Attachments

Attachment 1

Previous Five-Year Review Recommendations

Previous Five-Year Review Recommendations Iron Mountain Mine Five-Year Review

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This memorandum reviews the status of recommendations and issues provided in the U.S. Environmental Protection Agency (EPA) September 2003 *Third Five-Year Review Report for Iron Mountain Mine* (IMM) *Superfund Site, Redding, California* (IMM Third Five-Year Review) (EPA, 2003).

Achieving Chronic Copper Standards in the Sacramento River

The IMM Third Five-year Review (EPA, 2003) described an issue and provided recommendations regarding compliance with copper water quality standards within the Sacramento River. The issue and recommendations are repeated below, followed by a description of the status.

Issue: The Contribution of the Upstream Water Copper Concentration

The IMM Third Five-Year Review (EPA, 2003) identified the following issue:

> California Toxics Rule promulgated a standard of 4.1 ppb dissolved copper as a 96-hour chronic average standard to be met at the Sacramento River below Keswick Dam. The upgradient water from Shasta Dam has a dissolved copper content of under 1 ppb to 4 ppb. This upgradient water quality will make the water management component of the selected remedy difficult to achieve.

Recommendation: Exceedances of the Chronic Copper Standard at Keswick

The IMM Third Five-Year Review (EPA, 2003) provided the following recommendations in response to the issue presented above:

> After the remedy is implemented at Slickrock Creek, the water quality leaving the site will improve. This improved quality may be enough to meet protective water quality standards and to overcome the water management difficulties at Spring Creek Debris dam due, in part, to the upgradient quality of the Shasta Dam water and current Shasta Dam operations. EPA should obtain surface water quality data that is necessary to characterize the performance of the remedy once the Slickrock Creek Retention Dam is completed.

EPA should also continue to work with the Central Valley Regional Water Quality Control Board (Water Board) and the Bureau of Reclamation (Reclamation) to obtain additional data to characterize the sources and locations of metal concentrations in Shasta Lake and to evaluate operational options that could manage the metal discharges from Shasta Dam. The Water Board expects to continue to work with the Mining Remedial Recovery Company to reduce the metal discharges from several mines in the West Shasta Mining District. EPA should monitor the progress of this work.

The Records of Decision (ROD) anticipated an uncontrolled release from the site once in approximately every 30 years while meeting the instantaneous maximum copper standard in the Sacramento River. EPA should rely on the data obtained after the remedy at Slickrock Creek is operational to perform an analysis to estimate the frequency of an uncontrolled release under operations to meet both an instantaneous maximum standard and a 96-hour average chronic standard. The impact on the fishery resource in the Sacramento River from the uncontrolled releases should be discussed among the regulatory stakeholders at Iron Mountain Mine – U.S. EPA, the State of California, the Department of Fish & Game, the National Oceanic and Atmospheric Administration, the Fish and Wildlife Service and the Bureau of Reclamation. Based upon these discussions, a new Memorandum of Understanding should be developed to resolve the problem of heavy metal loading from Shasta Dam and the water management efficiency of Spring Creek Debris Dam. It is estimated that two to three years of wet season data will be needed after the 1997 ROD remedy becomes operational before the exceedance issue can be fully addressed.

Status: Exceedances of the Chronic Copper Standard in Keswick Reservoir

In the IMM Third Five-Year Review (EPA, 2003), EPA identified that upgradient Shasta Lake water quality could negatively impact the water management component of the IMM remedy. This issue is still outstanding. EPA has implemented recommendations identified in the IMM Third Five-Year Review, including collection of additional surface water quality data. However, additional action is required as discussed in this section. Attachment 4 "Site Evaluation and Compliance at Keswick Dam" of the IMM Fourth Five-Year Review (CH2M HILL, 2008a) provides an evaluation of surface water quality data collected by EPA during the fourth five-year review period to determine the effectiveness of the IMM remedial actions and to compare current loads from IMM and Shasta Lake to the Sacramento River.

The Record of Decision 4 (ROD 4) (EPA, 1997) Slickrock Creek Retention Reservoir (SCRR) remedy was determined by EPA and the state of California to be operational and functional on August 26, 2004 (CH2M HILL, 2004a). Since completion of SCRR, EPA has continued to obtain surface water quality data necessary to characterize the performance of the IMM remedy. EPA has collected weekly surface water quality data during the 2005, 2006, 2007, and 2008 water year wet seasons at locations in Boulder Creek and Slickrock Creek drainages; influent and effluent from the high-density sludge treatment plant at the Iron Mountain Mine (IMM) Superfund Site; and locations downgradient from IMM, including Spring Creek and Sacramento River below Keswick Dam. The Site Operator, Iron Mountain

Operations (IMO), collects and analyzes samples at various onsite locations to ensure that components of the IMM remedy are functioning in accordance with the requirements of the October 2000 *Statement of Work* (SOW), *Site Operations and Maintenance, Iron Mountain Mine, Shasta County, California* (EPA, 2000). Attachment 3 "Minnesota Flats Treatment Effluent Discharge" (CH2M HILL, 2008b) and Attachment 4 "Site Evaluation and Compliance at Keswick Dam" of the IMM Fourth Five-Year Review (CH2M HILL, 2008a) provide evaluations of these data. Data obtained since completion of the SCRR remedy in 2004 should be used as part of the Operable Unit 6 (OU-6) remedial investigation (RI), feasibility study (FS), and ROD for IMM to estimate the frequency of an uncontrolled release under operations to meet both an instantaneous maximum standard and a 96-hour average chronic standard.

EPA, the Water Board, and Reclamation have obtained data to characterize the sources and locations of metal concentrations in Shasta Lake and to evaluate operational options that could manage the metal discharges from Shasta Dam. EPA has also collected surface water quality data to monitor the progress of remediation of mines within the West Shasta Mining District. EPA has performed discharge measurements and water quality sampling in the West Squaw and Little Backbone Creek drainages during the 2006, 2007, and 2008 water year wet seasons (CGI Technical Services, Inc. [CGI], 2008). The Water Board has collected depth-discrete samples and water quality parameter readings in and near Shasta Lake during multiple events, including June 2002, October 2002, and January 2003 (Water Board, 2003). Reclamation's Northern California Area Office has collected water quality data in the Sacramento River below Shasta and Keswick Dams and in Spring Creek below Spring Creek Debris Dam (SCDD) and operational data for facilities, including Shasta Dam, Keswick Dam, and SCDD.

EPA and CH2M HILL prepared the *Shasta Lake Copper Input Loads Data Evaluation Report* (CH2M HILL, 2008c), which presents the data collected in West Squaw Creek, Little Backbone Creek, Sacramento River below Shasta Dam, Sacramento River below Keswick Dam, and Spring Creek below SCDD. The data will be used to develop the OU-6 RI/FS and ROD and potential revision of the 1980 memorandum of understanding for operation of SCDD. The report also provides an evaluation of data presented in the *Use Attainability Analysis for Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for Beneficial Uses at West Squaw Creek* (UAA), prepared by the Central Valley Regional Water Quality Control Board (Water Board, 2004). A discussion of outstanding issues related to Shasta Lake water quality is provided in Attachment 4 "Site Evaluation and Compliance at Keswick Dam" of the IMM Fourth Five-Year Review (CH2M HILL, 2008a).

EPA met with the Water Board and the State Water Resources Control Board on February 26, 2008, regarding the UAA and copper input loads to the Sacramento River. EPA also met with the U.S. Forest Service, Reclamation, CGI, and National Oceanic and Atmospheric Administration on April 8, 2008, regarding EPA's IMM Superfund Site remedy, mine remediation in the West Squaw Creek watershed, and operations of the Central Valley Project. Additional discussions will be necessary among the regulatory stakeholders at IMM regarding the impact on the fishery resource in the Sacramento River from ongoing IMM and Shasta Lake metal releases. Based upon these discussions, a new

memorandum of understanding should be developed to resolve the problem of heavy metal loading from Shasta Dam and the water management efficiency of SCDD.

Site Maintenance Issues

The IMM Third Five-year Review (EPA, 2003) concluded that the IMM site was generally well-maintained, but there were a few items that would need to be addressed to improve the operation of the site. The general issue and recommendations are repeated below, followed by the status of each specific site maintenance issue identified during the Third Five-year Review inspection.

Issue: Miscellaneous Site Maintenance Issues

The IMM Third Five-Year Review (EPA, 2003) identified the following issue:

> CH2M Hill identified minor items to be repaired at the site. In general, the treatment plant and related facilities are properly operated and maintained with no major issues.

Recommendation: Miscellaneous Site Maintenance Issues

The IMM Third Five-Year Review (EPA, 2003) provided the following general recommendation in response to the issue presented above:

> EPA should provide the list of maintenance issues to the Site Operator and develop a time frame for the work to be completed. The site maintenance items should be completed prior to the start of the wet season. EPA should continue the O&M oversight program and provide annual inspections and a follow-up program to ensure the recommendations are completed satisfactorily.

Status of Specific Site Maintenance Issues

The status of site maintenance recommendations and issues identified during the IMM Third Five-Year Review was obtained from a meeting between CH2M HILL and IMO on March 27, 2008 (Carver, 2008); CH2M HILL's April 3, 2008, IMM sitewide inspection; the March 2008 *Churn Creek Construction Co. Inc., Iron Mountain Job List – Per Wes Franks* (2008 Maintenance List) provided by IMO; conclusions from other site inspections performed during the IMM Fourth Five-Year Review period; and a meeting with CH2M HILL, IMO, and AIG Consultants, Inc. (AIG) on April 25, 2008. Observations and recommendations from IMM inspections are provided in Attachment 5 (CH2M HILL, 2008d) and Attachment 6 (CH2M HILL, 2008e) of the IMM Fourth Five-Year Review.

1. **Recommendation:** Continue follow-up with Shasta County for the repair of Iron Mountain Road between Flat Creek bridge and the entrance gate.

   IMO Response: Shasta County repaired potholes along Iron Mountain Road 2 years ago (Carver, 2008).

   Status: The road is currently in good condition, and no current issues have been identified.

2. **Recommendation:** Seal the pavement cracks (alligatoring) occurring along and on the plant road between the entrance gate to a location below Drying Bed 4. This is planned to occur after the sludge haul.

   IMO Response: IMO has performed crack sealing and partial pavement sealing as appropriate during the IMM Fourth Five-Year Review period (Carver, 2008).

   Status: This is a routine maintenance item. IMO performs ongoing maintenance of the IMM roads in accordance with the requirements of the SOW. The SOW requires that Iron Mountain Road from the property boundary to the Emergency Storage Tank be maintained for access for highway and two-wheel-drive vehicles, remained paved, and have "Full Maintenance" (EPA, 2000). Road maintenance is included on the 2008 Maintenance List.

3. **Recommendation:** Fill the gullying that is occurring on the uphill slopes of Drying Beds 1 and 2 and on the downslopes of sludge Drying Beds 3 and 4 and seed the bare areas. Improve the drainage in these areas to reduce the reoccurrence of the gullying.

   IMO Response: During the April 3, 2008, site inspection, Wes Franks/IMO stated that he regularly monitors this area, and the gullying has not increased over the last 5 to 6 years (CH2M HILL, 2008e).

   Status: Gullying continues to occur on the sludge drying bed bank below Drying Bed 4. Most of the gullying appears to be minor, but some gullies are deeper. Gullying on the sludge drying bed bank below sludge Drying Bed 4 should continue to be monitored, and if gullying worsens, drainage should be redirected or the area should be vegetated.

4. **Recommendation:** Complete the removal of the scale material in the acid mine drainage (AMD) conveyance pipelines.

   IMO Response: Brown's Plumbing used equipment to mechanically remove scale from the AMD pipelines before SCRR went into service (Carver, 2008).

   Status: As discussed in Attachment 6 of the IMM Fourth Five-Year Review (CH2M HILL, 2008e), IMO should make certain that AMD pipeline inspections and capacity estimates are being performed annually in accordance with the SOW and are certified in an annual letter to EPA.

5. **Recommendation:** Review the temporary drainage plan for the clean water diversion from the upper Slick Rock Creek basin. Provide temporary diversions to avoid damage to the access road and downstream construction particularly if the construction is not complete prior to the rainy season.

   IMO Response: The ROD 4 SCRR remedy, including the clean water diversion, was completed in 2004 (CH2M HILL, 2004a).

   Status: The recommendation was fully addressed.

6. **Recommendation:** Review the temporary drainage plans around the borrow and storage sites (near Road Markers 12 and 18) along Iron Mountain Road. Clean culverts and construct drainage ditches.

IMO Response: The area surrounding Road Marker 12 was used as a decomposed granite borrow area, and the area around Road Marker 18 was used for storage of earth fill, rocks, and decomposed granite, as part of the SCRR construction project. The SCRR construction project was completed in 2004 (CH2M HILL, 2004a). IMO cleans drainage control structures and ditches annually (Carver, 2008).

Status: The recommendation was fully addressed.

7. **Recommendation:** Complete the Boulder Creek tailings dam protection project.

   IMO Response: Improvements to the Boulder Creek tailings dam were completed in 2004, as documented in the *Final Construction Report for Spillway Improvements at the Boulder Creek Tailings Area* (TRC, 2005). The earthwork construction was implemented during January and February 2004, and the concrete and shotcrete construction was implemented during September 2004.

   Status: The recommendation was fully addressed.

8. **Recommendation:** Continue the study and demonstration of alternative repair materials for lining the Spring Creek diversion pipeline.

   IMO Response: In the Proposed Scope of Work and Contract Award for *Spring Creek Diversion RCCP Pipe Inspection and Repair Project* (IMO, 2003a, 2003b), IMO proposed and has implemented a pipeline inspection and repair program. The program includes annual inspection of the pipeline, preparation of a pipeline inspection report for EPA review, evaluating and selecting the appropriate pipeline repair methods and materials, and implementing the repairs with appropriate quality assurance and quality control inspection and documentation (IMO, 2003b). Studies and evaluations performed by the Site Operator have indicated that it would be costly and technically challenging to restore or replace the pipeline liner system. For these reasons, the comprehensive liner repair program, as described in the SOW, has not been conducted. IMO is continuing the annual pipeline inspection and pipeline repair process to maintain the structural integrity of the pipeline.

   Status: The Upper Spring Creek Diversion Pipeline lining continues to deteriorate with use, and as the lining is removed, the underlying concrete erodes (IMO, 2008a). The 2007 inspection report for the Upper Spring Creek Clean Water Diversion concluded that the extent and depth of erosion is not a structural concern at this time, however, the eroded concrete and liner should be monitored on an annual basis (IMO, 2008a). IMO, in consultation with their materials expert, should develop a work plan for review by EPA that details the long-term inspection and repair approach to mitigate future deterioration and maintain the pipeline to meet the requirements of the SOW. Attachment 6 of the IMM Fourth Five-Year Review (CH2M HILL, 2008e) provided considerations for improvements to the existing inspection and repair program.

9. **Recommendation:** Complete the scour protection on the Spring Creek Diversion impact structure.

   IMO Response: The Upper Spring Creek Diversion impact structure was covered with stainless steel during the 2004 maintenance inspection (IMO, 2008a).

Status: No issues with the Upper Spring Creek Diversion impact structure were noticed during the April 3, 2008, inspection. Stainless steel plates on the impact structure appeared to be in good condition.

10. **Recommendation:** Consider installing the remaining horizontal drains in the Boulder Creek slide area.

    IMO Response: IMO has implemented additional measures since the IMM Third Five-Year Review to address the continued displacement of the Boulder Creek landslide, and the landslide effects on the Lawson Mine (CH2M HILL, 2008e; IMO, 2008a). Settlement monuments (21 total) are surveyed by Pace Civil, Inc., to determine surface movements within the slope failure complex. The SOW requires annual surveys of settlement monuments, or more frequent surveys of the landslide area if movement of the landslide is observed. The most recent survey was performed on September 27, 2007. The data are reported annually in the *Boulder Creek Landslide Survey Data Report* (IMO, 2008a). The Mines Group, Inc., evaluates the data annually in the *Boulder Creek Landslide Annual Inspection and Evaluation* (2007).

    Status: The effectiveness of recent drainage improvements at the Boulder Creek landslide area should continue to be monitored, and further control measures should be considered and implemented, as necessary, to help control future displacement of the landslide (CH2M HILL, 2008e).

11. **Recommendation:** Replace the exposed polyvinyl chloride (PVC) pipe at the ends of the horizontal drains with ultraviolet (UV)-resistant piping.

    IMO Response: The exposed PVC portions of the horizontal drain pipe have not been replaced.

    Status: Attachment 6 of the IMM Fourth Five-Year Review recommends that these portions of the horizontal drains on top of and surrounding the Boulder Creek landslide be covered with a UV-resistant coating or replaced with UV-resistant piping (CH2M HILL, 2008e).

12. **Recommendation:** Determine the contents of the fluid in the chemical storage tanks across the road from the cementation plant and provide proper containment if required or properly dispose of the contents.

    IMO Response: The tanks, equipment, and drums in this area are the property of Mr. T. W. Arman, Iron Mountain Mines, Inc. IMO discussed the contents of the tanks with Mr. Arman. The tanks were stated to contain AMD, sodium silicate, and Mr. Arman's Ag-Gel fertilizer product (Carver, 2008).

    Status: EPA will contact Mr. Arman to request that Iron Mountain Mines, Inc. provide proper containment for the tanks or properly dispose of the contents. Three 6,500-gallon poly tanks are located adjacent to the east side of the metal shed that is across the road from the cementation plant. These tanks contained approximately 8,600 gallons of fluid during the April 3, 2008, inspection. An additional poly tank of similar volume is located within the metal shed, with equipment. Many 55-gallon plastic drums are stored on the north side of the metal shed, and most appeared to be empty during the April 3, 2008, site inspection. There is no secondary containment for any of the tanks or drums.

Precipitates had formed on the pipe connection for the middle poly tank located outside of the metal shed, indicating a leak. Sand between the poly tanks and the shed was wet, but fluid was not visibly leaking from the tanks during the inspection (CH2M HILL, 2008e).

13. **Recommendation:** Remove sediments above the Boulder Creek sampling station and above the Upper Spring Creek diversion. These are routine planned activities.

    IMO Response: This is a routine maintenance item. Sediment that accumulated behind the weir at Boulder Creek sampling location (BCMO) was dredged in mid-March 2008, and additional cleanout is scheduled for fall 2008. IMO's 2008 Maintenance List includes removal of sediment and gravel that has accumulated in the sedimentation basins upstream from the Upper Spring Creek diversion intake and the SCRR clean water diversion intake.

    Status: Sediment and gravel that has accumulated in the sedimentation basins upstream from the Upper Spring Creek diversion intake and SCRR clean water diversion intake should be removed routinely to insure capacity at all times of the diversion structures and clean water diversion (CH2M HILL, 2008e). These items are required under Sections 9.14.6, 9.10.2.2, and 9.10.4.2 of the SOW, respectively.

Treatment Plant Audit Recommendations

The IMM Third Five-year Review (EPA, 2003) provided recommendations regarding the Minnesota Flats Treatment Plant (MFTP), using conclusions from the Attachments *Minnesota Flats Treatment Plant Audit* and *Minnesota Flats Treatment Plant Effluent Discharge* (EPA, 2003). The general issue and recommendations are repeated below, followed by a description of the status of each specific treatment plant recommendation.

Issue: Treatment Plant Audit

The IMM Third Five-Year Review (EPA, 2003) identified the following issue:

> CH2M Hill has been working with AIG Consultants, Inc. to investigate the reported water quality exceedances for dissolved copper and zinc from the treatment plant effluent. Our review indicates that the Site Operator is properly operating the treatment plant, that the treatment plant effluent is meeting the discharge requirements for dissolved copper, and that further study is required to assess whether the performance standard should be revised for dissolved zinc. Our review indicates that the analytical methodology being used by the Site Operator does not accurately measure the low dissolved copper concentrations in the treatment plant effluent. Our review also indicates that the methodology used by the Site Operator reports higher concentrations of zinc than other more accurate methodologies, but the discharges may not be able to meet the standard set by EPA. The investigation found that the zinc anodes may have been contributing to the high zinc discharges. EPA will continue its investigation of the zinc discharges to determine an appropriate response to the reported zinc water quality effluent exceedances from the treatment plant.

CH2M Hill also made recommendations in regards to updating the O&M manual, maintenance tracking program, and emergency response program.

Recommendations: Treatment Plant Audit

The IMM Third Five-Year Review (EPA, 2003) provided the following general recommendation in response to the issue presented above:

> EPA should continue to investigate the reasons and resolve in the near-term for the reported water quality exceedances from the treatment plant. Any recommendations from the investigation should be implemented and follow-up to ensure that the water quality standards leaving the treatment plant are met. The Site Operator will be directed to revise the analytical methodology used to monitor plant performance, as currently recommended. EPA should provide the list of documents that need updating to AIG Consultants, Inc. and develop a time frame for the work to be completed.

Status of Specific Treatment Plant Audit Recommendations

1. **Recommendation:** Update the O&M manual in anticipation of when the more dilute Slickrock Creek Retention Reservoir water is added to the current AMD for treatment. Update the O&M plan and the health and safety plan to reflect current operations and updated emergency contact information and procedures.

   Status: Onsite documents and records were verified as part of the IMM Fourth Five-Year Review, as documented in the *Site Inspection Checklist* (CH2M HILL, 2008d). IMO contracted SHN Consulting Engineers to update the health and safety plan and injury and illness prevention plan in September 2007 (SHN Consulting Engineers, 2007a and 2007b). IMO updated emergency contact information in the *Emergency Response Plan and Contingency Procedures, Iron Mountain Operations, Redding, Shasta County, California* in April 2008 (IMO, 2008b).

   CH2M HILL developed the *Operations and Maintenance Manual, Slickrock Creek Retention Reservoir Project* (CH2M HILL, 2004b).Operations at the MFTP have not changed substantially in response to the addition of SCRR inflows; therefore, IMO has not identified changes needed in the IMO O&M plan (IMO, 2001; Carver, 2008). After startup and shakedown testing, the following MFTP operational guidelines were recommended for periods of high inflow from the SCRR (CH2M HILL, 2005). These are consistent with requirements in the SCRR O&M Manual (CH2M HILL, 2004b):

   - SCRR inflow to the MFTP will be slowly ramped up during storm events by adjusting the SCRR intake gates and using the emergency holding tank.
   - The discharge from the SCRR will be limited to 3,000 gallons per minute (gpm) (plus 250 from the Old/No. 8 Mine), depending on water elevation within the reservoir, time of year, and forecasted weather.
   - Discharge of 4,000 gpm will be avoided, unless necessary for dam operation.

2. **Recommendation:** Create a readily accessible emergency response plan (e.g., Cardex or equivalent system) that provides concise instructions to operators on how to respond to

plant or other emergencies. This information is currently located in various sections of the O&M plan and other documents and is not readily accessible to operators during an emergency. The plan should be kept in the control room, and all plant personnel should be familiar with the contents of the plan.

Status: IMO has developed the *Emergency Response Plan and Contingency Procedures, Iron Mountain Operations, Redding, Shasta County, California* (IMO, 2008b). The 2000 SOW (EPA, 2000), IMO's O&M plan (IMO, 2001), and IMO's emergency response plan and contingency procedures (IMO, 2008b) specify procedures for emergency response and routine and non-routine O&M. IMO should look for opportunities to continue to improve their emergency preparedness, including annually updating the emergency response plan and contingency procedures, posting emergency contact numbers in a prominent location, and ensuring that IMO staff are familiar with emergency procedures (CH2M HILL, 2008e).

3. **Recommendation:** Install a computerized maintenance system that interfaces with the operations computer. This system would track run hours and maintenance completed on each piece of equipment. The system would also maintain a spare parts inventory. Implementing this type of system would decrease the facility's vulnerability to the loss of one or more personnel.

   Status: IMO is using Microsoft Excel spreadsheets to track MFTP maintenance and is evaluating other maintenance software that generate lists and schedules of maintenance items to complete (Carver, 2008). It is recommended that IMO and AIG continue to develop strategies to decrease the vulnerability to the loss of IMO personnel (CH2M HILL, 2008e).

4. **Recommendation:** Perform additional flow testing of the MFTP at a 6,500-gpm AMD influent rate to verify that the plant can process design flows after SCRR flows are added. The previous test routed AMD through both reactors to the thickener. An additional test should be conducted to route the flow from Reactor TK-1 to the thickener. The previous flow testing was conducted using very dilute AMD with the reactors at low solids content. Additional testing should be conducted for influent from the SCRR with the reactors at the operational solids content.

   Status: Startup and shakedown testing for SCRR was performed between March and June 2004 (CH2M HILL, 2004a). Guidelines to improve operations are presented in Specific Treatment Plant Audit Recommendation Number 1, and are consistent with the SCRR O&M Manual (CH2M HILL, 2004b). SCRR has been operated since 2004, and the MFTP has been in substantial compliance with Clean Water Act effluent limits for pH, total cadmium, total copper, total zinc, and total lead during the performance period (CH2M HILL, 2008b).

5. **Recommendation:** The IMO contract laboratory's methodology for analysis of dissolved metals and associated detection limits does not permit evaluation of compliance with best available technology (BAT) requirements. Modification of the IMO contract laboratory's methodology and detection limits should be considered.

   Status: IMO retained Basic Laboratories to provide analytical services under a revised subcontract agreement. Basic Laboratories implemented revised analytical procedures

on February 1, 2004, in accordance with its new subcontract with IMO. The data collected in 2004, after revised analytical procedures were implemented, showed marked improvement in IMO's ability to demonstrate compliance with the dissolved copper standards (CH2M HILL, 2004c). The laboratory reporting limits and method detection limits for dissolved copper and dissolved zinc were significantly improved with the new analytical methods. A comparison of IMO and EPA data for the treatment plant effluent collected since operation of SCRR is presented in Attachment 3 ("Minnesota Flats Treatment Plant Effluent Discharge") to the IMM Fourth Five-Year Review (CH2M HILL, 2008b).

6. **Recommendation:** The investigation suggests that the exceedances of the dissolved zinc standards may be, at least in part, attributable to the zinc anodes that were recently installed to provide cathodic protection for the thickener tank. Additional data are required to determine the impact of the removal of the zinc anodes on the quality of the plant effluent.

   Status: IMO replaced zinc anodes with aluminum anodes in summer 2006 (Carver, 2008).

7. **Recommendation:** EPA demonstrated that MFTP substantially complies with the daily BAT effluent limitations for dissolved cadmium and dissolved copper. The data do not demonstrate compliance with the BAT requirements for dissolved zinc. Following startup of the SCRR in January 2004, the data should be reevaluated to determine whether modification of the BAT requirements is warranted.

   Status: A meeting was held with AIG, EPA, IMO, and CH2M HILL on October 26, 2005, to discuss potential modifications to Section 14.2.3.2 of the SOW. Particularly, a reevaluation of the BAT performance standards was recommended for the high-density sludge treatment process based on actual treatment plant performance after the startup of the SCRR (CH2M HILL, 2005). An evaluation of MFTP data collected between 2004 and 2007 was performed as part of the IMM Fourth Five-Year Review and is documented in Attachment 3 (CH2M HILL, 2008b). This memorandum evaluates recent data and information pertaining to the effluent discharge concentrations and provides specific recommendations for changes to the BAT effluent limitations for the MFTP.

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Attachment 2
List of Documents Reviewed

List of Documents Reviewed
Iron Mountain Mine Five-Year Review

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The following documents were reviewed as part of the IMM Fourth Five-Year Review:

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Attachment 3

Minnesota Flats Treatment Plant Effluent Discharge

Minnesota Flats Treatment Plant Effluent Discharge Iron Mountain Mine Five-Year Review

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Introduction

This memorandum provides an evaluation of the operational performance of the Minnesota Flats Treatment Plant (MFTP) at Iron Mountain Mine (IMM) in meeting the Performance Standards for treatment plant effluent discharge. The evaluation focuses on the plant's performance in meeting the discharge limits contained in the IMM Scope of Work (SOW), dated October 2, 2000 (U.S. Environmental Protection Agency [EPA], 2000). This memorandum also provides recommendations for modifications to the technology-based effluent controls.

The SOW includes the requirements necessary to operate and maintain the selected CERCLA remedy at the IMM site. The IMM Remedy includes collecting, conveying, and treating acid mine drainage (AMD) from the Richmond Mine workings, the Lawson Mine workings, the Old/No. 8 Mine workings, and the disturbed portion of the Slickrock Creek watershed that is collected behind the Slickrock Creek Retention Reservoir (SCRR).

The IMM Remedy includes treatment of AMD by a high-density sludge (HDS) treatment process used at MFTP, and the long-term onsite storage of sludge generated from the treatment process. The data reviewed in this report were collected during the Fourth Five-Year Review performance period: August 1, 2003, through January 31, 2008. SCRR startup and shakedown testing occurred during this performance period.

Figure 1 presents the AMD flows treated at MFTP during the performance period. (Figures appear at the end of the document.) Approximately 4,500 acre-feet (1.5 billion gallons) of AMD were treated at MFTP during the Fourth Five-Year Review performance period. Figure 2 presents the approximate monthly copper and zinc loads removed by MFTP. Approximately 600,000 pounds of copper and 2 million pounds of zinc were removed from the site contaminant discharges during the performance period.

Effluent Discharge Requirements

Sections 8 and 14 of the SOW state the Performance Standards required for operation of MFTP. These sections include the following requirements.

The applicable or relevant and appropriate requirements (ARARs) specify that the AMD neutralization facility shall be designed and operated to maximize the removal of metals through the use of the HDS treatment process and, as a minimum, meet the Clean Water Act (CWA) Effluent Guidelines and Standards for Ore Mining and Dressing at 40 CFR 440.102(a) and 440.103(a) as specified in Table 1 (SOW Section 14.2.2.6).

TABLE 1
CWA Effluent Guidelines and Standards
Minnesota Flats Treatment Plant Effluent Discharge, Iron Mountain Mine Five-Year Review

Parameter	30-day Average[a] (mg/L)	Daily Maximum[b] (mg/L)
Copper (Total)	0.15	0.30
Cadmium Total)	0.05	0.10
Zinc (Total)	0.75	1.5
Lead (Total)	0.3	0.6
TSS[c]	20	30
pH[c]	6.0 to 9.0	6.0 to 9.0

[a]Average of daily concentration values for 30 consecutive days.
[b]Maximum allowable concentration measured for any one day.
[c]Applicable for discharge to Flat Creek.

Notes:

mg/L = milligrams per liter
TSS = total suspended solids

The CWA system of technology-based effluent controls requires that discharges achieve the best practicable control technology (BPT) and the best available technology economically achievable (BAT). The existing HDS AMD neutralization facility demonstrated metal discharge levels during the past 5 years substantially below the CWA limits specified in Table 1. The HDS control technology currently employed at the facility constitutes BAT for the purpose of the SOW. BAT effluent limits should be set from metal removal levels achieved at MFTP. The BAT limits are specified in Table 2 as daily maximum, 7-day average, and 30-day average concentrations (SOW Section 14.2.2.7). These limits were set in October 2000 from the limited MFTP data available at that time.

TABLE 2
BAT Control Technology Limits
Minnesota Flats Treatment Plant Effluent Discharge, Iron Mountain Mine Five-Year Review

Parameter	30-day Average[a] (µg/L)	7-day Average[b] (µg/L)	Daily Maximum[c] (µg/L)
Copper (dissolved)	5	10	15
Cadmium (dissolved)	1	2	3
Zinc (dissolved)	10	20	30

[a]Running average of daily values for 30 consecutive days.
[b]Running average of daily values for 7 consecutive days (2 x 30 day average).
[c]Maximum allowable for any one day (3 x 30-day average).

Note:

µg/L = micrograms per liter

Source: Table 14-2, *Statement of Work, Site Operations and Maintenance, Iron Mountain Mine*, October 2, 2000.

EPA provided the following exceptions for compliance with the effluent limits given in Tables 1 and 2:

- The SOW required effluent discharged to lower Spring Creek to comply with the effluent limits specified in Tables 1 and 2, except for pH and TSS. As stated in ROD2 and ROD3, EPA determined that for the effluent discharged to lower Spring Creek, it would not be necessary to adjust the effluent pH because of the acidic nature and buffering capacity of the creek. Treatment to TSS levels prescribed in the CWA is not necessary because of the high TSS levels in Spring Creek (SOW Section 14.2.2.9).
- The Site Operator would not be responsible for exceeding effluent requirements during high wind conditions that could cause a carryover of solids in the thickener overflow and related exceedances of the total allowable metal concentrations (SOW Section 14.2.2.8). High wind conditions are considered to be maximum wind speeds greater than 20 miles per hour (mph) (Carver, 2008).
- EPA intended to re-evaluate the BAT control technology limits in 2001 or 2002, following the anticipated completion of the ROD 4 SCRR project. Because of delays in completing the SCRR project, limit re-evaluation was rescheduled for after completion of SCRR. This evaluation is presented in this technical memorandum.
- The 2000 SOW states that the BAT effluent limits will be re-evaluated and modified if appropriate every 5 years after the initial re-evaluation of limits following completion of the ROD 4 SCRR project (SOW Section 14.2.3.2).

Compliance Monitoring Data

The data used to conduct this review are maintained by CH2M HILL in electronic databases. Most of the data used to assess compliance with the SOW requirements were supplied directly by the Site Operator, Iron Mountain Operations (IMO). Additional data used for this review were collected by CH2M HILL for EPA. Although the database provides a substantially complete record of analytical data collected over the past 5 years, there were some limitations to its use. For example, the effects of operations (e.g., plant shutdowns) or natural conditions (e.g., wind) on effluent quality were not described in the database.

IMO data were used for the review except where noted otherwise. Table 3 summarizes the compliance data reported by IMO since August 1, 2003. For the purposes of this report, calculations used the method detection limit (MDL) for non-detect values.

Additional data presented include samples collected by CH2M HILL during annual wet season sampling. At the time of this report, CH2M HILL data collected from December 2007 through January 2008 are considered preliminary, because these data have not been through final validation by CH2M HILL chemists.

TABLE 3
Summary of IMO Effluent Monitoring Data, August 1, 2003, through January 31, 2008
Minnesota Flats Treatment Plant Effluent Discharge, Iron Mountain Mine Five-Year Review

Parameter	No. of Results	No. of Non-detects	Percent Non-detects	Median Non-detect Value
Cadmium, Dissolved	1,511	2	0.1	0.15
Cadmium, Total	1,524	33	2.2	1.0
Copper, Dissolved	1,520	20	1.3	0.6
Copper, Total	1,519	2	0	1.5
Zinc, Dissolved	1,519	0	0	N/A
Zinc, Total	1,519	0	0	N/A
Daily pH	1,522	N/A	N/A	N/A
Daily Flow	1,635	N/A	N/A	N/A

Note:
N/A = Not Applicable

Clean Water Act Limit Compliance Summary

This section summarizes IMO compliance with CWA requirements and discusses reasons for concentrations exceeding the limits, if known. Figures showing daily metals concentrations also show CH2M HILL compliance oversight concentrations, where available.

pH

pH did not exceed CWA daily or monthly limits for MFTP plant effluent during the days reported. Figure 3 shows the MFTP effluent pH for the performance period.

Total Cadmium

Total cadmium did not exceed CWA daily or 30-day average limits for all days reported. The average of IMO concentrations equaled 2.8 µg/L, with a minimum of 0.6 µg/L and a maximum of 33.6 µg/L. The maximum result of 33.6 µg/L occurred on August 13, 2004. Total copper and total zinc maximum results also occurred on that date, as discussed further below. Figure 4 shows the daily, and Figure 5 shows the 30-day rolling average of total cadmium concentrations for the performance period.

Total Copper

Total copper concentrations were within the CWA daily limit for more than 99 percent of the days reported. On 8 days (0.5 percent of IMO data), total copper concentrations exceeded the CWA daily limit. The average of all concentrations equaled 82 µg/L, with a minimum of non-detect (MDL of 1 µg/L) and a maximum of 1,310 µg/L. Figure 6 shows the daily and Figure 7 shows the 30-day rolling average of total copper concentrations for the performance period.

The maximum result of 1,310 µg/L occurred on August 13, 2004. IMO reported in the *August 2004 Monthly Progress Report* (IMO, 2004a) that high concentrations of total copper and total zinc occurred on August 7 and August 13, 2004, because of MFTP startup

following thickener cleaning and inspection. Table 4 summarizes each date on which total copper and zinc exceeded the CWA daily limit, and describes likely causes as reported by IMO in monthly progress reports.

Total metals concentrations at MFTP are influenced by high winds, greater than 20 mph, as described previously. Concentrations might also have been influenced during startup of SCRR as IMO became operationally familiar with release of water from SCRR. The initial fill of SCRR began on March 12, 2004, and performance testing and dewatering of the reservoir occurred through June 25, 2004 (CH2M HILL, 2004b).

TABLE 4
Factors Influencing Total Copper Concentrations Exceeding the CWA Daily Limit[a]
Minnesota Flats Treatment Plant Effluent Discharge, Iron Mountain Mine Five-Year Review

Date	Analyte	Result (µg/L)	Reason for Exceedance[b]	Maximum Recorded Wind Speed (mph)
2/25/2004	Total copper	336	Windy conditions impacted TSS and total copper	29.53
6/25/2004	Total copper	459	No assignable cause identified	NR
8/7/2004	Total copper	597	Thickener Cleaning and Inspection	12.97
8/7/2004	Total zinc	1,950	Thickener Cleaning and Inspection	12.97
8/13/2004	Total copper	1,310	Thickener Cleaning and Inspection	11.18
8/13/2004	Total zinc	4,330	Thickener Cleaning and Inspection	11.18
8/25/2004	Total copper	705	Windy conditions impacted TSS	21.9
8/25/2004	Total zinc	2,420	Windy conditions impacted TSS	21.9
9/17/2004	Total copper	376	Windy conditions impacted TSS and total copper	27.5
4/7/2005	Total copper	304	No assignable cause identified	NR
1/7/2006	Total copper	333	High TSS was measured but no assignable cause identified for high total copper	15.21

[a]Total cadmium is not included because there were no values in excess of the CWA limits.
[b]As reported in IMO Monthly Progress Reports.

Notes:
Wind speeds greater than 20 mph are considered high winds that could affect total metals concentrations (Carver, 2008)
NR = Not Reported

The CWA 30-day average limit was exceeded on 96 days (6 percent of IMO data). The date range for which the CWA 30-day average limit was exceeded generally coincided with the dates on which the CWA daily limit was also exceeded.

Total Zinc

Total zinc concentrations were within the CWA daily limit for more than 99 percent of the days reported. On 3 days (0.2 percent of IMO data), total zinc concentrations exceeded the CWA daily limit. The average of all concentrations equaled 305 µg/L, with a minimum of

3 µg/L and a maximum of 4,330 µg/L. Figure 8 shows the daily and Figure 9 shows the 30-day rolling average of total zinc concentrations for the performance period.

The maximum result of 4,330 µg/L occurred on August 13, 2004 (Table 4). IMO reported in the *August 2004 Monthly Progress Report* (IMO, 2004a) that high concentrations of total copper and total zinc occurred on August 7 and August 13, 2004, because of treatment plant startup following thickener cleaning and inspection in late July (see Table 4). Total zinc did not exceed the CWA 30-day average limit.

Total Lead

The SOW does not require IMO to collect samples to demonstrate compliance with CWA limits for lead. However, CH2M HILL (for EPA) periodically analyzes effluent grab samples for lead as part of its oversight monitoring program. CH2M HILL data were used to provide the information for this section.

During the performance period, CH2M HILL collected 79 effluent samples for lead analysis. Most of these samples were collected weekly during the winter months. The average for all the samples equaled 19 µg/L, with a minimum of non-detect (MDL of 0.0357 µg/L) and a maximum of 83.2 µg/L. The maximum lead result of 83.2 µg/L occurred on February 1, 2005. This date coincides with above average results for total cadmium, copper, and zinc in samples collected by CH2M HILL and IMO (CH2M HILL, 2005a; IMO, 2005), although no assignable cause was identified. IMO reported that TSS also exceeded the CWA limit on February 1, 2005 (IMO, 2005). None of the CH2M HILL total lead data exceeded CWA daily or 30-day average limits.

Best Available Technology Limit Compliance

This section summarizes IMO compliance with BAT requirements and discusses reasons for concentrations exceeding the limits, if known. Figures showing daily metals concentrations also show CH2M HILL compliance oversight concentrations, where available.

Dissolved Cadmium

Dissolved cadmium concentrations were within the BAT daily limit for more than 99 percent of the days reported. On 1 day (less than 0.1 percent of IMO data), cadmium concentrations exceeded the daily limit. The average of all concentrations equaled 1.1 µg/L, with a minimum of non-detect (MDL of 0.1 µg/L) and a maximum of 4.3 µg/L. The maximum result of 4.3 µg/L occurred on June 1, 2004, which had recorded wind speeds above 20 mph. IMO did not report any operational anomalies on this day in the *June 2004 Monthly Progress Report* (IMO, 2004b). Figure 10 shows the daily, Figure 11 shows the 7-day rolling average, and Figure 12 shows the 30-day rolling average of dissolved cadmium concentrations for the performance period.

Table 5 summarizes each date on which dissolved cadmium, copper, and zinc exceeded the BAT daily limit, and likely causes as reported by IMO in monthly progress reports.

TABLE 5
Factors Influencing Dissolved Cadmium and Copper Concentrations Exceeding the BAT Daily Limit
Minnesota Flats Treatment Plant Effluent Discharge, Iron Mountain Mine Five-Year Review

Date	Analyte	Result (µg/L)	Reason for Exceedance[b]	Maximum Recorded Wind Speed (mph)
8/15/2003	Dissolved copper	15	No assignable cause identified	11
9/3/2003	Dissolved copper	16	No assignable cause identified	28.41
9/7/2003	Dissolved copper	15	No assignable cause identified	27.51
10/1/2003	Dissolved copper	15	No assignable cause identified	13.42
10/9/2003	Dissolved copper	16	No assignable cause identified	24.38
12/15/2003	Dissolved copper	15	No assignable cause identified	9.62
12/16/2003	Dissolved copper	15	No assignable cause identified	9.17
12/17/2003	Dissolved copper	17	No assignable cause identified	7.83
12/18/2003	Dissolved copper	17	No assignable cause identified	7.83
12/19/2003	Dissolved copper	19	No assignable cause identified	10.96
12/27/2003	Dissolved copper	15	No assignable cause identified	6.71
1/13/2004	Dissolved copper	19	No assignable cause identified	10.07
1/22/2004	Dissolved copper	17	No assignable cause identified	7.38
2/26/2004	Dissolved copper	16.5	No assignable cause identified	23.71
4/1/2004	Dissolved copper	42.1	Sample preparation protocol deviation	21.47
4/8/2004	Dissolved copper	30.7	Sample preparation protocol deviation	16.33
4/15/2004	Dissolved copper	51.3	Sample preparation protocol deviation	25.28
4/22/2004	Dissolved copper	41.4	Sample preparation protocol deviation	17.22
4/29/2004	Dissolved copper	25.3	Sample preparation protocol deviation	21.03
6/1/2004	Dissolved cadmium	4.3	No assignable cause identified	22.82
11/18/2004	Dissolved copper	91.9	No assignable cause identified	11.2
12/8/2004	Dissolved copper	27.9	No assignable cause identified	15.4
2/25/2005	Dissolved copper	34.4	No assignable cause identified	8.72
11/2/2005	Dissolved copper	28.7	No assignable cause identified	17.22
7/19/2006	Dissolved copper	33.5	No assignable cause identified	9.17

[a]Dissolved zinc is not included because 97 percent of the data was above the BAT daily limit.
[b]Reported by IMO in Monthly Progress Reports.

Note:
Wind speeds greater than 20 mph are considered high winds that could affect total metals concentrations (Carver, 2008). Wind speeds are provided here for reference, but are not considered assignable causes for high dissolved metals concentrations.

On 17 days (1 percent of IMO data), dissolved cadmium concentrations exceeded the BAT 7-day average limit. Except for the June 1, 2004, data point, the days exceeding the 7-day limit coincide with the highest concentration peaks observed in the daily data (see Figure 10), which occurred between January 14 and 20, 2007, and between December 13 and 22, 2007. No operational activity was identified as related to these exceedances in the IMO Monthly Progress Reports (IMO, 2008 and 2007).

Nine hundred days (55 percent of IMO data) exceeded the BAT 30-day average limit. In general, samples collected during wet months exceeded the limit; samples collected during dry months were within the limit. Exceedances of the BAT 30-day average cadmium limit do not appear to be related to specific operational activities or meteorological conditions (i.e., high winds).

Dissolved Copper

Dissolved copper concentrations were within the BAT daily limit for more than 98 percent of the days reported. On 24 days (1.6 percent of IMO data), dissolved copper concentrations exceeded the daily limit. The average of all concentrations equaled 3.6 µg/L, with a minimum of non-detect (MDL of 0.6 µg/L) and a maximum of 91.9 µg/L. The maximum result of 91.9 µg/L occurred on November 18, 2004. The maximum dissolved zinc result also occurred on that date (see Table 5). No operational activity was identified as related to these relatively high dissolved concentrations in the IMO Monthly Progress Report (IMO, 2004c). Figure 13 shows the daily, Figure 14 shows the 7-day rolling average, and Figure 15 shows the 30-day rolling average of dissolved copper concentrations for the performance period.

On 83 days (5 percent of IMO data), dissolved copper concentrations exceeded the BAT 7-day average limit. The majority (76) of these days occurred prior to the startup of SCRR. The remaining 7 days coincide with the maximum daily concentration during the period, reported for November 18, 2004.

On 278 days (17 percent of IMO data), dissolved copper concentrations exceeded the BAT 30-day average limit. The majority (248) of these days occurred prior to the startup of SCRR. The remaining 30 days coincide with the maximum daily concentration during the period, reported for November 18, 2004.

Dissolved Zinc

Dissolved zinc concentrations exceeded BAT daily, 7-day average, and 30-day average limits for the majority of the days reported. The daily limit was exceeded on 1,477 days (97 percent of IMO data). The average of all concentrations equaled 61 µg/L, with a minimum of 3.7 µg/L and a maximum of 363 µg/L. The maximum result of 363 µg/L occurred on November 18, 2004 (see Table 5). Figure 16 shows the daily, Figure 17 shows the 7-day rolling average, and Figure 18 shows the 30-day rolling average of dissolved zinc concentrations for the performance period.

On all days, zinc concentrations exceeded BAT 7-day and 30-day average limits. Results in excess of BAT limits for dissolved zinc are not related to specific operational activities or meteorological conditions (i.e., high winds).

Best Available Technology Limit Evaluation

The 2000 SOW states that the BAT effluent limits will be evaluated after 2 years of continuous operation of SCRR, and modifications will be made to the BAT effluent limits if appropriate. The 2000 SOW also states that the BAT effluent limits will be re-evaluated every 5 years thereafter and modified if appropriate (SOW Section 14.2.3.2). The SCRR remedy implemented under ROD4 was determined operational and functional by EPA and the State of California on August 26, 2004 (CH2M HILL, 2004b). At the time of the Fourth IMM Five-Year Review, 3.5 years of data had been collected at MFTP since completion of SCRR.

In addition to the need to re-evaluate limits because of changes associated with SCRR, there is also a need to re-evaluate the limits with regard to the performance of the IMO treatment plant. Specifically, when MFTP is operating normally, the effluent frequently exceeds BAT daily, 7-day, and 30-day limits for dissolved zinc, and the BAT 30-day limit for dissolved cadmium.

AIG Consultants, Inc. (AIG), EPA, IMO, and CH2M HILL met on Wednesday, October 26, 2005, to discuss the SOW, proposed clarifications and modifications to the SOW, and other miscellaneous items (CH2M HILL, 2005b). One of the agenda items was reevaluation of BAT performance standards. At that time, EPA stated its intention to formally modify the SOW.

The available IMO and CH2M HILL effluent analytical data for cadmium, copper, and zinc were reviewed, and it was determined that the following changes to BAT limits were reasonable:

- Change from 30 to 300 μg/L for daily dissolved zinc
- Change from 20 to 150 μg/L for 7-day average dissolved zinc
- Change from 10 to 100 μg/L for 30-day average dissolved zinc
- Change from 1 to 2 μg/L for 30-day average dissolved cadmium

Figures 10 through 18 show the dissolved cadmium, copper, and zinc data for the IMM Fourth Five-Year Review period and the associated BAT limits. These data show that MFTP would be able to meet the revised BAT limits proposed at the time of the October 26, 2005, meeting.

Iron Mountain Operations and CH2M HILL Data Comparison

IMO and CH2M HILL data were statistically compared by using paired and pooled data tests. Only samples collected by IMO and CH2M HILL on the same date during the period August 1, 2003, through January 31, 2008, were used. For result values below the MDL, the MDL was used. Where statistically significant differences are evident between CH2M HILL and IMO data, this statistical comparison should be used to identify and resolve potential differences in field or laboratory techniques. However, the analysis presented earlier in this memorandum shows that both datasets result in similar conclusions of MFTP performance and compliance with CWA standards and BAT limits.

The data were paired by sample date and then compared by using the Pearson correlation, the Spearman correlation, and the Wilcoxon signed rank test. The results of the correlation

tests are shown in Table 6. The values for the coefficients developed by the Pearson and Spearman correlations can range between -1 and 1. Values of the correlation coefficient close to +1 (positive correlation) imply that as one variable increases so does the other; the reverse holds for values close to -1. A value of +1 implies a perfect positive linear correlation (i.e., all the data pairs lie on a straight line with a positive slope). A value of -1 implies perfect negative linear correlation. Values close to 0 imply little correlation between the variables. The correlation coefficients for a comparison of treatment plant effluent data ranged from 0.67 to -0.14, indicating that there is not a good correlation between the IMO and CH2M HILL paired data points.

TABLE 6
Correlation Coefficients for a Comparison of Paired IMO and CH2M HILL Treatment Plant Effluent Data
Minnesota Flats Treatment Plant Effluent Discharge, Iron Mountain Mine Five-Year Review

Type	Parameter	Pearson Correlation Coefficient	Spearman Correlation Coefficient
Total	Cadmium	0.417	0.390
Total	Copper	0.294	0.346
Total	Zinc	0.198	0.149
Dissolved	Cadmium	0.339	0.606
Dissolved	Copper	-0.098	-0.144
Dissolved	Zinc	0.613	0.670

The Spearman correlation is typically more robust in treating outlier data than the Pearson correlation because it does not allow outlier pairs to dominate the analysis. Because the Spearman and Pearson coefficients are similar in magnitude, except for dissolved cadmium, it can be concluded that outlier points did not have a large impact on the correlations. Figure 19 shows scatter plots for each of the analytes.

From visual interpretation, the scatter plots generally show a weaker correlation for total metals than for dissolved metals. Dissolved cadmium appears to have the strongest correlation of the dissolved metals. Dissolved zinc also has the highest Spearman and Pearson correlation coefficients (see Table 6).

The paired data were also evaluated with the Wilcoxon signed rank evaluation, as shown in Table 7. This evaluation provides the statistical probability that the datasets are not different. Probabilities less than 0.05 percent were considered statistically significant. From this evaluation, only total and dissolved cadmium were shown as having a statistical difference. The Wilcoxon signed rank test assigns less weight to distribution tails than to center points.

TABLE 7
Wilcoxon Signed Rank Comparison of Paired IMO and CH2M HILL Treatment Plant Effluent Data
Minnesota Flats Treatment Plant Effluent Discharge, Iron Mountain Mine Five-Year Review

Type	Parameter	Probability that the Observed Differences Would Occur Purely by Chance	Statistical Decision with 0.05 Significance Level
Total	Cadmium	0.002	Significantly Different
Total	Copper	0.440	No Significant Difference
Total	Zinc	0.074	No Significant Difference
Dissolved	Cadmium	0.000	Significantly Different

TABLE 7
Wilcoxon Signed Rank Comparison of Paired IMO and CH2M HILL Treatment Plant Effluent Data
Minnesota Flats Treatment Plant Effluent Discharge, Iron Mountain Mine Five-Year Review

Type	Parameter	Probability that the Observed Differences Would Occur Purely by Chance	Statistical Decision with 0.05 Significance Level
Total	Cadmium	0.002	Significantly Different
Total	Copper	0.440	No Significant Difference
Total	Zinc	0.074	No Significant Difference
Dissolved	Copper	0.462	No Significant Difference
Dissolved	Zinc	0.352	No Significant Difference

The following are known issues with the existing data that might cause differences in the paired datasets:

- The MDL used by CH2M HILL for dissolved copper during the December 2006 through April 2007 sampling season was higher than the IMO MDL. In the *Quality Assurance Project Plan* (CH2M HILL, 2007b), CH2M HILL requested that a more sensitive analytical method, ICP-MS (E200.8), be used for copper, which should result in better agreement between the CH2M HILL and IMO dissolved copper data.
- Laboratories previously contracted by CH2M HILL experienced zinc blank contamination. Starting in January 2007, the EPA Region 9 laboratory began analyzing samples collected by CH2M HILL. The EPA Region 9 laboratory has not had any blank contamination issues. Therefore, total and dissolved zinc analyses performed by the EPA Region 9 laboratory should have better agreement with IMO data.
- The effluent composite collected by IMO is not well mixed prior to sample collection. Because of this, solids might settle out within the composite collection container, which could increase the total cadmium, copper, and zinc concentrations at the bottom of the container as compared to the top. IMO collects an effluent sample from the top portion of the container prior to CH2M HILL collecting an effluent sample from the bottom portion of the container. This could result in lower suspended solids in IMO's sample and higher suspended solids in CH2M HILL's sample, which could bias CH2M HILL's results high, and IMO's results low.

The following recommendations could be considered to help reconcile the known differences between the datasets, and to provide data for further comparison:

- The effluent composite sample should be well mixed by IMO and by CH2M HILL prior to collecting sample. This will help to ensure that solids are distributed uniformly throughout the composite sample and possibly reduce the differences in total metals concentrations. Section 6.1.1 of the IMO O&M manual (IMO, 2001) should be modified to specify that the composite sample is well mixed.
- As sample volume allows, split sample analyses could be performed during the 2008 to 2009 wet season to help identify potential differences in laboratory methodology. CH2M HILL recommends that split samples be collected by IMO and analyzed at the EPA Region 9 laboratory.

- As sample volume allows, additional duplicate effluent samples could be collected during the 2008 to 2009 wet season to provide additional data for statistical analysis and to quantify variability resulting from sampling or analytical methodology. CH2M HILL will plan to collect duplicate effluent samples for analysis at the EPA Region 9 laboratory.
- IMO should be provided a copy of CH2M HILL's annual IMM Surface Water Sampling Summary Report.

The data were also pooled (i.e., grouped as unpaired data) and compared by using the Wilcoxon rank sum evaluation. The rank sum evaluation is a central tendency test that provides the statistical probability that the unpaired datasets are not different. As in the previous analysis, probabilities less than 0.05 percent were considered statistically significant. The results of this evaluation are shown in Table 8. Figure 20 shows box and whisker plots for the pooled data comparison for each of the analytes. From this evaluation, only total and dissolved cadmium show a statistical difference. These results agree with the Wilcoxon signed rank evaluation.

These results demonstrate that CH2M HILL and IMO data for total and dissolved copper and zinc generally agree over time.

TABLE 8
Wilcoxon Rank Sum Comparison of Pooled IMO and CH2M HILL Treatment Plant Effluent Data
Minnesota Flats Treatment Plant Effluent Discharge, Iron Mountain Mine Five-Year Review

Type	Parameter	Probability that the Observed Differences Would Occur Purely by Chance	Statistical Decision with 0.05 Significance Level
Total	Cadmium	0.018	CH2M HILL > IMO
Total	Copper	0.848	No Significant Difference
Total	Zinc	0.259	No Significant Difference
Dissolved	Cadmium	0.002	CH2M HILL > IMO
Dissolved	Copper	0.171	No Significant Difference
Dissolved	Zinc	0.418	No Significant Difference

Conclusions and Five-Year Review Recommendations

From this review of the treatment plant effluent data collected over the past 5 years, the following conclusions and recommendations have been made.

Clean Water Act Effluent Limits

Conclusion

The treatment plant was in substantial compliance with CWA effluent limits for pH, total cadmium, total copper, total zinc, and total lead during the performance period. The instances where CWA daily or 30-day average limits were exceeded were rare and frequently could be attributed to operational conditions or other known factors. The MFTP exceeded the 30-day average total copper discharge limit by a small amount after the startup of the SCRR.

Recommendation

In a meeting among AIG, EPA, IMO, and CH2M HILL on October 26, 2005, discussions were conducted regarding the performance of the MFTP (CH2M HILL, 2005b). EPA agreed that IMO had operated MFTP properly, and the attendees discussed several hypotheses for the cause in the increase of the total copper concentrations in the discharge and several operational strategies for reducing the total copper concentrations to meet the SOW requirements. The following IMM treatment plant operational guidelines were recommended for periods of high inflow from SCRR (CH2M HILL, 2005b). These are consistent with requirements in the Slickrock Creek Retention Reservoir O&M Manual (CH2M HILL, 2004a):

- Slickrock Creek Retention Reservoir inflow to the IMM treatment plant will be slowly ramped up during storm events by adjusting the Slickrock Creek Retention Reservoir intake gates and using the emergency holding tank.
- The discharge from the Slickrock Creek Retention Reservoir will be limited to 3,000 gallons per minute (gpm) (plus 250 gpm from the Old/No. 8 Mine), depending on water elevation within the reservoir, time of year, and forecasted weather.
- Discharge of 4,000 gpm will be avoided, unless necessary for dam operation

Best Available Technology Effluent Limits

Conclusion

EPA demonstrated that MFTP substantially complies with BAT limits for daily and 7-day average dissolved cadmium and copper, and the BAT 30-day average for dissolved copper. The data do not demonstrate compliance with BAT requirements for dissolved zinc, or the BAT 30-day average for dissolved cadmium.

Recommendation

EPA should formally revise the SOW to modify BAT effluent limits based on metal removal level currently achieved at the MFTP. The following revisions to BAT limits are recommended:

- Change daily dissolved zinc BAT limit from 30 to 300 μg/L
- Change 7-day average dissolved zinc BAT limit from 20 to 150 μg/L
- Change 30-day average dissolved zinc BAT limit from 10 to 100 μg/L
- Change 30-day average dissolved cadmium BAT limit from 1 to 2 μg/L

Iron Mountain Operations and CH2M HILL Data Comparison

Linear correlations between paired CH2M HILL and IMO data resulted in relatively low correlation coefficients. Further statistical analysis of paired and pooled CH2M HILL and IMO datasets showed that there is a statistically significant difference between the dissolved and total cadmium data. Both datasets result in similar conclusions of MFTP performance

and compliance with CWA standards and BAT limits. However, the following recommendations are presented to help reconcile differences between the datasets, and to provide data for further comparison:

- The effluent composite sample should be well mixed by IMO and by CH2M HILL prior to collecting sample. This will help to ensure that solids are distributed uniformly throughout the composite sample and possibly reduce the differences in total metals concentrations. Section 6.1.1 of the IMO O&M manual (IMO, 2001) should be modified to specify that the composite sample is well mixed.
- As sample volume allows, split sample analyses could be performed during the 2008 to 2009 wet season to help identify potential differences in laboratory methodology. CH2M HILL recommends that split samples be collected by IMO and analyzed at the EPA Region 9 laboratory.
- As sample volume allows, additional duplicate effluent samples could be collected during the 2008 to 2009 wet season to provide additional data for statistical analysis and to quantify variability resulting from sampling or analytical methodology. CH2M HILL will plan to collect duplicate effluent samples for analysis at the EPA Region 9 laboratory.

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Figures

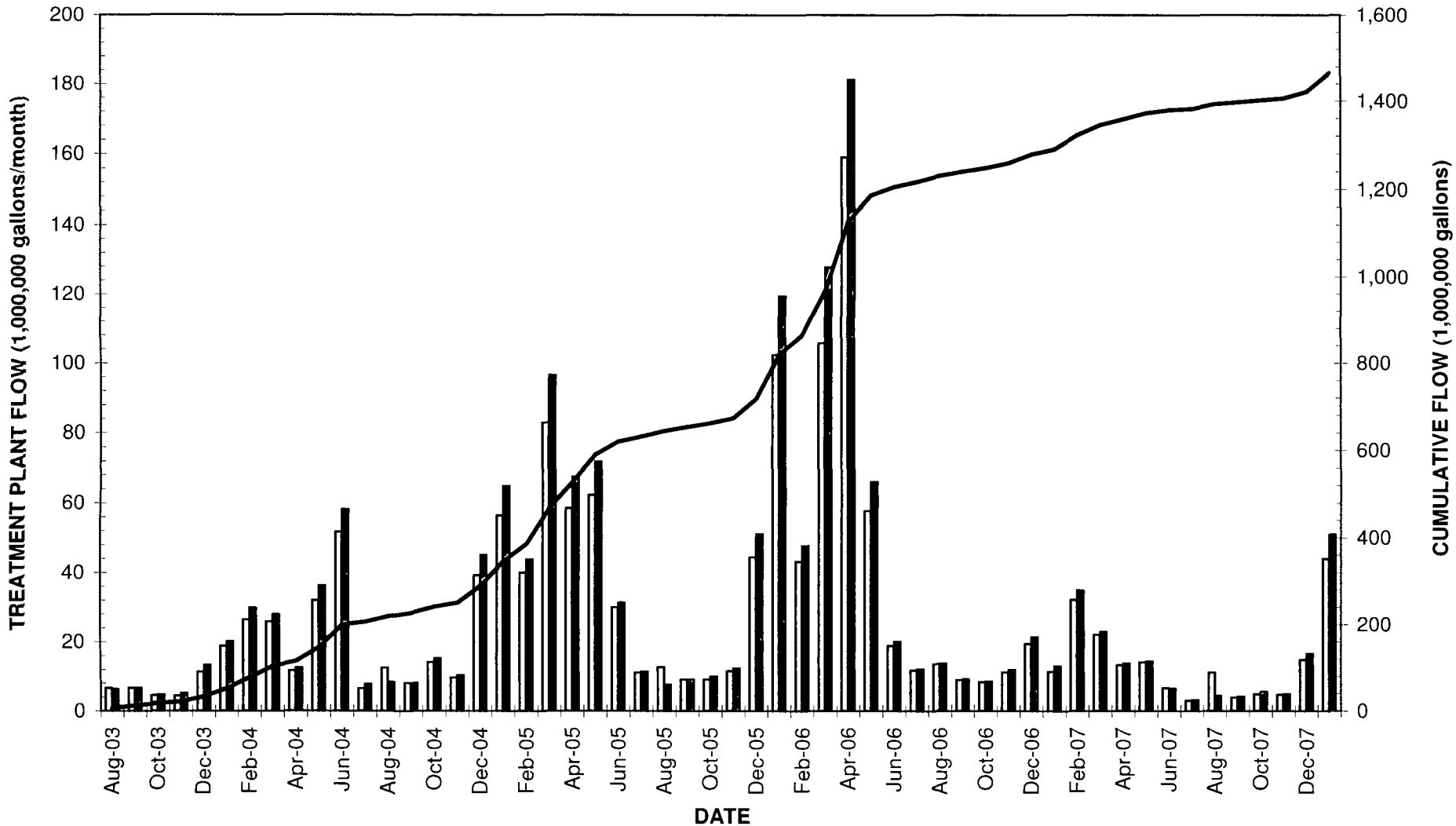

FIGURE 1
MFTP MONTHLY FLOW SUMMARY
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE

2003-2008_Figures-5yr-Review.xls: F1-flow

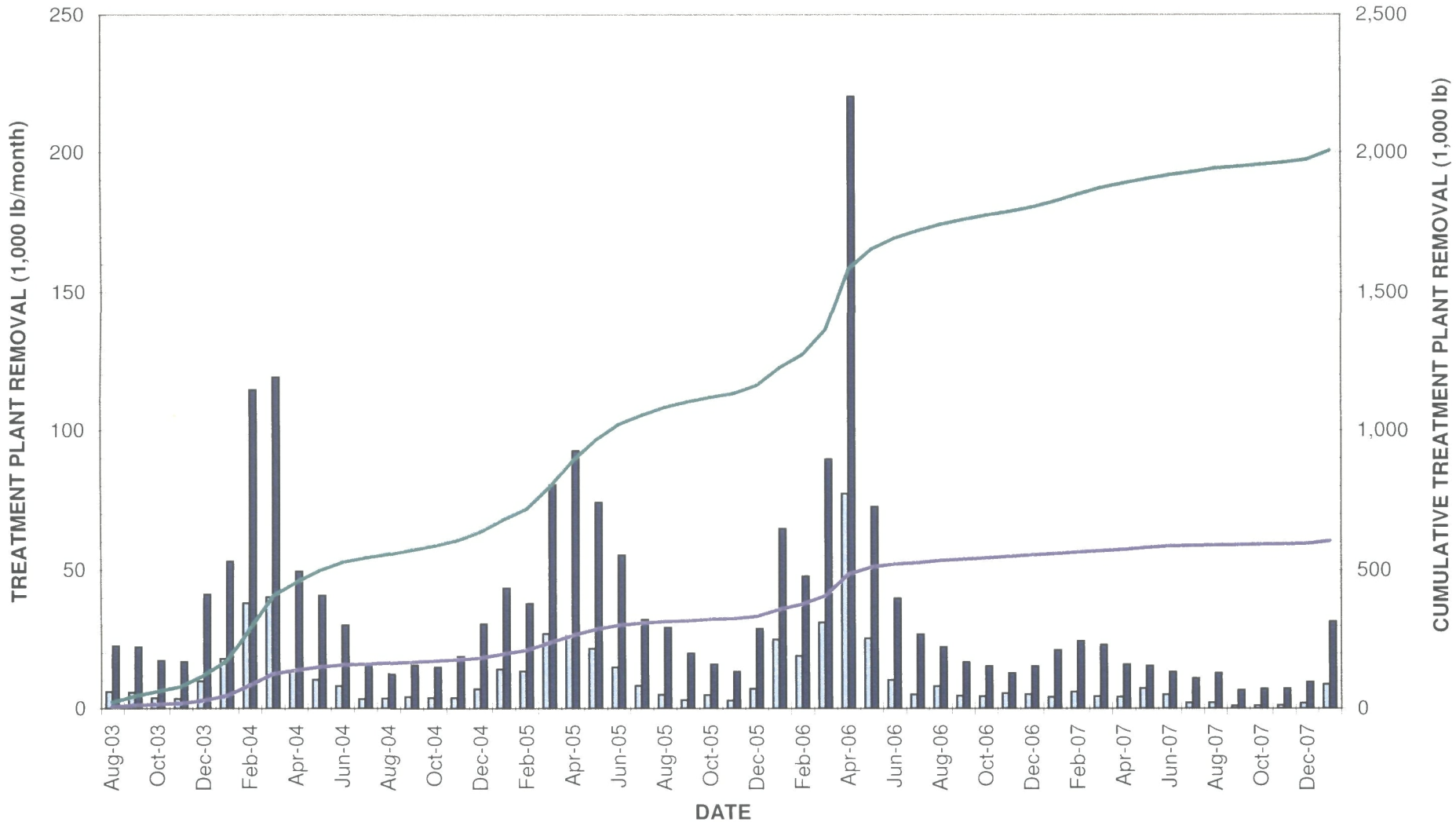

FIGURE 2
MFTP MONTHLY COPPER AND ZINC LOAD REMOVAL SUMMARY
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2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE

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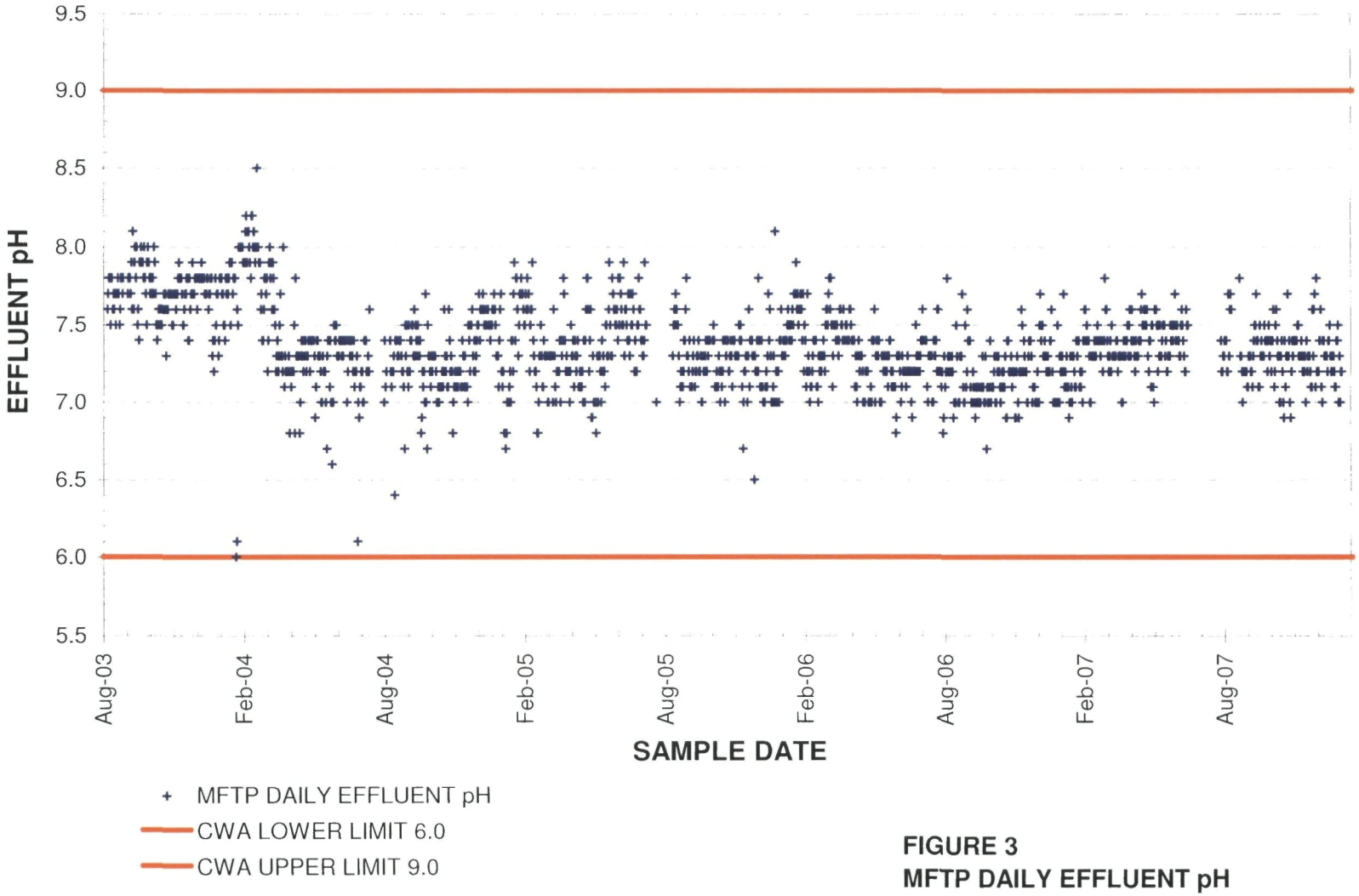
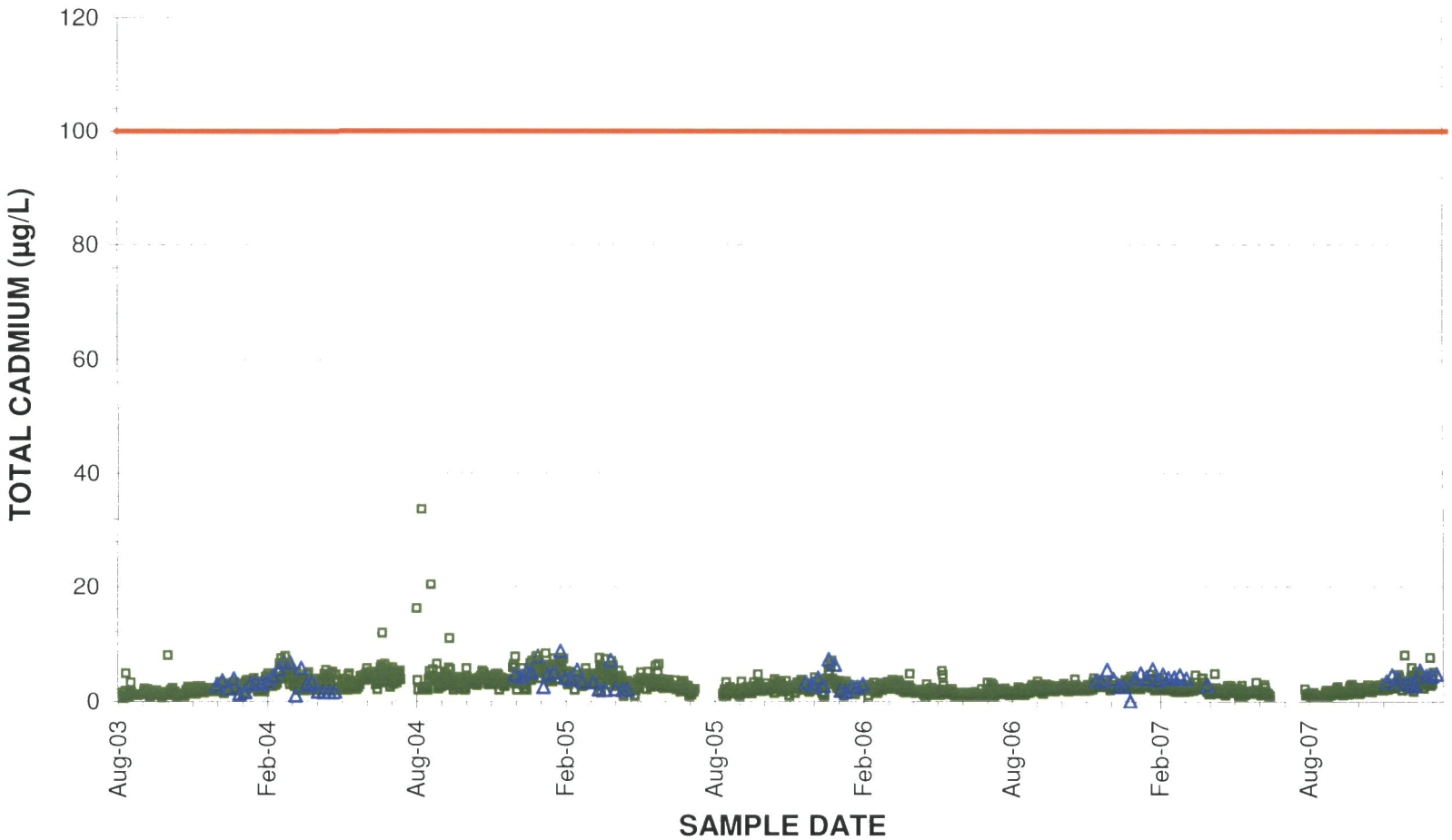


FIGURE 3
MFTP DAILY EFFLUENT pH
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE



MFTP TOTAL CADMIUM DAILY
CH2M HILL TOTAL CADMIUM
CWA DAILY MAXIMUM 100 µg/L

FIGURE 4
MFTP DAILY EFFLUENT TOTAL CADMIUM
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE

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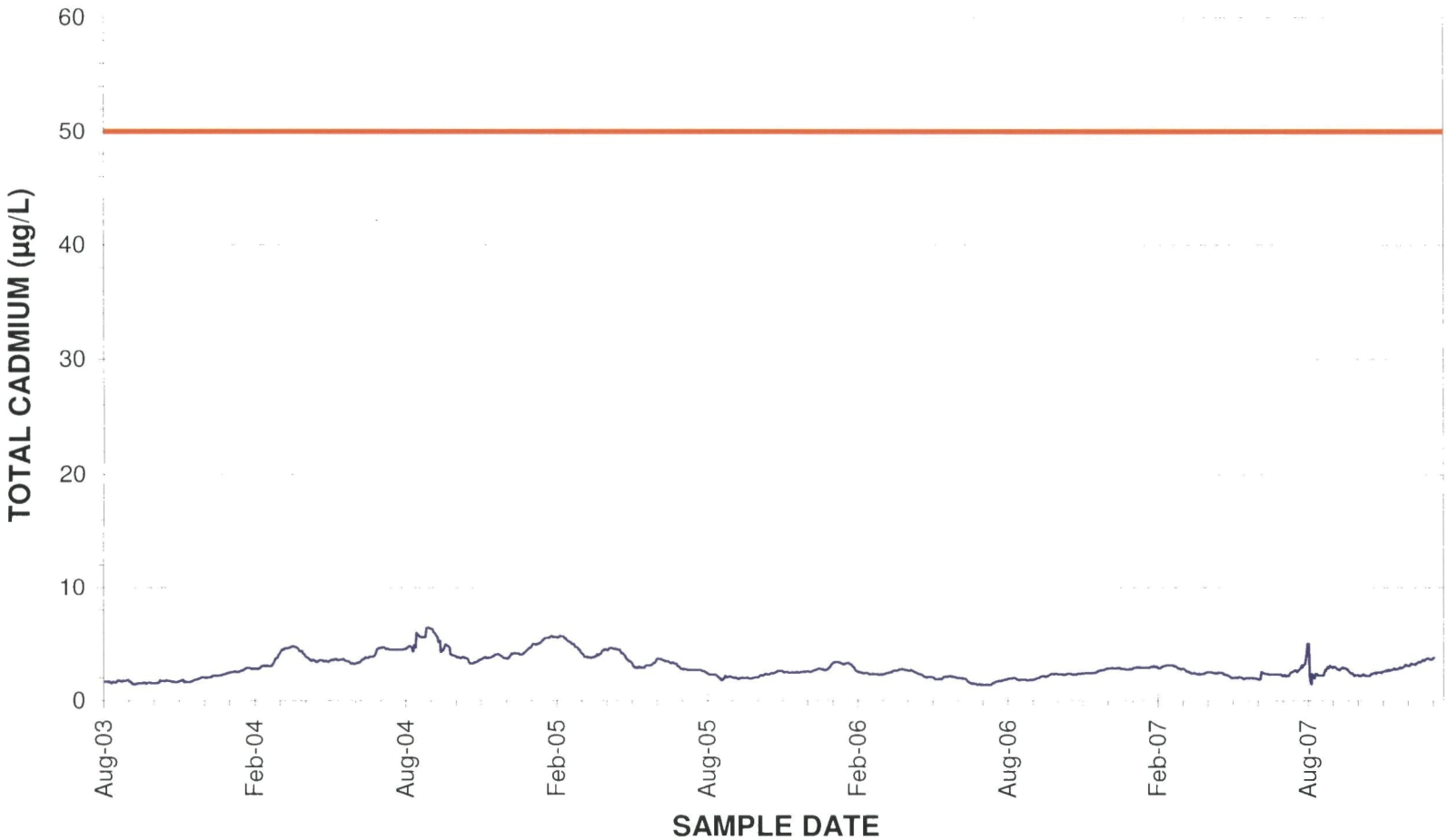


TOTAL CADMIUM 30-DAY AVERAGE
CWA 30-DAY MAXIMUM 50 µg/L

FIGURE 5
MFTP 30-DAY AVERAGE EFFLUENT
TOTAL CADMIUM
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE

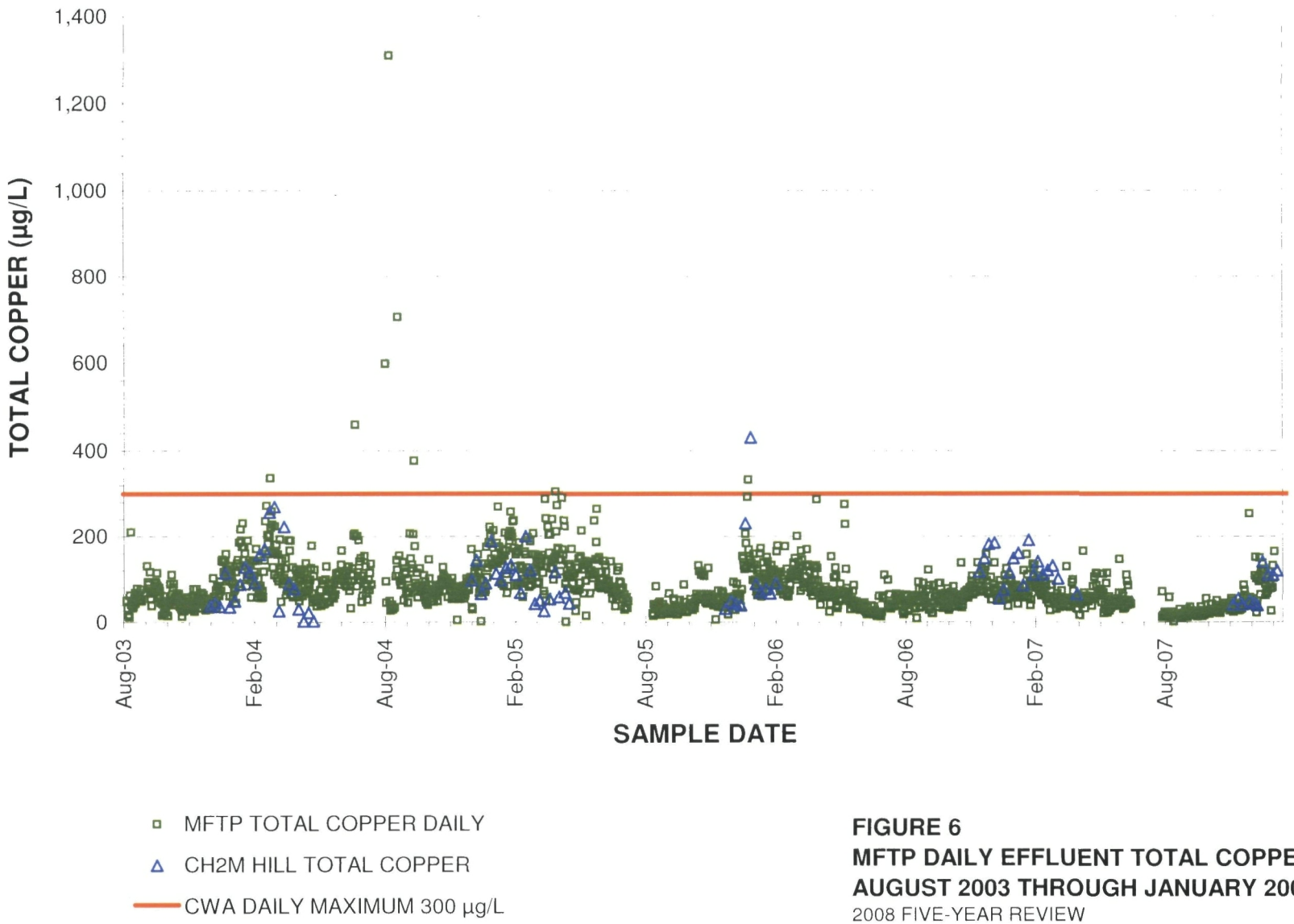
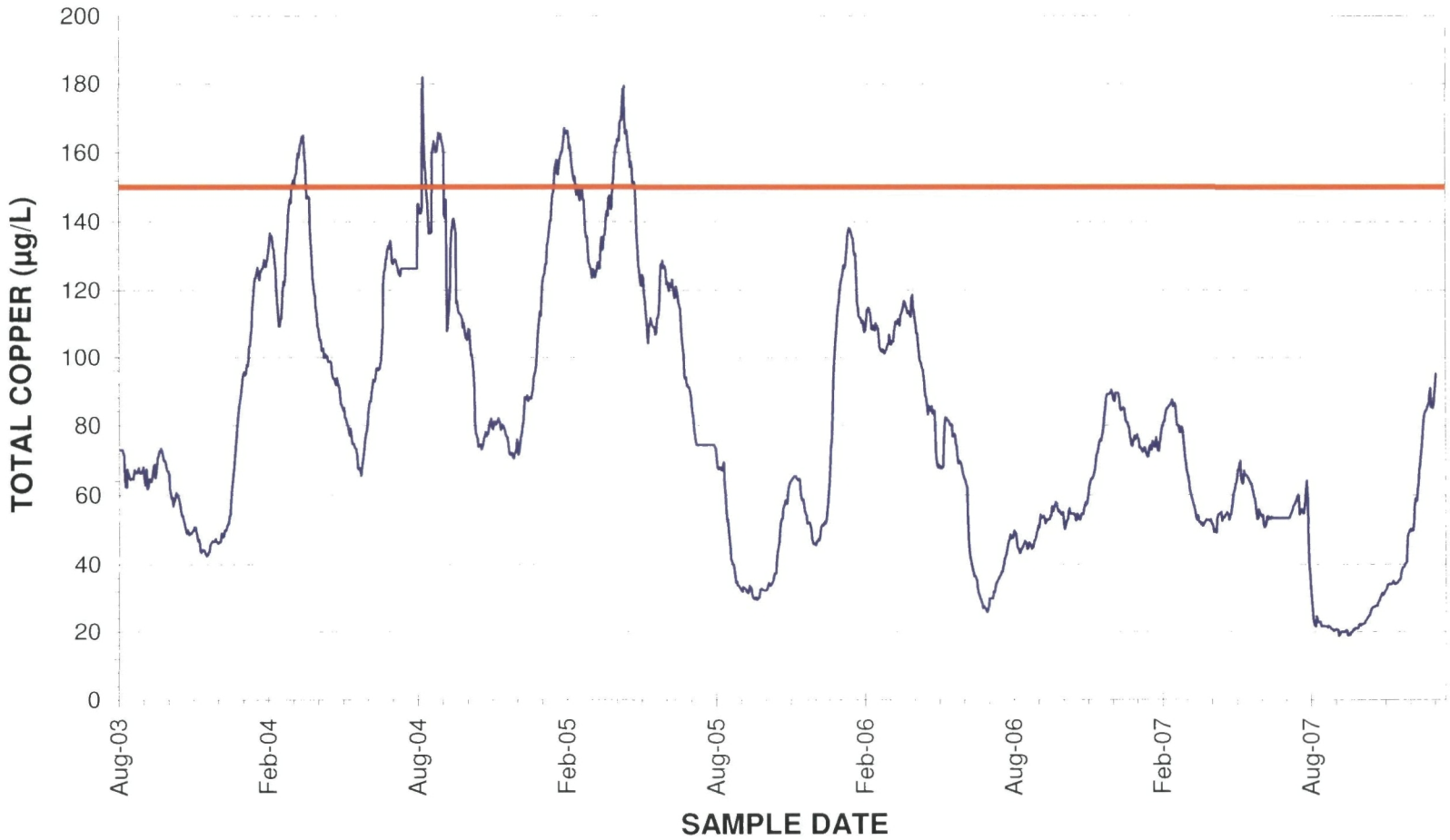


FIGURE 6
MFTP DAILY EFFLUENT TOTAL COPPER
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE



TOTAL COPPER 30-DAY AVERAGE

CWA 30-DAY MAXIMUM 150 µg/L

FIGURE 7
MFTP 30-DAY AVERAGE EFFLUENT TOTAL COPPER
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE

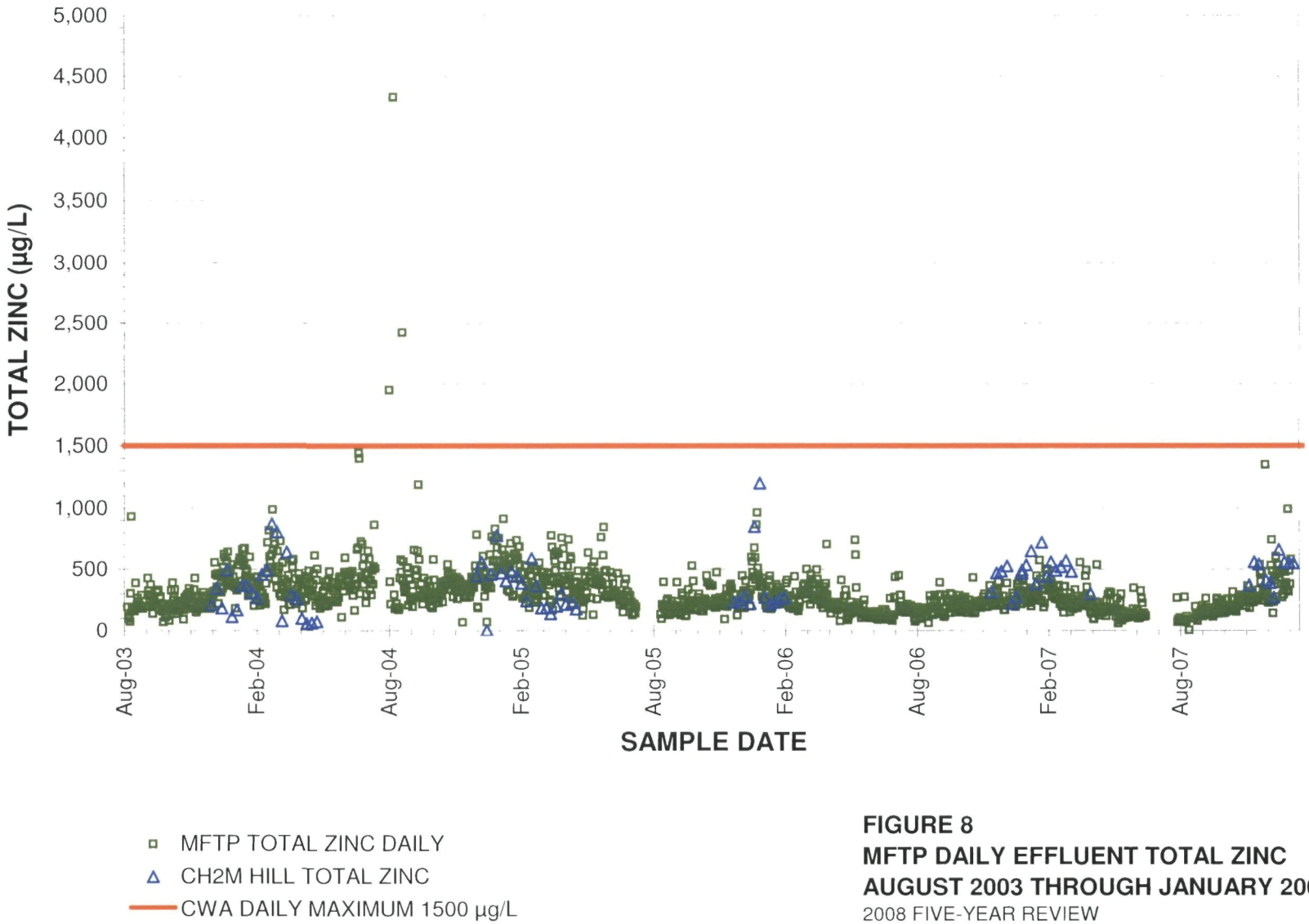
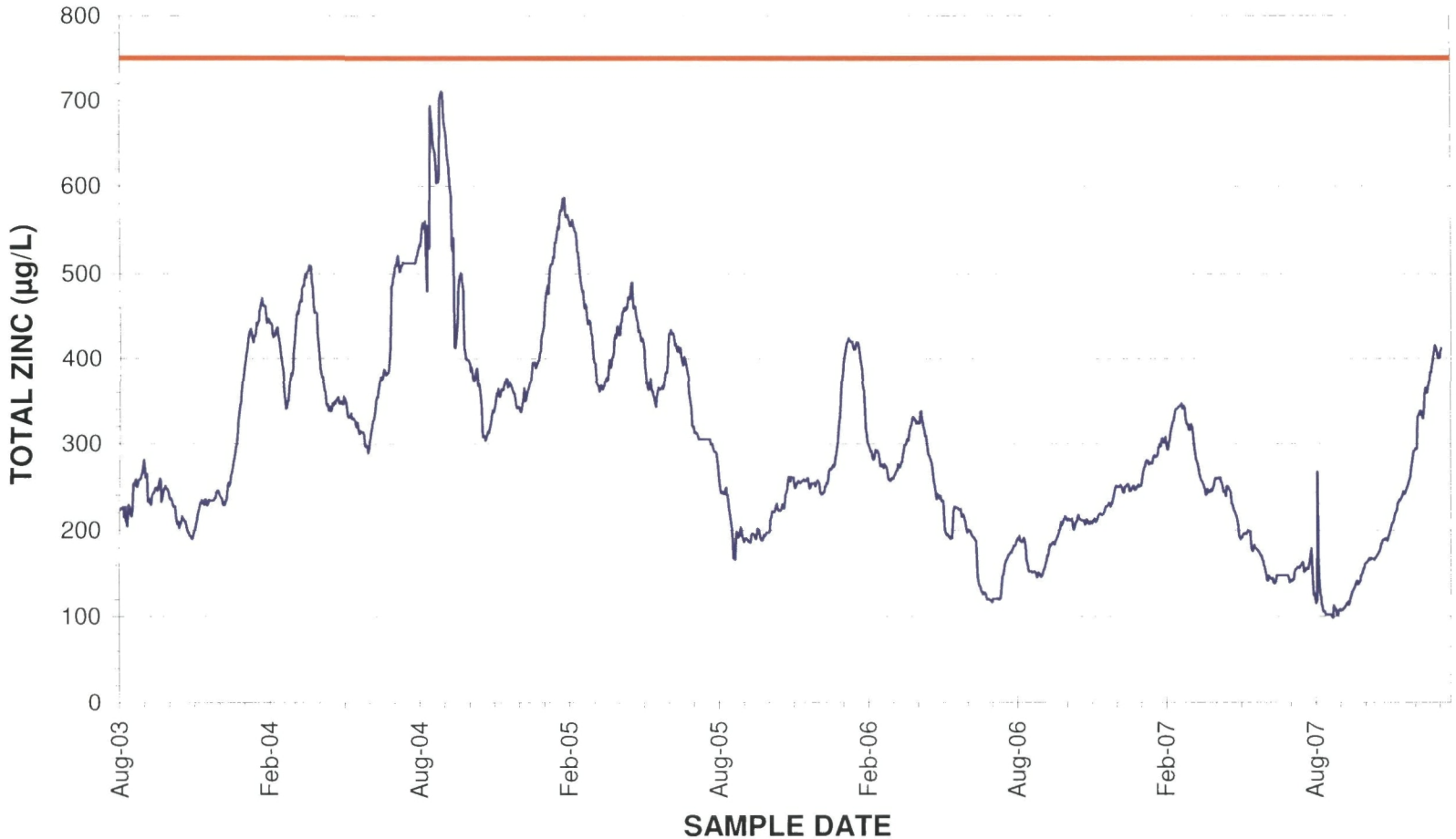


FIGURE 8
MFTP DAILY EFFLUENT TOTAL ZINC
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE



TOTAL ZINC 30-DAY AVERAGE
CWA 30-DAY MAXIMUM 750 µg/L

FIGURE 9
MFTP 30-DAY AVERAGE EFFLUENT
TOTAL ZINC
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE

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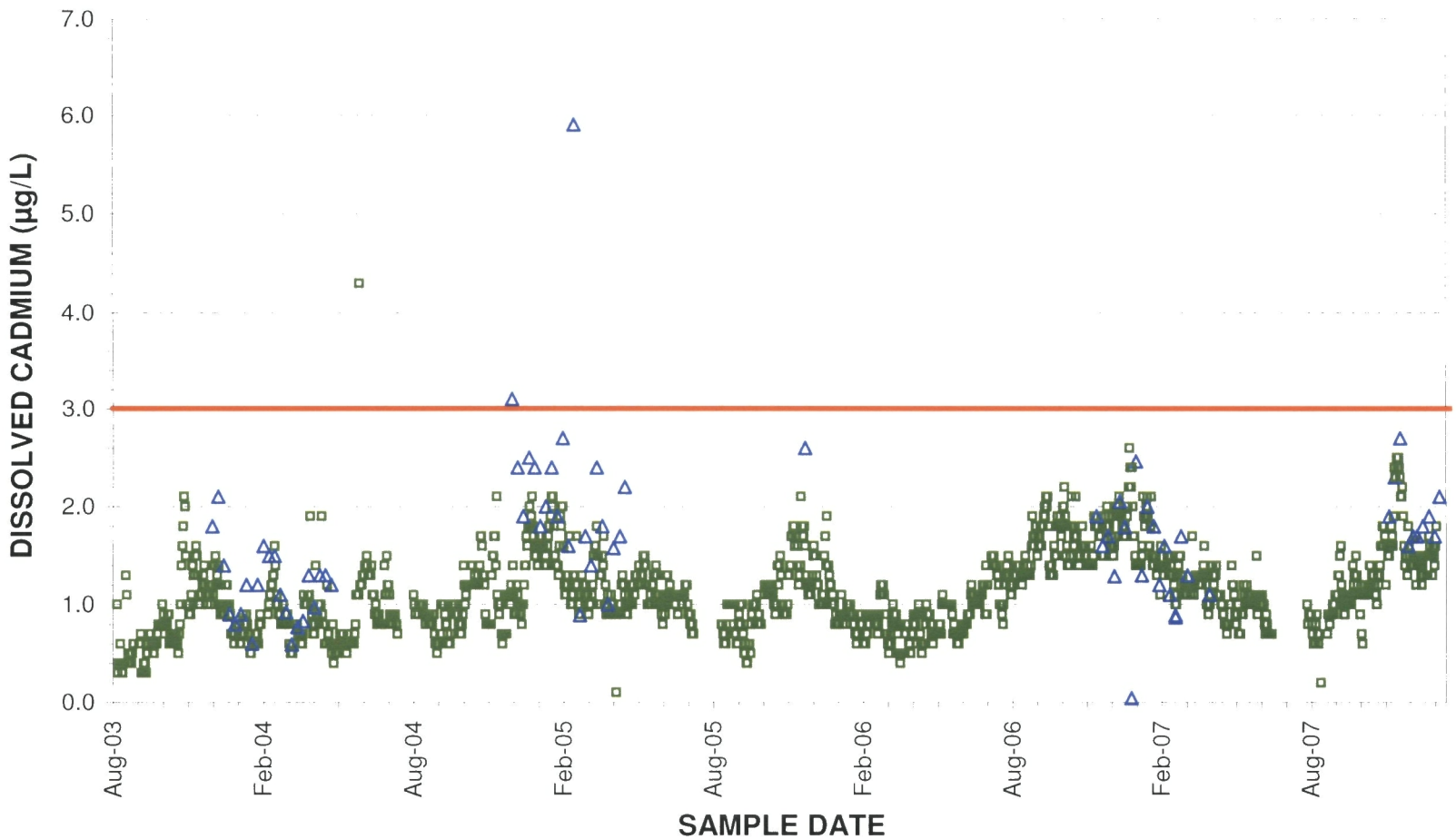

MFTP DISSOLVED CADMIUM DAILY
CH2M HILL DISSOLVED CADMIUM
BAT DAILY MAXIMUM 3 µg/L

FIGURE 10
MFTP DAILY EFFLUENT DISSOLVED CADMIUM
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE

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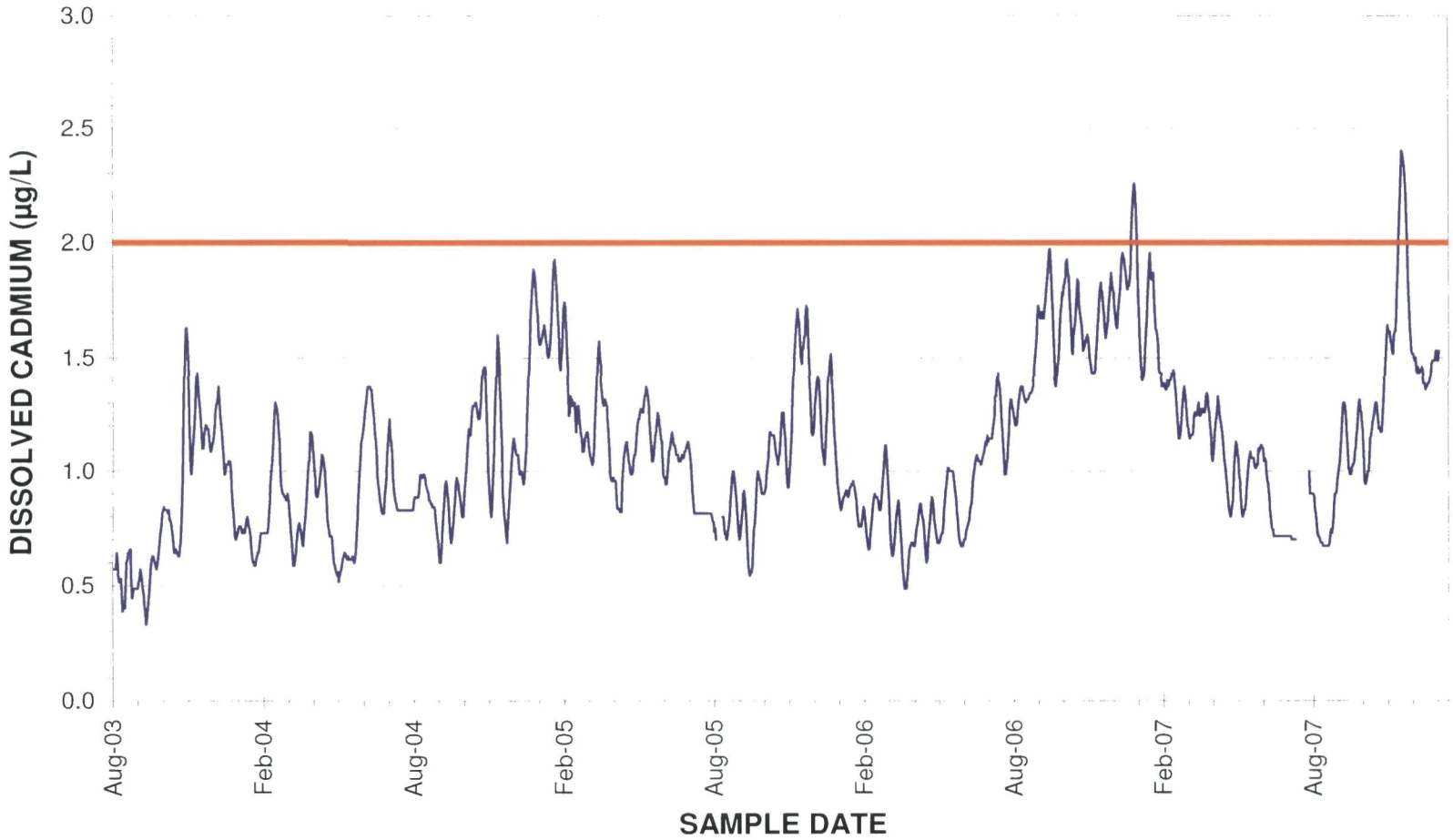
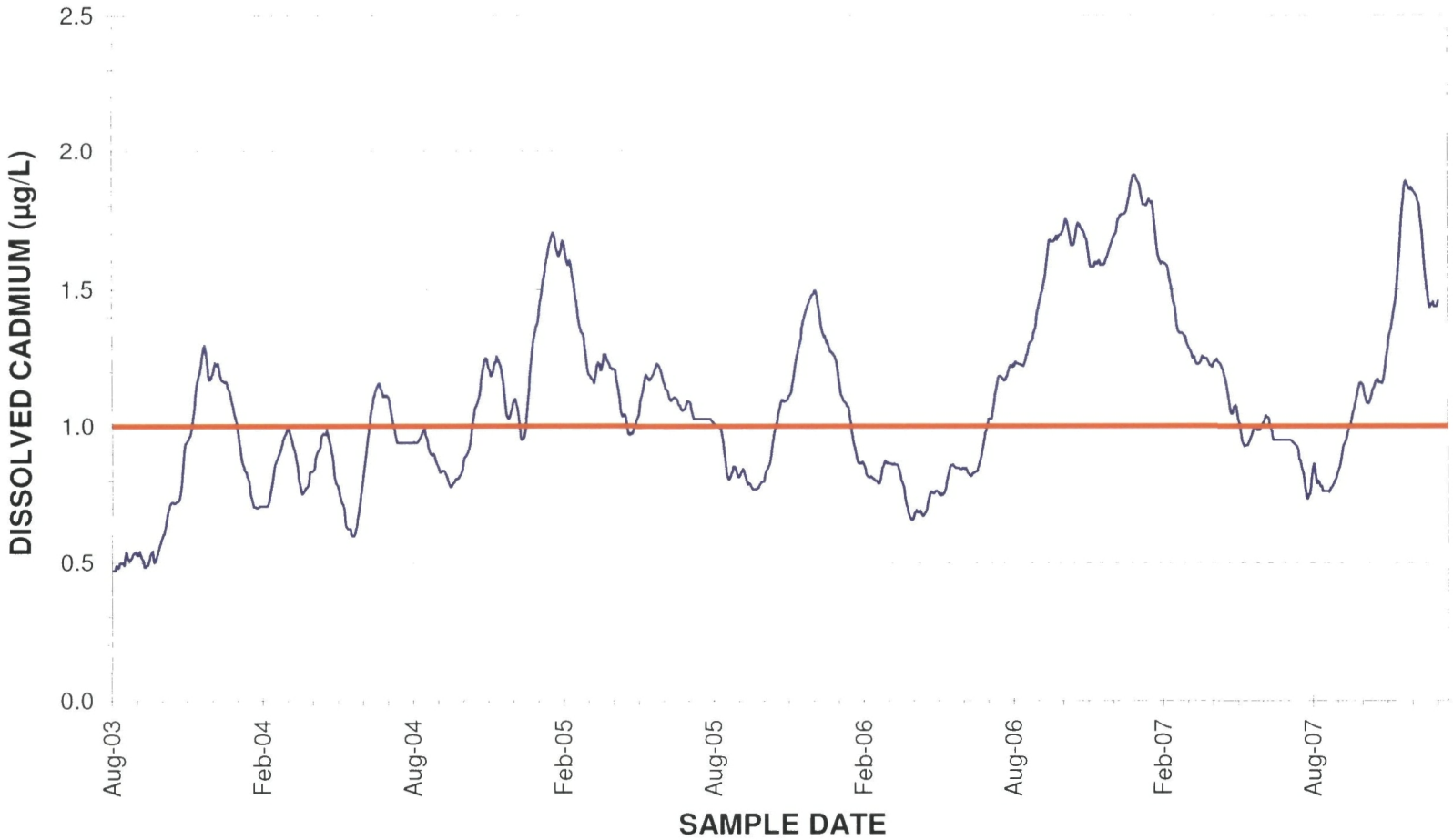


DISSOLVED CADMIUM 7-DAY AVERAGE

BAT 7-DAY MAXIMUM 2 µg/L

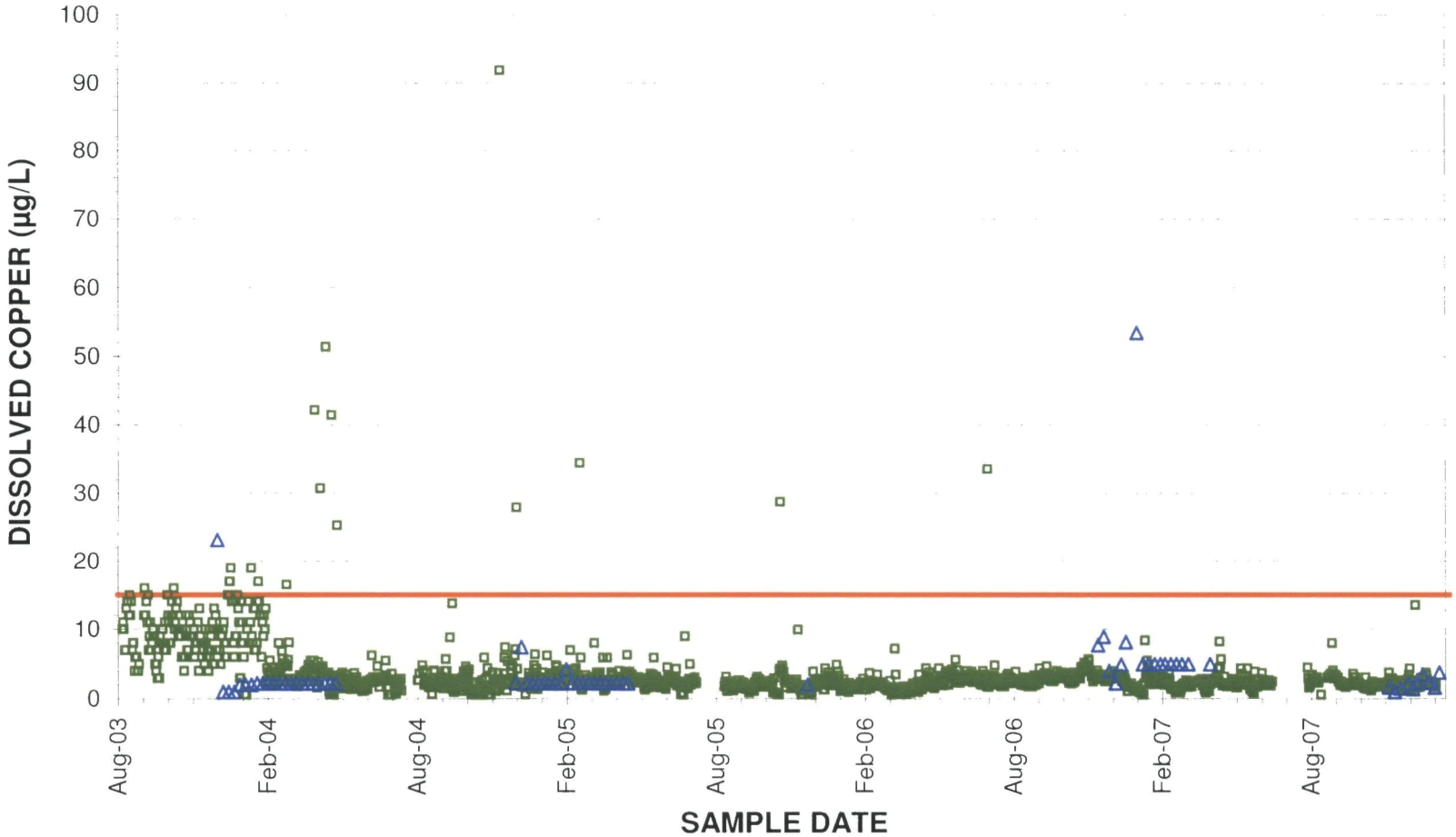
FIGURE 11
MFTP 7-DAY AVERAGE EFFLUENT DISSOLVED CADMIUM
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE



MFTP DISSOLVED CADMIUM 30-DAY AVERAGE

BAT 30-DAY MAXIMUM 1 µg/L

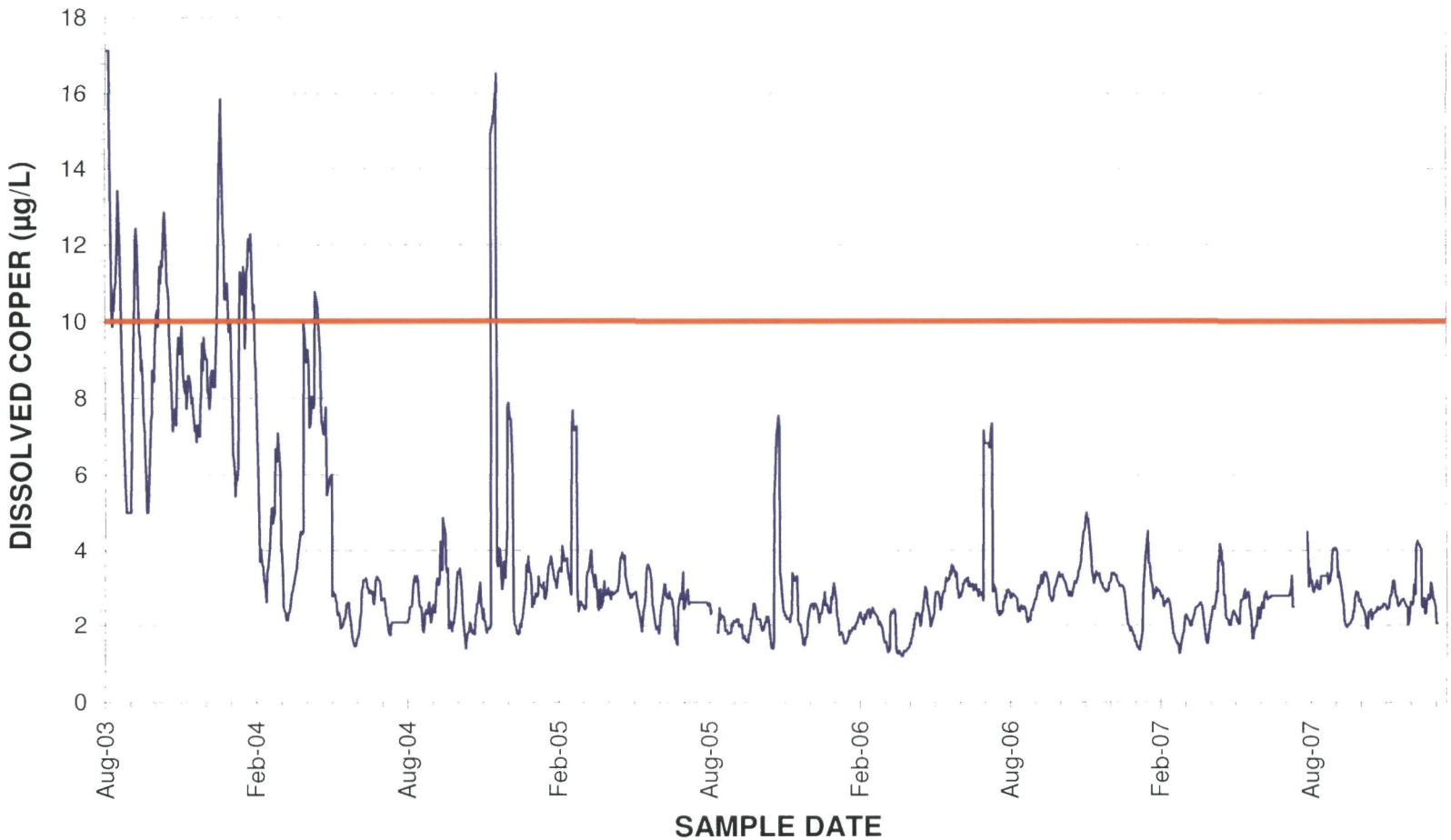
FIGURE 12
MFTP 30-DAY AVERAGE EFFLUENT DISSOLVED CADMIUM
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE



MFTP DISSOLVED COPPER DAILY
CH2M HILL DISSOLVED COPPER
BAT DAILY MAXIMUM 15 µg/L

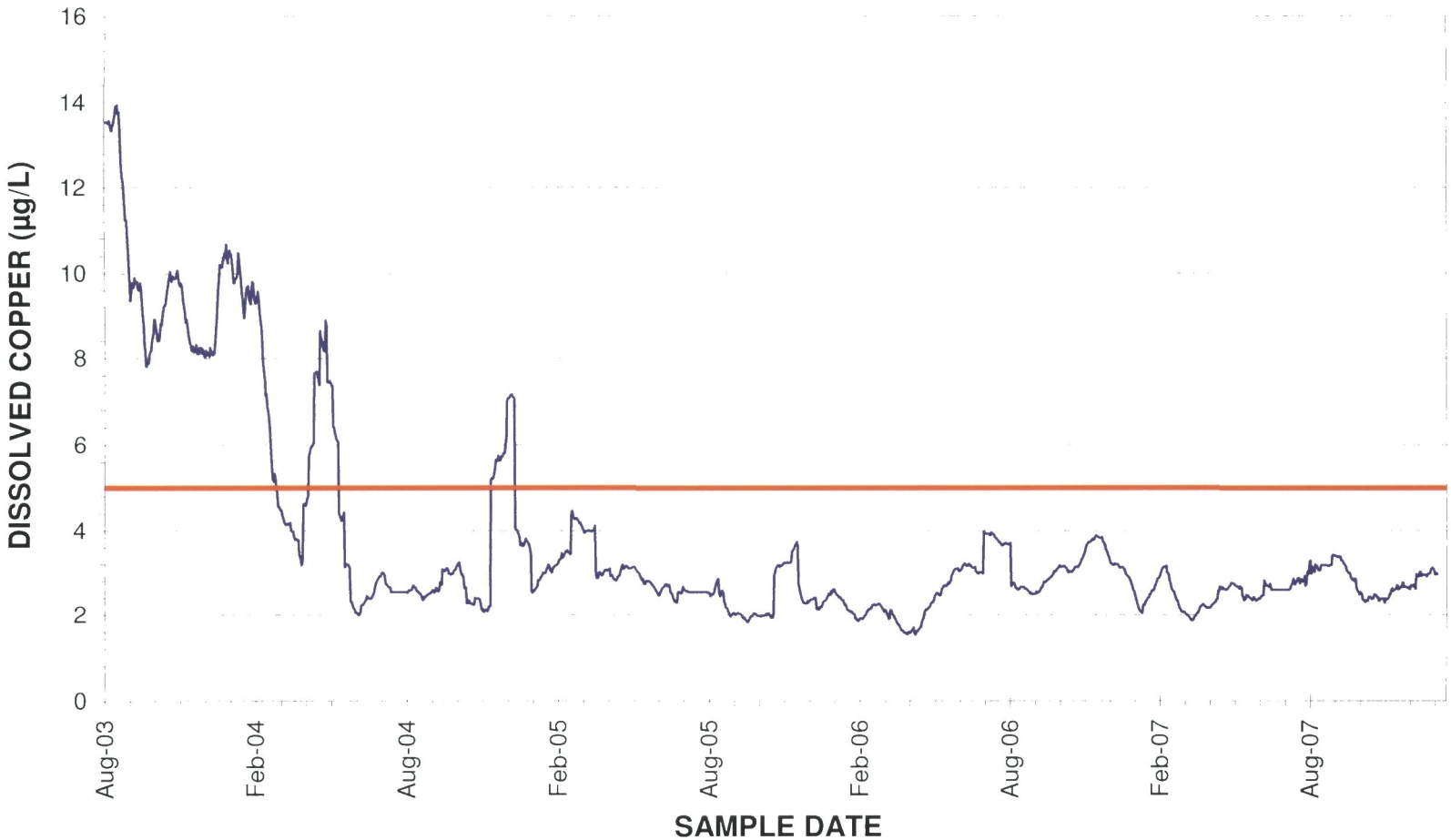
FIGURE 13
MFTP DAILY EFFLUENT DISSOLVED COPPER
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE

2003-2008_Figures-5yr-Review.xls: F13-batCu



DISSOLVED COPPER 7-DAY AVERAGE
BAT 7-DAY MAXIMUM 10 µg/L

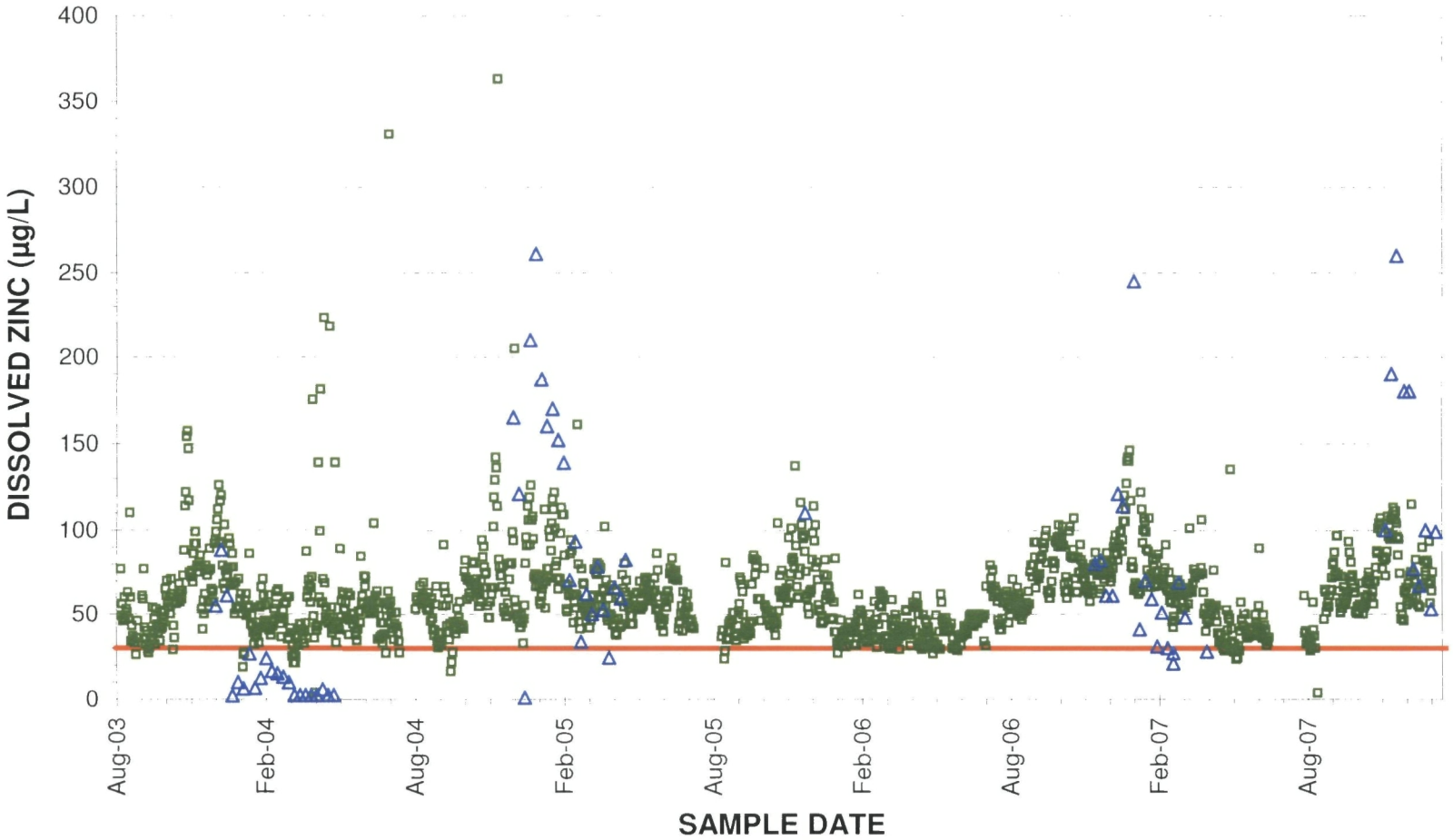
FIGURE 14
MFTP 7-DAY AVERAGE EFFLUENT DISSOLVED COPPER
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE



MFTP DISSOLVED COPPER 30-DAY AVERAGE

BAT 30-DAY MAXIMUM 5 µg/L

FIGURE 15
MFTP 30-DAY AVERAGE EFFLUENT DISSOLVED COPPER
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE



MFTP DISSOLVED ZINC DAILY
CH2M HILL DISSOLVED ZINC
BAT DAILY MAXIMUM 30 µg/L

FIGURE 16
MFTP DAILY EFFLUENT DISSOLVED ZINC
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE

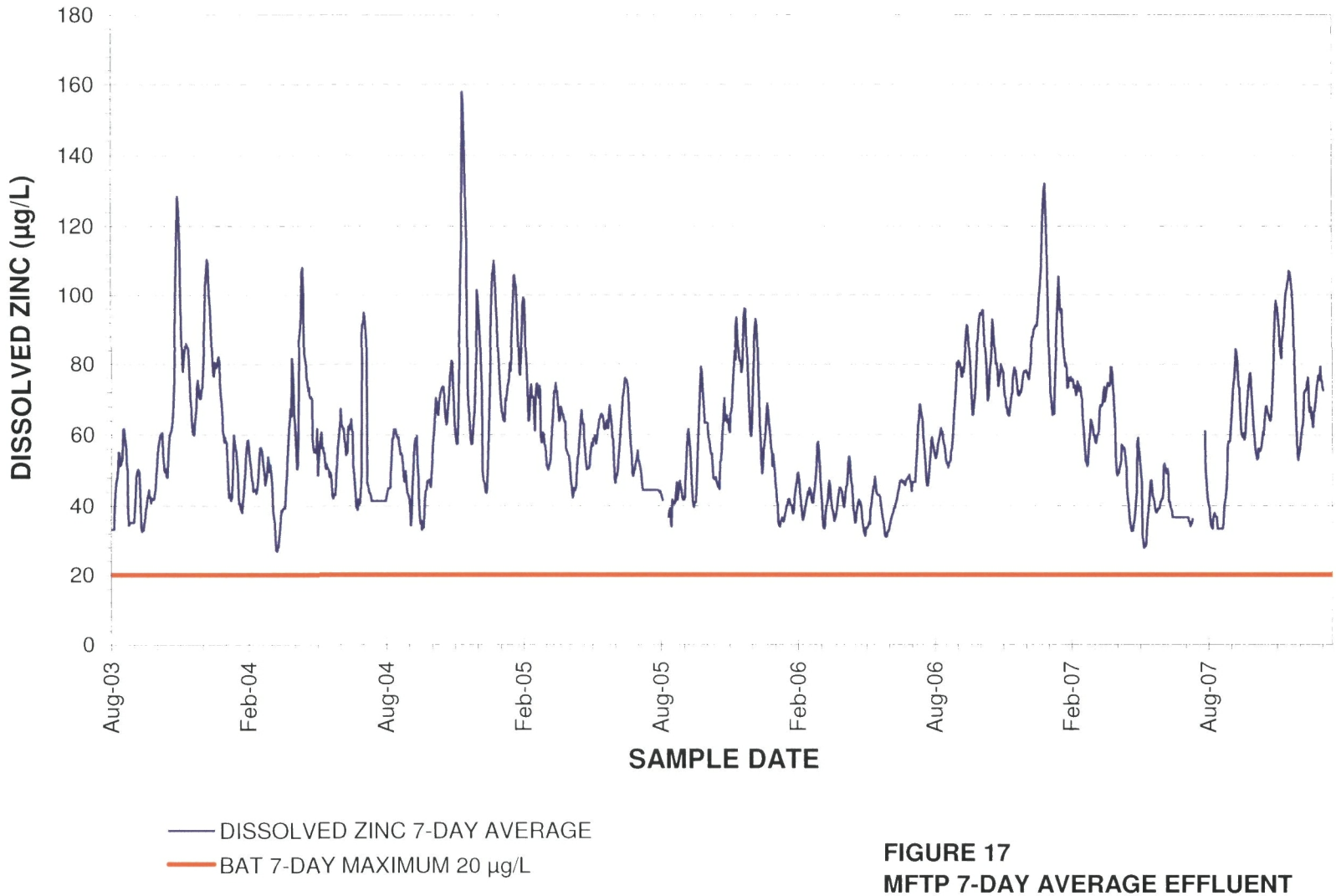


FIGURE 17
MFTP 7-DAY AVERAGE EFFLUENT
DISSOLVED ZINC
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE

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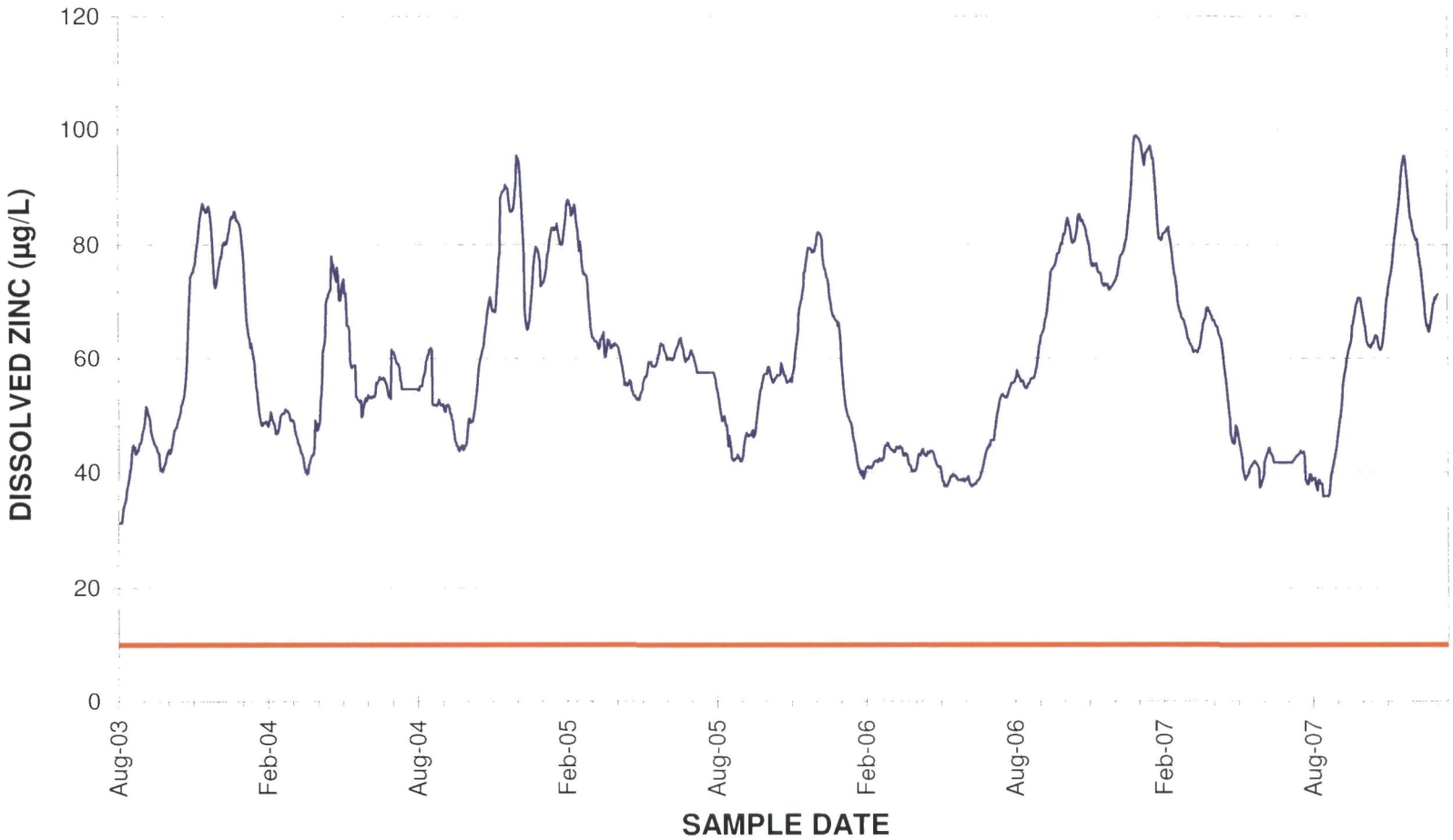

MFTP DISSOLVED ZINC 30-DAY AVERAGE

BAT 30-DAY MAXIMUM 10 µg/L

FIGURE 18
MFTP 30-DAY AVERAGE EFFLUENT DISSOLVED ZINC
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE

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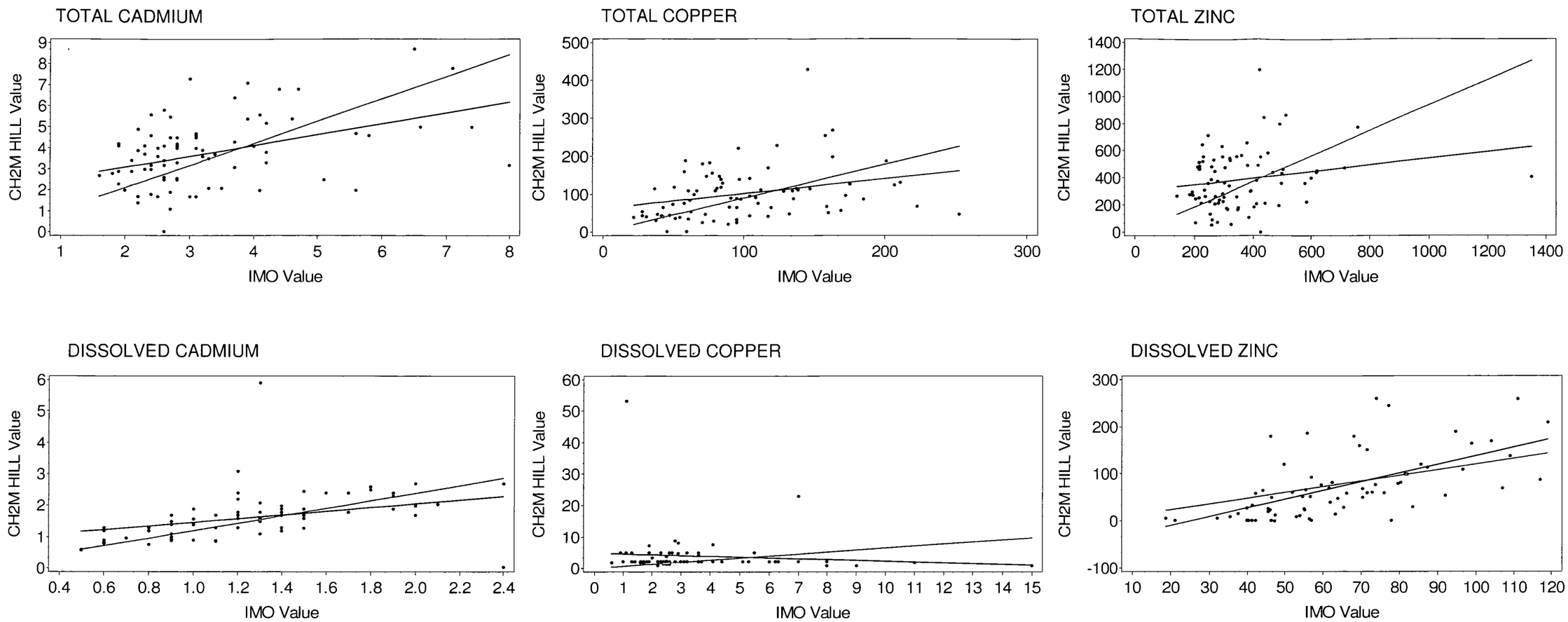

NOTES:
1. X- AND Y-AXES ARE CONCENTRATIONS IN µg/L
2. GRAY CORRELATION LINES ARE FORCED THROUGH ZERO
3. BLACK CORRELATION LINES MIGHT HAVE NON-ZERO Y-AXIS INTERCEPTS.

FIGURE 19
CORRELATION/STRAIGHT LINE REGRESSION PLOTS FOR CH2M HILL AND IMO PAIRED DATA
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE

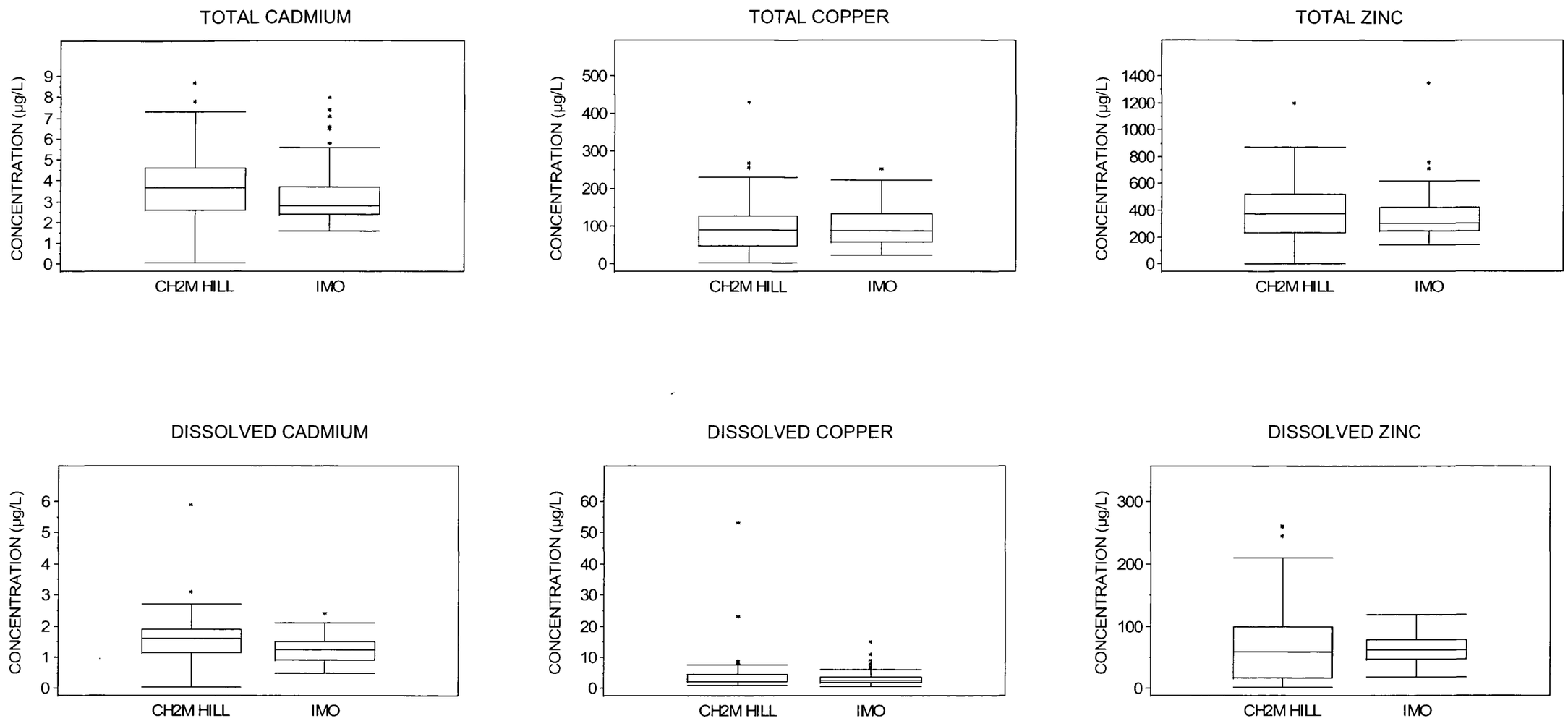

FIGURE 20
BOX AND WHISKER PLOTS FOR
CH2M HILL AND IMO POOLED DATA
AUGUST 2003 THROUGH JANUARY 2008
2008 FIVE-YEAR REVIEW
IRON MOUNTAIN MINE

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