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Database of Water Quality and Groundwater Elevation Within and Surrounding the Lee Acres Landfill, New Mexico, 1985–2020

Data Report 1154

U.S. Department of the Interior
U.S. Geological Survey

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Acknowledgments

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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
acre	0.4047	square hectometer (hm^2)
acre	0.004047	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
	Mass	
ounce, avoirdupois (oz)	28.35	gram (g)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F = (1.8 × °C) + 32.

Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88) or the National Geodetic Vertical Datum of 1929 (NGVD 29), as indicated.

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83) or the North American Datum of 1927 (NAD 27), as indicated.

Altitude, as used in this report, refers to distance above the vertical datum.

Supplemental Information

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

Concentrations of chemical constituents in water are given in either milligrams per liter (mg/L [parts per million]) or micrograms per liter (µg/L [parts per billion]).

Abbreviations

BLM	Bureau of Land Management
COC	contaminant of concern
E	estimated results
EPA	U.S. Environmental Protection Agency
GBR	Giant Bloomfield Refinery
LAGBRD	Lee Acres-Giant Bloomfield Refinery Database
ND	no detection above method detection limits
NMED	New Mexico Environment Department
NMOCD	New Mexico Oil Conservation Division
NWIS	National Water Information System
ROD	record of decision
USGS	U.S. Geological Survey

Database of Water Quality and Groundwater Elevation Within and Surrounding the Lee Acres Landfill, New Mexico, 1985–2020

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Abstract

This report describes the background information related to and the contents of the Lee Acres-Giant Bloomfield Refinery Database (LAGBRD), which is a compilation of monitoring data collected at the Lee Acres Landfill and the Giant Bloomfield Refinery near Farmington, New Mexico. LAGBRD includes monitoring data from as early as 1985, when awareness was increasing regarding contamination from liquid waste lagoons at the landfill and fuel releases at the refinery. Water quality and groundwater elevation data from sampling locations at the landfill and the refinery are included in the database. LAGBRD was compiled in cooperation with the Bureau of Land Management, which operates the Lee Acres Landfill, in order to facilitate future studies into the characteristics of groundwater contamination and background geochemistry at the landfill and refinery sites.

Introduction

The Lee Acres Landfill, located in northwestern New Mexico approximately 6 miles east of Farmington, New Mexico, is a former 60-acre landfill that is adjacent to an unnamed arroyo approximately 1 mi above its confluence with the San Juan River (fig. 1). The landfill was operated by San Juan County from May 1962 through April 1986 on land leased from the Bureau of Land Management (BLM). The New Mexico Environment Department (NMED) detected chlorinated solvents in liquid waste lagoons at the site in 1985 (NMED, 1986). The site was placed on the National Priorities List in 1990 by the U.S. Environmental Protection Agency (EPA) because of the presence of heavy metals and volatile organic compounds in groundwater and soils surrounding the site (EPA, 2004). Since that time, the U.S. Geological Survey (USGS) has performed regular groundwater monitoring at the site in cooperation with the BLM, which oversees the site. Alluvial aquifer background concentration ranges were published in the site's remedial investigation report (Roy F. Weston, Inc., 1995), and cleanup levels for the seven contaminants of concern (COCs) at the site were set by the EPA in the site's record of decision (ROD) (EPA, 2004). The alluvial aquifer background concentration ranges for several parameters and cleanup levels for the COCs at the landfill are described in table 1. Dissolved manganese is the only COC that is persistent in Lee Acres Landfill monitoring wells in concentrations larger than cleanup levels described in the ROD (EPA, 2004; USGS, 2021). Several monitoring wells that continue to have elevated dissolved manganese concentrations are located on Giant Bloomfield Refinery (GBR) property, which borders the Lee Acres Landfill directly to the south (figs. 1 and 2). GBR is a former crude oil refinery that operated from 1973 to 1982. Following 1982, the site was used as a truck maintenance and dispatching headquarters for Giant Industries. In 1986, Giant Industries began remediating the site because of several historical releases of diesel fuel, crude oil, and gasoline (Geoscience Consultants, Ltd., 1988; LT Environmental, Inc., 2020).

Remediation activities at GBR have included groundwater treatment and onsite recharge of the treated water to the alluvial aquifer (Giant Industries Arizona, Inc., 1993). Groundwater treatment was discontinued in 2015, but groundwater quality, treatment system influent and effluent water quality, and groundwater elevations continue to be monitored annually at GBR. During regular groundwater monitoring, groundwater samples collected from GBR wells upgradient from historical fuel release sites have exceeded regulatory standards for manganese, iron, and chromium (LT Environmental, Inc., 2020). More investigation is required to determine the possible sources of elevated concentrations of metals at GBR wells.

Groundwater has been monitored at the Lee Acres Landfill and GBR since 1985. Several State, Federal, and private entities have been involved in groundwater sample collection at the landfill and at GBR (NMED, 1986; Geoscience Consultants, Ltd., 1988; Roy F. Weston, Inc., 1995). The long monitoring histories at the landfill and the refinery have resulted in an array of data related to these sites that exists in different locations, forms, and standards. In cooperation with the BLM, the USGS compiled these data into a single, usable database, called Lee Acres-Giant Bloomfield Refinery Database (LAGBRD), to aid future investigations into the sources of contamination at the Lee Acres Landfill and GBR.

Table 1. Alluvial aquifer background concentrations for selected parameters and cleanup levels for contaminants of concern at the Lee Acres Landfill near Farmington, New Mexico.

[The alluvial aquifer background concentrations and cleanup levels for the organic contaminants (*cis*-1,2-dichloroethene, *trans*-1,2-dichloroethene, tetrachloroethene, trichloroethene, and vinyl chloride) refer to values of raw, unfiltered water; NA, not applicable (not a contaminant of concern at the Lee Acres Landfill); ND, nondetect]

Parameter	Alluvial aquifer background concentration range (micrograms per liter)[1]	Cleanup level (micrograms per liter)[2]
Total chloride	6,400 to 62,900	NA
Dissolved manganese	16.1 to 1,680	346
Dissolved nickel	ND to 10.5	200
Dissolved chromium	14.4 to 31.2	NA
Dissolved iron	ND to 2,460	NA
cis-1,2-Dichloroethene	ND	70
trans-1,2-Dichloroethene	ND	100
Tetrachloroethene (perchloroethylene [PCE])	ND	5
Trichloroethene (TCE)	NA[3]	5
Vinyl chloride	ND	1

[1]Alluvial aquifer background concentration ranges from the "Remedial Investigation Report for the Lee Acres Landfill" (Roy F. Weston, Inc., 1995).

[2]Cleanup levels from the Lee Acres Landfill record of decision (U.S. Environmental Protection Agency, 2004).

[3]Trichloroethene was detected in 3 of 43 alluvial aquifer background samples collected for the remedial investigation and was eliminated as a background contaminant because of the low frequency of detection (Roy F. Weston, Inc., 1995).

Purpose and Scope

Publicly available water quality and groundwater elevation data were gathered and compiled into LAGBRD. This report explains the database structure and data fields within LAGBRD, describes the sources of data included in LAGBRD, and displays time-series plots of some of the compiled water quality data. Figures 3–7 display the locations of samples represented in LAGBRD. The database is available at https://doi.org/10.3133/dr1154.

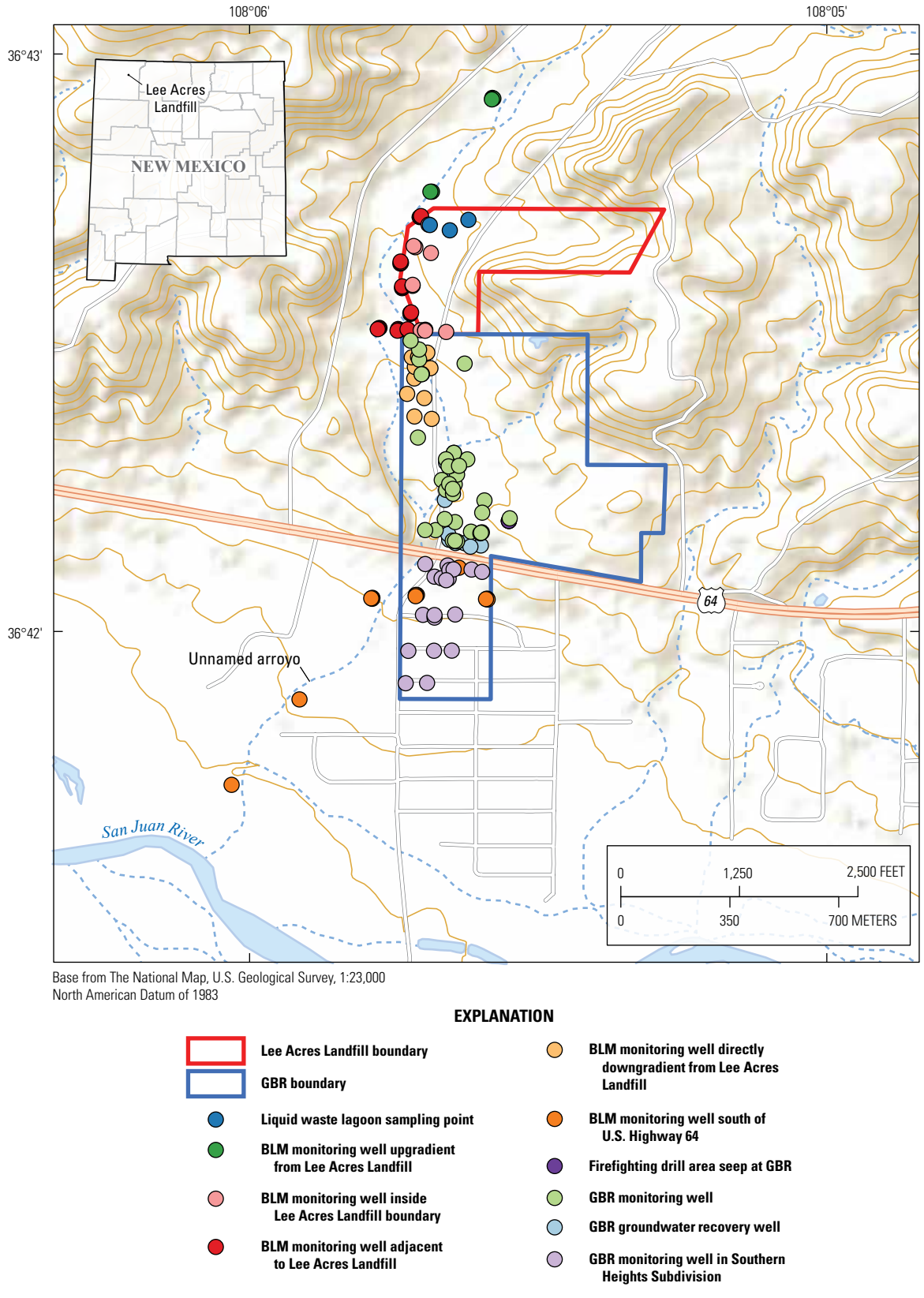


Figure 1. Locations of the Lee Acres Landfill and the Giant Bloomfield Refinery (GBR) adjacent to an unnamed arroyo approximately 1 mile above its confluence with the San Juan River near Farmington, New Mexico (Roy F. Weston, Inc., 1995; LT Environmental, Inc., 2020). Figure also shows Bureau of Land Management (BLM) and GBR monitoring locations.

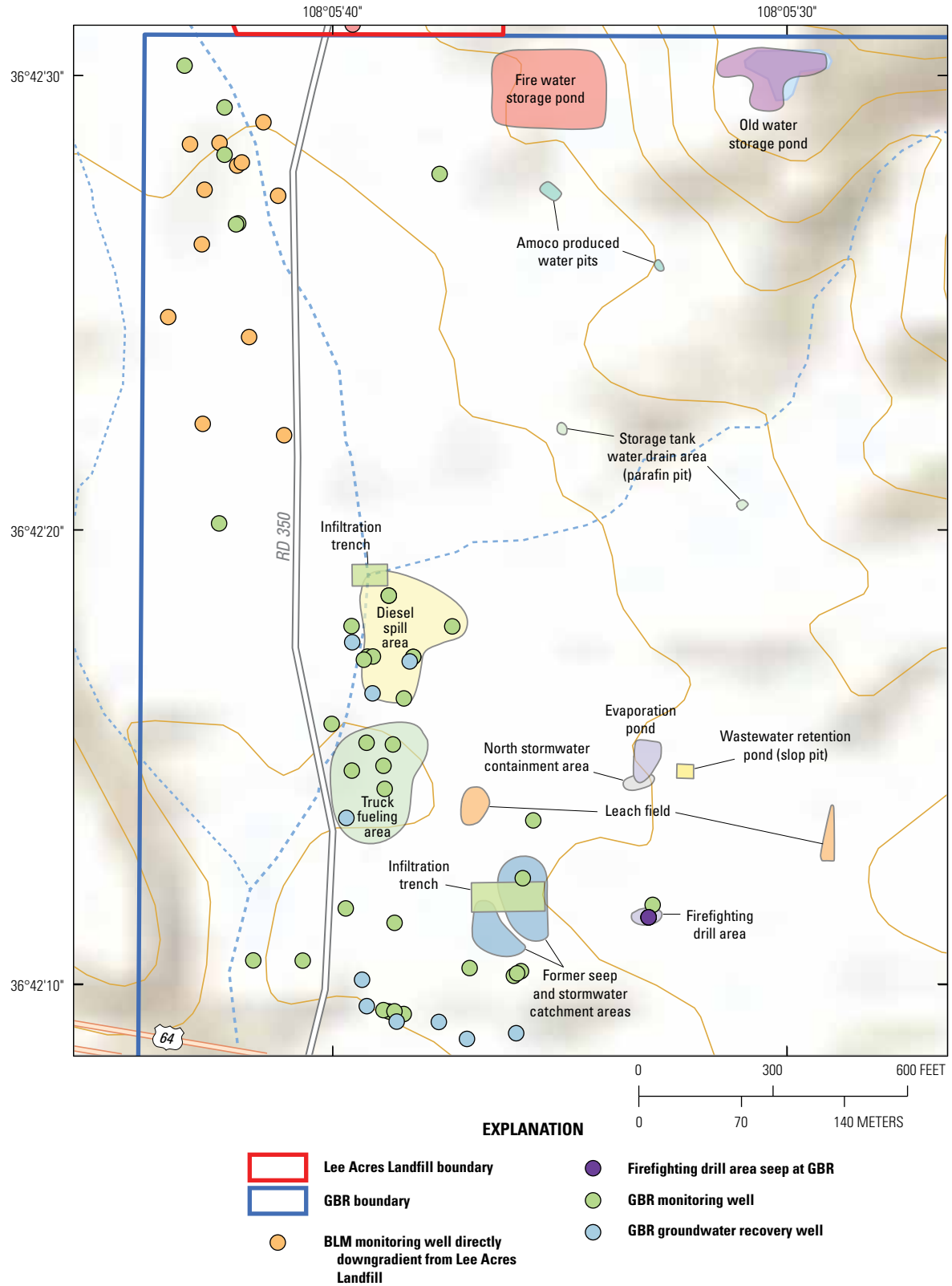


Figure 2. Locations of Bureau of Land Management (BLM) monitoring wells and other wells and surface features related to refinery operations and remediation activities near historical fuel release sites at Giant Bloomfield Refinery (GBR), located downgradient from the Lee Acres Landfill near Farmington, New Mexico (Geoscience Consultants, Ltd., 1988).

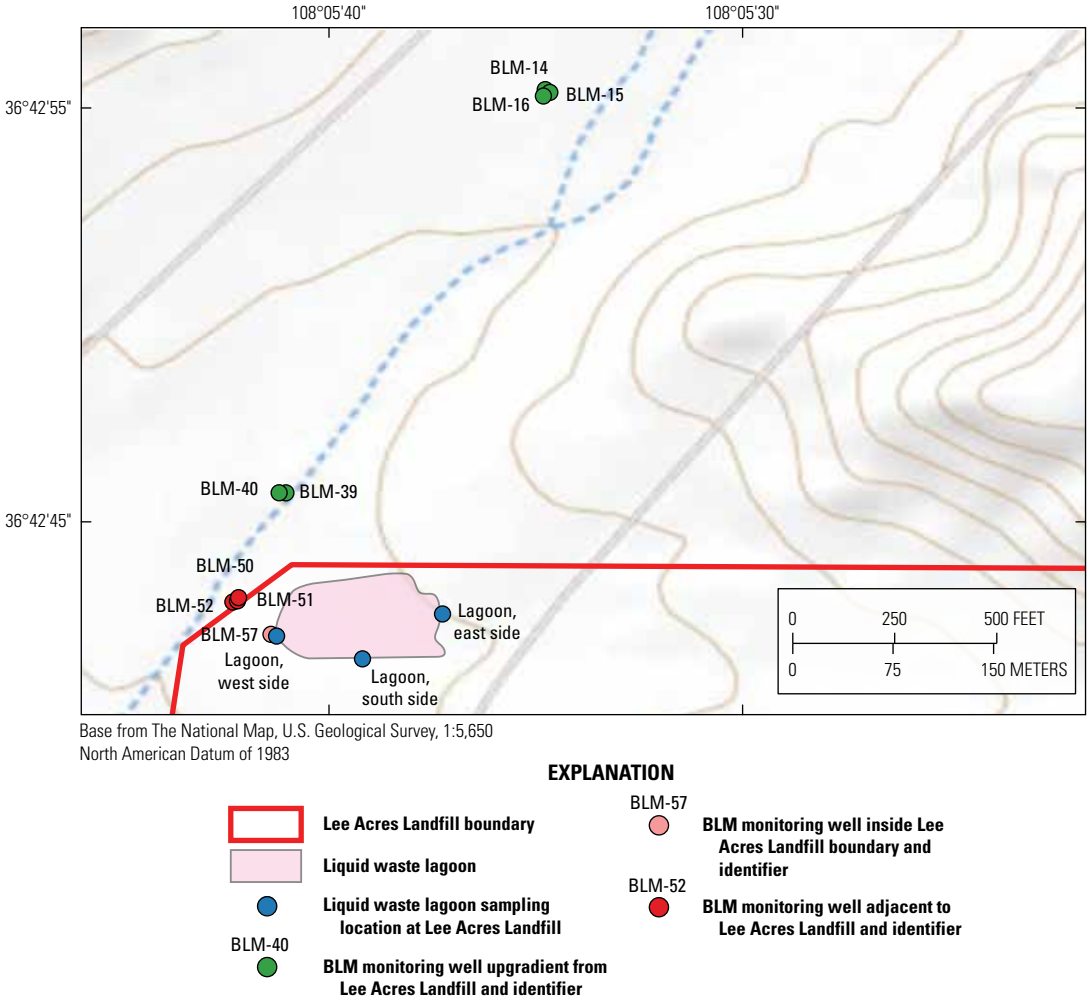


Figure 3. Locations of Bureau of Land Management (BLM) monitoring wells and liquid waste lagoon sampling locations upgradient from, within, and adjacent to the Lee Acres Landfill near Farmington, New Mexico.

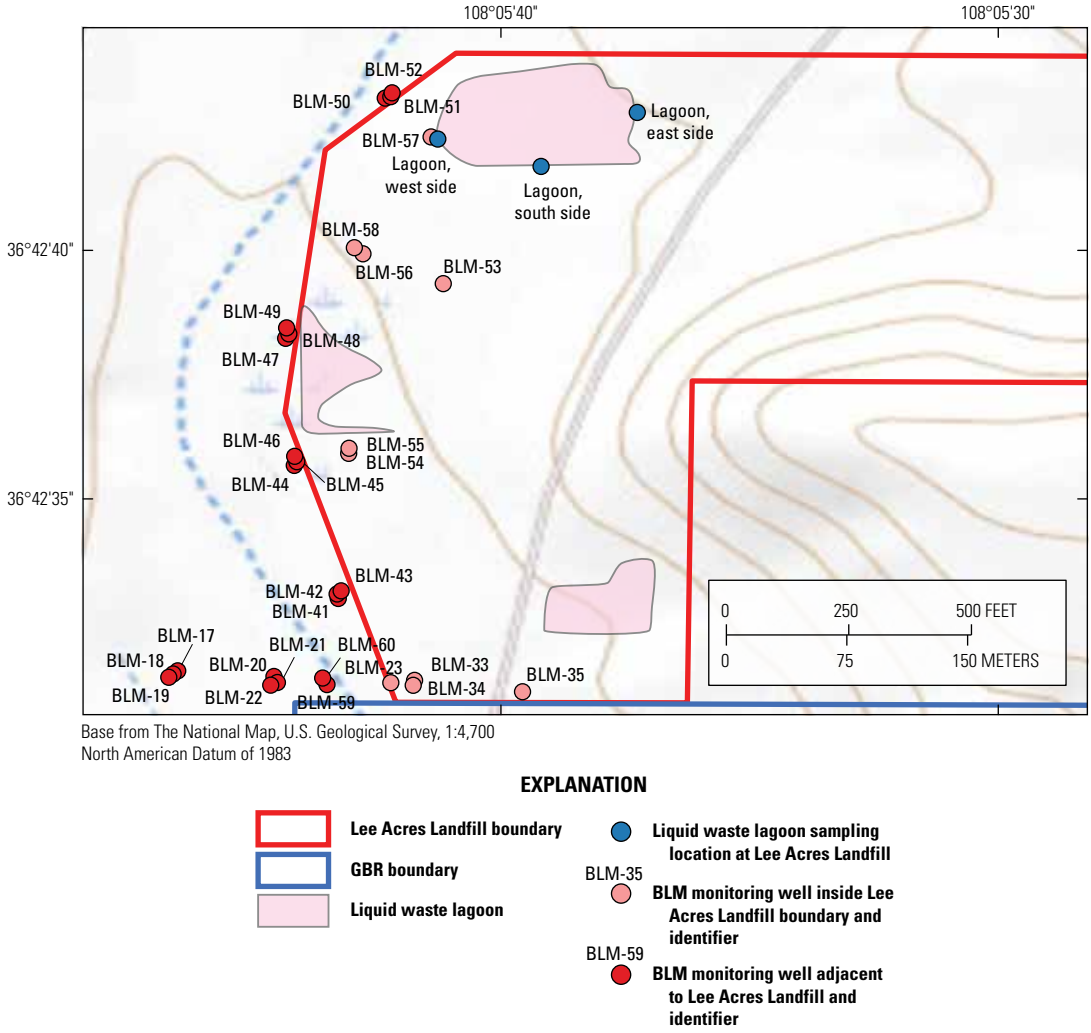


Figure 4. Locations of Bureau of Land Management (BLM) monitoring wells and liquid waste lagoon sampling locations within the boundary of and adjacent to the Lee Acres Landfill outside of the Giant Bloomfield Refinery boundary near Farmington, New Mexico.

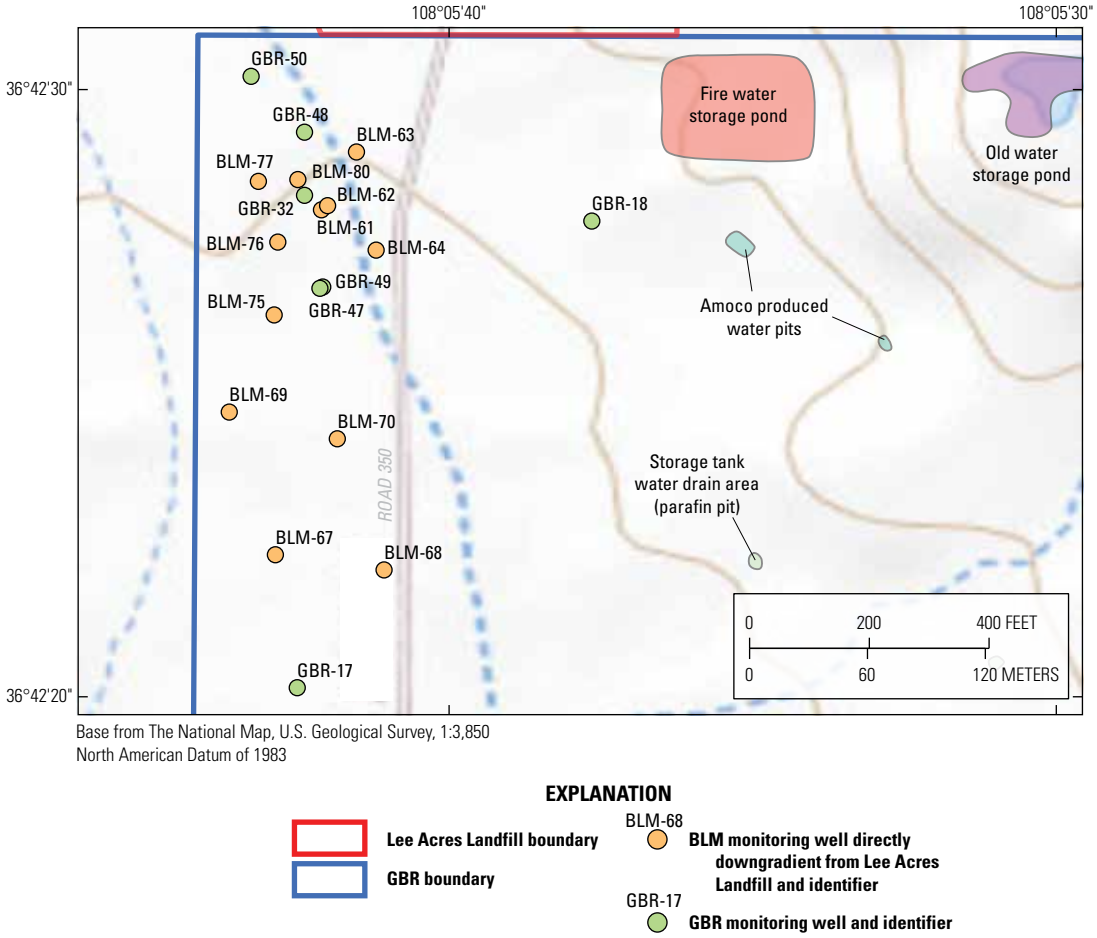
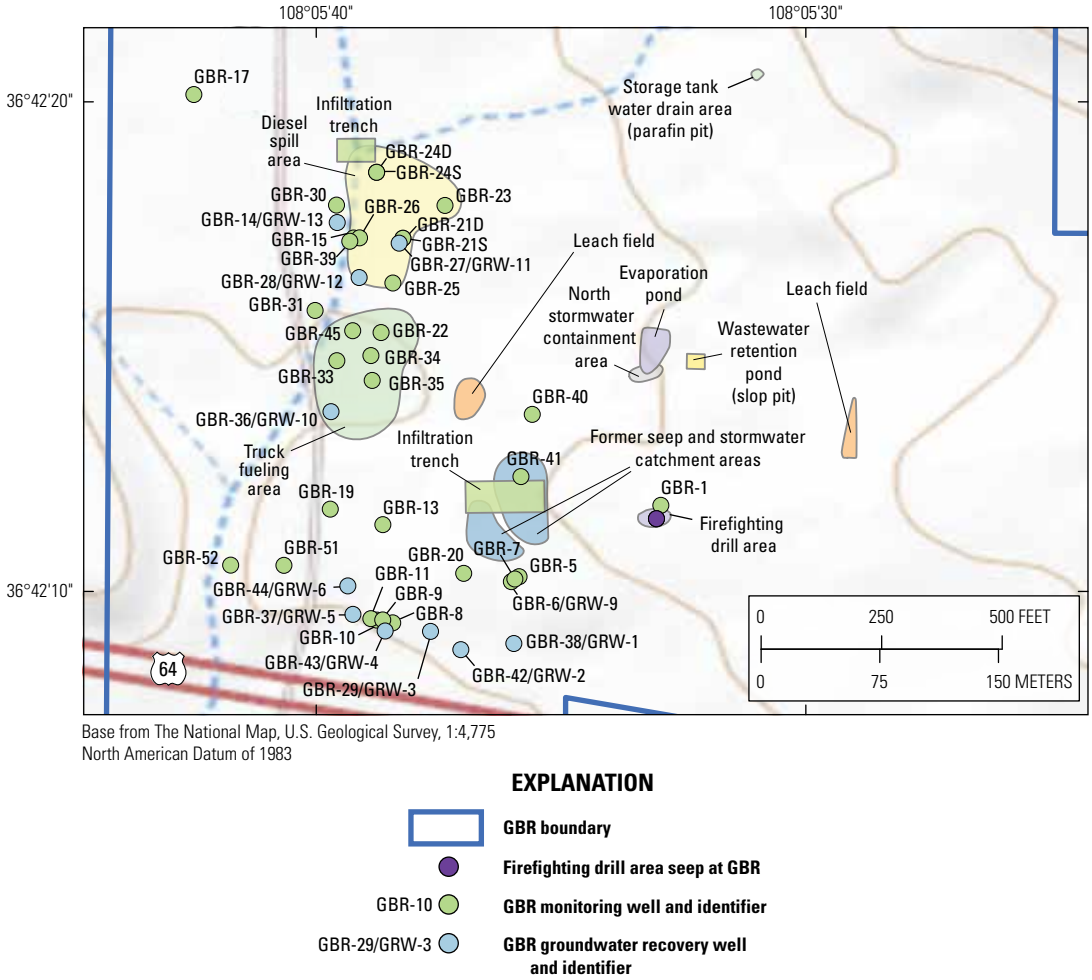


Figure 5. Locations of Bureau of Land Management (BLM) and Giant Bloomfield Refinery (GBR) monitoring wells directly downgradient from the Lee Acres Landfill near Farmington, New Mexico. These sites are all within the GBR boundary.



Base from The National Map, U.S. Geological Survey, 1:4,775
North American Datum of 1983

EXPLANATION

- **GBR boundary**
- **Firefighting drill area seep at GBR**
- GBR-10 **GBR monitoring well and identifier**
- GBR-29/GRW-3 **GBR groundwater recovery well and identifier**

Figure 6. Locations of Giant Bloomfield Refinery (GBR) monitoring wells, GBR groundwater recovery wells (GRW), and a subterranean seep within the GBR boundary near Farmington, New Mexico.

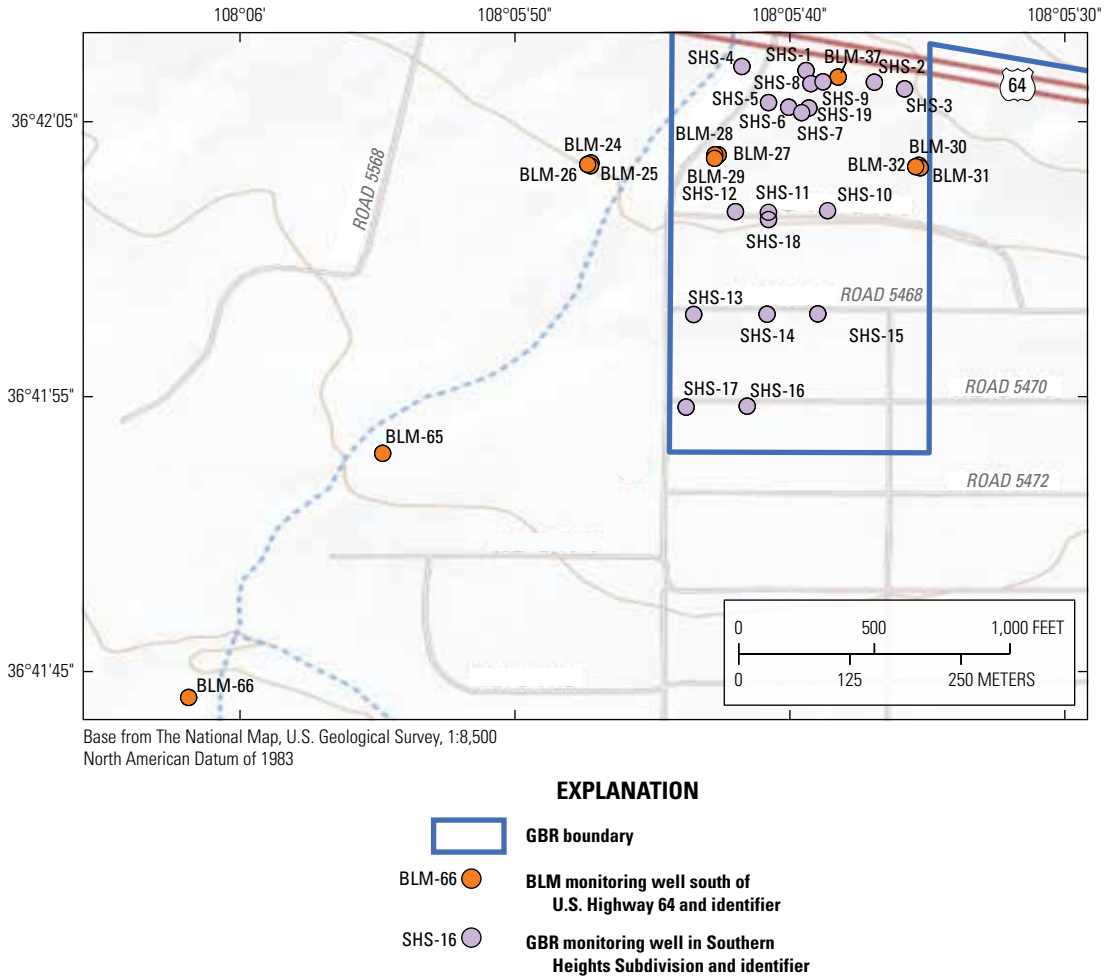


Figure 7. Locations of Bureau of Land Management (BLM) and Giant Bloomfield Refinery (GBR) monitoring wells south of U.S. Highway 64 near Farmington, New Mexico. GBR monitoring wells within the Southern Heights Subdivision (SHS) are named with an "SHS-" prefix.

Database Characteristics

LAGBRD is a relational database created in Microsoft Access for Office 365. The structure of the database is a modification of that used by the USGS National Water Information System (NWIS) database (USGS, 2021). Described below are summaries of the contents and structure of the relations of the tables in addition to details of data sources and quality assurance procedures of the data presented.

Database Contents and Structure

LAGBRD (available at https://doi.org/10.3133/dr1154) contains six related tables: "Sites," "WQ_Result," "GW_Elevation," "Remark_Cd," "Val_Qual_Cd," and "Field_Explanation."

The "Sites" table in LAGBRD contains site-level information on the locations where the water quality and groundwater elevation data contained in the database were collected. Data fields in the "Sites" table are described in table 2 and in the "Field_Explanation" table in LAGBRD.

The "WQ_Result" table in LAGBRD contains water quality information by result (each row of the table contains information pertaining to a single result) collected from wells at the Lee Acres Landfill and GBR, liquid waste lagoons at the Lee Acres Landfill, effluent from the GBR groundwater treatment system, and a subterranean seep at GBR associated with a firefighting drill area. Data fields in the "WQ_Result" table are described in table 3 and in the "Field_Explanation" table in LAGBRD. Each water quality result in the "WQ_Result" table is associated with a sampling location connected to the "Sites" table through the "loc_station_nm" field. Water quality parameters ("parameter_nm" field in the "WQ_Result" table) are named according to NWIS parameter naming convention. NWIS parameter names include the chemical name, a code for the sample medium (in LAGBRD, "wu" for unfiltered water,

Table 2. Definitions of field names contained in the "Sites" table of the Lee Acres-Giant Bloomfield Refinery Database (LAGBRD; available at https://doi.org/10.3133/dr1154).

Field	Field description
USGS_site_no	U.S. Geological Survey site identification number; if blank, the site does not exist in the National Water Information System database
USGS_station_nm	U.S. Geological Survey station name; if blank, the site does not exist in the National Water Information System database
loc_station_nm	Local station name
site_type	Site type (monitoring well, Giant Bloomfield Refinery treatment system, underground seep, groundwater recovery well, or Lee Acres Landfill liquid waste lagoon)
site_assoc	The entity the site is associated with (the Lee Acres Landfill, the Giant Bloomfield Refinery, or the Southern Heights Subdivision)
lat_va	Latitude value of site in decimal degrees, if known
long_va	Longitude value of site in decimal degrees, if known
coord_datum	Latitude/longitude datum, if known
alt_va	Altitude of land-surface datum, if known
alt_datum	Altitude datum, if known
alt_acy_va	Altitude accuracy in feet, if known
hole_depth_va	Total borehole depth in feet below land-surface datum (for wells only), if known
csng_top_va	Depth to top of casing in feet below land surface (negative if top of casing is above ground) (for wells only), if known
csng_bottom_va	Depth to bottom of casing in feet below land surface (for wells only), if known
csng_dia_va	Inner diameter of the casing in inches (for wells only), if known
csng_material	Casing material (for wells only), if known
screen_top_va	Depth to the top of the screened interval in feet below land surface (for wells only), if known
screen_bottom_va	Depth to the bottom of the screened interval in feet below land surface (for wells only), if known
screen_material	Screened interval material (for wells only), if known
screen_dia_va	Screened interval diameter in inches (for wells only), if known
site_note	Notes on site-level information
data_src	Citation of data source

"wf" for filtered water, or "water" if it is unknown whether a sample was filtered), and sometimes additional information about the parameter, such as the sample fraction or the analytical method. The units of the result are also included in the "parameter_nm" field. Data were not always available for every field in the "WQ_Result" table because of the variations in sampling methodologies of the parties involved in groundwater monitoring at these sites. For instance, some data in LAGBRD were transcribed from tables in reports and were not accompanied by analytical laboratory reports; analytical method, reporting level, reporting level type, and result value qualifiers may not be known for such data.

The "GW_Elevation" table in LAGBRD contains groundwater elevation data from NWIS and from GBR monitoring reports. Data fields in the "GW_Elevation" table are described in table 4 and in the "Field_Explanation" table in LAGBRD. Each groundwater elevation measurement in the "GW_Elevation" table is associated with a sampling location connected to the "Sites" table through the "loc_station_nm" field. Groundwater elevation data from annual GBR monitoring reports are presented in LAGBRD as reported, despite inconsistencies between the reported elevations and water-level measurements.

The tables "Remark_Cd" and "Val_Qual_Cd" in LAGBRD act as keys to explain the coded data in fields "remark_cd" and "val_qual_cd" in the table "WQ_Result." The fields of tables "Remark_Cd" and "Val_Qual_Cd" are described in table 5 and table 6 and in the "Field_Explanation" table in LAGBRD. The "Field_Explanation" table in LAGBRD, which is also included as table 7 in this report, provides explanations of the field names in the other tables in LAGBRD.

LAGBRD also contains two regular queries, "WQ_Result_Inorganic" and "WQ_Result_Organic," which filter the water quality results from the "WQ_Result" table into organic and inorganic parameters. Finally, LAGBRD contains two crosstab queries, "WQ_Result_Inorganic_Crosstab" and "WQ_Result_Organic_Crosstab," which present the data contained in the by-result queries "WQ_Result_Inorganic" and "WQ_Result_Organic" in a by-sample format. The formatting of the by-sample crosstab queries makes the output of these queries useful for plotting and manipulating the data

Table 3. Definitions of field names contained in the "WQ_Result" table of the Lee Acres-Giant Bloomfield Refinery Database (LAGBRD; available at https://doi.org/10.3133/dr1154).

Field	Field description
loc_station_nm	Local station name
sample_dt	Water sample collection date, if given in the data source
sample_yr	Water sample collection year, if the exact date is not given in the data source
sample_mo_qrt	Water sample collection month or quarter, if the exact date is not given in the data source; for several samples in 1989, only the sample quarter was given
sample_dt_calc	Water sample collection date, if given in the data source, or the first day of the month or quarter the sample was collected
parameter_nm	Water quality parameter (wu, unfiltered water; wf, filtered water; water, it is unknown whether a sample was filtered)
parameter_tp	Type of water quality parameter (organic or inorganic)
method	Analytical method of the result, if known
result_va	Result value. If a sample is reported as nondetect, result value is equal to reporting level value, if available, and remark code is "<." If a result is nondetect and a reporting level value is not available, result value is set to "ND"
remark_cd	Remark code associated with result_va, if applicable; codes explained in the table Remark_Cd in LAGBRD
val_qual_cd	Value qualifier code associated with result_va, if applicable; codes explained in the table Val_Qual_Cd in LAGBRD
rpt_lev_va	Reporting level value, if known
rpt_lev_cd	If rpt_lev_va is known, type of reporting level used in rpt_lev_va, as described in the data source
result_unit	Units of measure for result_va and rpt_lev_va
wq_note	Contains notes on result-level information
data_src	Citation of data source

in spreadsheet applications such as Microsoft Excel, though users should be aware that these data are presented without their associated remarks and value qualifiers. Remarks and value qualifiers are contained in the "remark_cd" and "val_qual_cd" fields in the "WQ_Result" table. The by-result format of the "WQ_Result" table makes it well suited for working in programming environments such as R (R Core Team; https://www.r-project.org/) or Python (Python Software Foundation; https://www.python.org/).

Database Data Sources

Site-level information contained in the "Sites" table in LAGBRD is from a variety of sources. Site-level information on the liquid waste lagoons at the Lee Acres Landfill is from NMED (1986). Site-level information on BLM monitoring wells is from NWIS (USGS, 2021) and from the "Remedial Investigation Report for the Lee Acres Landfill" (Roy F. Weston, Inc., 1995). NWIS is also the source of information for several GBR monitoring wells (USGS, 2021). Information on other GBR monitoring wells, groundwater recovery wells, and the underground seep at the firefighting drill area is from that site's discharge plan application (Geoscience Consultants, Ltd., 1988) and stage 1 abatement plan (LT Environmental, Inc., 2020). Monitoring results from the GBR treatment system do not have coordinates in LAGBRD because treatment system effluent was released to several infiltration trenches at GBR and the specific discharge location was not provided in the monitoring reports. Figure 2 displays the locations of two infiltration trenches used by GBR for the release of effluent from that site's treatment system.

The water quality and groundwater elevation data contained in LAGBRD were collected by NMED, USGS, and private contractors on behalf of the BLM and GBR to satisfy site characterization and monitoring requirements. The field "data_src," which is built into the "Site," "WQ_Result," and "GW_Elevation" tables in LAGBRD, contains the citation of the database or report from which the data originated.

All data in LAGBRD collected by the USGS originate from NWIS (USGS, 2021). Monitoring activities at the Lee Acres Landfill followed protocols described in the sampling and analysis plan for that site (Fredrick Gebhardt, USGS New Mexico Water Science Center, written commun., 2021). Other general guidelines that were followed during the collection and review of the USGS-collected water-level data in LAGBRD are described in the USGS New Mexico Water Science Center internal document "Quality-Assurance Plan for Data Collection, Processing, and Archival in the New Mexico Water Science Center" (Kimberly Beisner, USGS New Mexico Water Science Center, written commun., 2020). Monitoring activities at GBR followed protocols described in

Table 4. Definitions of field names contained in the "GW_Elevation" table of the Lee Acres-Giant Bloomfield Refinery Database (LAGBRD; available at https://doi.org/10.3133/dr1154).

Field	Field description
loc_station_nm	Local station name
lev_dt	Water-level measurement date, if given in the data source
lev_yr	Water-level measurement year, if the exact date is not given in the data source
lev_mo	Water-level measurement month, if the exact date is not given in the data source
lev_dt_calc	Water-level measurement date, if given in the data source, or the first day of the month the water-level measurement was collected
csng_top_alt_va	Altitude of the top of casing in feet above datum, for Giant Bloomfield Refinery monitoring data
lev_va_below_land_surf	Water level in feet referenced to land-surface datum, for data downloaded from the National Water Information System database; land-surface elevation provided in the table Sites in LAGBRD
lev_va_below_csng_top	Water level in feet referenced to top of casing, for Giant Bloomfield Refinery monitoring data
lev_product_va_below_csng_top	Floating product level in feet referenced to top of casing, for Giant Bloomfield Refinery monitoring data
thickness_product_va	Floating product thickness in feet, for Giant Bloomfield Refinery monitoring data, as reported
lev_va_above_datum	Altitude of the water surface (adjusted for floating product thickness) in feet referenced to altitude datum, as reported. Altitude datum for National Water Information System sites can be found in the table Sites in LAGBRD. The altitude datum is not known for some data collected by the Giant Bloomfield Refinery
data_src	Citation of data source

Table 5. Definitions of field names contained in the "Remark_Cd" table of the Lee Acres-Giant Bloomfield Refinery Database (LAGBRD; available at https://doi.org/10.3133/dr1154).

Field	Field description
remark_cd	Remark code
remark_nm	Name associated with the remark code
remark_description	Description of the remark

Table 6. Definitions of field names contained in the "Val_Qual_Cd" table of the Lee Acres-Giant Bloomfield Refinery Database (LAGBRD; available at https://doi.org/10.3133/dr1154).

Field	Field description
val_qual_cd	Value qualifier code
val_qual_description	Description of the value qualifier code

Table 7. Definitions of field names contained in the "Field_Explanation" table of the Lee Acres-Giant Bloomfield Refinery Database (LAGBRD; available at https://doi.org/10.3133/dr1154).

Field	Field description
table_nm	Name of LAGBRD table in which the field is found
field_nm	Field name
field_explanation	Explanation of the field

the 1988 discharge plan application for that site (Geoscience Consultants, Ltd., 1988). Data from GBR reporting sources are presented in LAGBRD as reported. USGS staff did not review the data quality of the reported GBR data.

Data collected at GBR were reported to the New Mexico Oil Conservation Division (NMOCD) and are available from the online NMOCD data repository (NMOCD, 2021). Regulatory data collection and reporting protocols associated with the GBR data in LAGBRD are contained in the 1993 discharge plan for GBR (Giant Industries Arizona, Inc., 1993). Where available, GBR data in the "WQ_Result" table in LAGBRD originate from analytical laboratory results and include detailed result-level information, such as analytical method, reporting level, reporting level type, and value qualifiers.

Regular monitoring data collected by the USGS at the Lee Acres Landfill and by private contractors at GBR represent the bulk of data available in LAGBRD, but there are several other data sources. During initial site investigations, NMED collected samples from liquid waste lagoons within the Lee Acres Landfill (NMED, 1986), the results of which are included in LAGBRD. Also included in LAGBRD are groundwater quality monitoring results from the "Remedial Investigation Briefing Document for the Lee Acres Landfill" (Roy F. Weston, Inc., 1991). Sampling was performed for the landfill's remedial investigation by Roy F. Weston, Inc., on behalf of the BLM. Finally, water quality data from groundwater wells and an underground seep from the GBR discharge plan application (Geoscience Consultants, Ltd., 1988) are included in LAGBRD. When analytical methods for water quality data are known, they are included in the "method" field of the "WQ_Result" table in LAGBRD.

Time-Series Plots

The uniform formatting and naming of the water chemistry data contained in LAGBRD make it a useful tool for visualizing data from the Lee Acres Landfill and GBR that previously existed only in disparate sources. There are 131 sites with water quality data in LAGBRD and more than 2,100 water quality samples spanning from 1985 to 2020. Table 8 summarizes statistics that describe the water quality data in the database, including sampling start and end dates and sources of water quality data for each sampling location in the database.

The remainder of this section contains time-series plots generated from data contained in LAGBRD but is not an exhaustive display of those data. Some of the plots in this section contain many nondetect results (ND; analytes that may be present in a sample but were not detected above method detection limits) or estimated results (E; results are estimated, formerly applied to results above method detection limits but below reporting levels). Nondetect results are plotted at their reporting level and are symbolized as open diamonds, and estimated results are symbolized as open squares. The data in LAGBRD are associated with several different reporting level types. The reporting level and reporting level type are contained in the table "WQ_Result" in LAGBRD when those data are available. Because laboratory practices changed over time, and because a number of different laboratories and analytical methods were used to analyze samples from the Lee Acres Landfill and GBR, reporting levels are generally not constant for the analytes in LAGBRD. These changes in reporting level are evident in the nondetect results in the time-series plots.

Because of the large number of sites, results have been plotted in groups of sites according to site operator and location relative to the Lee Acres Landfill and GBR. Time-series plots of chloride concentration data from LAGBRD are displayed in figures 8–14. Anion samples collected at the Lee Acres Landfill by USGS personnel were historically not filtered, and figures 8–11 display the total, unfiltered chloride results for those samples. GBR monitoring reports do not explicitly state whether anion samples were filtered or unfiltered, and so it is unknown whether the GBR anion data in LAGBRD represent dissolved or total sample fractions. Figures 12–14 display the chloride results in LAGBRD from GBR reports with unknown chloride fractions. The two inorganic COCs listed in the ROD (EPA, 2004) for the Lee Acres Landfill are dissolved manganese and dissolved nickel. At GBR, dissolved manganese, dissolved chromium, and dissolved iron have been detected above alluvial aquifer background concentrations (table 1) at several monitoring wells. Time-series plots of dissolved manganese, dissolved nickel, dissolved chromium, and dissolved iron at BLM and GBR monitoring sites are displayed in figures 15–42. Since 2011, the GBR monitoring plan has included analysis of total metals at some of their monitoring locations. Time-series plots of total metals at GBR sites are displayed in figures 43–54. The BLM monitoring plan has not historically included analysis of total metals.

Table 8. Site-level summary statistics of the water quality data within the Lee Acres-Giant Bloomfield Refinery Database (LAGBRD; available at https://doi.org/10.3133/dr1154).

[BLM, Bureau of Land Management; RI, Lee Acres remedial investigation; USGS, U.S. Geological Survey; GBR, Giant Bloomfield Refinery; GRW, groundwater recovery well; NMED, New Mexico Environment Department; SHS, Southern Heights Subdivision]

Local station name	Site type	Water quality sampling start date (month/day/year)	Water quality sampling end date (month/day/year)	Number of water quality samples in LAGBRD	Number of individual water quality results in LAGBRD	Water quality data source(s)[1]
BLM-14	Monitoring well	12/15/1987	5/17/1990	17	197	RI
BLM-15	Monitoring well	12/15/1987	11/16/2004	31	1,159	RI, USGS
BLM-16	Monitoring well	12/16/1987	5/17/1990	16	205	RI
BLM-17	Monitoring well	12/15/1987	5/16/1990	17	196	RI
BLM-18	Monitoring well	12/15/1987	5/16/1990	17	244	RI
BLM-19	Monitoring well	12/16/1987	5/16/1990	17	203	RI
BLM-20	Monitoring well	12/15/1987	5/16/1990	17	171	RI
BLM-21	Monitoring well	12/15/1987	11/17/2004	32	1,178	RI, USGS
BLM-22	Monitoring well	12/15/1987	5/16/1990	18	220	RI
BLM-23	Monitoring well	12/16/1987	5/16/1990	17	224	RI
BLM-24	Monitoring well	12/16/1987	5/20/1990	19	166	RI
BLM-25	Monitoring well	12/16/1987	5/20/1990	17	201	RI
BLM-26	Monitoring well	12/16/1987	5/20/1990	19	186	RI
BLM-27	Monitoring well	12/16/1987	5/19/1990	17	198	RI
BLM-28	Monitoring well	12/16/1987	5/19/1990	17	197	RI
BLM-29	Monitoring well	12/16/1987	5/19/1990	17	192	RI
BLM-30	Monitoring well	12/16/1987	5/19/1990	18	224	RI
BLM-31	Monitoring well	12/16/1987	5/19/1990	17	194	RI
BLM-32	Monitoring well	12/16/1987	5/19/1990	19	225	RI
BLM-33	Monitoring well	2/8/1989	5/16/1990	7	119	RI
BLM-34	Monitoring well	2/8/1989	5/16/1990	7	103	RI

Table 8. Site-level summary statistics of the water quality data within the Lee Acres-Giant Bloomfield Refinery Database (LAGBRD; available at https://doi.org/10.3133/dr1154).—Continued

[BLM, Bureau of Land Management; RI, Lee Acres remedial investigation; USGS, U.S. Geological Survey; GBR, Giant Bloomfield Refinery; GRW, groundwater recovery well; NMED, New Mexico Environment Department; SHS, Southern Heights Subdivision]

Local station name	Site type	Water quality sampling start date (month/day/year)	Water quality sampling end date (month/day/year)	Number of water quality samples in LAGBRD	Number of individual water quality results in LAGBRD	Water quality data source(s)[1]
BLM-35	Monitoring well	2/8/1989	5/16/1990	7	131	RI
BLM-37	Monitoring well	5/16/1989	4/28/1990	7	179	RI
BLM-39	Monitoring well	3/1/1990	8/4/2020	56	3,946	RI, USGS
BLM-40	Monitoring well	3/1/1990	5/17/1990	3	46	RI
BLM-41	Monitoring well	3/1/1990	5/18/1990	3	40	RI
BLM-42	Monitoring well	3/1/1990	11/16/2004	17	988	RI, USGS
BLM-43	Monitoring well	3/1/1990	5/18/1990	3	39	RI
BLM-44	Monitoring well	3/2/1990	5/17/1990	3	36	RI
BLM-45	Monitoring well	3/2/1990	8/4/2020	49	3,584	RI, USGS
BLM-46	Monitoring well	3/2/1990	5/17/1990	3	38	RI
BLM-47	Monitoring well	3/3/1990	5/17/1990	3	36	RI
BLM-48	Monitoring well	3/3/1990	11/16/2004	17	971	RI, USGS
BLM-49	Monitoring well	3/3/1990	5/17/1990	3	38	RI
BLM-50	Monitoring well	3/20/1990	5/17/1990	3	47	RI
BLM-51	Monitoring well	3/20/1990	11/16/2004	17	980	RI, USGS
BLM-52	Monitoring well	3/20/1990	5/17/1990	3	36	RI
BLM-53	Monitoring well	3/21/1990	5/21/1990	3	39	RI
BLM-54	Monitoring well	3/4/1990	5/21/1990	3	53	RI
BLM-55	Monitoring well	3/4/1990	11/16/2004	17	984	RI, USGS
BLM-56	Monitoring well	3/6/1990	11/16/2004	25	1,533	RI, USGS
BLM-57	Monitoring well	3/21/1990	11/16/2004	25	1,539	RI, USGS

Table 8. Site-level summary statistics of the water quality data within the Lee Acres-Giant Bloomfield Refinery Database (LAGBRD; available at https://doi.org/10.3133/dr1154).—Continued

[BLM, Bureau of Land Management; RI, Lee Acres remedial investigation; USGS, U.S. Geological Survey; GBR, Giant Bloomfield Refinery; GRW, groundwater recovery well; NMED, New Mexico Environment Department; SHS, Southern Heights Subdivision]

Local station name	Site type	Water quality sampling start date (month/day/year)	Water quality sampling end date (month/day/year)	Number of water quality samples in LAGBRD	Number of individual water quality results in LAGBRD	Water quality data source(s)[1]
BLM-58	Monitoring well	3/6/1990	5/22/1990	3	36	RI
BLM-59	Monitoring well	3/2/1990	5/18/1990	3	36	RI
BLM-60	Monitoring well	3/2/1990	8/5/2020	49	3,674	RI, USGS
BLM-61	Monitoring well	3/21/1990	5/20/1990	3	37	RI
BLM-62	Monitoring well	3/21/1990	8/5/2020	49	3,569	RI, USGS
BLM-63	Monitoring well	3/21/1990	5/20/1990	3	40	RI
BLM-64	Monitoring well	3/21/1990	5/20/1990	3	39	RI
BLM-65	Monitoring well	3/20/1990	5/20/1990	3	41	RI
BLM-66	Monitoring well	3/20/1990	5/18/1990	3	32	RI
BLM-67	Monitoring well	5/20/1998	11/18/2004	14	933	USGS
BLM-68	Monitoring well	5/20/1998	8/5/2020	41	3,184	USGS
BLM-69	Monitoring well	5/20/1998	8/5/2020	16	1,164	USGS
BLM-70	Monitoring well	5/20/1998	5/14/2003	11	730	USGS
BLM-75	Monitoring well	5/19/1998	8/5/2020	46	3,527	USGS
BLM-76	Monitoring well	5/19/1998	11/17/2004	13	875	USGS
BLM-77	Monitoring well	5/19/1998	8/5/2020	46	3,571	USGS
BLM-80	Monitoring well	12/20/2005	8/5/2020	31	2,450	USGS
Filter discharge	GBR treatment system	10/1/1993	12/1/1993	3	173	GBR
Firefighting drill area seep	Underground seep	10/24/1985	11/21/1986	4	94	GBR
Firefighting drill area seep, east	Underground seep	6/5/1986	6/5/1986	1	3	GBR
Firefighting drill area seep, west	Underground seep	10/29/1985	10/29/1985	1	2	GBR

Table 8. Site-level summary statistics of the water quality data within the Lee Acres-Giant Bloomfield Refinery Database (LAGBRD; available at https://doi.org/10.3133/dr1154).—Continued

[BLM, Bureau of Land Management; RI, Lee Acres remedial investigation; USGS, U.S. Geological Survey; GBR, Giant Bloomfield Refinery; GRW, groundwater recovery well; NMED, New Mexico Environment Department; SHS, Southern Heights Subdivision]

Local station name	Site type	Water quality sampling start date (month/day/year)	Water quality sampling end date (month/day/year)	Number of water quality samples in LAGBRD	Number of individual water quality results in LAGBRD	Water quality data source(s)[1]
GBR treatment system effluent	GBR treatment system	3/14/1989	8/3/2015	132	7,233	GBR
GBR-1	Monitoring well	6/5/1986	6/5/1986	1	6	GBR
GBR-10	Monitoring well	11/21/1986	11/21/1986	1	19	GBR
GBR-11	Monitoring well	4/1/1986	8/6/2015	5	94	GBR
GBR-13	Monitoring well	4/15/1986	12/12/1989	12	343	GBR
GBR-14/GRW-13	Groundwater recovery well	10/17/1986	1/1/2001	24	1,229	GBR
GBR-15	Monitoring well	10/17/1986	1/1/2001	29	1,365	GBR
GBR-17	Monitoring well	5/29/1986	11/5/2019	71	3,538	RI, USGS, GBR
GBR-18	Monitoring well	5/9/1986	5/19/1990	9	119	RI, GBR
GBR-19	Monitoring well	10/17/1986	10/8/1992	4	102	RI, GBR
GBR-20	Monitoring well	5/9/1986	8/6/2015	5	63	GBR
GBR-21	Monitoring well	5/9/1986	5/9/1986	1	4	GBR
GBR-21D	Monitoring well	10/17/1986	8/7/2015	2	10	GBR
GBR-22	Monitoring well	5/9/1986	8/7/2015	3	14	GBR
GBR-23	Monitoring well	4/18/1986	4/18/1986	1	3	GBR
GBR-24	Monitoring well	4/18/1986	6/5/1986	3	27	GBR
GBR-24D	Monitoring well	10/17/1986	11/6/2019	45	2,710	GBR
GBR-24S	Monitoring well	11/21/1986	8/25/1988	2	34	RI, GBR
GBR-25	Monitoring well	5/9/1986	8/7/2015	3	15	GBR
GBR-26	Monitoring well	5/9/1986	8/7/2015	3	47	GBR
GBR-27/GRW-11	Groundwater recovery well	10/24/1985	11/21/1986	4	74	GBR

Table 8. Site-level summary statistics of the water quality data within the Lee Acres-Giant Bloomfield Refinery Database (LAGBRD; available at https://doi.org/10.3133/dr1154).—Continued

[BLM, Bureau of Land Management; RI, Lee Acres remedial investigation; USGS, U.S. Geological Survey; GBR, Giant Bloomfield Refinery; GRW, groundwater recovery well; NMED, New Mexico Environment Department; SHS, Southern Heights Subdivision]

Local station name	Site type	Water quality sampling start date (month/day/year)	Water quality sampling end date (month/day/year)	Number of water quality samples in LAGBRD	Number of individual water quality results in LAGBRD	Water quality data source(s)[1]
GBR-28/GRW-12	Groundwater recovery well	5/29/1986	9/4/1990	3	18	GBR
GBR-29/GRW-3	Groundwater recovery well	5/30/1986	10/11/2018	32	1,979	GBR
GBR-30	Monitoring well	10/17/1986	11/6/2019	45	2,645	RI, GBR
GBR-31	Monitoring well	10/17/1986	10/15/2018	60	2,880	RI, GBR
GBR-32	Monitoring well	4/30/1987	11/5/2019	62	2,960	RI, USGS, GBR
GBR-33	Monitoring well	3/15/1989	10/8/1990	8	477	RI, GBR
GBR-36/GRW-10	Groundwater recovery well	9/4/1990	9/4/1990	1	8	GBR
GBR-37/GRW-5	Groundwater recovery well	9/4/1990	9/4/1990	1	8	GBR
GBR-38/GRW-1	Groundwater recovery well	9/4/1990	9/4/1990	1	8	GBR
GBR-39	Monitoring well	5/9/1986	10/17/1986	2	39	GBR
GBR-40	Monitoring well	6/24/1993	6/24/1993	1	13	GBR
GBR-41	Monitoring well	6/24/1993	6/24/1993	1	13	GBR
GBR-42/GRW-2	Groundwater recovery well	9/8/1989	6/1/1997	3	81	GBR
GBR-43/GRW-4	Groundwater recovery well	4/2/1990	4/8/1992	9	529	GBR
GBR-44/GRW-6	Groundwater recovery well	4/2/1990	10/12/2018	31	2,065	GBR
GBR-45	Monitoring well	10/1/1996	10/1/1996	1	37	GBR
GBR-47	Monitoring well	3/14/1989	6/13/1989	3	199	RI, GBR
GBR-48	Monitoring well	3/14/1989	11/5/2019	51	2,806	RI, USGS, GBR

Table 8. Site-level summary statistics of the water quality data within the Lee Acres-Giant Bloomfield Refinery Database (LAGBRD; available at https://doi.org/10.3133/dr1154).—Continued

[BLM, Bureau of Land Management; RI, Lee Acres remedial investigation; USGS, U.S. Geological Survey; GBR, Giant Bloomfield Refinery; GRW, groundwater recovery well; NMED, New Mexico Environment Department; SHS, Southern Heights Subdivision]

Local station name	Site type	Water quality sampling start date (month/day/year)	Water quality sampling end date (month/day/year)	Number of water quality samples in LAGBRD	Number of individual water quality results in LAGBRD	Water quality data source(s)[1]
GBR-49	Monitoring well	3/14/1989	11/5/2019	56	2,685	RI, USGS, GBR
GBR-5	Monitoring well	1/23/1986	1/10/1990	5	85	RI, GBR
GBR-50	Monitoring well	10/1/1989	11/5/2019	51	2,772	RI, USGS, GBR
GBR-51	Monitoring well	6/12/1989	10/11/2018	21	1,216	RI, GBR
GBR-52	Monitoring well	6/12/1989	11/5/2019	23	1,315	RI, GBR
GBR-6/GRW-9	Monitoring well	11/20/1986	6/24/1993	9	352	RI, GBR
GBR-7	Monitoring well	10/17/1986	1/9/1990	3	77	RI, GBR
GBR-8	Monitoring well	10/17/1986	8/6/2015	10	374	RI, GBR
GBR-9	Monitoring well	10/17/1986	8/25/1988	3	54	RI, GBR
Lagoon, east side	Lee Acres Landfill liquid waste lagoon	2/27/1985	2/27/1985	1	38	NMED
Lagoon, south side	Lee Acres Landfill liquid waste lagoon	5/2/1985	5/2/1985	1	42	NMED
Lagoon, west side	Lee Acres Landfill liquid waste lagoon	1/11/1985	2/27/1985	2	77	NMED
SHS-1	Monitoring well	9/6/1989	6/1/2017	6	228	RI, GBR
SHS-10	Monitoring well	1/1/1991	1/1/2005	39	1,635	GBR
SHS-12	Monitoring well	1/1/1991	1/1/2005	39	1,638	GBR
SHS-13	Monitoring well	1/1/1991	1/22/2018	40	1,706	GBR
SHS-14	Monitoring well	1/9/1992	1/22/2018	7	351	GBR
SHS-15	Monitoring well	1/1/1991	1/22/2018	30	1,328	GBR
SHS-16	Monitoring well	1/1/1991	1/22/2018	41	1,742	GBR

Table 8. Site-level summary statistics of the water quality data within the Lee Acres-Giant Bloomfield Refinery Database (LAGBRD; available at https://doi.org/10.3133/dr1154).—Continued

[BLM, Bureau of Land Management; RI, Lee Acres remedial investigation; USGS, U.S. Geological Survey; GBR, Giant Bloomfield Refinery; GRW, groundwater recovery well; NMED, New Mexico Environment Department; SHS, Southern Heights Subdivision]

Local station name	Site type	Water quality sampling start date (month/day/year)	Water quality sampling end date (month/day/year)	Number of water quality samples in LAGBRD	Number of individual water quality results in LAGBRD	Water quality data source(s)[1]
SHS-17	Monitoring well	8/1/1992	1/22/2018	35	1,460	GBR
SHS-18	Monitoring well	8/10/1992	1/23/2018	8	383	GBR
SHS-19	Monitoring well	1/1/2004	1/23/2018	6	323	GBR
SHS-2	Monitoring well	9/6/1989	6/1/2017	6	192	RI, GBR
SHS-3	Monitoring well	1/1/1991	1/1/2003	26	1,134	GBR
SHS-4	Monitoring well	7/7/1992	6/1/2017	16	677	GBR
SHS-5	Monitoring well	1/15/2009	6/1/2017	2	94	GBR
SHS-6	Monitoring well	1/1/1991	1/23/2018	24	1,080	GBR
SHS-8	Monitoring well	8/1/2001	10/11/2018	11	754	GBR
SHS-9	Monitoring well	1/9/1992	11/5/2019	8	406	GBR

[1]Data sources: RI, Roy F. Weston, Inc. (1995); USGS, U.S. Geological Survey (2021); GBR, data related to site investigations and regular monitoring at the Giant Bloomfield Refinery compiled in an online data repository (New Mexico Oil Conservation Division, 2021); NMED, New Mexico Environment Department (1986).

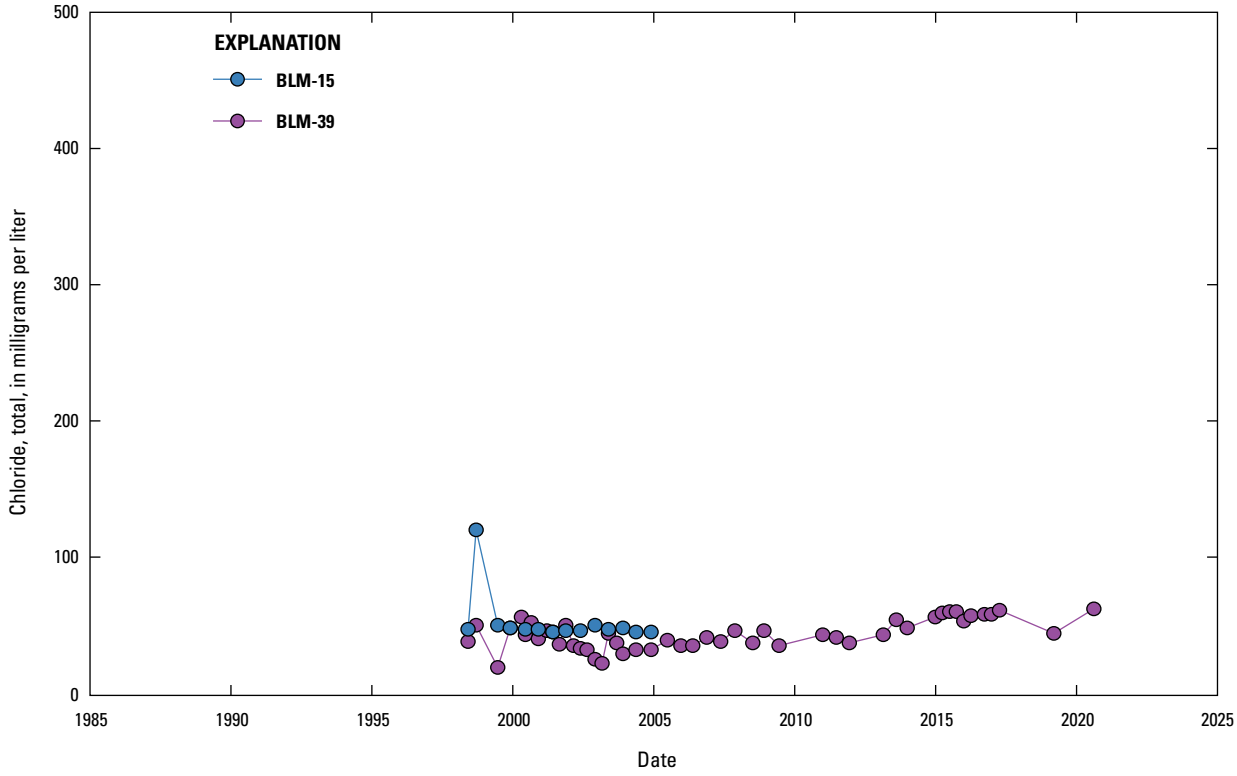


Figure 8. Total chloride concentration over time at Bureau of Land Management (BLM) monitoring wells upgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 3; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for total chloride at the Lee Acres Landfill range from 6.4 to 62.9 milligrams per liter (Roy F. Weston, Inc., 1995). Chloride is not a contaminant of concern at the Lee Acres Landfill.

Five of the COCs described in the ROD (EPA, 2004) are organic compounds: *cis*-1,2-dichloroethene, *trans*-1,2-dichloroethene, tetrachloroethene (also called perchloroethylene or PCE), trichloroethene (also called TCE), and vinyl chloride. All results for the organic COCs in LAGBRD and discussed in this report represent raw, unfiltered water. Results for these organic COCs for BLM monitoring wells upgradient from the Lee Acres Landfill, within the landfill boundary, adjacent to the landfill, or directly downgradient from the landfill are displayed as time-series plots in figures 55–66. Because there were few detections of organic COCs at wells south of U.S. Highway 64, time-series plots of organic COCs from that area have been omitted from this report. In the instances where there were no detections above reporting levels at a BLM well within an area, then that time-series plot has been omitted. Specifically, *trans*-1,2-dichloroethene has not been detected in any BLM well within those areas, so *trans*-1,2-dichloroethene time-series plots, which would display only reporting levels, have been omitted. Likewise, there have been no detections of trichloroethene in BLM wells upgradient from the landfill (except one suspect value reported in the remedial investigation [Roy F. Weston, Inc., 1991], which is not displayed herein), nor have there been detections of vinyl chloride in BLM wells upgradient from the landfill, adjacent to the landfill, or directly downgradient from the landfill.

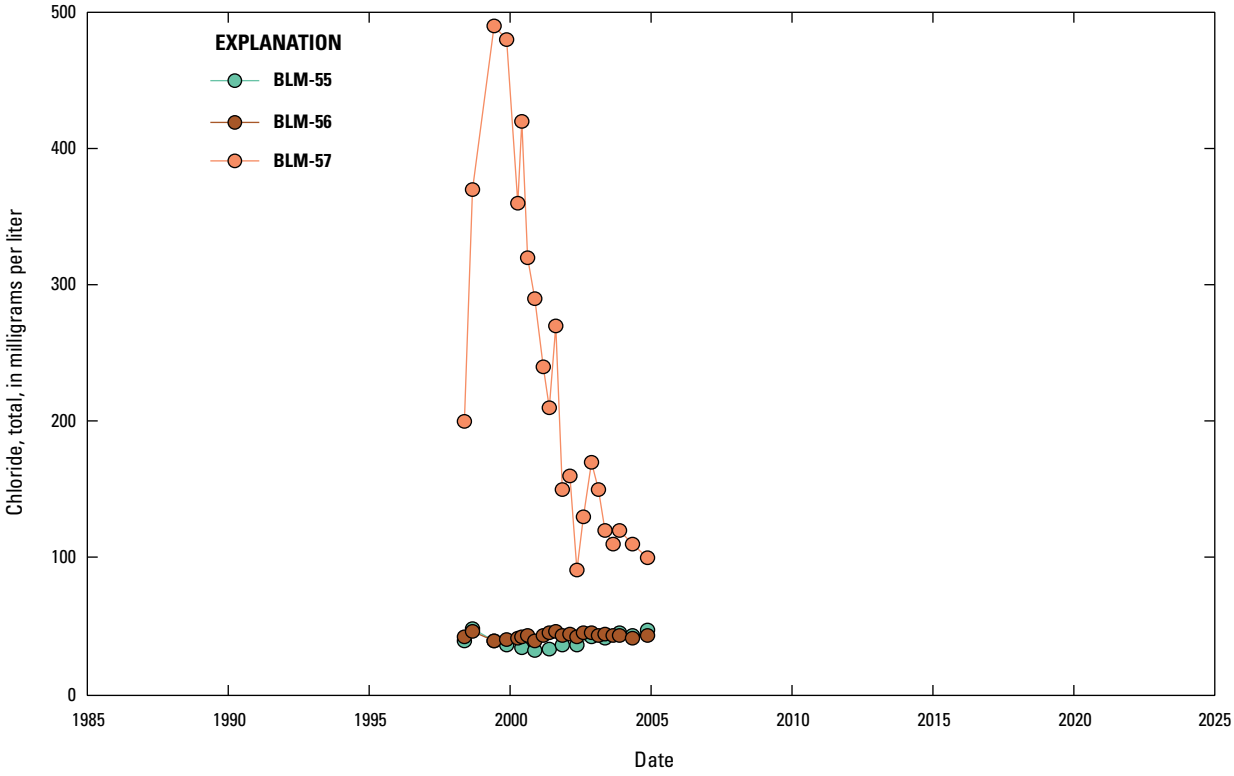


Figure 9. Total chloride concentration over time at Bureau of Land Management (BLM) monitoring wells within the boundary of the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for total chloride at the Lee Acres Landfill range from 6.4 to 62.9 milligrams per liter (Roy F. Weston, Inc., 1995). Chloride is not a contaminant of concern at the Lee Acres Landfill.

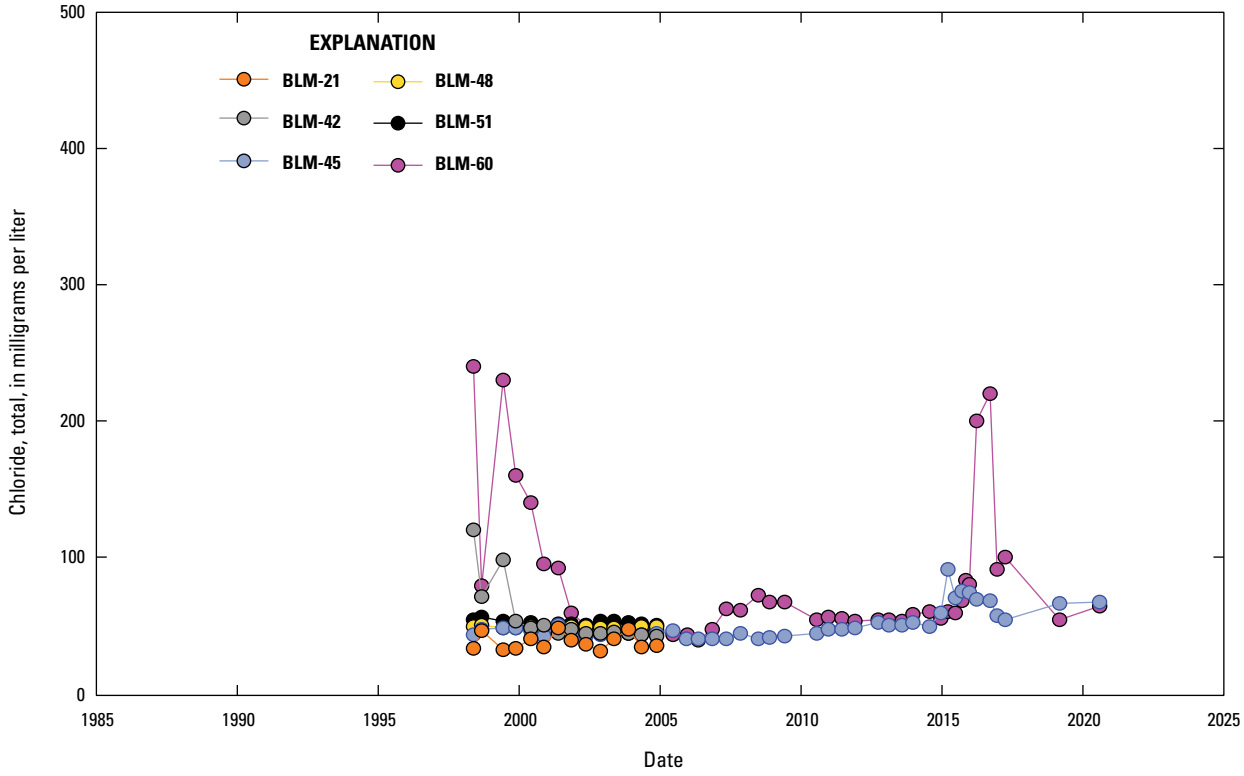


Figure 10. Total chloride concentration over time at Bureau of Land Management (BLM) monitoring wells adjacent to the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for total chloride at the Lee Acres Landfill range from 6.4 to 62.9 milligrams per liter (Roy F. Weston, Inc., 1995). Chloride is not a contaminant of concern at the Lee Acres Landfill.

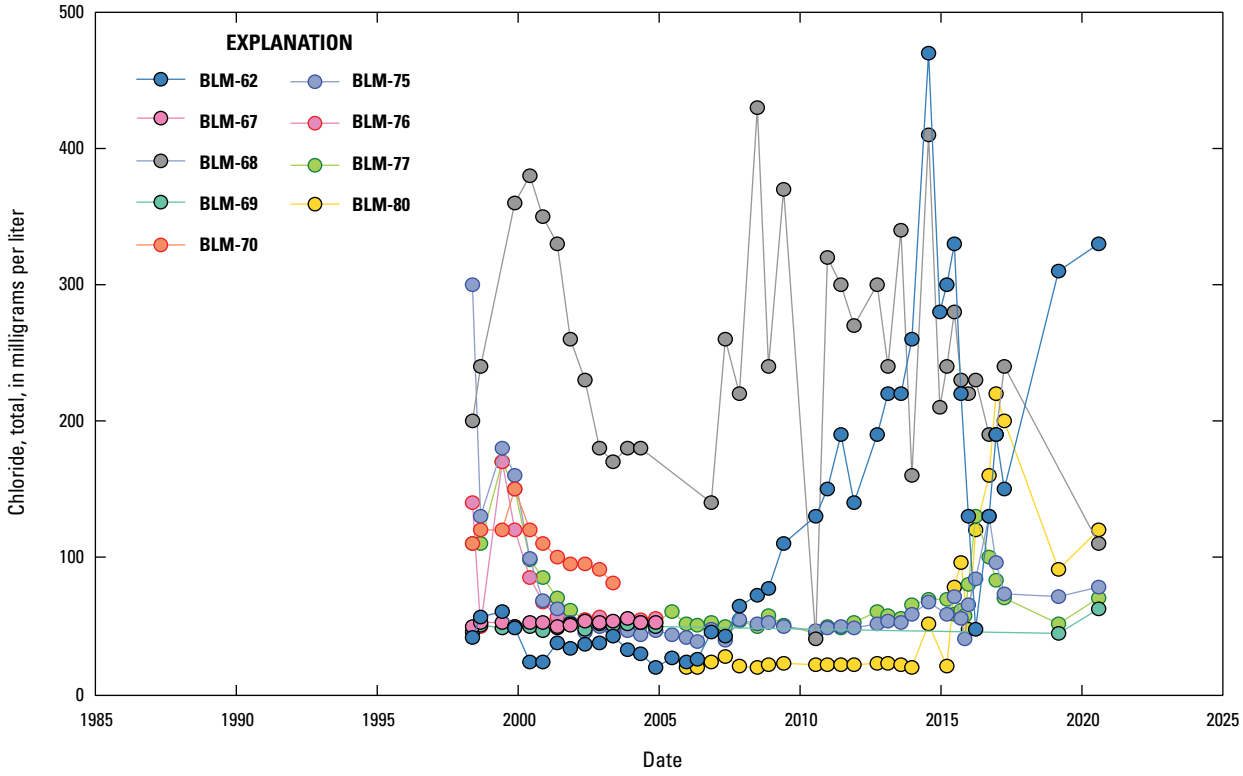


Figure 11. Total chloride concentration over time at Bureau of Land Management (BLM) monitoring wells directly downgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for total chloride at the Lee Acres Landfill range from 6.4 to 62.9 milligrams per liter (Roy F. Weston, Inc., 1995). Chloride is not a contaminant of concern at the Lee Acres Landfill.

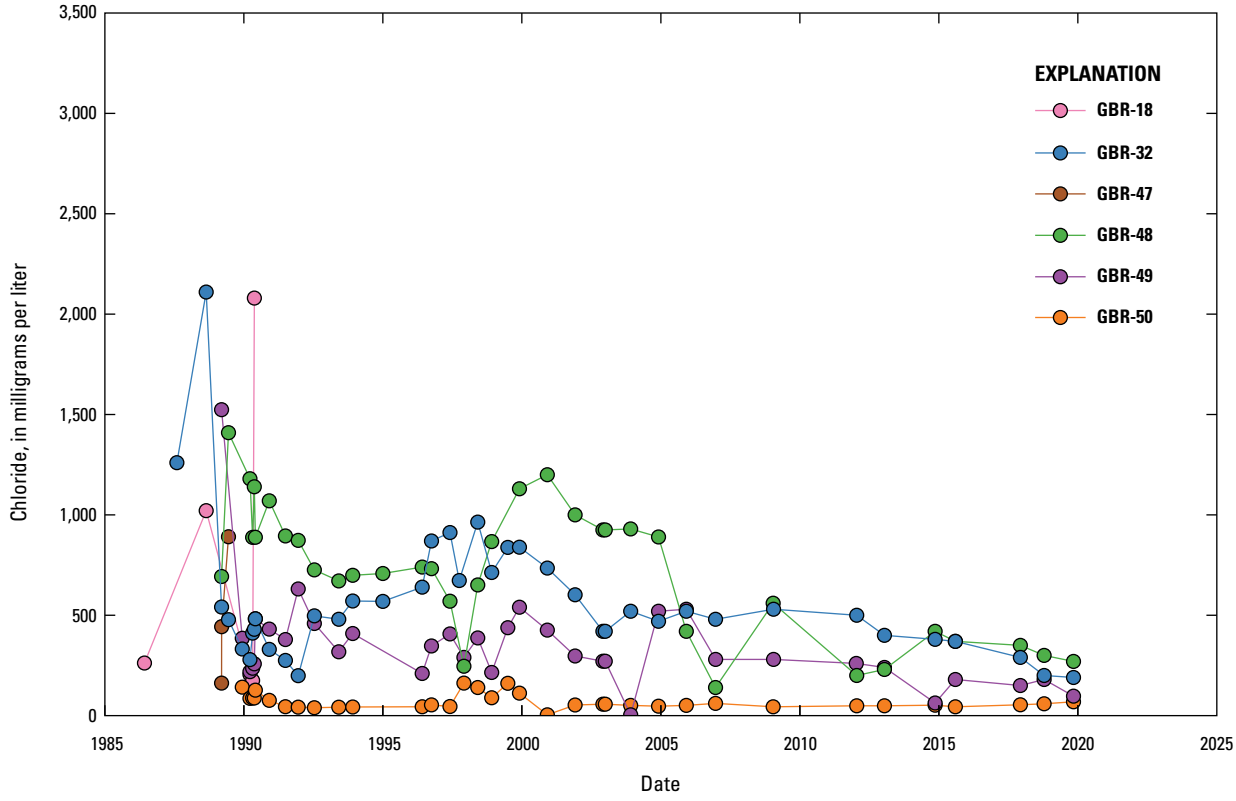


Figure 12. Chloride concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells upgradient from refinery operations at GBR near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8. Whether these chloride results are total or dissolved is unknown (not reported). As shown in table 1, the alluvial aquifer background concentrations for total chloride at the Lee Acres Landfill range from 6.4 to 62.9 milligrams per liter (Roy F. Weston, Inc., 1995). Chloride is not a contaminant of concern at the Lee Acres Landfill.

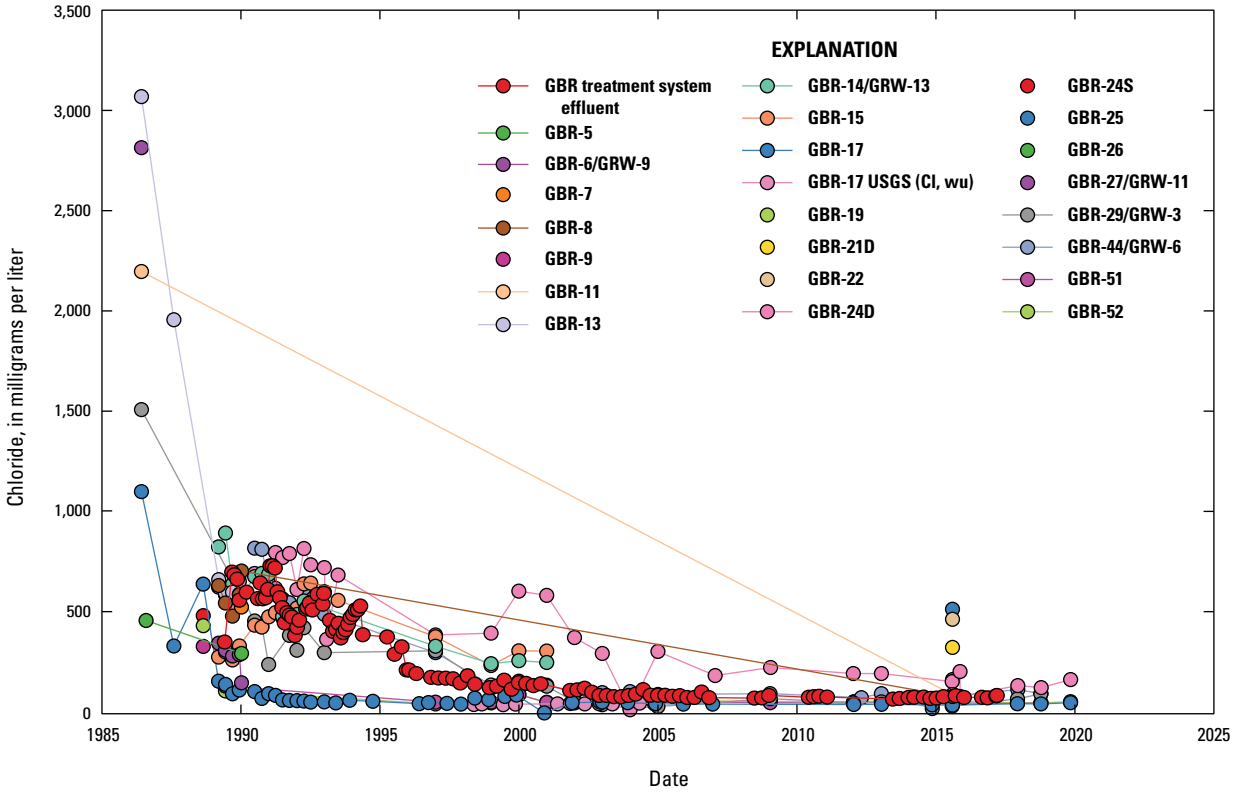


Figure 13. Chloride concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells, groundwater recovery wells (GRW), and treatment system effluent near refinery operations at GBR near Farmington, New Mexico. Locations of wells and infiltration trenches, which accept the treatment system effluent, are shown in figure 6; data sources are specified in table 8. Whether these chloride results are total or dissolved is unknown (not reported). As shown in table 1, the alluvial aquifer background concentrations for total chloride at the Lee Acres Landfill range from 6.4 to 62.9 milligrams per liter (Roy F. Weston, Inc., 1995). Chloride is not a contaminant of concern at the Lee Acres Landfill. Well GBR-17 was monitored by the U.S. Geological Survey (USGS) between 1998 and 2004; the results from those unfiltered samples are labeled in the figure explanation as "GBR-17 USGS (Cl, wu)." Cl, chloride; wu, unfiltered water.

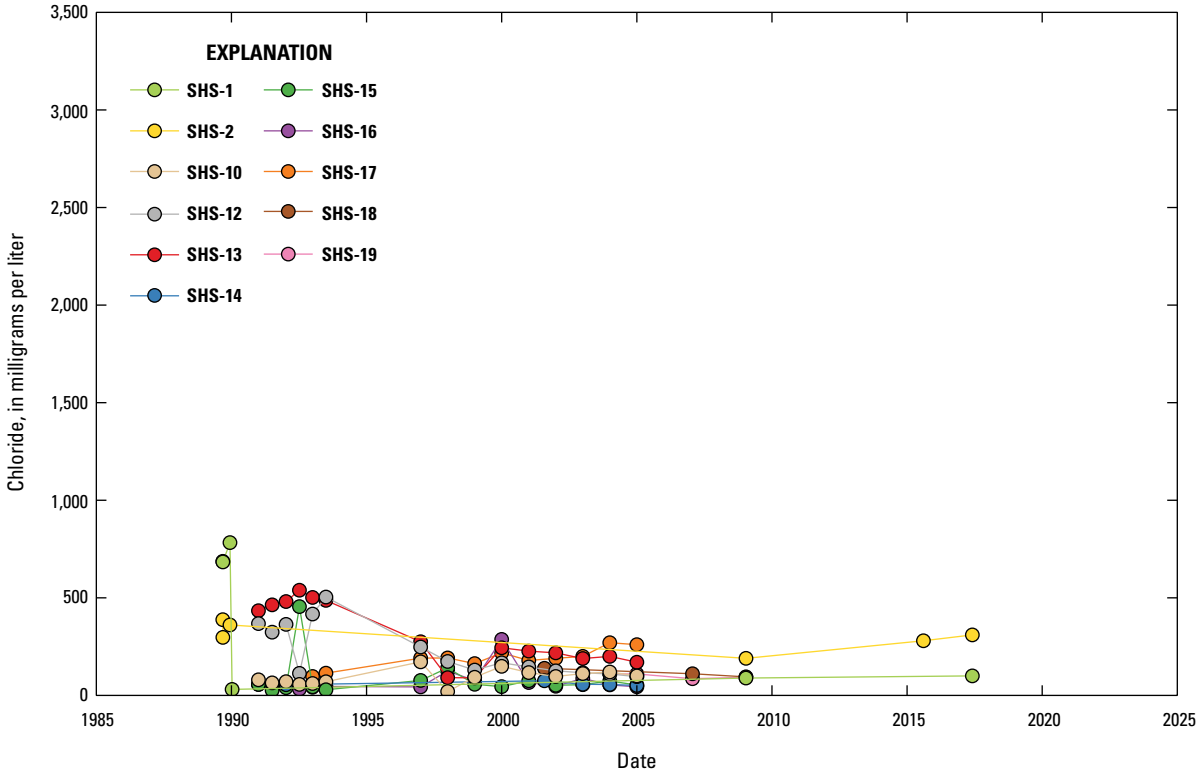


Figure 14. Chloride concentration over time at Southern Heights Subdivision (SHS) monitoring wells south of U.S. Highway 64 near Farmington, New Mexico. SHS wells were monitored by the Giant Bloomfield Refinery. Locations of wells are shown in figure 7; data sources are specified in table 8. Whether these chloride results are total or dissolved is unknown (not reported). As shown in table 1, the alluvial aquifer background concentrations for total chloride at the Lee Acres Landfill range from 6.4 to 62.9 milligrams per liter (Roy F. Weston, Inc., 1995). Chloride is not a contaminant of concern at the Lee Acres Landfill.

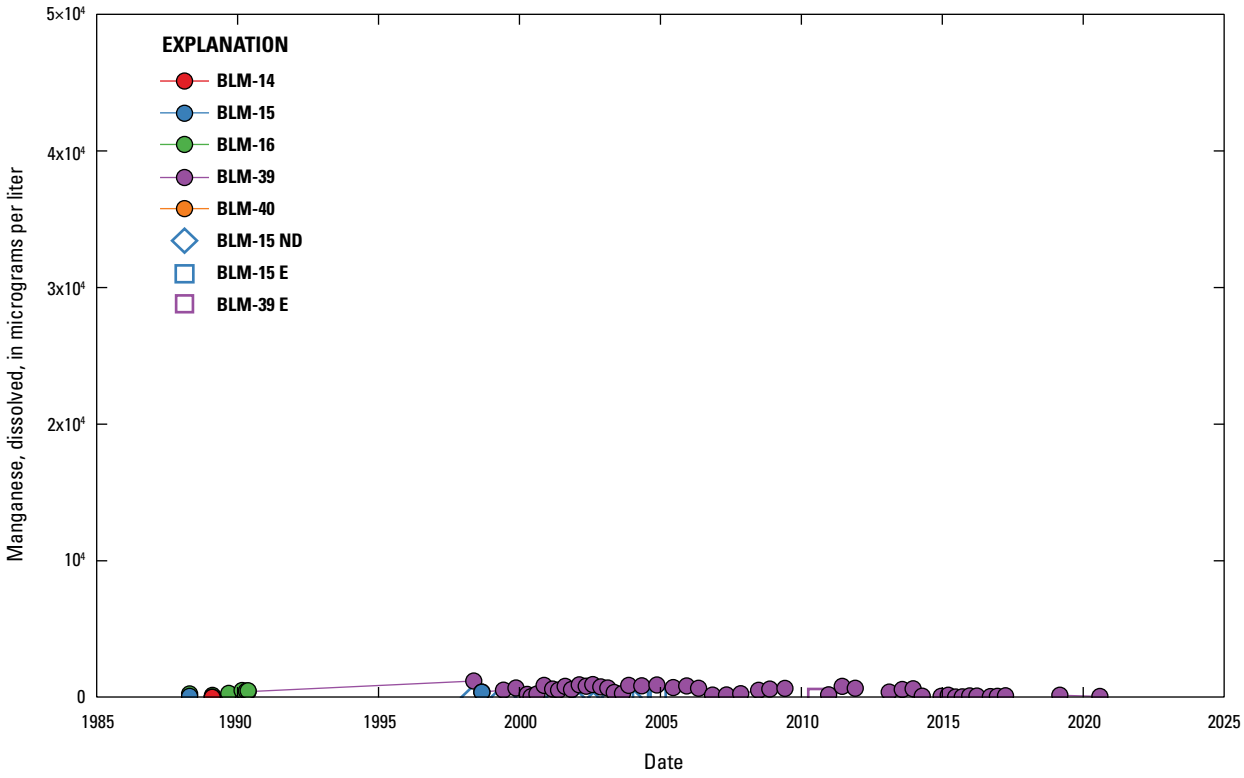


Figure 15. Dissolved manganese concentration over time at Bureau of Land Management (BLM) monitoring wells upgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 3; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved manganese at the Lee Acres Landfill range from 16.1 to 1,680 micrograms per liter (Roy F. Weston, Inc., 1995), and the cleanup level for dissolved manganese at the Lee Acres Landfill is 346 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

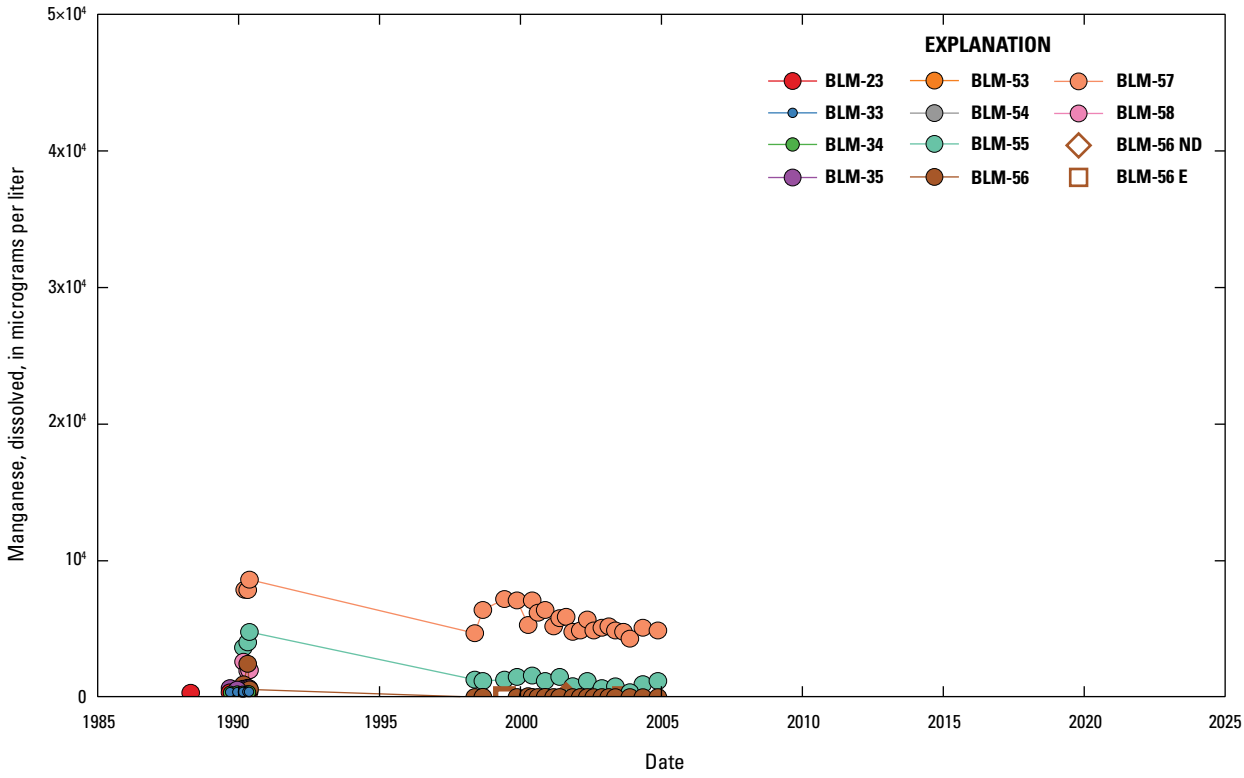


Figure 16. Dissolved manganese concentration over time at Bureau of Land Management (BLM) monitoring wells within the boundary of the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved manganese at the Lee Acres Landfill range from 16.1 to 1,680 micrograms per liter (Roy F. Weston, Inc., 1995), and the cleanup level for dissolved manganese at the Lee Acres Landfill is 346 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

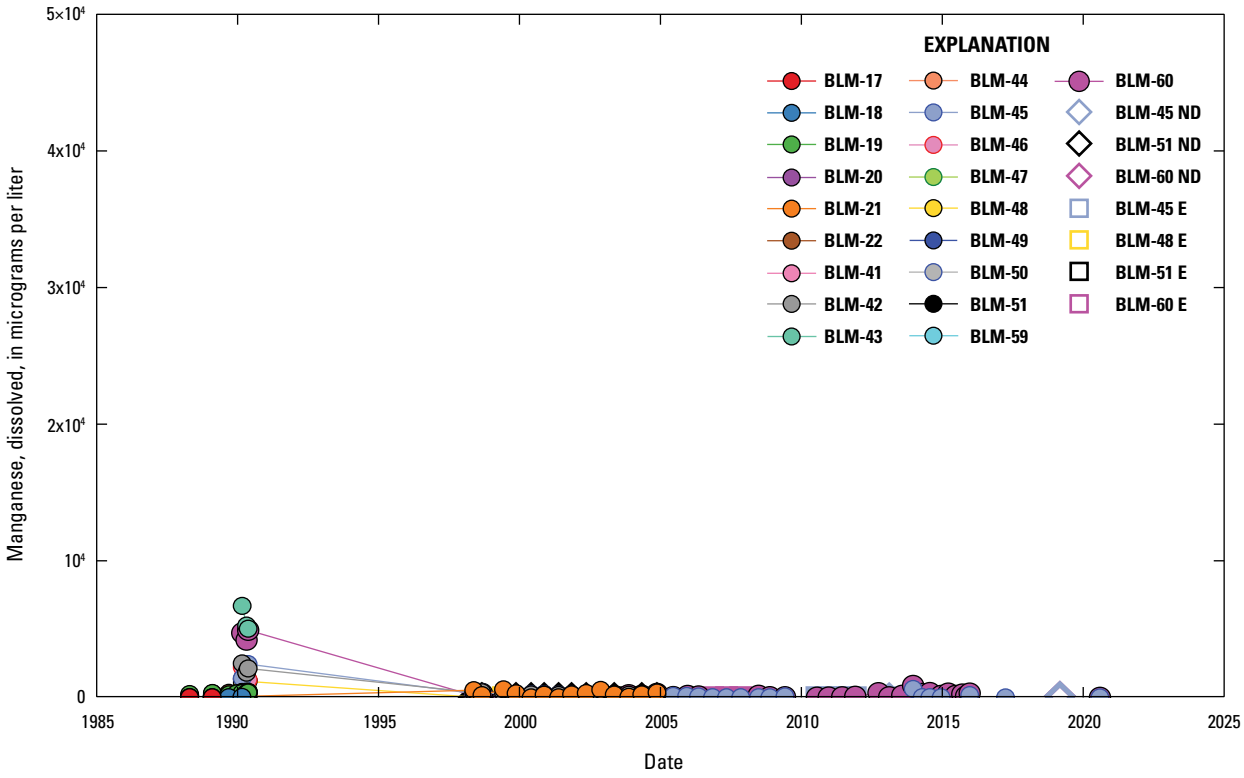


Figure 17. Dissolved manganese concentration over time at Bureau of Land Management (BLM) monitoring wells adjacent to the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved manganese at the Lee Acres Landfill range from 16.1 to 1,680 micrograms per liter (Roy F. Weston, Inc., 1995), and the cleanup level for dissolved manganese at the Lee Acres Landfill is 346 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

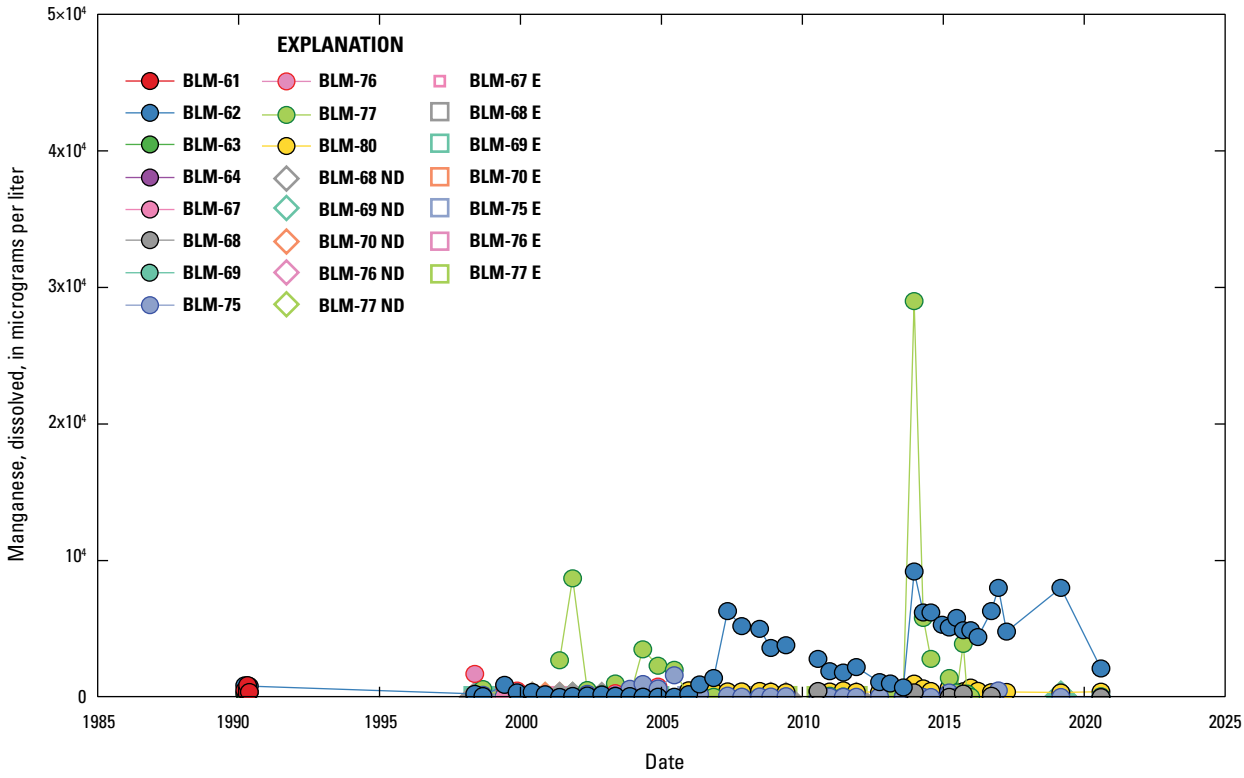


Figure 18. Dissolved manganese concentration over time at Bureau of Land Management (BLM) monitoring wells directly downgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved manganese at the Lee Acres Landfill range from 16.1 to 1,680 micrograms per liter (Roy F. Weston, Inc., 1995), and the cleanup level for dissolved manganese at the Lee Acres Landfill is 346 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

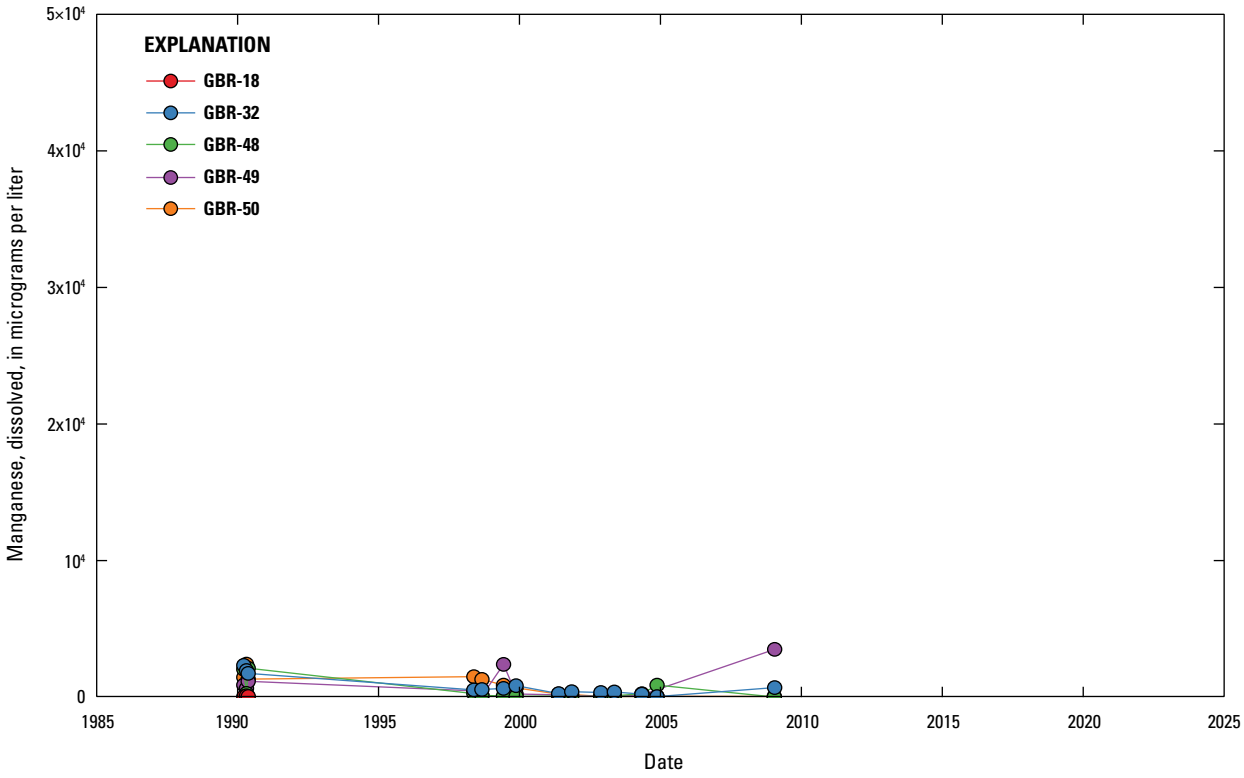


Figure 19. Dissolved manganese concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells upgradient from refinery operations at GBR near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved manganese at the Lee Acres Landfill range from 16.1 to 1,680 micrograms per liter (Roy F. Weston, Inc., 1995), and the cleanup level for dissolved manganese at the Lee Acres Landfill is 346 micrograms per liter (U.S. Environmental Protection Agency, 2004).

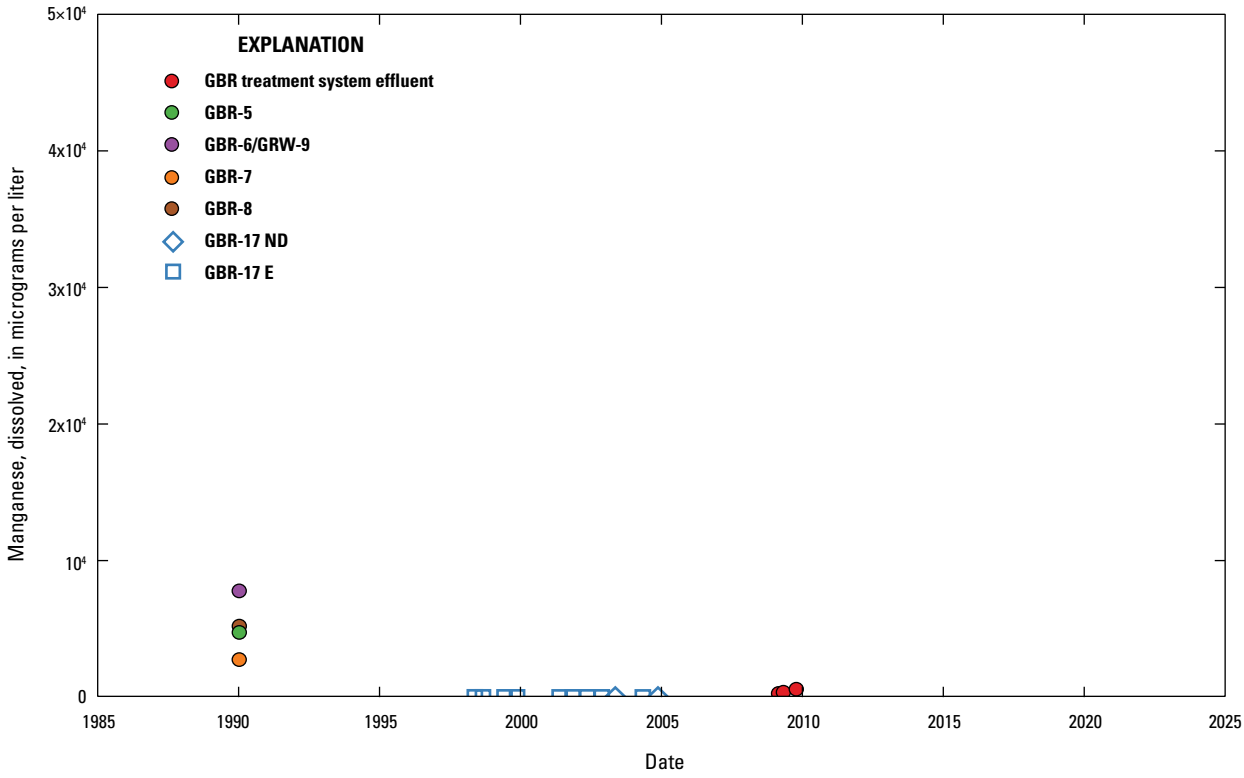


Figure 20. Dissolved manganese concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells, groundwater recovery wells (GRW), and treatment system effluent near refinery operations at GBR near Farmington, New Mexico. Locations of wells and infiltration trenches, which accept the treatment system effluent, are shown in figure 6; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved manganese at the Lee Acres Landfill range from 16.1 to 1,680 micrograms per liter (Roy F. Weston, Inc., 1995), and the cleanup level for dissolved manganese at the Lee Acres Landfill is 346 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

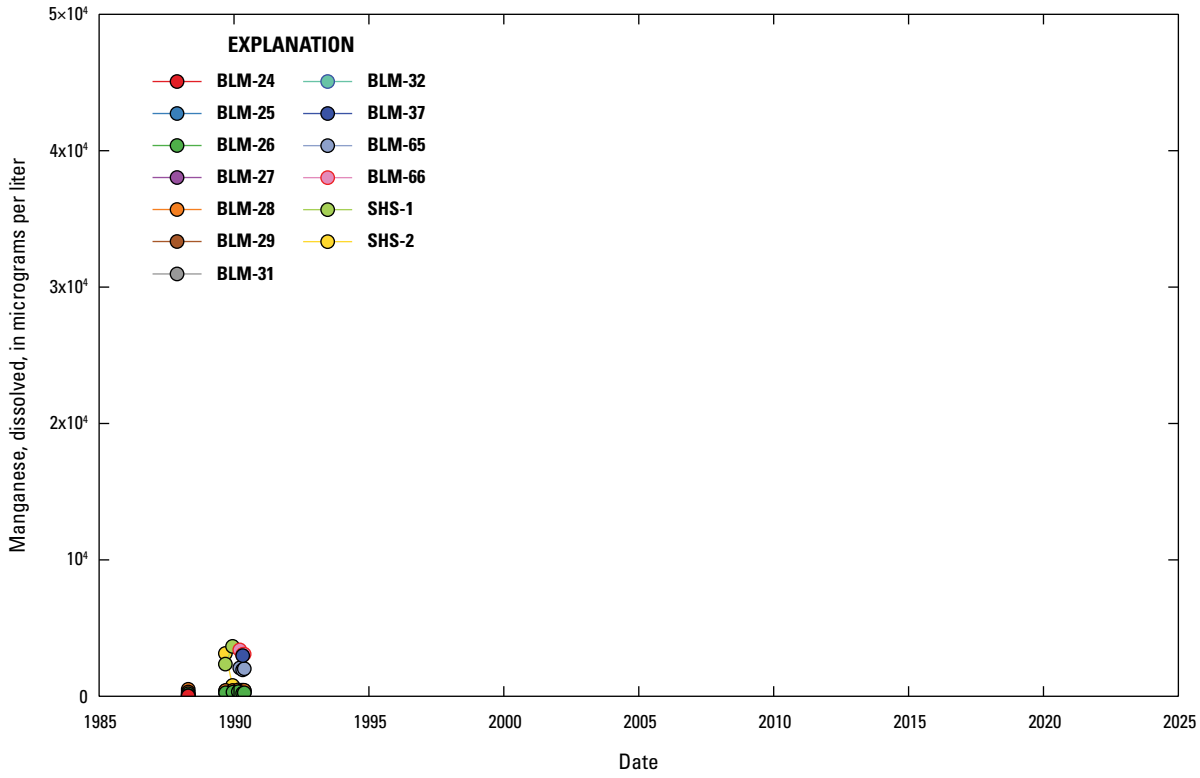


Figure 21. Dissolved manganese concentration over time at Bureau of Land Management (BLM) and Southern Heights Subdivision (SHS) monitoring wells south of U.S. Highway 64 near Farmington, New Mexico. SHS wells were monitored by the Giant Bloomfield Refinery. Locations of wells are shown in figure 7; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved manganese at the Lee Acres Landfill range from 16.1 to 1,680 micrograms per liter (Roy F. Weston, Inc., 1995), and the cleanup level for dissolved manganese at the Lee Acres Landfill is 346 micrograms per liter (U.S. Environmental Protection Agency, 2004).

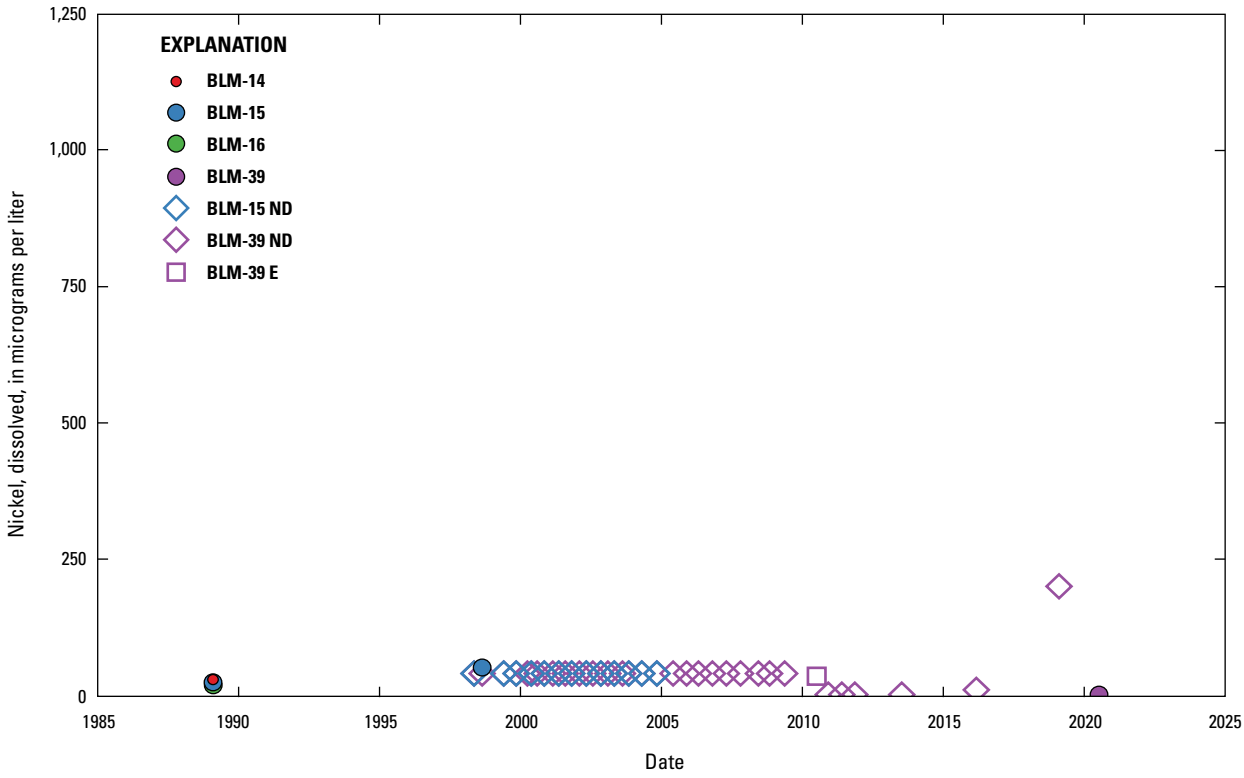


Figure 22. Dissolved nickel concentration over time at Bureau of Land Management (BLM) monitoring wells upgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 3; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved nickel at the Lee Acres Landfill range from nondetect to 10.5 micrograms per liter (Roy F. Weston, Inc., 1995), and the cleanup level for dissolved nickel at the Lee Acres Landfill is 200 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

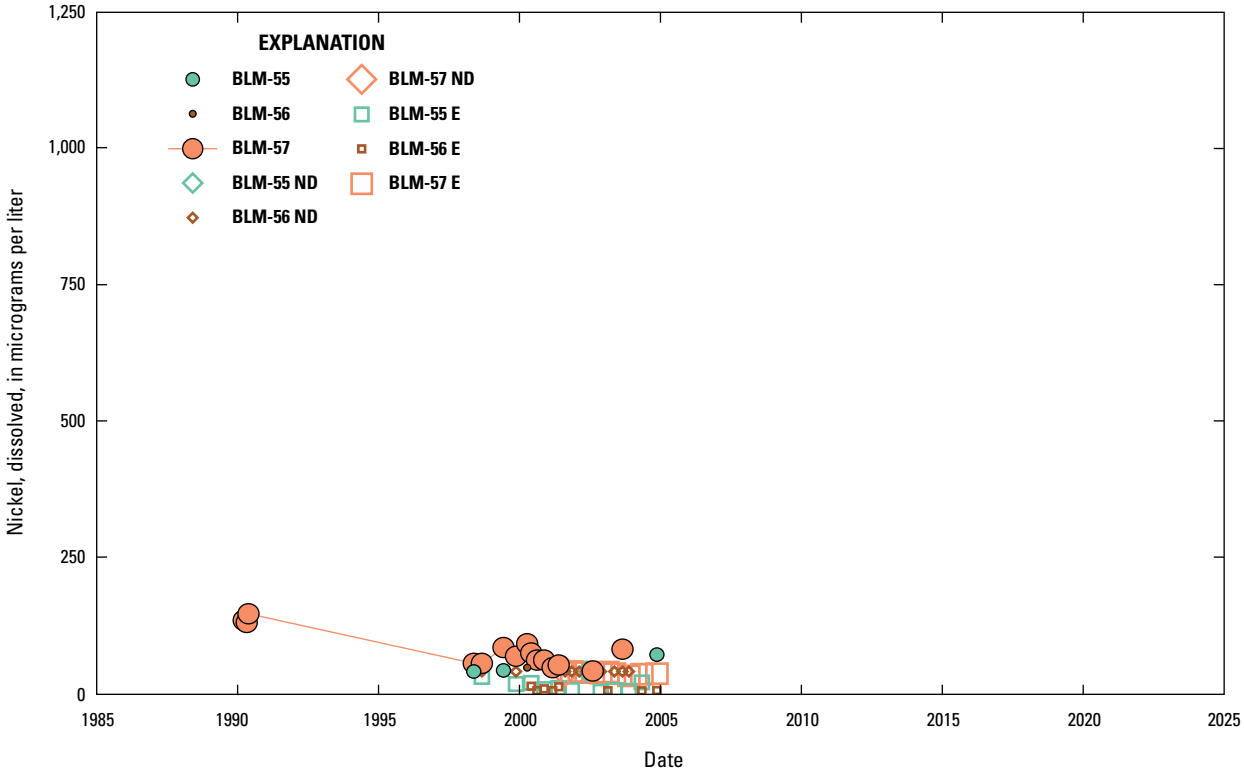


Figure 23. Dissolved nickel concentration over time at Bureau of Land Management (BLM) monitoring wells within the boundary of the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved nickel at the Lee Acres Landfill range from nondetect to 10.5 micrograms per liter (Roy F. Weston, Inc., 1995), and the cleanup level for dissolved nickel at the Lee Acres Landfill is 200 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

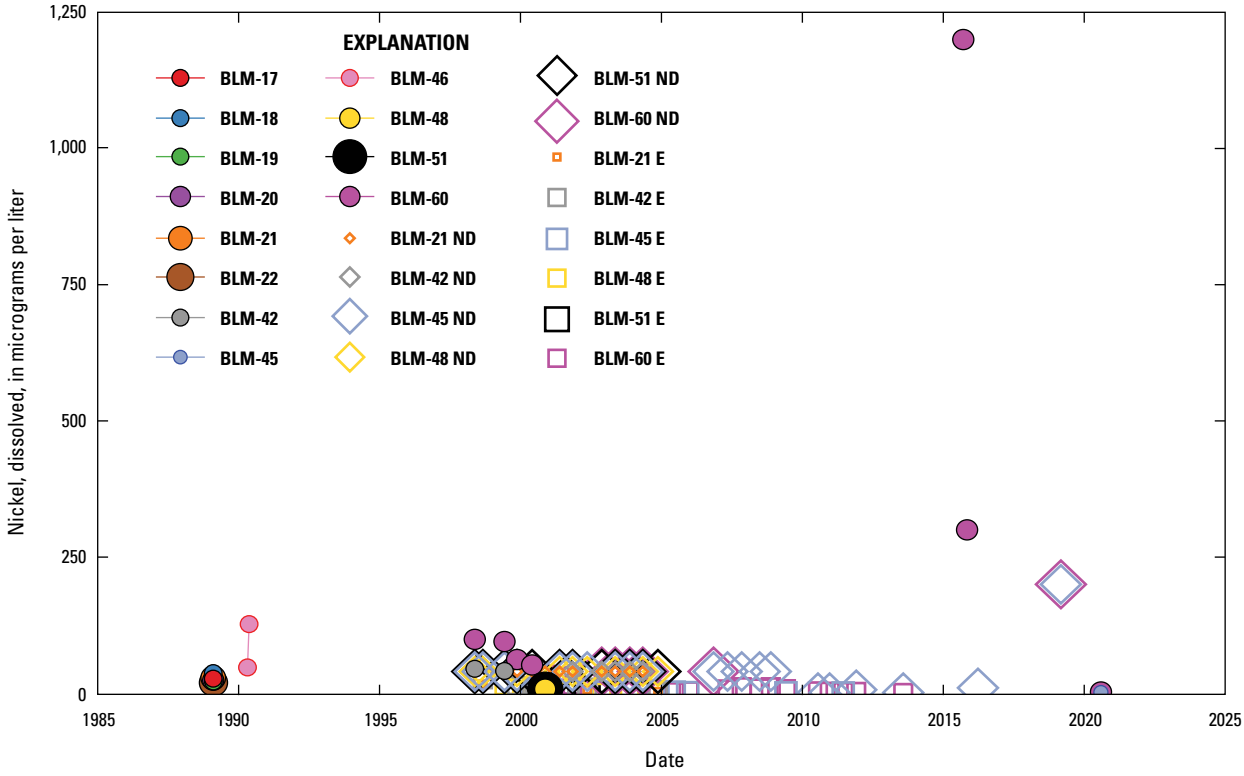


Figure 24. Dissolved nickel concentration over time at Bureau of Land Management (BLM) monitoring wells adjacent to the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved nickel at the Lee Acres Landfill range from nondetect to 10.5 micrograms per liter (Roy F. Weston, Inc., 1995), and the cleanup level for dissolved nickel at the Lee Acres Landfill is 200 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

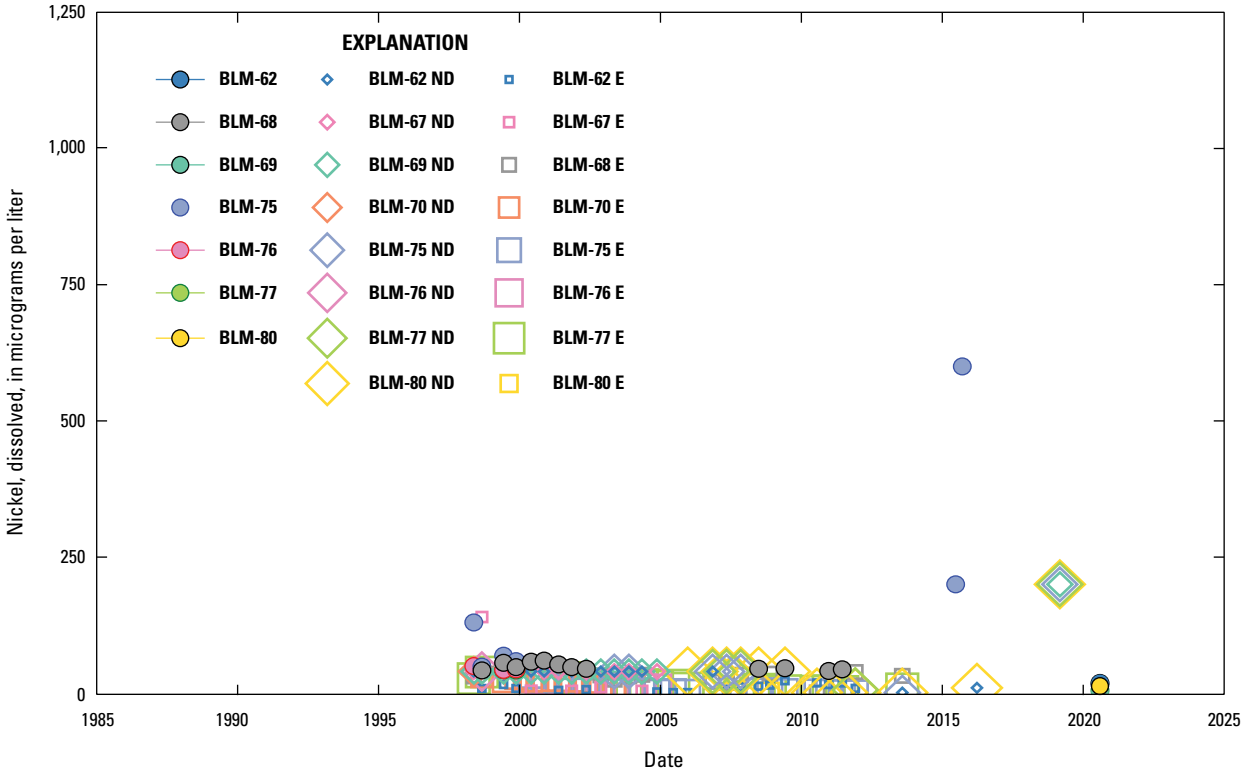


Figure 25. Dissolved nickel concentration over time at Bureau of Land Management (BLM) monitoring wells directly downgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved nickel at the Lee Acres Landfill range from nondetect to 10.5 micrograms per liter (Roy F. Weston, Inc., 1995), and the cleanup level for dissolved nickel at Lee Acres is 200 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

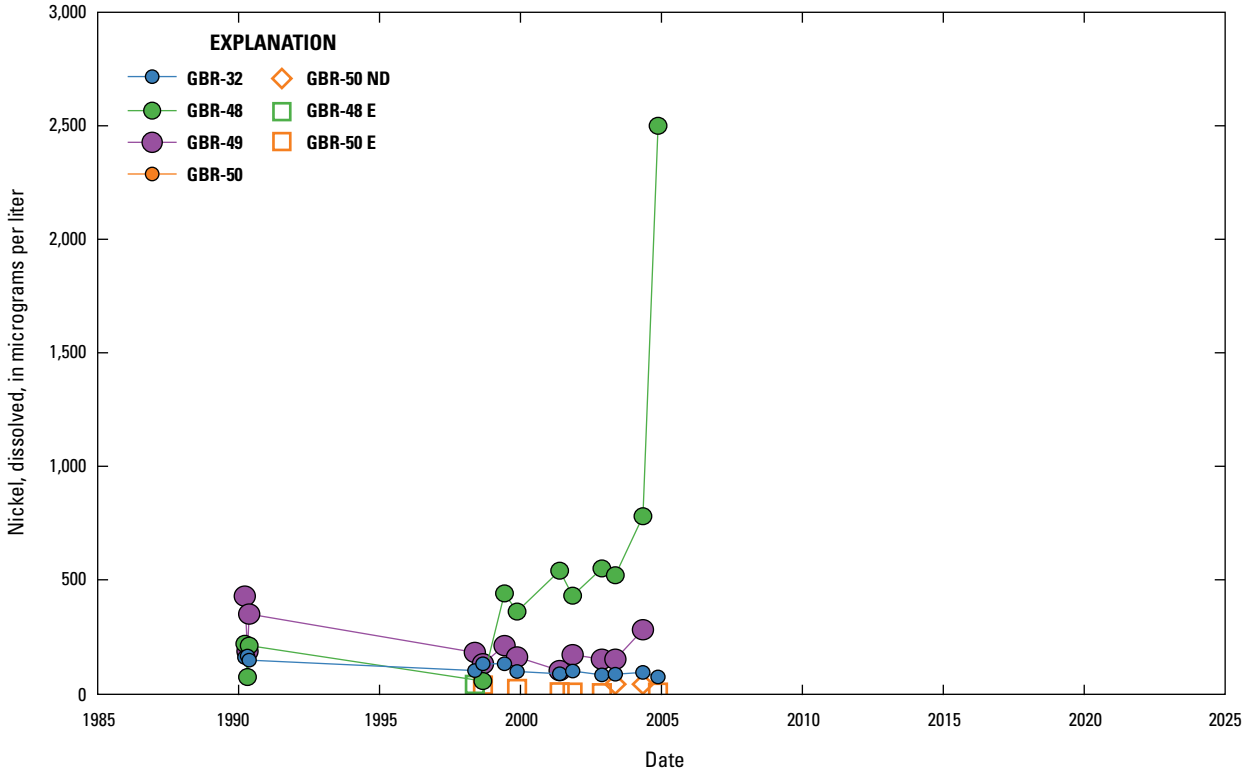


Figure 26. Dissolved nickel concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells upgradient from refinery operations at GBR near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved nickel at the Lee Acres Landfill range from nondetect to 10.5 micrograms per liter (Roy F. Weston, Inc., 1995), and the cleanup level for dissolved nickel at the Lee Acres Landfill is 200 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

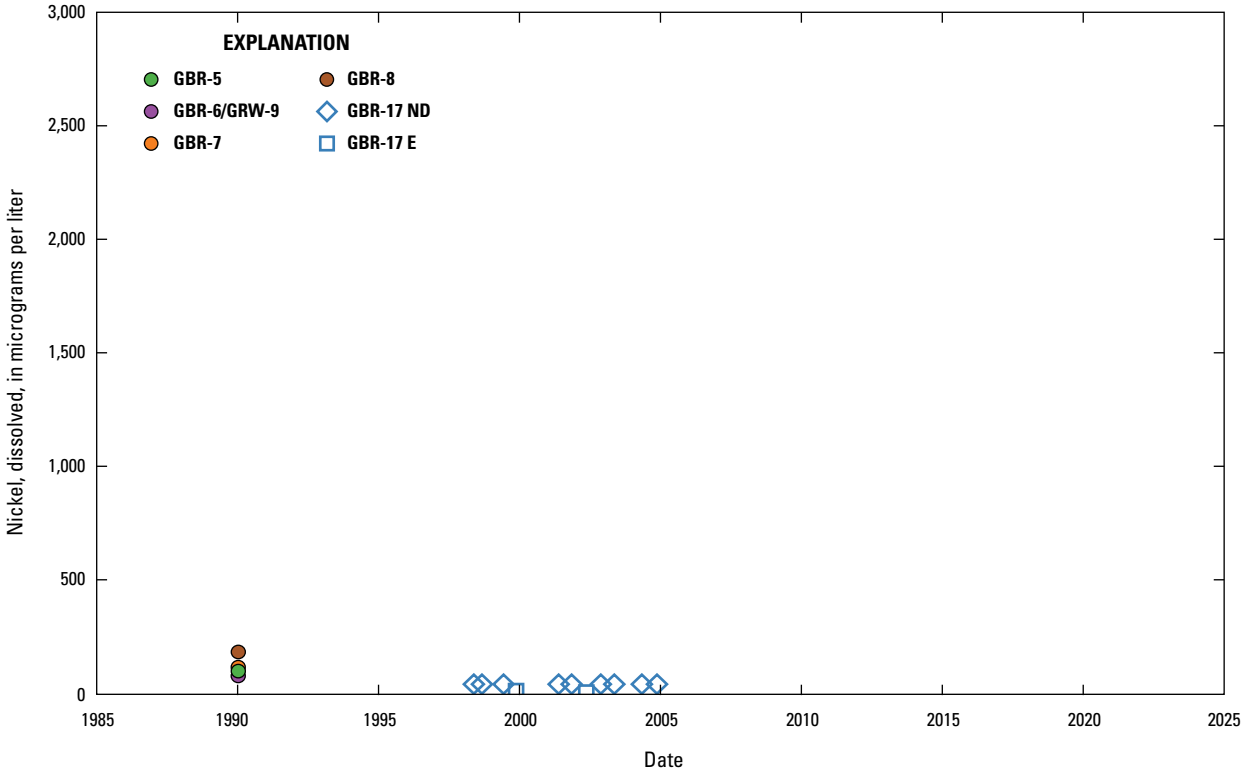


Figure 27. Dissolved nickel concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells near refinery operations at GBR near Farmington, New Mexico. Locations of wells are shown in figure 6; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved nickel at the Lee Acres Landfill range from nondetect to 10.5 micrograms per liter (Roy F. Weston, Inc., 1995), and the cleanup level for dissolved nickel at the Lee Acres Landfill is 200 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

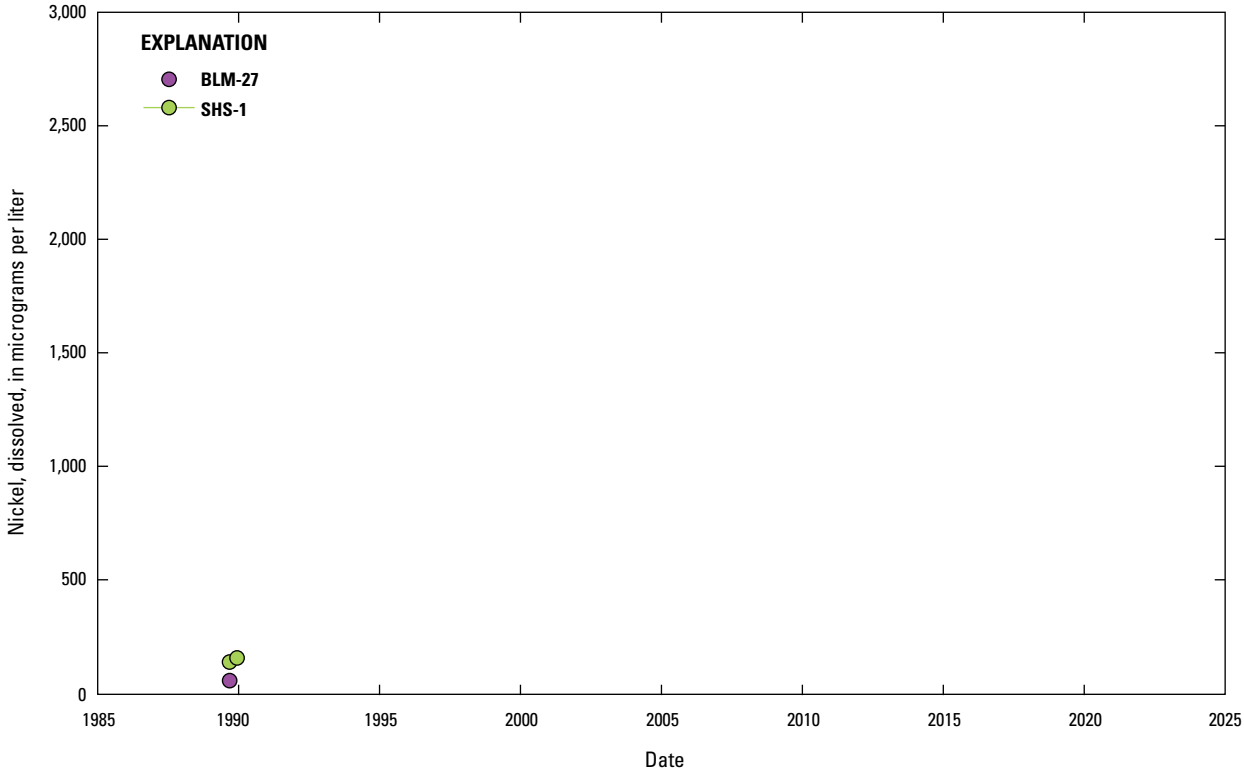


Figure 28. Dissolved nickel concentration over time at Bureau of Land Management (BLM) and Southern Heights Subdivision (SHS) monitoring wells south of U.S. Highway 64 near Farmington, New Mexico. SHS wells were monitored by the Giant Bloomfield Refinery. Locations of wells are shown in figure 7; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved nickel at the Lee Acres Landfill range from nondetect to 10.5 micrograms per liter (Roy F. Weston, Inc., 1995), and the cleanup level for dissolved nickel at the Lee Acres Landfill is 200 micrograms per liter (U.S. Environmental Protection Agency, 2004).

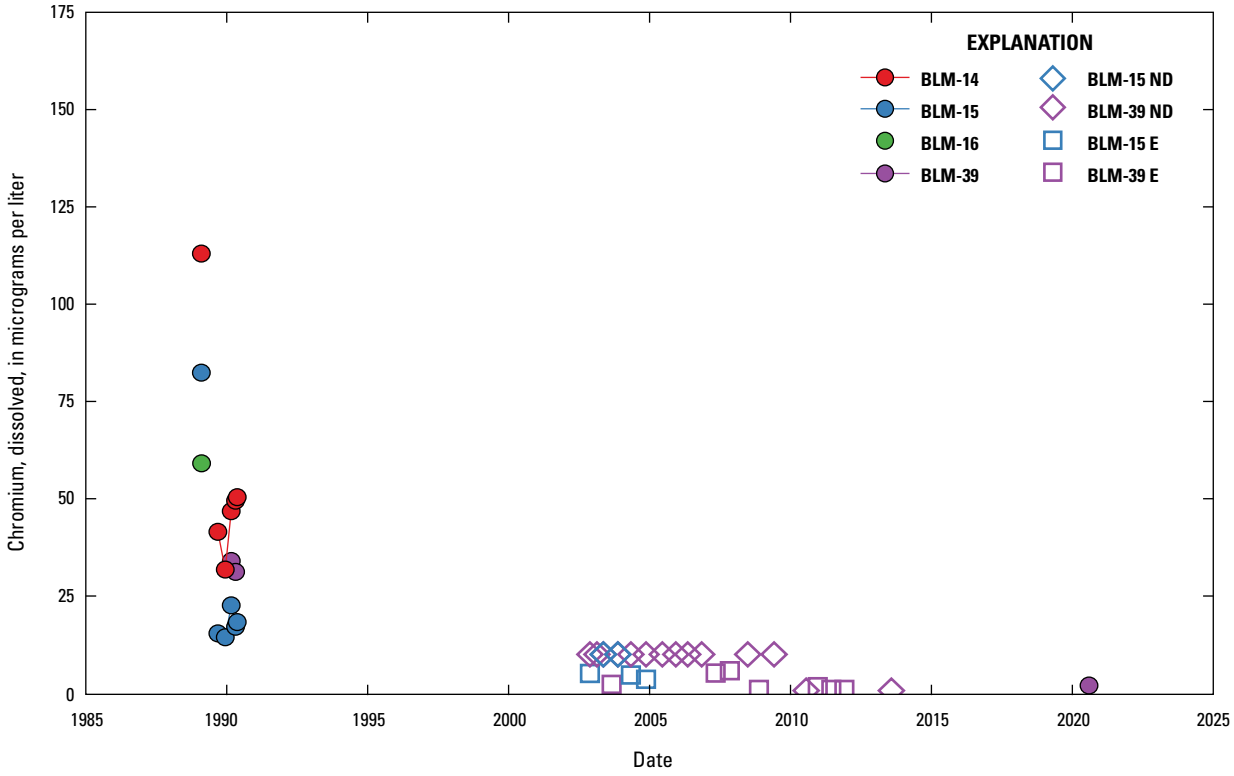


Figure 29. Dissolved chromium concentration over time at Bureau of Land Management (BLM) monitoring wells upgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 3; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved chromium at the Lee Acres Landfill range from 14.4 to 31.2 micrograms per liter (Roy F. Weston, Inc., 1995). Chromium is not a contaminant of concern at the Lee Acres Landfill. ND, no detection above method detection limits; E, estimated results.

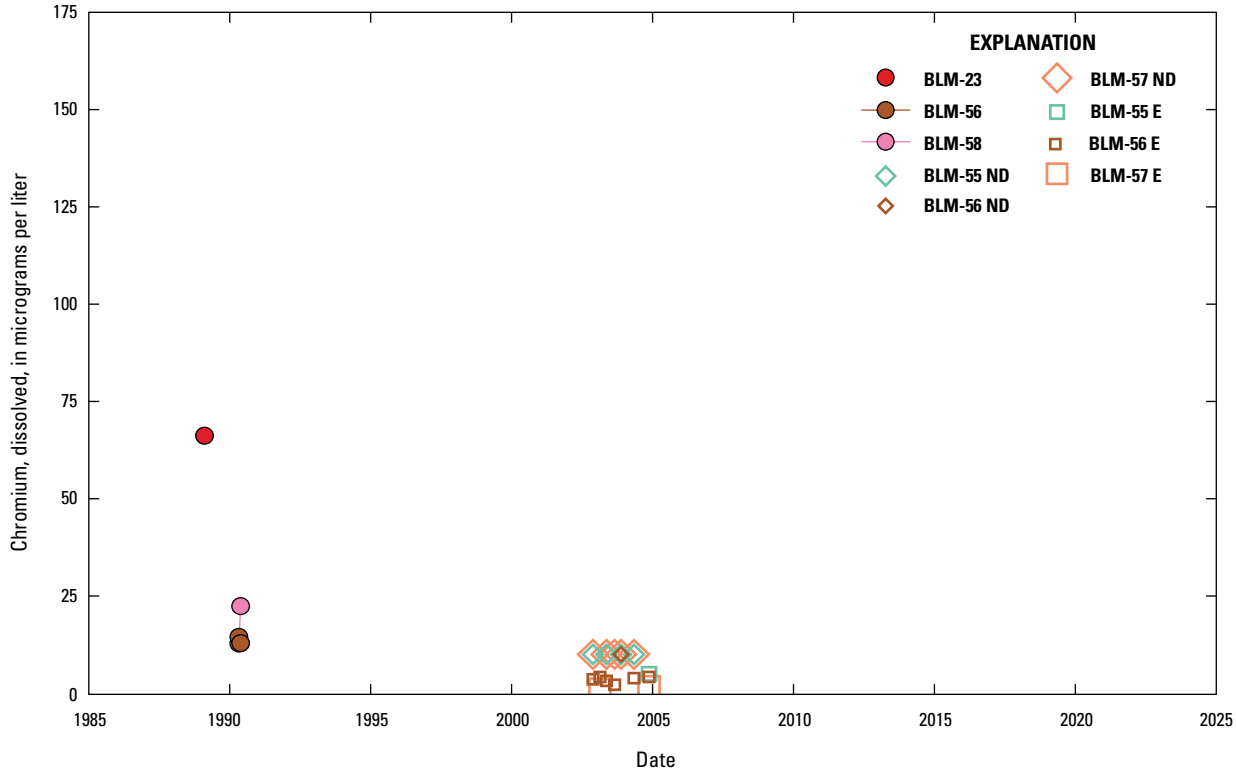


Figure 30. Dissolved chromium concentration over time at Bureau of Land Management (BLM) monitoring wells within the boundary of the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved chromium at the Lee Acres Landfill range from 14.4 to 31.2 micrograms per liter (Roy F. Weston, Inc., 1995). Chromium is not a contaminant of concern at the Lee Acres Landfill. ND, no detection above method detection limits; E, estimated results.

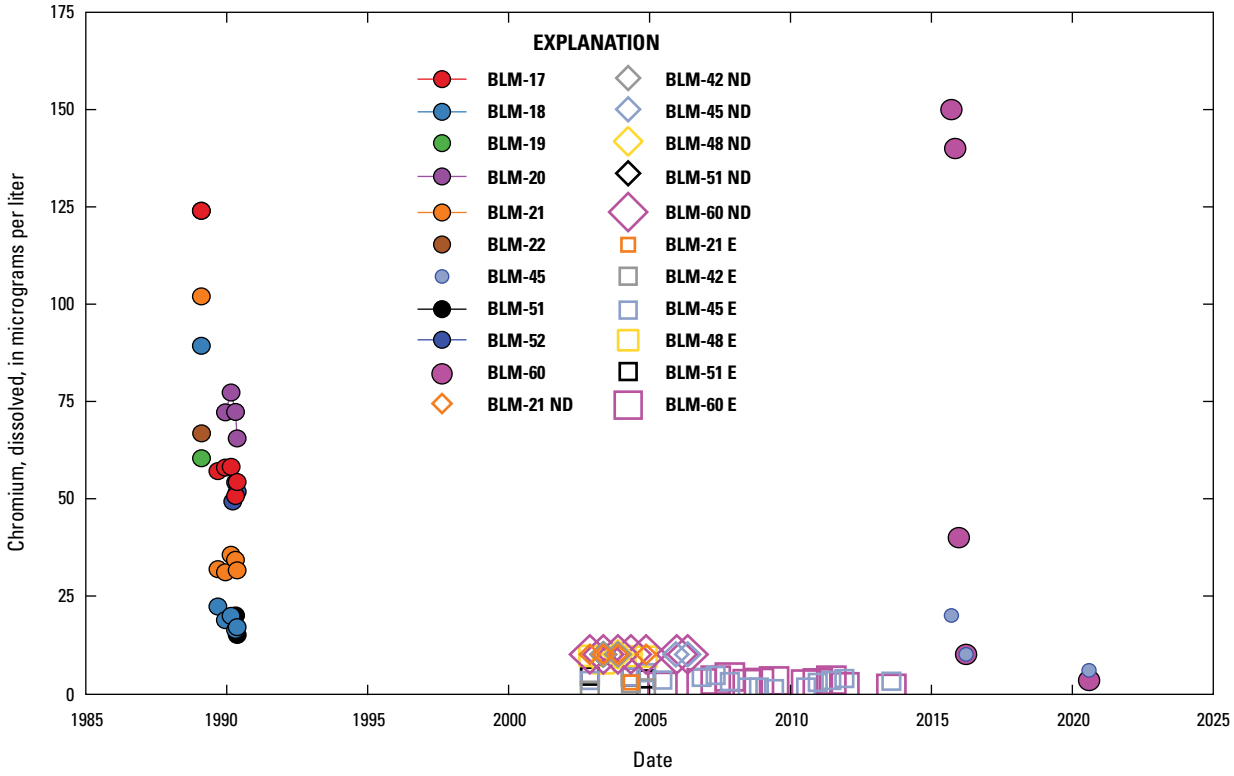


Figure 31. Dissolved chromium concentration over time at Bureau of Land Management (BLM) monitoring wells adjacent to the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved chromium at the Lee Acres Landfill range from 14.4 to 31.2 micrograms per liter (Roy F. Weston, Inc., 1995). Chromium is not a contaminant of concern at the Lee Acres Landfill. ND, no detection above method detection limits; E, estimated results.

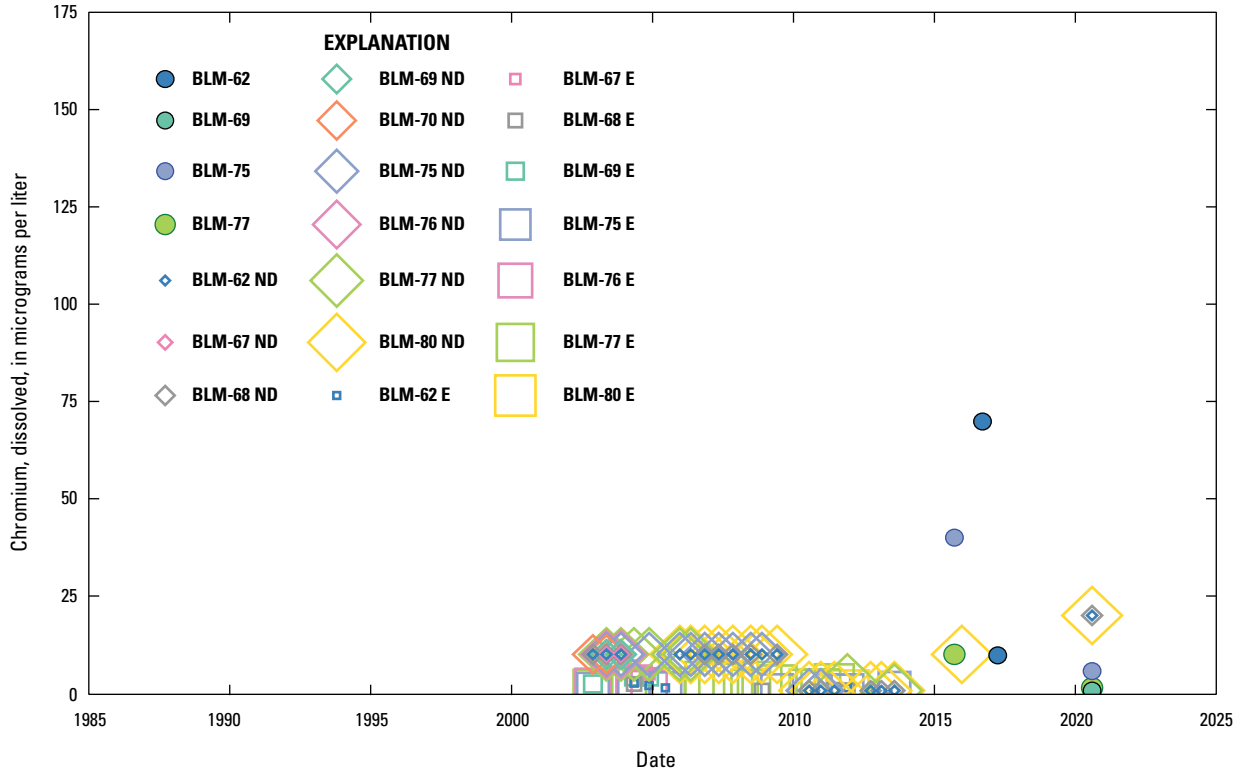


Figure 32. Dissolved chromium concentration over time at Bureau of Land Management (BLM) monitoring wells directly downgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved chromium at the Lee Acres Landfill range from 14.4 to 31.2 micrograms per liter (Roy F. Weston, Inc., 1995). Chromium is not a contaminant of concern at the Lee Acres Landfill. ND, no detection above method detection limits; E, estimated results.

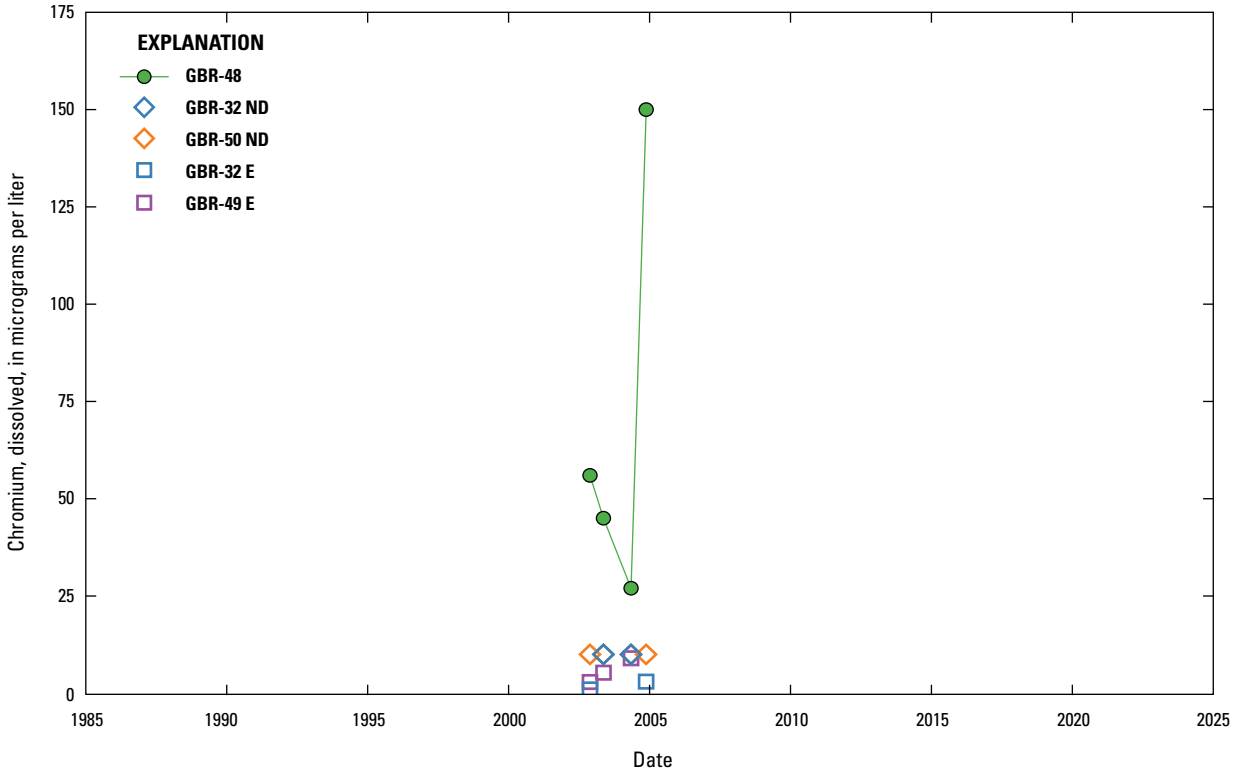


Figure 33. Dissolved chromium concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells upgradient from refinery operations at GBR near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved chromium at the Lee Acres Landfill range from 14.4 to 31.2 micrograms per liter (Roy F. Weston, Inc., 1995). Chromium is not a contaminant of concern at the Lee Acres Landfill. ND, no detection above method detection limits; E, estimated results.

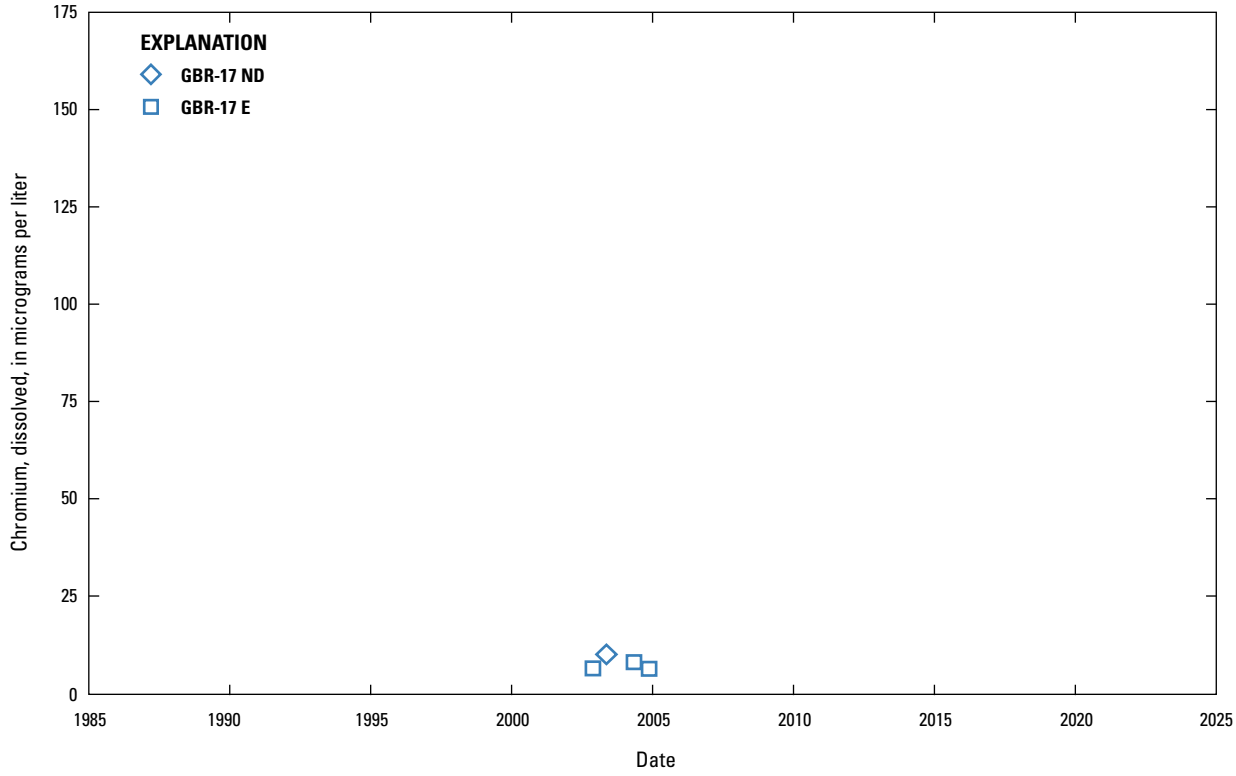


Figure 34. Dissolved chromium concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells near refinery operations at GBR near Farmington, New Mexico. Locations of wells are shown in figure 6; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved chromium at the Lee Acres Landfill range from 14.4 to 31.2 micrograms per liter (Roy F. Weston, Inc., 1995). Chromium is not a contaminant of concern at the Lee Acres Landfill. ND, no detection above method detection limits; E, estimated results.

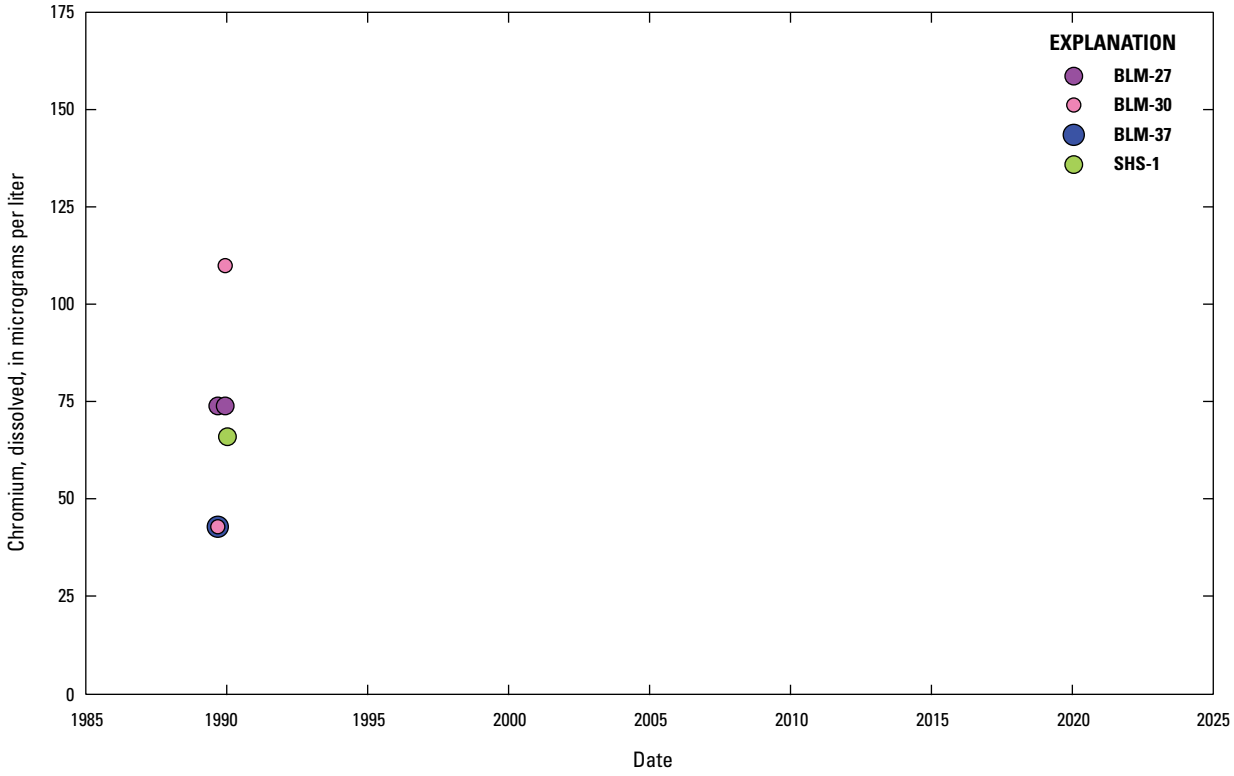


Figure 35. Dissolved chromium concentration over time at Bureau of Land Management (BLM) and Southern Heights Subdivision (SHS) monitoring wells south of U.S. Highway 64 near Farmington, New Mexico. SHS wells were monitored by the Giant Bloomfield Refinery. Locations of wells are shown in figure 7; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved chromium at the Lee Acres Landfill range from 14.4 to 31.2 micrograms per liter (Roy F. Weston, Inc., 1995). Chromium is not a contaminant of concern at the Lee Acres Landfill.

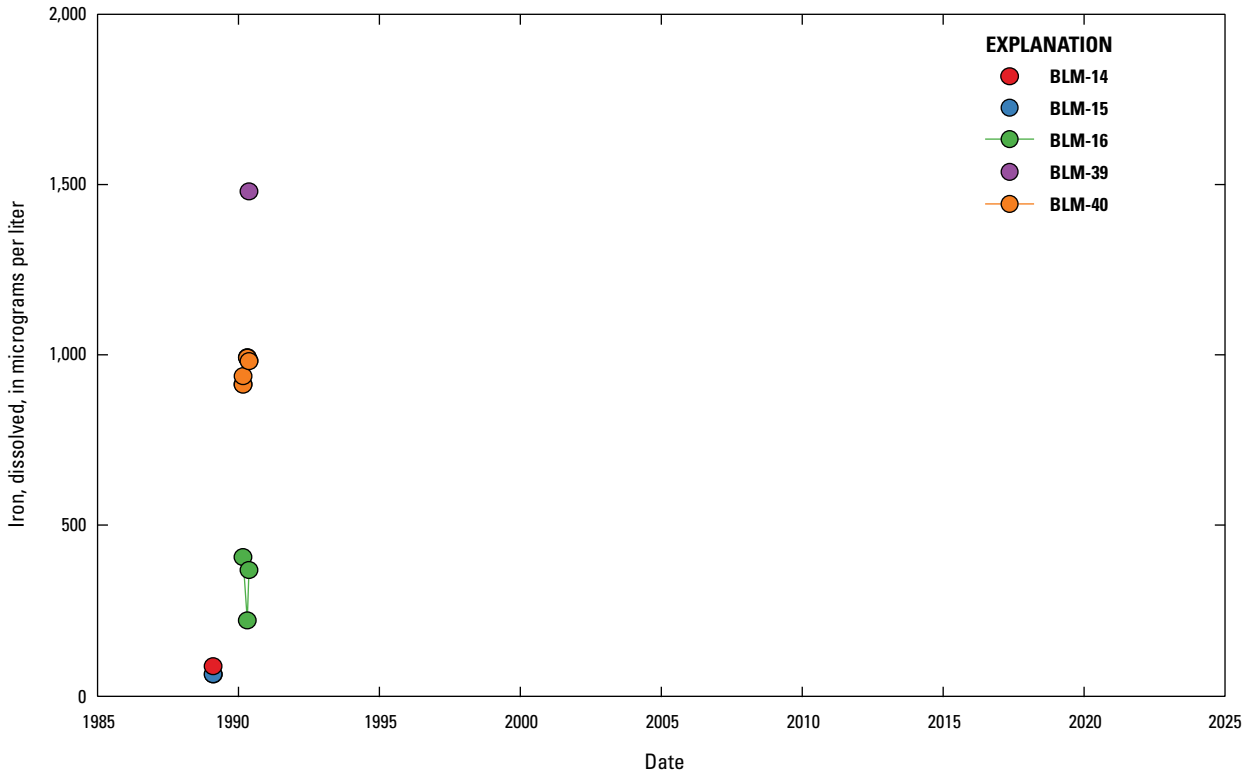


Figure 36. Dissolved iron concentration over time at Bureau of Land Management (BLM) monitoring wells upgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 3; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved iron at the Lee Acres Landfill range from nondetect to 2,460 micrograms per liter (Roy F. Weston, Inc., 1995). Iron is not a contaminant of concern at the Lee Acres Landfill.

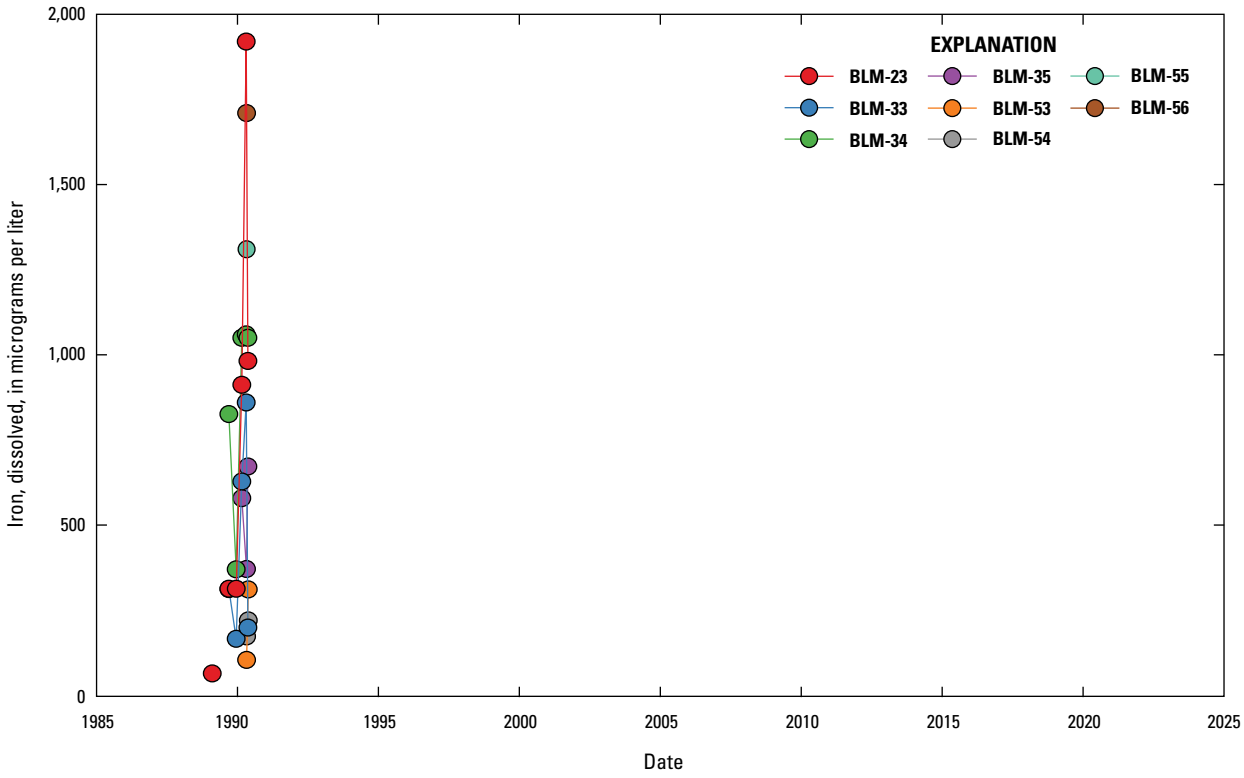


Figure 37. Dissolved iron concentration over time at Bureau of Land Management (BLM) monitoring wells within the boundary of the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved iron at the Lee Acres Landfill range from nondetect to 2,460 micrograms per liter (Roy F. Weston, Inc., 1995). Iron is not a contaminant of concern at the Lee Acres Landfill.

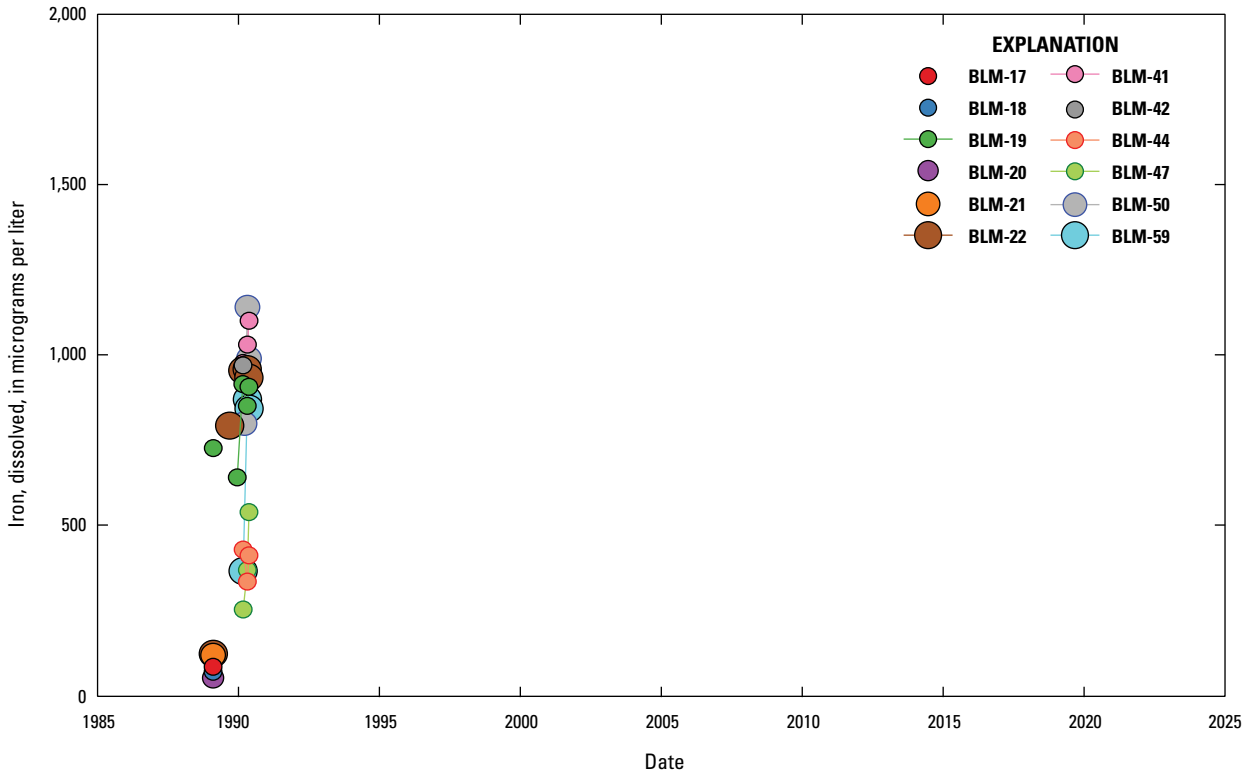


Figure 38. Dissolved iron concentration over time at Bureau of Land Management (BLM) monitoring wells adjacent to the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved iron at the Lee Acres Landfill range from nondetect to 2,460 micrograms per liter (Roy F. Weston, Inc., 1995). Iron is not a contaminant of concern at the Lee Acres Landfill.

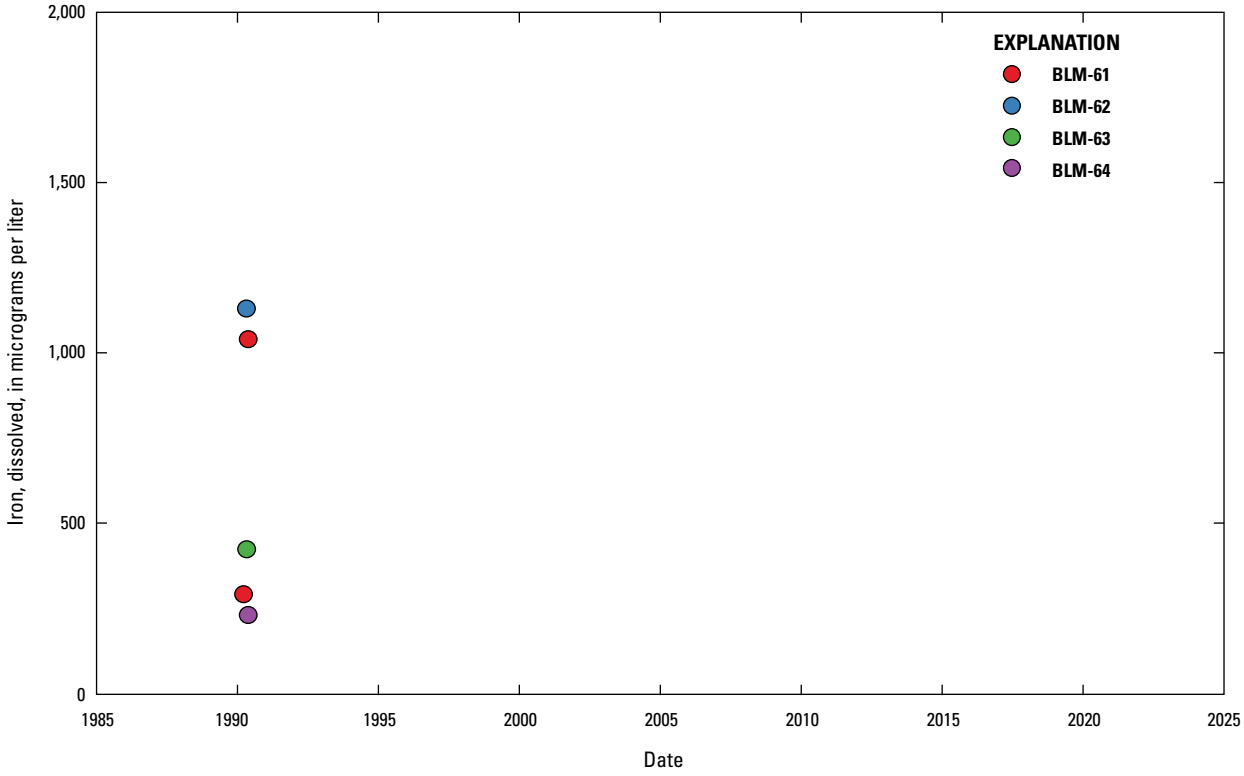


Figure 39. Dissolved iron concentration over time at Bureau of Land Management (BLM) monitoring wells directly downgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved iron at the Lee Acres Landfill range from nondetect to 2,460 micrograms per liter (Roy F. Weston, Inc., 1995). Iron is not a contaminant of concern at the Lee Acres Landfill.

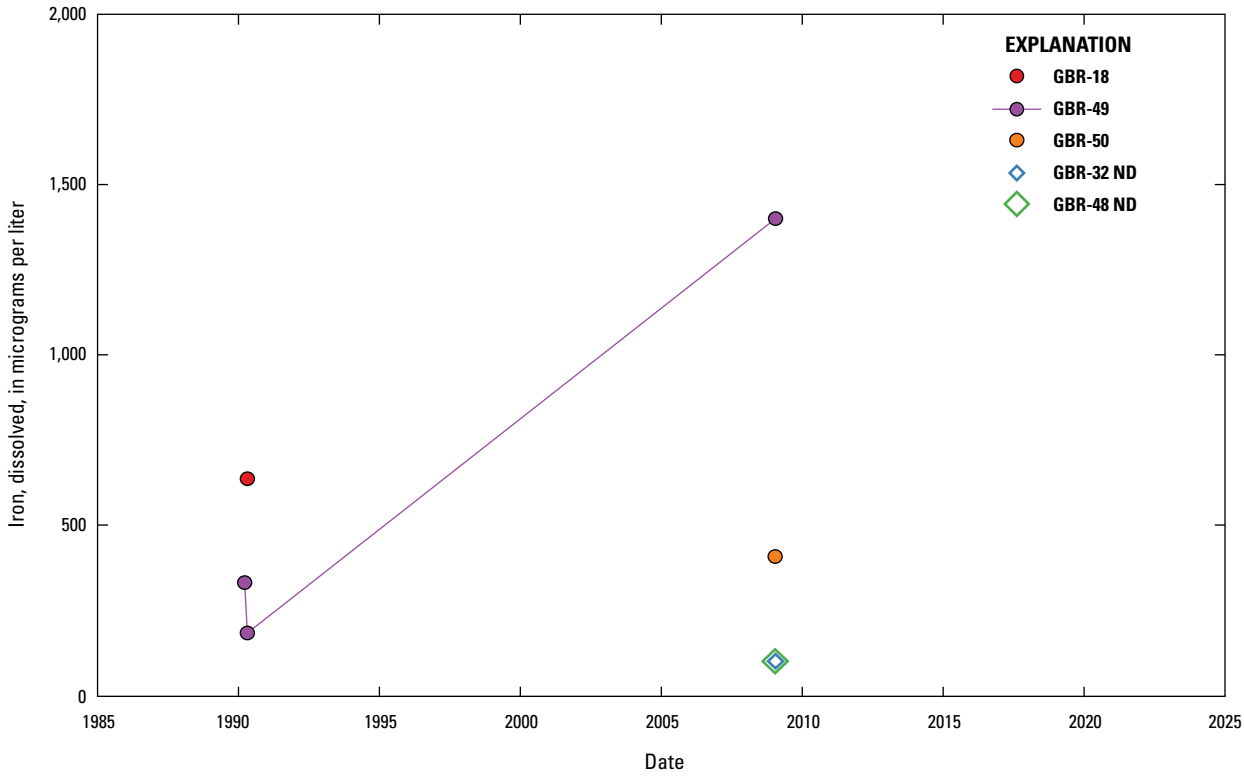


Figure 40. Dissolved iron concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells upgradient from refinery operations at GBR near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved iron at the Lee Acres Landfill range from nondetect to 2,460 micrograms per liter (Roy F. Weston, Inc., 1995). Iron is not a contaminant of concern at the Lee Acres Landfill. ND, no detection above method detection limits.

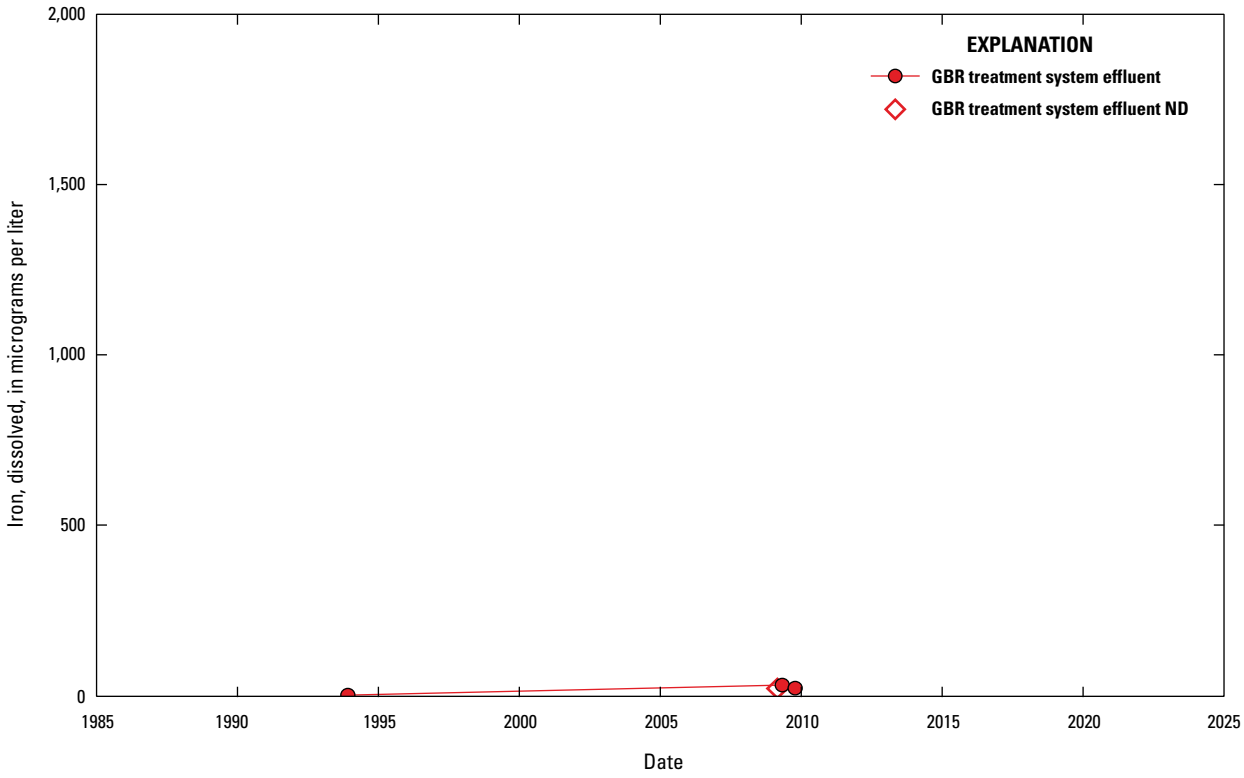


Figure 41. Dissolved iron concentration over time in Giant Bloomfield Refinery (GBR) treatment system effluent at GBR near Farmington, New Mexico. Locations of infiltration trenches, which accept the treatment system effluent, are shown in figure 6; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved iron at the Lee Acres Landfill range from nondetect to 2,460 micrograms per liter (Roy F. Weston, Inc., 1995). Iron is not a contaminant of concern at the Lee Acres Landfill. ND, no detection above method detection limits.

Summary of Results, 1985–2020

This section discusses the results of the BLM monitoring well data contained in LAGBRD for the analytes depicted in the time-series plots (figs. 8–66) with references to the ROD for the landfill (EPA, 2004).

BLM-14 was sampled from December 1987 to May 1990 (table 8). At this well, there are no results for total chloride. There is only one result for dissolved manganese (fig. 15). Sampled on February 6, 1989, the dissolved manganese concentration is 8.7 micrograms per liter (µg/L). There is only one result for dissolved nickel (fig. 22): 28.9 µg/L on February 6, 1989. Dissolved chromium concentrations range from 31.8 µg/L (December 13, 1989) to 113 µg/L (February 6, 1989) (fig. 29). There is only one result for dissolved iron (fig. 36): sampled on February 6, 1989, the dissolved iron concentration is 85.5 µg/L. There are no results for the organic COCs described in the ROD.

BLM-15 was sampled from December 1987 to November 2004 (table 8). At this well, total chloride concentrations range from 45 milligrams per liter (mg/L) (May 22, 2001; May 4, 2004; and November 16, 2004) to 120 mg/L (September 1, 1998) (fig. 8). Dissolved manganese concentrations range from no detection above reporting levels (multiple dates) to 380 µg/L on September 1, 1998 (fig. 15). Dissolved nickel results (fig. 22) all represent no detection above reporting levels except for two samples: 23.8 µg/L on February 6, 1989, and 51 µg/L on September 1, 1998. Dissolved chromium results range from no detection above reporting levels (multiple dates) to 82.4 µg/L (February 6, 1989) (fig. 29). There is one result for iron, 61.9 µg/L on February 6, 1989 (fig. 36). *cis*-1,2-Dichloroethene (fig. 55) and *trans*-1,2-dichloroethene were not detected above reporting levels. Tetrachloroethene was not detected above reporting levels except in one sample (fig. 59): 2 µg/L on September 1, 1998. Trichloroethene was not detected above reporting levels except in one sample collected on December 15, 1987, with a concentration of 140 µg/L. This result is suspect and therefore omitted from the time-series plots, as BLM-15 is upgradient from the landfill and the result exceeds the highest concentration of trichloroethene detected in any other BLM well (including those within and adjacent to the landfill boundary) by an order of magnitude. Vinyl chloride was not detected above reporting levels in this area and was thus excluded from the time-series plots of concentrations.

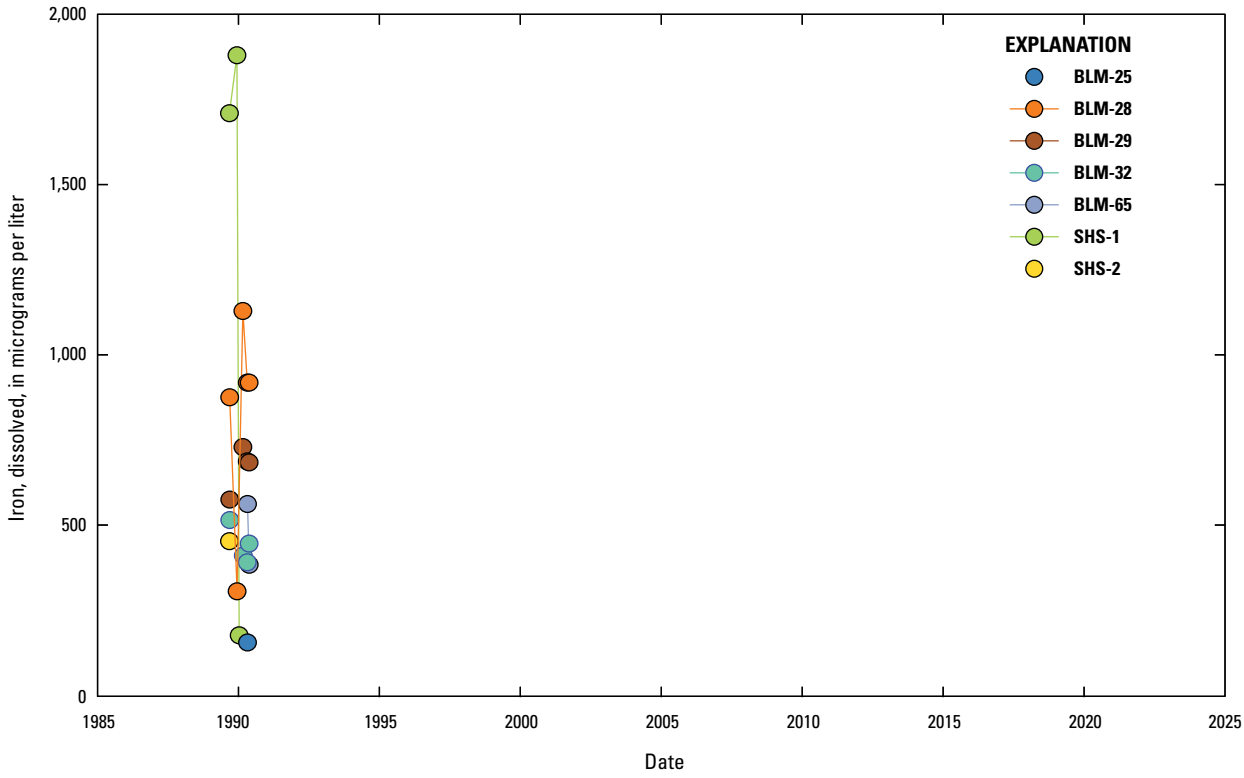


Figure 42. Dissolved iron concentration over time at Bureau of Land Management (BLM) and Southern Heights Subdivision (SHS) monitoring wells south of U.S. Highway 64 near Farmington, New Mexico. SHS wells were monitored by the Giant Bloomfield Refinery. Locations of wells are shown in figure 7; data sources are specified in table 8. As shown in table 1, the alluvial aquifer background concentrations for dissolved iron at the Lee Acres Landfill range from nondetect to 2,460 micrograms per liter (Roy F. Weston, Inc., 1995). Iron is not a contaminant of concern at the Lee Acres Landfill.

BLM-16 was sampled from December 1987 to May 1990 (table 8). At this well, there are no results for total chloride. Dissolved manganese concentrations range from 149 µg/L (February 9, 1989) to 504 µg/L (February 28, 1990) (fig. 15). There is one result for dissolved nickel of 18.4 µg/L on February 9, 1989 (fig. 22). There is one dissolved chromium result of 59.1 µg/L on February 9, 1989 (fig. 29). Dissolved iron concentrations range from 61.4 µg/L (February 9, 1989) to 406 µg/L (February 28, 1990) (fig. 36). The only organic COC described in the ROD that has a result is tetrachloroethene, which had a concentration of 1.3 µg/L on September 8, 1989 (fig. 59).

BLM-17 was sampled from December 1987 to May 1990 (table 8). At this well, there are no total chloride results. There are two results for dissolved manganese (fig. 17): 17 µg/L on April 19, 1988, and 8.7 µg/L on February 6, 1989. The only result for dissolved nickel has a concentration of 26.9 µg/L on February 6, 1989 (fig. 24). Dissolved chromium concentrations range from 50.7 µg/L (April 25, 1990) to 124 µg/L (February 6, 1989) (fig. 31). There is one result for dissolved iron of 83.8 µg/L on February 6, 1989 (fig. 38). The only organic COC from the ROD is tetrachloroethene. The tetrachloroethene result, collected on December 15, 1987, is 9 µg/L (fig. 61).

BLM-18 was sampled from December 1987 to May 1990 (table 8). At this well, there are no total chloride results. Dissolved manganese concentrations range from 16.1 µg/L (September 8, 1989) to 39.4 µg/L (February 26, 1990) (fig. 17). The two results for dissolved nickel, both collected on February 6, 1989, have concentrations of 37.1 µg/L and 36.5 µg/L (fig. 24). Dissolved chromium concentrations range from 16.3 µg/L (April 25, 1990) to 89.3 µg/L (February 6, 1989) (fig. 31). The two results for dissolved iron were both collected on February 6, 1989, and have concentrations of 69.1 µg/L and 131 µg/L (fig. 38). There are no results for the organic COCs described in the ROD.

BLM-19 was sampled from December 1987 to May 1990 (table 8). At this well, there are no results for total chloride. Dissolved manganese concentrations range from 225 µg/L (September 12, 1989) to 359 µg/L (May 16, 1990) (fig. 17). The only result for dissolved nickel, from February 8, 1989, has a concentration of 21.8 µg/L (fig. 24). The one result for dissolved chromium, collected on February 8, 1989, has a concentration of 60.4 µg/L (fig. 31). Dissolved iron concentrations range from 640 µg/L (December 16, 1989) to 914 µg/L (February 26, 1990) (fig. 38). There are no results for the organic COCs described in the ROD.

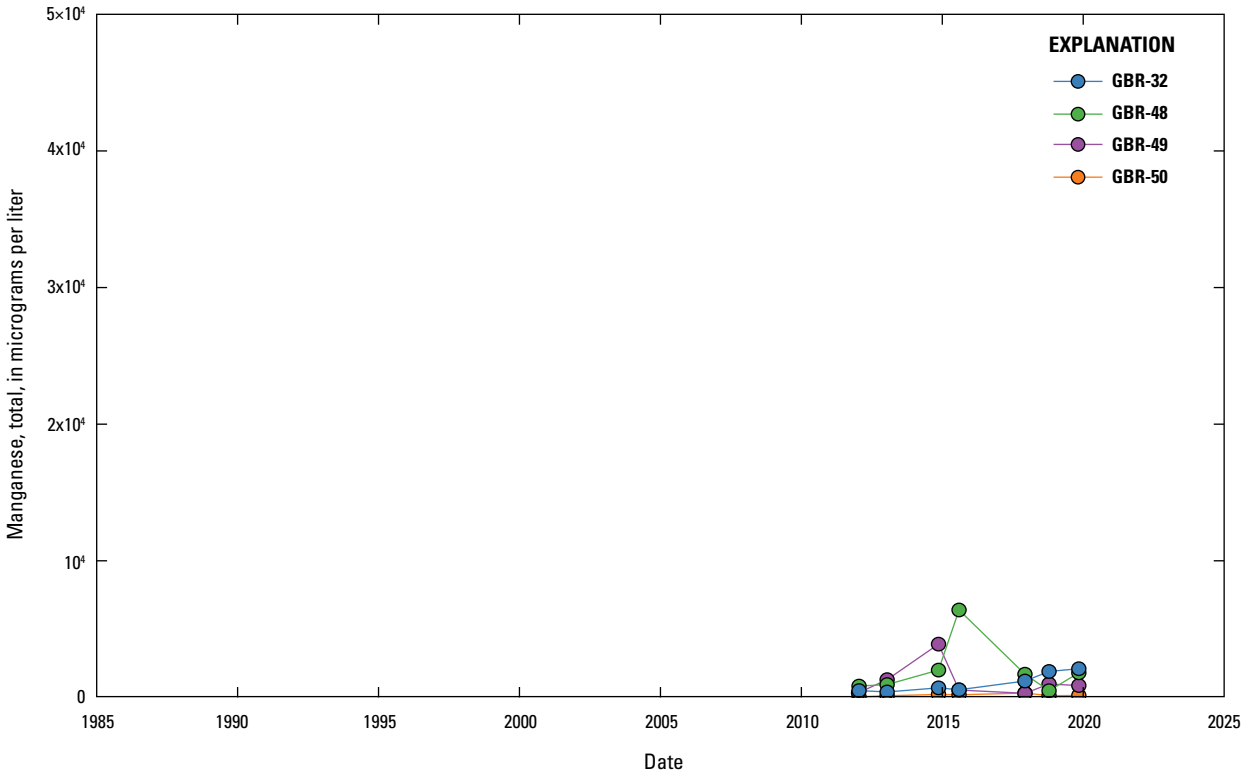


Figure 43. Total manganese concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells upgradient from refinery operations at GBR near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8.

BLM-20 was sampled from December 1987 to May 1990 (table 8). At this well, there are no total chloride results. The two results for dissolved manganese (fig. 17) are 79 µg/L on April 20, 1988, and 8.7 µg/L on February 6, 1989. There is one result for dissolved nickel (fig. 24): 24 µg/L on February 6, 1989. Dissolved chromium concentrations range from 65.5 µg/L (May 16, 1990) to 124 µg/L (February 6, 1989) (fig. 31). There is one result for dissolved iron (fig. 38): 51.2 µg/L collected on February 6, 1989. There are no results for the organic COCs described in the ROD.

BLM-21 was sampled from December 1987 to November 2004 (table 8). At this well, total chloride concentrations range from 31 mg/L (November 19, 2002) to 48 mg/L (May 22, 2001) (fig. 10). Dissolved manganese concentrations range from 1.6 µg/L (May 31, 2000) to 590 µg/L (June 8, 1999) (fig. 17). Only one result for dissolved nickel was above reporting levels, collected on February 6, 1989, with a concentration of 28.4 µg/L (fig. 24). Dissolved chromium concentrations range from no detection above reporting levels (multiple dates) to 102 µg/L (February 6, 1989) (fig. 31). The only result for dissolved iron (fig. 38) is 118 µg/L on February 6, 1989. The organic COCs described in the ROD were not detected above reporting levels.

BLM-22 was sampled from December 1987 to May 1990 (table 8). At this well, there are no results for total chloride. Dissolved manganese concentrations range from 98 µg/L (April 20, 1988) to 376 µg/L (April 24, 1990) (fig. 17). There is one dissolved nickel result (fig. 24): 19.5 µg/L on February 9, 1989. The only result for dissolved chromium (fig. 31) is 66.8 µg/L on February 9, 1989. Dissolved iron concentrations range from 122 µg/L (February 9, 1989) to 958 µg/L (April 24, 1990) (fig. 38). There are no results for the organic COCs described in the ROD.

BLM-23 was sampled from December 1987 to May 1990 (table 8). At this well, there are no results for total chloride or dissolved nickel. Dissolved manganese concentrations range from 339 µg/L (April 20, 1988) to 377 µg/L (April 24, 1990) (fig. 16). The only result for dissolved chromium is 66.2 µg/L on February 8, 1989 (fig. 30). Dissolved iron concentrations range from 64.3 µg/L (February 8, 1989) to 1,920 µg/L (April 24, 1990) (fig. 37). There are no results for the organic COCs described in the ROD.

BLM-24 was sampled from December 1987 to May 1990 (table 8. At this well, there are no results for total chloride, dissolved nickel, dissolved chromium, or dissolved iron. The only result for dissolved manganese is 30 µg/L on April 21, 1988 (fig. 21). There are no results for the organic COCs described in the ROD.

BLM-25 was sampled from December 1987 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. The only result for dissolved manganese is 47 µg/L on April 21, 1988 (fig. 21).

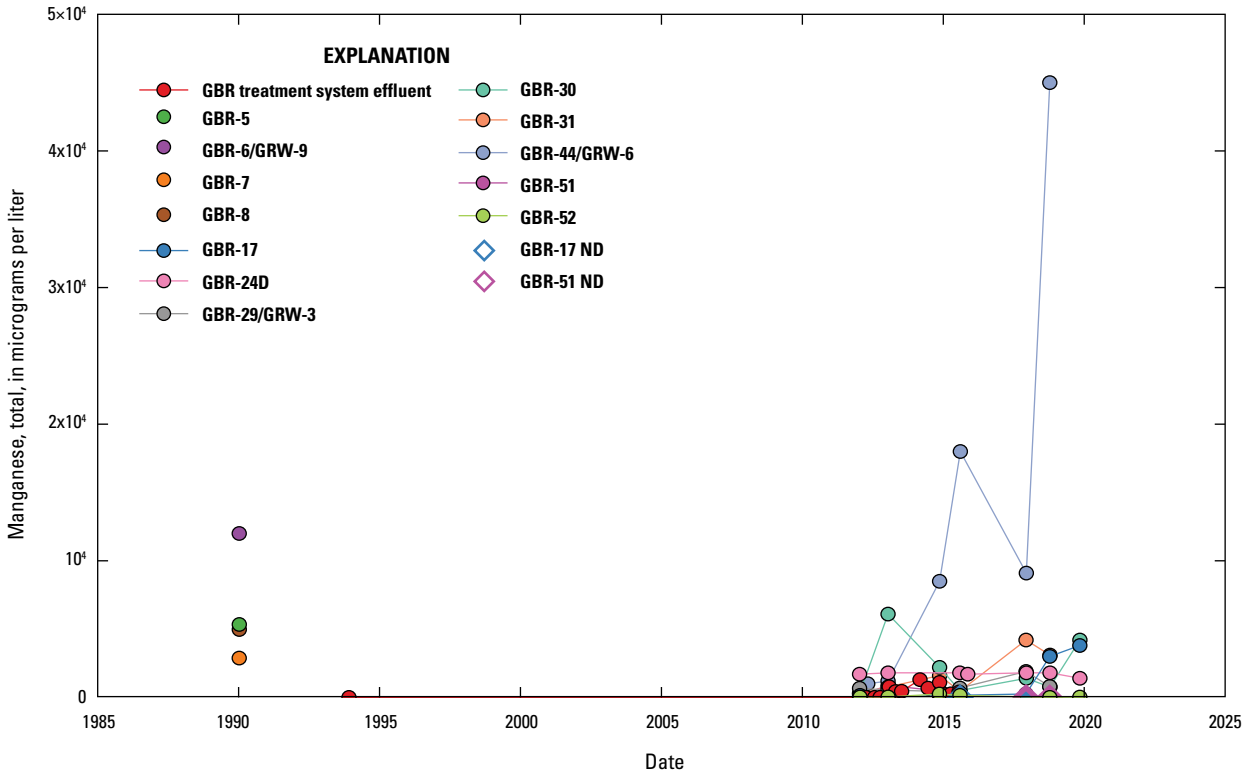


Figure 44. Total manganese concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells, groundwater recovery wells (GRW), and treatment system effluent near refinery operations at GBR near Farmington, New Mexico. Locations of wells and infiltration trenches, which accept the treatment system effluent, are shown in figure 6; data sources are specified in table 8. ND, no detection above method detection limits.

The only result for dissolved iron is 158 µg/L on April 28, 1990 (fig. 42). The only organic COC from the ROD with results is tetrachloroethene, collected on May 20, 1990, with a concentration of 2 µg/L.

BLM-26 was sampled from December 1987 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, dissolved chromium, or dissolved iron. Dissolved manganese concentrations range from 182 µg/L (April 21, 1988) to 335 µg/L (February 28, 1990) (fig. 21). The only organic COC from the ROD with results is trichloroethene, which was sampled on July 19, 1988, and had a concentration of 7 µg/L.

BLM-27 was sampled from December 1987 to May 1990 (table 8). At this well, there are no results for total chloride or dissolved iron. There are two dissolved manganese results, both collected on April 21, 1988 (fig. 21). Their values are 18 µg/L and 70 µg/L. There is one result for dissolved nickel, sampled on September 7, 1989, with a concentration of 60.2 µg/L (fig. 28). There are two results for dissolved chromium (fig. 35). Both results have the same value of 74 µg/L; one was collected on September 7, 1989, and the other was collected on December 12, 1989. There are no results for the organic COCs described in the ROD.

BLM-28 was sampled from December 1987 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. Dissolved manganese concentrations range from 426 µg/L (December 14, 1989) to 511 µg/L (April 21, 1988) (fig. 21). Dissolved iron concentrations range from 308 µg/L (December 14, 1989) to 1,130 µg/L (February 27, 1990) (fig. 42). There are no results for the organic COCs described in the ROD.

BLM-29 was sampled from December 1987 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. Dissolved manganese concentrations range from 307 µg/L (December 17, 1989) to 419 µg/L (February 27, 1990, and April 25, 1990) (fig. 21). Dissolved iron concentrations range from 577 µg/L (September 10, 1989) to 731 µg/L (February 27, 1990) (fig. 42). There are no results for the organic COCs described in the ROD.

BLM-30 was sampled from December 1987 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved manganese, dissolved nickel, or dissolved iron. There are two results for dissolved chromium (fig. 35): 43 µg/L on September 7, 1989, and 110 µg/L on December 12, 1989. There are no results for the organic COCs described in the ROD.

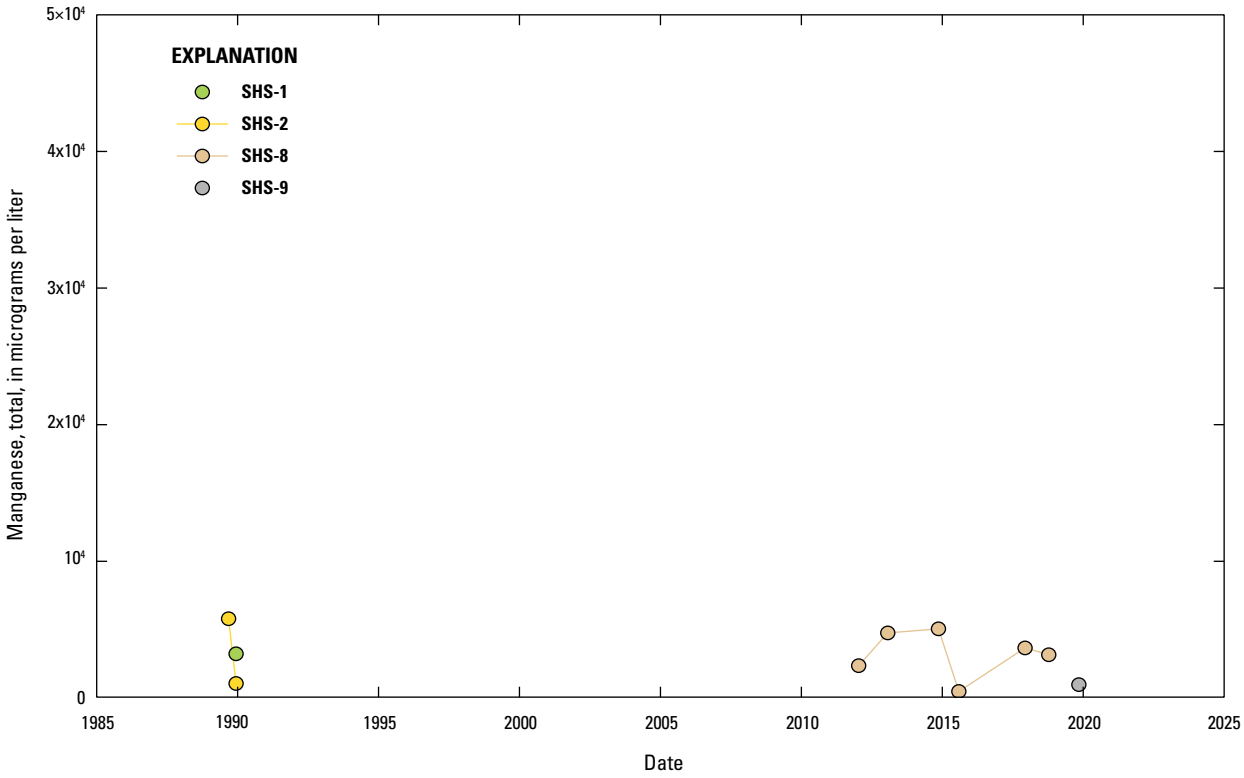


Figure 45. Total manganese concentration over time at Southern Heights Subdivision (SHS) monitoring wells south of U.S. Highway 64 near Farmington, New Mexico. SHS wells were monitored by the Giant Bloomfield Refinery. Locations of wells are shown in figure 7; data sources are specified in table 8.

BLM-31 was sampled from December 1987 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, dissolved chromium, or dissolved iron. Dissolved manganese concentrations range from 136 µg/L (April 21, 1988) to 267 µg/L (May 19, 1990) (fig. 21). There are no results for the organic COCs described in the ROD.

BLM-32 was sampled from December 1987 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. Dissolved manganese concentrations range from 283 µg/L (December 17, 1989) to 335 µg/L (April 25, 1990) (fig. 21). Dissolved iron concentrations range from 393 µg/L (April 25, 1990) to 517 µg/L (September 10, 1989) (fig. 42). There are no results for the organic COCs described in the ROD.

BLM-33 was sampled from February 1989 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. Dissolved manganese concentrations range from 387 µg/L (September 12, 1989) to 411 µg/L (May 16, 1990) (fig. 16). Dissolved iron concentrations range from 166 µg/L (December 15, 1989) to 860 µg/L (April 24, 1990) (fig. 37). There are no results for the organic COCs described in the ROD.

BLM-34 was sampled from February 1989 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. Dissolved manganese concentrations range from 340 µg/L (September 11, 1989, and February 26, 1990) to 372 µg/L (May 16, 1990) (fig. 16). Dissolved iron concentrations range from 370 µg/L (December 15, 1989) to 1,060 µg/L (April 24, 1990) (fig. 37). There are no results for the organic COCs described in the ROD.

BLM-35 was sampled from February 1989 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. Dissolved manganese concentrations range from 570 µg/L (December 15, 1989) to 756 µg/L (September 12, 1989) (fig. 16). Dissolved iron results are from three dates: 579 µg/L on February 26, 1990; 371 µg/L on April 28, 1990; and 672 µg/L on May 16, 1990 (fig. 37). There are no results for the organic COCs described in the ROD.

BLM-37 was sampled from May 1989 to April 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved iron. There is only one dissolved manganese result (fig. 21): 2,980 µg/L on April 28, 1990. There is one result for dissolved chromium of 43 µg/L on September 7, 1989 (fig. 35). The only organic COC described in the ROD with results is *trans*-1,2-dichloroethene with a concentration of 3 µg/L on December 12, 1989.

BLM-39 was sampled from March 1990 to August 2020 (table 8). At this well, total chloride concentrations range from 19 mg/L (June 8, 1999) to 62 mg/L (August 4, 2020) (fig. 8). Dissolved manganese concentrations range from no detection

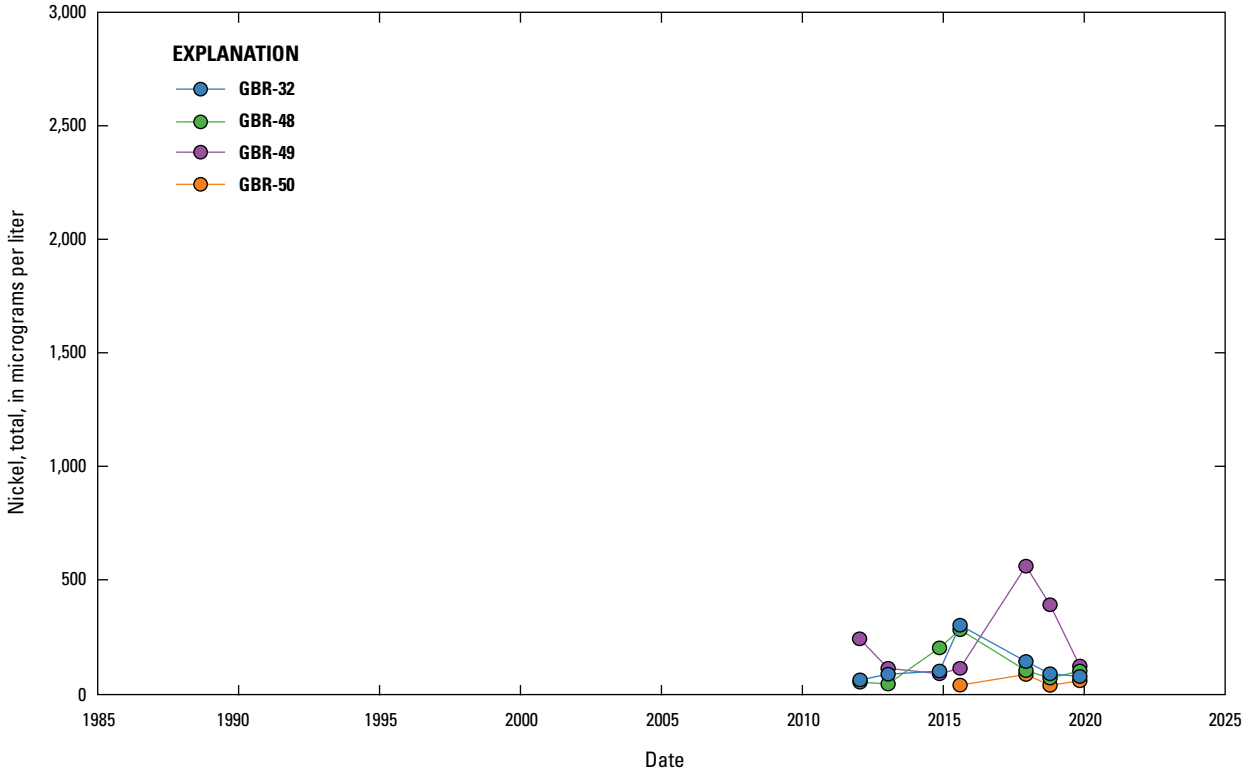


Figure 46. Total nickel concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells upgradient from refinery operations at GBR near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8.

above reporting levels (July 23, 2010) to 1,200 µg/L (May 19, 1998) (fig. 15). Dissolved nickel concentrations range from no detection above reporting levels (multiple dates) to an estimated value of 35 µg/L (July 23, 2010) (fig. 22). Dissolved chromium concentrations range from no detection above reporting levels (multiple dates) to 34 µg/L (March 1, 1990) (fig. 29). The only result for dissolved iron is 1,480 µg/L on May 17, 1990 (fig. 36). *cis*-1,2-Dichloroethene was not detected above reporting levels except in one sample with a concentration of 0.4 µg/L on June 23, 2015 (fig. 55). All *trans*-1,2-dichloroethene results represent no detection above reporting levels. Tetrachloroethene was not detected above reporting levels except in one sample with a concentration of 1 µg/L collected on July 23, 2010 (fig. 59). Trichloroethene and vinyl chloride were not detected above reporting levels.

BLM-40 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. Dissolved manganese concentrations range from 426 µg/L (March 1, 1990) to 470 µg/L (April 26, 1990) (fig. 15). Dissolved iron concentrations range from 914 µg/L (March 1, 1990) to 993 µg/L (April 26, 1990) (fig. 36). There are no results for the organic COCs described in the ROD.

BLM-41 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. There are three results for dissolved manganese (fig. 17): 400 µg/L on March 1, 1990; 385 µg/L on April 27, 1990; and 409 µg/L on May 18, 1990. The three results for dissolved iron (fig. 38) are 976 µg/L on March 1, 1990; 1,030 µg/L on April 27, 1990; and 1,100 µg/L on May 18, 1990. There are no results for the organic COCs described in the ROD.

BLM-42 was sampled from March 1990 to November 2004 (table 8). At this well, total chloride concentrations range from 42 mg/L (November 16, 2004) to 120 mg/L (May 19, 1998) (fig. 10). Dissolved manganese concentrations range from 180 µg/L (May 22, 2001; November 6, 2001; May 15, 2002; and November 16, 2004) to 2,490 µg/L (March 1, 1990) (fig. 17). Dissolved nickel was not detected above reporting levels except in two samples: 45 µg/L on May 19, 1998, and 41 µg/L on June 8, 1999 (fig. 24). Dissolved chromium was not detected above reporting levels (fig. 31). The only result for dissolved iron is 969 µg/L on March 1, 1990 (fig. 38). The organic COCs described in the ROD were not detected above reporting levels.

BLM-43 was sampled from March 1990 to May 1990 (table 8). At this well, there are no data for total chloride, dissolved nickel, dissolved chromium, or dissolved iron. There are three results for dissolved manganese (fig. 17): 6,700 µg/L on March 1, 1990; 5,260 µg/L on April 27, 1990; and 5,030 µg/L on May 18, 1990. There are no results for the organic COCs described in the ROD.

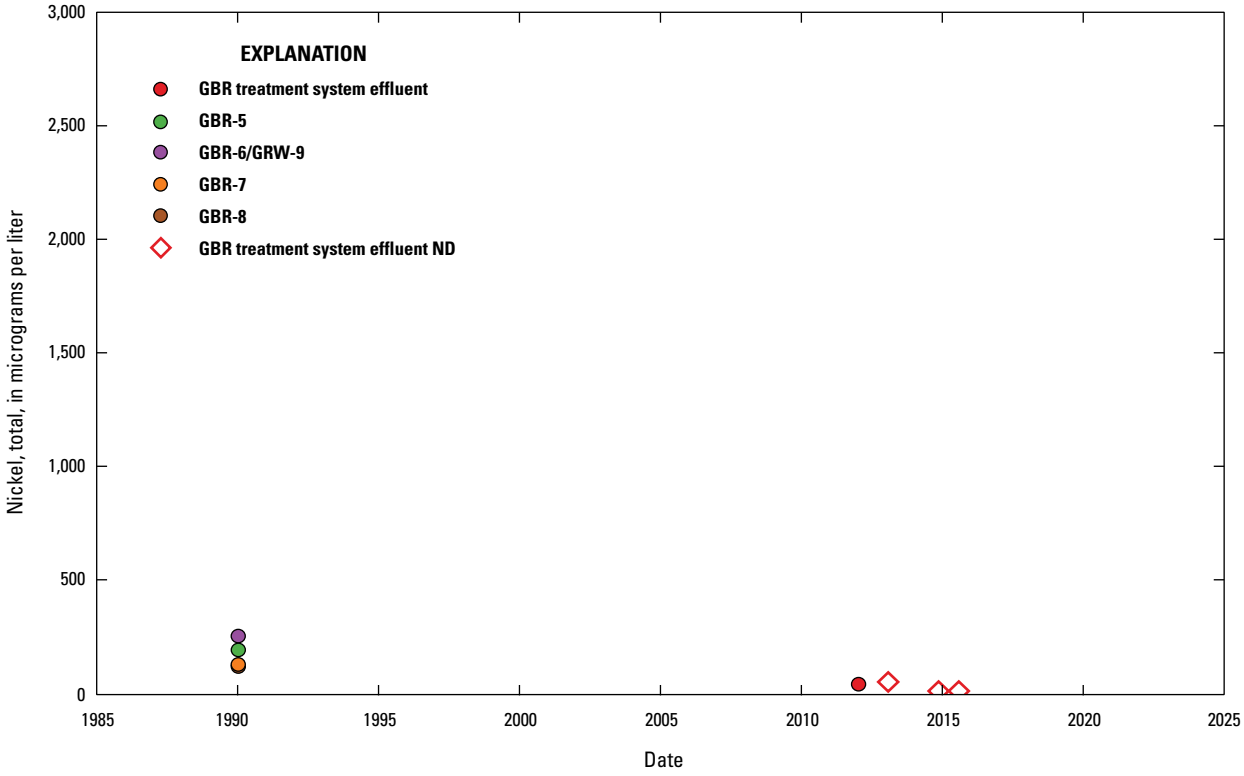


Figure 47. Total nickel concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells, groundwater recovery wells (GRW), and treatment system effluent near refinery operations at GBR near Farmington, New Mexico. Locations of wells and infiltration trenches, which accept the treatment system effluent, are shown in figure 6; data sources are specified in table 8. ND, no detection above method detection limits.

BLM-44 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. The three results for dissolved manganese (fig. 17) are 388 µg/L on March 2, 1990; 421 µg/L on April 26, 1990; and 402 µg/L on May 17, 1990. The three results for dissolved iron (fig. 38) are 428 µg/L on March 2, 1990; 334 µg/L on April 26, 1990; and 411 µg/L on May 17, 1990. There are no results for the organic COCs described in the ROD.

BLM-45 was sampled from March 1990 to August 2020 (table 8). At this well, there are no dissolved iron results. Total chloride concentrations range from 40 mg/L (multiple dates) to 91 mg/L (March 19, 2015) (fig. 10). Dissolved manganese concentrations range from no detection above reporting levels (multiple dates) to 2,440 µg/L (May 17, 1990) (fig. 17). Dissolved nickel was not detected above reporting levels (fig. 24). Dissolved chromium concentrations range from no detection above reporting levels (multiple dates) to 20 µg/L on September 17, 2015 (fig. 31). *cis*-1,2-Dichloroethene (fig. 57) was not detected above reporting levels except in one sample with a concentration of 0.4 µg/L on June 23, 2015. The remainder of the organic COCs described in the ROD were not detected above reporting levels.

BLM-46 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved chromium, or dissolved iron. The three results for dissolved manganese are 2,210 µg/L on March 2, 1990; 1,100 µg/L on February 26, 1990; and 1,290 µg/L on May 17, 1990 (fig. 17). The two results for dissolved nickel are 47.5 µg/L (April 26, 1990) and 127 µg/L (May 17, 1990) (fig. 24). There are no results for the organic COCs described in the ROD.

BLM-47 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. The three results for dissolved manganese are 420 µg/L on March 3, 1990; 462 µg/L on April 26, 1990; and 484 µg/L on May 17, 1990 (fig. 17). The three results for dissolved iron are 252 µg/L on March 3, 1990; 368 µg/L on April 26, 1990; and 538 µg/L on May 17, 1990 (fig. 38). There are no results for the organic COCs described in the ROD.

BLM-48 was sampled from March 1990 to November 2004 (table 8). At this well, there are no results for dissolved iron. Total chloride concentrations range from 44 mg/L on November 17, 2003, to 50 mg/L on September 1, 1998 (fig. 10). Dissolved manganese concentrations range from below reporting levels (June 8, 1999) to 1,220 µg/L (April 26, 1990) (fig. 17). Dissolved nickel was not detected

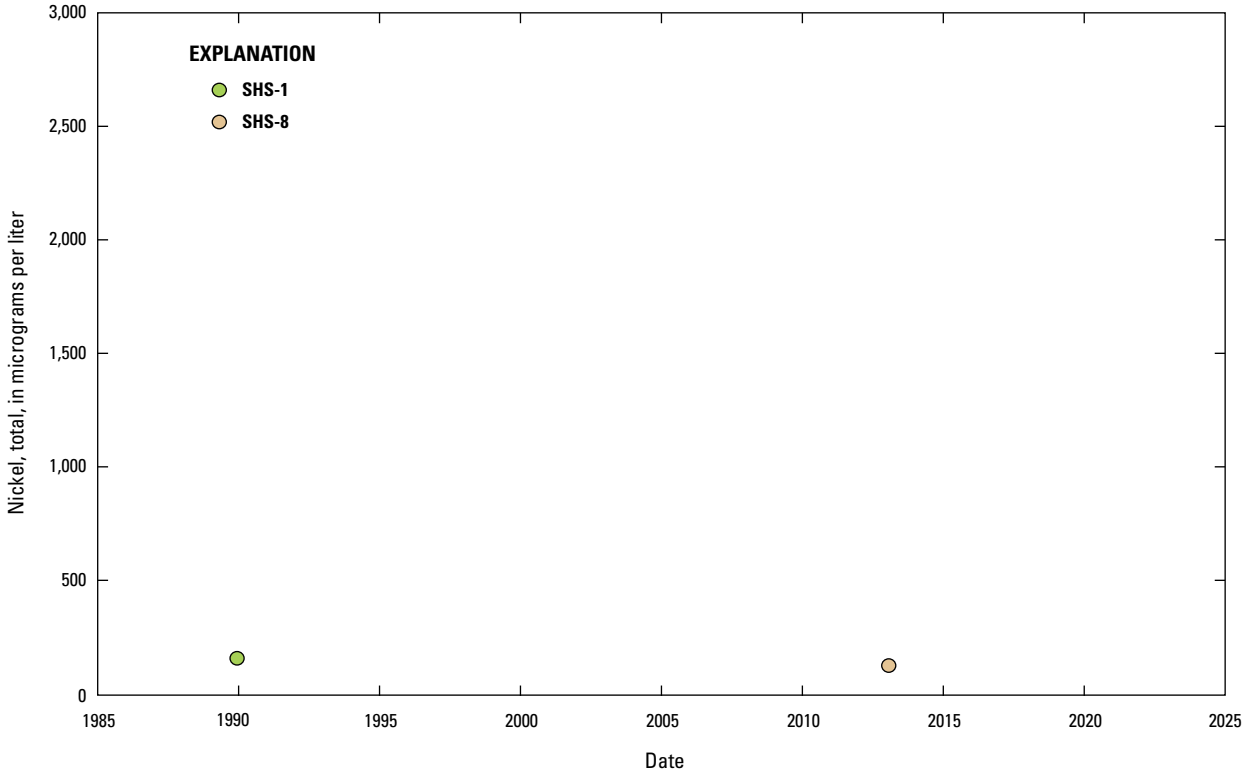


Figure 48. Total nickel concentration over time at Southern Heights Subdivision (SHS) monitoring wells south of U.S. Highway 64 near Farmington, New Mexico. SHS wells were monitored by the Giant Bloomfield Refinery. Locations of wells are shown in figure 7; data sources are specified in table 8.

above reporting levels (fig. 24). Dissolved chromium was not detected above reporting levels (fig. 31). The organic COCs described in the ROD were not detected above reporting levels.

BLM-49 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, dissolved chromium, or dissolved iron. There are three results for dissolved manganese (fig. 17): 1,340 µg/L on March 3, 1990; 1,470 µg/L on April 26, 1990; and 1,240 µg/L on May 17, 1990. The one result for tetrachloroethene has a value of 12 µg/L on April 26, 1990 (fig. 61). The one result for trichloroethene has a value of 9.8 µg/L on April 26, 1990 (fig. 64). There are no results for the other organic COCs described in the ROD.

BLM-50 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. Dissolved manganese concentrations range from 367 µg/L on April 27, 1990, to 404 µg/L on May 17, 1990 (fig. 17). Dissolved iron concentrations range from 798 µg/L on March 20, 1990, to 1,140 µg/L on April 27, 1990 (fig. 38). There are no results for the organic COCs described in the ROD.

BLM-51 was sampled from March 1990 to November 2004 (table 8). At this well, there are no results for dissolved iron. Total chloride concentrations range from 48 mg/L (November 16, 2000) to 56 mg/L (September 1, 1998) (fig. 10). Of the 17 dissolved manganese results, 14 represent no detection above reporting levels (fig. 17). The results representing detections are 73.4 µg/L on March 20, 1990; 33.5 µg/L on April 26, 1990; and 31.8 µg/L on May 17, 1990. Dissolved nickel was not detected above reporting levels (fig. 24). Dissolved chromium concentrations range from no detection above reporting levels (multiple dates) to 20 µg/L on April 26, 1990 (fig. 31). The organic COCs described in the ROD were not detected above reporting levels.

BLM-52 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved manganese, dissolved nickel, or dissolved iron. The three results for dissolved chromium are 49.3 µg/L on March 20, 1990; 54.2 µg/L on April 26, 1990; and 51.8 µg/L on May 17, 1990 (fig. 31). There are no results for the organic COCs described in the ROD.

BLM-53 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. The three results for dissolved manganese are 191 µg/L on March 21, 1990; 415 µg/L on April 29, 1990; and 440 µg/L on May 21, 1990 (fig. 16). There are two results for dissolved iron (fig. 37): 104 µg/L on April 29, 1990, and 311 µg/L on May 21, 1990. There are no results for the organic COCs described in the ROD.

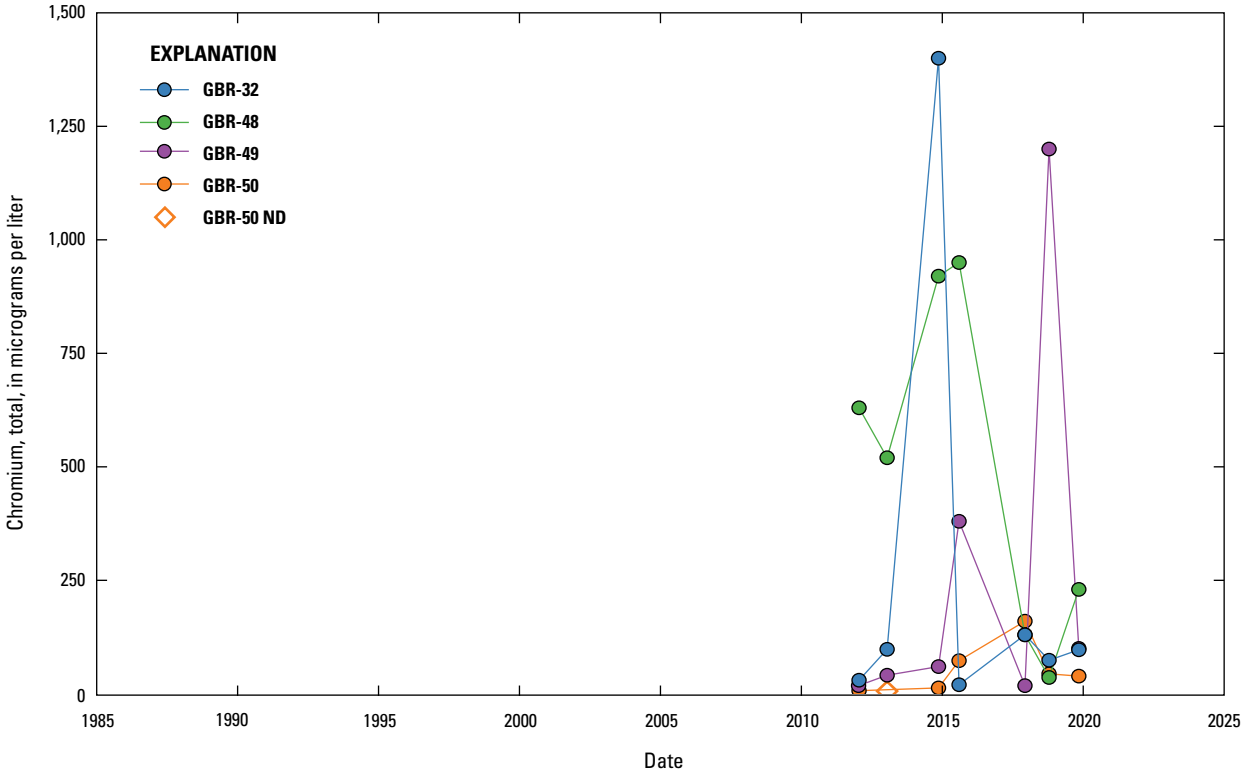


Figure 49. Total chromium concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells upgradient from refinery operations at GBR near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8. ND, no detection above method detection limits.

BLM-54 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. Dissolved manganese concentrations range from 417 µg/L on March 4, 1990, to 461 µg/L on May 21, 1990 (fig. 16). The two results for dissolved iron are 173 µg/L on April 29, 1990, and 220 µg/L on May 21, 1990 (fig. 37). There are no results for the organic COCs described in the ROD.

BLM-55 was sampled from March 1990 to November 2004 (table 8). Total chloride concentrations range from 32 mg/L (November 16, 2000) to 48 mg/L (September 1, 1998) (fig. 9). Dissolved manganese concentrations range from 380 µg/L (November 19, 2003) to 4,790 µg/L (May 21, 1990) (fig. 16). Of the 14 results for dissolved nickel, 11 are below reporting levels (fig. 23). The remaining results are 40 µg/L on May 19, 1998; 42 µg/L on June 8, 1999; and 71 µg/L on November 16, 2004. Dissolved chromium was not detected above reporting levels (fig. 30). The only result for dissolved iron is 1,310 µg/L on April 29, 1990 (fig. 37). There are 14 results for *cis*-1,2-dichloroethene (fig. 56). Twelve of those results represent no detection above reporting levels. The results above reporting levels are 20 µg/L on March 4, 1990, and 1.1 µg/L on May 19, 1998. *trans*-1,2-Dichloroethene was not detected above reporting levels. Twelve of the fourteen results for tetrachloroethene are below reporting levels (fig. 60). The two samples with tetrachloroethene results above reporting levels are 2 µg/L on April 29, 1990, and 1.7 µg/L on May 21, 1990. Trichloroethene was not detected above reporting levels except for the sample collected on April 29, 1990 (3.2 µg/L) (fig. 63). Vinyl chloride was not detected above reporting levels (fig. 66).

BLM-56 was sampled from March 1990 to November 2004 (table 8). Total chloride concentrations range from 39 mg/L (June 8, 1999, and November 16, 2000) to 46 mg/L (September 1, 1998, and August 15, 2001) (fig. 9). Dissolved manganese concentrations range from no detection above reporting levels (multiple dates) to 2,460 µg/L (April 29, 1990) (fig. 16). Dissolved nickel was not detected above reporting levels except on April 10, 2000, when it was detected at 47 µg/L (fig. 23). Of the nine results, dissolved chromium was not detected above reporting levels in seven of the samples and was detected at 14.5 µg/L on April 29, 1990, and 12.9 µg/L on May 22, 1990 (fig. 30). There is one result for dissolved iron (fig. 37): 1,710 µg/L on April 29, 1990. Organic COCs described in the ROD were not detected above reporting levels.

BLM-57 was sampled from March 1990 to November 2004 (table 8). At this well, there are no results for dissolved iron. Total chloride concentrations range from 91 mg/L on May 16, 2002, to 490 mg/L on June 8, 1999 (fig. 9). Dissolved manganese concentrations range from 4,300 µg/L (November 19, 2003) to 8,620 µg/L (May 22,

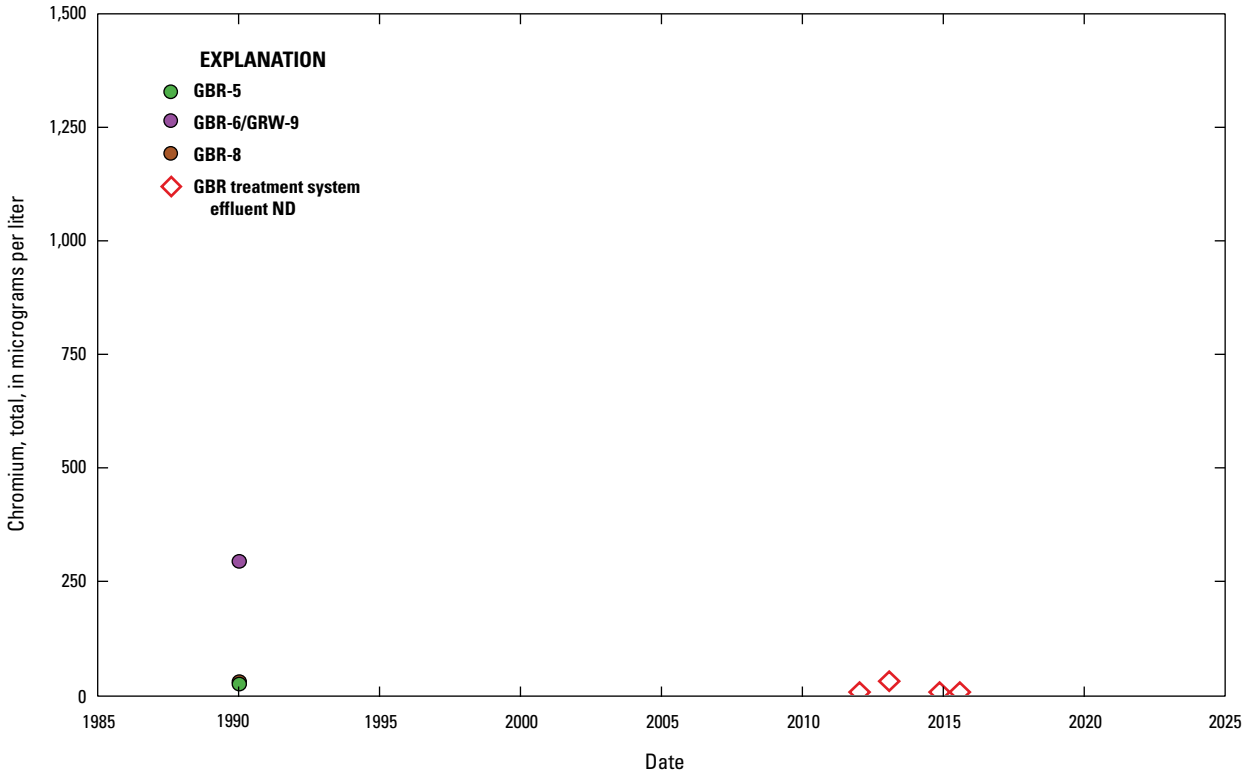


Figure 50. Total chromium concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells, groundwater recovery wells (GRW), and treatment system effluent near refinery operations at GBR near Farmington, New Mexico. Locations of wells and infiltration trenches, which accept the treatment system effluent, are shown in figure 6; data sources are specified in table 8. ND, no detection above method detection limits.

1990) (fig. 16). Dissolved nickel concentrations range from no detection above reporting levels (multiple dates) to 146 µg/L (May 22, 1990) (fig. 23). Dissolved chromium was not detected above reporting levels (fig. 30). Results for *cis*-1,2-dichloroethene range from no detection above reporting levels (multiple dates) to 14 µg/L (June 8, 1999) (fig. 56). *trans*-1,2-Dichloroethene and tetrachloroethene (fig. 60) were not detected above reporting levels. Trichloroethene was not detected above reporting levels among 13 of the 24 samples collected (fig. 63). The remaining trichloroethene results range from 0.7 µg/L (March 21, 1990) to 4.6 µg/L (June 8, 1999). Of the 24 samples collected with results for vinyl chloride, vinyl chloride was not detected above reporting levels in 17 of the samples (fig. 66). The remainder of the vinyl chloride results range from 2.3 µg/L (April 10, 2000) to 6.7 µg/L (March 21, 1990).

BLM-58 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved iron. There are three results for dissolved manganese (fig. 16): 2,610 µg/L on March 6, 1990; 1,940 µg/L on April 29, 1990; and 1,990 µg/L on May 22, 1990. There are two results for dissolved chromium (fig. 30): 12.8 µg/L on April 29, 1990, and 22.4 µg/L on May 22, 1990. There are no results for the organic COCs described in the ROD.

BLM-59 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. The three results for dissolved manganese (fig. 17) are 370 µg/L on March 2, 1990; 358 µg/L on April 27, 1990; and 406 µg/L on May 18, 1990. There are three results for dissolved iron (fig. 38): 365 µg/L on March 2, 1990; 869 µg/L on April 27, 1990; and 842 µg/L on May 18, 1990. There are no results for the organic COCs described in the ROD.

BLM-60 was sampled from March 1990 to August 2020 (table 8). At this well, there are no results for dissolved iron. Total chloride results range from 39 mg/L (May 10, 2006) to 240 mg/L (May 19, 1998) (fig. 10). Dissolved manganese concentrations range from no detection above reporting levels (multiple dates) to 4,920 µg/L (May 18, 1990) (fig. 17). Dissolved nickel concentrations range from no detection above reporting levels (multiple dates) to 1,200 µg/L (September 17, 2015) (fig. 24). Dissolved chromium concentrations range from no detection above reporting levels (multiple dates) to 150 µg/L (September 17, 2015) (fig. 31). All of the results for *cis*-1,2-dichloroethene are below reporting levels except for the sample collected on June 23, 2015 (0.4 µg/L) (fig. 57). All other organic COCs described in the ROD were not detected above reporting levels.

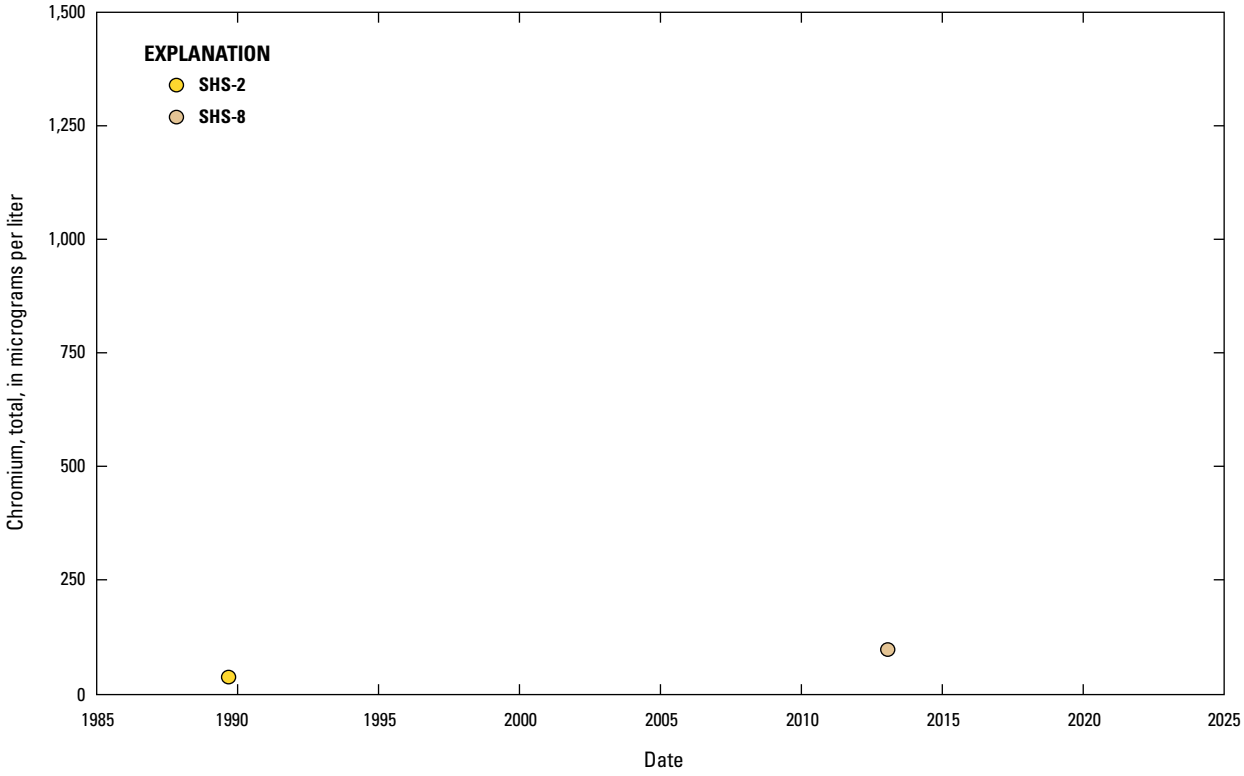


Figure 51. Total chromium concentration over time at Southern Heights Subdivision (SHS) monitoring wells south of U.S. Highway 64 near Farmington, New Mexico. SHS wells were monitored by the Giant Bloomfield Refinery. Locations of wells are shown in figure 7; data sources are specified in table 8.

BLM-61 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. There are three results for dissolved manganese (fig. 18): 512 µg/L on March 21, 1990; 882 µg/L on April 27, 1990; and 376 µg/L on May 20, 1990. There are two results for dissolved iron (fig. 39): 291 µg/L on March 21, 1990, and 1,040 µg/L on May 20, 1990. There are no results for the organic COCs described in the ROD.

BLM-62 was sampled from March 1990 to August 2020 (table 8). At this well, total chloride concentrations range from 19 mg/L (November 17, 2004) to 470 mg/L (August 24, 2014) (fig. 11). Dissolved manganese concentrations range from 12 µg/L (May 22, 2001) to 9,200 µg/L (December 20, 2013) (fig. 18). Dissolved nickel concentrations range from no detection above reporting levels (multiple dates) to an estimated value of 19 µg/L (July 22, 2010, and June 15, 2011) (fig. 25). Dissolved chromium was not detected above reporting levels except in two samples: 70 µg/L on September 15, 2016, and 10 µg/L on March 31, 2017 (fig. 32). There is one result for dissolved iron (fig. 39): 1,130 µg/L on April 27, 1990. *cis*-1,2-Dichloroethene was not detected above reporting levels except in the sample collected on June 23, 2015 (0.4 µg/L) (fig. 58). *trans*-1,2-Dichloroethene was not detected above reporting levels. Tetrachloroethene (fig. 62) and trichloroethene (fig. 65) were not detected above reporting levels except for detections of 4 µg/L and 2 µg/L, respectively, on September 1, 1998. Vinyl chloride was not detected above reporting levels.

BLM-63 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. There are three results for dissolved manganese (fig. 18): 252 µg/L on March 21, 1990; 443 µg/L on April 30, 1990; and 358 µg/L on May 20, 1990. There is one result for dissolved iron (fig. 39): 423 µg/L on April 30, 1990. There are no results for the organic COCs described in the ROD.

BLM-64 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. There are three results for dissolved manganese (fig. 18): 462 µg/L on March 21, 1990; 739 µg/L on April 28, 1990; and 606 µg/L on May 20, 1990. There is one result for dissolved iron (fig. 39): 230 µg/L on May 20, 1990. There are no results for the organic COCs described in the ROD.

BLM-65 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, or dissolved chromium. There are three results for dissolved manganese (fig. 21): 2,080 µg/L on March 20, 1990; 1,940 µg/L on April 28, 1990; and 2,020 µg/L on May 20, 1990. There are two results for

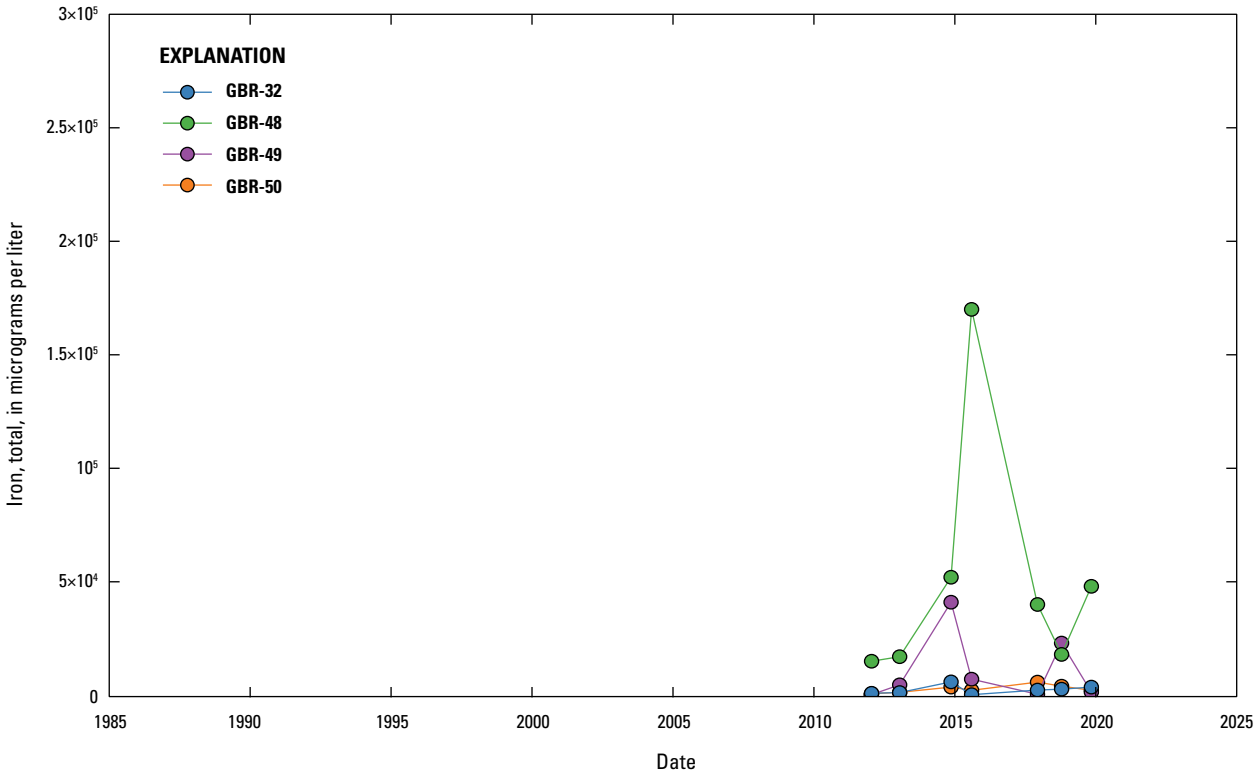


Figure 52. Total iron concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells upgradient from refinery operations at GBR near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8.

dissolved iron (fig. 42): 564 µg/L on April 28, 1990, and 386 µg/L on May 20, 1990. There are no results for the organic COCs described in the ROD.

BLM-66 was sampled from March 1990 to May 1990 (table 8). At this well, there are no results for total chloride, dissolved nickel, dissolved chromium, or dissolved iron. There are three results for dissolved manganese (fig. 21): 3,400 µg/L on March 20, 1990; 3,060 µg/L on April 28, 1990; and 3,090 µg/L on May 18, 1990. There are no results for the organic COCs described in the ROD.

BLM-67 was sampled from May 1998 to November 2004 (table 8). At this well, there are no results for dissolved iron. Total chloride concentrations range from 49 mg/L (May 20, 1998) to 55 mg/L (November 19, 2003) (fig. 11). Dissolved manganese concentrations range from no detection above reporting levels (multiple dates) to 28 µg/L (May 20, 1998) (fig. 18). Dissolved nickel concentrations range from no detection above reporting levels (multiple dates) to an estimated value of 140 µg/L (September 2, 1998) (fig. 25). Dissolved chromium was not detected above reporting levels (fig. 32). Except for trichloroethene, which was detected at 1.1 µg/L on May 6, 2004 (fig. 65), organic COCs described in the ROD were not detected above reporting levels.

BLM-68 was sampled from May 1998 to August 2020 (table 8). At this well, there are no results for dissolved iron. Total chloride concentrations range from 40 mg/L (July 23, 2010) to 430 mg/L (June 26, 2008) (fig. 11). Dissolved manganese concentrations range from no detection above reporting levels (multiple dates) to 450 µg/L (July 23, 2010) (fig. 18). Dissolved nickel concentrations range from no detection above reporting levels (multiple dates) to 60 µg/L (November 15, 2000) (fig. 25). Dissolved chromium concentrations range from no detection above reporting levels (multiple dates) to an estimated value of 0.9 µg/L (June 14, 2011) (fig. 32). *cis*-1,2-Dichloroethene concentrations range from no detection above reporting levels (multiple dates) to 35 µg/L (May 20, 1998) (fig. 58). *trans*-1,2-Dichloroethene was not detected above reporting levels. The results for tetrachloroethene range from no detection above reporting levels (multiple dates) to 8 µg/L (May 20, 1998, and September 2, 1998) (fig. 62). Trichloroethene was not detected above reporting levels between December 20, 2013, and August 5, 2020 (fig. 65). Between May 20, 1998, and July 31, 2013, trichloroethene results ranged from no detection above reporting levels (multiple dates) to 3 µg/L (May 20, 1998, and September 2, 1998). Vinyl chloride was not detected above reporting levels.

BLM-69 was sampled from May 1998 to August 2020 (table 8). At this well, there are no results for dissolved iron. Total chloride concentrations range from 44 mg/L (March 5, 2019) to 62 mg/L (August 5, 2020) (fig. 11). Dissolved manganese (fig. 18), dissolved nickel (fig. 25), and dissolved

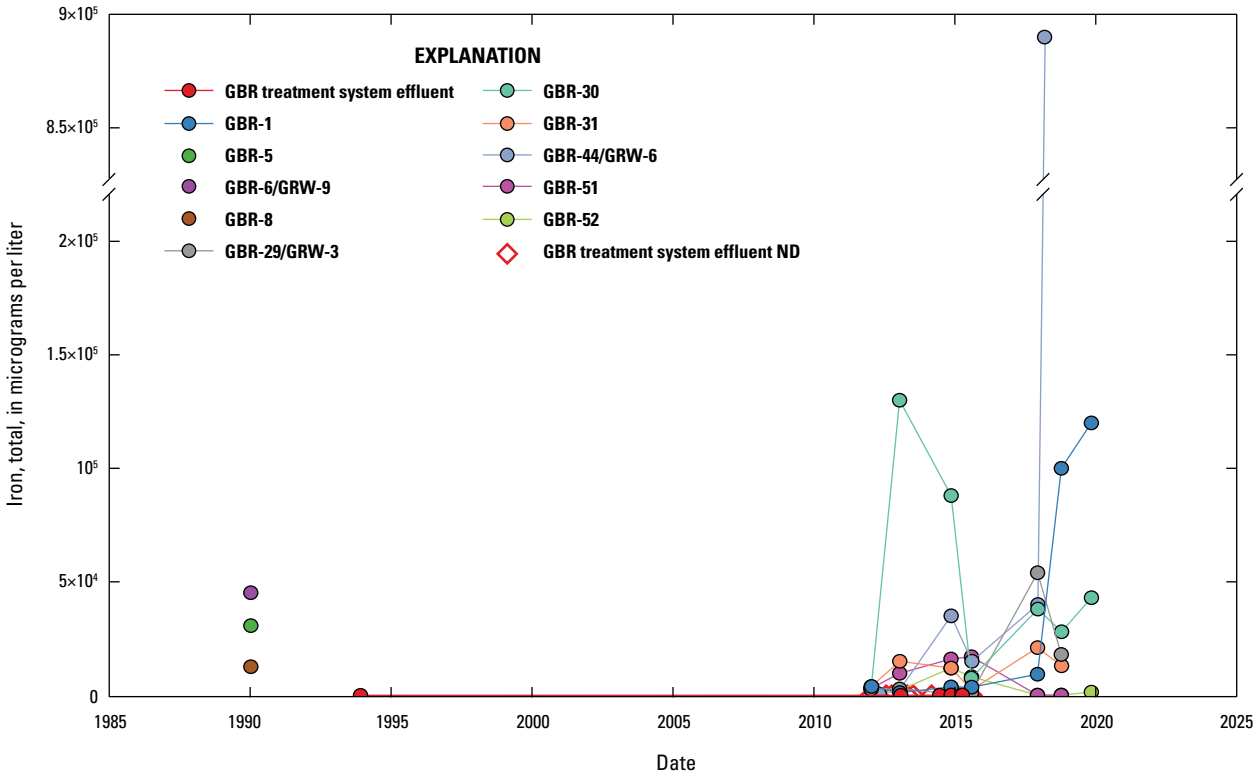


Figure 53. Total iron concentration over time at Giant Bloomfield Refinery (GBR) monitoring wells, groundwater recovery wells (GRW), and treatment system effluent near refinery operations at GBR near Farmington, New Mexico. Locations of wells and infiltration trenches, which accept the treatment system effluent, are shown in figure 6; data sources are specified in table 8. ND, no detection above method detection limits.

chromium (fig. 32) were not detected above reporting levels. Organic COCs described in the ROD were not detected above reporting levels.

BLM-70 was sampled from May 1998 to May 2003 (table 8). At this well, there are no results for dissolved iron. Total chloride concentrations range from 81 mg/L (May 14, 2003) to 150 mg/L (November 18, 1999) (fig. 11). Dissolved manganese (fig. 18), dissolved nickel (fig. 25), and dissolved chromium (fig. 32) were not detected above reporting levels. *cis*-1,2-Dichloroethene concentrations range from no detection above reporting levels (multiple dates) to 7.1 µg/L (May 20, 1998) (fig. 58). *trans*-1,2-Dichloroethene was not detected above reporting levels. Tetrachloroethene results range from no detection above reporting levels (multiple dates) to 3 µg/L (May 20, 1998, and September 2, 1998) (fig. 62). Trichloroethene (fig. 65) and vinyl chloride were not detected above reporting levels.

BLM-75 was sampled from May 1998 to August 2020 (table 8). At this well, there are no results for dissolved iron. Total chloride concentrations range from 38 mg/L (May 11, 2006) to 300 mg/L (May 19, 1998) (fig. 11). Dissolved manganese concentrations range from no detection above reporting levels (multiple dates) to 1,600 µg/L (June 16, 2005) (fig. 18). Dissolved nickel concentrations range from no detection above reporting levels (multiple dates) to 600 µg/L (September 17, 2015) (fig. 25). Dissolved chromium concentrations range from no detection above reporting levels (multiple dates) to 40 µg/L (September 17, 2015) (fig. 32). Results for *cis*-1,2-dichloroethene range from no detection above reporting levels (multiple dates) to 0.3 µg/L (June 23, 2015) (fig. 58). Other organic COCs described in the ROD were not detected above reporting levels.

BLM-76 was sampled from May 1998 to November 2004 (table 8). At this well, there are no results for dissolved iron. Total chloride concentrations range from 48 mg/L (May 14, 2003) to 170 mg/L (June 9, 1999) (fig. 11). Dissolved manganese concentrations range from no detection above reporting levels (multiple dates) to 1,700 µg/L (May 19, 1998) (fig. 18). Dissolved nickel concentrations range from no detection above reporting levels (multiple dates) to 50 µg/L (May 19, 1998) (fig. 25). Dissolved chromium was not detected above reporting levels (fig. 32). Results for *cis*-1,2-dichloroethene range from no detection above reporting levels (multiple dates) to 3.7 µg/L (May 19, 1998) (fig. 58). *trans*-1,2-Dichloroethene was not detected above reporting levels. Tetrachloroethene was not detected above reporting levels except in two samples: 2 µg/L on May 19, 1998, and 1.3 µg/L on June 9, 1999 (fig. 62). Trichloroethene (fig. 65) and vinyl chloride were not detected above reporting levels.

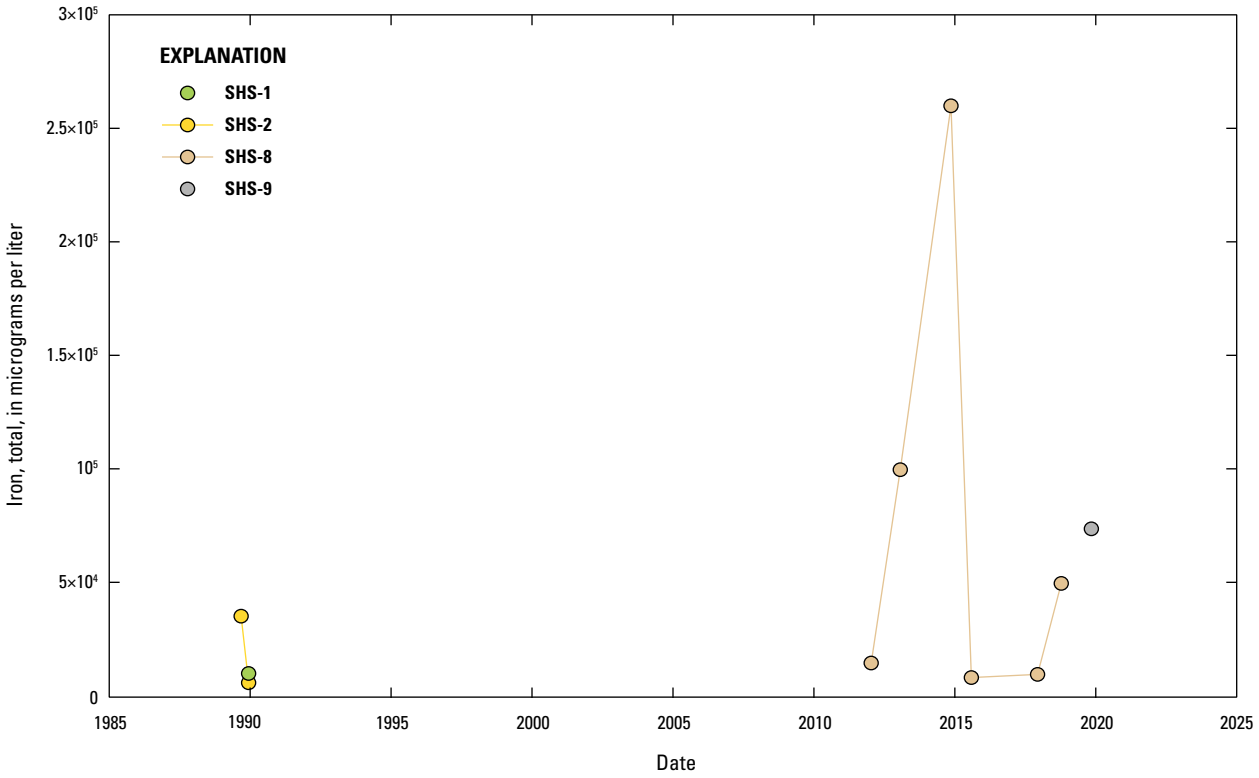


Figure 54. Total iron concentration over time at Southern Heights Subdivision (SHS) monitoring wells south of U.S. Highway 64 near Farmington, New Mexico. SHS wells were monitored by the Giant Bloomfield Refinery. Locations of wells are shown in figure 7; data sources are specified in table 8.

BLM-77 was sampled from May 1998 to August 2020 (table 8). At this well, there are no results for dissolved iron. Total chloride concentrations range from 44 mg/L (July 22, 2010) to 170 mg/L (June 8, 1999) (fig. 11). Dissolved manganese concentrations range from no detection above reporting levels (multiple dates) to 29,000 µg/L (December 19, 2013) (fig. 18). Dissolved nickel concentrations range from no detection above reporting levels (multiple dates) to 42 µg/L (June 8, 1999, and November 18, 1999) (fig. 25). Dissolved chromium concentrations range from no detection above reporting levels (multiple dates) to 10 µg/L (September 17, 2015) (fig. 32). *cis*-1,2-Dichloroethene was detected above reporting levels in only two samples (fig. 58): 1.9 µg/L on May 19, 1998, and 1.6 µg/L on June 8, 1999. *trans*-1,2-Dichloroethene was not detected above reporting levels. Tetrachloroethene concentrations range from no detection above reporting levels (multiple dates) to 2 µg/L (May 19, 1998, and September 1, 1998) (fig. 62). Trichloroethene (fig. 65) and vinyl chloride were not detected above reporting levels.

BLM-80 was sampled from December 2005 to August 2020 (table 8). At this well, there are no results for dissolved iron. Total chloride concentrations range from 19 mg/L (December 20, 2005; May 11, 2006; June 26, 2008; and December 19, 2013) to 220 mg/L (December 15, 2016) (fig. 11). Dissolved manganese concentrations range from 340 µg/L (March 4, 2019) to 990 µg/L (December 19, 2013) (fig. 18). Dissolved nickel (fig. 25) and dissolved chromium (fig. 32) were not detected above reporting levels. *cis*-1,2-Dichloroethene was not detected above reporting levels except in one sample with a concentration of 0.4 µg/L on June 23, 2015 (fig. 58). Tetrachloroethene was not detected above reporting levels except in one sample with a concentration of 1 µg/L on March 25, 2016 (fig. 62). The remainder of the organic COCs described in the ROD were not detected above reporting levels.

Database Advantages and Limitations

LAGBRD is a tool that can be leveraged to provide a deeper understanding of groundwater contamination and the background geochemistry at the Lee Acres Landfill and GBR. While not an interpretive product, the data within LAGBRD could be used in future analyses, such as a comparative study of the groundwater chemistry at both sites that accounts for spatial and temporal trends. This type of study could provide insight into the sources of contamination in groundwater at these sites. A notable benefit of having water chemistry results compiled in LAGBRD is the ease with which chemical trends in groundwater could be reviewed and analyzed.

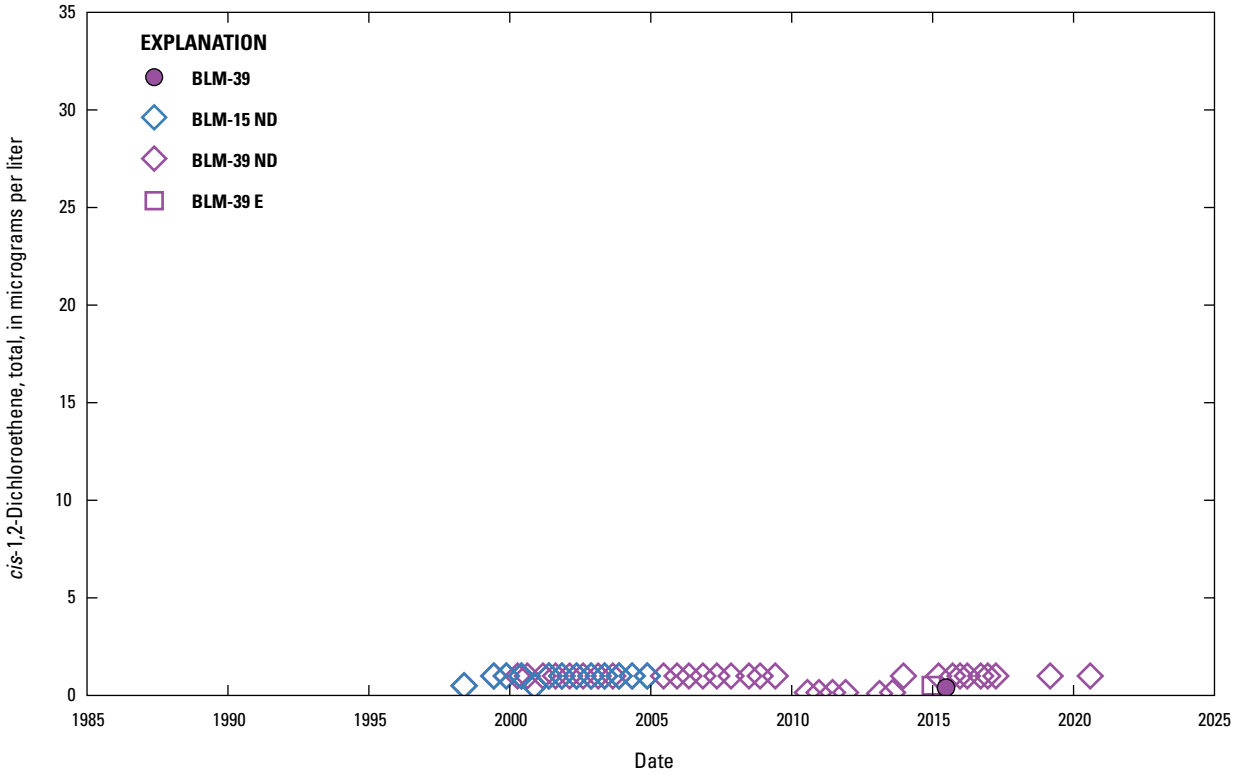


Figure 55. *cis*-1,2-Dichloroethene concentration over time at Bureau of Land Management (BLM) monitoring wells upgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 3; data sources are specified in table 8. As shown in table 1, *cis*-1,2-dichloroethene was not detected in the alluvial aquifer background samples collected at the Lee Acres Landfill (Roy F. Weston, Inc., 1995), and the cleanup level for *cis*-1,2-dichloroethene at the Lee Acres Landfill is 70 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

A difficulty encountered during the compilation of data within LAGBRD is related to the disparity among sampling methods, analytical methods, and record keeping of data from different sources. For instance, regular groundwater samples collected at the Lee Acres Landfill are analyzed for dissolved metals, whereas GBR has analyzed samples for total (unfiltered) metals since 2011; hence, these results are not comparable. Additionally, regular sampling at the Lee Acres Landfill does not include sampling and analysis of iron, a metal that is regularly detected at elevated levels at GBR. Future work could benefit from coordination of sampling protocols between the Lee Acres Landfill and GBR.

Finally, manganese, which at BLM wells is the COC that consistently exceeds cleanup goals described in the ROD (EPA, 2004), is sensitive to reducing conditions (McMahon and others, 2019). The cleanup goal for manganese (table 1) is 346 µg/L. Expanding the sampling plan at Lee Acres Landfill to include more redox sensitive species could lead to a better understanding of manganese mobility in groundwater at the Lee Acres Landfill.

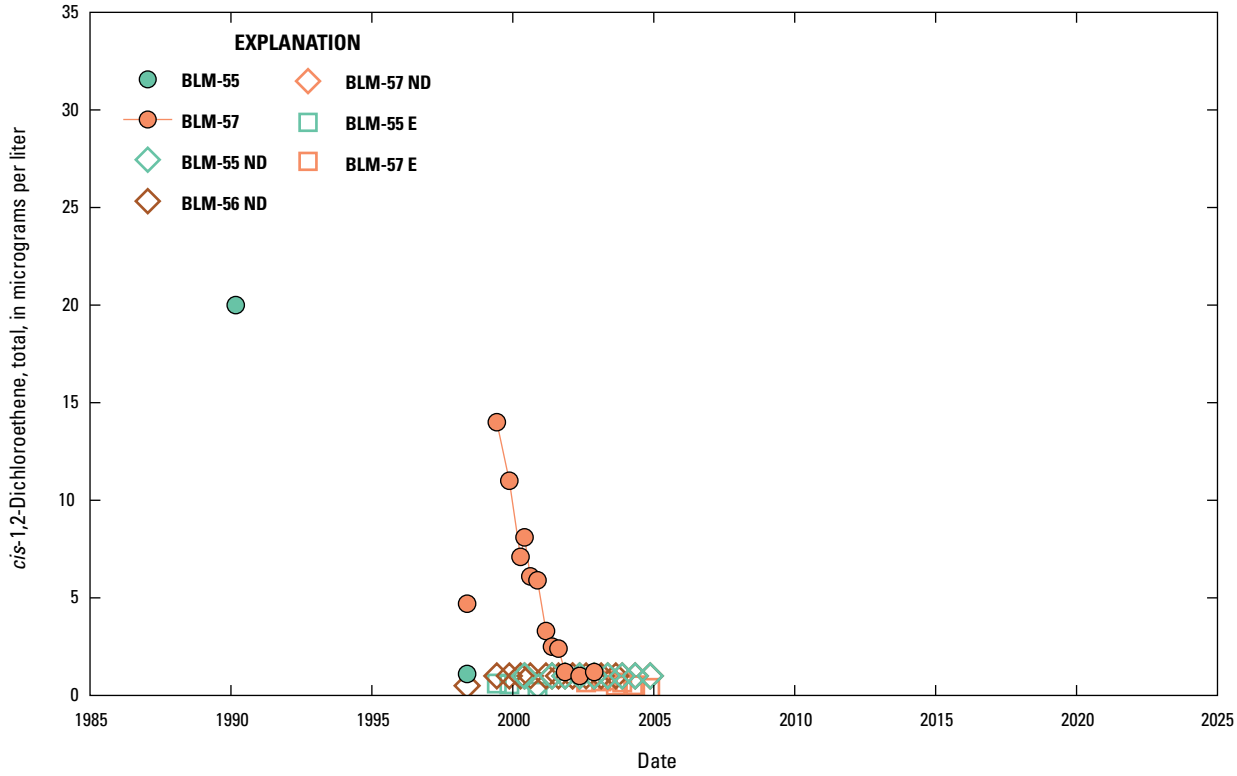


Figure 56. *cis*-1,2-Dichloroethene concentration over time at Bureau of Land Management (BLM) monitoring wells within the boundary of the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, *cis*-1,2-dichloroethene was not detected in the alluvial aquifer background samples collected at the Lee Acres Landfill (Roy F. Weston, Inc., 1995), and the cleanup level for *cis*-1,2-dichloroethene at the Lee Acres Landfill is 70 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

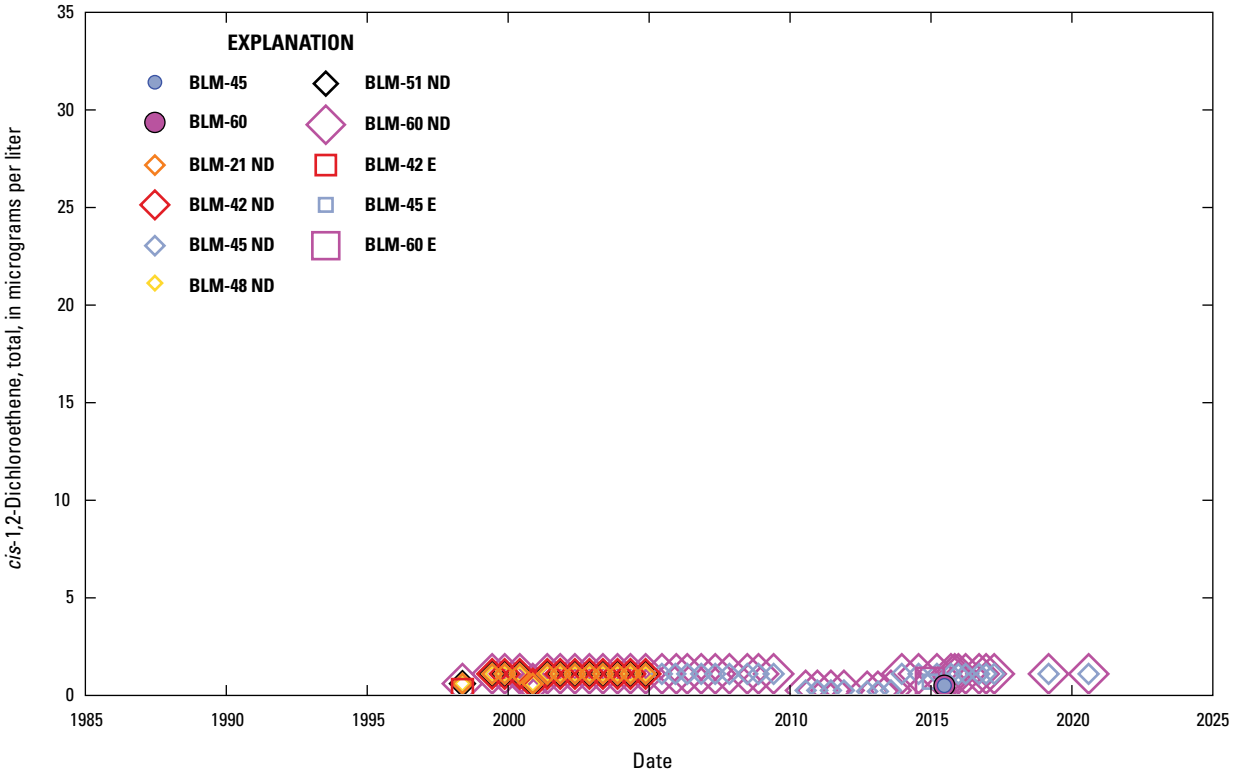


Figure 57. *cis*-1,2-Dichloroethene concentration over time at Bureau of Land Management (BLM) monitoring wells adjacent to the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, *cis*-1,2-dichloroethene was not detected in the alluvial aquifer background samples collected at the Lee Acres Landfill (Roy F. Weston, Inc., 1995), and the cleanup level for *cis*-1,2-dichloroethene at the Lee Acres Landfill is 70 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

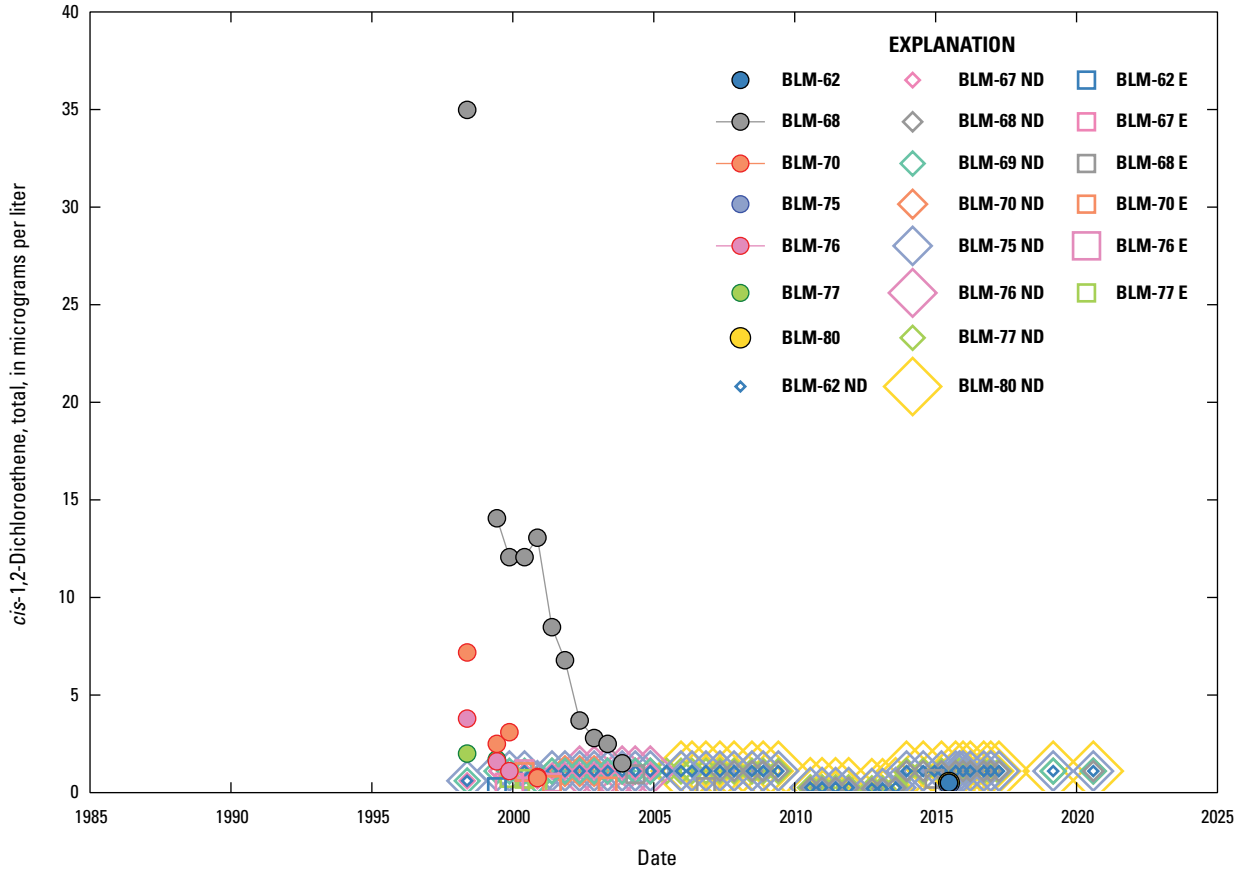


Figure 58. *cis*-1,2-Dichloroethene concentration over time at Bureau of Land Management (BLM) monitoring wells directly downgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8. As shown in table 1, *cis*-1,2-dichloroethene was not detected in the alluvial aquifer background samples collected at the Lee Acres Landfill (Roy F. Weston, Inc., 1995), and the cleanup level for *cis*-1,2-dichloroethene at the Lee Acres Landfill is 70 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

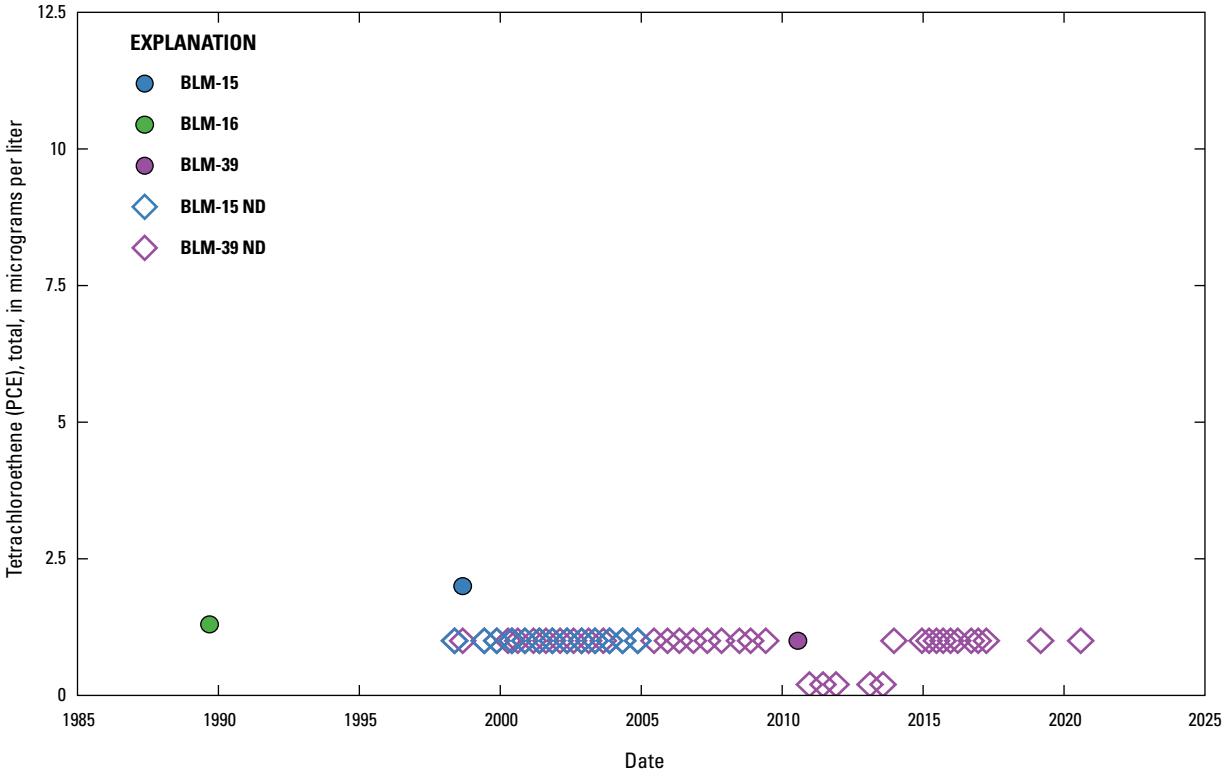


Figure 59. Tetrachloroethene (perchloroethylene [PCE]) concentration over time at Bureau of Land Management (BLM) monitoring wells upgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 3; data sources are specified in table 8. As shown in table 1, tetrachloroethene was not detected in the alluvial aquifer background samples collected at the Lee Acres Landfill (Roy F. Weston, Inc., 1995), and the cleanup level for tetrachloroethene at the Lee Acres Landfill is 5 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits.

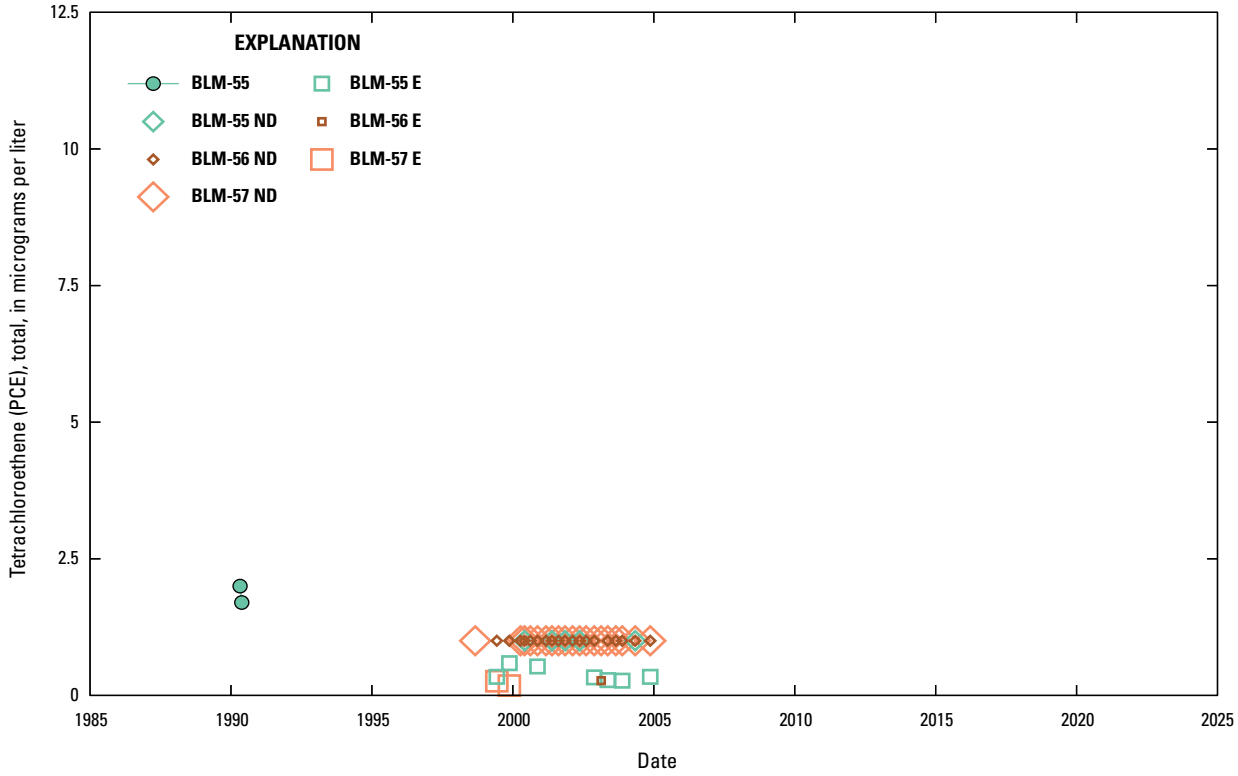


Figure 60. Tetrachloroethene (perchloroethylene [PCE]) concentration over time at Bureau of Land Management (BLM) monitoring wells within the boundary of the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, tetrachloroethene was not detected in the alluvial aquifer background samples collected at the Lee Acres Landfill (Roy F. Weston, Inc., 1995), and the cleanup level for tetrachloroethene at the Lee Acres Landfill is 5 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

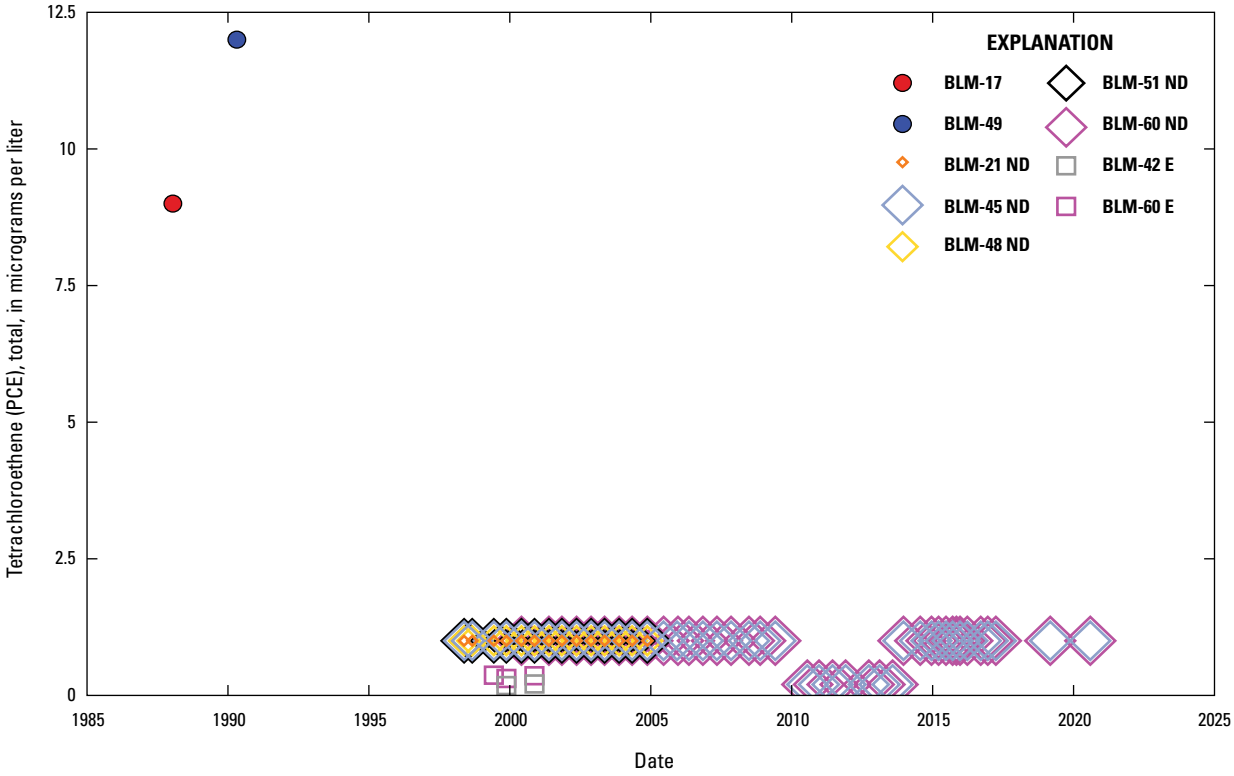


Figure 61. Tetrachloroethene (perchloroethylene [PCE]) concentration over time at Bureau of Land Management (BLM) monitoring wells adjacent to the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, tetrachloroethene was not detected in the alluvial aquifer background samples collected at the Lee Acres Landfill (Roy F. Weston, Inc., 1995), and the cleanup level for tetrachloroethene at the Lee Acres Landfill is 5 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

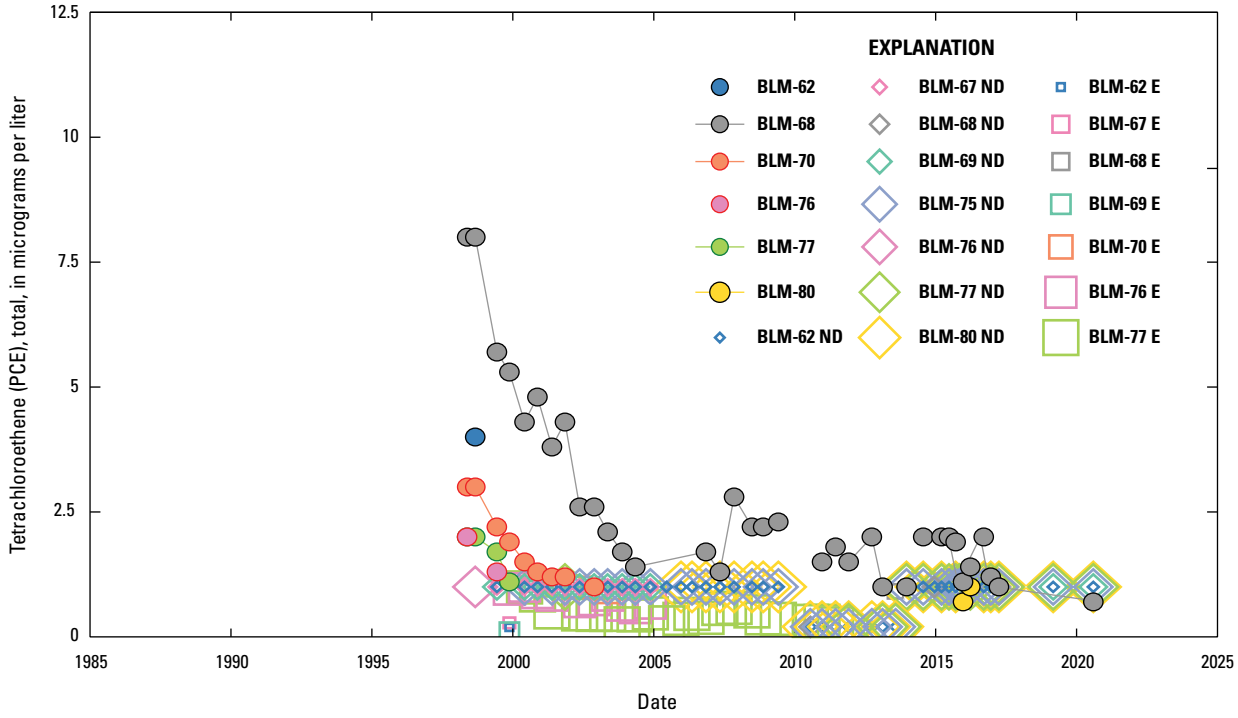


Figure 62. Tetrachloroethene (perchloroethylene [PCE]) concentration over time at Bureau of Land Management (BLM) monitoring wells directly downgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8. As shown in table 1, tetrachloroethene was not detected in the alluvial aquifer background samples collected at the Lee Acres Landfill (Roy F. Weston, Inc., 1995), and the cleanup level for tetrachloroethene at the Lee Acres Landfill is 5 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

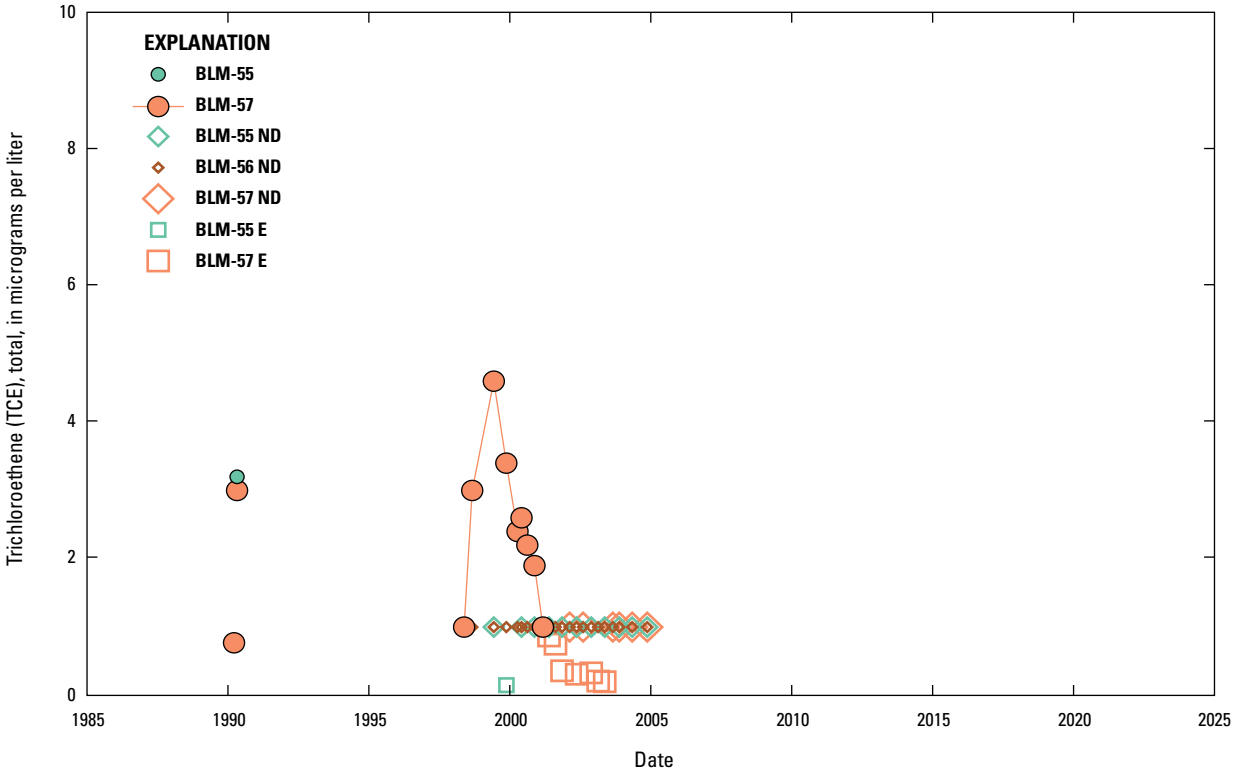


Figure 63. Trichloroethene (TCE) concentration over time at Bureau of Land Management (BLM) monitoring wells within the boundary of the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, trichloroethene was eliminated as a background contaminant in the alluvial aquifer at the Lee Acres Landfill (Roy F. Weston, Inc., 1995), and the cleanup level for trichloroethene at the Lee Acres Landfill is 5 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

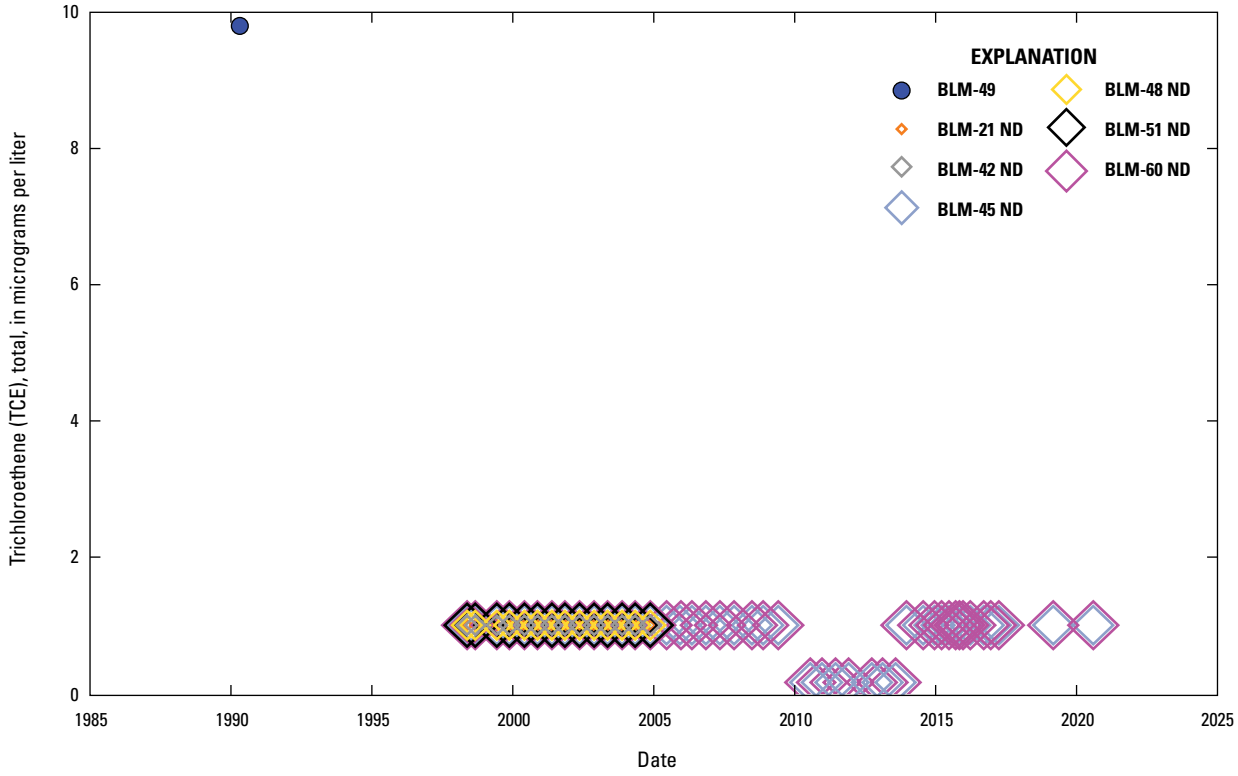


Figure 64. Trichloroethene (TCE) concentration over time at Bureau of Land Management (BLM) monitoring wells adjacent to the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, trichloroethene was eliminated as a background contaminant in the alluvial aquifer at the Lee Acres Landfill (Roy F. Weston, Inc., 1995), and the cleanup level for trichloroethene at the Lee Acres Landfill is 5 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits.

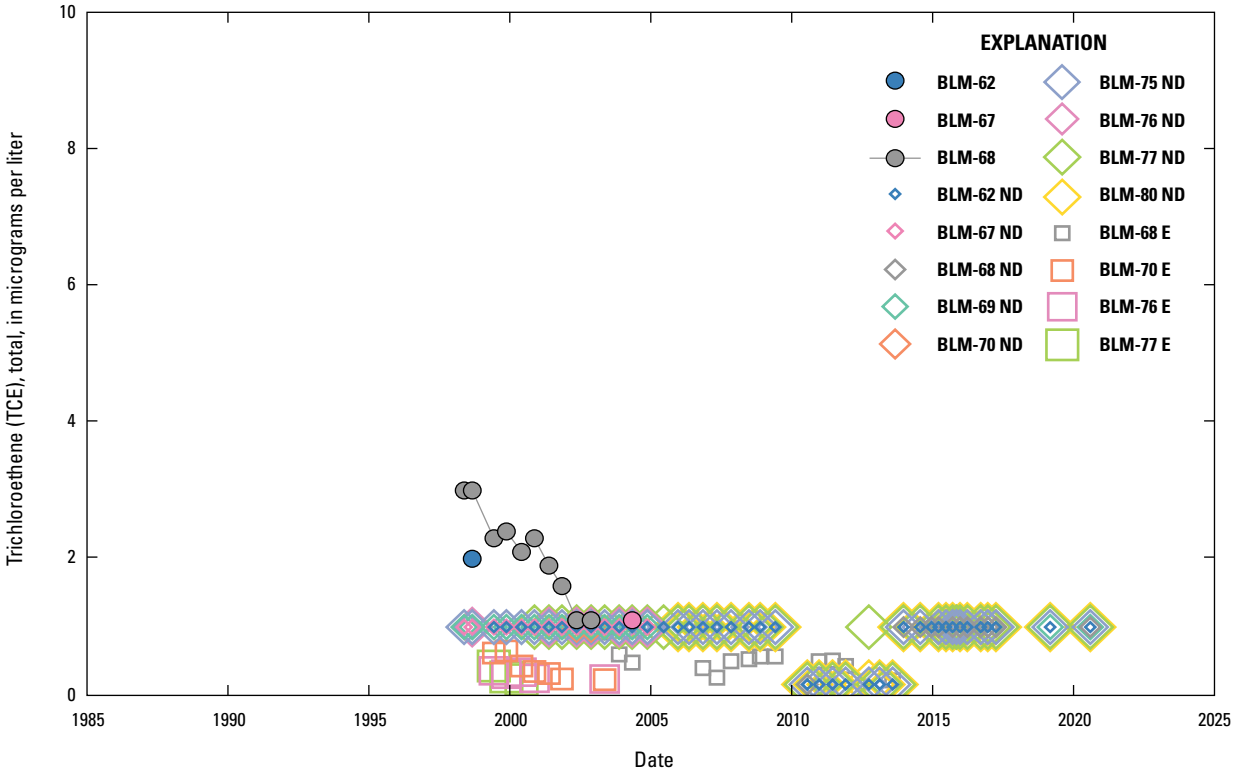


Figure 65. Trichloroethene (TCE) concentration over time at Bureau of Land Management (BLM) monitoring wells directly downgradient from the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 5; data sources are specified in table 8. As shown in table 1, trichloroethene was eliminated as a background contaminant in the alluvial aquifer at the Lee Acres Landfill (Roy F. Weston, Inc., 1995), and the cleanup level for trichloroethene at the Lee Acres Landfill is 5 micrograms per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

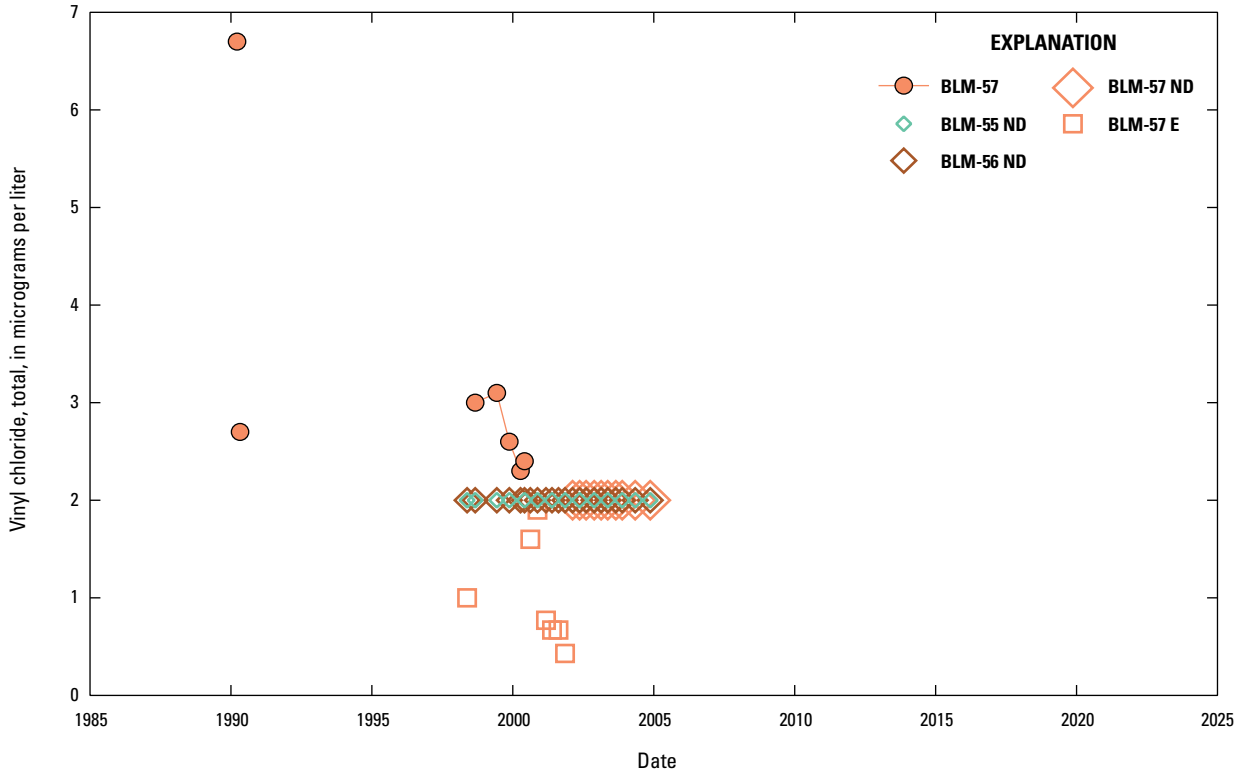


Figure 66. Vinyl chloride concentration over time at Bureau of Land Management (BLM) monitoring wells within the boundary of the Lee Acres Landfill near Farmington, New Mexico. Locations of wells are shown in figure 4; data sources are specified in table 8. As shown in table 1, vinyl chloride was not detected in the alluvial aquifer background samples collected at the Lee Acres Landfill (Roy F. Weston, Inc., 1995), and the cleanup level for vinyl chloride at the Lee Acres Landfill is 1 microgram per liter (U.S. Environmental Protection Agency, 2004). ND, no detection above method detection limits; E, estimated results.

Summary

At the Lee Acres Landfill and the Giant Bloomfield Refinery (GBR), near Farmington, New Mexico, the long history of groundwater monitoring and involvement of various parties have led to a variety of disparate data sources in several formats. The Lee Acres-Giant Bloomfield Refinery Database (LAGBRD) is a Microsoft Access database that is a compilation of publicly available water quality and groundwater elevation data from the Lee Acres Landfill and GBR sites that span from 1985, when awareness was increasing regarding contamination from liquid waste lagoons at the landfill and fuel releases at the refinery, to 2020. Sources of data represented in LAGBRD include the U.S. Geological Survey National Water Information System, data collected by GBR for monitoring required by the New Mexico Oil Conservation Division, and site investigation data from both the landfill and the refinery.

This report discusses the purpose and structure of LAGBRD and contains maps of sampling locations and site features at the Lee Acres Landfill and GBR. This report also contains time-series plots created using LAGBRD data including total chloride, chloride of unknown filtration status, dissolved manganese, dissolved nickel, dissolved chromium, dissolved iron, *cis*-1,2-dichloroethene, tetrachloroethene, trichloroethene, and vinyl chloride, as well as time-series plots of total manganese, total nickel, total chromium, and total iron in GBR wells where dissolved metals were not consistently measured. The figures in this report can be used for reference by site managers to visualize the spatial and temporal relationships of data from the Lee Acres Landfill and GBR. However, this report does not interpret the data or explain why several metals continue to exceed regional background levels in monitoring wells at these sites. Dissolved manganese concentrations in several Bureau of Land Management and GBR monitoring wells downgradient from the landfill continue to be elevated relative to alluvial aquifer background concentrations. Furthermore, dissolved chromium and dissolved iron have exceeded regional background levels at several GBR wells upgradient from refinery operations. LAGBRD is a tool that can be leveraged for future work related to groundwater contamination and the background geochemistry at these sites.

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