Rates

Date	LS1 to LS2	LS3 to LS2	LS2 to FBR Treatment Plant
Jan-13	583.1	249.9	749.6
Feb-13	587.6	249.9	749.7
Mar-13	559.3	249.5	746.0
Apr-13	626.3	249.9	749.6
May-13	634.2	248.2	742.9
Jun-13	522.5	249.9	749.7
Jul-13	522.2	238.2	731.4
Aug-13	433.5	232.3	630.2
Sep-13	506.0	273.1	687.4
Oct-13	508.1	305.6	744.1
Nov-13	468.0	281.0	692.0
Dec-13	488.3	303.1	732.7
Jan-14	582.0	309.5	862.7
Feb-14	598.4	317.4	874.6
Mar-14	597.2	295.7	844.9
Apr-14	613.0	313.3	870.2
May-14	622.0	312.4	870.6
Jun-14	492.5	312.4	849.5
Jul-14	569.2	298.4	868.9
Aug-14	620.6	308.1	869.5
Sep-14	624.0	369.5	873.8
Oct-14	622.2	309.1	873.0
Nov-14	625.6	280.2	875.8
Dec-14	624.6	282.4	873.7
Jan-15	621.0	332.3	795.7
Feb-15	642.5	268.0	959.3
Mar-15	633.8	249.2	941.9
Apr-15	624.3	249.9	846.4
May-15	624.4	261.9	749.6
Jun-15	624.3	249.9	749.6
Minimum	433.5	232.3	630.2
Maximum	642.5	369.5	959.3
Average	580.0	281.7	805.2

Source: Envirogen Technologies, Inc., GWETS Field Sheets updated on a weekly basis.

LS - Lift Station.

FBR - Fluidized bed reactor.

gpm - Gallons per minute averaged during the month.

Minimum, maximum, and average values are from January 2013 to June 2015.

Table 2-7. FBR Treatment Plant Effluent Pipe Flow Rates

Date	FBR Treatment Plant Effluent to Las Vegas Wash (gpm)
Jan-13	871.1
Feb-13	931.1
Mar-13	917.3
Apr-13	918.3
May-13	890.0
Jun-13	940.9
Jul-13	765.7
Aug-13	954.5
Sep-13	941.6
Oct-13	970.7
Nov-13	890.5
Dec-13	904.6
Jan-14	941.7
Feb-14	949.7
Mar-14	958.0
Apr-14	965.7
May-14	950.7
Jun-14	906.4
Jul-14	767.9
Aug-14	879.7
Sep-14	803.2
Oct-14	824.6
Nov-14	820.3
Dec-14	785.2
Jan-15	830.5
Feb-15	932.0
Mar-15	918.1
Apr-15	900.2
May-15	857.9
Jun-15	831.8
Minimum	765.7
Maximum	970.7
Average	890.7

FBR - Fluidized reactor bed.

gpm - Gallons per minute averaged during the month.

Minimum, maximum, and average values are from January 2013 to June 2015.

Table 2-8. Influent Piping Summary

Location	Pipeline Section	Diameter (inches)	Material	Estimated Length (feet)
LS1 to LS2	Continuous section	10	HDPE	8200
LS3 to LS2	LS3 to Pabco Road	10	HDPE	630
	Pabco Road to LS2	8	HDPE	1730
LS2 to GWETS	LS2 to southern end of Pabco Road	12	HDPE	6780
	Southern end of Pabco Road to GW-11 pond	12	HDPE	3680
IWF East Feed	Single pipe conveying flows from the following wells: I-D, I-M, I-E, I-N, I-X, I-F, I-Q, I-G, I-T, I-U, I-H, I-P, I-W, I-O, I-V, I-I, I-Z, I-J, I-K, I-AC, and I-AD	6	HDPE	1320
IWF West Feed	Single pipe conveying flows from the following wells: I-AA, I-AB, I-AR, I-B, I-R, I-Y, I-L, I-S, and I-C	4	HDPE	450
AWF Well Lines to LS3	Single pipe to each pumping well	--	--	--
	ART-1 to LS3	4	HDPE	356
	ART-1A to LS3	4	HDPE	356
	ART-2 to LS3	4	HDPE	268
	ART-2A to LS3	4	HDPE	268
	ART-3 to LS3	4	HDPE	195
	ART-3A to LS3	4	HDPE	195
	ART-4 to LS3	4	HDPE	42
	ART-4A to LS3	4	HDPE	42
	ART-5 to LS3	4	HDPE	480
	ART-6 to LS3	4	HDPE	585
	ART-7 to LS3	4	HDPE	690
	ART-7A to LS3	4	HDPE	690
	ART-7B to LS3	4	HDPE	690
			Total AWF	***4,857***
SWF Well Lines to LS1	Single pipe to each pumping well	--	--	--
	PC-117 to LS1	4	HDPE	1026
	PC-116 to LS1	4	HDPE	1132
	PC-99R2/R3 to LS1	4	HDPE	1228
	PC-115R to LS1	4	HDPE	1342
	PC-118 to LS1	4	HDPE	1452
	PC-119 to LS1	4	HDPE	1551
	PC-120 to LS1	4	HDPE	1648
	PC-121 to LS1	4	HDPE	1750
	PC-133 to LS1	4	HDPE	877
			Total SWF	***12,006***

1 From Table 2, 2013 GWETS Optimization Project Work Plan, Nevada Environmental Response Trust Site.

2 The information presented in this table is summarized from communications with current and former GWETS operators as well as from available design drawings—not all of which were Drawings of Record, or so-called "as-builts." The information in this table has not been field-verified.

AWF = Athens Road Well Field.
GWETS = Groundwater Extraction and Treatment System.
HDPE = High-density polyethylene.
IWF = Interceptor Well Field.
LS1 = Lift Station 1.
LS2 = Lift Station 2.
LS3 = Lift Station 3.
SWF = Seep Well Field.

Table 3-1. Estimated Maximum Well Pump Capacities

Pump Location		Pump Model Number	Total Well Depth (feet bgs)	Lowest Well Level (feet bgs)	Assumed Line Friction Loss (feet)	Well Pump Max Head (feet)	Comparison of Maximum Pumping Rates (gpm)	
							Calculated Well Flow at Max Head	Actual Recorded Maximum Flow[1]
SWF Pumping Wells	PC-99R2/99R3	150S200-11	55.3	51.3	5	56.3	206	87.8
	PC-115R	***85S50-3***	55.5	51.5	5	56.5	206	105.1
	PC-116R	150S200-11	55.5	51.5	5	56.5	206	153.3
	PC-117	85S50-3	53.0	49.0	5	54.0	117	125.0
	PC-118	85S50-3	51.0	47.0	5	52.0	117	93.7
	PC-119	85S50-3	47.0	43.0	5	48.0	117	93.0
	PC-133	***5S05-13***	40.2	36.2	5	41.2	6.8	4.7
	Subtotal for SWF wells:						***1203***	--
AWF Pumping Wells	ART-1/1A	40S20-7	56.0	52.0	5	57.0	55	23.6
	ART-2/2A	60S30-5	56.0	52.0	5	57.0	80	62.5
	ART-3	40S20-7	47.0	43.0	5	48.0	55	49.2
	ART-3A	40S20-7	55.0	51.0	5	56.0	55	
	ART-4	40S20-7	46.4	42.4	5	47.4	55	15.8
	ART-7/7A/7B	25S07-5	41.0	37.0	5	42.0	34.5	31.7
	ART-8/8A	***60S30-5***	50.5	46.5	5	51.5	80	71.2
	ART-9/6/6A	***60S30-5***	45.5	41.5	5	46.5	80	62.4
	PC-150	***5S05-13***	45.0	41.0	5	46.0	--	4.5
	Subtotal for AWF wells:						***495***	--
IWF Pumping Wells	I-A[2]	***5S05-13***	41.0	37.0	5	42.0	6.8	--
	I-AA	5S05-13	46.0	42.0	5	47.0	6.8	1.4
	I-AB	5S05-13	51.0	47.0	5	52.0	6.8	0.4
	I-AC	5S05-13	50.0	46.0	5	51.0	6.8	0.1
	I-AD	5S05-13	50.0	46.0	5	51.0	6.8	0.4
	I-AR	***5S05-13***	45.0	41.0	5	46.0	6.8	1.6
	I-B	***5S05-13***	43.0	39.0	5	44.0	6.8	1.8
	I-C	***5S05-13***	43.0	39.0	5	44.0	6.8	7.0
	I-D	***5S05-13***	45.0	41.0	5	46.0	6.8	3.3
	I-E	5S05-13	44.0	40.0	5	45.0	6.8	2.9
	I-F	***5S05-13***	43.8	39.8	5	44.8	6.8	4.8
	I-G	***5S05-13***	39.3	35.3	5	40.3	6.8	1.1

Table 3-1. Estimated Maximum Well Pump Capacities (continued)

Pump Location		Pump Model Number	Total Well Depth (feet bgs)	Lowest Well Level (feet bgs)	Assumed Line Friction Loss (feet)	Well Pump Max Head (feet)	Comparison of Maximum Pumping Rates (gpm)	
							Calculated Well Flow at Max Head	Actual Recorded Maximum Flow[1]
IWF Pumping Wells (continued)	I-H	***5S05-13***	43.6	39.6	5	44.6	6.8	1.5
	I-I	***5S05-13***	41.0	37.0	5	42.0	6.8	4.9
	I-J	***5S05-13***	41.0	37.0	5	42.0	6.8	7.0
	I-K	***5S05-13***	35.8	31.8	5	36.8	6.8	5.3
	I-L	***5S05-13***	40.0	36.0	5	41.0	6.8	3.3
	I-M	***5S05-13***	40.0	36.0	5	41.0	6.8	5.0
	I-N	5S05-13	38.0	34.0	5	39.0	6.8	3.2
	I-O	5S05-13	40.0	36.0	5	41.0	6.8	3.6
	I-P	5S05-13	44.5	40.5	5	45.5	6.8	6.2
	I-Q	*5S05-13*	40.0	36.0	5	41.0	6.8	1.1
	I-R	***5S05-13***	43.0	39.0	5	44.0	6.8	3.9
	I-S	***5S05-13***	45.2	41.2	5	46.2	6.8	5.2
	I-T	***5S05-13***	45.2	41.2	5	46.2	6.8	0.7
	I-U	***5S05-13***	45.0	41.0	5	46.0	6.8	1.5
	I-V	***5S05-13***	45.0	41.0	5	46.0	6.8	5.9
	I-W	5S05-13	50.5	46.5	5	51.5	6.8	1.1
	I-X	5S05-13	50.5	46.5	5	51.5	6.8	4.3
	I-Y	5S05-13	50.5	46.5	5	51.5	6.8	1.6
	I-Z	***5S05-13***	35.0	31.0	5	36.0	6.8	8.8
						Subtotal for IWF wells:	***204***	--

Wells with currently active pumps were used for maximum capacity estimation.

Pump models in bold italicized font were assumed based on actual well performance.

AWF - Athens Road Well Field.

bgs - Below ground surface.

gpm - gallons per minute.

IWF - Interceptor Well Field.

SWF - Seep Well Field.

1 Actual maximum pumping rates per well from January 2013 to June 2015 (see Tables 2-2 through 2-4).

2 Well I-A was repalced by well I-AR.

Table 3-2. Summary of Maximum Pipeline Capacity from Individual Wells to Lift Stations

Well Field	Well Used	Capacity (gpm)	Head (feet)	Velocity (fps)
SWF	PC-121	307	300	8
		190	127	5
AWF	ART-7	727	300	19
		190	29	5
IWF	I-AD	1395	300	17
		412	40	5

fps - Feet per second.
gpm - Gallons per minute.

Table 3-3. GWTP Pumps Maximum Capacity Evaluation

Pump ID	Estimated Electrical Motor Size (hp)	Assumed Electrical Motor Efficiency	Assumed Pump Efficiency	Estimated Required Discharge Head (feet)	Calculated Maximum Flow (gpm)
P-1A	2	80%	60%	20	190
P-4A	3	80%	60%	40	143
P-4B	3	80%	60%	40	143

gpm - Gallons per minute.

hp - Horsepower.

Table 3-4. GWTP Filter Press Maximum Capacity Evaluation

Parameter	Value	Units	Reference
GWTP current flow	70	gpm	Actual data
Filter-press nominal capacity	5	cu. ft	Based on specifications
Filter-press number of cycles per day	2	Dimensionless	Actual data
Dewatered filter cake density	80	lbs/cu. ft	Common value assumed
Dewatered filter cake solids content	0.35	Dimensionless	Common value assumed
Actual dry filter cake generation at 70 gpm flow	10	dry solids per quarter, tons	Actual data
Filter cake daily volume at 70 gpm flow	7.9	cu. ft/day	Calculated
Filter cake maximum daily volume	10.0	cu. ft/day	Calculated
Maximum flow as limited by filter press	88	gpm	Calculated

cu. ft - Cubic feet.

gpm - Gallons per minute.

GWTP - Groundwater treatment plant.

lbs - Pounds.

Table 3-5. GWTP Clarifier Maximum Capacity Evaluation

Parameter	Value	Units	Reference
Tube settler length	7	feet	Actual data
Number of tube settlers	7	Dimensionless	Actual data
Tube settler IFR 6036 flow per unit area	3	gpm	Based on specifications
Safety coefficient	75%	Dimensionless	Assumed
Maximum flow as limited by filter press	110	gpm	Calculated

gpm - Gallons per minute.

Table 3-6. GWETS Infrastructure Hydraulic Capacity Summary

Item	Capacity (gpm)	Notes
SWF		
Current Extraction Rate	530	
Well Pumps	1,200	Assumes continued use of existing pumps
LS1 Pump	650	Estimated range is 650 to 736 gpm
LS1-LS2 Pipeline	980	Requires LS1 pump upgrade
AWF		
Current Extraction Rate	280	
Well Pumps	500	Assumes continued use of existing pumps
LS3 Pump	380	Estimated range is 378 to 547 gpm
LS3-LS2 Pipeline	750	Requires LS3 pump upgrade
LS2		
LS2 Pump	1,170	
LS2-GW-11 Pipeline	1,340	Requires LS2 pump upgrade
IWF		
Current Extraction Rate	70	
Well Pumps	200	Assumes continued use of existing pumps
GWTP	90	Existing system
Upgraded GWTP	200	Requires major upgrade or replacement of GWTP
FBRs		
Hydraulic Capacity	>1,000	
Effluent Pipeline		
NPDES Permit Limit	1,000	
Pump Station	1,190	Requires NPDES permit modification
Effluent Pipeline	~1,000	Current maximum; 1,185 if no blockage

AWF - Athens Road Well Field.
FBR - Fluidized bed reactor.
GWTP - Groundwater Treatment Plant.
IWF - Interceptor Well Field.
LS21 - Lift Station 1.
LS2 - Lift Station 2.
LS3 - Lift Station 3.
SWF - Seep Well Field.

Table 4-1. Potential GWETS Modifications Cost Summary

VFD Installation	
Seep Well Field (well pumps)	$90,000
Athens Road Well Field (well pumps)	$140,000
Interceptor Well Field (well pumps)	$270,000
Lift Stations 1, 2, and 3	$210,000
Lift Stations and Effluent Pump Station Pumps Replacement	
Lift Station 1	$190,000
Lift Station 2	$230,000
Lift Station 3	$160,000
Effluent Pump Station	$190,000
GWTP Modifications Alternatives	
Alternative 1 - Bypass GWTP and Update Ferrous Sulfate Feed	$60,000
Alternative 2 - Key Equipment Update	$370,000
Alternative 3 - Entire GWTP Replacement	$690,000
GW-11 Water Balance Instrumentation	
Water Balance Instrumentation	$290,000

GWETS - Groundwater Extraction and Treatment System.
GWTP - Groundwater treatment plant.
VFD - Variable frequency drive.
Costs are rounded up to the nearest $10,000.
Cost estimates are conceptual for the purpose of relative comparison of the alternatives.

Table 5-1. GWETS Performance Monitoring and Data Accessbility Cost Estimate

Item	No of Units	Units	Unit Price	Extended Price
Base–Networking Infrastructure				
Project management	80	Hours	$ 150	$ 12,000
Control room - web service for SCADA/Historian data retrieval	216	Hours	$ 100	$ 21,600
Control room - server	6	Each	$ 4,000	$ 24,000
Remote server - data collection daemon	120	Hours	$ 100	$ 12,000
Remote server - SQL server programming	60	Hours	$ 100	$ 6,000
Remote server - web service	180	Hours	$ 100	$ 18,000
Remote server - server	1	Each	$ 4,000	$ 4,000
Router/switches/networking equipment	1	Lump sum	$ 40,000	$ 40,000
Infrastructure troubleshooting and diagnostics	120	Hours	$ 100	$ 12,000
			Total Networking Cost	***$ 149,600***
Tier 1 User Interface				
Networking infrastructure cost (common for all three tiers)	1	Lump sum	$ 149,600	$ 149,600
Tier 1 user interface development	300	Hours	$ 100	$ 30,000
Tier 1 user interface deployment and troubleshooting	72	Each	$ 100	$ 7,200
Tier 1 yearly maintenance and incremental upgrades	96	Each	$ 100	$ 9,600
			Tier 1 Subtotal	*$ 196,400*
			Contingency (@30%)	$ 59,000
			Contractor OH&P (@ 20%)	$ 39,000
			Engineering and Management (@20%)	$ 39,000
			Total Tier 1 Cost	***$333,400***
Tier 2 User Interface				
Networking infrastructure cost (common for all three tiers)	1	Lump sum	$ 149,600	$ 149,600
Tier 2 user interface development	360	Hours	$ 100	$ 36,000
Tier 2 user interface deployment and troubleshooting	96	Each	$ 100	$ 9,600
Tier 2 yearly maintenance and incremental upgrades	160	Each	$ 100	$ 16,000
			Tier 2 Subtotal	*$ 211,200*
			Contingency (@30%)	$ 63,000
			Contractor OH&P (@ 20%)	$ 42,000
			Engineering and Management (@20%)	$ 42,000
			Total Tier 2 Cost	***$358,200***
Tier 3 User Interface				
Networking infrastructure cost (common for all three tiers)	1	Lump sum	$ 149,600	$ 149,600
Tier 3 user interface development	680	Hours	$ 100	$ 68,000
Tier 3 user interface deployment and troubleshooting	160	Each	$ 100	$ 16,000
Tier 3 yearly maintenance and incremental upgrades	240	Each	$ 100	$ 24,000
			Tier 3 Subtotal	*$257,600*
			Contingency (@30%)	$ 77,000
			Contractor OH&P (@ 20%)	$ 52,000
			Engineering and Management (@20%)	$ 52,000
			Total Tier 3 Cost	***$438,600***

SCADA - Supervisory control and data acquisition.
SQL - Structured Query Language.
OH&P - Overhead and profit.
Cost estimates are conceptual for the purpose of relative comparison of the alternatives.

Table 5-2. Enhanced Operational Matrix, Tier 1 I/O List

Tag	Loop	Service Description	P&ID	Field Device	PLC	IO Type	Rack	Module	Channel	Range/Closed State
PI	40025	LS#1 discharge pressure	PID-401	PT-40025	LS1	AI	0	1	2	0-200 psig
YL	40011	LS#1 pump 1 run status	PID-401	LS1-P1	LS1	DI	0	5	5	Pump on
YL	40012	LS#1 pump 2 run status	PID-401	LS1-P2	LS1	DI	0	5	8	Pump on
FI	42001	LS#1 flow to LS#2	PID-421	FT-42001	LS2	AI	0	0	0	0-1200 gpm
FI	42003	LS#3 flow to LS#2	PID-421	FT-42002	LS2	AI	0	0	1	0-1200 gpm
FI	42026	LS#2 flow to filter plant	PID-421	FT-42026	LS2	AI	0	0	3	0-1500 gpm
PI	42025	LS#2 discharge pressure	PID-421	PIT-42025	LS2	AI	0	0	4	0-200 psig
PI	41025	LS#3 discharge pressure	PID-412	PIT-41025	LS3	AI	0	1	1	0-200 psig
YL	41011	LS#3 pump 1 run status	PID-412	LS3-P1	LS3	DI	0	6	4	Pump on
YL	41012	LS#3 pump 2 run status	PID-412	LS3-P2	LS3	DI	0	6	7	Pump on

Information from list of input/outputs (I/Os) available for data logging after iinstallation of the instrumentation and infrastructure required for implementation of the Enhanced Operational Metrics project
AI - Analog input.
DI - Digital input.
LS - Lift Station.
P&ID - Piping and Instrumentation Diagram.
psig - Pounds per square inch gauge.

Table 5-3. Enhanced Operational Matrix, Tier 2 I/O List

Tag	Loop	Service Description	P&ID	Field Device	PLC	IO Type	Rack	Module	Channel	Range/Closed State
YL	44001	Interceptor well I-AA pump run status	PID-441	I-AA	IWF	DI	1	2	1	Pump running
YL	44002	Interceptor well I-AB pump run status	PID-441	I-AB	IWF	DI	1	2	3	Pump running
YL	44003	Interceptor well I-B pump run status	PID-441	I-B	IWF	DI	1	2	5	Pump running
YL	44004	Interceptor well I-R pump run status	PID-441	I-R	IWF	DI	1	2	7	Pump running
YL	44005	Interceptor well I-Y pump run status	PID-441	I-Y	IWF	DI	1	2	9	Pump running
YL	44006	Interceptor well I-L pump run status	PID-441	I-L	IWF	DI	1	2	11	Pump running
YL	44007	Interceptor well I-S pump run status	PID-441	I-S	IWF	DI	1	2	13	Pump running
YL	44008	Interceptor well I-C pump run status	PID-441	I-C	IWF	DI	1	2	15	Pump running
YL	44011	Interceptor well I-F pump run status	PID-442	I-F	IWF	DI	1	3	1	Pump running
YL	44012	Interceptor well I-X pump run status	PID-442	I-X	IWF	DI	1	3	3	Pump running
YL	44013	Interceptor well I-N pump run status	PID-442	I-N	IWF	DI	1	3	5	Pump running
YL	44014	Interceptor well I-E pump run status	PID-442	I-E	IWF	DI	1	3	7	Pump running
YL	44015	Interceptor well I-M pump run status	PID-442	I-M	IWF	DI	1	3	9	Pump running
YL	44016	Interceptor well I-D pump run status	PID-442	I-D	IWF	DI	1	3	11	Pump running
YL	44017	Interceptor well I-AR pump run status	PID-442	I-AR	IWF	DI	1	3	13	Pump running
YL	44021	Interceptor well I-O pump run status	PID-443	I-O	IWF-RIO	DI	1	2	1	Pump running
YL	44022	Interceptor well I-W pump run status	PID-443	I-W	IWF-RIO	DI	1	2	3	Pump running
YL	44023	Interceptor well I-P pump run status	PID-443	I-P	IWF-RIO	DI	1	2	5	Pump running
YL	44024	Interceptor well I-H pump run status	PID-443	I-H	IWF-RIO	DI	1	2	7	Pump running
YL	44025	Interceptor well I-U pump run status	PID-443	I-U	IWF-RIO	DI	1	2	9	Pump running
YL	44026	Interceptor well I-T pump run status	PID-443	I-T	IWF-RIO	DI	1	2	11	Pump running
YL	44027	Interceptor well I-G pump run status	PID-443	I-G	IWF-RIO	DI	1	2	13	Pump running
YL	44028	Interceptor well I-Q pump run status	PID-443	I-Q	IWF-RIO	DI	1	2	15	Pump running
YL	44031	Interceptor well I-AD pump run status	PID-444	I-AD	IWF-RIO	DI	1	3	1	Pump running
YL	44032	Interceptor well I-AC pump run status	PID-444	I-AC	IWF-RIO	DI	1	3	3	Pump running
YL	44033	Interceptor well I-K pump run status	PID-444	I-K	IWF-RIO	DI	1	3	5	Pump running
YL	44034	Interceptor well I-J pump run status	PID-444	I-J	IWF-RIO	DI	1	3	7	Pump running
YL	44035	Interceptor well I-Z pump run status	PID-444	I-Z	IWF-RIO	DI	1	3	9	Pump running
YL	44036	Interceptor well I-I pump run status	PID-444	I-I	IWF-RIO	DI	1	3	11	Pump running
YL	44037	Interceptor well I-V pump run status	PID-444	I-V	IWF-RIO	DI	1	3	13	Pump running
PI	40025	LS#1 discharge pressure	PID-401	PT-40025	LS1	AI	0	1	2	0-200 psig
YL	40011	LS#1 pump 1 run status	PID-401	LS1-P1	LS1	DI	0	5	5	Pump on
YL	40012	LS#1 pump 2 run status	PID-401	LS1-P2	LS1	DI	0	5	8	Pump on
YL	40133	Well PC-133 pump run status	PID-401	PC-133	LS1	DI	0	5	14	Pump on
YL	40099	Well PC-99R3 (Center) pump run status	PID-401	PC-99R3	LS1	DI	0	6	0	Pump on
YL	40115	Well PC-115R (West) pump run status	PID-401	PC-115R	LS1	DI	0	6	2	Pump on

Table 5-3. Enhanced Operational Matrix, Tier 2 I/O List (continued)

Tag	Loop	Service Description	P&ID	Field Device	PLC	IO Type	Rack	Module	Channel	Range/Closed State
YL	40116	Well PC-116R (East) pump run status	PID-401	PC-116R	LS1	DI	0	6	4	Pump on
YL	40117	Well PC-117 pump run status	PID-401	PC-117	LS1	DI	0	6	6	Pump on
YL	40118	Well PC-118 pump run status	PID-401	PC-118	LS1	DI	0	6	8	Pump on
YL	40119	Well PC-119 pump run status	PID-401	PC-119	LS1	DI	0	6	10	Pump on
YL	40120	Well PC-120 pump run status	PID-401	PC-120	LS1	DI	0	6	12	Pump on
YL	40121	Well PC-121 pump run status	PID-401	PC-121	LS1	DI	0	6	14	Pump on
HC	40011C	LS#1 pump 1 run command	PID-401	LS1-P1	LS1	DO	0	7	0	Run pump
HC	40012C	LS#1 pump 2 run command	PID-401	LS1-P2	LS1	DO	0	7	1	Run pump
FI	42001	LS#1 flow to LS#2	PID-421	FT-42001	LS2	AI	0	0	0	0-1200 gpm
FI	42003	LS#3 flow to LS#2	PID-421	FT-42002	LS2	AI	0	0	1	0-1200 gpm
FI	42026	LS#2 flow to filter plant	PID-421	FT-42026	LS2	AI	0	0	3	0-1500 gpm
PI	42025	LS#2 discharge pressure	PID-421	PIT-42025	LS2	AI	0	0	4	0-200 psig
PI	41025	LS#3 discharge pressure	PID-412	PIT-41025	LS3	AI	0	1	1	0-200 psig
YL	41001A	Well ART-1A pump run status	PID-411	ART-P1A	LS3	DI	0	4	1	Pump on
YL	41001	Well ART-1 pump run status	PID-411	ART-P1	LS3	DI	0	4	3	Pump on
YL	41002A	Well ART-2A pump run status	PID-411	ART-P2A	LS3	DI	0	4	5	Pump on
YL	41002	Well ART-2 pump run status	PID-411	ART-P2	LS3	DI	0	4	7	Pump on
YL	41003A	Well ART-3A pump run status	PID-411	ART-P3A	LS3	DI	0	4	9	Pump on
YL	41003	Well ART-3 pump run status	PID-411	ART-P3	LS3	DI	0	4	11	Pump on
YL	41004A	Well ART-4A pump run status	PID-411	ART-P4A	LS3	DI	0	4	13	Pump on
YL	41004	Well ART-4 pump run status	PID-411	ART-P4	LS3	DI	0	4	15	Pump on
YL	41008A	Well ART-8A pump run status	PID-411	ART-P8A	LS3	DI	0	5	1	Pump on
YL	41008	Well ART-8 pump run status	PID-411	ART-P8	LS3	DI	0	5	3	Pump on
YL	41006	Well ART-6 pump run status	PID-412	ART-P6	LS3	DI	0	5	5	Pump on
YL	41009	Well ART-9 pump run status	PID-412	ART-P9	LS3	DI	0	5	7	Pump on
YL	41007A	Well ART-7A pump run status	PID-412	ART-P7A	LS3	DI	0	5	9	Pump on
YL	41007B	Well ART-7B pump run status	PID-412	ART-P7B	LS3	DI	0	5	11	Pump on
YL	41150	Well PC-150 pump run status	PID-412	PC-150	LS3	DI	0	5	13	Pump on
YL	41011	LS#3 pump 1 run status	PID-412	LS3-P1	LS3	DI	0	6	4	Pump on
YL	41012	LS#3 pump 2 run status	PID-412	LS3-P2	LS3	DI	0	6	7	Pump on

Information from list of input/outputs (I/Os) available for data logging after iinstallation of the instrumentation and infrastructure required for implementation of the Enhanced Operational Metrics project
AI - Analog input.
DI - Digital input.
DO - Digital output.
gpm - Gallons per minute.
LS - Lift Station.
P&ID - Piping and Instrumentation Diagram.
psig - Pounds per square inch gauge.

Table 5-4. Enhanced Operational Matrix, Tier 3 I/O List

Tag	Loop	Service Description	P&ID	Field Device	PLC	IO Type	Rack	Module	Channel	Range/Closed State
LI	44001	Interceptor well I-AA water level	PID-441	LT-44001	IWF	AI	0	0	0	el. 1708-1738 ft
LI	44002	Interceptor well I-AB water level	PID-441	LT-44002	IWF	AI	0	0	1	el. 1705-1735 ft
LI	44003	Interceptor well I-B water level	PID-441	LT-44003	IWF	AI	0	0	2	el. 1708-1738 ft
LI	44004	Interceptor well I-R water level	PID-441	LT-44004	IWF	AI	0	0	3	el. 1707-1737 ft
LI	44005	Interceptor well I-Y water level	PID-441	LT-44005	IWF	AI	0	0	4	el. 1702-1732 ft
LI	44006	Interceptor well I-L water level	PID-441	LT-44006	IWF	AI	0	0	5	el. 1709-1739 ft
LI	44007	Interceptor well I-S water level	PID-441	LT-44007	IWF	AI	0	0	6	el. 1705-1735 ft
LI	44008	Interceptor well I-C water level	PID-441	LT-44008	IWF	AI	0	0	7	el. 1710-1740 ft
LI	44011	Interceptor well I-F water level	PID-442	LT-44011	IWF	AI	0	1	0	el. 1705-1735 ft
LI	44012	Interceptor well I-X water level	PID-442	LT-44012	IWF	AI	0	1	1	el. 1700-1730 ft
LI	44013	Interceptor well I-N water level	PID-442	LT-44013	IWF	AI	0	1	2	el. 1713-1743 ft
LI	44014	Interceptor well I-E water level	PID-442	LT-44014	IWF	AI	0	1	3	el. 1708-1738 ft
LI	44015	Interceptor well I-M water level	PID-442	LT-44015	IWF	AI	0	1	4	el. 1712-1742 ft
LI	44016	Interceptor well I-D water level	PID-442	LT-44016	IWF	AI	0	1	5	el. 1707-1737 ft
LI	44017	Interceptor well I-AR water level	PID-442	LT-44017	IWF	AI	0	1	6	el. 1715-1745 ft
FI	44001	Interceptor well I-AA discharge flow	PID-441	FIT-44001	IWF	AI	0	2	0	0-10 gpm
FI	44002	Interceptor well I-AB discharge flow	PID-441	FIT-44002	IWF	AI	0	2	1	0-5 gpm
FI	44003	Interceptor well I-B discharge flow	PID-441	FIT-44003	IWF	AI	0	2	2	0-10 gpm
FI	44004	Interceptor well I-R discharge flow	PID-441	FIT-44004	IWF	AI	0	2	3	0-10 gpm
FI	44005	Interceptor well I-Y discharge flow	PID-441	FIT-44005	IWF	AI	0	2	4	0-20 gpm
FI	44006	Interceptor well I-L discharge flow	PID-441	FIT-44006	IWF	AI	0	2	5	0-10 gpm
FI	44007	Interceptor well I-S discharge flow	PID-441	FIT-44007	IWF	AI	0	2	6	0-20 gpm
FI	44008	Interceptor well I-C discharge flow	PID-441	FIT-44008	IWF	AI	0	2	7	0-20 gpm
FI	44011	Interceptor well I-F discharge flow	PID-442	FIT-44011	IWF	AI	0	3	0	0-20 gpm
FI	44012	Interceptor well I-X discharge flow	PID-442	FIT-44012	IWF	AI	0	3	1	0-5 gpm
FI	44013	Interceptor well I-N discharge flow	PID-442	FIT-44013	IWF	AI	0	3	2	0-10 gpm
FI	44014	Interceptor well I-E discharge flow	PID-442	FIT-44014	IWF	AI	0	3	3	0-10 gpm
FI	44015	Interceptor well I-M discharge flow	PID-442	FIT-44015	IWF	AI	0	3	4	0-10 gpm
FI	44016	Interceptor well I-D discharge flow	PID-442	FIT-44016	IWF	AI	0	3	5	0-10 gpm
FI	44017	Interceptor well I-AR discharge flow	PID-442	FIT-44017	IWF	AI	0	3	6	0-5 gpm
YL	44001	Interceptor well I-AA pump run status	PID-441	I-AA	IWF	DI	1	2	1	Pump running
YL	44002	Interceptor well I-AB pump run status	PID-441	I-AB	IWF	DI	1	2	3	Pump running
YL	44003	Interceptor well I-B pump run status	PID-441	I-B	IWF	DI	1	2	5	Pump running
YL	44004	Interceptor well I-R pump run status	PID-441	I-R	IWF	DI	1	2	7	Pump running
YL	44005	Interceptor well I-Y pump run status	PID-441	I-Y	IWF	DI	1	2	9	Pump running
YL	44006	Interceptor well I-L pump run status	PID-441	I-L	IWF	DI	1	2	11	Pump running
YL	44007	Interceptor well I-S pump run status	PID-441	I-S	IWF	DI	1	2	13	Pump running
YL	44008	Interceptor well I-C pump run status	PID-441	I-C	IWF	DI	1	2	15	Pump running

Table 5-4. Enhanced Operational Matrix, Tier 3 I/O List (continued)

Tag	Loop	Service Description	P&ID	Field Device	PLC	IO Type	Rack	Module	Channel	Range/Closed State
YL	44011	Interceptor well I-F pump run status	PID-442	I-F	IWF	DI	1	3	1	Pump running
YL	44012	Interceptor well I-X pump run status	PID-442	I-X	IWF	DI	1	3	3	Pump running
YL	44013	Interceptor well I-N pump run status	PID-442	I-N	IWF	DI	1	3	5	Pump running
YL	44014	Interceptor well I-E pump run status	PID-442	I-E	IWF	DI	1	3	7	Pump running
YL	44015	Interceptor well I-M pump run status	PID-442	I-M	IWF	DI	1	3	9	Pump running
YL	44016	Interceptor well I-D pump run status	PID-442	I-D	IWF	DI	1	3	11	Pump running
YL	44017	Interceptor well I-AR pump run status	PID-442	I-AR	IWF	DI	1	3	13	Pump running
LI	44021	Interceptor well I-O water level	PID-443	LT-44021	IWF-RIO	AI	0	0	0	el. 1712-1742 ft
LI	44022	Interceptor well I-W water level	PID-443	LT-44022	IWF-RIO	AI	0	0	1	el. 1710-1740 ft
LI	44023	Interceptor well I-P water level	PID-443	LT-44023	IWF-RIO	AI	0	0	2	el. 1707-1737 ft
LI	44024	Interceptor well I-H water level	PID-443	LT-44024	IWF-RIO	AI	0	0	3	el. 1708-1738 ft
LI	44025	Interceptor well I-U water level	PID-443	LT-44025	IWF-RIO	AI	0	0	4	el. 1707-1737 ft
LI	44026	Interceptor well I-T water level	PID-443	LT-44026	IWF-RIO	AI	0	0	5	el. 1705-1735 ft
LI	44027	Interceptor well I-G water level	PID-443	LT-44027	IWF-RIO	AI	0	0	6	el. 1710-1740 ft
LI	44028	Interceptor well I-Q water level	PID-443	LT-44028	IWF-RIO	AI	0	0	7	el. 1710-1740 ft
LI	44031	Interceptor well I-AD water level	PID-444	LT-44031	IWF-RIO	AI	0	1	0	el. 1710-1740 ft
LI	44032	Interceptor well I-AC water level	PID-444	LT-44032	IWF-RIO	AI	0	1	1	el. 1710-1740 ft
LI	44033	Interceptor well I-K water level	PID-444	LT-44033	IWF-RIO	AI	0	1	2	el. 1710-1740 ft
LI	44034	Interceptor well I-J water level	PID-444	LT-44034	IWF-RIO	AI	0	1	3	el. 1710-1740 ft
LI	44035	Interceptor well I-Z water level	PID-444	LT-44035	IWF-RIO	AI	0	1	4	el. 1710-1740 ft
LI	44036	Interceptor well I-I water level	PID-444	LT-44036	IWF-RIO	AI	0	1	5	el. 1710-1740 ft
LI	44037	Interceptor well I-V water level	PID-444	LT-44037	IWF-RIO	AI	0	1	6	el. 1710-1740 ft
FI	44021	Interceptor well I-O discharge flow	PID-443	FIT-44021	IWF-RIO	AI	0	2	0	0-10 gpm
FI	44022	Interceptor well I-W discharge flow	PID-443	FIT-44022	IWF-RIO	AI	0	2	1	0-5 gpm
FI	44023	Interceptor well I-P discharge flow	PID-443	FIT-44023	IWF-RIO	AI	0	2	2	0-20 gpm
FI	44024	Interceptor well I-H discharge flow	PID-443	FIT-44024	IWF-RIO	AI	0	2	3	0-10 gpm
FI	44025	Interceptor well I-U discharge flow	PID-443	FIT-44025	IWF-RIO	AI	0	2	4	0-5 gpm
FI	44026	Interceptor well I-T discharge flow	PID-443	FIT-44026	IWF-RIO	AI	0	2	5	0-5 gpm
FI	44027	Interceptor well I-G discharge flow	PID-443	FIT-44027	IWF-RIO	AI	0	2	6	0-5 gpm
FI	44028	Interceptor well I-Q discharge flow	PID-443	FIT-44028	IWF-RIO	AI	0	2	7	0-10 gpm
FI	44031	Interceptor well I-AD discharge flow	PID-444	FIT-44031	IWF-RIO	AI	0	3	0	0-5 gpm
FI	44032	Interceptor well I-AC discharge flow	PID-444	FIT-44032	IWF-RIO	AI	0	3	1	0-5 gpm
FI	44033	Interceptor well I-K discharge flow	PID-444	FIT-44033	IWF-RIO	AI	0	3	2	0-10 gpm
FI	44034	Interceptor well I-J discharge flow	PID-444	FIT-44034	IWF-RIO	AI	0	3	3	0-10 gpm
FI	44035	Interceptor well I-Z discharge flow	PID-444	FIT-44035	IWF-RIO	AI	0	3	4	0-10 gpm
FI	44036	Interceptor well I-I discharge flow	PID-444	FIT-44036	IWF-RIO	AI	0	3	5	0-20 gpm
FI	44037	Interceptor well I-V discharge flow	PID-444	FIT-44037	IWF-RIO	AI	0	3	6	0-20 gpm
YL	44021	Interceptor well I-O pump run status	PID-443	I-O	IWF-RIO	DI	1	2	1	Pump running

Table 5-4. Enhanced Operational Matrix, Tier 3 I/O List (continued)

Tag	Loop	Service Description	P&ID	Field Device	PLC	IO Type	Rack	Module	Channel	Range/Closed State
YL	44022	Interceptor well I-W pump run status	PID-443	I-W	IWF-RIO	DI	1	2	3	Pump running
YL	44023	Interceptor well I-P pump run status	PID-443	I-P	IWF-RIO	DI	1	2	5	Pump running
YL	44024	Interceptor well I-H pump run status	PID-443	I-H	IWF-RIO	DI	1	2	7	Pump running
YL	44025	Interceptor well I-U pump run status	PID-443	I-U	IWF-RIO	DI	1	2	9	Pump running
YL	44026	Interceptor well I-T pump run status	PID-443	I-T	IWF-RIO	DI	1	2	11	Pump running
YL	44027	Interceptor well I-G pump run status	PID-443	I-G	IWF-RIO	DI	1	2	13	Pump running
YL	44028	Interceptor well I-Q pump run status	PID-443	I-Q	IWF-RIO	DI	1	2	15	Pump running
YL	44031	Interceptor well I-AD pump run status	PID-444	I-AD	IWF-RIO	DI	1	3	1	Pump running
YL	44032	Interceptor well I-AC pump run status	PID-444	I-AC	IWF-RIO	DI	1	3	3	Pump running
YL	44033	Interceptor well I-K pump run status	PID-444	I-K	IWF-RIO	DI	1	3	5	Pump running
YL	44034	Interceptor well I-J pump run status	PID-444	I-J	IWF-RIO	DI	1	3	7	Pump running
YL	44035	Interceptor well I-Z pump run status	PID-444	I-Z	IWF-RIO	DI	1	3	9	Pump running
YL	44036	Interceptor well I-I pump run status	PID-444	I-I	IWF-RIO	DI	1	3	11	Pump running
YL	44037	Interceptor well I-V pump run status	PID-444	I-V	IWF-RIO	DI	1	3	13	Pump running
LI	40099	Well PC-99R3 (Center) water level	PID-401	LT-40099	LS1	AI	0	0	0	el.1525-1555 ft
LI	40115	Well PC-115R (West) water level	PID-401	LT-40115	LS1	AI	0	0	1	el.1525-1555 ft
LI	40116	Well PC-116R (East) water level	PID-401	LT-40116	LS1	AI	0	0	2	el.1525-1555 ft
LI	40117	Well PC-117 water level	PID-401	LT-40117	LS1	AI	0	0	3	el.1525-1555 ft
LI	40118	Well PC-118 water level	PID-401	LT-40118	LS1	AI	0	0	4	el.1525-1555 ft
LI	40119	Well PC-119 water level	PID-401	LT-40119	LS1	AI	0	0	5	el.1525-1555 ft
LI	40120	Well PC-120 water level	PID-401	LT-40120	LS1	AI	0	0	6	el.1525-1555 ft
LI	40121	Well PC-121 water level	PID-401	LT-40121	LS1	AI	0	0	7	el.1525-1555 ft
LI	40133	Well PC-133 water level	PID-401	LT-40133	LS1	AI	0	1	0	el.1525-1555 ft
PI	40025	LS#1 discharge pressure	PID-401	PT-40025	LS1	AI	0	1	2	0-200 psig
FI	40099	Well PC-99R3 (Center) discharge flow	PID-401	FT-40099	LS1	AI	0	2	0	0-360 gpm
FI	40115	Well PC-115R (West) discharge flow	PID-401	FT-40115	LS1	AI	0	2	1	0-360 gpm
FI	40116	Well PC-116R (East) discharge flow	PID-401	FT-40116	LS1	AI	0	2	2	0-360 gpm
FI	40117	Well PC-117 discharge flow	PID-401	FT-40117	LS1	AI	0	2	3	0-365 gpm
FI	40118	Well PC-118 discharge flow	PID-401	FT-40118	LS1	AI	0	2	4	0-365 gpm
FI	40119	Well PC-119 discharge flow	PID-401	FT-40119	LS1	AI	0	2	5	0-365 gpm
FI	40120	Well PC-120 discharge flow	PID-401	FT-40120	LS1	AI	0	2	6	0-365 gpm
FI	40121	Well PC-121 discharge flow	PID-401	FT-40121	LS1	AI	0	2	7	0-365 gpm
FI	40133	Well PC-133 discharge flow	PID-401	FT-40133	LS1	AI	0	3	0	0-365 gpm
LC	40020	LS#1 wetwell level	PID-401	LIT-40020	LS1	AI	0	3	1	0-7 ft
SC	40011	LS#1 Wetwell Pump 1 Speed Control	PID-401	LS1-P1	LS1	AO	0	4	0	0-100% speed
SC	40012	LS#1 Wetwell Pump 2 Speed Control	PID-401	LS1-P2	LS1	AO	0	4	1	0-100% speed
YL	40011	LS#1 pump 1 run status	PID-401	LS1-P1	LS1	DI	0	5	5	Pump on
YL	40012	LS#1 pump 2 run status	PID-401	LS1-P2	LS1	DI	0	5	8	Pump on

Table 5-4. Enhanced Operational Matrix, Tier 3 I/O List (continued)

Tag	Loop	Service Description	P&ID	Field Device	PLC	IO Type	Rack	Module	Channel	Range/Closed State
YL	40133	Well PC-133 pump run status	PID-401	PC-133	LS1	DI	0	5	14	Pump on
YL	40099	Well PC-99R3 (Center) pump run status	PID-401	PC-99R3	LS1	DI	0	6	0	Pump on
YL	40115	Well PC-115R (West) pump run status	PID-401	PC-115R	LS1	DI	0	6	2	Pump on
YL	40116	Well PC-116R (East) pump run status	PID-401	PC-116R	LS1	DI	0	6	4	Pump on
YL	40117	Well PC-117 pump run status	PID-401	PC-117	LS1	DI	0	6	6	Pump on
YL	40118	Well PC-118 pump run status	PID-401	PC-118	LS1	DI	0	6	8	Pump on
YL	40119	Well PC-119 pump run status	PID-401	PC-119	LS1	DI	0	6	10	Pump on
YL	40120	Well PC-120 pump run status	PID-401	PC-120	LS1	DI	0	6	12	Pump on
YL	40121	Well PC-121 pump run status	PID-401	PC-121	LS1	DI	0	6	14	Pump on
HC	40011C	LS#1 pump 1 run command	PID-401	LS1-P1	LS1	DO	0	7	0	Run pump
HC	40012C	LS#1 pump 2 run command	PID-401	LS1-P2	LS1	DO	0	7	1	Run pump
FI	42001	LS#1 flow to LS#2	PID-421	FT-42001	LS2	AI	0	0	0	0-1200 gpm
FI	42003	LS#3 flow to LS#2	PID-421	FT-42002	LS2	AI	0	0	1	0-1200 gpm
FI	42026	LS#2 flow to filter plant	PID-421	FT-42026	LS2	AI	0	0	3	0-1500 gpm
PI	42025	LS#2 discharge pressure	PID-421	PIT-42025	LS2	AI	0	0	4	0-200 psig
FC	42026	LS#2 discharge flow valve position control	PID-421	FV-42026	LS2	AO	0	1	0	0-100 pct open
SC	42011	LS#2 pump 1 speed command	PID-421	LS2-P1	LS2	AO	0	1	1	0-100% speed
SC	42012	LS#2 pump 2 speed command	PID-421	LS2-P2	LS2	AO	0	1	2	0-100% speed
LI	41001	Well ART-1 water level	PID-411	LT-41001	LS3	AI	0	0	0	el.1570-1620 ft
LI	41002	Well ART-2 water level	PID-411	LT-41002	LS3	AI	0	0	1	el.1570-1620 ft
LI	41003	Well ART-3 water level	PID-411	LT-41003	LS3	AI	0	0	2	el.1570-1620 ft
LI	41004	Well ART-4 water level	PID-411	LT-41004	LS3	AI	0	0	3	el.1580-1610 ft
LI	41008	Well ART-8 water level	PID-411	LT-41008	LS3	AI	0	0	4	el.1570-1620 ft
LI	41009	Well ART-9 water level	PID-411	LT-41009	LS3	AI	0	0	5	el.1585-1615 ft
LI	41007	Well ART-7A water level	PID-412	LT-41007	LS3	AI	0	0	6	el.1580-1610 ft
LI	41150	Well PC-150 water level	PID-412	LT-41150	LS3	AI	0	0	7	el.1580-1610 ft
LC	41020	LS#3 wetwell level	PID-412	LT-41020	LS3	AI	0	1	0	0-7 ft
PI	41025	LS#3 discharge pressure	PID-412	PIT-41025	LS3	AI	0	1	1	0-200 psig
FI	41001	Wells ART-1/1A discharge flow	PID-412	FT-41001	LS3	AI	0	2	0	0-161 gpm
FI	41002	Wells ART-2/2A discharge flow	PID-412	FT-41002	LS3	AI	0	2	1	0-161 gpm
FI	41003	Wells ART-3/3A discharge flow	PID-412	FT-41003	LS3	AI	0	2	2	0-161 gpm
FI	41004	Wells ART-4/4A discharge flow	PID-412	FT-41004	LS3	AI	0	2	3	0-161 gpm
FI	41008	Wells ART-8/8A discharge flow	PID-412	FT-41008	LS3	AI	0	2	4	0-161 gpm
FI	41009	Wells ART-9/6 discharge flow	PID-412	FT-41009	LS3	AI	0	2	5	0-161 gpm
FI	41007	Wells ART-7A/B discharge flow	PID-412	FT-41007	LS3	AI	0	2	6	0-161 gpm
FI	41150	Well PC-150 discharge flow	PID-412	FT-41150	LS3	AI	0	2	7	0-161 gpm
SC	41011	LS#3 pump 1 speed command	PID-412	LS3-P1	LS3	AO	0	3	0	0-100% speed
SC	41012	LS#3 pump 2 speed command	PID-412	LS3-P2	LS3	AO	0	3	1	0-100% speed

Table 5-4. Enhanced Operational Matrix, Tier 3 I/O List (continued)

Tag	Loop	Service Description	P&ID	Field Device	PLC	IO Type	Rack	Module	Channel	Range/Closed State
YL	41001A	Well ART-1A pump run status	PID-411	ART-P1A	LS3	DI	0	4	1	Pump on
YL	41001	Well ART-1 pump run status	PID-411	ART-P1	LS3	DI	0	4	3	Pump on
YL	41002A	Well ART-2A pump run status	PID-411	ART-P2A	LS3	DI	0	4	5	Pump on
YL	41002	Well ART-2 pump run status	PID-411	ART-P2	LS3	DI	0	4	7	Pump on
YL	41003A	Well ART-3A pump run status	PID-411	ART-P3A	LS3	DI	0	4	9	Pump on
YL	41003	Well ART-3 pump run status	PID-411	ART-P3	LS3	DI	0	4	11	Pump on
YL	41004A	Well ART-4A pump run status	PID-411	ART-P4A	LS3	DI	0	4	13	Pump on
YL	41004	Well ART-4 pump run status	PID-411	ART-P4	LS3	DI	0	4	15	Pump on
YL	41008A	Well ART-8A pump run status	PID-411	ART-P8A	LS3	DI	0	5	1	Pump on
YL	41008	Well ART-8 pump run status	PID-411	ART-P8	LS3	DI	0	5	3	Pump on
YL	41006	Well ART-6 pump run status	PID-412	ART-P6	LS3	DI	0	5	5	Pump on
YL	41009	Well ART-9 pump run status	PID-412	ART-P9	LS3	DI	0	5	7	Pump on
YL	41007A	Well ART-7A pump run status	PID-412	ART-P7A	LS3	DI	0	5	9	Pump on
YL	41007B	Well ART-7B pump run status	PID-412	ART-P7B	LS3	DI	0	5	11	Pump on
YL	41150	Well PC-150 pump run status	PID-412	PC-150	LS3	DI	0	5	13	Pump on
YL	41011	LS#3 pump 1 run status	PID-412	LS3-P1	LS3	DI	0	6	4	Pump on
YL	41012	LS#3 pump 2 run status	PID-412	LS3-P2	LS3	DI	0	6	7	Pump on

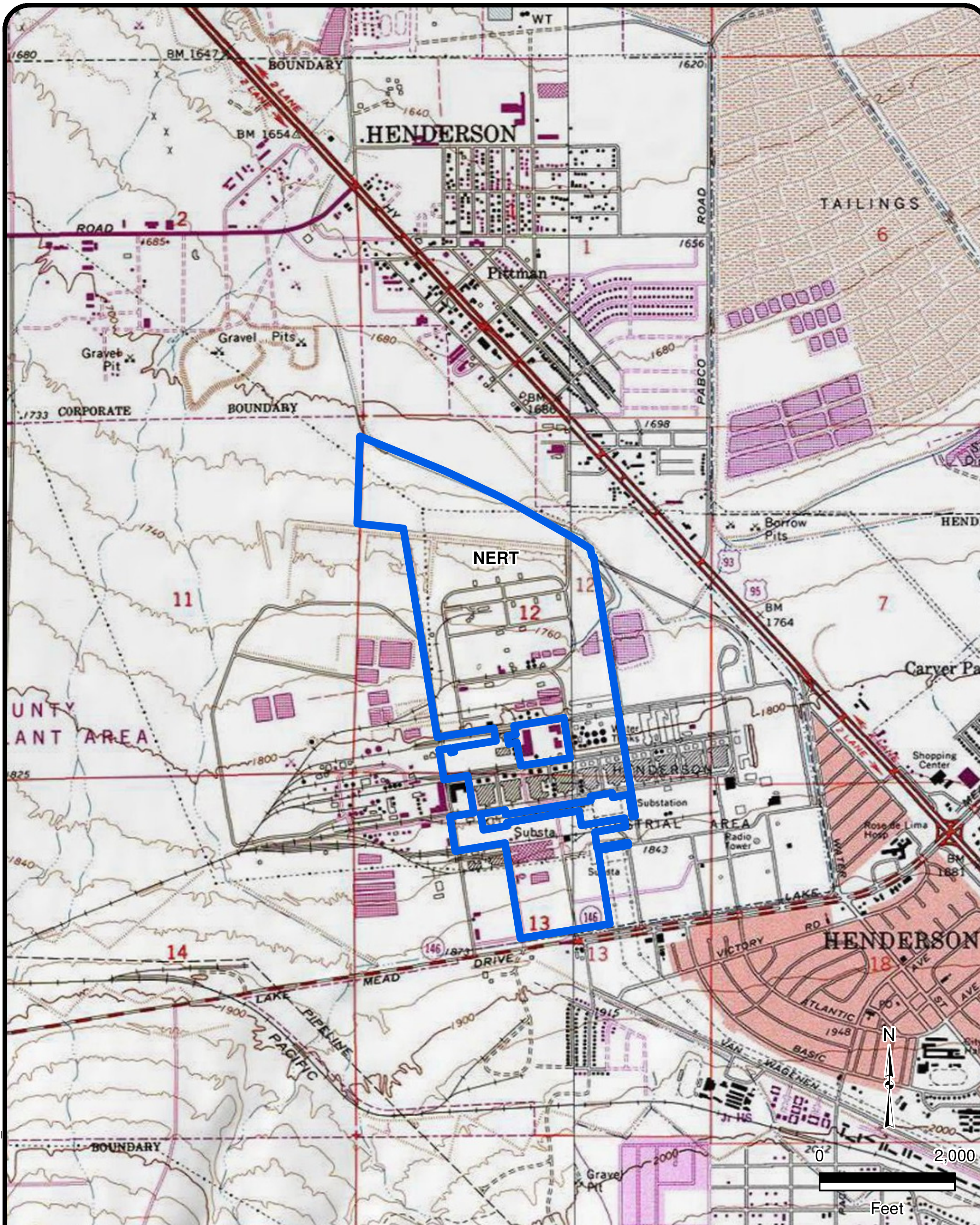
Information from list of input/outputs (I/Os) available for data logging after iinstallation of the instrumentation and infrastructure required for implementation of the Enhanced Operational Metrics project
AI - Analog input.
AO - Analog output.
DI - Digital input.
DO - Digital output.
ft - Feet.
gpm - Gallons per minute.
LS - Lift Station.
P&ID - Piping and Instrumentation Diagram.
psig - Pounds per square inch gauge.

Table 5-5. Web User Interface Tier Screening

Parameter/Feature	Tier 1	Tier 2	Tier 3
LS1, LS2, LS3, IWF, FBR Flow Rate/Totalizer	●	●	●
LS1, LS3, IWF, FBR Pressure	●	●	●
LS1, LS2, LS3 Pump 1 and 2 On/Off Status	●	●	●
LS1, LS2, LS3 Pump 1 and 2 VFD Frequency			●
GW-11 Flow Rate/Totalizer		●	●
GW-11 Pond Level			● (if available)
IWF, SWF, AWF Well Pump Status		● (Auxillary Screen)	● (Auxillary Screen)
IWF, SWF, AWF Well Pump Flow Rate			● (Auxillary Screen)
IWF, SWF, AWF Well Water Level			● (Auxillary Screen)
Perchlorate/Hexavalent Chromium Mass Recovery Data	● (Total; Main Screen)	● (Total; Main Screen)	● (Total, IFW, SWF, AWF; Auxillary Screen)
Perchlorate/Hexavalent Chromium Trending	● (Total; Main Screen)	● (Total; Main Screen)	● (Total, IFW, SWF, AWF; Auxillary Screen)
Critical Parameter Status Bar/Gauge		● (4x)	● (7x)
Approximate Performance Metrics I/Os Required	10x	66x	169x
Approximate Bandwidth Requirements (kb/s)	2	4	6
Cost	$ 92,800	$ 100,400	$ 112,200
Implementation Complexity	Low	Moderate	High
Benefits:			
Visualization Detail	Low-level	Moderate-level	High-level
Stream-Lined Main Operations Display	●	●	●
Automated Mass Recovery Tracking	Total	Total	Total; by Well Field
Well Field Maintenance Enhancement	None	Moderate	High

AWF - Athens Road Well Field.
FBR - Fluidized bed reactor.
I/Os - Input/outputs.
IWF - Interceptor Well Field.
LS1 - Lift Station 1.
LS2 - Lift Station 2.
LS3 - Lift Station 3.
SWF - Seep Well Field.
VFD - Variable frequency drive.
kb/s - Kilobits per second.

FIGURES



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GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

SITE LOCATION MAP

Project No.:	114-520225
Date:	JUL. 28, 2015
Designed By:	SRP

Figure No.

1-1

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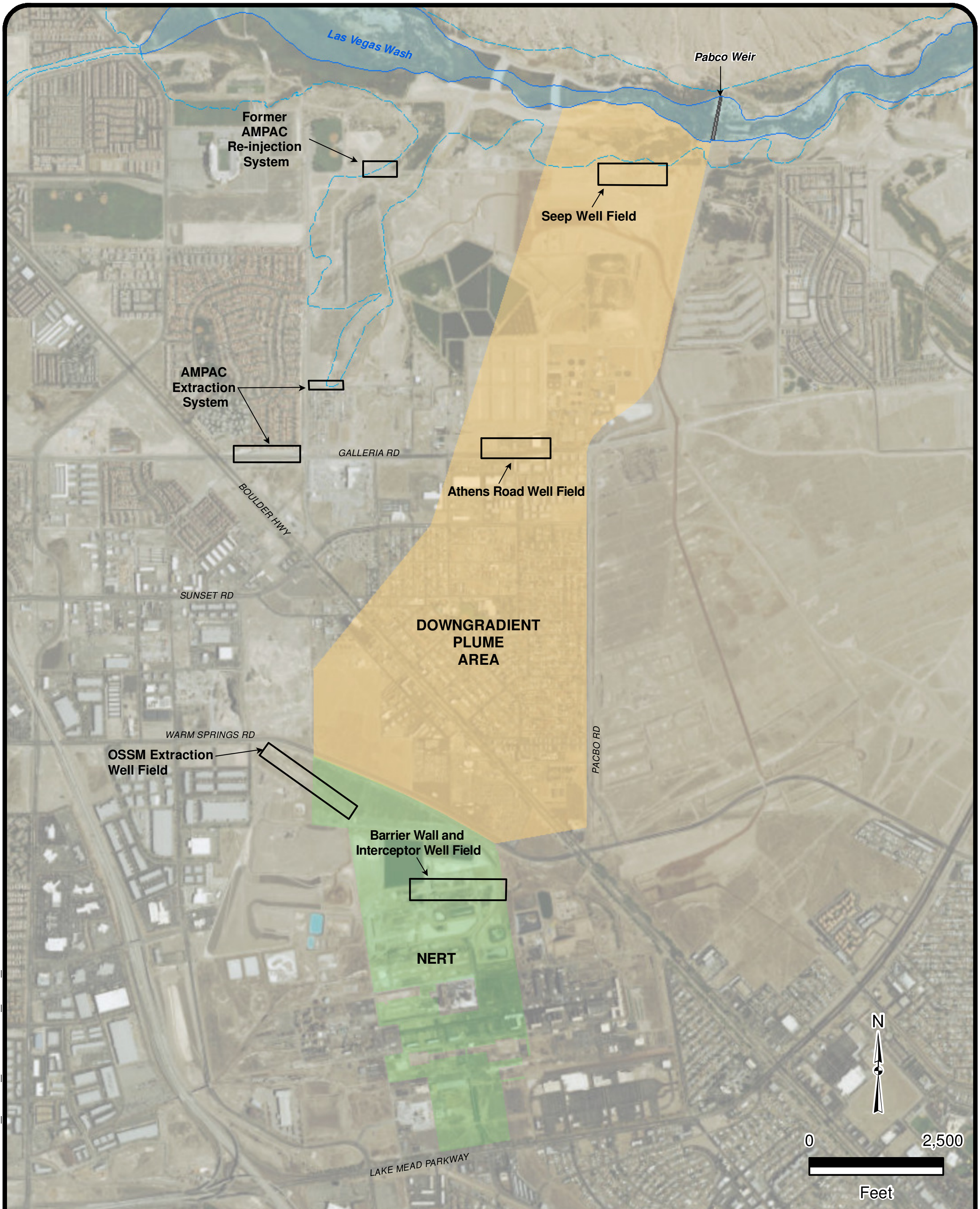

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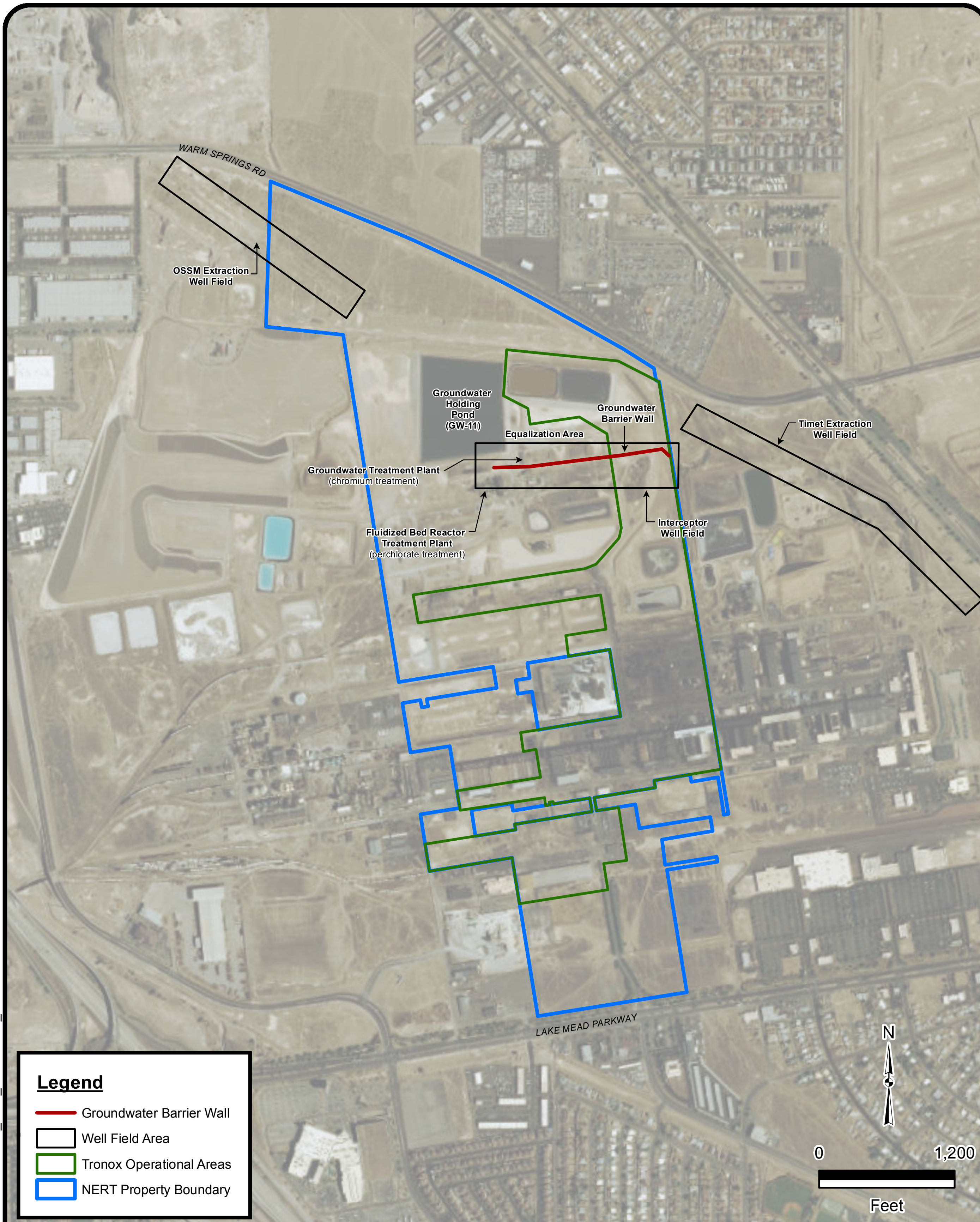
GROUNDWATER EXTRACTION AND TREATMENT SYSTEM CONTINUOUS OPTIMIZATION PROGRAM	
AREA LOCATION MAP	

Project No.:	114-520225
Date:	JUL. 31, 2015
Designed By:	SRP
Figure No.	**1-2**



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CONTINUOUS OPTIMIZATION PROGRAM

NERT SITE FEATURES

Project No.:	114-520225
Date:	AUG. 24, 2015
Designed By:	SRP

Figure No.
1-3

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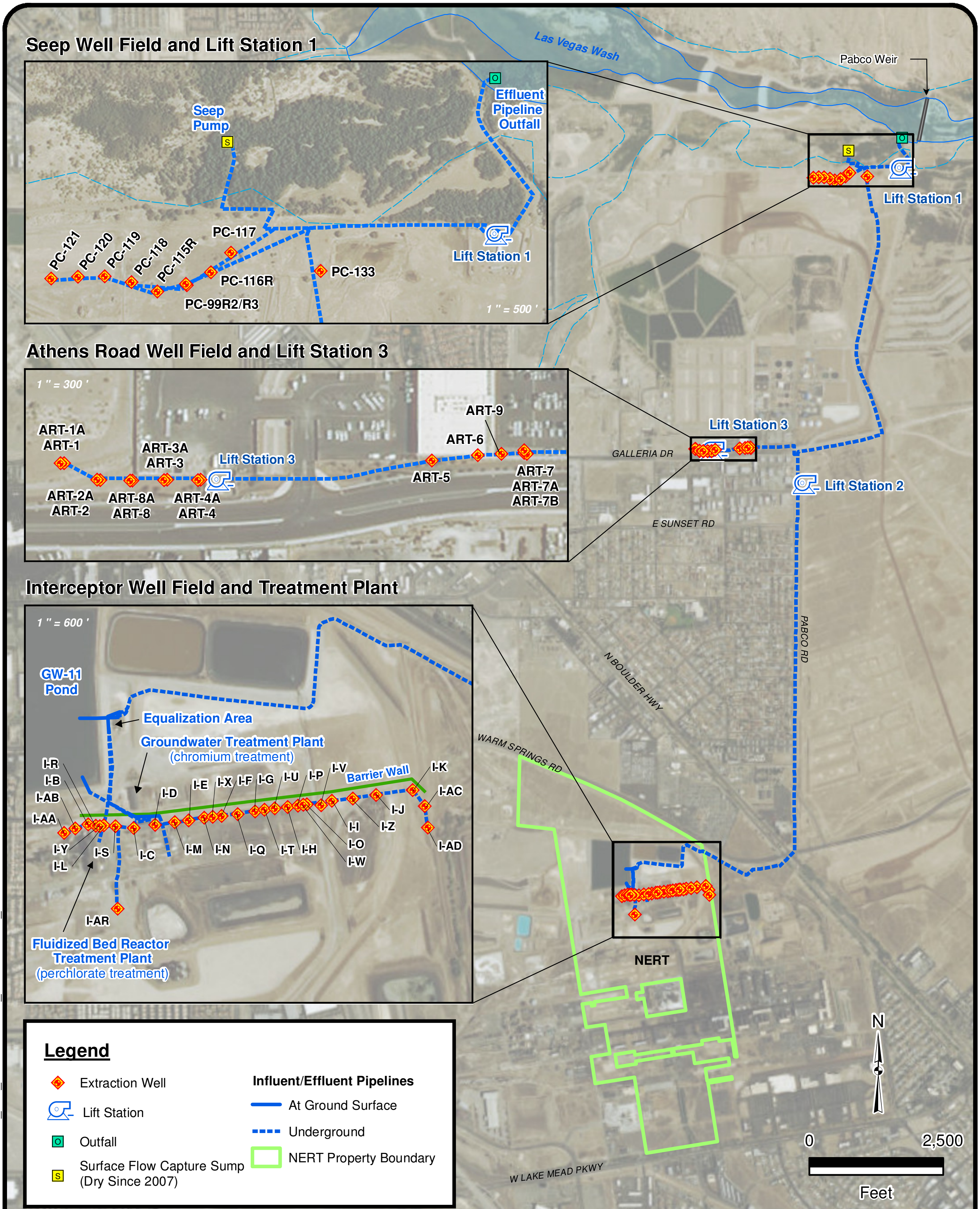

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GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

GROUNDWATER EXTRACTION AND TREATMENT SYSTEM PLAN

Project No.:	114-520225
Date:	AUG. 12, 2015
Designed By:	SRP
Figure No.	2-1

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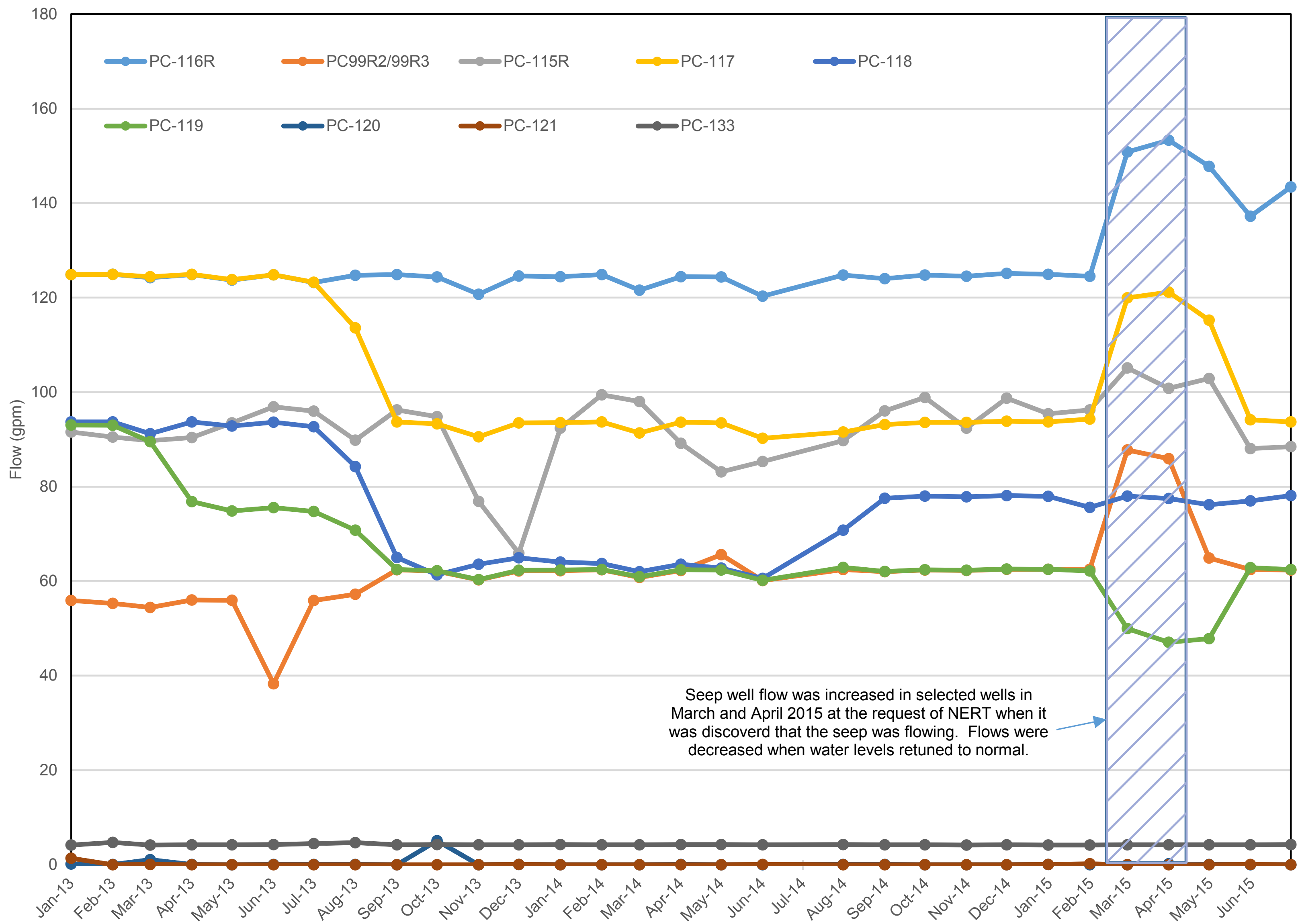

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NEVADA ENVIRONMENTAL RESPONSE TRUST

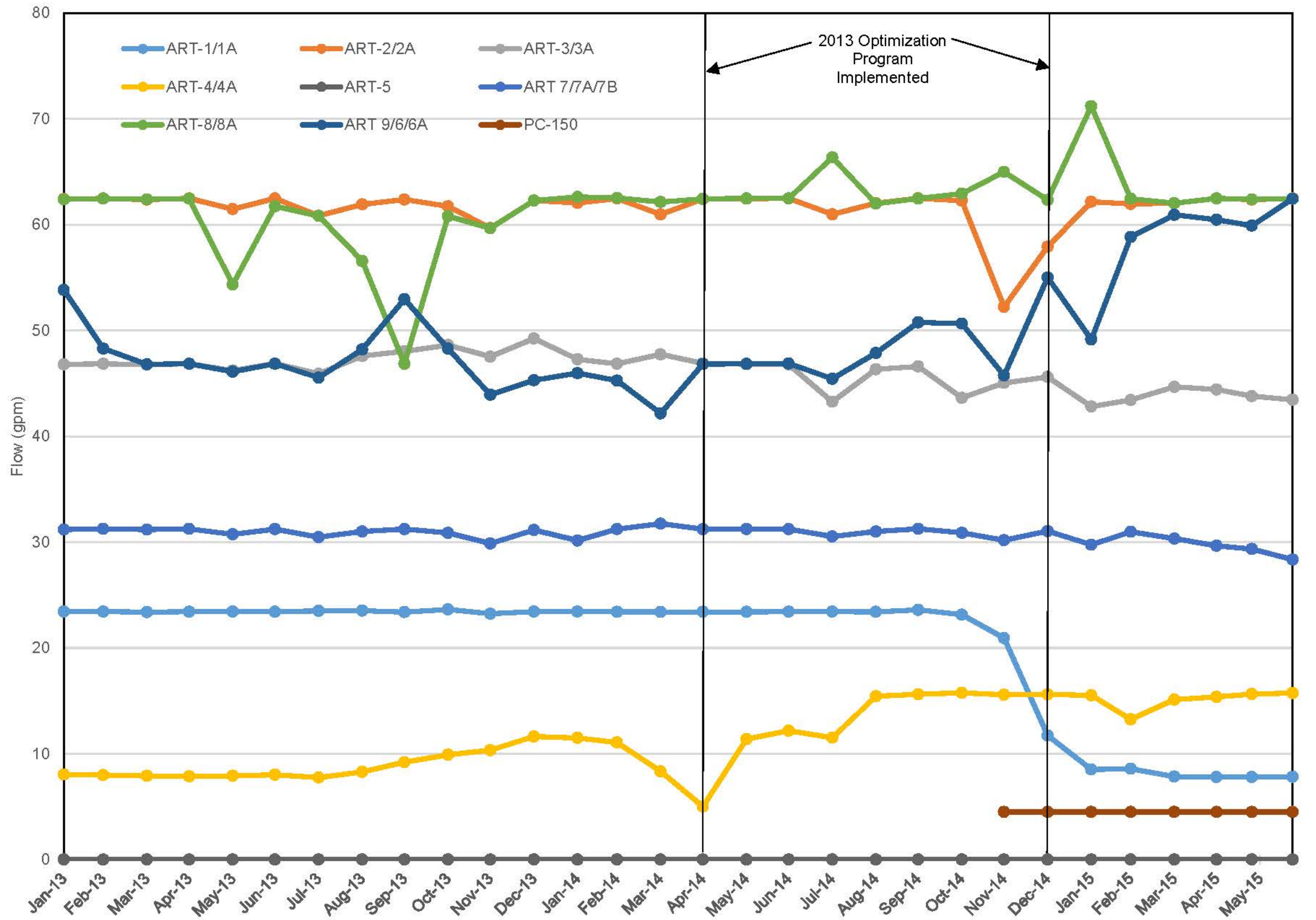
GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

SEEP WELL FIELD
AVERAGE MONTHLY FLOW RATES

Project No.:	114-520225
Date:	AUG 17, 2015
Designed By:	SRP

Figure No.

2-2



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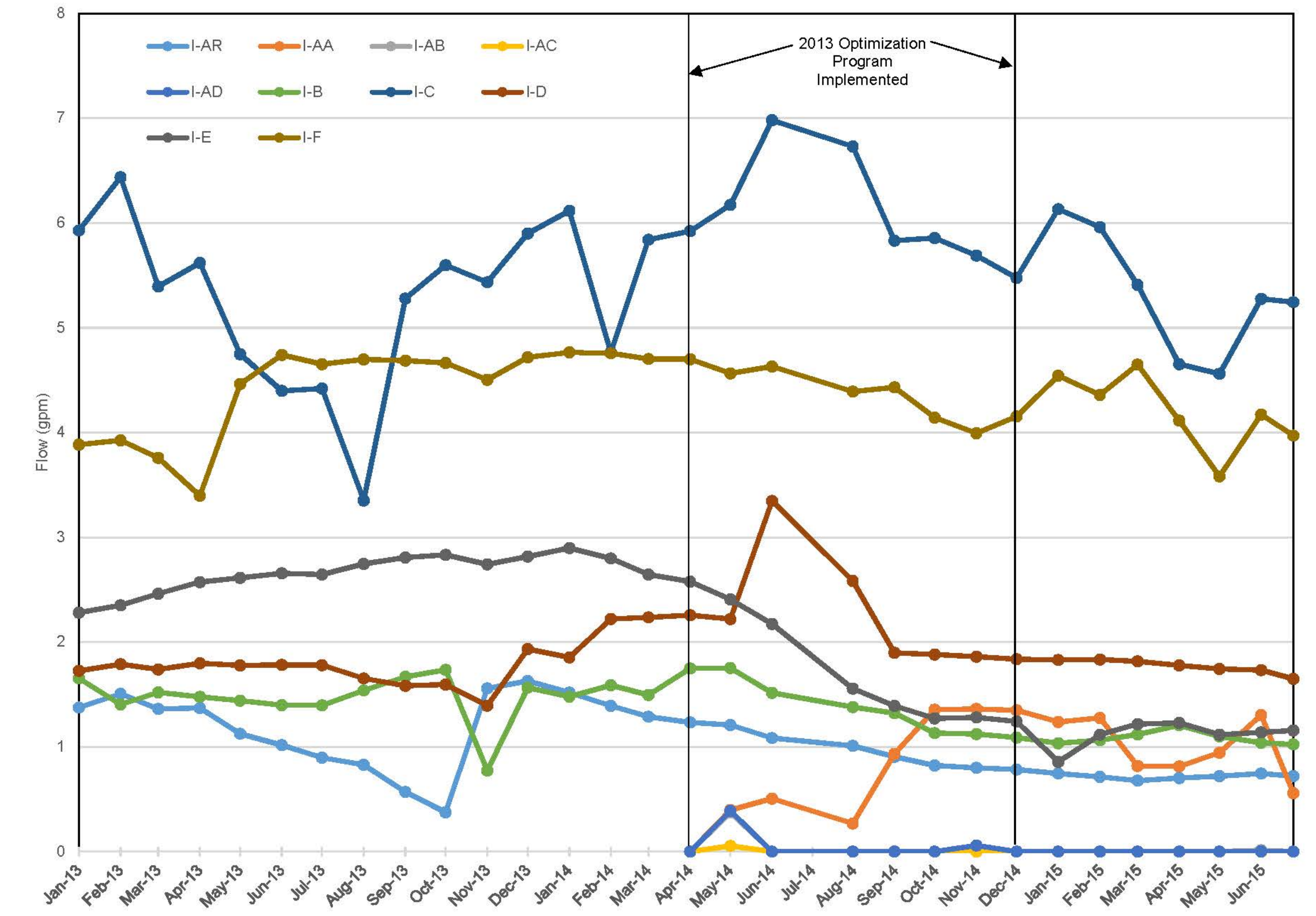
NEVADA ENVIRONMENTAL RESPONSE TRUST

GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

ATHENS ROAD WELL FIELD
AVERAGE MONTHLY FLOW RATES

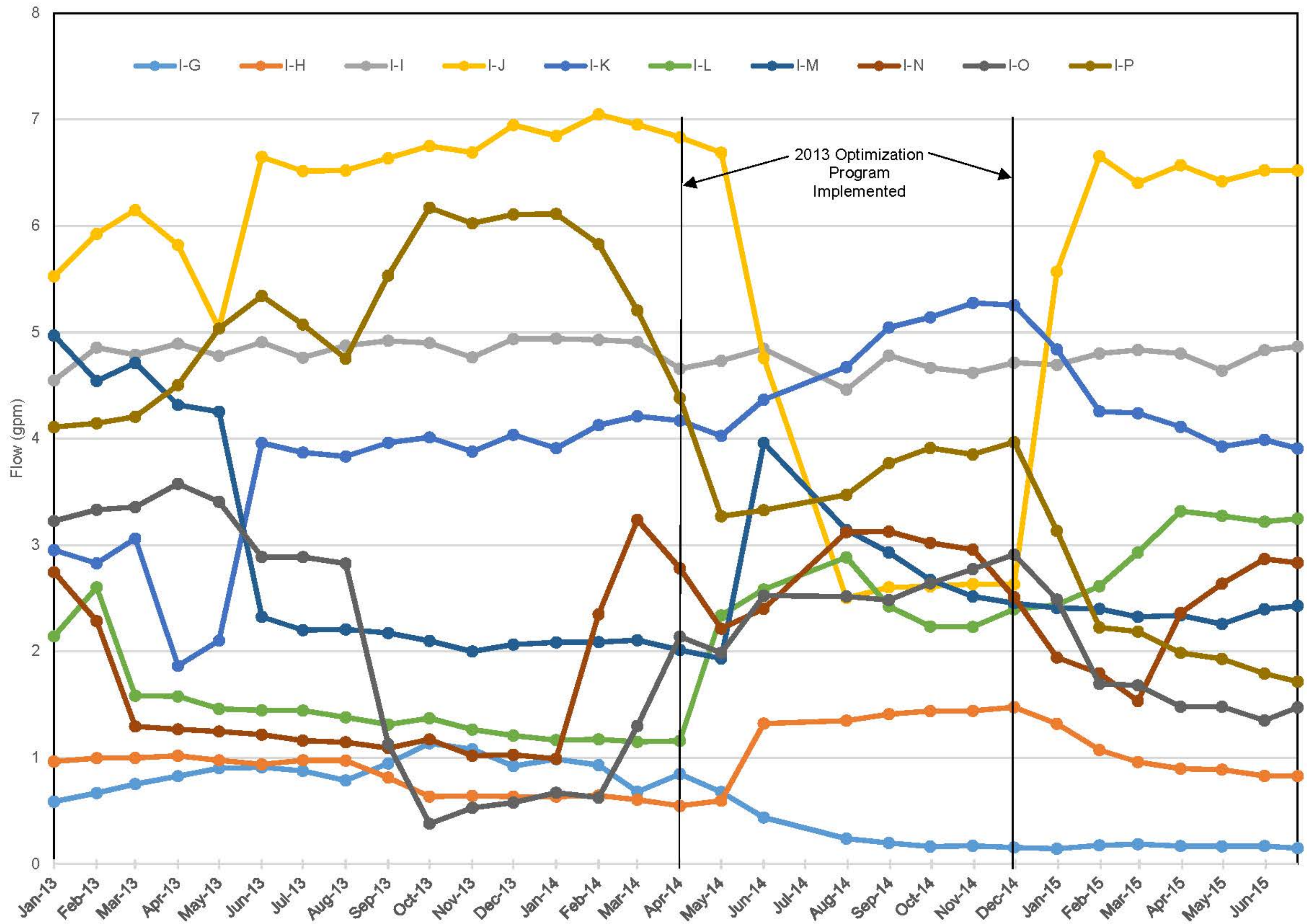
Project No.:	114-520225
Date:	AUG 03, 2015
Designed By:	SRP
Figure No.	2-3

AUG 03, 2015 P:\GIS\NERT\MXD\NERT_ATHENSROADWELLFLOWRATE_GRAPH.MXD



TETRA TECH www.tetratech.com 1489 West Warm Springs Road, Suite 110 Henderson, Nevada 89014 PHONE: (702) 966-8340	**NEVADA ENVIRONMENTAL RESPONSE TRUST** GROUNDWATER EXTRACTION AND TREATMENT SYSTEM CONTINUOUS OPTIMIZATION PROGRAM **INTERCEPTOR WELL FIELD AVERAGE MONTHLY FLOW RATES WELLS I-AR THROUGH I-F**	Project No.: 114-520225 Date: JUL 30, 2015 Designed By: SRP Figure No. **2-4A**

JUL 30, 2015 P:\GIS\NERT\MXD\NERT_INTERCEPTORWELLFLOWRATE_GRAPHA.MXD



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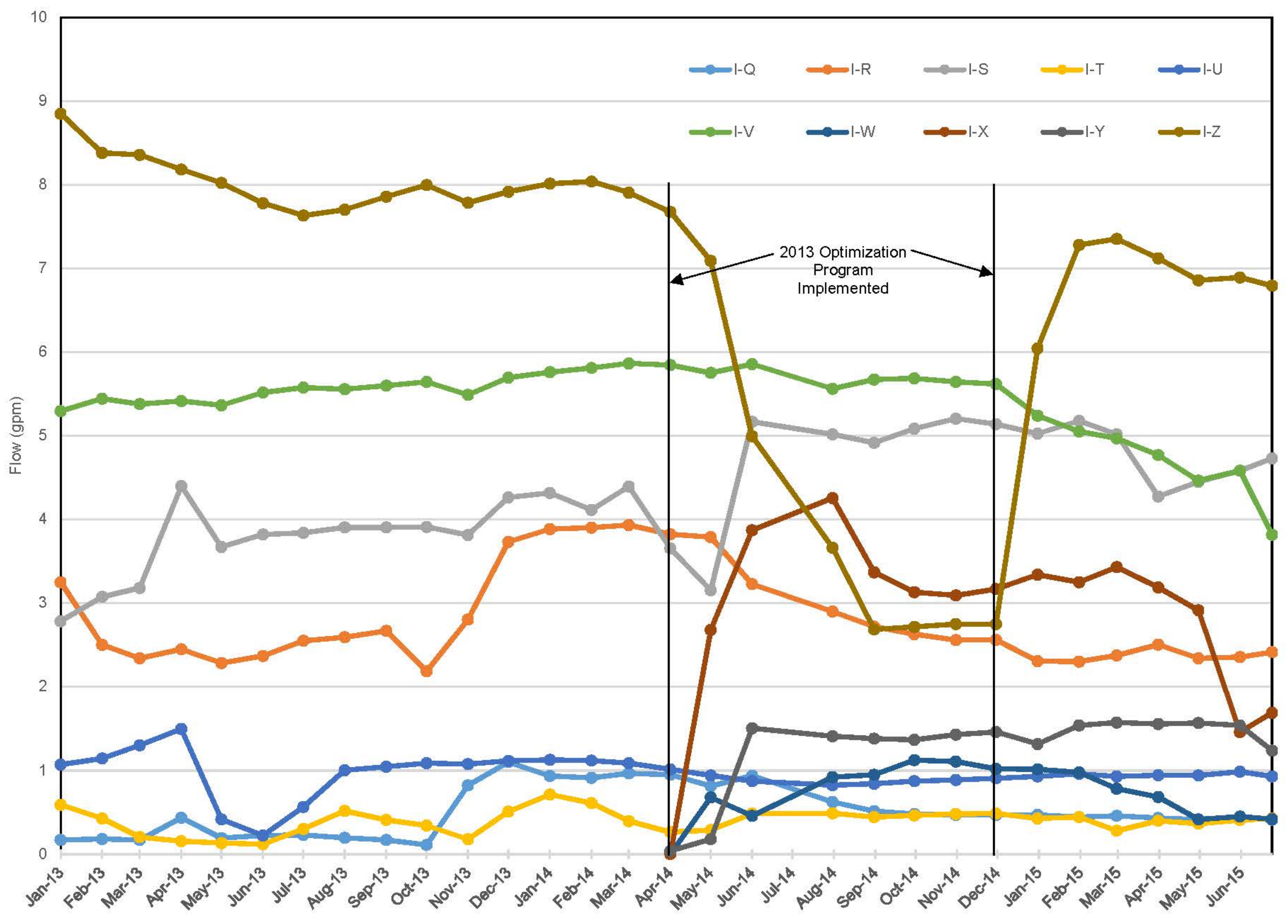
NEVADA ENVIRONMENTAL RESPONSE TRUST

GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

INTERCEPTOR WELL FIELD
AVERAGE MONTHLY FLOW RATES
WELLS I-G THROUGH I-P

Project No.:	114-520225
Date:	JUL 30, 2015
Designed By:	SRP
Figure No.	**2-4B**

JUL 30, 2015 P:\GIS\NERT\MXD\NERT_INTERCEPTORWELLFLOWRATE_GRAPHB.MXD



JUL 30, 2015 P:\GIS\NERT\MXD\NERT_INTERCEPTORWELLFLOWRATE_GRAPHC.MXD

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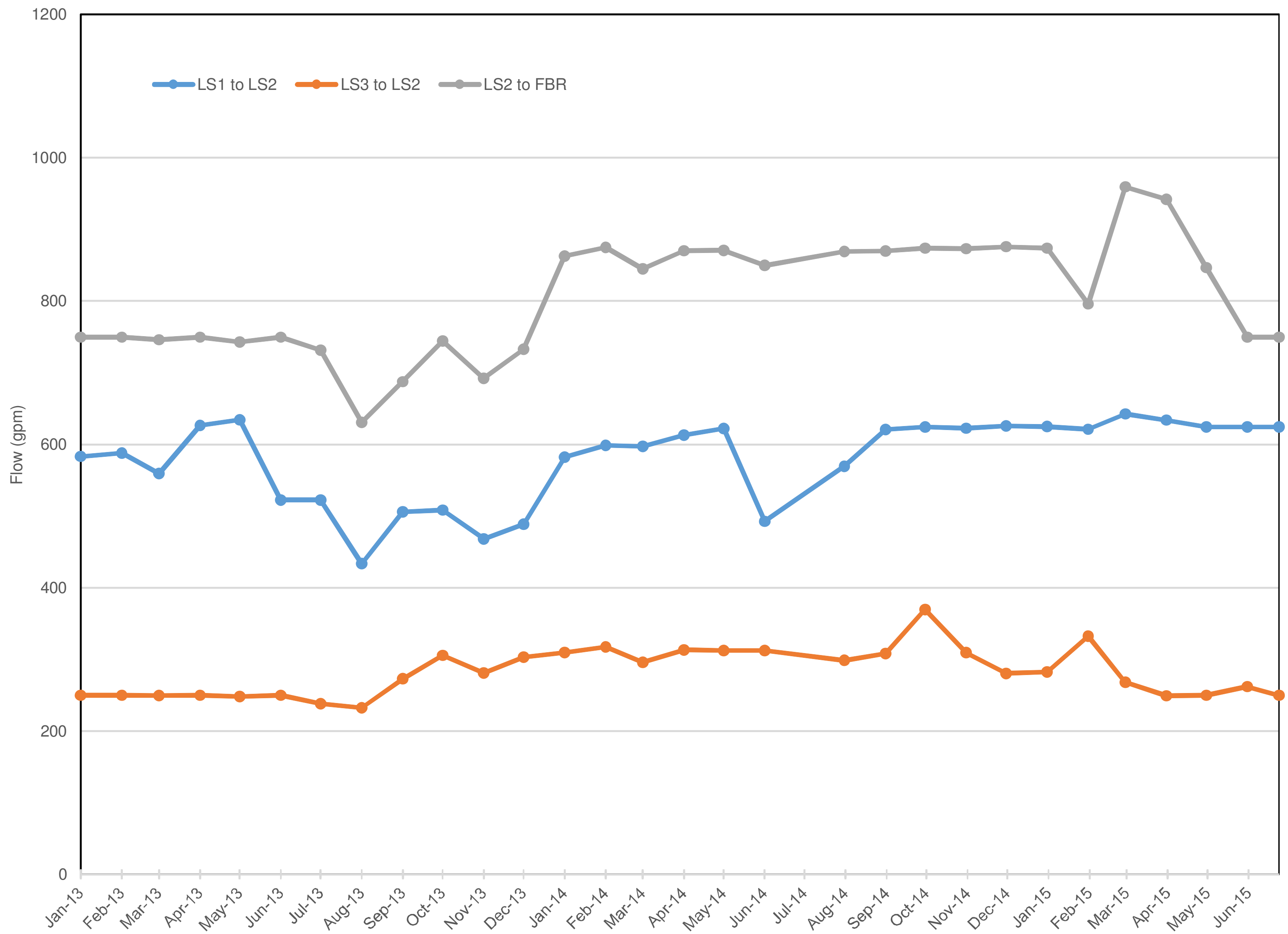
GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

INTERCEPTOR WELL FIELD
AVERAGE MONTHLY FLOW RATES
WELLS I-Q THROUGH I-Z

Project No.:	114-520225
Date:	JUL 30, 2015
Designed By:	SRP
Figure No.	**2-4C**



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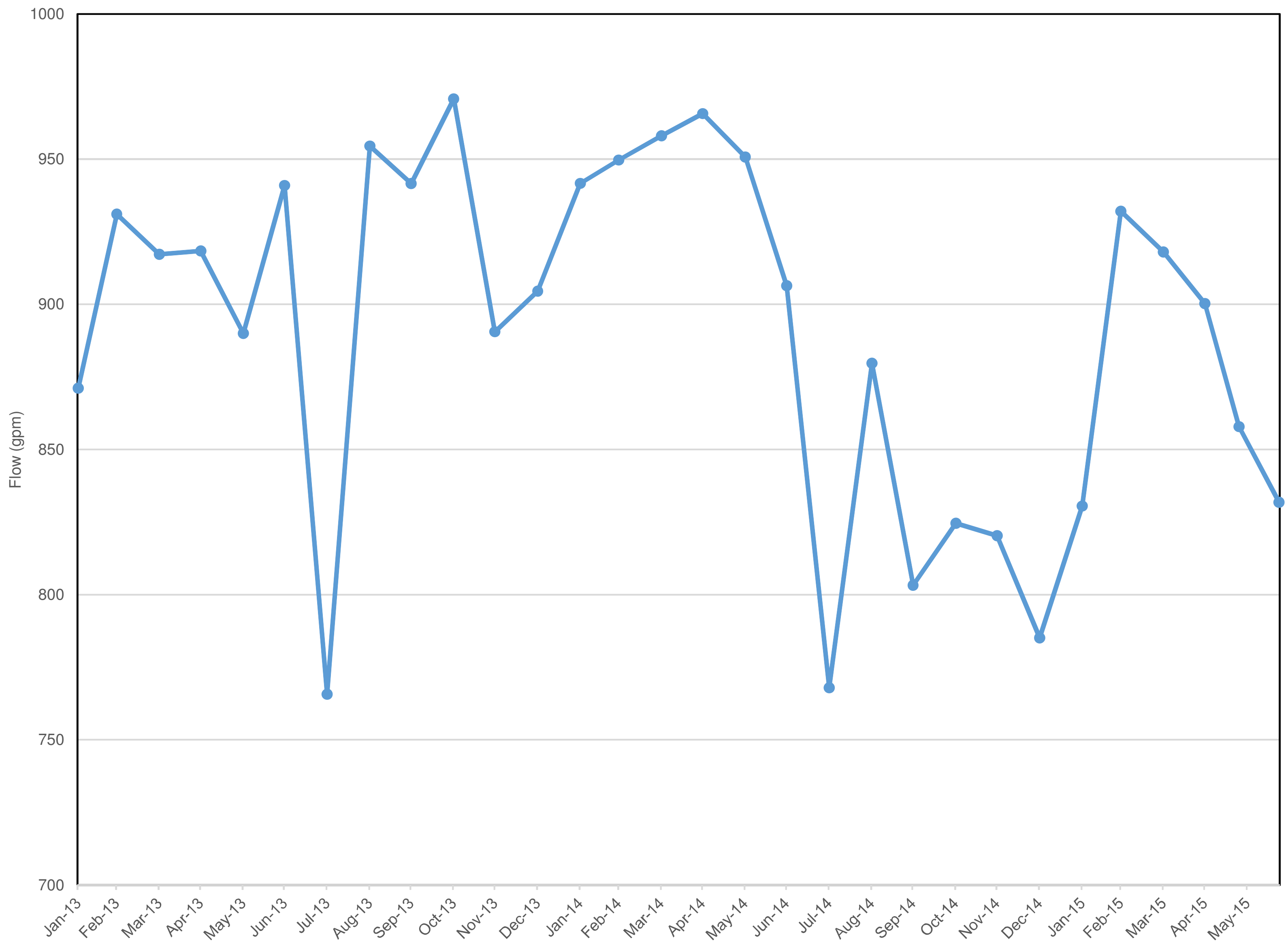
NEVADA ENVIRONMENTAL RESPONSE TRUST

GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

LIFT STATION
MONTHLY AVERAGE FLOW RATES

Project No.:	114-520225
Date:	JUL 30, 2015
Designed By:	SRP
Figure No.	**2-5**

JUL 30, 2015 P:\GIS\NERT\MXD\NERT_LISTSTATIONMONTHLYFLOWRATE_GRAPH.MXD



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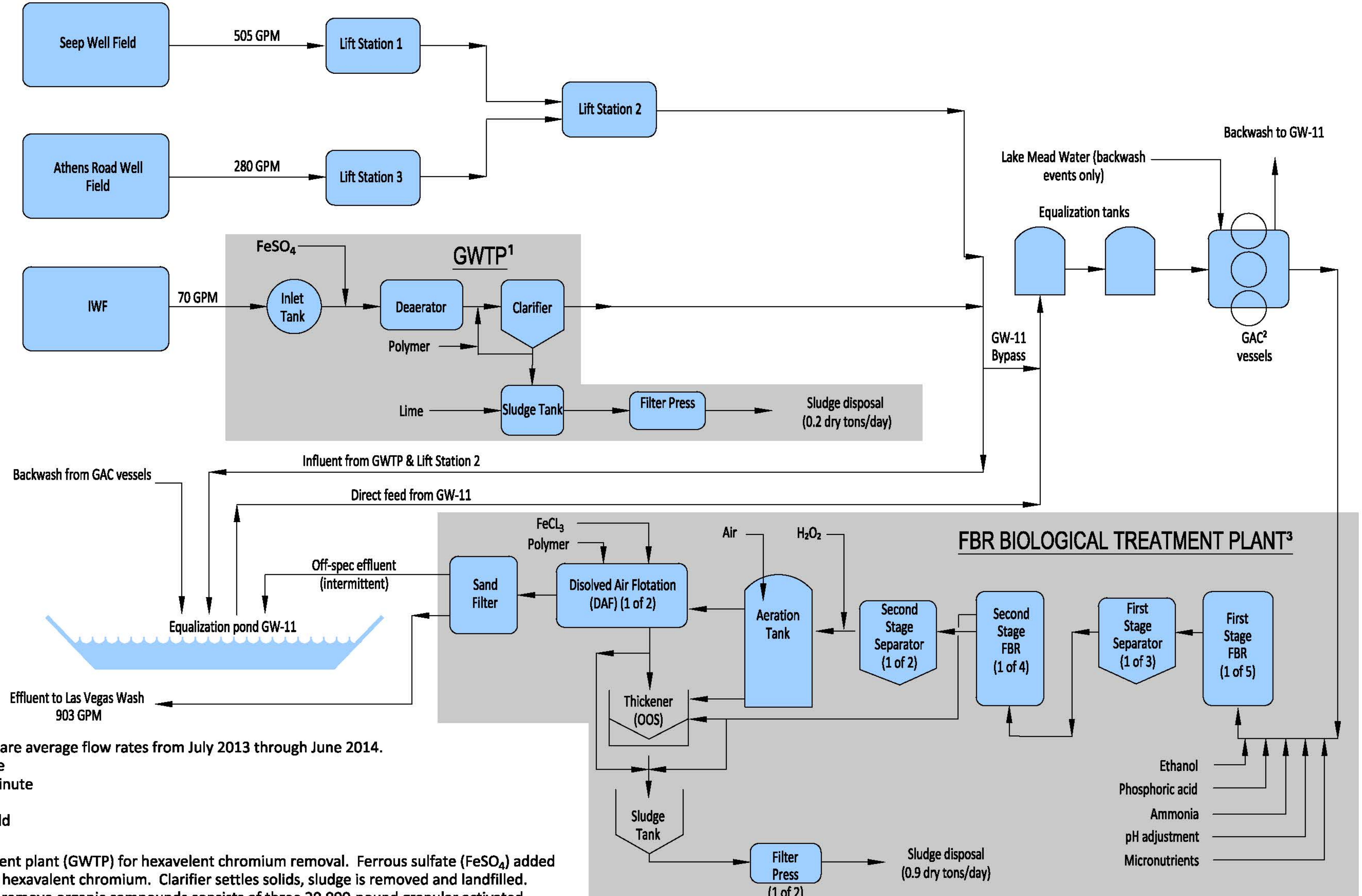
GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

EFFLUENT PIPE MONTHLY FLOW RATES
DISCHARGE FROM FBR TREATMENT PLANT

Project No.:	114-520225
Date:	AUG 03, 2015
Designed By:	SRP
Figure No.	**2-6**

AUG 03, 2015 P:\GIS\NERT\MXD\NERT_FBRPLANT_EFFLUENTFLOWRATES.MXD



Notes:
The process flows shown are average flow rates from July 2013 through June 2014.
GPM = Gallons per minute
ml/min = Milliliters per minute
OOS = Out of service
IWF = Interceptor well field

1) Groundwater treatment plant (GWTP) for hexavelent chromium removal. Ferrous sulfate ($FeSO_4$) added to chemically reduce hexavalent chromium. Clarifier settles solids, sludge is removed and landfilled.
2) Carbon treatment to remove organic compounds consists of three 20,000-pound granular activated carbon (GAC) vessels.
3) Fluidized bed reactor (FBR) biological treatment plant for removal of perchlorate consistes of five 33,000-gallon first-stage FBRs, four 28,000-gallon second-stage FBRs, aeration (air and hydrogen peroxide, H_2O_2), dissolved air flotation (DAF), two plate and frame filter presses, and a sand filter.

TAKEN FROM ENVIRON 2014 ANNUAL REMEDIAL PERFORMANCE REPORT

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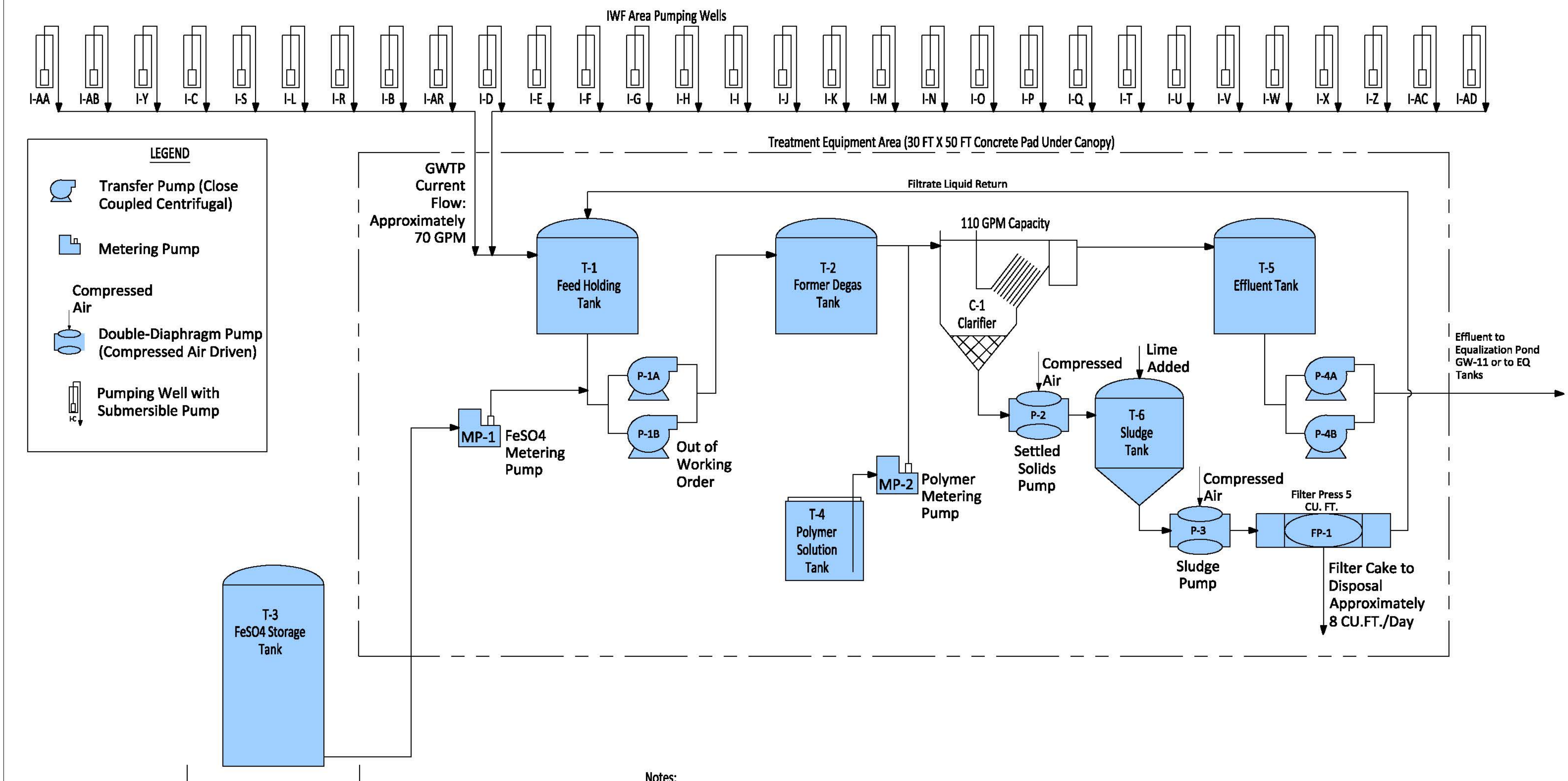
GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
FLOW DIAGRAM

DATE:	7/15/15
PROJECT NO.:	2121C-PB-00204
DESIGNED BY:	DB
DRAWN BY:	DB
CHECKED BY:	JC
SHEET:	1 OF 1

FIGURE 2-7



Notes:
FT = Feet
CU. FT. = Cubic Feet
GPM = Gallons per minute
IWF = Interceptor Well Field
GWTP = Groundwater Treatment Plant

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NEVADA ENVIRONMENTAL RESPONSE TRUST
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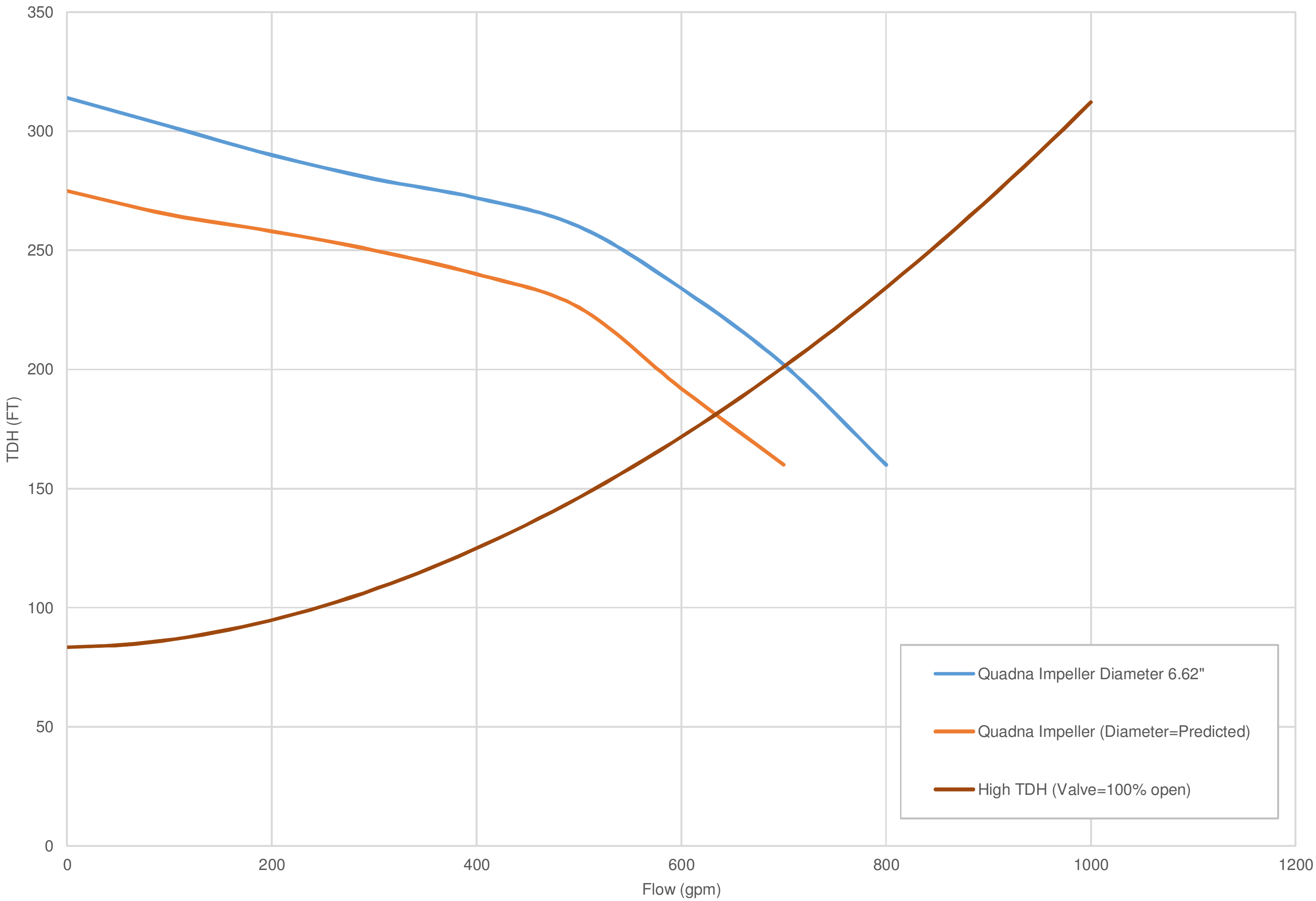
CURRENT GWTP
FLOW DIAGRAM

DATE:	7/15/15
PROJECT NO.: 2121C-PB-00204	
DESIGNED BY:	DB
DRAWN BY:	DB
CHECKED BY:	JC
SHEET: 1 OF 1	

FIGURE 2-8



JUL 30, 2015 P:\GIS\NERT\MXD\NERT_LS1_LS2_PUMPSYSTEMCURVE.MXD

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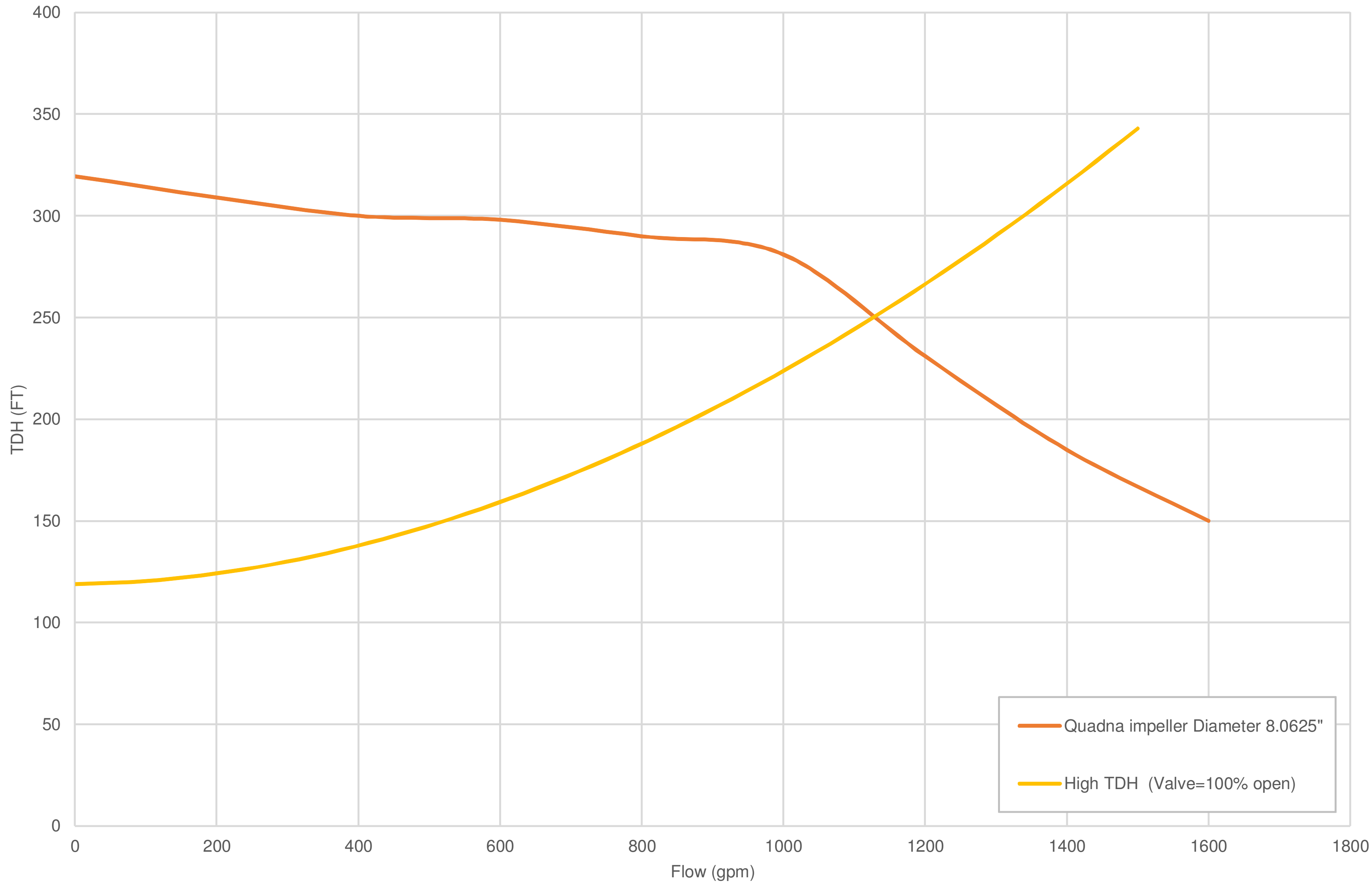
GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

LS1 TO LS2 PUMP AND SYSTEM CURVES

Project No.:	114-520225
Date:	JUL 30, 2015
Designed By:	SRP

Figure No.
3-1



JUL 30, 2015 P:\GIS\NERT\MXD\NERT_LS2_PLANT_PUMPSYSTEMCURVE.MXD

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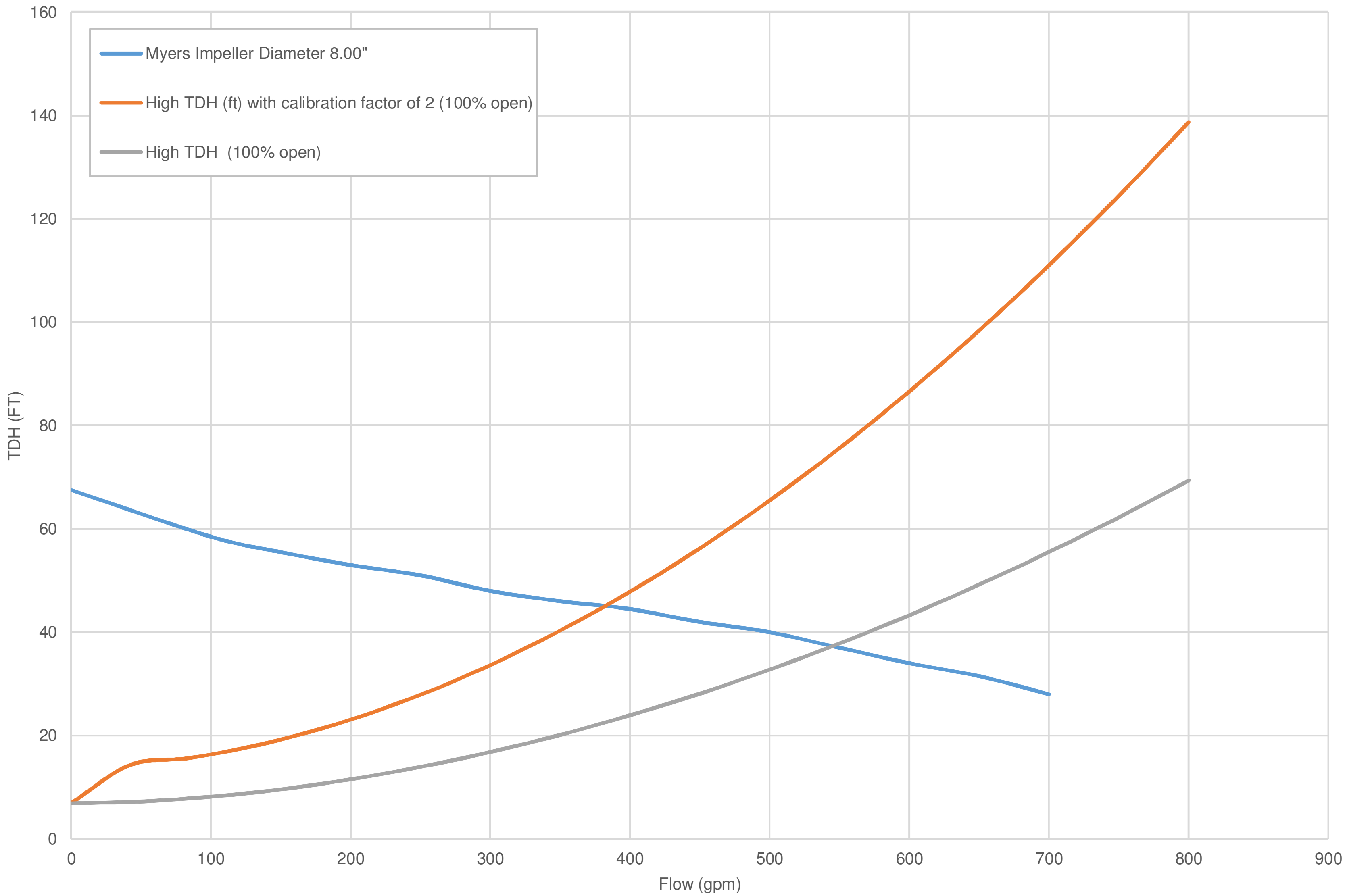
GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

LS2 TO PLANT PUMP AND SYSTEM CURVES

Project No.:	114-520225
Date:	JUL 30, 2015
Designed By:	SRP
Figure No.	**3-2**



JUL 30, 2015 P:\GIS\NERT\MXD\NERT_LS3_LS2_PUMPSYSTEMCURVE.MXD

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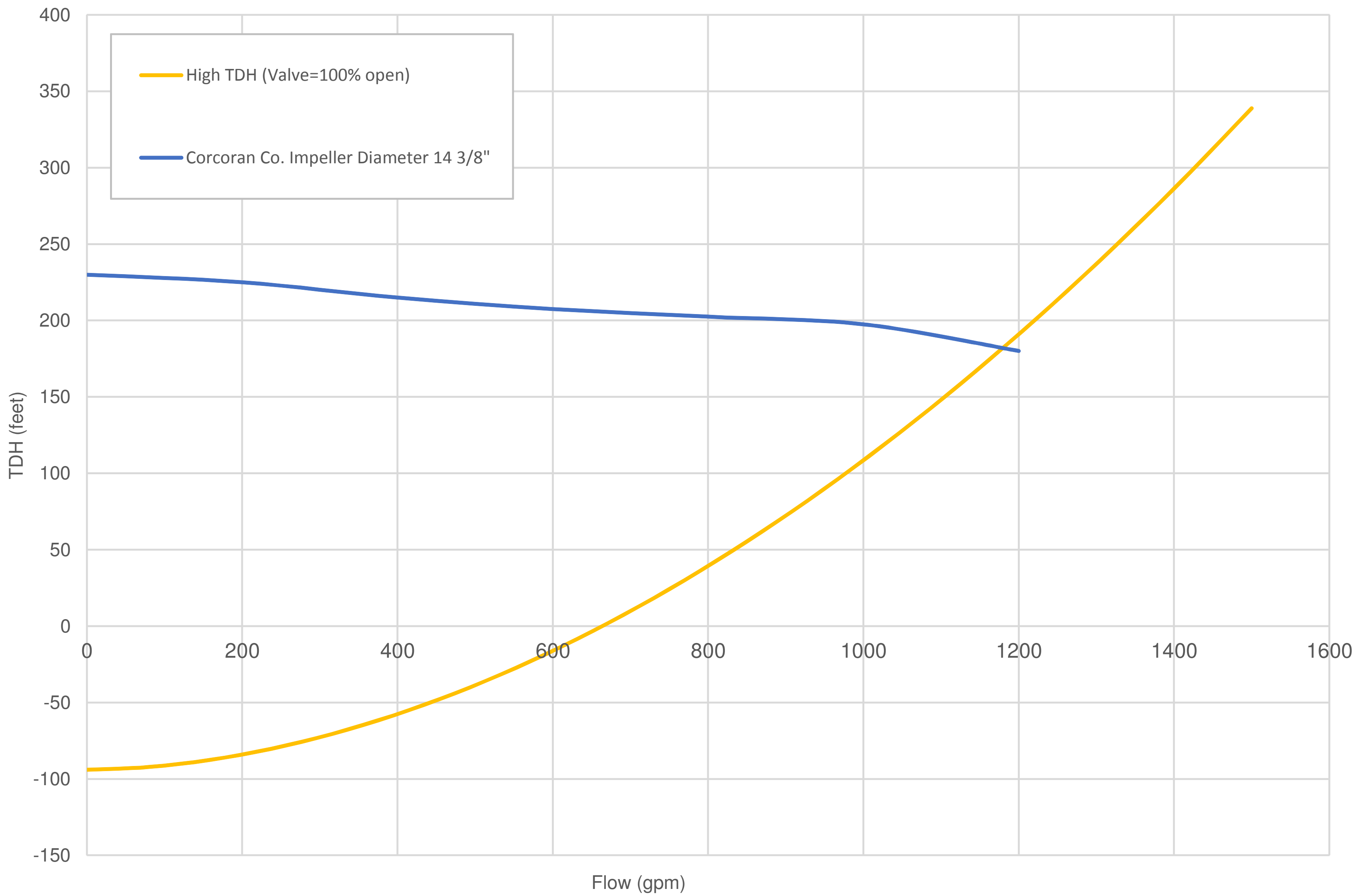
GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

LS3 TO LS2 PUMP AND SYSTEM CURVES

Project No.:	114-520225
Date:	JUL 30, 2015
Designed By:	SRP

Figure No.
3-3



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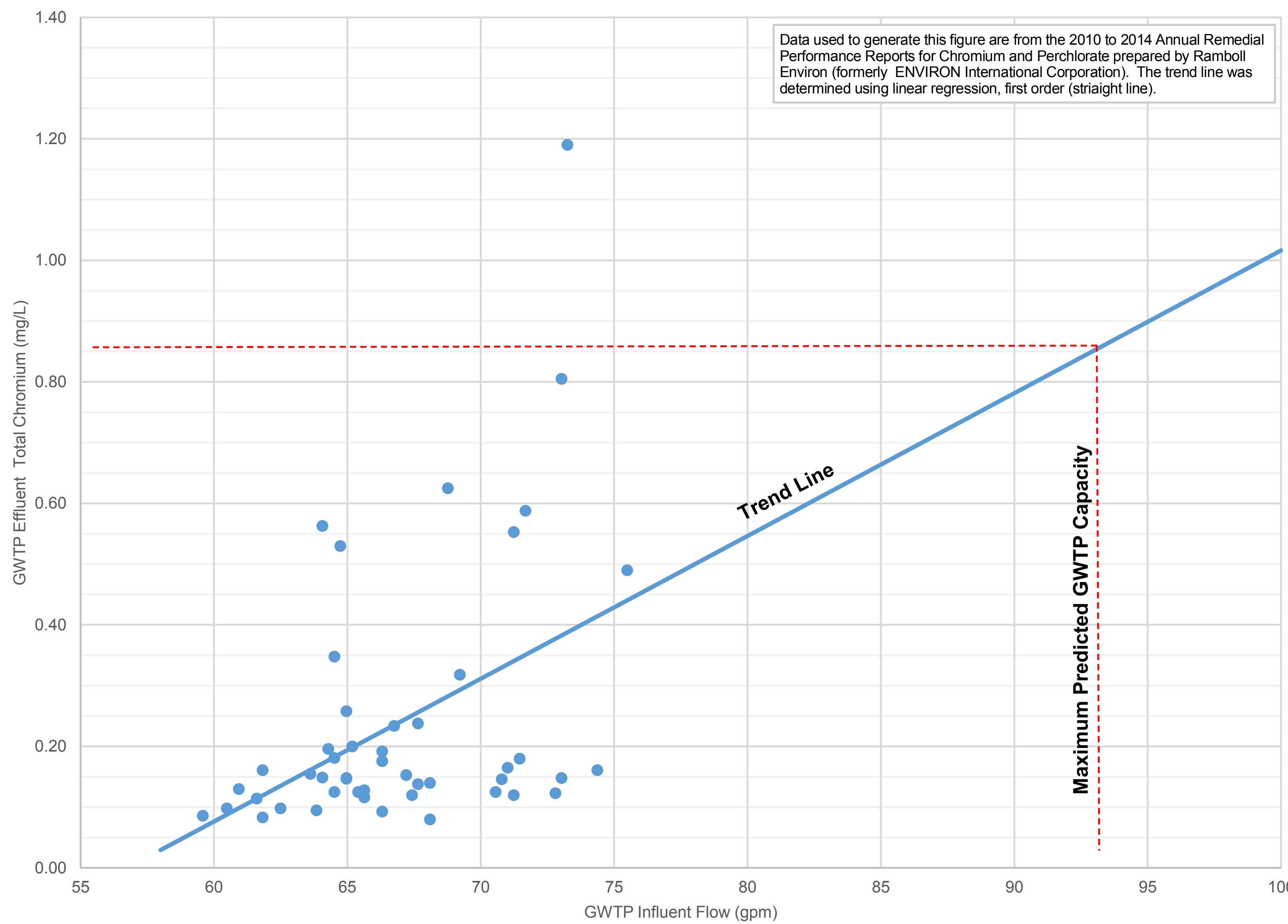
GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

EFFLUENT PIPELINE TO LAS VEGAS WASH
PUMP AND SYSTEM CURVES

Project No.:	114-520225
Date:	AUG 03, 2015
Designed By:	SRP

Figure No.
3-4

AUG 03, 2015 P:\GIS\NERT\MXD\NERT_EFFLUENT_LVW_PUMPSYSTEMCURVE.MXD



AUG 24, 2015 P:\GIS\NERT\MXD\NERT_HISTORICGWTPINFLUENT.MXD

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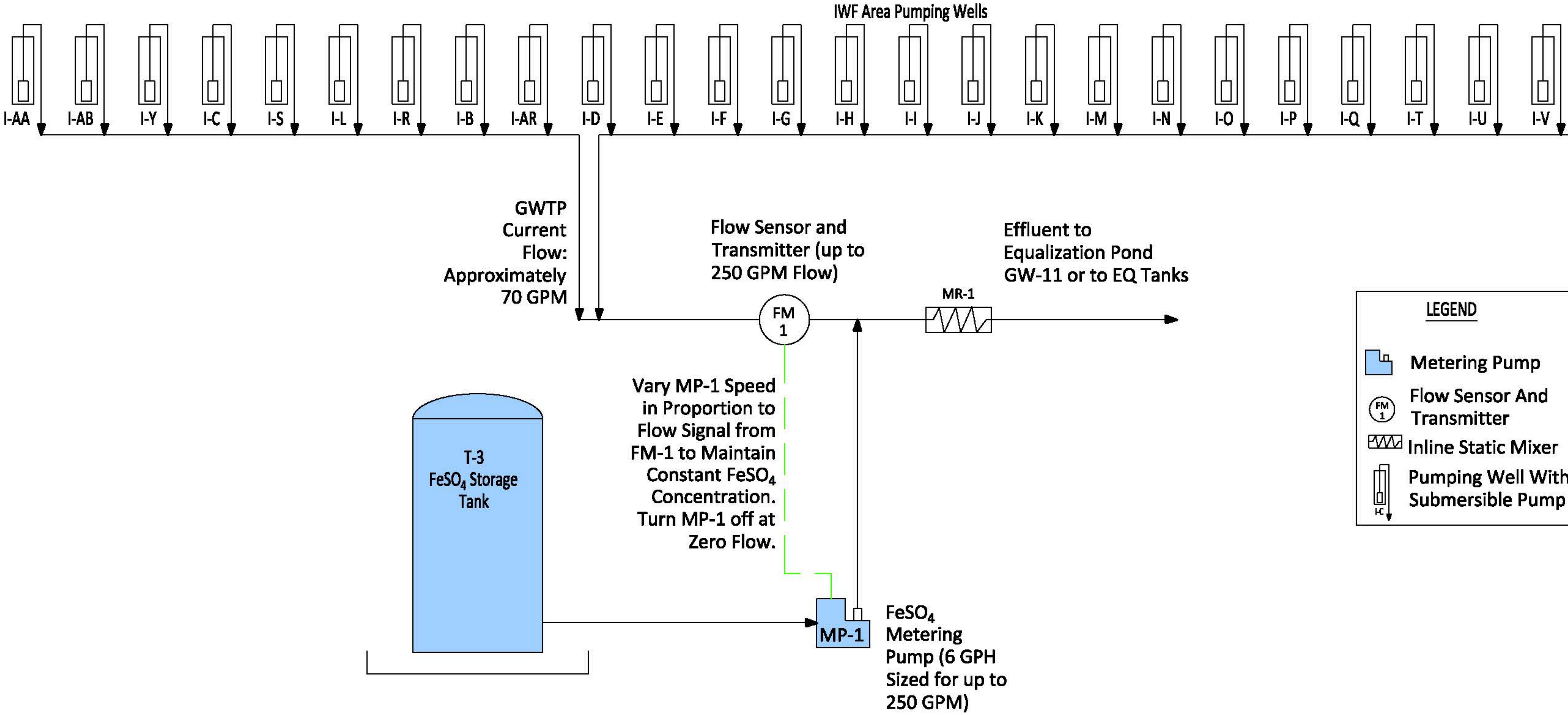
NEVADA ENVIRONMENTAL RESPONSE TRUST

GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

CHROMIUM CONCENTRATIONS VS. GWTP FLOW

Project No.:	114-520225
Date:	AUG 24, 2015
Designed By:	SRP
Figure No.	**3-5**



Notes:
GPH = Gallons per hour
GPM = Gallons per minute
IWF = Interceptor Well Field
GWTP = Ground Water Treatment Plan

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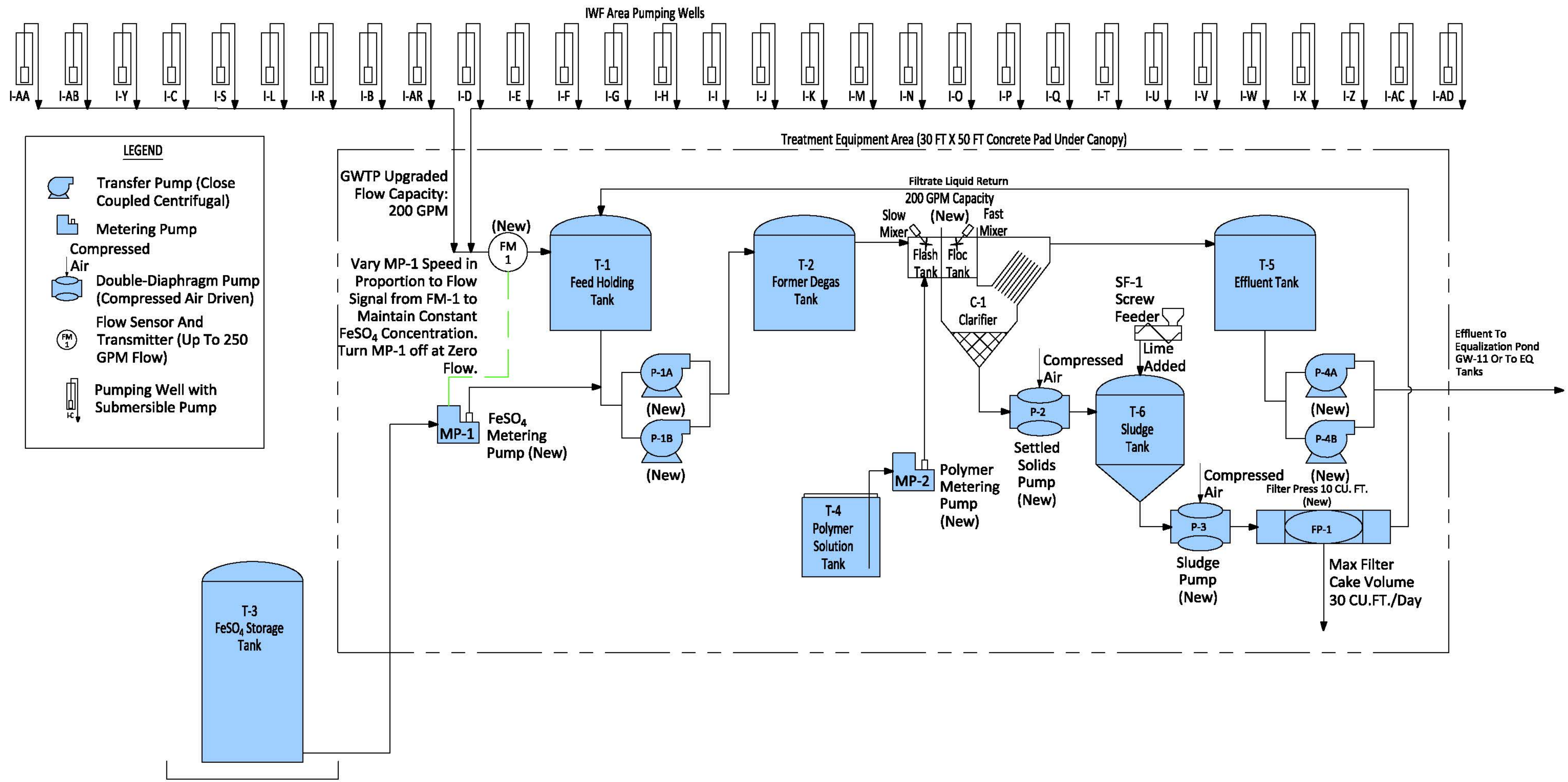
GWTP UPGRADE ALTERNATVE #1
FLOW DIAGRAM

DATE:	7/15/15
PROJECT NO.: 2121C-PB-00204	
DESIGNED BY:	DB
DRAWN BY:	DB
CHECKED BY:	JC
SHEET: 1 OF 1	

FIGURE 4-1



Notes:
FT = Feet
CU. FT. = Cubic Feet
GPM = Gallons per minute
OOS = Out of service
IWF = Interceptor well field

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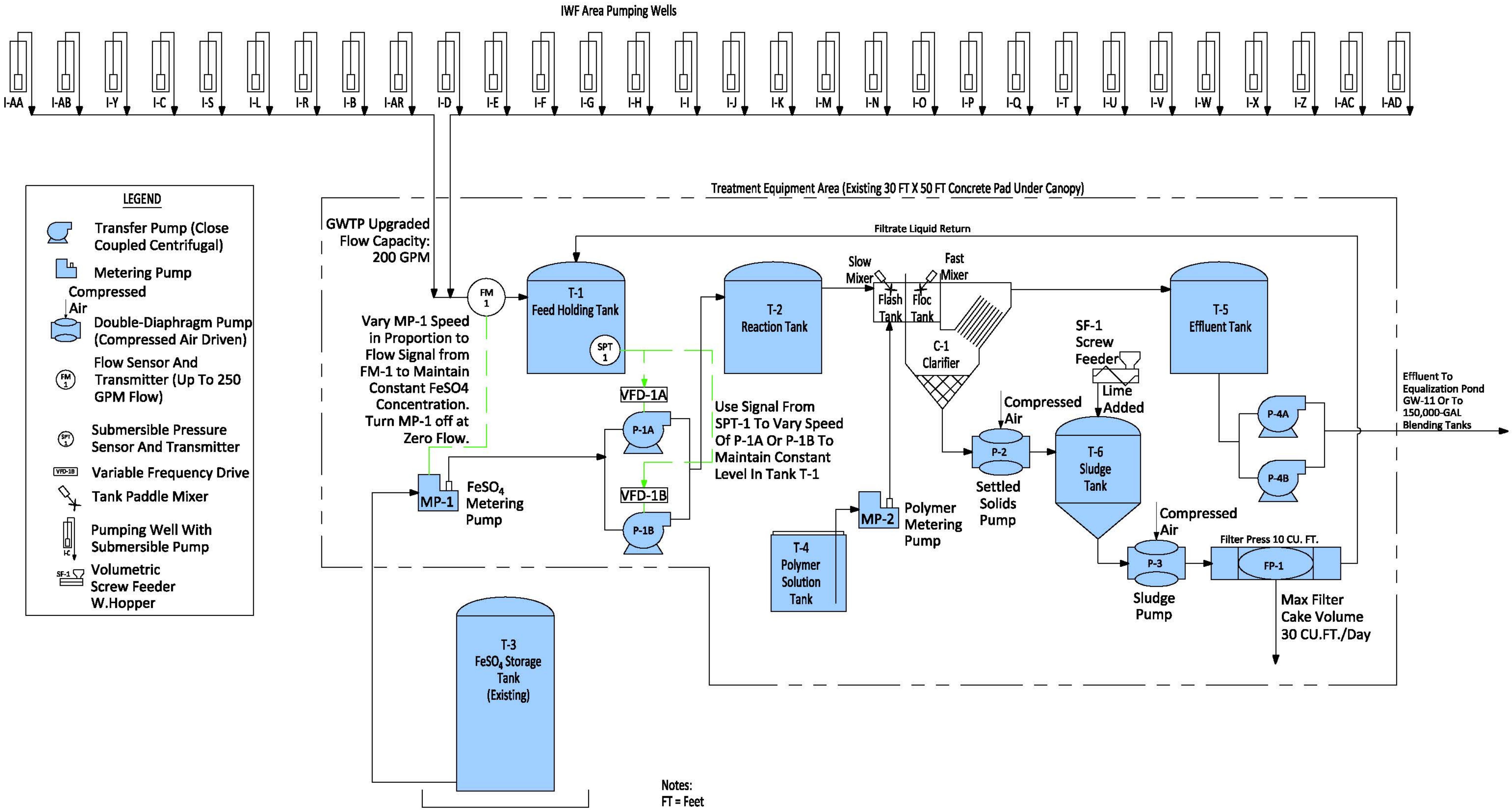
GWTP UPGRADE ALTERNATVE #2
FLOW DIAGRAM

DATE:	8/18/15
PROJECT NO.: 2121C-PB-00204	
DESIGNED BY:	DB
DRAWN BY:	DB
CHECKED BY:	JC
SHEET: 1 OF 1	

FIGURE 4-2



Notes:
FT = Feet
CU. FT. = Cubic Feet
GPM = Gallons per minute
OOS = Out of service
IWF = Interceptor well field

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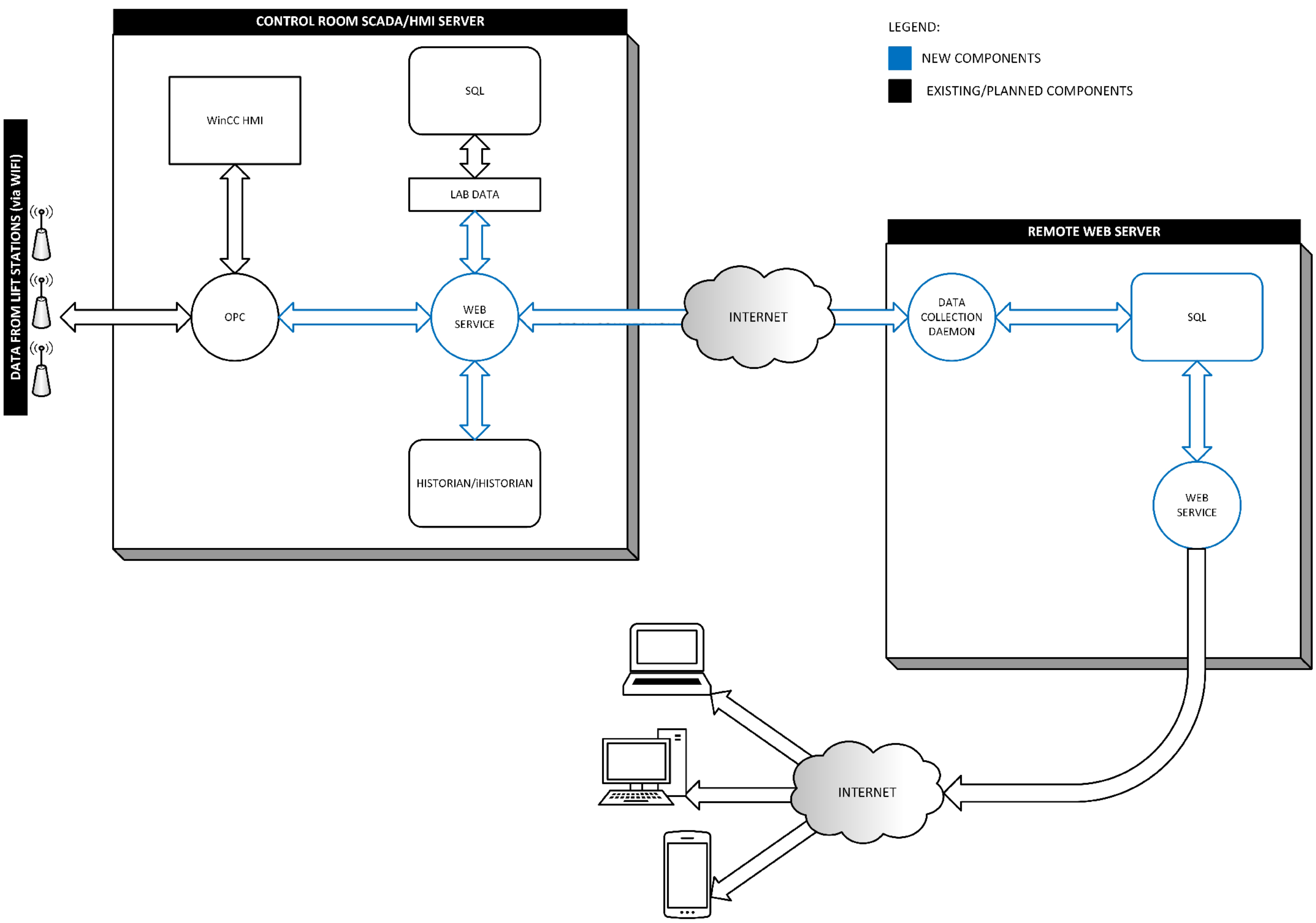
GWTP UPGRADE ALTERNATVE #3
FLOW DIAGRAM

DATE:	8/18/15
PROJECT NO.:	2121C-PB-00204
DESIGNED BY:	DB
DRAWN BY:	DB
CHECKED BY:	JC
SHEET:	1 OF 1

FIGURE 4-3



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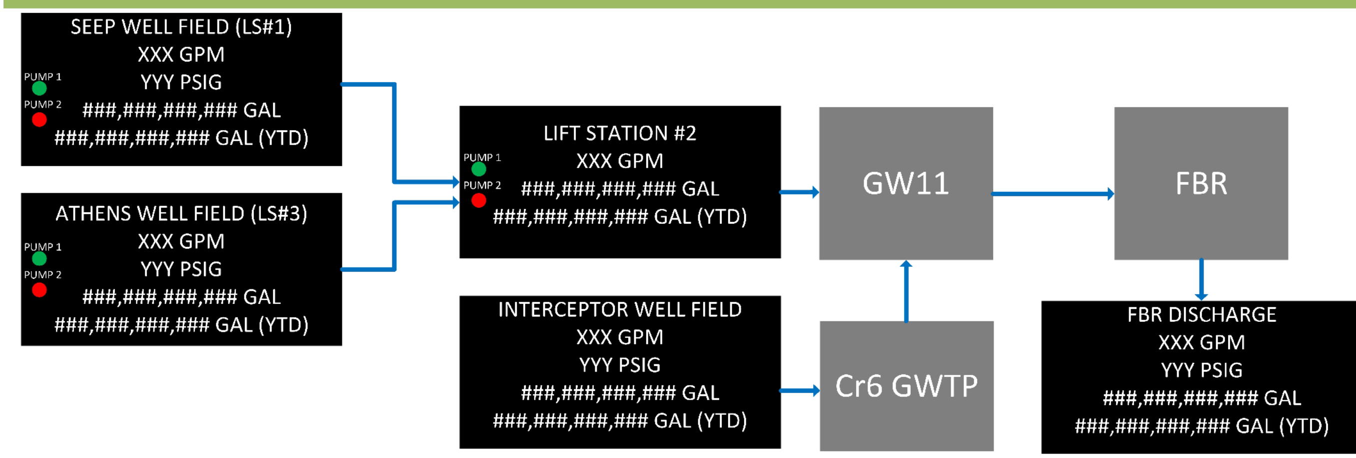
GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

NETWORK DIAGRAM

Project No.:	114-520225
Date:	AUG. 12, 2015
Designed By:	SRP

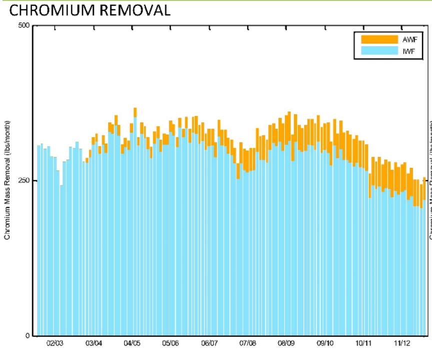
Figure No.
5-1

GWETS OPERATING CONDITIONS

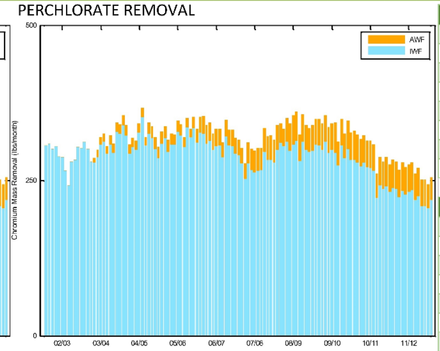


TRENDING AND HISTORICAL INFORMATION DASHBOARD

CHROMIUM REMOVAL



PERCHLORATE REMOVAL



Chromium Removal Summary:	Value	Units	Date
Cr6 Sample 1	####	µg/L	6/26/2015
Totalizer at Sample 1	####	gal	6/26/2015
Cr6 Sample 2	####	µg/L	5/26/2015
Totalizer at Sample 2	####	gal	5/26/2015
Incremental Cr6 Mass	####	lbs	5/26 - 6/26
Average Incremental Cr6 Removal	####	lbs/day	5/26 - 6/26
Total Cr6 Mass Removal at Sample 1	####	tons	--
Estimated Current Cr6 Mass Removal	####	tons	--

Perchlorate Removal Summary:	Value	Units	Date
Perchlorate Sample 1	####	µg/L	6/26/2015
Totalizer at Sample 1	####	gal	6/26/2015
Perchlorate Sample 2	####	µg/L	5/26/2015
Totalizer at Sample 2	####	gal	5/26/2015
Incremental Perchlorate Mass	####	lbs	5/26 - 6/26
Average Incremental Perchlorate Removal	####	lbs/day	5/26 - 6/26
Total Perchlorate Mass Removal at Sample 1	####	tons	--
Estimated Current Perchlorate Mass Removal	####	tons	--

Total Cr 6 Removed: XXX,XXX tons **Total Perchlorate Removed: XXX,XXX tons**

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NEVADA ENVIRONMENTAL RESPONSE TRUST

GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

TIER 1 SCREEN 1 CONCEPTUAL LAYOUT

Project No.: 114-520225
Date: AUG. 12, 2015
Designed By: SRP

Figure No.
5-2

AUG. 12, 2015 P:\GIS\NERT\MXD\NERT_TIER1_SCREEN.MXD

WELL PUMP STATUS

09/12/2015 16:32 PM

GWETS OPERATING CONDITIONS

SEEP WELL FIELD (LS#1)
XXX GPM
YYY PSIG
PUMP 1
PUMP 2
###,###,###,### GAL
###,###,###,### GAL (YTD)

ATHENS WELL FIELD (LS#3)
XXX GPM
YYY PSIG
PUMP 1
PUMP 2
###,###,###,### GAL
###,###,###,### GAL (YTD)

LIFT STATION #2
XXX GPM
PUMP 1
PUMP 2
###,###,###,### GAL
###,###,###,### GAL (YTD)

GW-11
###,###,###,### GAL
###,###,###,### GAL (YTD)

FBR

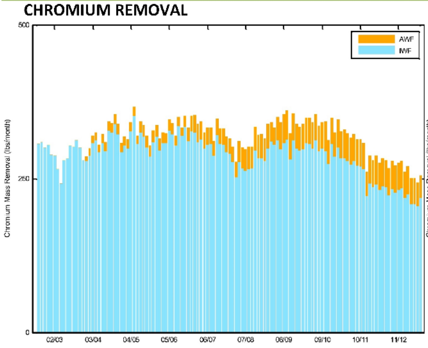
INTERCEPTOR WELL FIELD
XXX GPM
YYY PSIG
###,###,###,### GAL
###,###,###,### GAL (YTD)

Cr6 GWTP

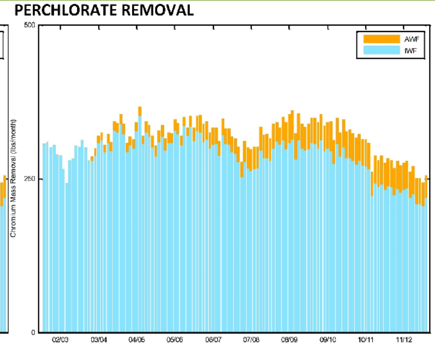
FBR DISCHARGE
XXX GPM
YYY PSIG
###,###,###,### GAL
###,###,###,### GAL (YTD)

TRENDING AND HISTORICAL INFORMATION DASHBOARD

CHROMIUM REMOVAL



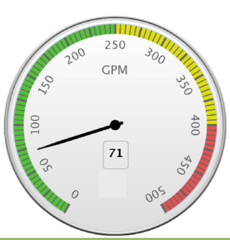
PERCHLORATE REMOVAL



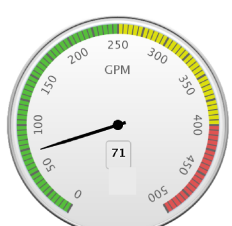
Chromium Removal Summary:	Value	Units	Date
Cr6 Sample 1	####	µg/L	6/26/2015
Totalizer at Sample 1	####	gal	6/26/2015
Cr6 Sample 2	####	µg/L	5/26/2015
Totalizer at Sample 2	####	gal	5/26/2015
Incremental Cr6 Mass	####	lbs	5/26 - 6/26
Average Incremental Cr6 Removal	####	lbs/day	5/26 - 6/26
Total Cr6 Mass Removal at Sample 1	####	tons	--
Estimated Current Cr6 Mass Removal	####	tons	--

Perchlorate Removal Summary:	Value	Units	Date
Perchlorate Sample 1	####	µg/L	6/26/2015
Totalizer at Sample 1	####	gal	6/26/2015
Perchlorate Sample 2	####	µg/L	5/26/2015
Totalizer at Sample 2	####	gal	5/26/2015
Incremental Perchlorate Mass	####	lbs	5/26 - 6/26
Average Incremental Perchlorate Removal	####	lbs/day	5/26 - 6/26
Total Perchlorate Mass Removal at Sample 1	####	tons	--
Estimated Current Perchlorate Mass Removal	####	tons	--

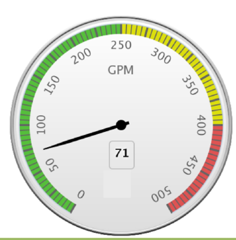
SEEP WELL FIELD LS#1 FLOW



ATHENS WELL FIELD LS#3 FLOW



INTERCEPTOR WELL FIELD FLOW



FBR DISCHARGE FLOW

Total Cr6 Removed: XXX,XXX tons   Total Perchlorate Removed: XXX,XXX tons

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NEVADA ENVIRONMENTAL RESPONSE TRUST

GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

TIER 2 SCREEN 1 CONCEPTUAL LAYOUT

Project No.: 114-520225
Date: AUG. 12, 2015
Designed By: SRP

Figure No.
5-3

AUG. 12, 2015 P:\GIS\NERT\MXD\NERT_TIER2_SCREEN1.MXD

MAIN SCREEN

09/12/2015 16:32 PM

WELL PUMP STATUS OVERVIEW

INTERCEPTOR WELL FIELD PUMP STATUS

	Interceptor well I-AA Pump Status
	Interceptor well I-AB Pump Status
	Interceptor well I-B Pump Status
	Interceptor well I-R Pump Status
	Interceptor well I-Y Pump Status
	Interceptor well I-L Pump Status
	Interceptor well I-S Pump Status
	Interceptor well I-C Pump Status
	Interceptor well I-F Pump Status
	Interceptor well I-X Pump Status
	Interceptor well I-N Pump Status
	Interceptor well I-E Pump Status
	Interceptor well I-M Pump Status
	Interceptor well I-D Pump Status
	Interceptor well I-AR Pump Status
	Interceptor well I-O Pump Status
	Interceptor well I-W Pump Status
	Interceptor well I-P Pump Status
	Interceptor well I-H Pump Status
	Interceptor well I-U Pump Status
	Interceptor well I-T Pump Status
	Interceptor well I-G Pump Status
	Interceptor well I-Q Pump Status
	Interceptor well I-AD Pump Status
	Interceptor well I-AC Pump Status
	Interceptor well I-K Pump Status
	Interceptor well I-J Pump Status
	Interceptor well I-Z Pump Status
	Interceptor well I-I Pump Status
	Interceptor well I-V Pump Status

SEEP WELL FIELD PUMP STATUS

	Well PC-99R3 (Center) Pump Status
	Well PC-115R (West) Pump Status
	Well PC-116R (East) Pump Status
	Well PC-117 Pump Status
	Well PC-118 Pump Status
	Well PC-119 Pump Status
	Well PC-120 Pump Status
	Well PC-121 Pump Status
	Well PC-133 Pump Status

ATHENS WELL FIELD PUMP STATUS

	Well ART-1A Pump Status
	Well ART-1 Pump Status
	Well ART-2A Pump Status
	Well ART-2 Pump Status
	Well ART-3A Pump Status
	Well ART-3 Pump Status
	Well ART-4A Pump Status
	Well ART-4 Pump Status
	Well ART-8A Pump Status
	Well ART-8 Pump Status
	Well ART-6 Pump Status
	Well ART-9 Pump Status
	Well ART-7A Pump Status
	Well ART-7B Pump Status
	Well PC-150 Pump Status

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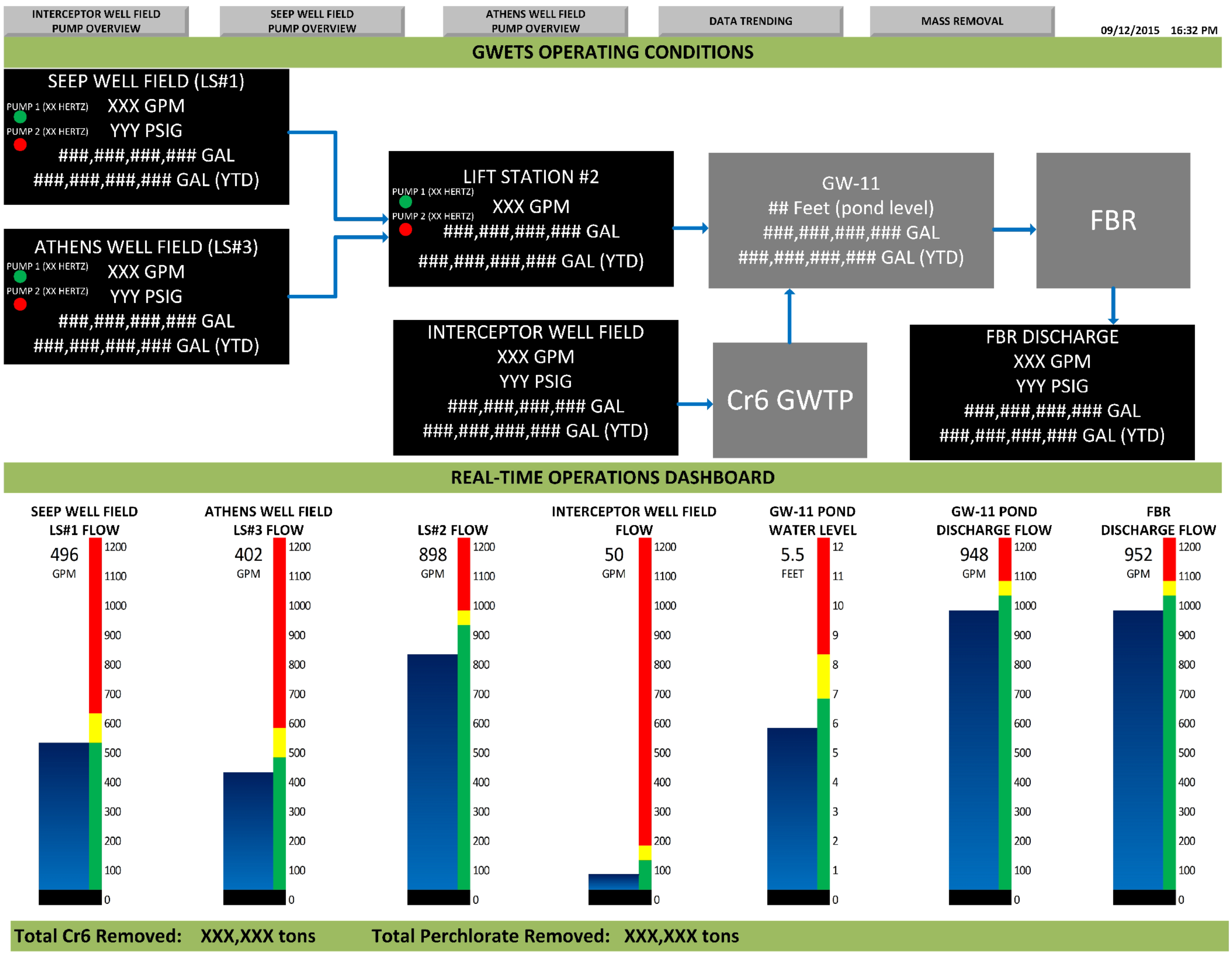
NEVADA ENVIRONMENTAL RESPONSE TRUST

GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

TIER 2 SCREEN 2 CONCEPTUAL LAYOUT

Project No.:	114-520225
Date:	AUG. 12, 2015
Designed By:	SRP
Figure No.	5-4

AUG. 12, 2015 P:\GIS\NERT\MXD\NERT_TIER2_SCREEN2.MXD



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NEVADA ENVIRONMENTAL RESPONSE TRUST

GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

TIER 3 SCREEN 1 CONCEPTUAL LAYOUT

Project No.:	114-520225
Date:	AUG. 12, 2015
Designed By:	SRP

Figure No.

5-5

MAIN SCREEN | SEEP WELL FIELD PUMP OVERVIEW | ATHENS WELL FIELD PUMP OVERVIEW | DATA TRENDING | MASS REMOVAL

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INTERCEPTOR WELL FIELD PUMP OVERVIEW

Status	Pump ID	Well Flow		Water Level	
		Value	Units	Value	Units
	Interceptor well I-AA Pump	20	gpm	30	feet bls
	Interceptor well I-AB Pump	##	gpm	###	feet bls
	Interceptor well I-B Pump	##	gpm	###	feet bls
	Interceptor well I-R Pump	##	gpm	###	feet bls
	Interceptor well I-Y Pump	##	gpm	###	feet bls
	Interceptor well I-L Pump	##	gpm	###	feet bls
	Interceptor well I-S Pump	##	gpm	###	feet bls
	Interceptor well I-C Pump	##	gpm	###	feet bls
	Interceptor well I-F Pump	##	gpm	###	feet bls
	Interceptor well I-X Pump	##	gpm	###	feet bls
	Interceptor well I-N Pump	##	gpm	###	feet bls
	Interceptor well I-E Pump	##	gpm	###	feet bls
	Interceptor well I-M Pump	##	gpm	###	feet bls
	Interceptor well I-D Pump	##	gpm	###	feet bls
	Interceptor well I-AR Pump	##	gpm	###	feet bls
	Interceptor well I-O Pump	##	gpm	###	feet bls
	Interceptor well I-W Pump	##	gpm	###	feet bls
	Interceptor well I-P Pump	##	gpm	###	feet bls
	Interceptor well I-H Pump	##	gpm	###	feet bls
	Interceptor well I-U Pump	##	gpm	###	feet bls
	Interceptor well I-T Pump	##	gpm	###	feet bls
	Interceptor well I-G Pump	##	gpm	###	feet bls
	Interceptor well I-Q Pump	##	gpm	###	feet bls
	Interceptor well I-AD Pump	##	gpm	###	feet bls
	Interceptor well I-AC Pump	##	gpm	###	feet bls
	Interceptor well I-K Pump	##	gpm	###	feet bls
	Interceptor well I-J Pump	##	gpm	###	feet bls
	Interceptor well I-Z Pump	##	gpm	###	feet bls
	Interceptor well I-I Pump	##	gpm	###	feet bls
	Interceptor well I-V Pump	##	gpm	###	feet bls

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GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

TIER 3 SCREEN 2 CONCEPTUAL LAYOUT

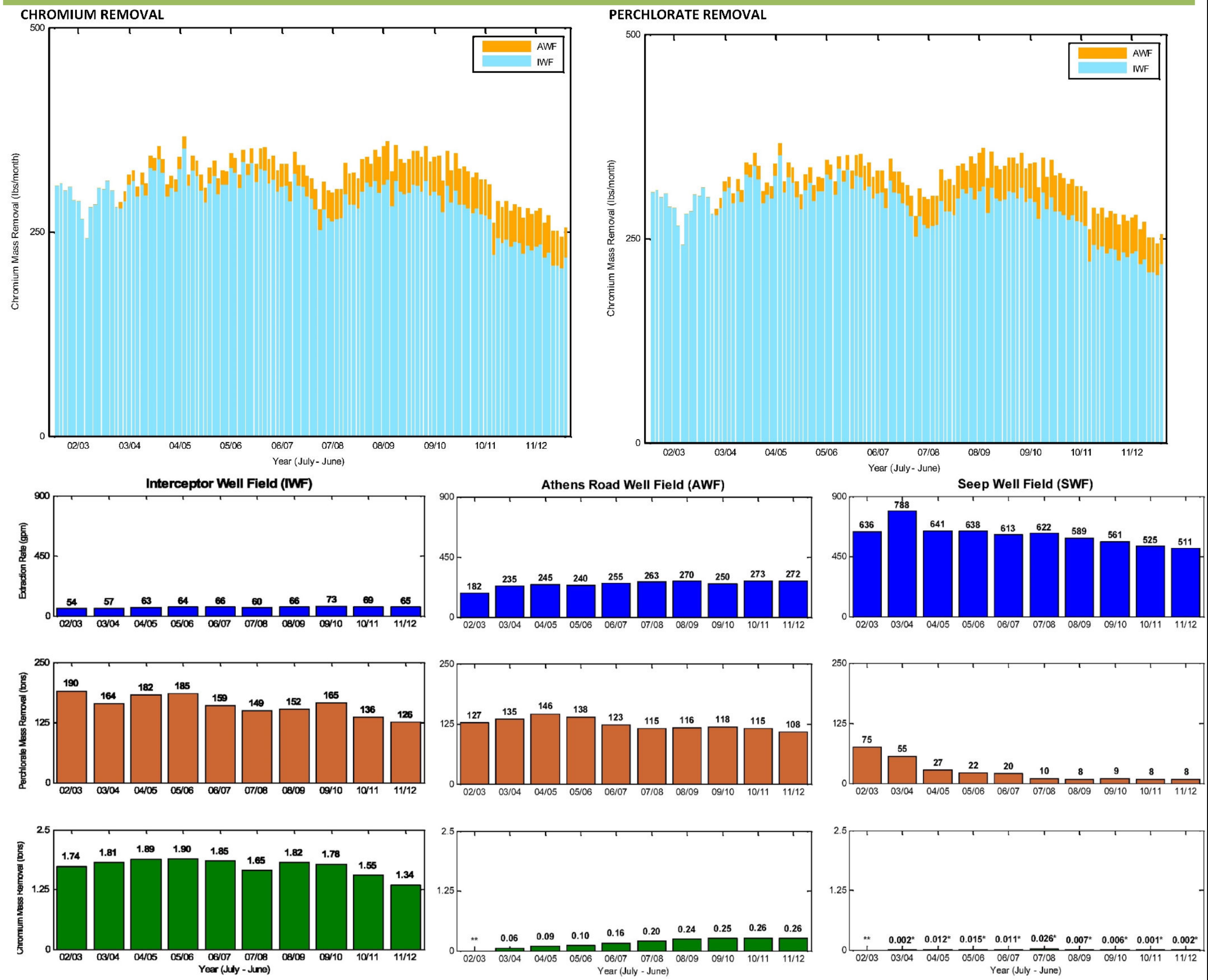
Project No.:	114-520225
Date:	AUG. 12, 2015
Designed By:	SRP
Figure No.	5-6

AUG. 12, 2015 P:\GIS\NERT\MXD\NERT_TIER3_SCREEN2.MXD

MAIN SCREEN | INTERCEPTOR WELL FIELD PUMP OVERVIEW | SEEP WELL FIELD PUMP OVERVIEW | ATHENS WELL FIELD PUMP OVERVIEW | MASS REMOVAL

09/12/2015 16:32 PM

DATA TRENDING



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GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

TIER 3 SCREEN 3 CONCEPTUAL LAYOUT

Project No.:	114-520225
Date:	AUG. 12, 2015
Designed By:	SRP

Figure No.

5-7

MAIN SCREEN | INTERCEPTOR WELL FIELD PUMP OVERVIEW | SEEP WELL FIELD PUMP OVERVIEW | ATHENS WELL FIELD PUMP OVERVIEW | DATA TRENDING

09/12/2015 16:32 PM

MASS REMOVAL

Total Perchlorate Removal Summary:	Value	Units	Date
Perchlorate Sample 1	####	µg/L	6/26/2015
Totalizer at Sample 1	####	gal	6/26/2015
Perchlorate Sample 2	####	µg/L	5/26/2015
Totalizer at Sample 2	####	gal	5/26/2015
Incremental Perchlorate Mass	####	lbs	5/26 - 6/26
Average Incremental Perchlorate Removal	####	lbs/day	5/26 - 6/26
Total Perchlorate Mass Removal at Sample 1	####	tons	--
Estimated Current Perchlorate Mass Remova	####	tons	--

Total Chromium Removal Summary:	Value	Units	Date
Cr6 Sample 1	####	µg/L	6/26/2015
Totalizer at Sample 1	####	gal	6/26/2015
Cr6 Sample 2	####	µg/L	5/26/2015
Totalizer at Sample 2	####	gal	5/26/2015
Incremental Cr6 Mass	####	lbs	5/26 - 6/26
Average Incremental Cr6 Removal	####	lbs/day	5/26 - 6/26
Total Cr6 Mass Removal at Sample 1	####	tons	--
Estimated Current Cr6 Mass Removal	####	tons	--

SWF Perchlorate Removal Summary:	Value	Units	Date
Perchlorate Sample 1	####	µg/L	6/26/2015
Totalizer at Sample 1	####	gal	6/26/2015
Perchlorate Sample 2	####	µg/L	5/26/2015
Totalizer at Sample 2	####	gal	5/26/2015
Incremental Perchlorate Mass	####	lbs	5/26 - 6/26
Average Incremental Perchlorate Removal	####	lbs/day	5/26 - 6/26
Total Perchlorate Mass Removal at Sample 1	####	tons	--
Estimated Current Perchlorate Mass Remova	####	tons	--

AWF Perchlorate Removal Summary:	Value	Units	Date
Perchlorate Sample 1	####	µg/L	6/26/2015
Totalizer at Sample 1	####	gal	6/26/2015
Perchlorate Sample 2	####	µg/L	5/26/2015
Totalizer at Sample 2	####	gal	5/26/2015
Incremental Perchlorate Mass	####	lbs	5/26 - 6/26
Average Incremental Perchlorate Removal	####	lbs/day	5/26 - 6/26
Total Perchlorate Mass Removal at Sample 1	####	tons	--
Estimated Current Perchlorate Mass Remova	####	tons	--

IFW Perchlorate Removal Summary:	Value	Units	Date
Perchlorate Sample 1	####	µg/L	6/26/2015
Totalizer at Sample 1	####	gal	6/26/2015
Perchlorate Sample 2	####	µg/L	5/26/2015
Totalizer at Sample 2	####	gal	5/26/2015
Incremental Perchlorate Mass	####	lbs	5/26 - 6/26
Average Incremental Perchlorate Removal	####	lbs/day	5/26 - 6/26
Total Perchlorate Mass Removal at Sample 1	####	tons	--
Estimated Current Perchlorate Mass Remova	####	tons	--

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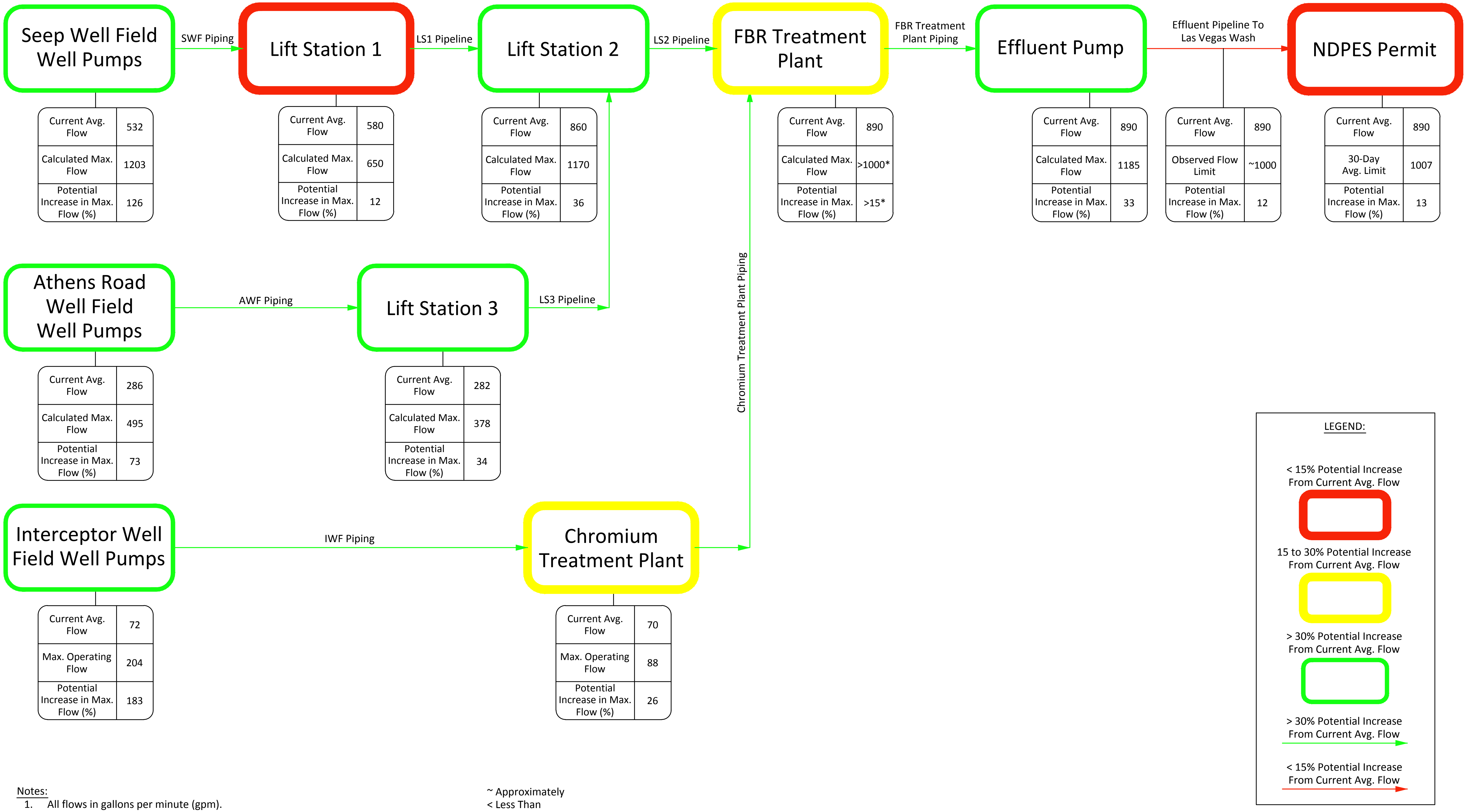
GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTINUOUS OPTIMIZATION PROGRAM

TIER 3 SCREEN 4 CONCEPTUAL LAYOUT

Project No.: 114-520225
Date: AUG. 12, 2015
Designed By: SRP

Figure No.
5-8



Notes:

1. All flows in gallons per minute (gpm).
2. Current average flows obtained from GWETS field sheets.
3. NPDES 30-day average and daily maximum limits obtained from the Notice of Proposed Action for NPDES Permit NV0023060 provided by Nevada Department of Environmental Protection. This permit is recommended to be changed to address increase in flow.

* Evaluation of the FBR treatment plant is out of the scope of this project and will be addressed by Envirogen Technologies, Inc.

~ Approximately
< Less Than
> Greater Than
Avg. = Average
AWF = Athens Road Well Field
FBR = Fluidized Bed Reactor
IWF = Interceptor Well Field
LS = Lift Station
Max. = Maximum
SWF = Seep Well Field

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NEVADA ENVIRONMENTAL RESPONSE TRUST
HENDERSON, NEVADA

SUMMARY OF GWETS INFRASTRUCTURE EVALUATION

DATE: 8/18/15
PROJECT NO.: 2121C-PB-00204
DESIGNED BY: DB
DRAWN BY: DB
CHECKED BY: JC
SHEET: OF 1

FIGURE 6-1