Semi-Annual Remedial Performance Report for Chromium and Perchlorate

July 2010 – December 2010
Nevada Environmental Response Trust Site
Henderson, Nevada

Submitted in Accordance with the 1986 Chromium Consent Order and the 2001 Perchlorate Administrative Order on Consent

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Responsible CEM for this project

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 provided 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.

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1.0 INTRODUCTION

In accordance with the Consent Order for remediation of chromium-impacted groundwater at the Nevada Environmental Response Trust Site (the Site), finalized September 9, 1986, and the Administrative Order on Consent (AOC) for remediation of perchlorate-impacted groundwater in the Henderson area, finalized October 8, 2001, Northgate Environmental Management, Inc (Northgate) submits this remedial performance report to ENVIRON on behalf of the Nevada Environmental Response Trust (the Trust). This report is a mid-period data report for chromium and perchlorate. A detailed evaluation and presentation of data will be contained in the Annual Remedial Performance Report for Chromium and Perchlorate due to the Nevada Division of Environmental Protection (NDEP) in August 2011.

This report, covering the period July 2010 through December 2010, summarizes performance data for both the chromium and perchlorate remediation programs based on sampling performed during this period. The discussion in this report will be primarily limited to variances from historic conditions. Specifically, this report: 1) describes the hexavalent chromium remediation system and evaluates the effectiveness of the groundwater capture and treatment system installed to carry out the chromium remediation program; 2) describes the perchlorate remediation system (consisting of the on-site Interceptor well field, the off-site Athens Road well field, the off-site Seep well field and the off-site Seep surface-flow capture sump) and evaluates the effectiveness of the groundwater capture and treatment system installed to carry out the perchlorate remediation program; and 3) contains data requirements relevant to the chromium remediation system's Underground Injection Control (UIC) permit modification.

This report is provided as a hard copy report and electronically on a CD. Where electronic files are referenced, or information is stated as provided on CD, this information is contained on the complete report CD inserted at the front of the report. Appendix A contains MS Excel © compatible data tables with five quarters of analytical and water level data for all wells monitored, and monthly water levels for selected wells from August 2006 through December 2010 (provided on CD). Appendix B contains the laboratory reports and field sheets (provided on CD). Appendix C contains correspondence with NDEP including responses to comments on previous reports submitted by Tronox, LLC (Tronox; Appendix C can be found on CD). Appendix D contains the Data Validation Summary Report and electronic data deliverables (EDDs) containing chemical and water level data collected during the reporting period (both provided on CD).

2.0 AREA GROUNDWATER CONDITIONS

Figure 1 shows the locations of the remedial systems' components and the sampled monitoring wells. The performance of each component will be discussed separately starting with the Interceptor well field (IWF) and proceeding to the successively northward components. Plate 1 shows the locations of all wells associated with the Site.

2.1 Interceptor Well Field Area

The IWF area is shown on Figure 1, the Location Map. A bentonite-slurry wall was constructed as a physical barrier across the higher concentration portion of the perchlorate/chromium plume on the Site in 2001. The barrier wall is approximately 1,600 feet in length and 60 feet deep. The IWF consists of 23 extraction wells pumping from the Shallow water-bearing zone (WBZ) on the upgradient (south) side of the barrier wall, dewatering the coarse-grained alluvium (Qal) and the upper portion of the fine-grained Upper Muddy Creek formation (UMCf) in the vicinity of the pumping wells. The monthly average discharge rate for each well during December 2010 is shown on Table 1. This table compares the December discharge data to the same time period each year from December 2005 to present. The average total discharge in December 2010 was 67.6 gallons per minute (gpm). Seven additional extraction wells (I-W, I-X, I-Y, I-AA, I-AB, I-AC, and I-AD) have recently been plumbed and partially connected to the well field; when completed, these are expected to increase the amount of water extracted by the well field by up to 10 - 15 gpm.

Groundwater recharge trenches located downgradient (north) of the barrier wall have been used to inject stabilized Lake Mead water into the subsurface to replace water extracted by the well field. Reinjection ceased in September 2010 as the recharge trenches were removed to accommodate soil excavation and remediation activities at the Site, and there is currently no timeframe for repair of the trenches and resumption of recharge. Based on modeling results that indicate no significant benefit to remedial effectiveness from recharge, Northgate recommended deferring trench reconstruction while continuing to evaluate water level and chemical concentration data from wells in the recharge area to evaluate the environmental response in the *Technical Memorandum: Evaluation of Recharge at the Tronox Trenches, Henderson, Nevada* dated February 9, 2011.

Figures 2A through 2D present historic (December 2005 to December 2010) water elevations for selected pairs of monitoring wells located on opposite sides of the barrier wall. As shown on the figures, water levels in wells directly downgradient (north) of the barrier wall (wells M-69 through M-72) generally were approximately six to eight feet lower than water elevations in corresponding wells upgradient (south) of the wall in December 2010. The large drop in measured groundwater elevations across the barrier wall indicates that the wall is an effective barrier to groundwater flow. The figures show a decline in water elevations in the downgradient wells with no consistent decline in upgradient wells beginning around September 2010, when the recharge trenches were shut down and groundwater mounding associated with the recharge began to dissipate. The elevation changes range from less than one foot to over ten feet with the largest effects observed in well M-70.

2.2 Athens Road Field Area

As shown on Figure 1, the Athens Road well field (AWF; Athens Road is also known as Galleria Drive) was completed in 2002 as a series of 14 groundwater extraction wells at seven paired well locations located approximately 8,200 feet north (downgradient) of the barrier wall and IWF. The AWF was completed in March 2002 and continuous pumping began in October 2002. A 15th standalone extraction well, ART-9, began full time operation in September 2006 replacing the ART-6A well after groundwater elevations at the AWF dropped to a level at which the ART-6/6A well pair was no longer effective. The extraction wells are screened across the thickness of the saturated Qal and extract groundwater in the Shallow WBZ from two alluvial paleochannels located on either side of a UMCf ridge. Several additional wells were installed at the AWF in 2010, including several additional monitoring wells and ART-7B, adjacent to the existing extraction well pair ART-7 and ART-7A. ART-7B is deeper than the adjacent pair and may be converted to an extraction well for a possible improvement in capture at the well field. Recent recovery well discharge rates are shown in Table 2. In December 2010 the combined average discharge from the operating recovery wells ART-1, 2A, -3, -4A, -7, -8, and -9 was 267.7 gpm. Discharge rate comparisons back to December 2005 are also provided.

Groundwater elevations at selected wells within the well field from February 2002 through December 2010 are shown on Figure 3, the *Athens Road Well Field Drawdown* graph. The figure shows that groundwater levels have declined over the past year.

2.3 Seep Well Field Area

The Seep well field (SWF) and the Seep stream pumping station are located near the Las Vegas Wash, approximately 4,500 feet north (downgradient) of the AWF as shown on Figure 1. When pumping began in July 2002, the SWF consisted of three recovery wells situated over the deepest part of the alluvial channel. In February 2003 five additional wells (PC-117 to PC-121) and in December 2004 one additional well (PC-133) were completed in the SWF area. At present, the SWF consists of 10 wells – two of which (PC-99R2 and 99R3) are connected and operate as one.

The wells are screened through the saturated Qal and positioned over the deepest part of the alluvial channel containing the highest concentrations of perchlorate. The SWF is located about 600 feet south (upgradient) of the Seep stream surface-flow capture sump and pumping station. SWF recovery well discharge rates are presented in Table 3. In December 2010 the combined average discharge from the SWF was 530.8 gpm. Discharge rate comparisons back to December 2005 are also provided. The Seep stream has not flowed since mid-April 2007.

3.0 CHROMIUM MITIGATION PROGRAM

The four components of the chromium mitigation program, consisting of the IWF, groundwater barrier wall, groundwater recharge trenches and the AWF, are shown on Figure 1. For the six month period from July 2010 to December 2010, a total of about 1,886 pounds of chromium was captured and removed from the collected groundwater. Please note that for the discussion in this section and the groundwater well monitoring program, total chromium is conservatively considered to be entirely hexavalent chromium. A diagram of the groundwater chromium system is presented on Figure 4, the *Henderson Groundwater Treatment Flow Diagram*.

3.1 Chromium Plume

Appendix A contains the results of the last five quarters of groundwater elevation and analytical sampling data in Table A-1. Based on November 2010 total chromium analytical results, the highest total chromium concentration south (upgradient) of the barrier wall occurred in well I-T (31 mg/L) in the IWF, whereas north of the barrier wall the highest total chromium concentration measured was 9.7 mg/L in well M-73. The highest concentration measured north of the former recharge trenches was 2 mg/L in well PC-136. Overall, the plume remains fairly stable with concentrations continuing to decline along the trailing edge of the main plume upgradient of the IWF.

3.1.1 On-Site Interceptor Well Field Area

Figure 5, the *Interceptor Well Field Total Chromium Section Graph*, shows the concentrations of total chromium across the well field over the last five quarters. The figure shows that the total chromium concentrations are relatively stable on either end, with more significant fluctuations in concentration in the center of the well field.

Total chromium concentration data from the five Consent Order Appendix J wells (M-11, -23, -36, -72, and -86) are presented in Figure 6, the *Consent Order Appendix J Wells Total Chromium Concentration Trend Graph*. As shown on Figure 6, the total concentration measured in well M-36, located upgradient of the IWF, continued to decline over the reporting period. Concentrations remained steady or declined slightly in M-72, located immediately downgradient of the barrier wall, and M-23, located north of the IWF adjacent to Warm Springs Road. Concentrations remained steady or increased slightly in wells M-11, located southeast of the Chemstar facility, and M-86, located just northeast of the recharge trenches. It should be noted that there is only one data point from well M-86, which was previously damaged during recharge trench refurbishment activities in 2008, and was again abandoned to accommodate soil excavation and remediation activities during the third quarter of 2010.

3.1.2 Athens Road/Seep Well Fields Area

The groundwater recovery system at Athens Road (now called Galleria Drive) also treats chromium-impacted water, though at much lower concentrations than the IWF. As shown in Figure 7, the *Athens Road Well Field Total Chromium Section Graph*, chromium concentrations in the western paleochannel over the last year have been low relative to those in the eastern paleochannel. Chromium concentrations in ART-6 and ART-9, the highest at the AWF, were measured at 1.4 mg/L in November 2010. Chromium was measured in well ART-1 at an estimated concentration of 0.0026 mg/L of total chromium in November 2010, down from 0.54 mg/L in November 2009. Based on past experience, the higher reported concentration in 2009 is thought to be an artifact of the well construction and sampling techniques employed (i.e., insufficient purging and chromium leached from a stainless steel casing).

Total chromium present in groundwater collected in this area continues to be treated at Lift Station #3 with ferrous sulfate to reduce the hexavalent chromium species to insoluble trivalent chromium before the water is sent to the on-site perchlorate treatment system.

No total chromium section graph was prepared for the SWF located further north, because wells in this well field closest to the Las Vegas wash continue to contain minimal amounts of total chromium (as they have since the onset of data collection in February 2006).

3.2 On-Site Chromium Treatment System

The operation and maintenance of the total chromium reduction process was contracted to Veolia Water North America (formerly US Filter Operating Services) on August 1, 2003. The Trust retains responsibility for compliance with the terms of the 1986 Consent Order and the subsequent Underground Injection Control (UIC) Permit NEV94218. Table 4 contains the July 2010 to December 2010 process treatment data from the on-site Groundwater Treatment Plant (GWTP). The treated groundwater from the GWTP, which includes approximately 90 gpm from the GW-11 pond, is pumped to two 150,000 gallon tanks (BT-40 and -45 in series), then to the equalization tanks where it is combined with water from the off-site recovery systems. From the equalization tanks, most of the blended water flows through activated carbon beds before being filtered and pumped to the Fluidized Bed Reactors (FBRs) for treatment to destroy perchlorate, chlorate, and nitrate. A small portion of the blended GWTP flow (1 to 3 gpm) is not pumped to the FBRs but instead is returned to the GW-11 pond in order to avoid running the underflow pump dry.

As shown in Table 4, since July 2010 the average total chromium inflow concentration from the Interceptor wells to the GWTP is holding fairly steady in a range of 10.6 to 11.5 mg/L, which is down from the range of 11.8 to 13.1 mg/L one year ago. The reduction of hexavalent chromium by the GWTP has been consistently effective during the reporting period. Total chromium outflow concentrations for the last six months ranged from 0.134 to 0.256 mg/L – well below the required level established in the 1986 Consent Order, 1.7 mg/L. The hexavalent chromium outflow concentration during the reporting period ranged from <0.033 to 0.010 mg/L – well below the required level established in the 1986 Consent Order of 0.05 mg/L. For the period between July 2010 and December 2010 about 1,720 pounds of chromium have been removed from the groundwater.

Results of total chromium analyses from weekly FBR influent and effluent samples are presented in Table 5. These data, collected between July 2010 and December 2010, show that the FBR's influent total chromium concentrations varied from <0.00044 to 0.6 mg/L. Based on an average concentration of about 0.091 mg/L total chromium and an average flow rate of 930 gpm, the FBRs were receiving about 1.01 pounds of chromium per day from the equalization tanks. This includes chromium collected by AWF wells and treated with a ferrous sulfate drip. Treated water from the FBRs discharges to Las Vegas Wash (under authority of NPDES Permit NV0023060) just upgradient of the Pabco Road erosion control structure. Analyses of this water taken between July 2010 and December 2010 appear in Table 5 and show that all hexavalent chromium analyses have been non-detect at <0.000033 mg/L and that total chromium analyses have ranged from non-detect at <0.00044 to 0.023 mg/L, averaging 0.010 mg/L. At an influent concentration of about 1.0 pounds per day, the FBR system removed approximately an additional 166 pounds of chromium over the six-month period.

The sum of the chromium removed from the groundwater between July 2010 and December 2010 by the chromium recovery and treatment system and by the FBRs is approximately 1,886 pounds.

4.0 PERCHLORATE RECOVERY PROGRAM

The four components of the perchlorate recovery system, consisting of the IWF and barrier wall, AWF, SWF, and the Seep surface-flow capture sump, are shown on Figure 1. Figure 8, *Perchlorate Removed from the Environment July to December 2010*, shows the July - December 2010 monthly perchlorate recovery totals and the relative significance of each of the four components, whereas Table 6 shows the average pounds of perchlorate per day removed by each component. In the second half of 2010, a total of about 278,667 pounds of perchlorate (about 1,514 pounds per day) have been removed from the groundwater with the overall system. Of this total, about 149,552 pounds (813 pounds per day) came from the on-site IWF, about 120,731 pounds (656 pounds per day) came from the AWF, and about 8,384 pounds (46 pounds per day) came from the SWF. No perchlorate was removed by the Seep surface-flow capture sump, as the surface stream there is currently dry (as it has been for several years) and the sump pump is therefore not operating. For the entire 2010 calendar year, a total of about 582,931 pounds of perchlorate were captured, removed, and destroyed in the biological treatment system.

4.1 Perchlorate Plume

Appendix A contains the results of the last five quarters of groundwater elevation and analytical sampling data. Based on November 2010 perchlorate results, the highest concentration south of the Interceptor well field occurred in extraction well I-AR (2,400 mg/L; see Figure 1 for well location); north of the IWF the highest concentration measured was in well M-72 (1,000 mg/L), located directly north of the barrier wall; north of the recharge trenches the highest perchlorate concentration found was 550 mg/L in well M-44 between Warm Springs Road and Boulder Highway; north of the AWF the highest concentration was in well MW-K4 (220 mg/L) just north of the well field.

4.1.1 Interceptor Well Field Area

There are two sub-lobes of the perchlorate plume that impact the IWF; a western sub-lobe centered on wells I-R and I-L, and a wider eastern sub-lobe located east of well I-E. The eastern sub-lobe is associated with high TDS concentrations. High TDS concentrations are not associated with the western sub-lobe, which appears to have a separate source thought to be due to past piping leaks. Extraction well I-AR is located upgradient of the IWF near the source area of the western sub-lobe.

Figure 9, the *Interceptor Well Field Perchlorate Section Graph*, shows the perchlorate concentrations for the Interceptor wells for the last five quarters compared to concentrations measured in May 2002. The most recent quarterly data from November 2010 show that the perchlorate concentrations in many of the Interceptor wells are significantly lower than in May 2002, particularly in the highest concentration areas (approximately centered on extraction wells I-R and I-U) and on the edges of the western sub-lobe.

Figures 10 and 10A, the *Interceptor Well Field Perchlorate Trend Graphs*, show the historical concentration trends for the IWF extraction wells from 2002 through the December 2010. Like Figure 9, the graph shows an overall decline in perchlorate concentrations for wells located in the center of the plume, with lower concentrations measured in wells along the edge of the plume, particularly on the eastern sub-lobe, remaining relatively stable.

Since high perchlorate concentrations at the Site are often associated with high total dissolved solids (TDS) concentrations, a TDS section graph was constructed across the well field. Figure 11, the *Interceptor Well Field Total Dissolved Solids Section Graph*, shows that the broad zone of high TDS in the central part of the well field continues in the most recent sampling, concomitant with the eastern perchlorate sub-lobe. As noted above and shown on the figure, high perchlorate concentrations in the western sub-lobe of the plume are not associated with high TDS.

Figure 12 shows the monthly average perchlorate concentration from the IWF plotted against the calculated mass of perchlorate removed by the well field. As shown on the Figure, the monthly average perchlorate concentration has steadily decreased, with short-lived minor reversals, from 1,890 mg/L in October 2002 to 872 mg/L in December 2010, the lowest recorded concentration. As expected, the calculated perchlorate mass removal has followed a similar trend. An upward trend in mass removal calculations between 2008 and early 2010 is due to increasing pumping rates at the IWF over that time, leading to the capture and removal of additional perchlorate despite stagnant or decreasing concentrations.

Figure 13 plots perchlorate concentration and water level trends in monitoring well M-100, located approximately 700 feet north of the former recharge trenches. The Figure shows a sharp decrease in perchlorate concentrations beginning in early 2002, shortly after the barrier wall was installed at the IWF. Water level trends reflect infiltration and mounding of water recharged to the subsurface through the former recharge trenches. Clogging of the trenches and reduced infiltration are reflected in the decreasing water levels beginning about May 2007. The trenches were subsequently refurbished and again fully operational beginning in July 2009, with water levels in M-100 quickly rebounding. As shown on Figure 13, perchlorate concentrations in well M-100 remained relatively stable over the period of time with reduced recharge. Due to conflicts with excavation and remediation of chemically-impacted soil at the Site, recharge to the trenches was again suspended in mid-September, 2010. The recharge trenches are not currently operational. Water levels in M-100 showed a slight decreasing trend in the fourth quarter of 2010, and are expected to further decrease in 2011 with the cessation of recharge.

4.1.2 Athens Road Well Field Area

4.1.2.1 Athens Road Well Field

Historic perchlorate concentrations for the ART-series wells are shown in Figures 14 and 14A, the *Athens Road Perchlorate Concentration Trend Graphs*. Figure 14 consists of concentration-time plots for the AWF extraction wells from the start of continuous operation in 2002. Figure 14A, an expanded view of the last five quarters of Figure 14, shows that recent perchlorate concentrations in the AWF wells have remained stable with the exception of ART-6. ART-6 fluctuated between 76 mg/L and 380 mg/L over that time, continuing a trend that began in 2007. The highest concentration during the reporting period was 400 mg/L, measured in well ART-4 in September 2010.

Figure 15, the *Athens Road Well Field Perchlorate Section Graph*, an east-west section graph through the well field, presents quarterly monitoring data from extraction and monitoring wells over the past year in comparison to monitoring results from May 2002. As shown on the Figure, the plume is stable with data from November 2010 at or near the lowest concentrations measured for the year, and perchlorate concentrations on the western (PC-55 and ART-1) and eastern (PC-122) edges of the well field continue to remain low. Concentrations in the western paleochannel (PC-55 through ART-4) are generally lower than those measured in 2002, while concentrations in the eastern paleochannel (ART-6 through PC-122) appear higher although wells ART-9 and PC-122 did not exist in 2002 and there is limited data for comparison.

Figure 16, *Athens Road Well Field Perchlorate Concentration in ART-8 and Mass Removed,* compares the mass removed from the well field to the measured concentration in well ART-8. There are no significant changes to either over the reporting period.

Starting in August 2006, TDS data have been collected from the AWF wells. Figure 17, the *Athens Road Well Field Total Dissolved Solids Section Graph*, shows that TDS concentrations over the last five quarters have remained relatively stable in all wells, with concentrations measured in November 2010 at or near the lowest concentrations measured over the past 5 quarters. The exception is monitoring well PC-55 on the western edge of the AWF, which contains the lowest perchlorate concentration of all the AWF wells. The TDS in this well appears to be related to a high-TDS plume located west of the Site.

4.1.2.2 Athens Road Piezometer Well Line

About 250 feet north of the AWF, seven ARP-series wells and one MW-K-series well make up the Athens Road piezometer well line. The perchlorate concentrations of these wells are shown on Figures 18 and 18A, the *Athens Road Piezometer Wells Perchlorate Concentration Trend Graphs*. Figure 18 contains concentration-time plots beginning in late 2001, and Figure 18A shows an expanded view of the last five quarters. Former wells ARP-2 and ARP-3, which were buried/destroyed by construction activity north of the AWF in 2008, were replaced with wells ARP-2A and ARP-3A, located slightly north of the former locations and have been sampled monthly with the rest of the well line beginning in July 2010. With the exception of well MW-K4, concentration trends in the piezometer well line are gently decreasing or relatively flat. Concentrations in MW-K4 rose sharply from 57.8 mg/L to 300 mg/L between May 2008 and December 2009, indicating that some portion of the perchlorate plume was evading capture by the AWF. Over the past 12 months, the well has exhibited a gradual downward trend, with a concentration of 230 mg/L measured in December 2010. Concentrations in wells ARP-2A and ARP-3A, to the west of MW-K4, remain low and are consistent with concentrations measured previously in wells ARP-2 and ARP-3.

Figure 19, the *Athens Road Piezometer Well Line Perchlorate Concentration Section Graph,* an east-west section graph across the piezometer line, shows consistent perchlorate concentrations in all wells and a sharp decline since May 2002, with the exception of MW-K4.

4.1.2.3 City of Henderson WRF and Lower Ponds Well Lines

Intermediate between the AWF and the SWF are the City of Henderson Water Reclamation Facility (COH WRF) and the Lower Ponds monitoring well lines. Figures 20 and 20A, the *City of Henderson WRF Well Line Perchlorate Concentration Trend Graphs,* show the perchlorate concentrations in the COH WRF wells from January 2001 to December 2010. Figure 21 presents the COH WRF well line section graph. As shown on the Figures, concentrations in wells PC-98R and MW-K5 are somewhat erratic, but the overall concentration trends in the wells have been relatively flat since 2007 and are significantly lower than May 2002 in the center of the plume. Downward spikes in well concentrations may be related to COH WRF surface water infiltration. Figure 22, the *PC-98R Perchlorate vs. Water Elevation Trend Graph,* demonstrates that many of the low-concentration events are associated with a rapid increase in the water level in the well, inferred to be the result of increased infiltration from the COH WRF surface ponds.

The Lower Ponds well line is 2,200 feet north of the COH WRF well line. Figures 23 and 23A, the *Lower Ponds Well Line Perchlorate Concentrations Trend Graphs*, show that perchlorate concentrations have not shown much variation since about February 2004 and concentration trends continue to remain flat or decrease slightly. The last five quarters of data shown on Figure 23A show that the perchlorate concentration in well PC-56 spiked to 16 mg/L in November 2010, but was only 4.5 mg/L in December 2010. Concentrations in PC-56 historically are more variable than other wells on the Lower Ponds line. Figure 24, the *Lower Ponds Well Line Perchlorate Concentration Section Graph*, shows a comparison of the last five quarters of monitoring results with May 2002. The graph shows that concentrations in the wells are stable, with the exception of the brief spike in well PC-56, and are significantly reduced from the 2002 concentrations.

4.1.3 Seep Well Field Area

Figures 25 and 25A, the *Seep Well Field Perchlorate Concentration Trend Graphs,* show perchlorate concentrations in the SWF extraction wells between July 2001 and December 2010. As shown on the Figure, recent concentration trends in SWF wells are stable or slightly increasing. Concentrations in nearly all wells decreased in December 2010 from the previous month, and concentrations measured in wells PC-99R2/R3, PC-115R, and PC-116R were the lowest recorded for the last five quarters of monitoring. The highest concentration measured over the reporting period was 14 mg/L in well PC-99R2/R3 during the September 2010 monitoring event. Figure 26, the *Seep Well Field Perchlorate Section Graph*, shows that perchlorate concentrations have been stable over the past five quarters, and are over 90% lower than concentrations measured in the same wells in May 2002. Figure 27 is the *Seep Well Field Total Dissolved Solids Section* Graph. TDS concentrations in the SWF wells are also stable over the same period, and appear to be associated with the perchlorate plume.

Figure 28 shows the monthly average perchlorate concentration from the SWF plotted along with the calculated mass of perchlorate removed by the well field. In December 2010, the SWF removed 1,306 pounds of perchlorate at an average groundwater concentration of 6.8 mg/L.

4.2 On-Site Perchlorate Groundwater Treatment System and Remediation

Throughout the reporting period, groundwater was collected and treated in both the Groundwater Treatment Plant (GWTP; for on-site water containing hexavalent chromium) and the biological treatment plant (onsite, Athens Road and Seep Area collection systems, to remove nitrate, chlorate and perchlorate). Effluent from the biological treatment process was discharged into Las Vegas Wash and stayed within the limits specified in the NPDES NV0023060 discharge permit. Routine maintenance is completed as needed at the GWTP and FBRs.

Transfers of perchlorate from the AP-5 pond continued throughout the period. A total of 1,325 tons of perchlorate have been removed from AP-5, which exceeds the original estimate of about 1000 tons. Under terms of the 2005 AOC between Tronox, LLC and NDEP, the remaining contents of the AP-5 pond must be removed by August of 2011. The pond will then be decommissioned.

Perchlorate analytical results for the biological treatment process influent and effluent samples are presented in Table 7. For the reporting period of July through December 2010, Perchlorate concentrations in the FBR influent ranged from 120 to 200 mg/L. Perchlorate was not detected at concentrations exceeding the laboratory sample quantitation limit (SQL) in effluent discharged to Las Vegas Wash.

5.0 CONCLUSIONS

For the six-month period ending in December 2010, using the concentration data and extraction rates presented in Table 4, the chromium recovery and treatment system captured and removed approximately 1,720 pounds of chromium, or 9.3 pounds per day. In addition, approximately 166 pounds were removed by the FBRs over the six month period, for a total of 1,886 pounds of chromium captured and removed from the groundwater between July 2010 and December 2010. Chromium concentrations at the tail of the highest concentration area of the plume, upgradient of the IWF and barrier wall, continue a gradual decline. Capture and treatment of chromium at the IWF and AWF has been effective at reducing total chromium concentrations in groundwater to non-detectable concentrations or below drinking water standards prior to entering the wash.

Perchlorate continues to be captured by the four components of the remediation program: the IWF and barrier wall, AWF, SWF, and seep surface capture sump and pumping station. The seep surface stream has not flowed since 2007 and is not currently active. The remaining three well fields combined to extract groundwater containing perchlorate, which is destroyed at the on-Site FBRs. For the six-month period ending in December 2010, approximately 278,667 pounds of perchlorate were captured and destroyed by the FBRs.

As an ultimate measure of the effectiveness of the combined systems over the last ten years, it is worth noting the decrease in perchlorate loading in Las Vegas Wash since 1999. The perchlorate loading to the wash from all sources was 1,104 pounds/day in May 1999 compared to 68 pounds/day in October 2010. This represents a 93.8% drop in perchlorate loading to the wash over that period of time. A recent capture evaluation performed for the Site by Northgate (Northgate, 2010) estimated that the IWF is successful at removing more than 95% of the perchlorate mass flux reaching the IWF, and the combined AWF and SWF systems capture between 94% and 97% of the perchlorate flux reaching the AWF.

6.0 PROPOSED FUTURE ACTIVITIES

The Trust will continue to monitor the groundwater extraction and treatment system operating at the Site and prepare reports in accordance with the Consent order and AOC, as well as the requirements of regulatory permits governing the groundwater remediation effort.

The plumbing and connection of seven additional extraction wells has nearly been completed at the IWF. Completion of the work and initiation of pumping at these wells will further increase the capture and removal of perchlorate and chromium from groundwater at the well field. In addition, it will be determined if additional wells installed at the AWF should be connected and pumped to increase capture at that well field.

Finally, the current quarterly groundwater monitoring program no longer serves the intended purposes of the original monitoring program or is collected at a frequency that does not demonstrate changes or trends that are relevant to the program data objectives. A ten-year record of quarterly sampling results for perchlorate, and longer for chromium, has resulted in a robust enough data set to understand groundwater conditions. Concentration trends in many of the wells have stabilized and show only small incremental changes between monitoring events. Combined with the groundwater model recently developed for the Site, we believe that a reduced monitoring program focused on critical performance wells with less frequent large-scale sampling events would be appropriate for monitoring the effectiveness of the groundwater remedial efforts, and would allow resources to be more cost effectively utilized at the Site. It should be noted that some changes in the monitoring program may require modifications to the AOCs governing the groundwater remediation and groundwater programs.