

DISCOVERY TO CLOSURE

A Life Cycle Case Study of a Natural Gas Condensate Plume

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OUTLINE

- Discovery
- Remediation
- Updated LCSM
- Site Closure



Introduction

- The Site, located in West Texas is a former gas processing plant currently operated as a gas compressor and liquids separation station.
- Site is bounded by generally undeveloped privately owned lands with oil and gas production activities. Multiple active oil and gas wells and pipelines are present.
- LNAPL of concern is natural gas condensate.
- The area of concern (AOC) in which dissolved phase impacts have been observed extends offsite generally south to southwest.

Site Map



0 250 ft



Project History

Discovery...

Dissolved impacts observed in a (water) well.

2005 – Performed initial site assessment activities to establish plume delineation. Results indicated that delineation had not been achieved.

Late 2005 – 2006 – Additional wells installed to fully delineate the plume.

Remediation...

2006 – Conducted an SVE Pilot Study. Results indicated effectiveness of a full-scale system.

2008 – Quarterly groundwater sampling events started in May. Mobile ICE-based unit started SVE recovery operations until full-scale system installed.

2009 – Full-scale remediation system installed. System operated in SVE mode.



Project History

Updated LCSM...

September 2012 – RRC meeting to discuss remedial activities and path forward (Updated LCSM).

2013 – LCSM update

- LNAPL transmissivity testing (*LNAPL mobility and recoverability*).
- Targeted CPT/LIF (*Geology and source delineation*).
- Additional wells for source and dissolved phase delineation (*Delineation*).
- LCSM modeling (*Visual LCSM*).

April 2014 – Updated LCSM and site closure discussion with RRC.

May 2014 – Targeted TPE event conducted to remove “recoverable LNAPL”.

June 2014 – System shutdown and closure monitoring.

Risk-Based Cleanup Objectives

- Current risk-based cleanup standards for groundwater are Tier 1, MCL-Based Drinking Water Levels.
- No cleanup levels have been established for soil.
- System objective is source mass removal and compositional change for LNAPL with MNA/NSZD for groundwater.
- No onsite and offsite receptors.

Remediation System



ThermOx Unit and DPE Shed



DPE Shed Controller and PLC



Internal Components of DPE Shed



Internal Components of DPE Shed

Remediation System



ThermOx Unit



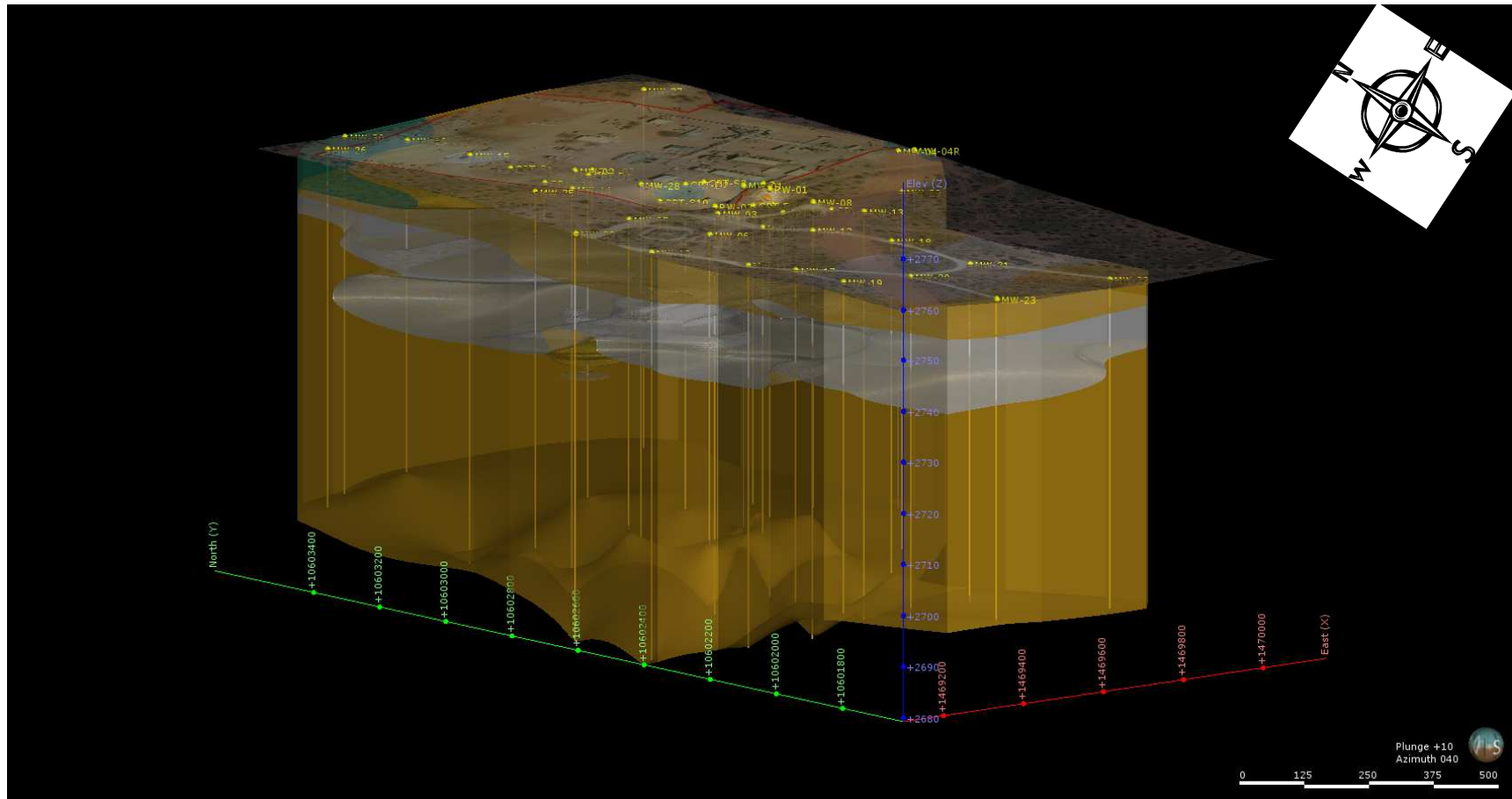
Extraction Well, Wellhead, and Piping



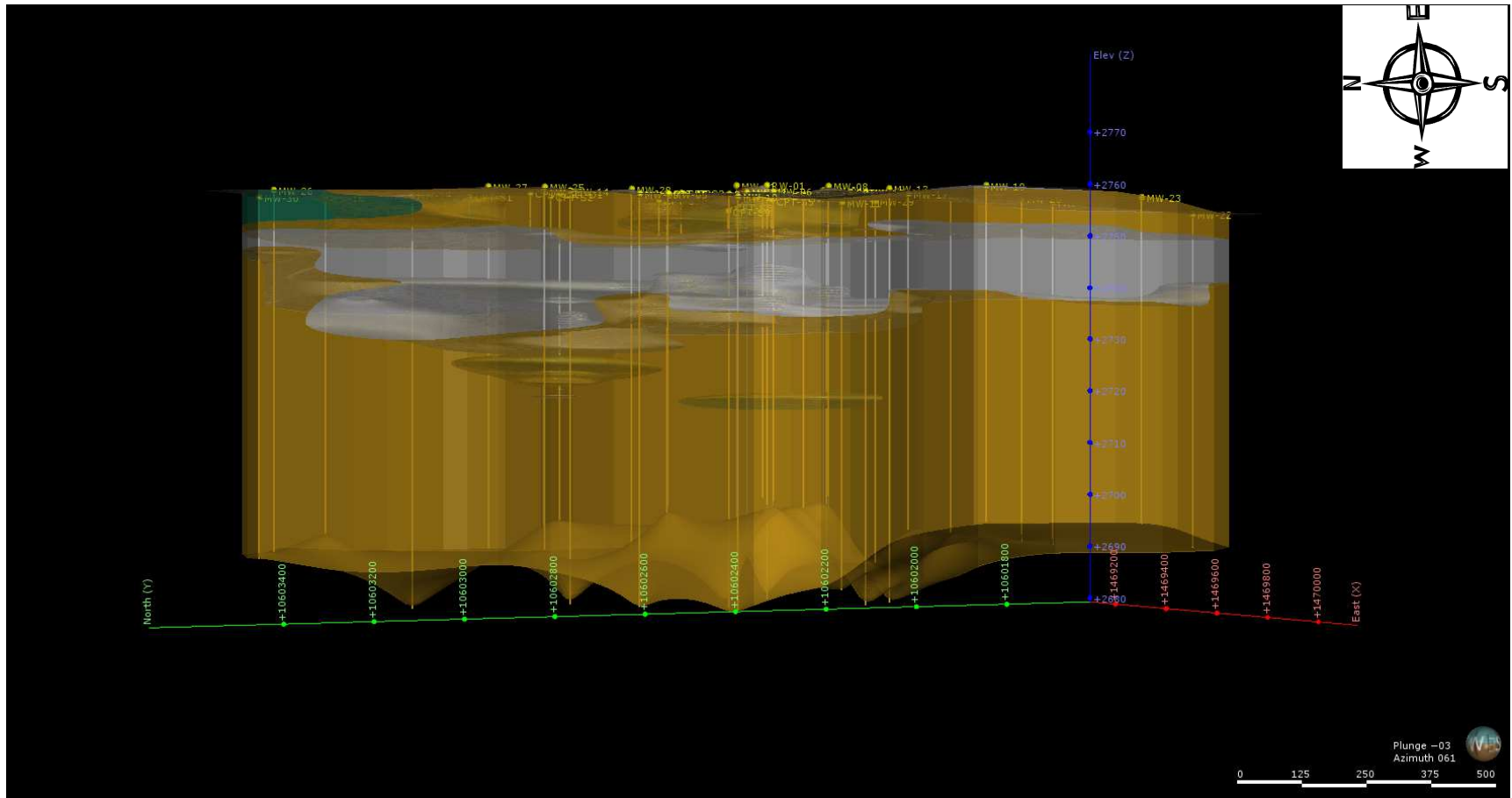
Exterior DPE Shed Manifold

LCSM UPDATE

GEOLOGY



GEOLOGY



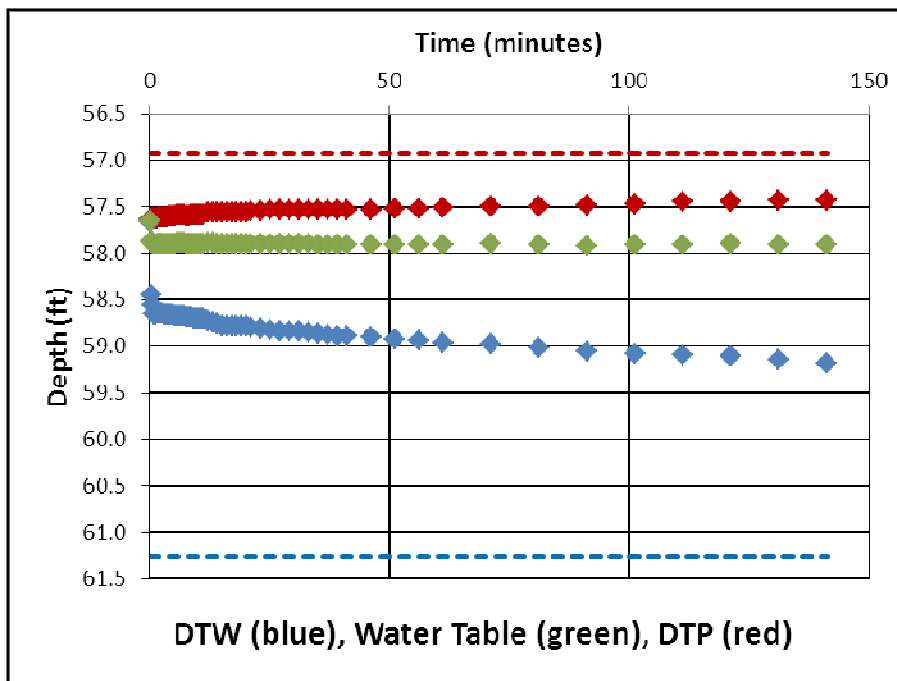
LNAPL Mobility/Migration



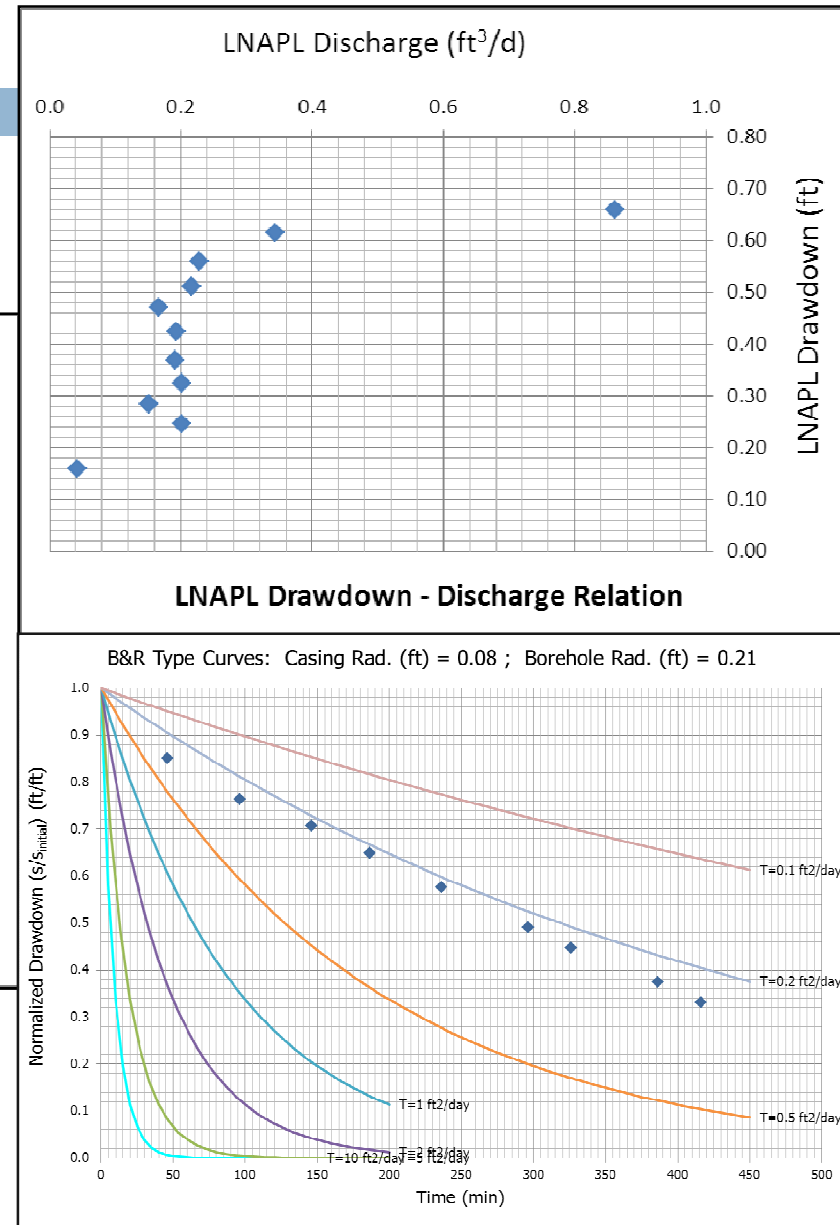
- Baildown tests conducted in MW-01 and MW-02 in Sep 2012.
- Estimated LNAPL Transmissivity using baildown test data.
- Transmissivity is a more accurate metric to evaluate LNAPL migration and mobility potential.

LNAPL Mobility/Migration

MW-01 (Sep 18, 2012)

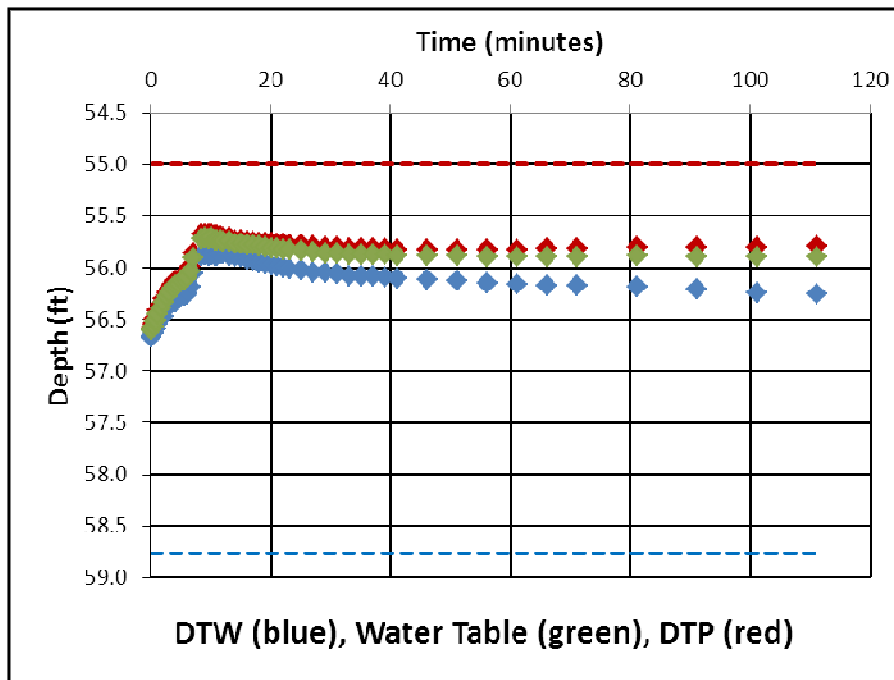


$$T_n \sim 0.2 \pm 0.03 \text{ ft}^2/\text{d}$$

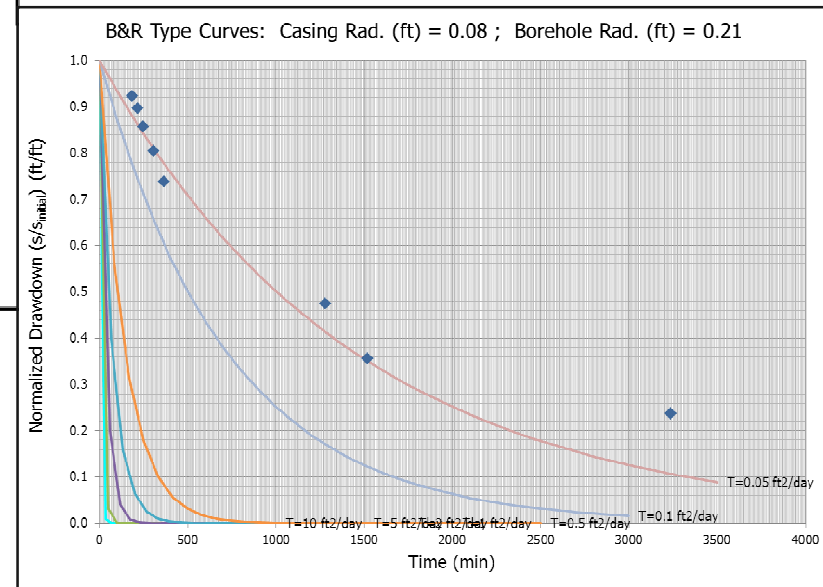
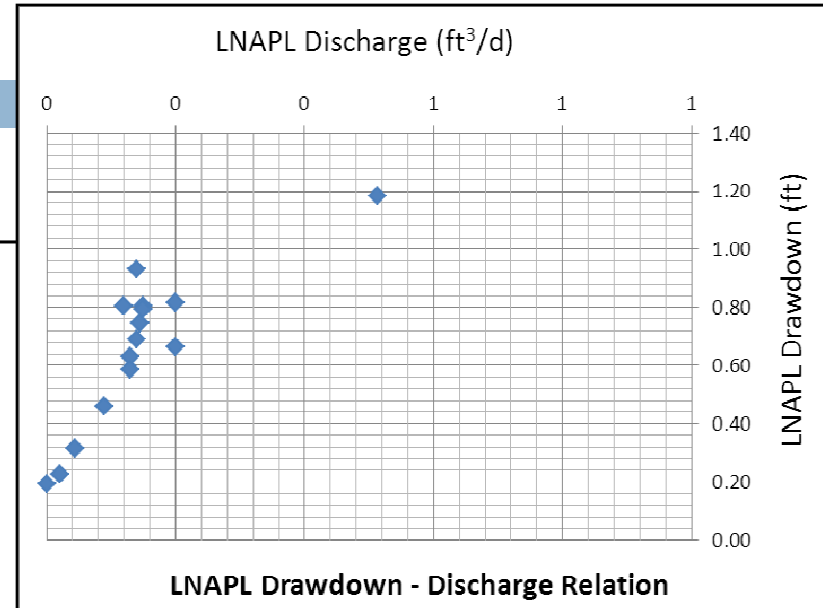


LNAPL Mobility/Migration

MW-02 (Sep 19, 2012)

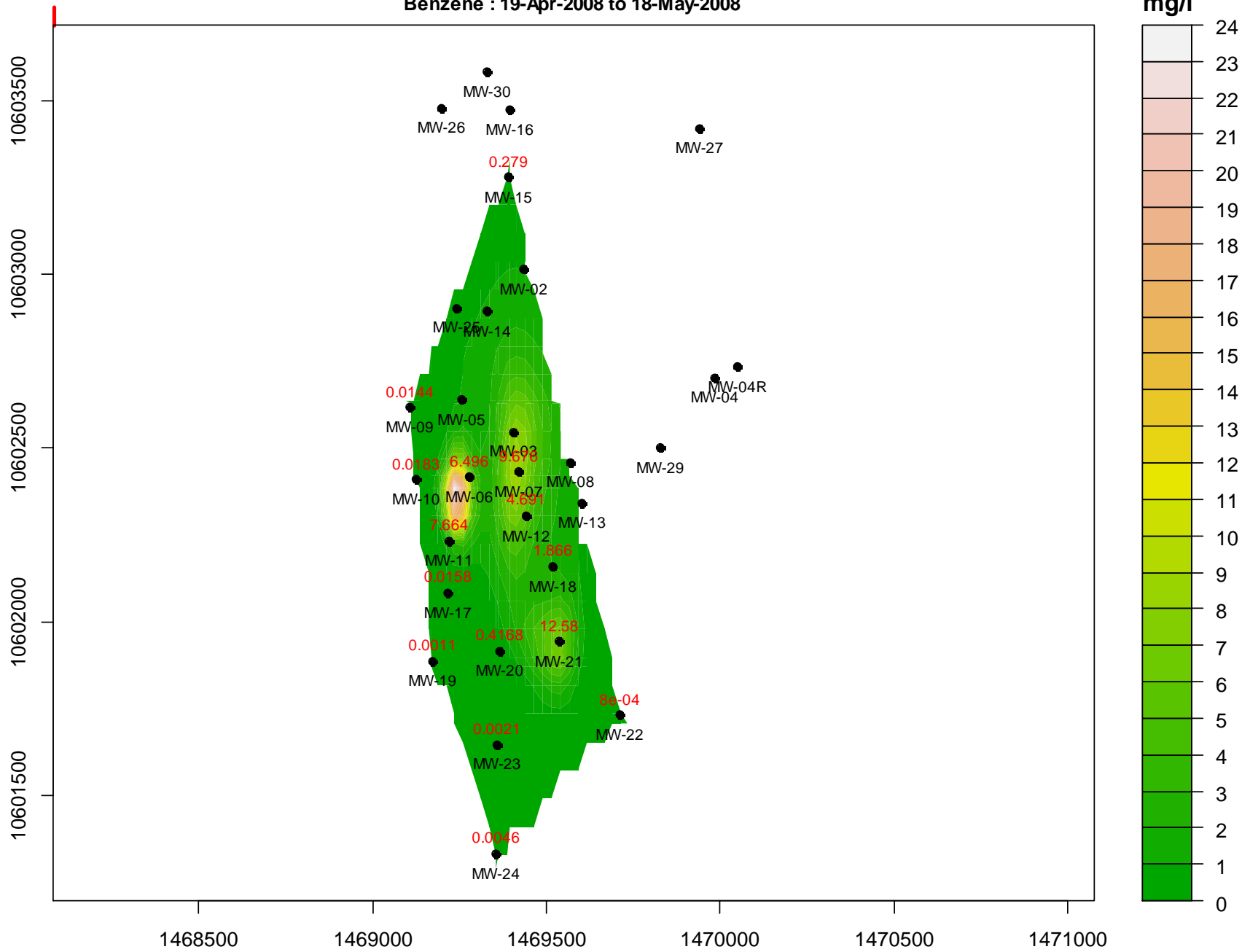


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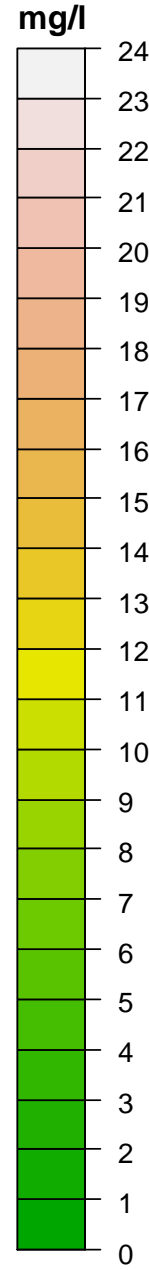
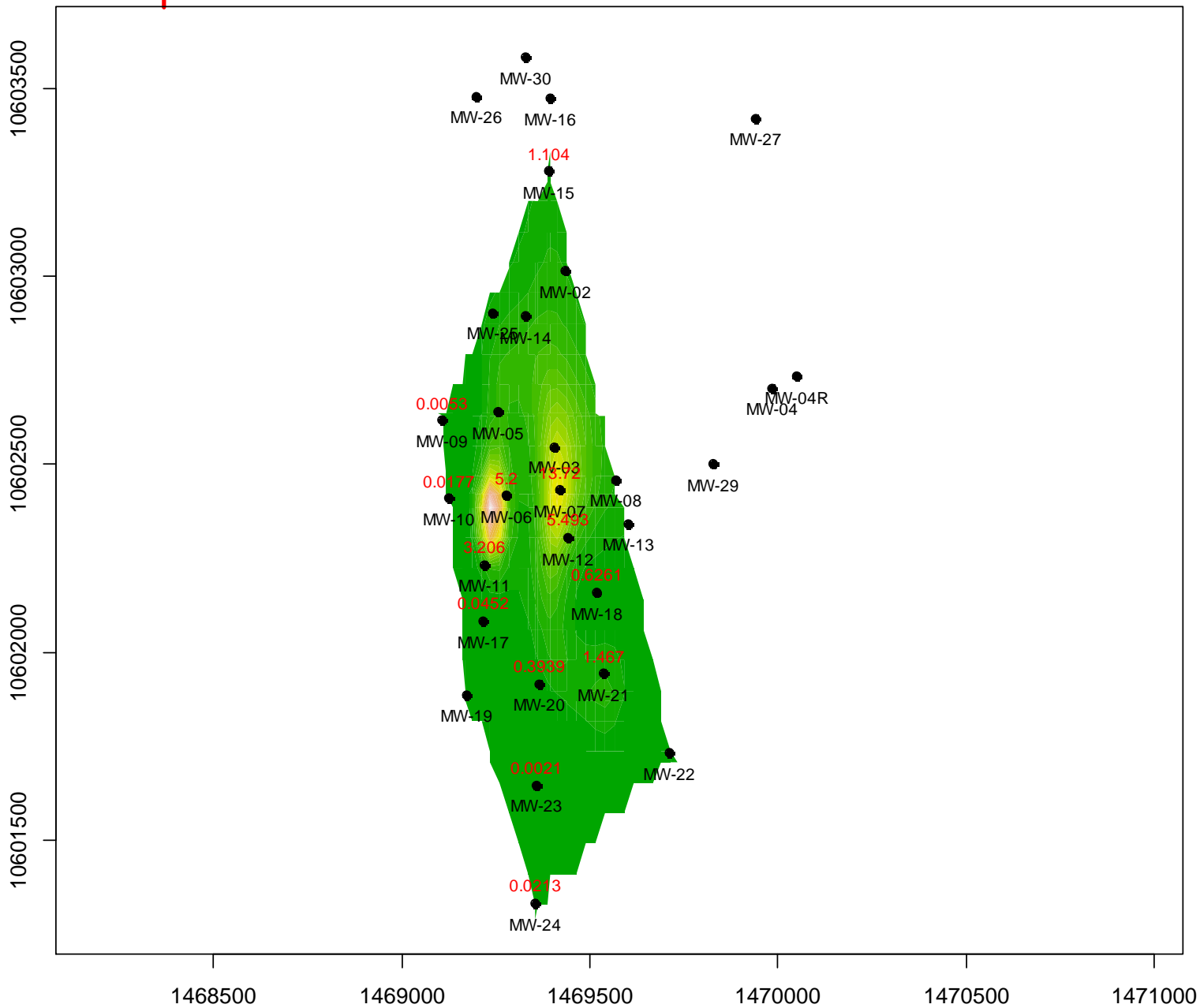


DISSOLVED BENZENE

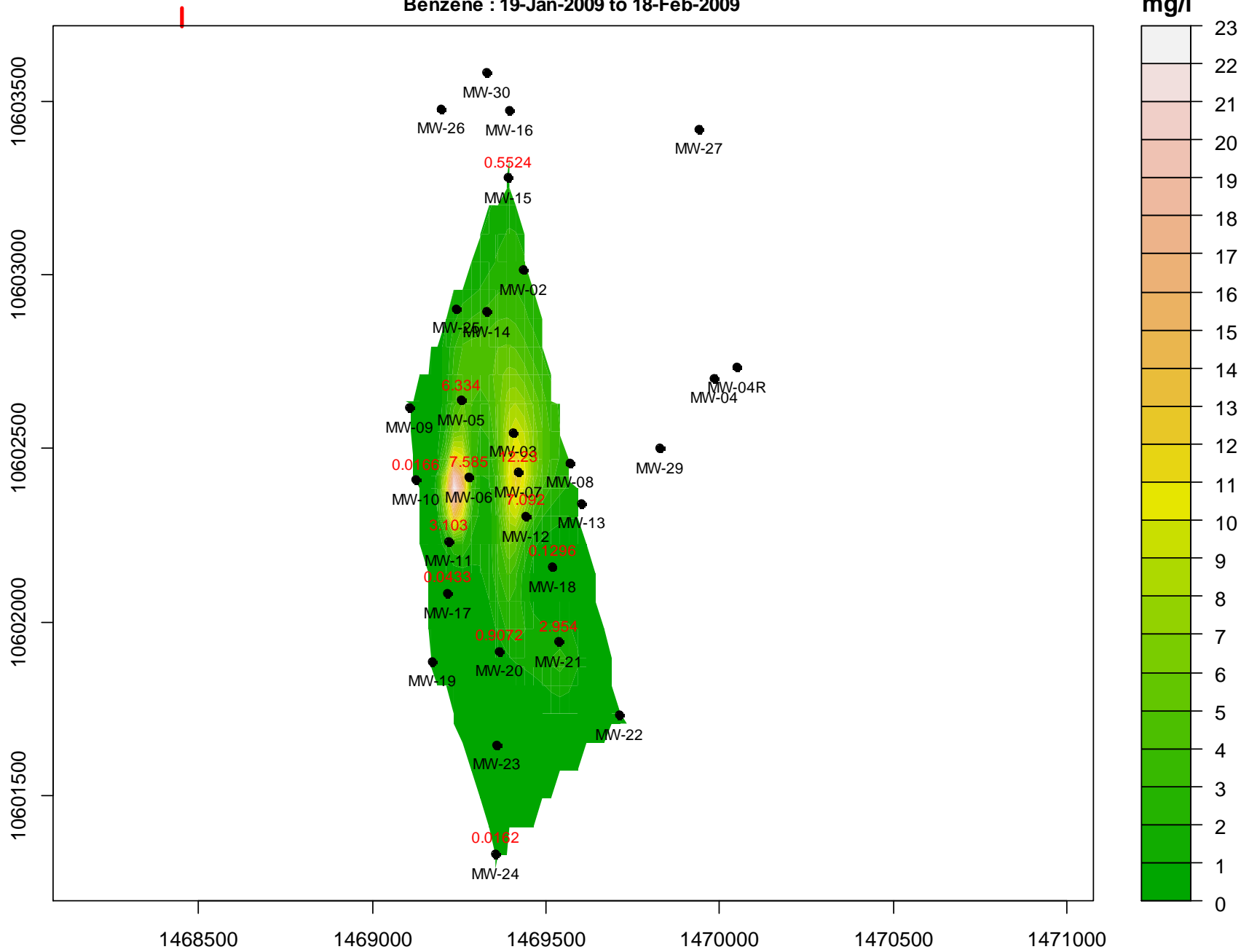
Benzene : 19-Apr-2008 to 18-May-2008



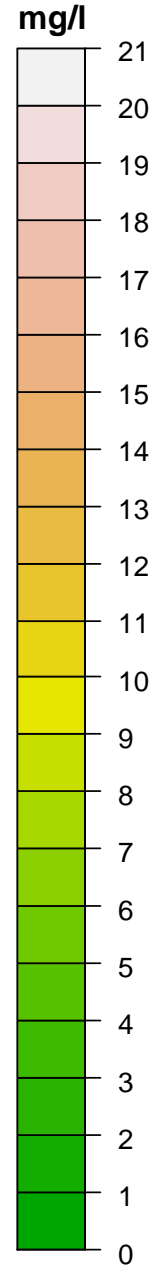
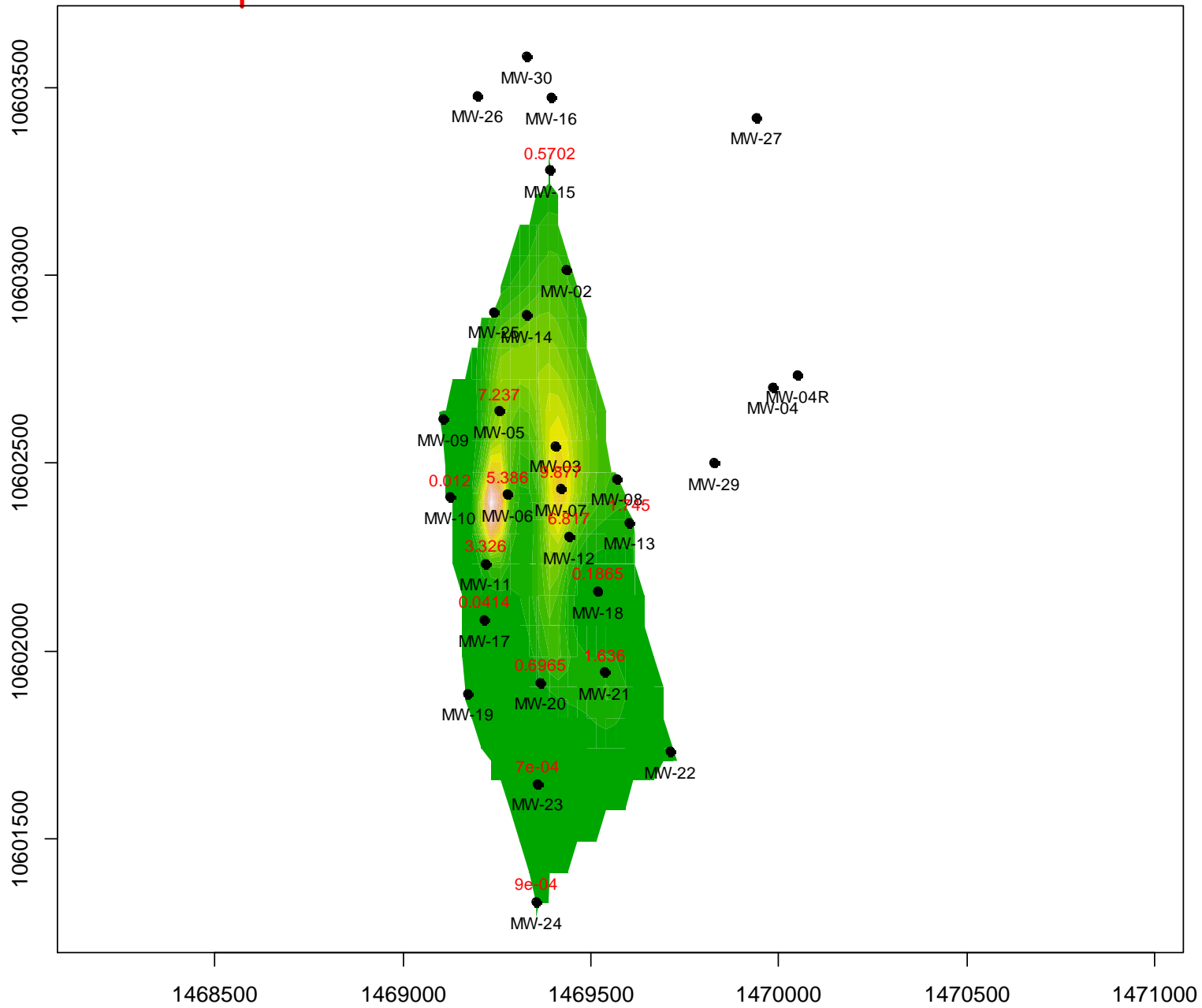
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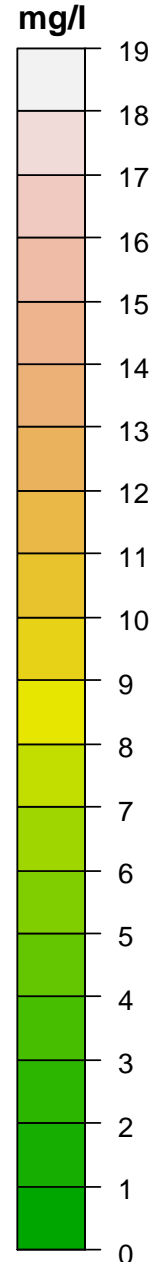
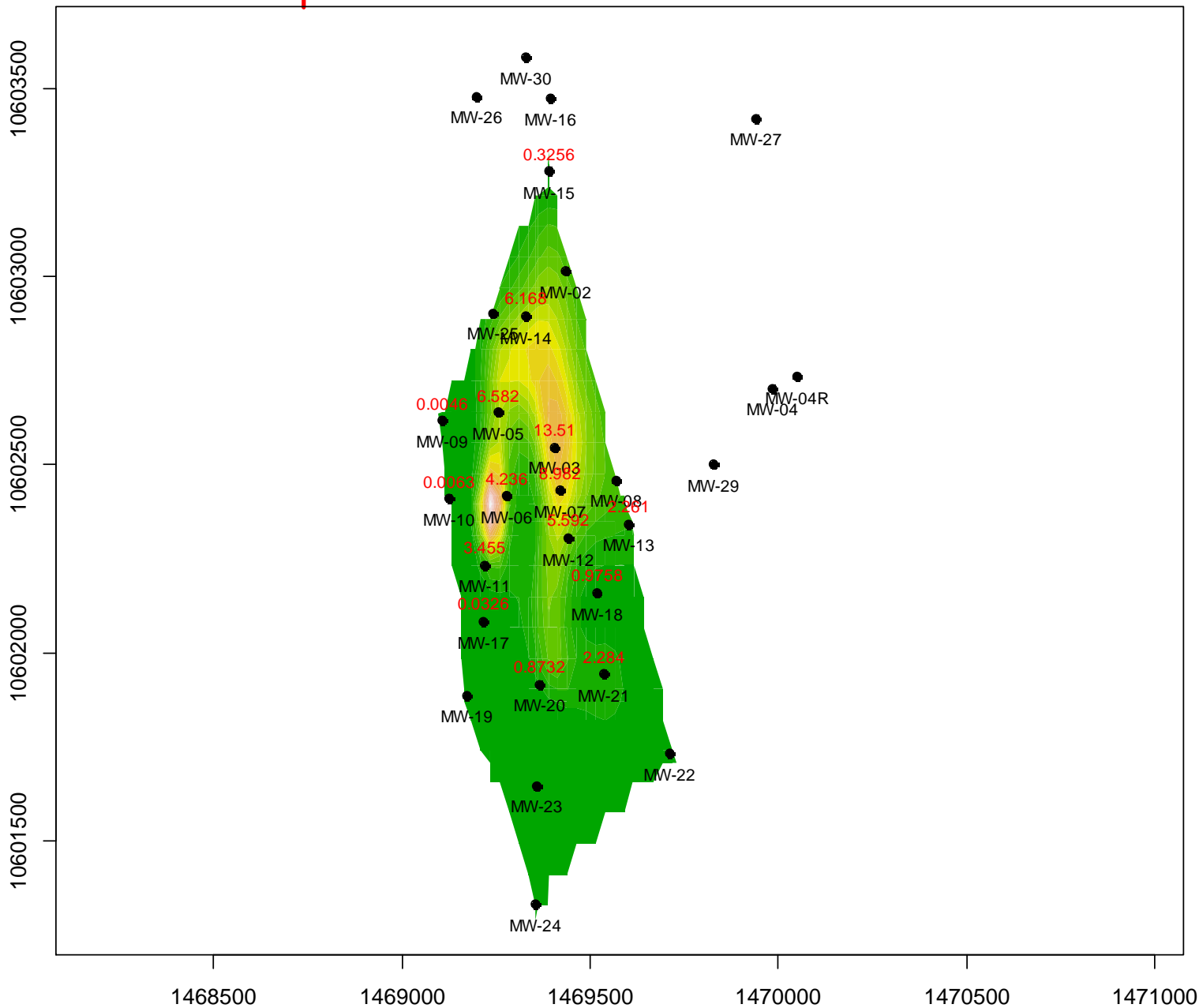
Benzene : 19-Jan-2009 to 18-Feb-2009



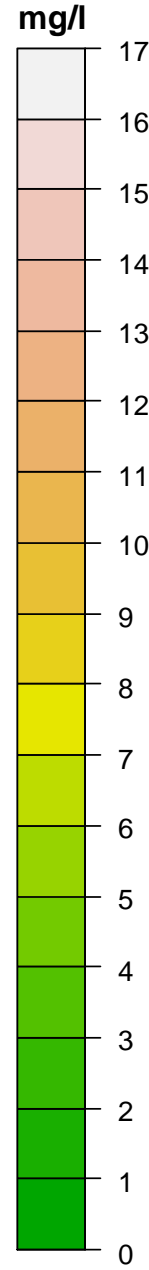
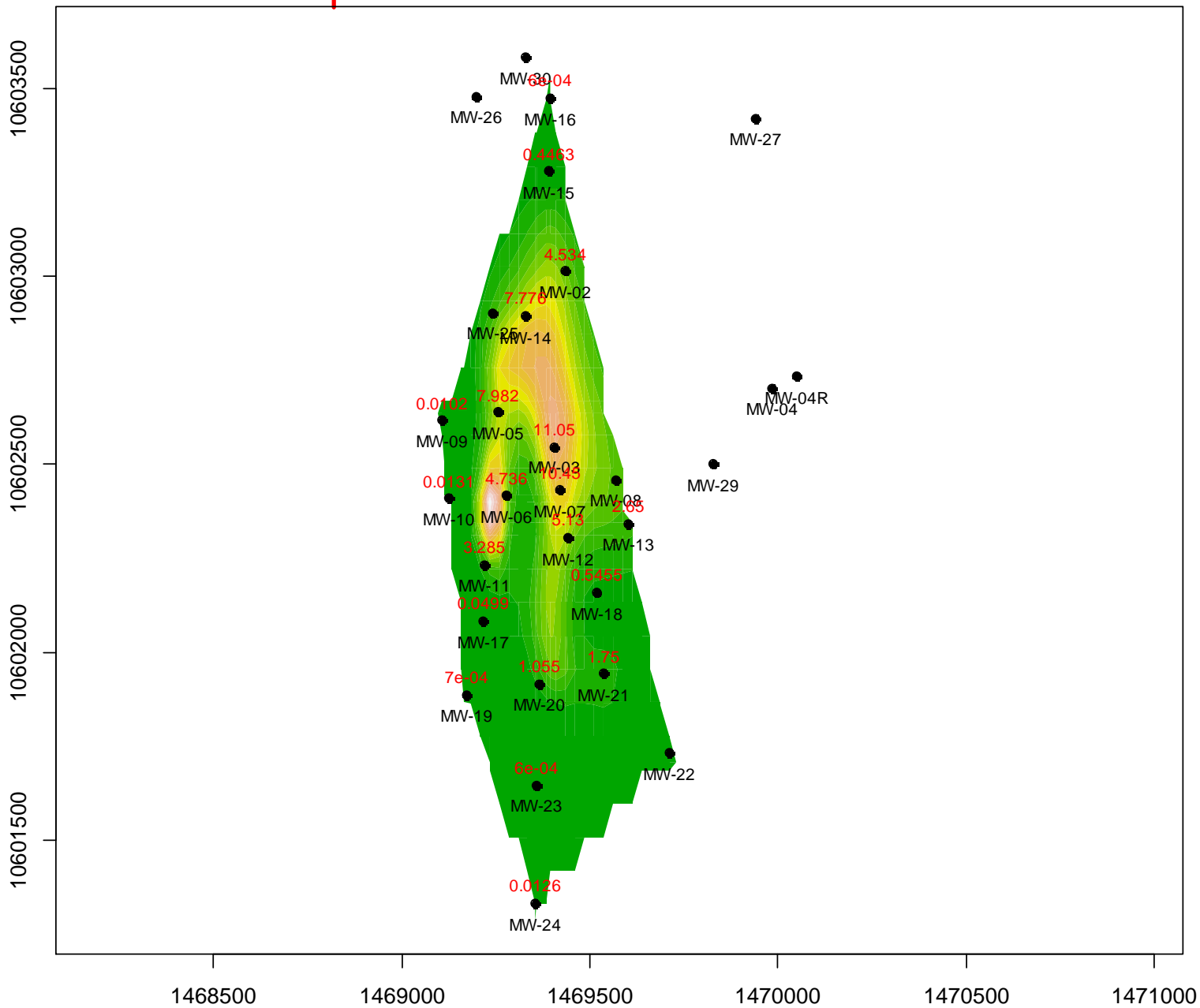
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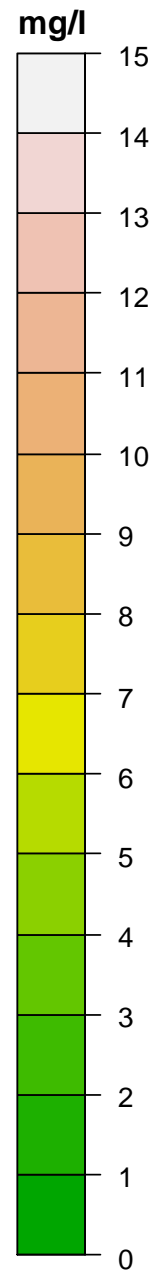
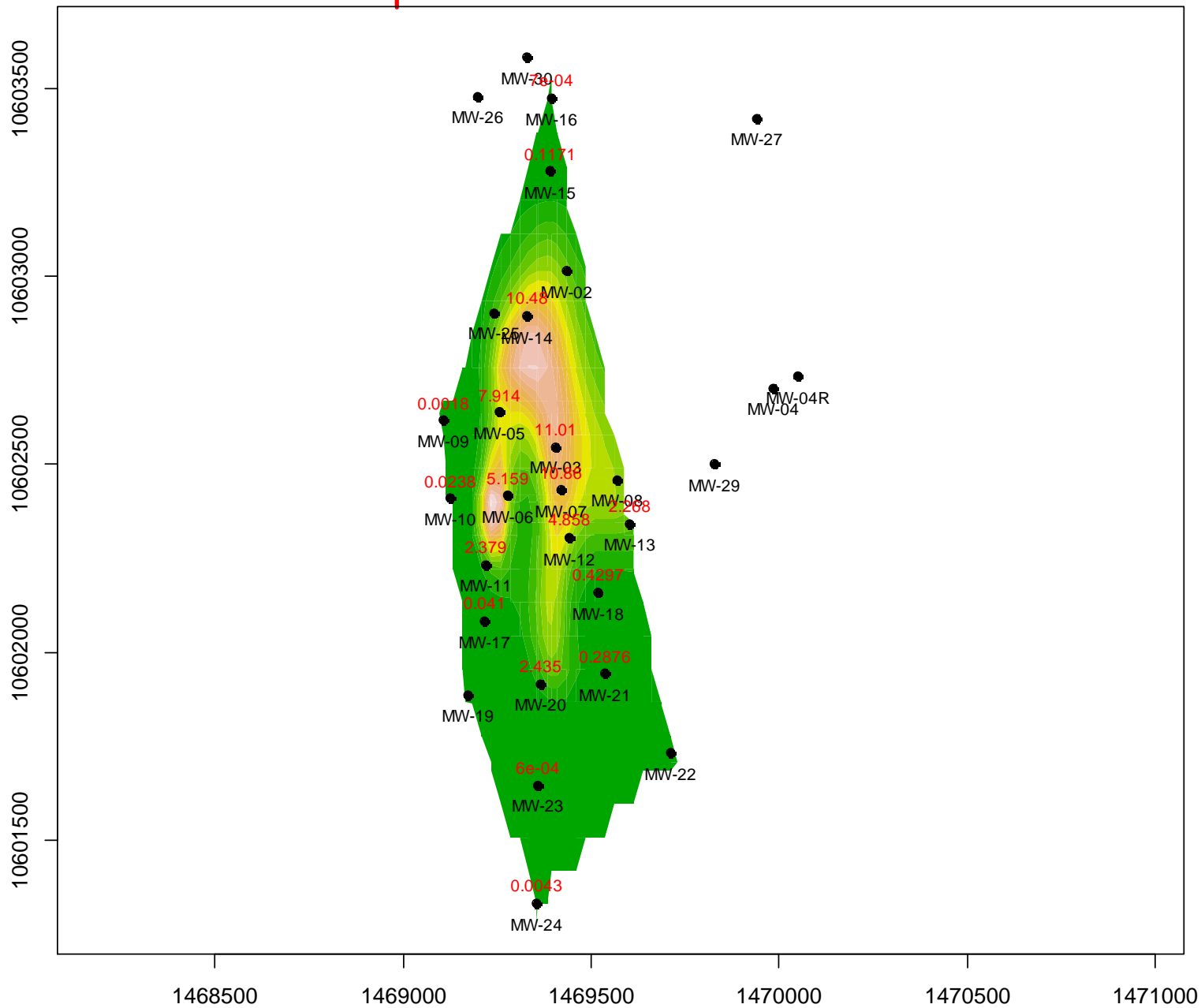
Benzene : 19-Aug-2009 to 18-Sep-2009



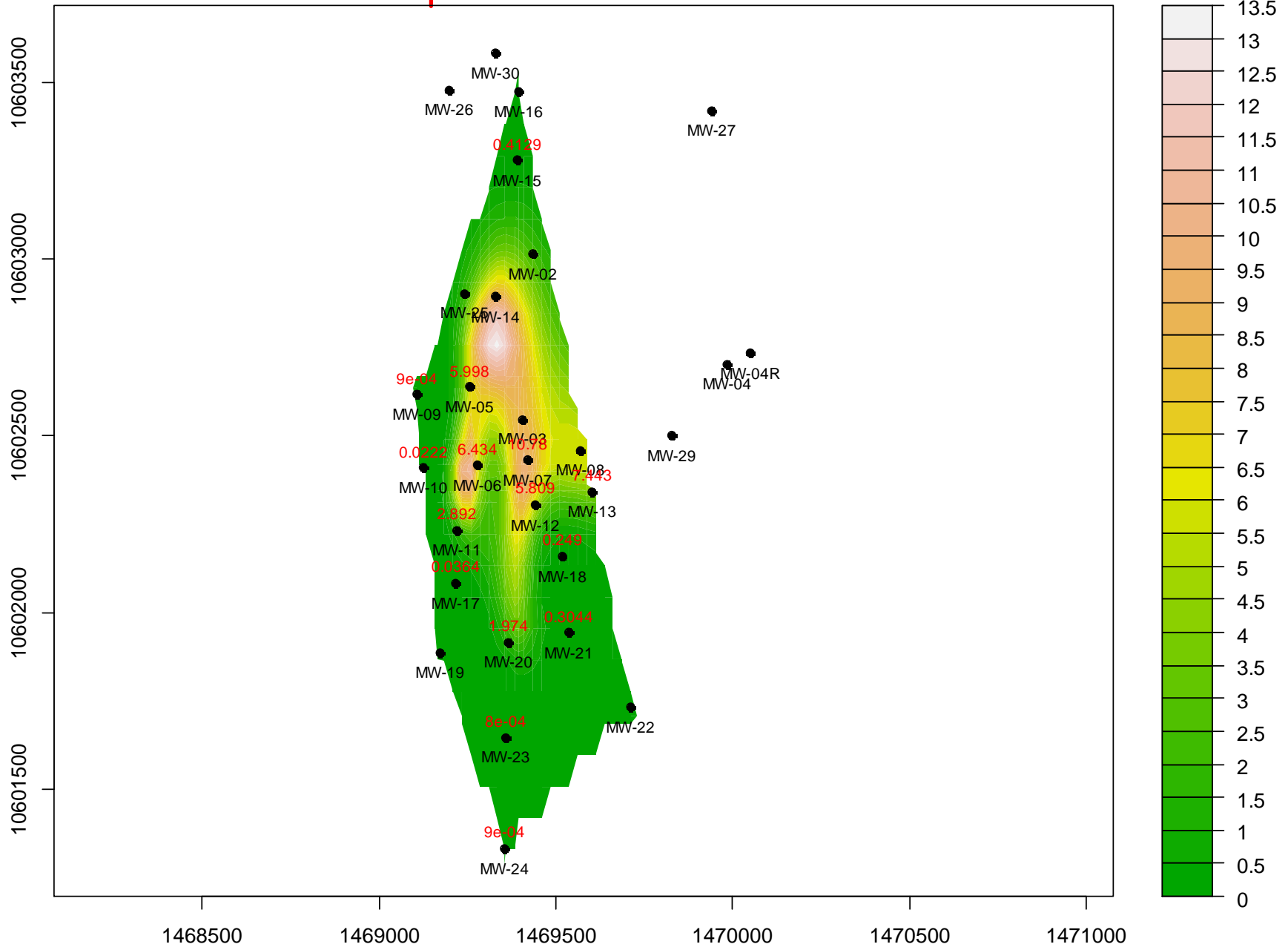
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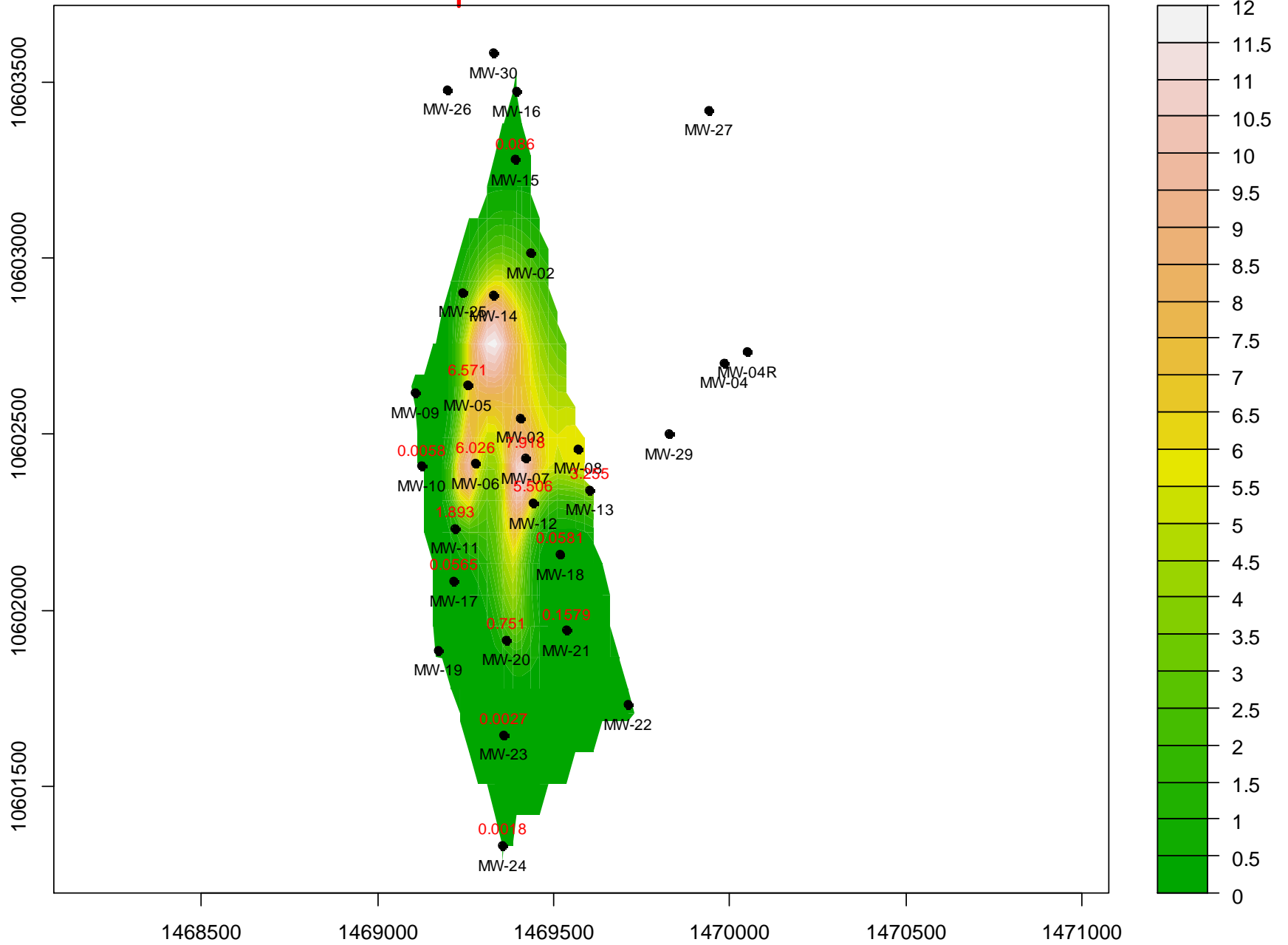
Benzene : 19-Feb-2010 to 18-Mar-2010



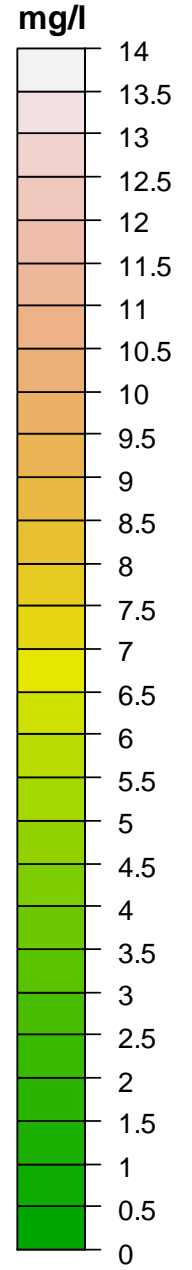
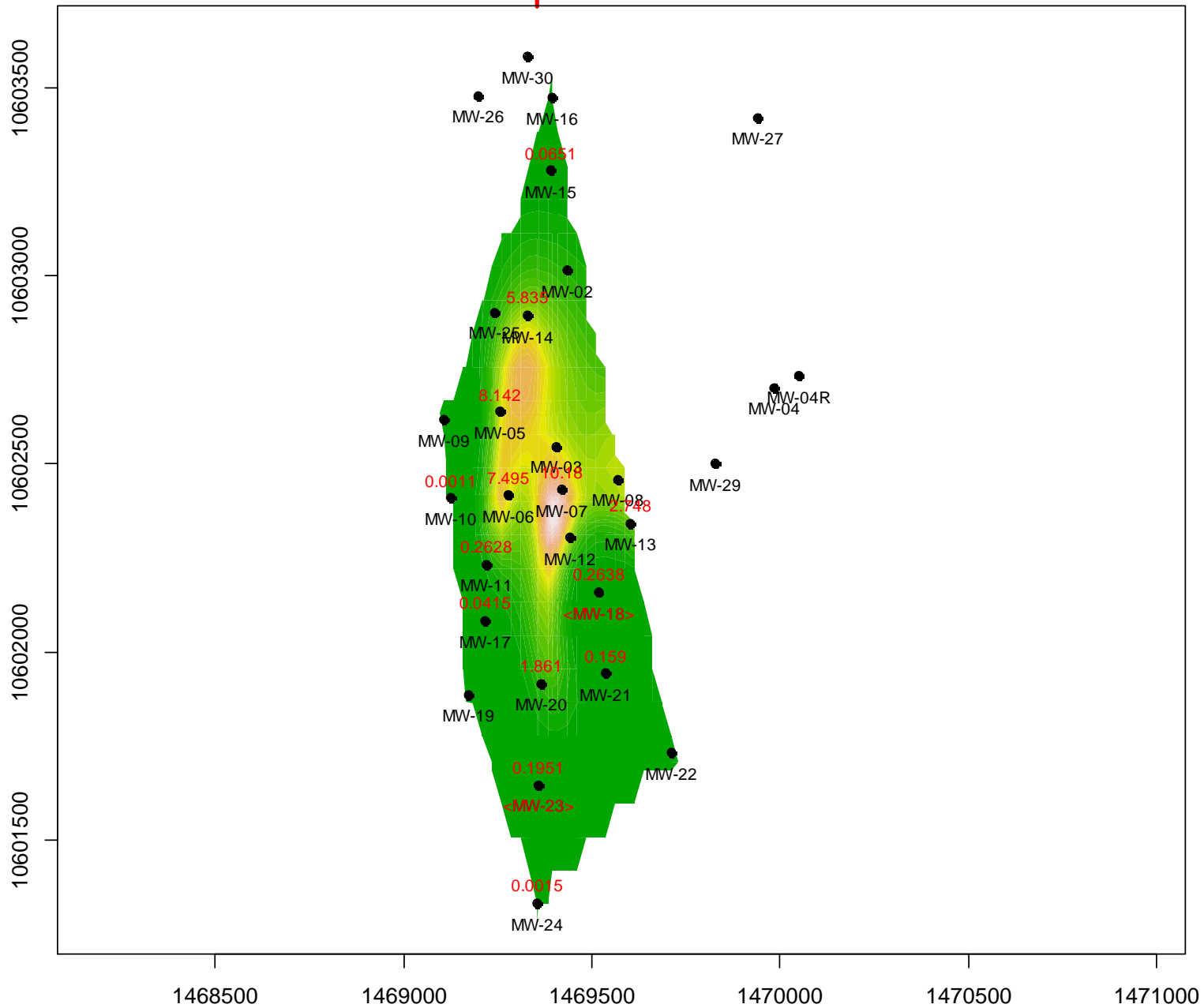
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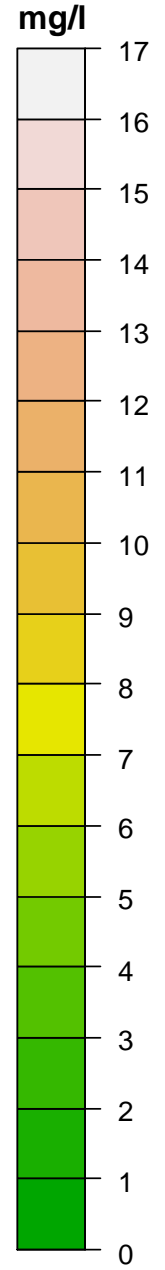
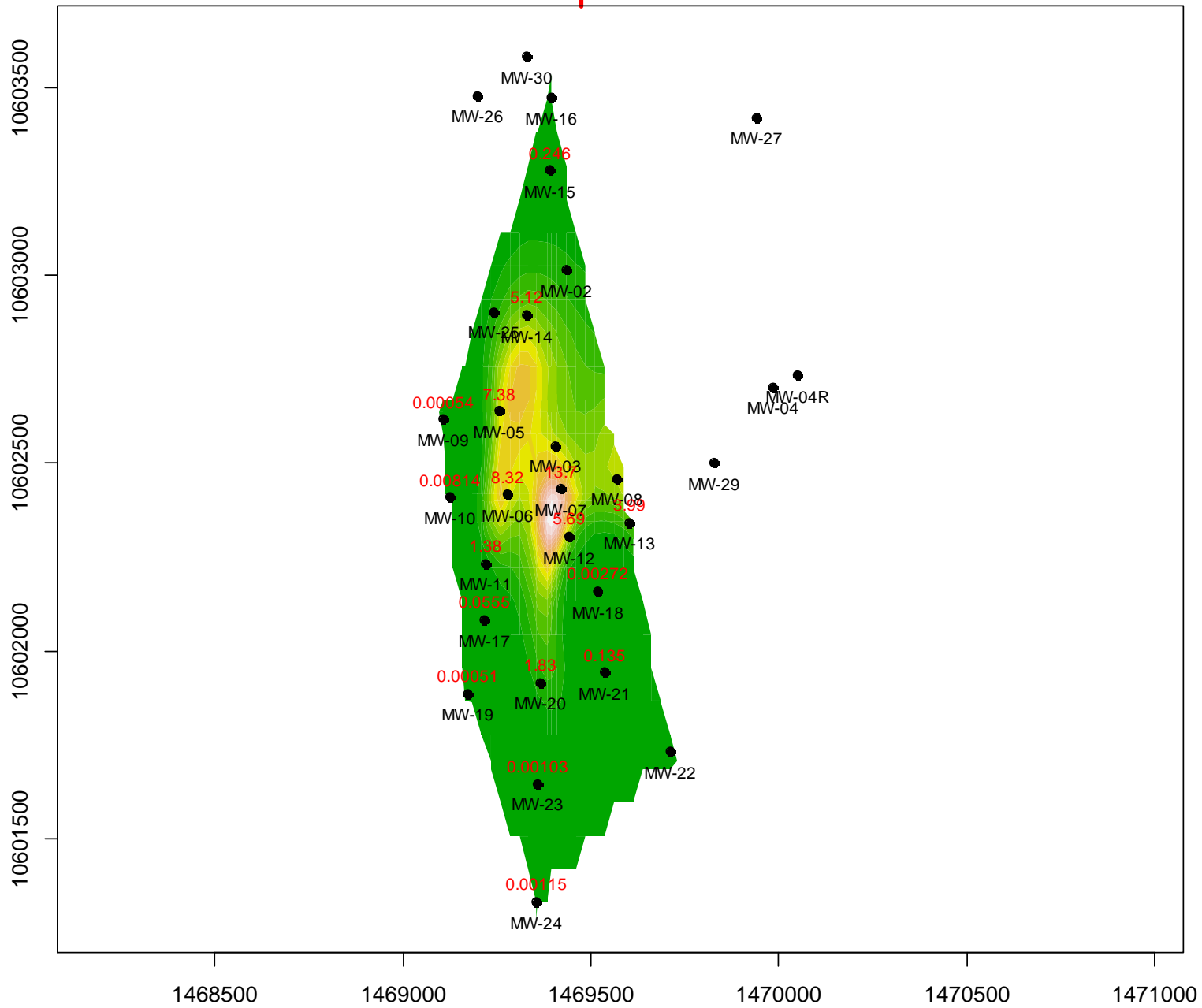
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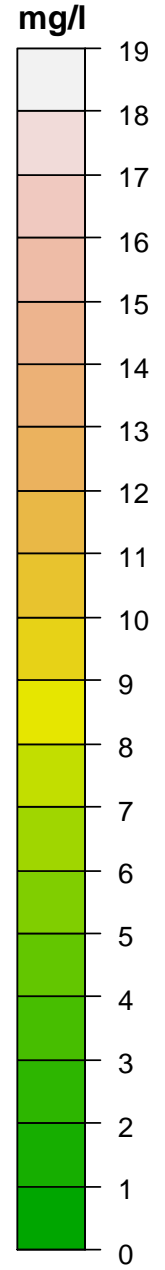
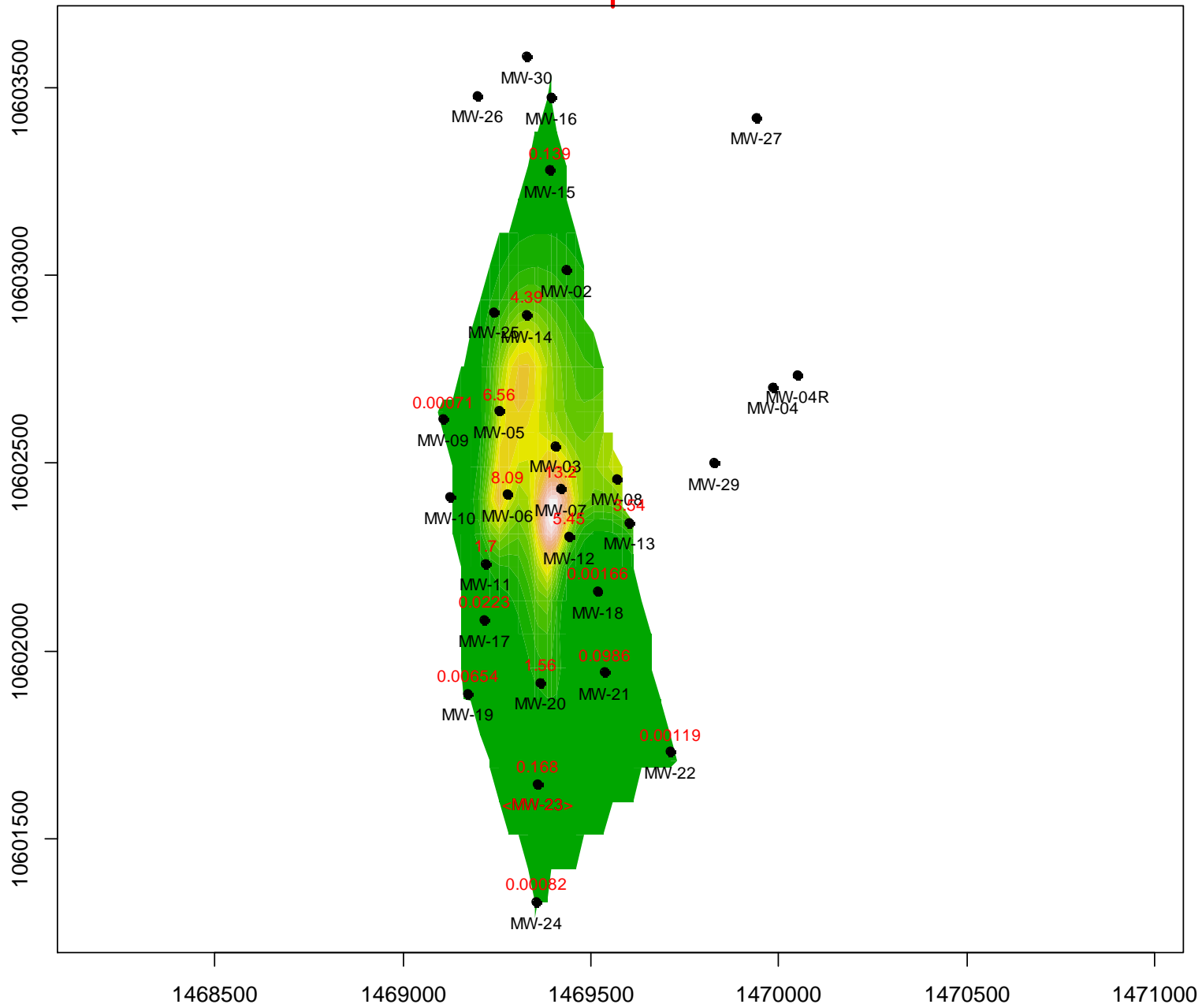
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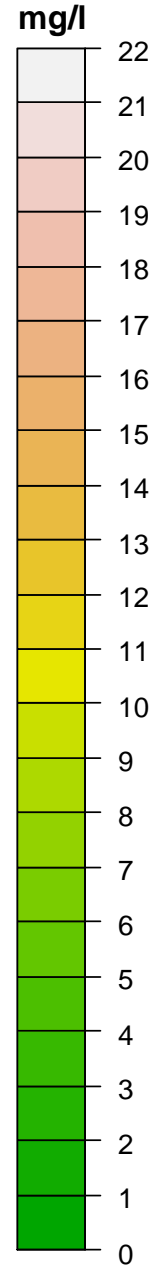
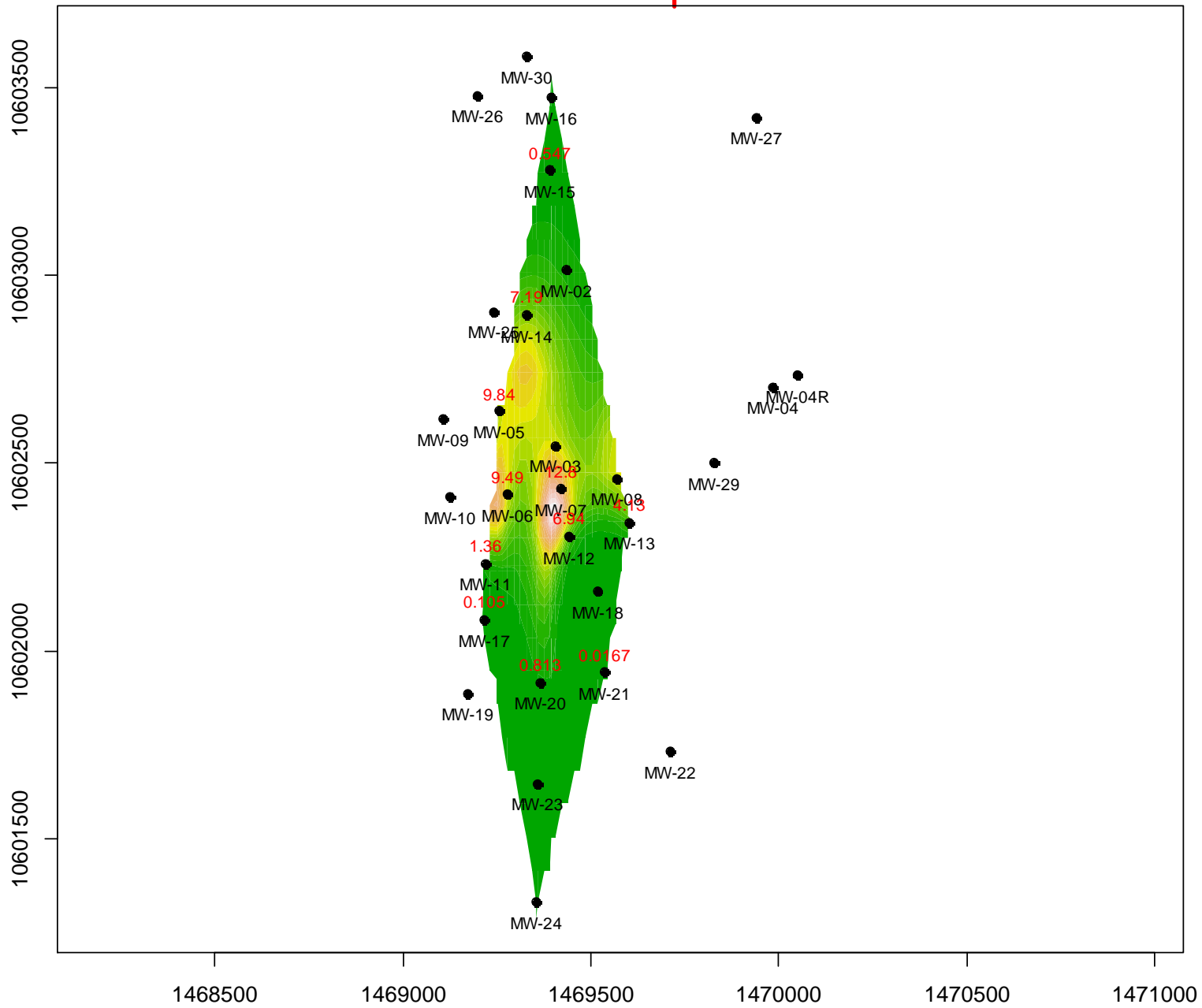
Benzene : 19-Feb-2011 to 18-Mar-2011



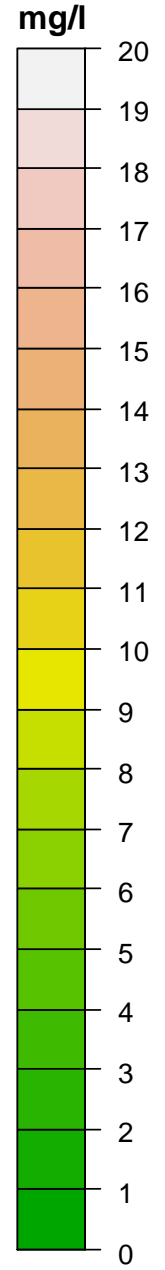
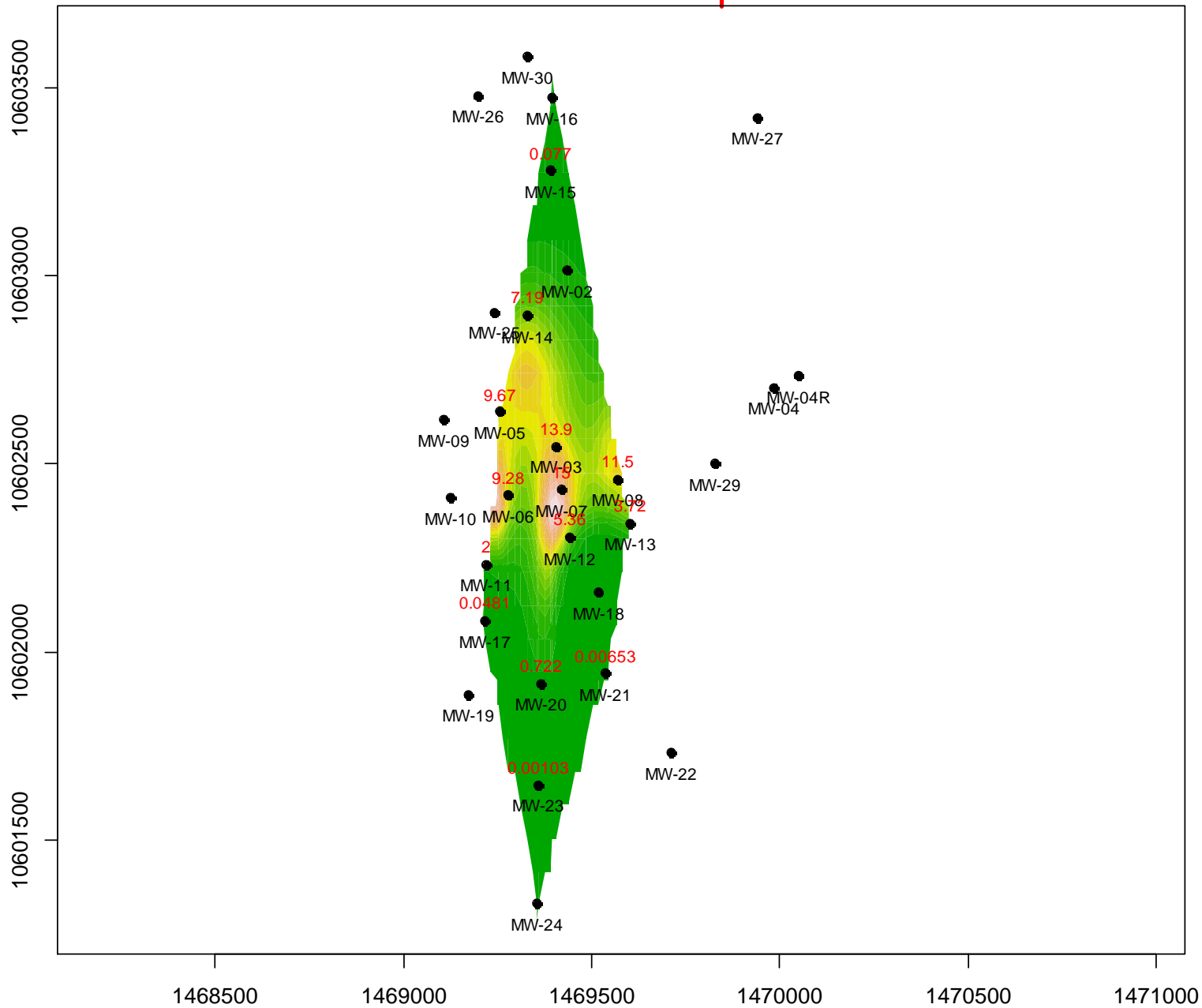
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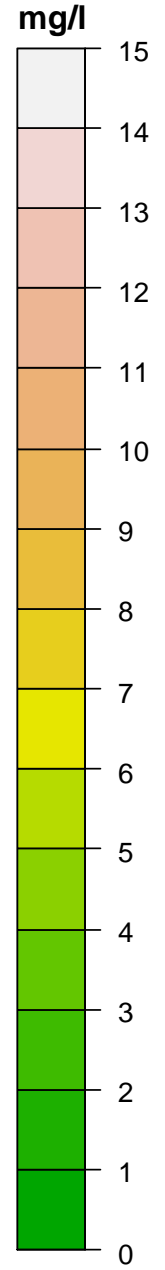
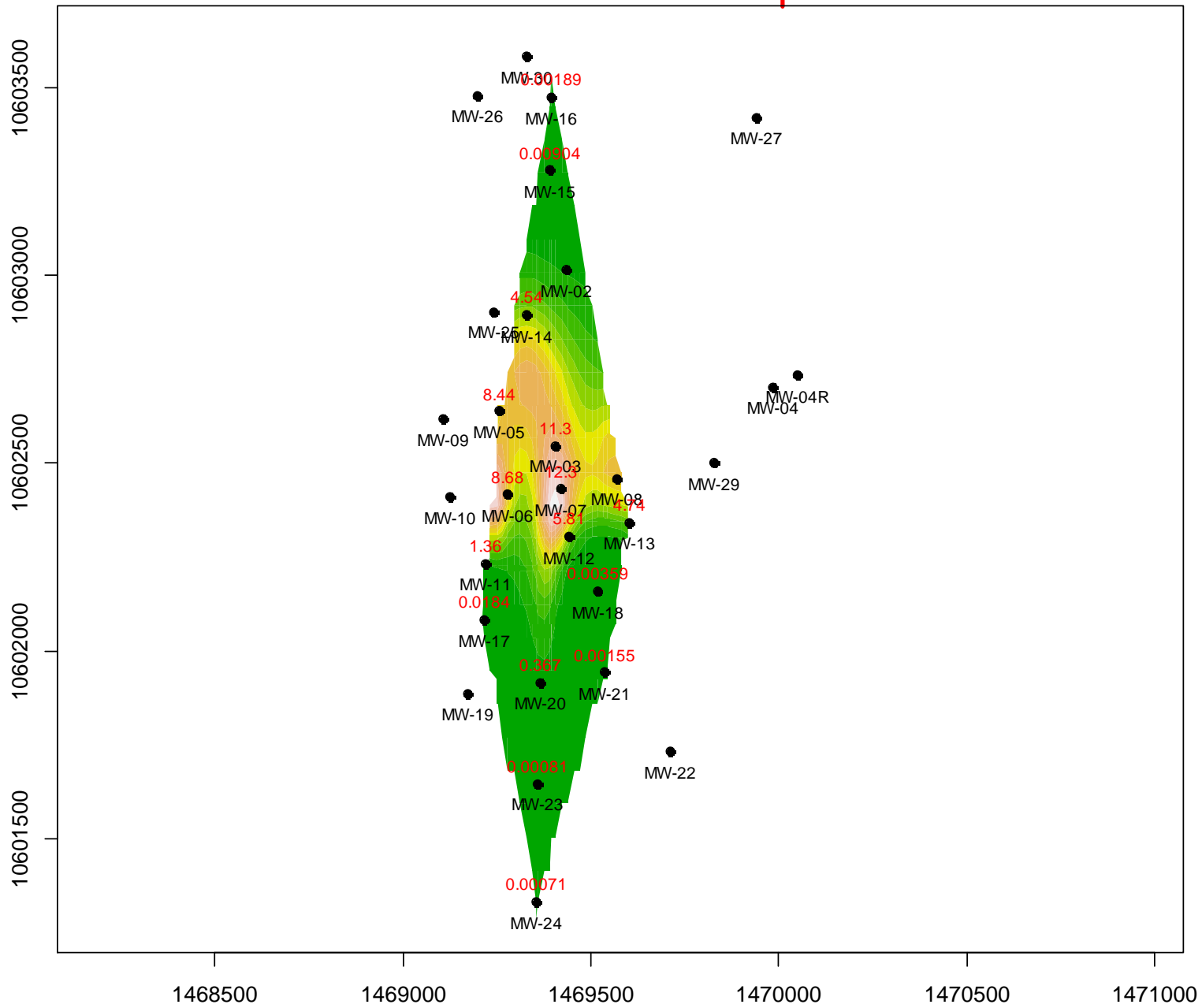
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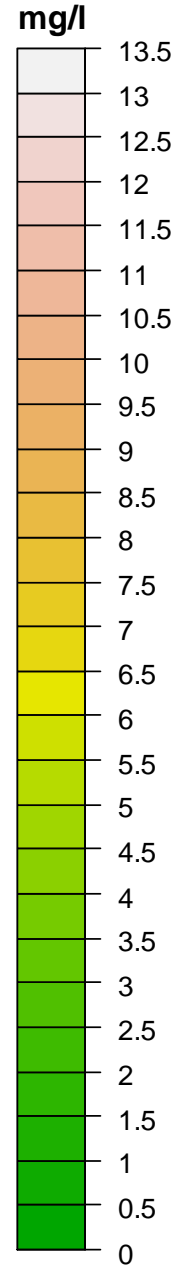
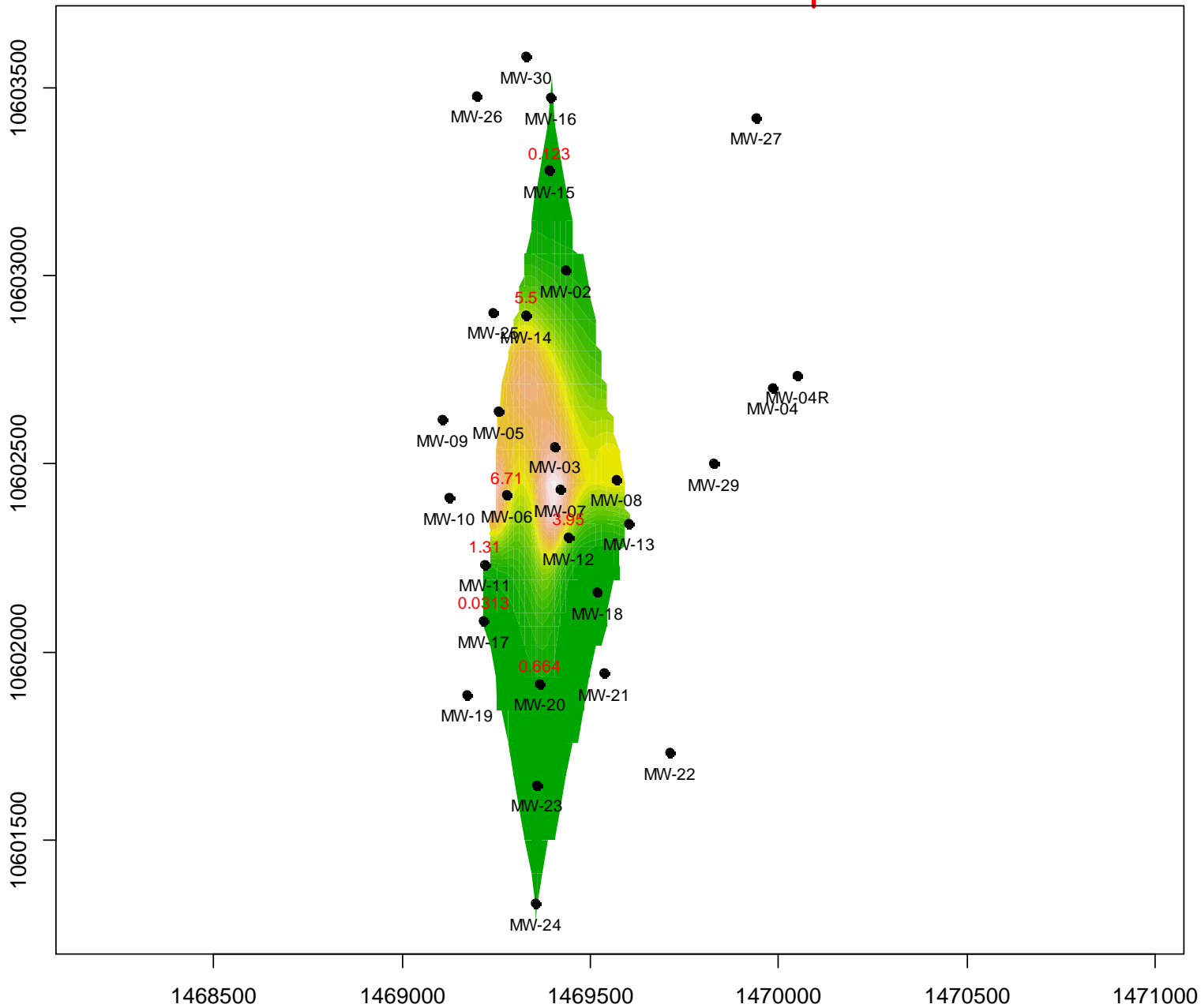
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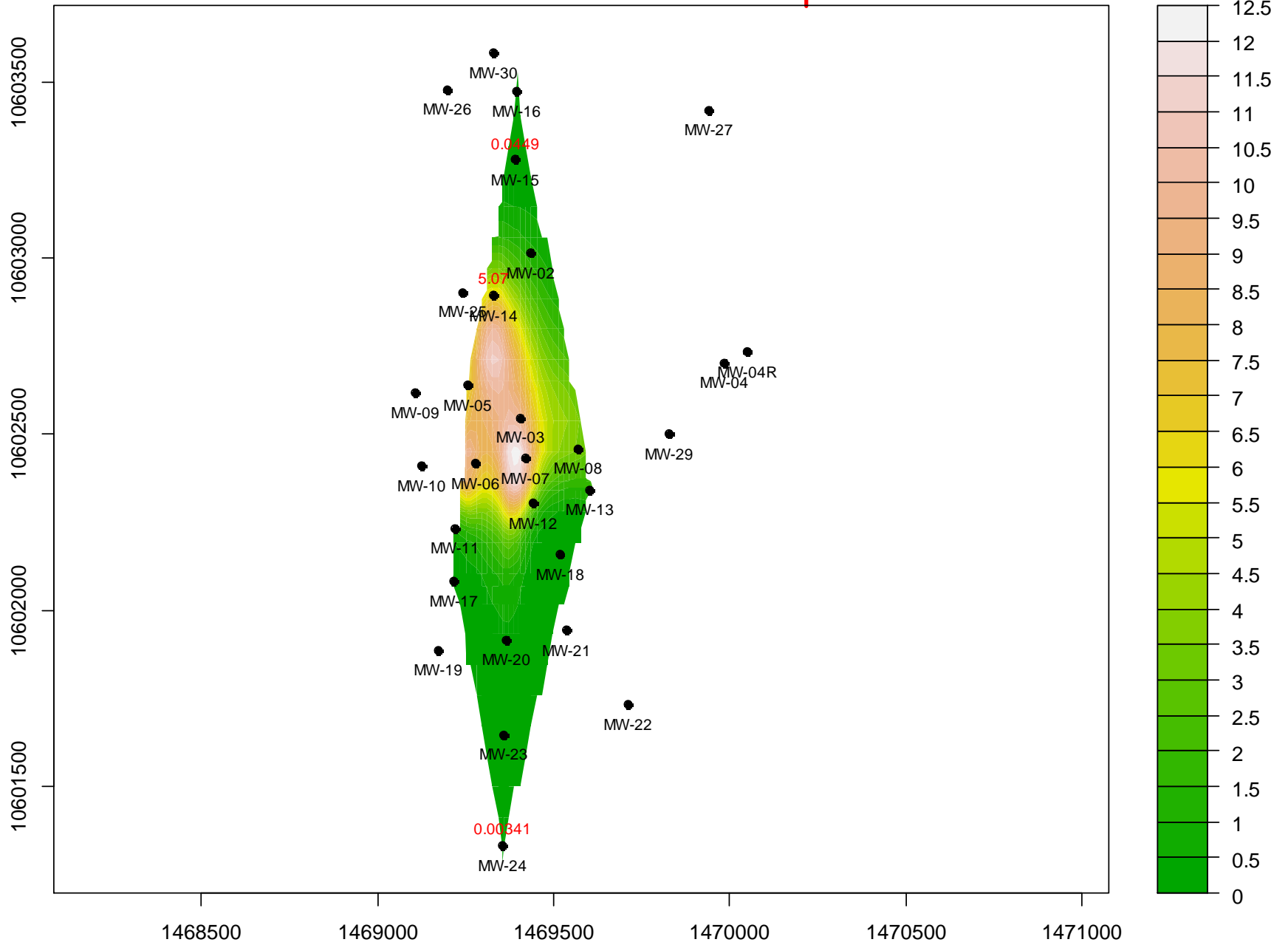
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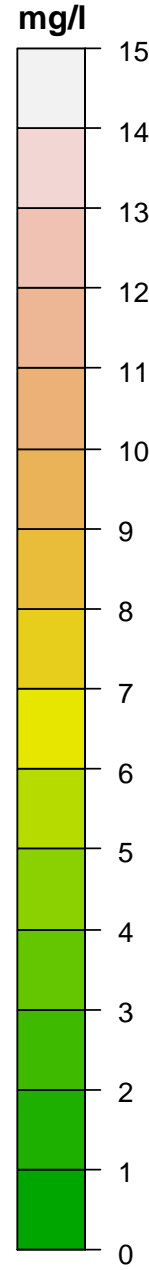
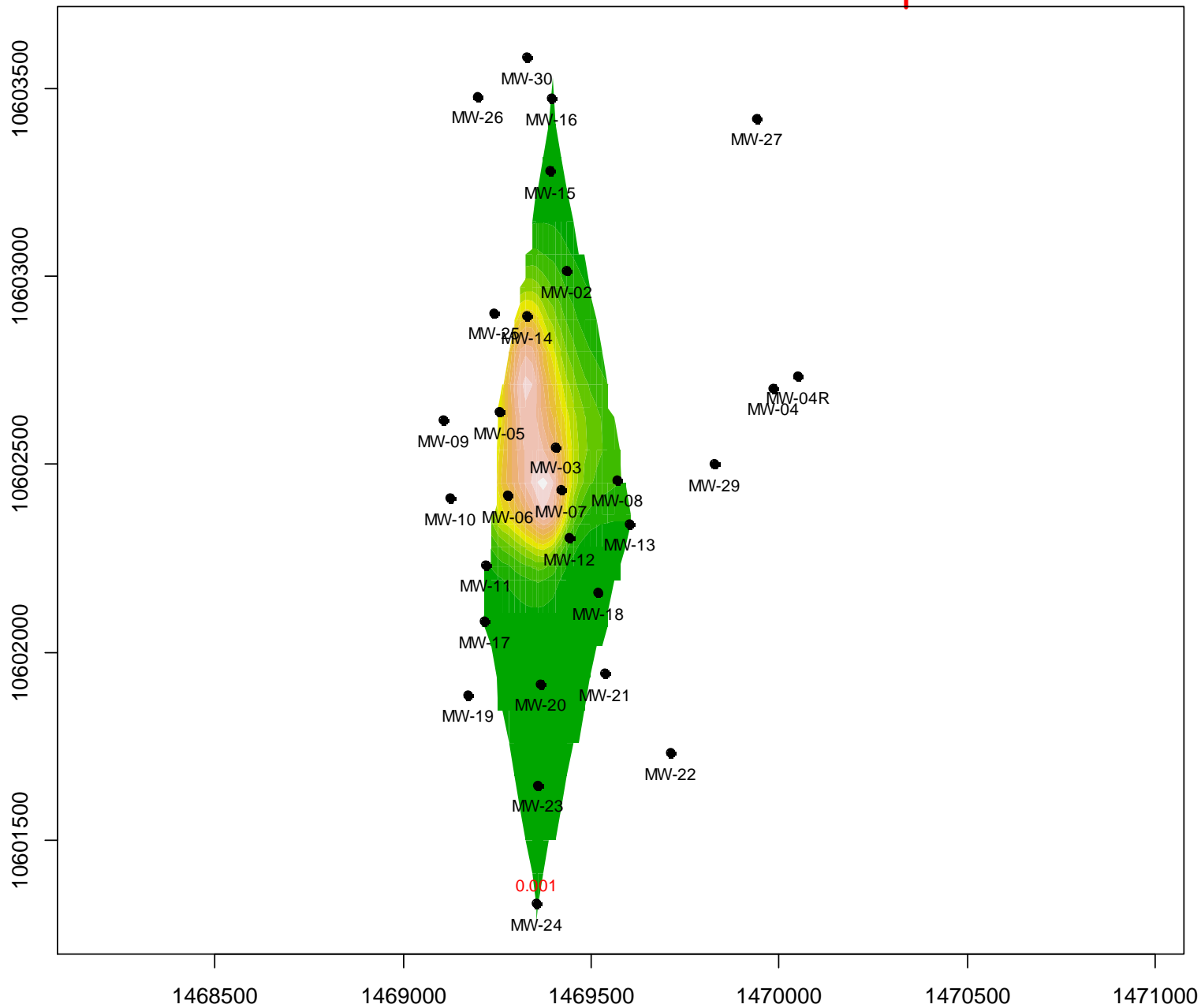
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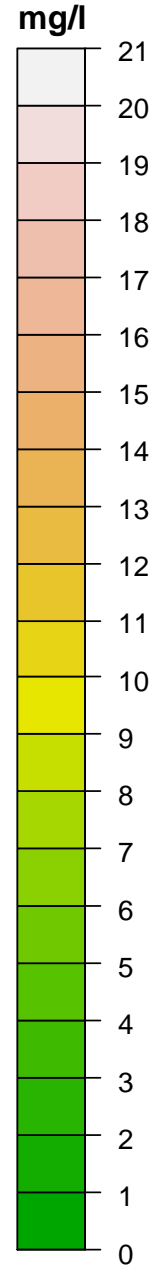
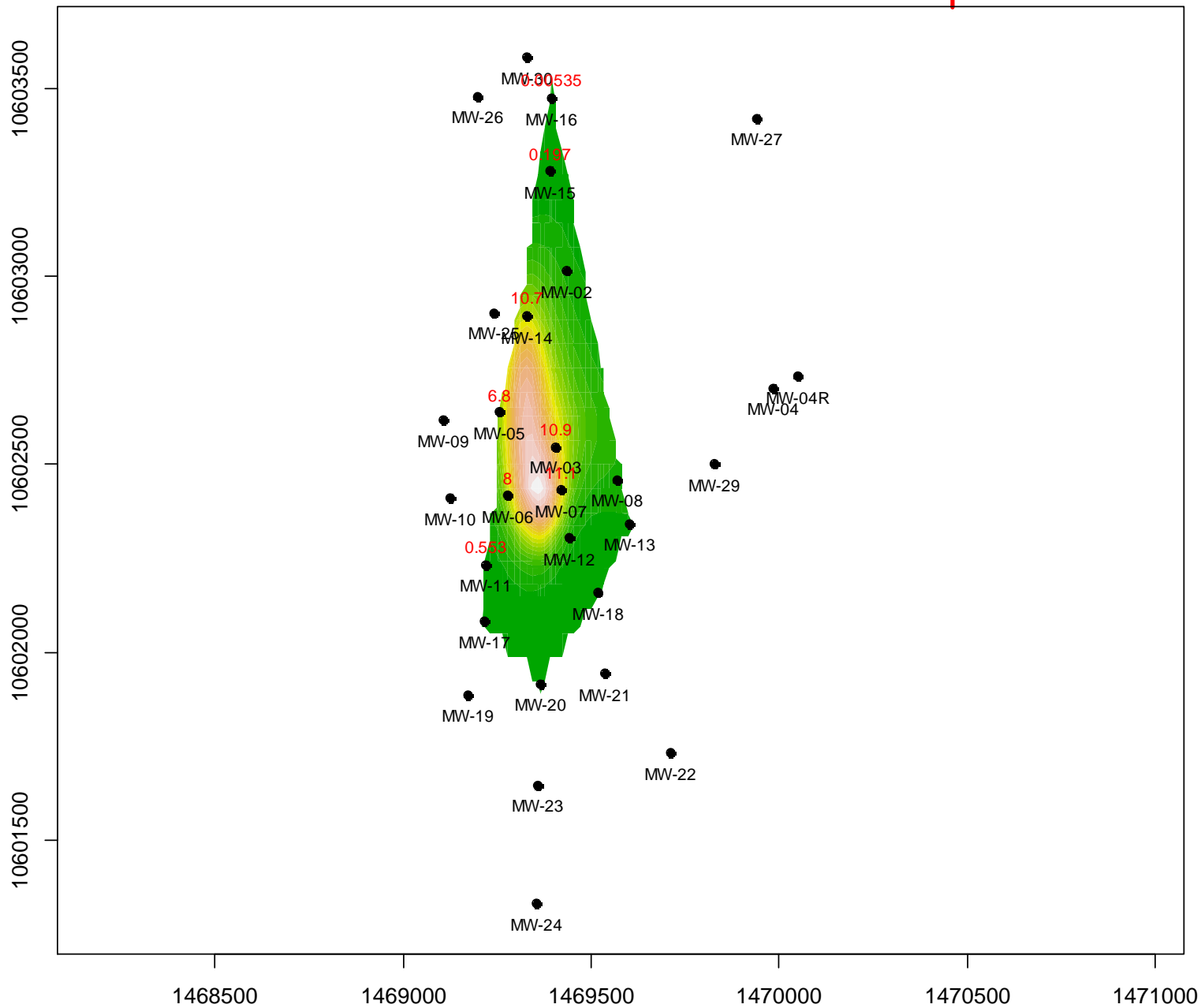
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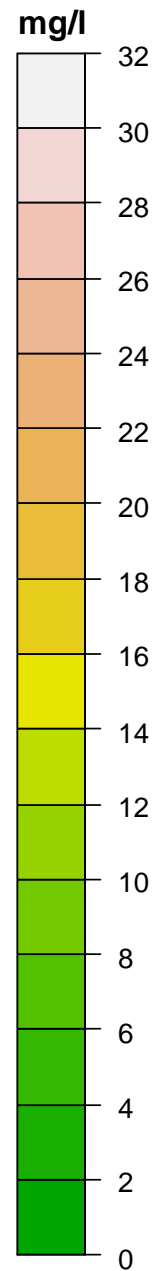
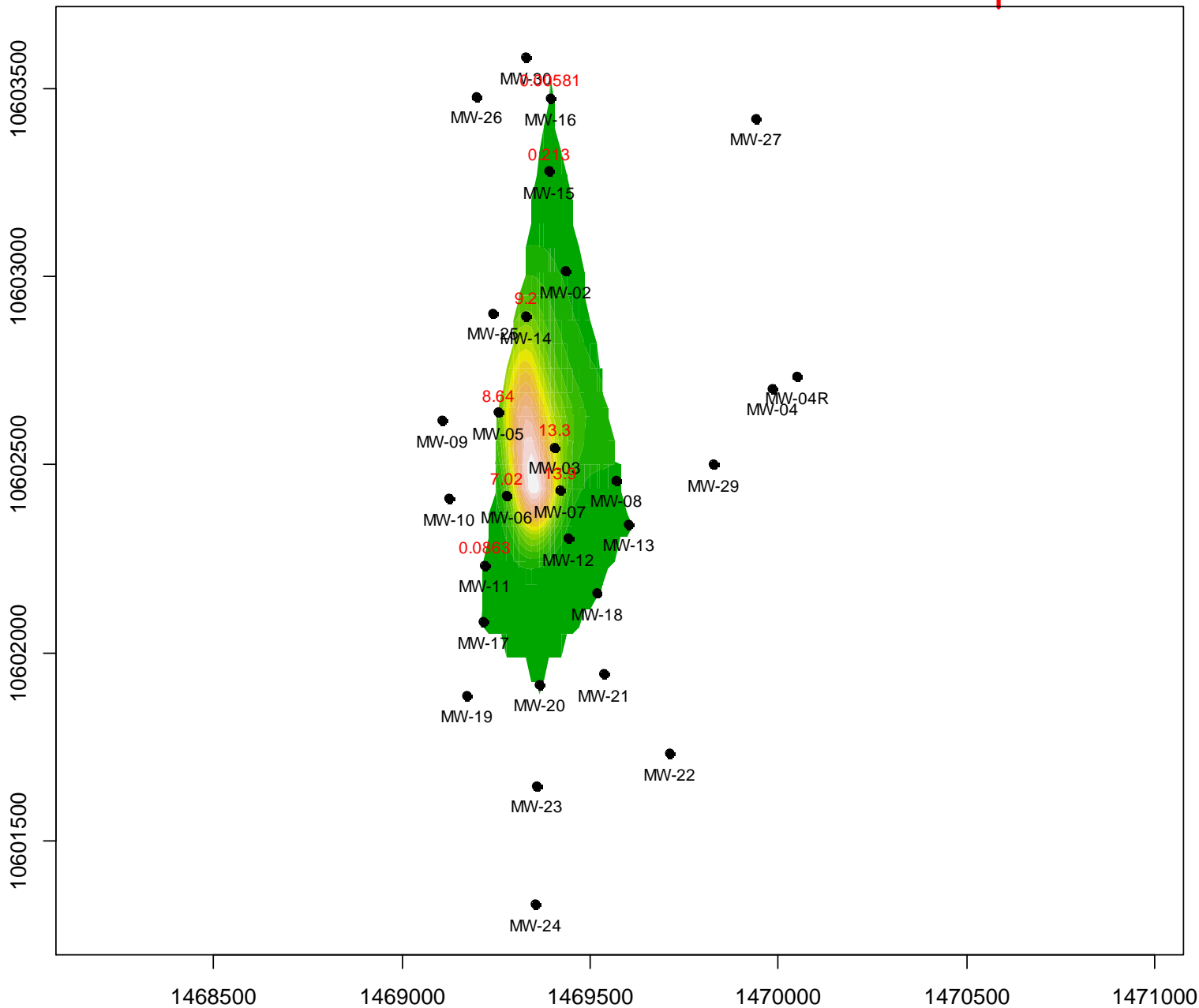
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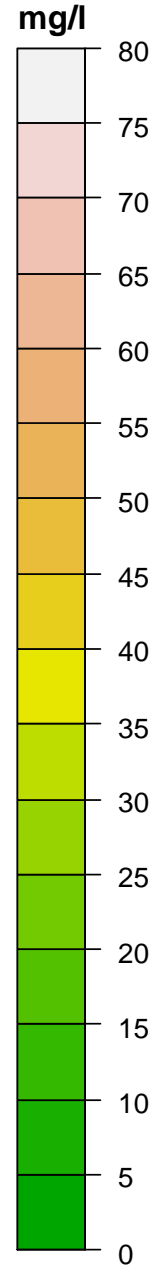
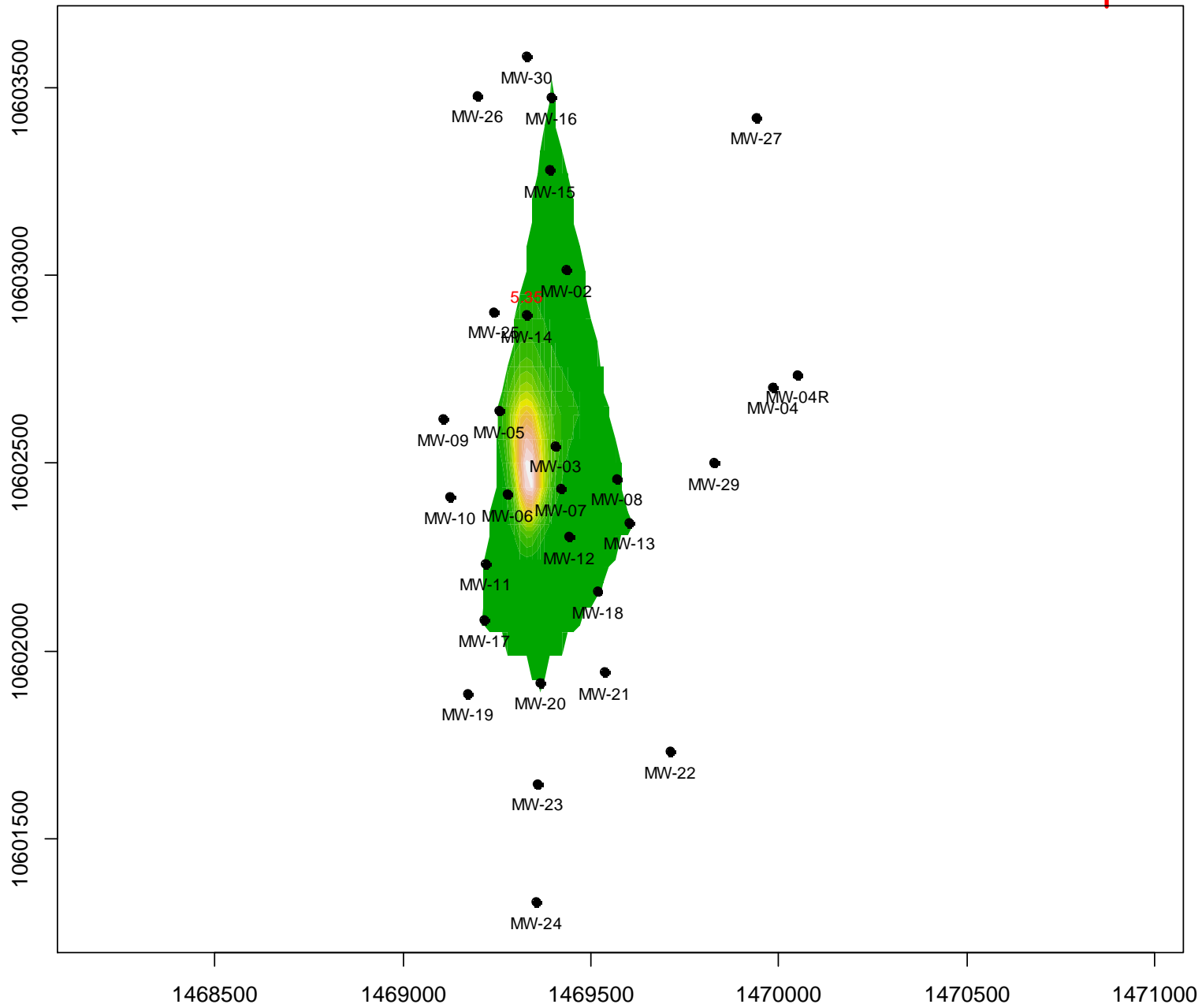
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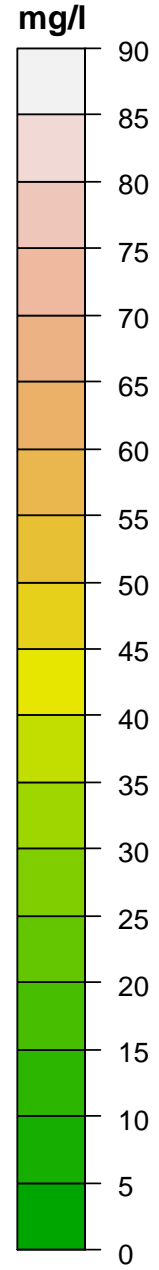
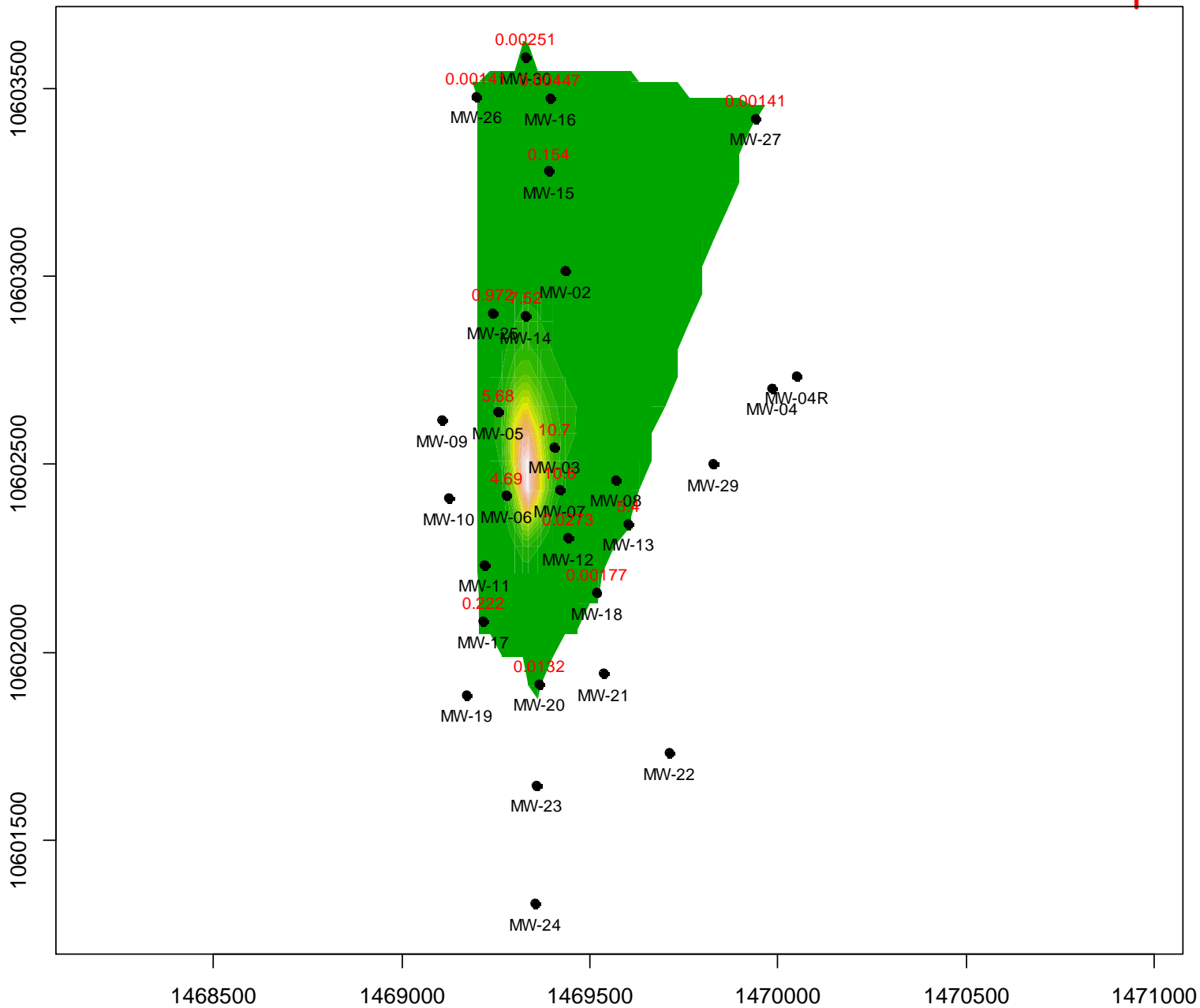
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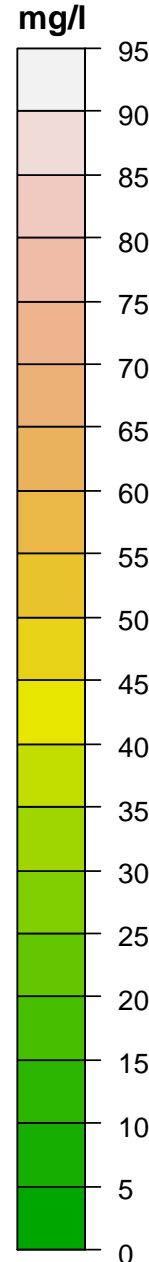
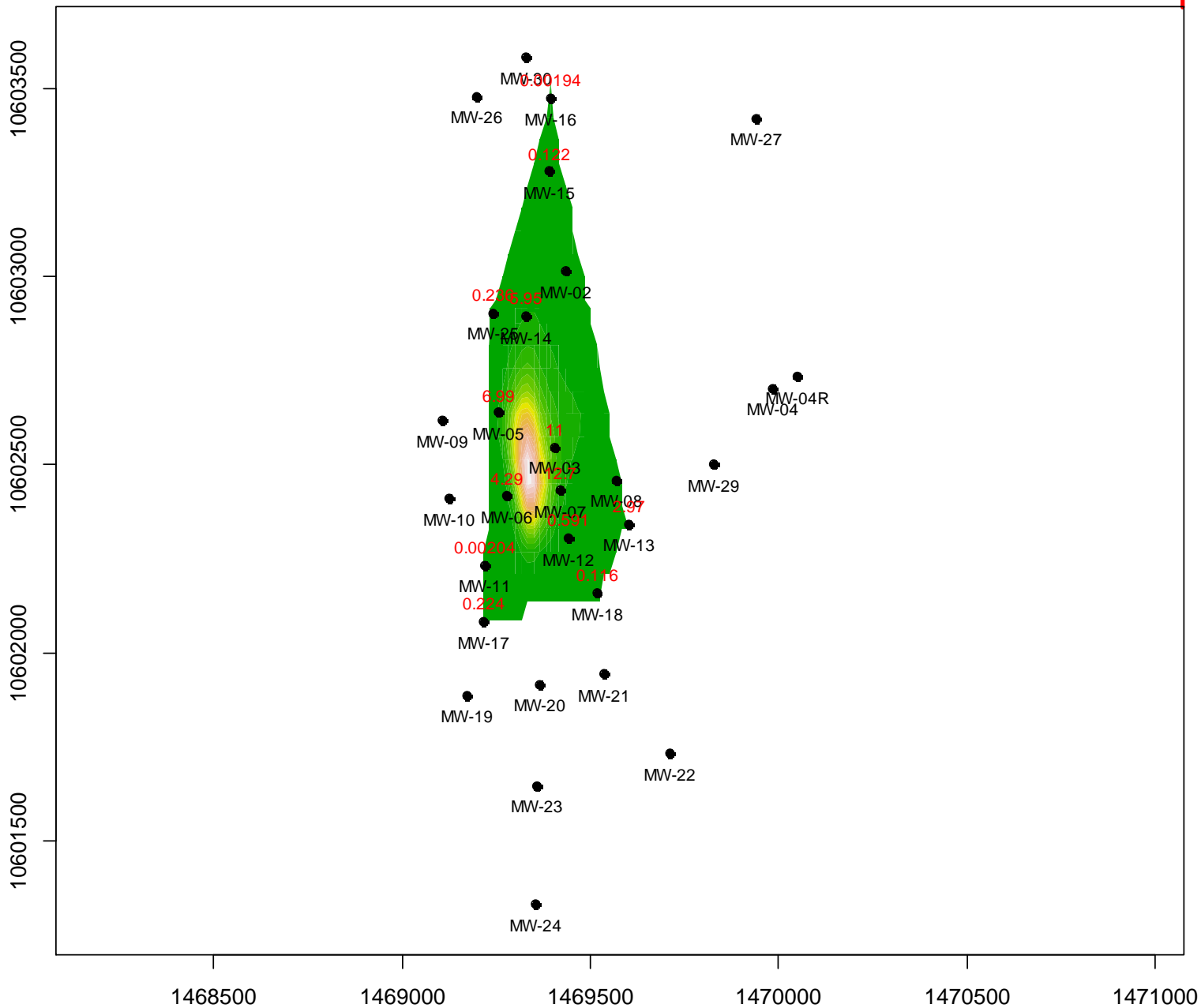
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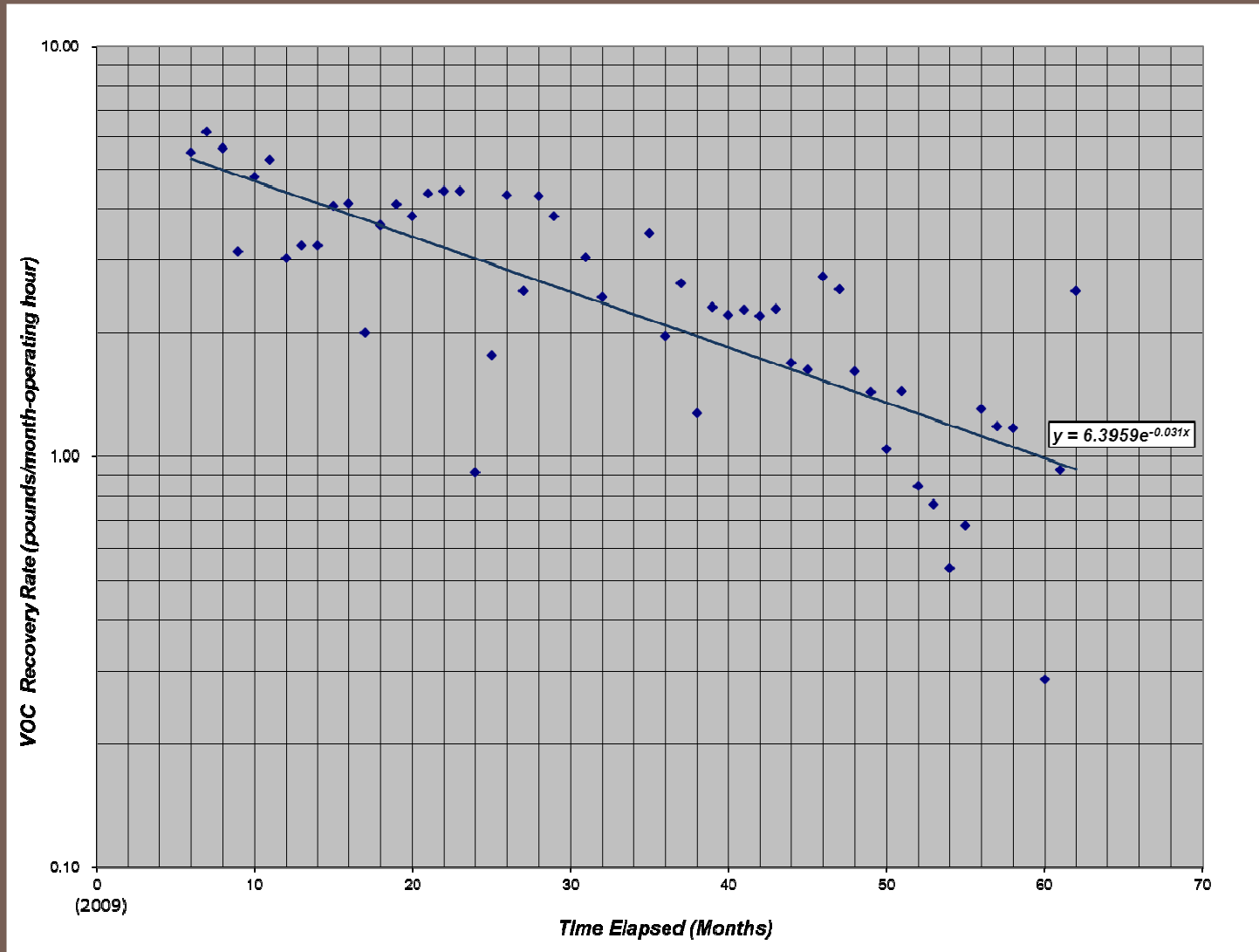
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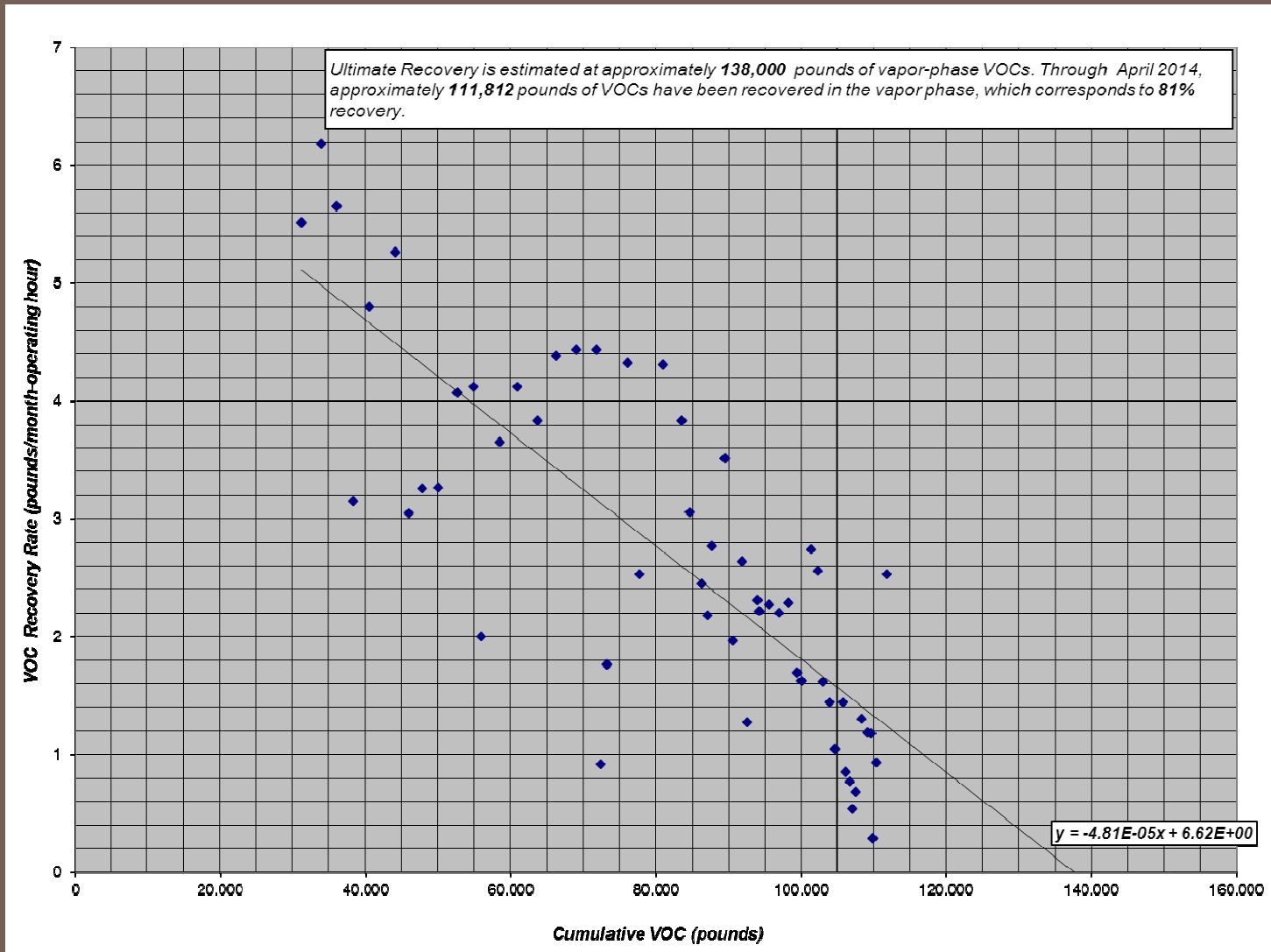
Benzene : 19-May-2014 to 18-Jun-2014



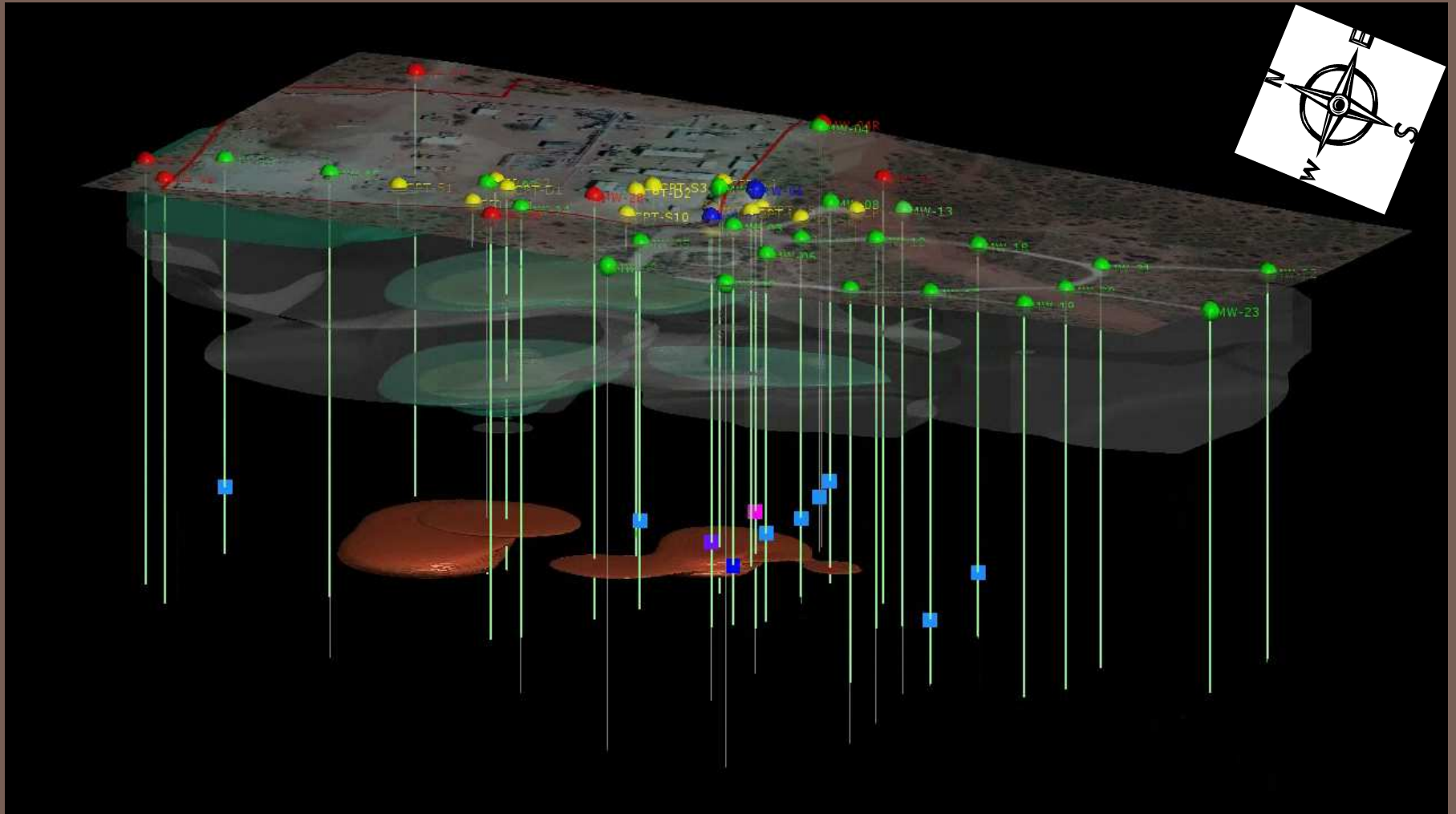
SVE SYSTEM – DECLINE CURVE ANALYSIS



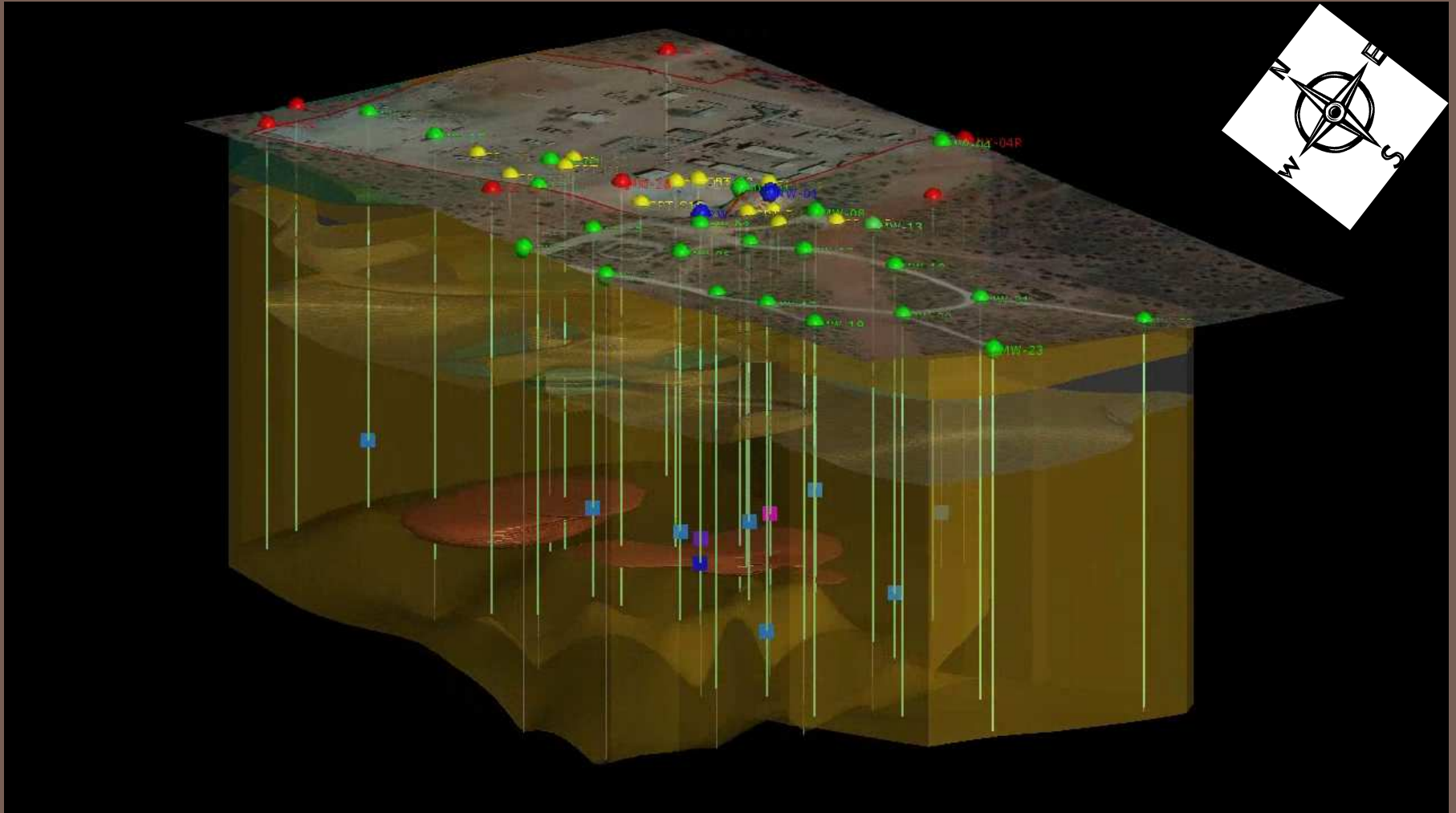
SVE SYSTEM – DECLINE CURVE ANALYSIS



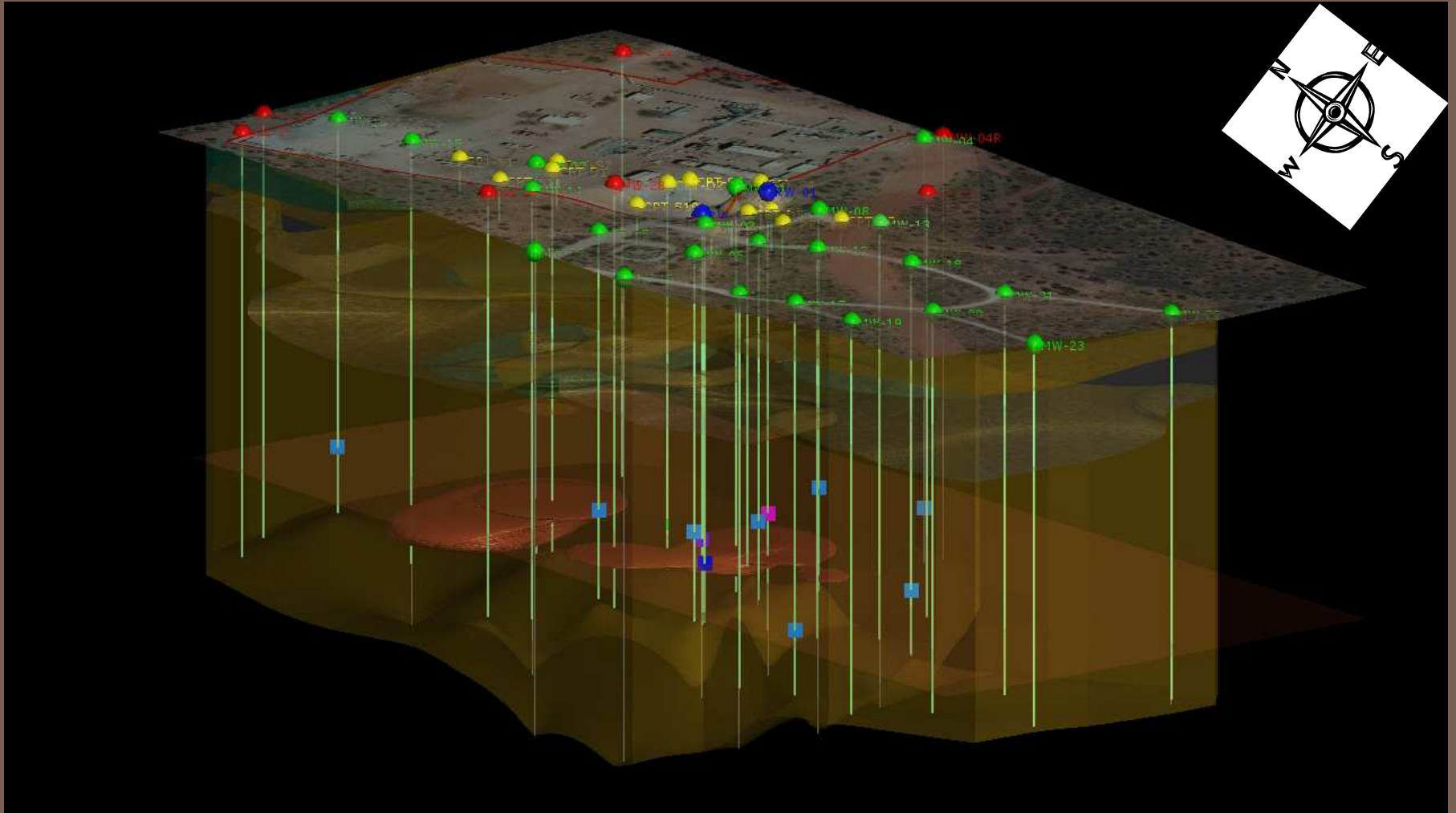
LCSM MODEL



LCSM MODEL



LCSM MODEL



PIPELINE MAP



Multiple operators – “potential” multiple contributions for dissolved phase

CONCLUSIONS

- There are no ongoing sources of LNAPL and existing impacts are due to historic sources.
- The horizontal extent of apparent NAPL source area is approximately 400 feet bounded by MW-02 to the north and RW-02 to the south while the vertical extent of source area extends to the groundwater table.
- The LNAPL and the dissolved benzene plume footprints have reduced as a result of the ongoing remedial and natural attenuation processes at the Site.
- The highest dissolved phase concentrations have decreased significantly and currently observed in the near vicinity of the LNAPL source area.
- The SVE system and the natural attenuation processes have resulted in (i) reduction in the mass of LNAPL, (ii) compositional change in LNAPL, (iii) and concentrations of the dissolved phase.
- Preliminary evaluation of the natural losses assessment indicates evidence of natural attenuation and natural source zone depletion.

KEY TAKEAWAYS

- **Risk-based LNAPL management is effective provided no other risk/receptors present.**
- **Development of a comprehensive LCSM is critical.**
- **Monitored natural attenuation (MNA)/ Natural source zone depletion (NSZD) can be an effective and alternate remedial option for such sites; natural losses have been demonstrated to be orders of magnitude higher than recovery from remedial technologies.**

THANK YOU