STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
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September 24, 2013

MR. LEE WILMOT
TTM TECHNOLOGIES, INC.
15 INDUSTRIAL PARK DRIVE
STAFFORD SPRINGS, CT 06076

Re: No Further Action at the following Site:

- **Site Name:** TTM Technologies Inc. Redmond Division
- **Site Address:** 17460 NE 67th Court, Redmond, WA
- **Facility/Site No.:** 13804
- **VCP Project No.:** NW 2195
- **Cleanup Site ID No.:** 1397

Dear Mr. Wilmot:

The Washington State Department of Ecology (Ecology) received your request for an opinion on your independent cleanup of the **TTM Technologies Inc. Redmond Division** facility (Site). This letter provides our opinion. We are providing this opinion under the authority of the Model Toxics Control Act (MTCA), Chapter 70.105D RCW.

Issue Presented and Opinion

Is further remedial action necessary to clean up contamination at the Site?

NO. Ecology has determined that no further remedial action is necessary to clean up contamination at the Site.

This opinion is based on an analysis of whether the remedial action meets the substantive requirements of MTCA, Chapter 70.105D RCW, and its implementing regulations, Chapter 173-340 WAC (collectively "substantive requirements of MTCA"). The analysis is provided below.

Description of the Site

This opinion applies only to the Site described below. The Site is defined by the nature and extent of contamination associated with the following release:

- Cupric Chloride into the Soil and Ground Water

Enclosure A includes a detailed description and diagram of the Site, as currently known to Ecology.

Please note a parcel of real property can be affected by multiple sites. At this time, we have no information that the parcels associated with this Site are affected by other sites.

Basis for the Opinion

1. City of Redmond, Washington, 2013. Letter from Amanda Balzer to Heather Vick, Ecology re: *Former TTM Technologies, Inc. Site – NFA Request, Located at 17460 NE 67th Court, Redmond, Washington 98052.* July 9.

2. Environmental Resources Management (ERM), 2013. *Former TTM Technologies, Inc. Site – Groundwater Monitoring Results Update Addendum.* Email with attachments to Heather Vick, Ecology. June 28.

3. ERM, 2013. *Former TTM Technologies, Inc. Site – Groundwater Monitoring Results Update*; Email with attachments to Heather Vick, Ecology. March 1.

4. ERM, 2012. *Groundwater Monitoring Report, May 9, 2012, Groundwater Monitoring Event, Former TTM Technologies, Inc. Facility, 17460 NE 67th Court, Redmond, WA.* July 19.

5. City of Redmond, Washington, 2012. Letter from Amanda Balzer to Heather Vick, Ecology re: *January 2012 Cleanup Action Report Addendum 1, Former TTM Technologies, Inc. Site – NFA Request, Located at 17460 NE 67th Court, Redmond, Washington 98052.* March 12.

6. ERM, 2012. *Cleanup Action Report Addendum No. 1, TTM Technologies, Inc. Facility, 17460 NE 67th Court, Redmond, WA.* January.

7. ERM, 2009. *Groundwater Monitoring Report, October 22, 2009, Groundwater Monitoring Event, TTM Technologies, Inc., 17460 NE 67th Court in Redmond, WA.* November 24.

8. ERM, 2009. *Cleanup Action Report, TTM Technologies, Inc. Facility in Redmond, WA.* October.

9. ERM, 2009. *Sampling and Analysis Plan for Quarterly Groundwater Monitoring, TTM Technologies, Inc. Facility in Redmond, WA, VCP No. NW2195.* August 25.

10. ERM-West, Inc., 2009. Technical Memorandum, *EHC-M™ Treatment of Copper in Groundwater at TTM Technologies, Inc. Redmond, WA.* May.

11. ERM, 2009. *Release Report for Cupric Chloride Released at the TTM Technologies, Inc. Facility located at 17460 NE 67th Court, Redmond, WA.* April 23, 2009.

Those documents are kept in the Central Files of the NWRO Regional Office of Ecology (NWRO) for review by appointment only. You can make an appointment by calling the NWRO resource contact at (425) 649-7064.

This opinion is void if any of the information contained in those documents is materially false or misleading.

Analysis of the Cleanup

Ecology has concluded that **no further remedial action** is necessary to clean up contamination at the Site. That conclusion is based on the following analysis:

1. Characterization of the Site.

Ecology has determined your characterization of the Site is sufficient to establish cleanup standards and select a cleanup action. The Site is described above and in **Enclosure A.**

2. Establishment of cleanup standards.

a. Cleanup Levels

Ecology has determined the cleanup levels and points of compliance you established for the Site meet the substantive requirements of MTCA.

Soil:
A simplified Terrestrial Ecological Evaluation (TEE) was conducted for the Site, and the results indicate that further TEE is not required because land use at the Property and surrounding area makes substantial wildlife exposure unlikely in accordance with WAC-173-340-7492(2)(a)(ii). Therefore, soil cleanup levels protective of terrestrial species are not applicable at this Site.

A Site-specific MTCA Method B soil cleanup level for copper (262 mg/kg) was established based on the protection of ground water. Ecology concurs.

Ground Water:
The standard MTCA Method B ground water cleanup level for copper (640 µg/L) has been applied. Ecology concurs.

b. Points of Compliance

Soil:
The Soil cleanup level was set based on protection of ground water and direct contact. The point of compliance is therefore in soil throughout the Site.

Ground Water:
The standard point of compliance for ground water is throughout the Site from the uppermost level of the saturated zone extending vertically to the lowest most depth which could potentially be affected by the Site.

3. Selection of cleanup action.

Ecology has determined the cleanup action you selected for the Site **meets** the substantive requirements of MTCA.

The cleanup action using EHC-M™ is designed to permanently lower the ORP in groundwater to sulfate reducing conditions. The fact that this has not occurred following the EHC-M™ amendment and follow up injections indicates that the system is underdesigned or that the compound is not well distributed in the subsurface.

4. Cleanup.

Ecology has determined the cleanup you performed **meets** the cleanup standards established for the Site.

Ground water in Site monitoring wells sampled since October 2009 has contained total copper at concentrations below the Method B cleanup level including four consecutive quarters in 2009 and 2010. During the October 2009 round, total arsenic was detected in MW-4S at a concentration of 11 µg/L which exceeded the Method A cleanup level of 5 µg/L. A second exceedence of total arsenic was recorded in MW-06 in January 2011, at a concentration of 5.4 µg/L, just above the Method A cleanup level. All of the sampling results for the Site are for total metals which may be more elevated than if dissolved concentrations were reported.

A total of eleven post-remedial action sampling rounds were conducted in which copper was detected at concentrations below the Method B cleanup level except for the tenth

round in November 2012 when MW-4S contained 770 µg/L of total copper. A statistical analysis was performed using Ecology's workbook (MTCAStat 97) with data from MW-4S. The statistical analysis resulted in a data set that best fit a lognormal distribution with an upper confidence limit of 594 µg/L, which is below the Method B cleanup level.

Listing of the Site

Based on this opinion, Ecology will initiate the process of removing the Site from our lists of hazardous waste sites, including:

- Confirmed and Suspected Contaminated Sites List.

Limitations of the Opinion

1. Opinion does not settle liability with the state.

Liable persons are strictly liable, jointly and severally, for all remedial action costs and for all natural resource damages resulting from the release or releases of hazardous substances at the Site. This opinion **does not**:

- Resolve or alter a person's liability to the state.
- Protect liable persons from contribution claims by third parties.

To settle liability with the state and obtain protection from contribution claims, a person must enter into a consent decree with Ecology under RCW 70.105D.040(4).

2. Opinion does not constitute a determination of substantial equivalence.

To recover remedial action costs from other liable persons under MTCA, one must demonstrate that the action is the substantial equivalent of an Ecology-conducted or Ecology-supervised action. This opinion does not determine whether the action you performed is substantially equivalent. Courts make that determination. *See* RCW 70.105D.080 and WAC 173-340-545.

3. State is immune from liability.

The state, Ecology, and its officers and employees are immune from all liability, and no cause of action of any nature may arise from any act or omission in providing this opinion. *See* RCW 70.105D.030(1)(i).

Termination of Agreement

Thank you for cleaning up the Site under the Voluntary Cleanup Program (VCP). This opinion terminates the VCP Agreement governing this project (#NW 2195).

For more information about the VCP and the cleanup process, please visit our web site: www.ecy.wa.gov/programs/tcp/vcp/vcpmain.htm. If you have any questions about this opinion or the termination of the Agreement, please contact me by phone at (425) 649-7064 or e-mail at hvic461@ecy.wa.gov.

Sincerely,

Heather Vick, LHg
NWRO Toxics Cleanup Program

Enclosures (1): A – Description and Diagrams of the Site

cc: Michael F. Mendes, ERM-West, Inc.
Amanda R. Balzer, City of Redmond
Sonia Fernandez, VCP Coordinator, Ecology
Dolores Mitchell, VCP Financial Manager, Ecology

Enclosure A

Description and Diagrams of the Site

Site Description

This section provides Ecology's interpretation and understanding of Site conditions, and forms the basis for the opinions expressed in the body of the letter.

Site: The Site is associated with a former circuit board manufacturing operation that was formerly conducted at 17460 NE 67th Court in Redmond, Washington (Property). In 2009, a solution of cupric chloride was released to soil and ground water at the Property. The estimated extent of copper contamination comprises the Site as shown on the Site Diagram.

Area and Property Description: The Property is located in a mixed industrial/commercial area in Redmond. It consists of one large manufacturing and warehouse building, a paved parking lot and landscaping.

Property History and Current Use: The Property was owned by Pacific Circuits, Inc. at the time of the release. The Property was used by TTM Technologies, Inc. for the manufacturing of printed circuit boards until the facility was shut down in March 2009. In 2010, the Property was sold to the Evangelical Chinese Church of Seattle. The Property is currently the location of the Evangelical Chinese Church of Seattle.

Sources of Contamination: In 2009, a release of cupric chloride was discovered beneath the former concrete secondary containment structure located just to the north of the manufacturing building. Totes of spent cupric chloride used in the etching process were stored in the containment structure from approximately 2003 through January 2009. Since no known spills of cupric chloride had been documented in the containment structure, it is likely that the release occurred slowly over an extended period of time. During investigative activities conducted to characterize the Site, copper-contaminated soils extending to the water table were located below and near the containment structure. Concentrations of copper exceeded their applicable cleanup levels in both soil and groundwater.

Surface/Storm Water System: Storm water on the Property moves via sheet-flow across paved surfaces into storm drains located in the driveways along the east and west sides of the manufacturing building. After entering the storm drains, storm water is directed to onsite drain tiles or dry wells, where it infiltrates directly into the subsurface. It is unlikely that surface water runoff had been impacted by the cupric chloride since the release occurred within a secondary containment structure under a roof. A drainage ditch is located approximately 1,500 feet northwest of the Property. Lake Sammamish is approximately 4,600 feet to the south of the Property and the Sammamish River is located approximately 4,600 feet west of the Property.

Geology: The soils underlying the Property consist of fine to medium sand and gravel alluvium with some silt to the maximum depth explored which was 30.5 feet below the ground surface (bgs).

Ground Water: Ground water occurs as a shallow, unconfined aquifer within the alluvium; the depth to ground water varies seasonally, ranging from approximately 8 to 11 feet bgs. Groundwater flows toward the south-southwest in the vicinity of the release area. A downward

vertical gradient appears to exist in an area southwest of the former source area based on ground water elevations measured in monitoring well pair MW-4S/MW-4D. A downward vertical gradient at this location is also suggested by a pre-remediation (April 2009) detection of copper in MW-4D of 28.6 µg/L. Since the 2009 amendment, copper has not been detected in MW-4D.

Water Supply: The Property is located within a critical aquifer recharge area for the City of Redmond's shallow unconfined aquifer which is located below the city center. Approximately 40% of Redmond's drinking water is supplied by five water supply wells. The Property is located in Wellhead Protection Zone 3 which includes areas from which the estimated ground water travel time to the wells after entering the aquifer is 5 to 10 years.

Soil and Ground Water Remediation: In June 2009, copper-stained concrete and approximately 158 tons of copper-contaminated soil were excavated from the Site and disposed of at Columbia Ridge Landfill in Arlington, Oregon. The excavation area under the former concrete containment structure reached a total depth of 11 feet. The footprint of the bottom of the excavation extended laterally to the north and south edges of the containment structure. The sloped sidewalls of the excavation extended 10 to 15 feet out from the sides of the containment structure as shown on the attached diagram. The area underlying the southeast corner of the containment structure was excavated to a depth of 9.5 feet. A portion of that area was over excavated after the initial confirmation soil samples contained copper that exceeded the MTCA Method B soil cleanup level. Confirmation soil samples collected following the over excavation contained copper at concentrations below the MTCA Method B cleanup level.

Prior to backfilling, a soil amendment consisting of 1,300 pounds of a metal remediation compound, EHC-M™, was mixed into the saturated soils and groundwater at the bottom of the excavation. EHC-M™ is used for the in-situ immobilization of soluble metals using enhanced precipitation and adsorption. The compound is designed to generate and maintain very low oxidation-reducing (ORP) conditions via microbial consumption of the carbon and electron acceptors.

EHC-M™ treats copper, a cation, in ground water by causing it to precipitate as a sulfide following stimulated heterotrophic microbial sulfate reduction to sulfide. Adventus, the manufacturer of EHC-M™, recommends baseline sampling prior to use of EHC-M™ for the immobilization of metals. The recommended baseline monitoring would include total and dissolved concentrations of target metals, pH, dissolved oxygen, ORP, anions (including chloride, sulfate, nitrate) and total organic carbon to evaluate conditions within the impacted area. Monitoring dissolved organic carbon, alkalinity and hardness would provide information regarding the Site soil and water chemistry which may help in analyzing the results. At a minimum, it is recommended by Adventus that pH, ORP, target metals, anions and TOC be monitored. Adventus also recommends measuring total and dissolved target metals. The concentration of dissolved metals within the treatment area is needed for the remedial design and

post-injection evaluation. According to Adventus, the ratio between total and dissolved metals is an indicator of the oxidation-reduction state of the aquifer.

Post Remediation Monitoring: Post-remediation ground water samples were analyzed for total copper and total arsenic. Two quarters of post-remediation ground water samples, in October and December 2009, were also analyzed for total chromium. The first round of ground water confirmation sampling conducted in October 2009 indicated compliance with the MTCA Method B ground water cleanup level for copper. However, the Method A cleanup level for arsenic (5 µg/L) was exceeded in several monitoring wells analyzed for total arsenic. Subsequent non-consecutive quarterly post-remediation sampling yielded declining concentrations of the analytes at values that were below the MTCA cleanup levels. In June 2010, the copper concentration in monitoring well MW-4S increased to 500 µg/L which was attributed to a small area of residual copper-impacted ground water beneath the former containment structure. As a result of the spike in copper at MW-4S, in December 2010, a total of 484 gallons of EHC-M™ was injected into 11 boring locations south of the former concrete containment structure.

Quarterly ground water sampling resumed in January 2011. At that time, increases in copper concentrations occurred in two downgradient monitoring wells, MW-05 and MW-06, and a well installed in the former source area, MW-07 but did not exceed the MTCA cleanup levels. In addition, the sample from MW-06 contained arsenic at a concentration exceeding the Method B cleanup level. The concentration of copper in MW-4S decreased to nearly what it was prior to the June 2010 spike and decreased farther to 44 µg/L in July 2011. Subsequent quarterly ground water sampling conducted through July 2011 demonstrated declining copper and arsenic concentrations in all of the wells with no exceedances of the MTCA Method B groundwater cleanup levels. A fourth consecutive quarter of ground water monitoring was not conducted in 2011.

A ground water sampling round conducted in May 2012 indicated that copper and arsenic concentrations in all Site monitoring wells were below the Method B cleanup levels.

According to Adventus, the achievement of sulphate-reducing conditions is critical to the long-term stabilization of copper using EHC-M™. However, instead of the ORP levels at the Site decreasing to the approximate range of -90 to -200 as expected, the ORP in all of the monitoring wells has increased since the December 2010 EHC-M™ injections. ORP values in July 2011 ranged from -18 at MW-07 to 336 at MW-03. The pH also has increased but the addition of EHC-M™ is designed to create neutral pH conditions so an increase would be expected since the natural pH of ground water in Redmond's drinking water aquifer normally ranges from 5.8 to 6.2. The altered pH is expected to decrease with time but not sufficient to cause dissolution of the immobilized copper and arsenic.

In May 2012, pH levels decreased in all of the wells, ranging from 5.9 to 6.0; ORP decreased slightly in all of the wells.

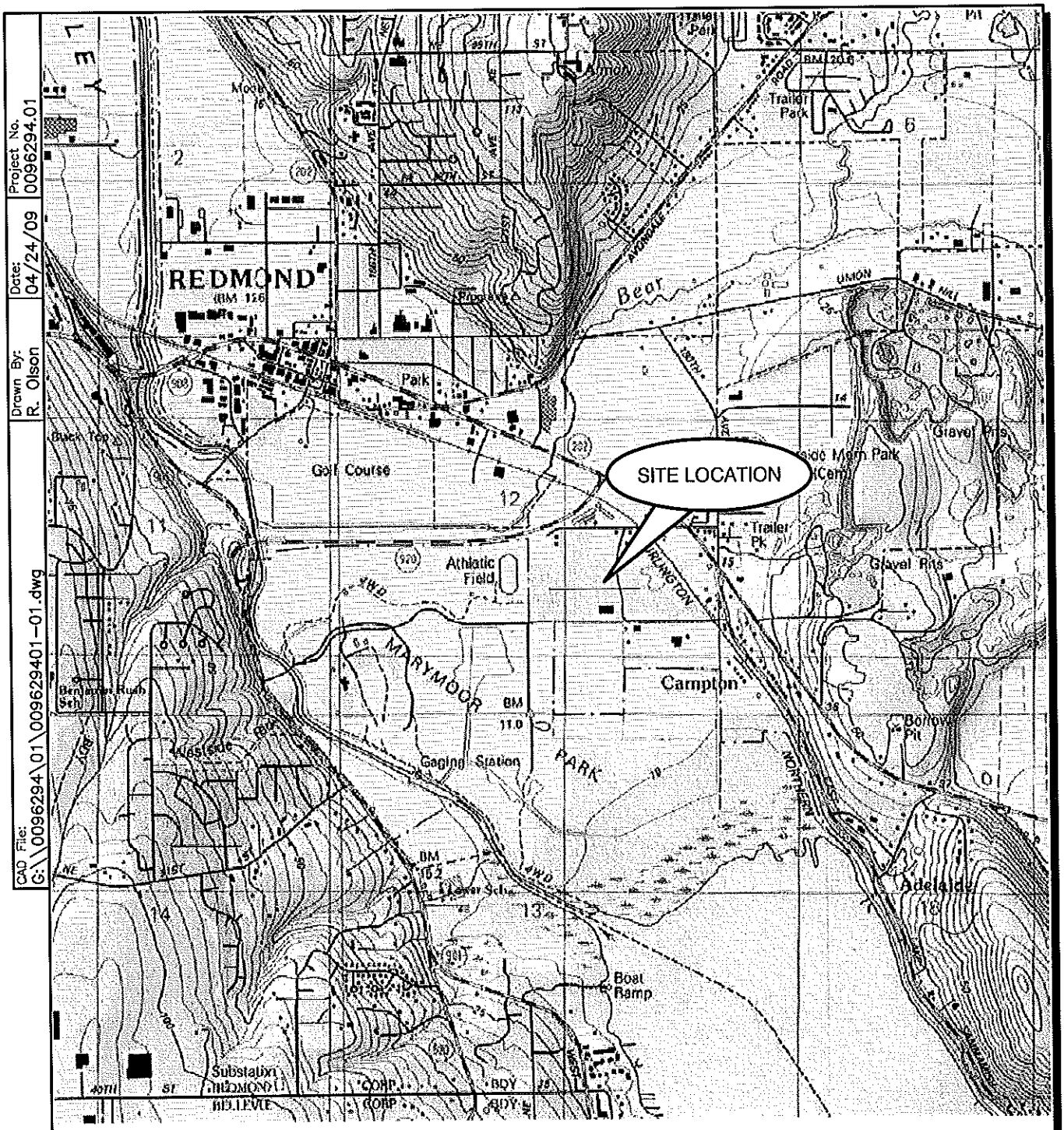
Ground water on the Site has been sampled since October 2009 without exceedences of the Method B cleanup level for copper. Due to the EHC-M™ injections, the quarterly ground water

sample for fall 2010 was not collected. A ground water sample representative of the fall quarter was requested by Ecology to show seasonal variations for copper. A ground water sampling round conducted in November 2012 yielded copper concentrations below the MTCA cleanup levels in all of the wells except MW-4S, which contained 770 µg/L of copper exceeding the Method B cleanup level. A ground water sampling round conducted a month later in December 2012 yielded copper concentrations below the Method B cleanup level in all the wells. The copper concentration in MW-4S was 200 µg/L.

In May 2013, a ground water sample collected from MW-4S and analyzed for total copper yielded a concentration of 170 µg/L.

Copper concentrations occurring in MW-4S since October 2009 were used to conduct a statistical analysis using Ecology's workbook (MTCAStat97 Site Module). The evaluation used 11 rounds of ground water sampling data which resulted in a data set that best fit a lognormal distribution. The values used in the analysis were the higher of two values obtained for MW-4S, the sample and the duplicate sample. The resulting upper confidence limit for MW-4S was 594 µg/L which is below the Method B cleanup level for copper of 640 µg/L.

Site Diagrams



References:
TOPOI® Software
U.S.G.S. 7.5 Minute Series (Topographic) Quadrangle, Redmond, WA
Version: 1982; Current: 1979

Figure 1
Site Location Map
TTM Technologies, Inc.
17460 NE 67th Court
Redmond, Washington

ERM 04/09

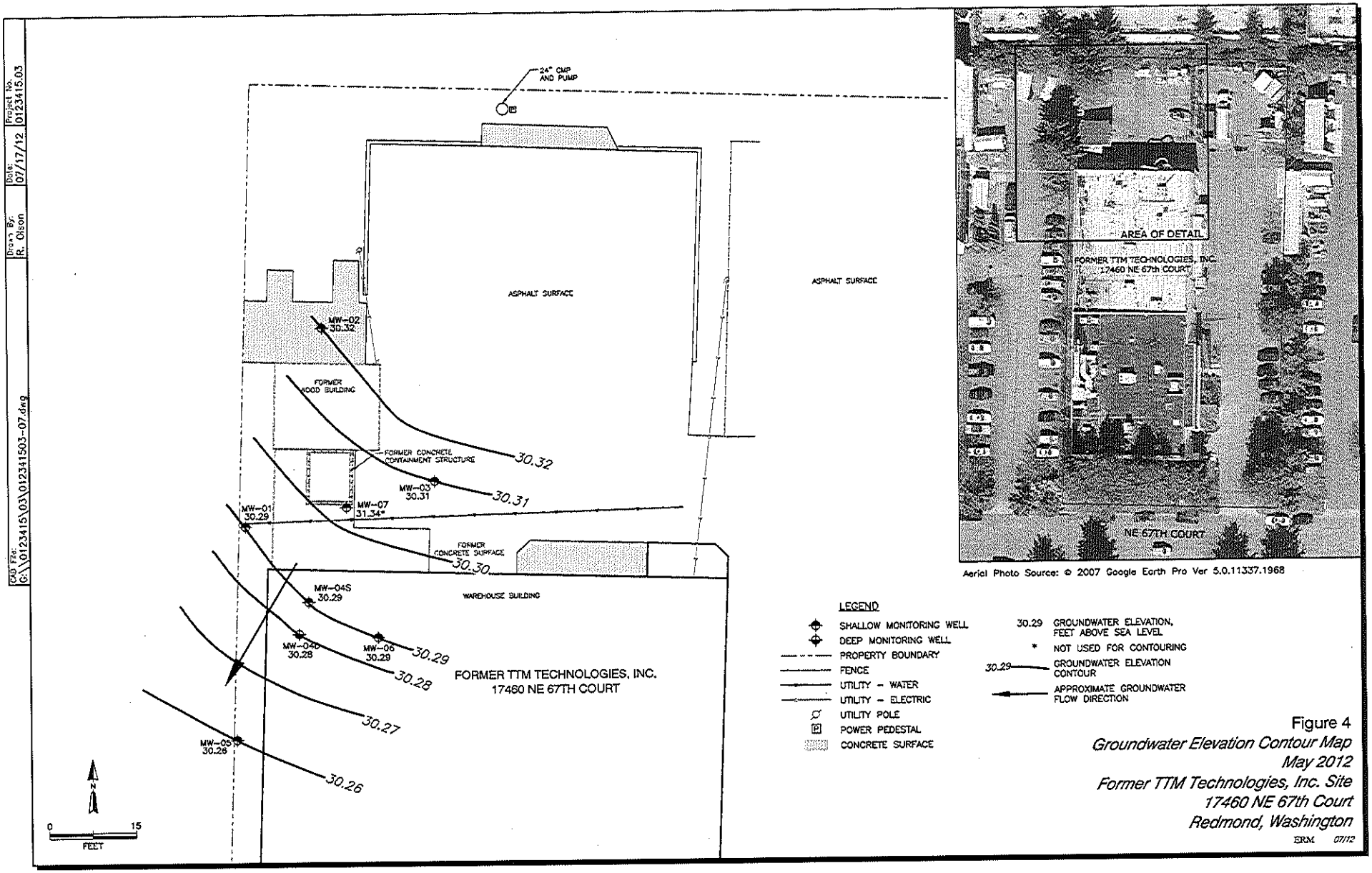


Figure 4

Groundwater Elevation Contour Map
May 2012
Former TTM Technologies, Inc. Site
17460 NE 67th Court
Redmond, Washington

ERM 07/12

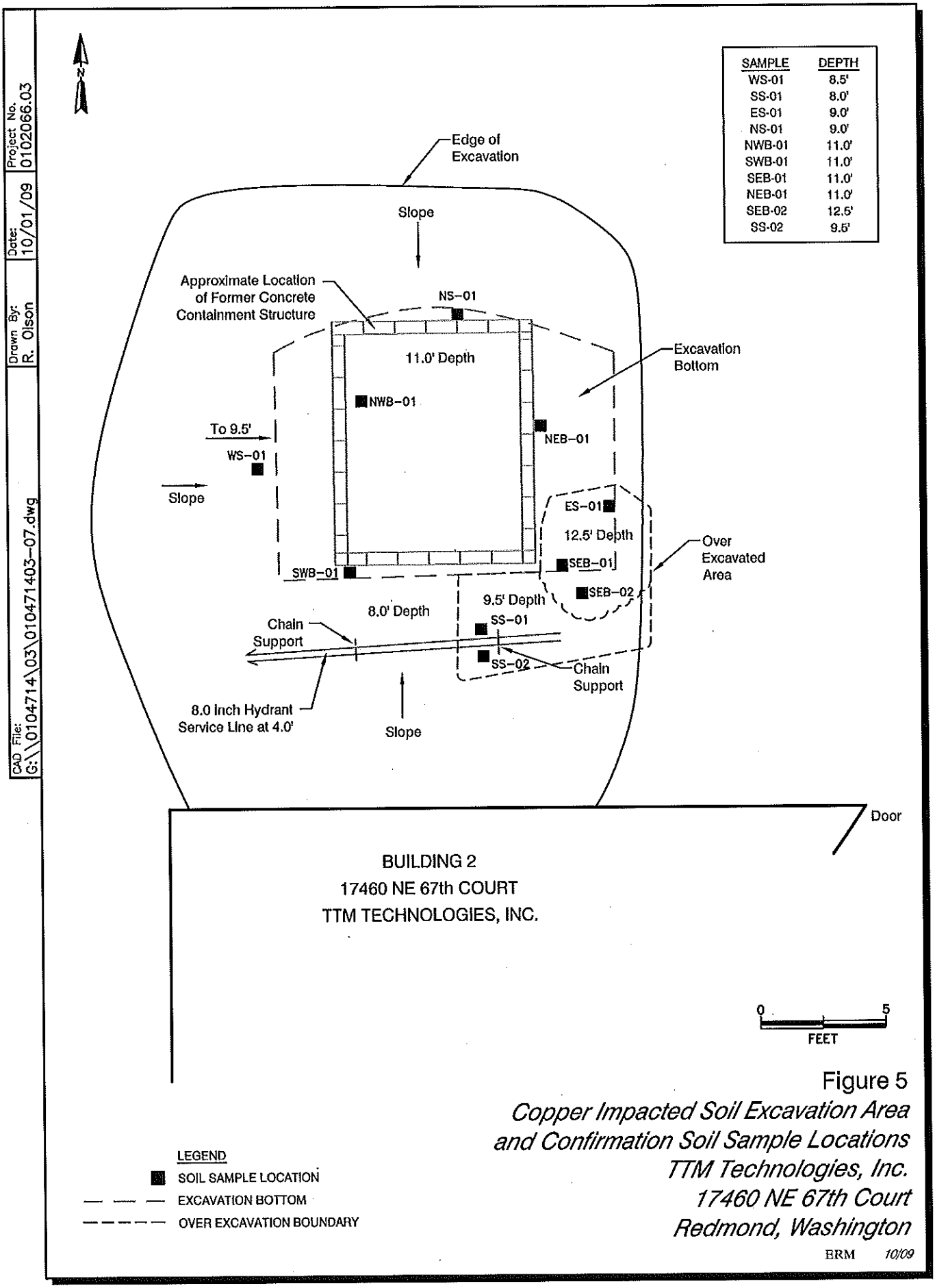


Figure 5

Copper Impacted Soil Excavation Area and Confirmation Soil Sample Locations
TTM Technologies, Inc.
17460 NE 67th Court
Redmond, Washington

ERM 10/09

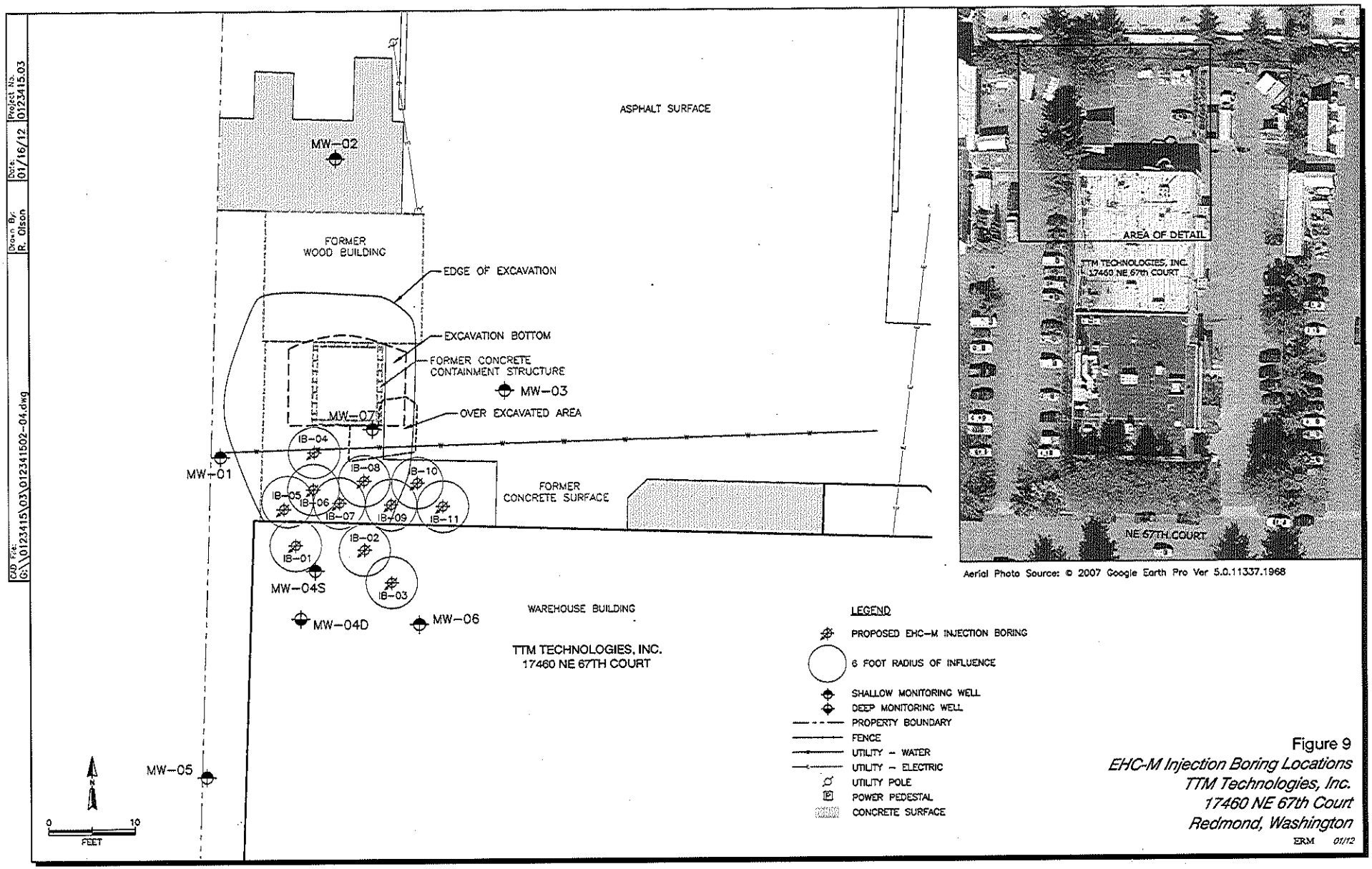


Figure 9

EHC-M Injection Boring Locations
TTM Technologies, Inc.
17460 NE 67th Court
Redmond, Washington

ERM 01/12

Figure 10
Total Copper Concentration Trends in Groundwater vs. Time
Former TTM Technologies, Inc. Site
Redmond, Washington

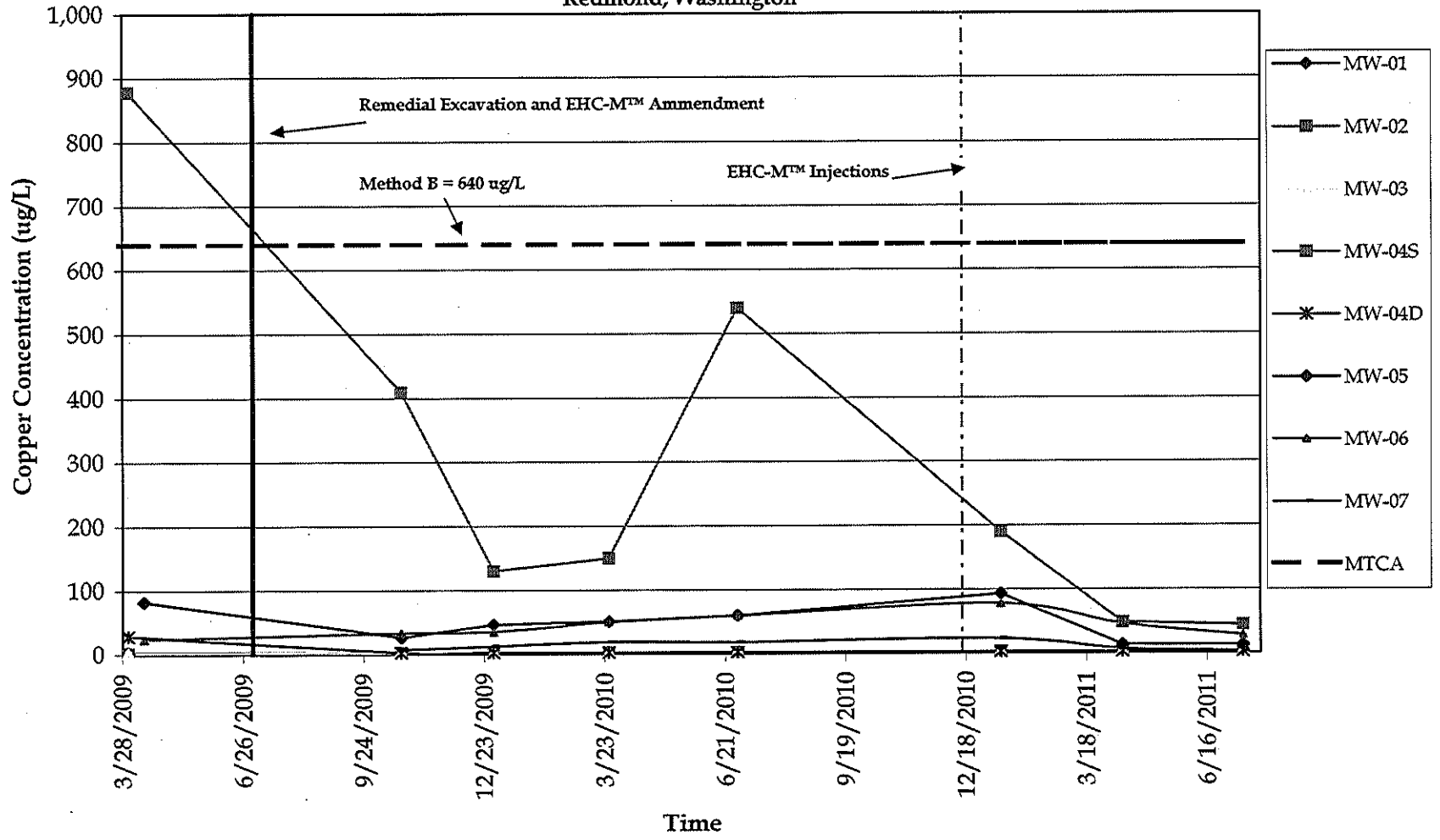


Figure 14
Groundwater Elevation vs. Time
Former TTM Technologies, Inc. Site
Redmond, Washington