RECEIVED
5/31/2013

**Zach Toellner**
HES Professional

**Marathon Oil Company**
743 Horizon Court
Suite 220
Telephone 970.244.5723 Mobile 970.260.0772
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Carlos Lujan
Colorado Oil and Gas Conservation Commission
796 Megan Ave., Suite 201
Rifle, CO 81650

**Re: 596-32C Pond, Facility ID 421284, REM#7734**

May 31, 2013

Dear Mr. Lujan:

Marathon Oil Company respectfully submits the attached Form 4 – Sundry Notice, updated Form 27 – Remediation Work Plan, Investigation and Remediation Work Plan, and related appendices for your review.

Marathon is currently engaged in response and remediation activities at the 596-32C Pond, and seeks feedback / approval of this plan in a timely manner to facilitate further response activities.

Please contact me with any questions, comments, or concerns.

Sincerely,

Zach Toellner
HES Professional

Attached:

Form 4 - Sundry Notice
Form 27 - Remediation Work Plan
Investigation and Remediation Work Plan

FORM 27 Rev 6/99

#7734

# State of Colorado
# Oil and Gas Conservation Commission

1120 Lincoln Street, Suite 801, Denver, Colorado 80203 (303)894-2100 Fax:(303)894-2109

FOR OGCC USE ONLY

OGCC Employee:
☐ Spill ☐ Complaint
☐ Inspection ☐ NOAV
Tracking No:

## SITE INVESTIGATION AND REMEDIATION WORKPLAN

This form shall be submitted to the Director for approval prior to the initiation of site investigation and remediation activities. Form 27 is intended to be used whenever possible. Additional documentation will be required when large volumes of soil and groundwater have been impacted or involve large facilities with multiple source areas. See Rule 910. Attach as many pages as needed to fully describe the proposed work.

## CAUSE OF CONDITION BEING INVESTIGATED AND REMEDIATED

☑ Spill or Release ☐ Plug & Abandon ☐ Central Facility Closure ☐ Site/Facility Closure ☐ Other (describe): Impoundment Liner Damage

OGCC Operator Number: 53650
Name of Operator: Marathon Oil
Address: 743 Horizon Court, Suite 220
City: Grand Junction State: CO Zip: 81506

Contact Name and Telephone:
Zach Toellner
No: 970-244-5723
Fax: 970-245-6287

API Number: NA
County: Garfield
Facility Name: 596-32C Pond
Facility Number: 421284
Well Name: NA
Well Number: NA
Location: (QtrQtr, Sec, Twp, Rng, Meridian): SESW Sec 32, T5S, R96W, 6th P.M. Latitude: 39.5677 Longitude: -108.1935

## TECHNICAL CONDITIONS

Type of Waste Causing Impact (crude oil, condensate, produced water, etc): Produced water

**Site Conditions:** Is location within a sensitive area (according to Rule 901e)? ☑ Y ☐ N If yes, attach evaluation.

Adjacent land use (cultivated, irrigated, dry land farming, industrial, residential, etc.): See attached Form 2a

Soil type, if not previously identified on Form 2A or Federal Surface Use Plan: See attached Form 2a

Potential receptors (water wells within 1/4 mi, surface waters, etc.): See attached Form 2a

**Description of Impact** (if previously provided, refer to that form or document):

| Impacted Media (check): | Extent of Impact: | How Determined: |
|---|---|---|
| ☑ Soils | See attached remediation work plan. | Soil samples collected below the liner indicated some impact. |
| ☐ Vegetation | | |
| ☐ Groundwater | | |
| ☐ Surface Water | | |

## REMEDIATION WORKPLAN

**Describe initial action taken** (if previously provided, refer to that form or document):

Marathon personnel immediately began pumping water from both the pond and the leak detection system, and both were drawn down until damage was visible above the water line. A portion of the liner was cut out to allow assessment of the soil below. Onsite and laboratory analysis indicated some impacted soil below the liner. Marathon is currently working to assess the full extent of imapcted soil to continue planning for remediation. (See Form 19)

**Describe how source is to be removed:**

Sections of liner may be pulled back or removed, and impacted soil will be removed for remediation by hand or mechanized equipment as appropriate.

**Describe how remediation of existing impacts is to be accomplished, including removal and disposal at an injection well or licensed facility, land treatment on site, removal of impacted groundwater, insitu bioremediation, burning of oily vegetation, etc.:**

Inert material will be added to reduce total concentrations of Table 910-1 constiutents to levels consistent with background and acceptable to COGCC, soil may be landfarmed onsite in a lined area of the pad, or soil may be removed and disposed of at an approved facility. As interim assessments are made, Marathon will continue to work with the COGCC to determine appropriate remediation efforts.

**Submit Page 2 with Page 1**

MAY 31, 2013
Form 27 update + workplan

REM # 7734

FORM 27 Rev 6/99

**State of Colorado**
**Oil and Gas Conservation Commission**
1120 Lincoln Street, Suite 801, Denver, Colorado 80203
(303)894-2100 Fax:(303)894-2109

Page 2

**REMEDIATION WORKPLAN (Cont.)**

Tracking Number: _____
Name of Operator: _____
OGCC Operator No: _____
Received Date: _____
Well Name & No: _____
Facility Name & No: 596-32C Pond

OGCC Employee:

**If groundwater has been impacted, describe proposed monitoring plan** (# of wells or sample points, sampling schedule, analytical methods, etc.):

No impact to groundwater or surfacewater has been indicated by sampling conducted to date. Marathon intends to install 4 groundwater monitoring wells surrounding the facility. Additionally, Marathon will continue to sample surface water (Little Creek) and look for potential water daylighting down gradient from the facility for the duration of response and remediation acitvities. See attached work plan.

**Describe reclamation plan.** Discuss existing and new grade recontouring; method and testing of compaction alleviation; and reseeding program, including location of new seed, seed mix and noxious weed prevention. Attach diagram or drawing. Use additional sheet for description if required.

N/A

**Attach samples and analytical results taken to verify remediation of impacts. Show locations of samples on an onsite schematic or drawing.**

**Is further site investigation required?** ☑ Y ☐ N If yes, describe:

Interim site investigation may be conducted as Marathon continues to withdraw water from the pond, as discussed in the work plan. Once the pond is empty, a more comprehensive investigation will take place to delineate the full extent of impacted soils.

**Final disposition of E&P waste** (landtreated and disposed onsite, name of licensed disposal facility, recycling, reuse, etc.):

Any impacted soil will be removed and mitigated as appropriate, and Marathon will seek approval from the COGCC after completion of an interim investigation. An inert material may be added to reduce total concentrations of Table 910-1 constiutents to levels consistent with background and acceptable to COGCC, soil may be removed and disposed of at an approved facility, or soil may be remediated onsite on a lined area of the location.

## IMPLEMENTATION SCHEDULE

| | | |
|---|---|---|
| Date Site Investigation Began: 4/12/2013 | Date Site Investigation Completed: ongoing | Date Remediation Plan Submitted: 5/31/13 |
| Remediation Start Date: | Anticipated Completion Date: | Actual Completion Date: TBD |

I hereby certify that the statements made in this form are, to the best of my knowledge, true, correct, and complete.

Print Name: Zach Toellner Signed: Z T

Title: HES Professional Date: 5/31/2013

OGCC Approved: Carly Bilyeu Title: EPS NW Region Date: 07/25/2013

# WORK PLAN

## Investigation and Remediation of 596-32C Produced Water Pond, Facility #421284, COGCC REM #7734

WORK PLAN

**Submitted To:** Marathon Oil Company
743 Horizon Court, Suite 220
Grand Junction, Colorado 81506

**Submitted By:** Golder Associates Inc.
44 Union Boulevard, Suite 300
Lakewood, Colorado 80228

**Distribution of Hard Copy Documents:**
2 copies – Colorado Oil and Gas Conservation Commission
1 copy – Marathon Oil Company
1 copy – Golder Associates Inc.

**May 31, 2013** **130-0253**

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## 1.0 INTRODUCTION

This Work Plan is issued for the Marathon Oil Company (MOC) 596-32C produced water pond located in Garfield County, Colorado, as shown on Figure 1 and referred to herein as the 32C pond. As a result of a monthly inspection, water within the 32C pond leak detection system was reported to MOC's local leadership on April 12, 2013. As previously reported to the Colorado Oil and Gas Conservation Commission (COGCC), MOC has taken initial steps in responding to the 32C pond liner damage, including submittal of a Spill/Release Report (Form 19) and an initial Site Investigation and Remediation Work Plan (Form 27). In addition, MOC response activities at the 32C pond are summarized in a May 23, 2013 letter to the COGCC, and these MOC response activities and planned investigations near the 32C facility were discussed with the COGCC on a May 24, 2013 conference call.

*Photo 1 – 596-32C Facility*

The objectives of the activities described in this Work Plan are to investigate and remediate any areas affected by the 32C pond liner damage in a timely and safe manner. This Work Plan describes the currently anticipated 32C scope of work and reviews work performed at the site since MOC's initial submittals to the COGCC. The anticipated 32C scope of work includes assessing the nature and extent of contamination, installation of groundwater monitoring wells, and evaluation of potential remediation efforts at the site.

On-going assessment of the 32C pond is being performed by MOC and Golder Associates Inc. (Golder) as an iterative process, with investigative results dictating subsequent steps in the investigation. As appropriate, this Work Plan will be updated throughout the project to include then-current data and corresponding changes in the investigative strategy. In connection with the liner breach investigation, MOC and Golder will inform the COGCC of our findings and will collaborate with the COGCC regarding appropriate actions in addressing any contamination that may be present.

### 1.1 Status of 32C Pond

As shown on the site plan provided in Appendix A-1, the 32C pond is 324 feet long, 120 feet wide, and approximately 15 feet deep. The as-built drawing provided in Appendix A-2 indicates a 32C pond capacity of 42,272 barrels. The 32C pond is underlain by primary and secondary 60-mil geomembrane liners, geonet layers between the liners and below the secondary liner, and layers of geotextile fabric above and below the lower geonet layer. This pond was excavated into sedimentary rock of the Uinta

Formation, which is up to approximately 1,000 feet in the region and is composed of silty sandstone, siltstone, and marlstone.

Although the 32C pond is currently permitted under COGCC Form 15, MOC plans to permit the pond as a centralized E&P waste management facility (Form 28). This permitting is being performed in accordance with COGCC requirements, which include submittal of pertinent geologic data, hydrologic data, groundwater monitoring results, and surface water monitoring results. The Geology Report prepared by Olsson and provided in Appendix A-3 includes background information pertinent to the 32C investigation, including site topography, soils, bedrock geology, geologic structure, surface water features, groundwater occurrence, aquifer properties, vicinity water wells, groundwater quality, and potential for surface water and groundwater impacts.

It is anticipated that data collection and monitoring performed for the produced water release investigation will be used in the Form 28 permitting process. For example, groundwater monitoring wells will be designed and installed so as to accomplish the objectives of both the soil remediation program and the Form 28 permitting, as described in Section 3.3.

## 1.2 Report Organization

In addition to the above summary of the status of the 32C pond, investigative activities performed to-date are described in Section 2, and planned investigative activities are described in Section 3 of this Work Plan. Finally, the currently envisioned contamination remediation/mitigation approach is outlined in Section 4. Documents and data used in project planning are provided in the appendices.

## 2.0 INVESTIGATIONS TO-DATE

Golder's initial on-site reconnaissance and investigation planning were performed by the Golder Project Manager and Project Director on May 15, 2013. Other investigations performed to-date in connection with the 32C pond liner damage are described in the following sections.

### 2.1 32C Pond Data Evaluations

Monthly water quality analyses have been performed for the 32C Pond, as detailed in Appendix A-4. April 2013 analyses of 32C pond produced water included the following key organic parameters: 119,000 micrograms per liter (µg/L) gasoline range organic petroleum hydrocarbons (GRO), 25,000 µg/L diesel range organic petroleum hydrocarbons (DRO), 17,500 µg/L benzene, 33,800 µg/L toluene, 922 µg/L ethylbenzene, and 12,500 µg/L total xylenes.

To allow water quality comparisons for samples from the 32C pond and leak detection system, MOC sampled the 32C pond leak detection system on April 12, 2013. As detailed in Appendix A-5, organic constituent analyses for the leak detection system water included 11,100 µg/L GRO, 11,000 µg/L DRO, 840 µg/L benzene, 1,890 µg/L toluene, 83 µg/L ethylbenzene, and 2,270 µg/L total xylenes. Although the water in the leak detection system was diluted relative to the produced water in the 32C pond, the leak detection system water had a similar chemical signature and is assumed to have included produced water from the pond.

### 2.2 Surface Water Sampling

On April 24, 2013, MOC personnel and a contracted environmental technician inspected the area surrounding the 32C pad and looked for seeps or springs, with the intention of sampling if any were found. Except for a spring located adjacent to Little Creek (approximately 4,000 feet north from the 32C pond, as shown on the Figure in Appendix B), no seeps or springs were found between the 32C pad and Little Creek to the northwest and House Log Gulch to the southeast.

As a precautionary measure, MOC had the contracted environmental technician sample Little Creek both upstream and downstream of 32C, and the noted spring adjacent to Little Creek was also sampled. Additional surface water sampling events were performed on May 10, 2013 and May 13, 2013, as detailed in the surface water analytical reports provided as Appendices B-1, B-2, and B-3. Based on monitoring performed at the four surface water sample locations shown on the Figure in Appendix B, no impacts to Little Creek are indicated.

### 2.3 32C Pond Liner and Subgrade Investigations

Immediately after MOC local leadership became aware of water being present within the 32C pond leak detection system, MOC began pumping operations from the 32C pond and from the pond's leak detection system to lower the water level in the pond and to understand the recharge rate within the interstitial

space between the primary and secondary liners. On April 23, 2013, MOC personnel located several holes in the pond's top liner, and continued pumping operations to reduce the water level below the holes observed. On the afternoon of April 24, 2013, the water level in the pond had subsided to below the holes, so MOC personnel were able to visually inspect the damage. It was noted that at least one of the nine holes identified at that time penetrated through both the primary and secondary liners. MOC continued to pump water from the pond and monitor the leak detection system for recharge. It was noted on April 25, 2013 that the pond's leak detection system had been pumped dry, and that further recharge of the leak detection system was not apparent.

After the water level in the pond allowed for sufficient freeboard, MOC scheduled a professional liner company to perform an assessment of the liner system integrity. On May 8 and 9, 2013, MOC contracted a local liner installation and repair company to assist in assessing and repairing damage to the liner. Twelve holes were confirmed through the top liner, seven of which punctured through the bottom liner. The penetrations in the bottom liner varied in size from nail-like holes to gashes ¼" by 2".

During the liner system assessment, a third party environmental contractor sampled the geologic materials present below the pond. Initial analyses (Appendix C-1) confirmed the presence of volatile organic compounds (VOCs) below the liner system in five sample holes excavated up to 4 feet horizontally away from the liner and 3.5 feet vertically. These sample holes encountered approximately 0.3 feet of soil placed as liner bedding material, which is underlain by sedimentary rock. The maximum VOC concentration of 219.4 parts per million (ppm) was present in the sample collected at a depth of 3.5 feet. As noted below, laboratory analyses on these samples indicated attenuation of contaminant concentrations with increasing depth, with the lowest concentrations measured in the samples collected at depths of 3.5 feet and 4 feet. Recent review indicates that sample collection and sample preservation procedures used for this initial soil sampling event may have contributed to these variations in sample results.

Confirmatory analytical laboratory testing of these five subgrade samples was performed, as detailed in Appendix C-2. Although benzene, toluene, ethylbenzene, and total xylenes (BTEX) were not detected in these subgrade samples, the following analytical results exceeded COGCC Table 910-1 standards.

- Total volatile and extractable petroleum hydrocarbons (TPH) – TPH concentrations in the subgrade materials ranged from 715 to 2,883 milligrams per kilogram (mg/kg), and averaged 1,985 mg/kg. The COGCC Table 910-1 standard for TPH is 500 mg/kg. It is noted that the lowest TPH concentrations were measured in the samples collected at depths of 3.5 feet and 4 feet.
- Sodium adsorption ratio (SAR) – SAR values in the subgrade materials ranged from 38.7 to 48.4, and averaged 44.9. The COGCC Table 910-1 standard for SAR is 12.

## 2.4 Test Pit Excavations

On May 20, 2013, a trackhoe was used to excavate two test pits immediately west of the 32C pond perimeter fence near the liner breach area, as shown on Figure 2. These investigative activities are summarized in the Daily Report provided as Appendix D-1, and logs of the test pits are included in Appendix D-2. Weathered silty sandstone was encountered in both test pits to a depth of 4 feet below ground surface (bgs), and trackhoe refusal was encountered in well indurated shale at depths of 4.5 to 5 feet bgs. The well indurated bedrock present in the TP-1 excavation is shown in Photo 2. Deeper trenching into this well indurated bedrock was not possible with the excavation equipment that was available at that time.

*Photo 2 – Well Indurated Bedrock in TP-1*

After excavating the initial test pit to a depth of 1 foot bgs, a photo-ionization detector (PID) was used to screen the excavated materials for VOCs. Similar PID screening of excavated materials was performed at representative depth intervals in both test pits, and all PID measurements were zero. Based on PID screening results, sample odors, and visual observations, it was concluded that contaminated materials were not present in the test pits.

## 2.5 Geologic Mapping

Golder performed initial geologic mapping of the 32C pond area on May 21, 2013 in support of development of the site hydrogeologic conceptual model, siting of the groundwater monitoring well network, and Form 28 permitting for the 32C facility. Geologic structure mapped at the site is shown on Figure 2. This geologic mapping resulted in the following observations and conclusions.

- Bedrock exposed in the excavated slopes adjacent to the 32C pond primarily consists of interbedded: 1) fine to medium grained silty sandstone, 2) marlstone, 3) siltstone, and 4) claystone. These sedimentary rocks are consistent with the Uinta Formation units present in the region.
- Bedrock weathering and induration vary across the mapped areas, but generally range from highly weathered (particularly near the exposed surfaces) to slightly weathered in the more cemented zones.

- Although bedding thicknesses are variable across the mapped areas, bedding tends to be relatively massive in the bedrock units present in the tall cut slope located east of the pond, such as the sandstone shown in Photo 3.
- Of the 13 locations where geologic structure was measured, bedrock bedding is relatively flat-laying at eight locations east of the pond, with beds dipping an average 10 degrees. At the five locations mapped northwest and southwest of the pond, the beds dip an average of 30 degrees. The contact between the sub-horizontal bedding and the steeper dipping strata is shown on Photo 4, which was taken south of the tank containment ring.

*Photo 3 – Massively Bedded Sandstone East of the 32C Pond*

*Photo 4 – Geologic Contact South of Tank Containment Ring*

Subsequent sections of this Work Plan describe the implications of these geologic mapping observations and conclusions on geologic containment of produced water from the pond, potential contaminant migration pathways, and site remediation.

## 3.0 PLANNED INVESTIGATIVE ACTIVITIES

Golder field work performed in support of this project will be in accordance with the Golder Health and Safety Plan and MOC health and safety guidance and requirements, which are issued separately from this Work Plan. Golder investigative activities will be documented on Daily Reports and by representative photographs. Documentation of the field investigations, evaluation of the investigative findings, descriptions of the site remediation activities will be compiled in reports to be submitted to the COGCC.

### 3.1 Surface Water Sampling

As described above, except for the spring noted in Section 2.3, no seeps or springs are present between the 32C pad and Little Creek to the northwest and House Log Gulch to the southeast. However, as a precautionary measure, surface water sampling of Little Creek is continuing on a weekly basis, with collection of one sample upstream and one sample downstream from 32C. This sampling will continue until otherwise agreed with the COGCC, as long as Little Creek continues to flow. Surface water sampling will be performed based on the Golder Technical Procedure provided in Appendix E-1, and analytical laboratory testing of surface water samples will be similar to that shown in Appendix B-3.

In connection with the weekly sampling of Little Creek, a MOC representative will: 1) inspect the area surrounding the 32C pad for seeps or springs; and 2) inspect the 32C liner system for any features that would be pertinent to the current investigation. These supplemental inspections will be performed weekly.

### 3.2 Investigatory Drilling

In support of groundwater monitoring well installation (Section 3.3), the bedrock at two locations will be air cored, resulting in nominal 3-inch diameter rock core for geologic examination. It is currently anticipated that borings MW-1 and MW-3 shown on Figure 3 will be air cored and MW-2 and MW-4 will be drilled using air rotary methods. The following major activities are planned at MW-1 and MW-3.

1. Drill a 7 7/8-inch diameter boring to bedrock using a tricone bit, and set temporary 6-inch surface casing.
2. Air core a 4 5/8-inch diameter boring to the desired depth, which is currently assumed to be approximately 300 feet bgs.
3. Collect the core samples using two complete split tube assemblies, which will allow continuous drilling while the core is being logged.
4. Ream the boring to 5 5/8-inch diameter in preparation for well installation.

Collecting drill cuttings at 5-foot intervals will allow geologic logging of bedrock at MW-2 and MW-4. All geologic samples will be screened for possible contamination based on sample odors and visual observations, and geologic samples from MW-3 will also be screened using a PID based on the proximity of this boring to the 32C pond. Rock core drilling and sampling will be performed based on the Golder Technical Procedure provided in Appendix E-2.

## 3.3 Groundwater Monitoring Well Installation and Sampling

It is anticipated that four groundwater monitoring wells will be installed on or near the 32C pad to monitor the uppermost aquifer beneath the site, which exceeds COGCC requirements for Form 28 permitting. Proposed well locations are shown on Figure 3, and the rationale for these groundwater monitoring locations is provided below.

- Although no water wells are located within one mile of the site, groundwater flow is expected to be strongly influenced by topography, with flow from topographically high groundwater recharge areas towards the drainages in the region. As noted in Appendix A-3, the overall groundwater flow direction in the region is expected to be northeastward towards the rim of the Roan Plateau, and northward towards the White River drainage.
- The 32C site is located in a topographically high area, and the nearest drainage is Little Creek located west and northwest from the site. Therefore, a northwestward component of groundwater flow is anticipated from the site towards Little Creek.
- Based on the current understanding of groundwater flow conditions in the site vicinity, MW-1 is designed as a hydraulically upgradient well and will be installed in the southern portion of the pad, and MW-2, MW-3, and MW-4 are designed as downgradient wells to the north.
- MW-2 will monitor potential groundwater flow to the northeast, MW-3 will be located adjacent to the pond liner breach area, and MW-4 will monitor potential groundwater flow to the northwest. Having four instead of three monitoring locations will allow more definitive determinations of groundwater flow directions and hydraulic gradients, and will provide a more robust and conservative groundwater monitoring network at the site.

If initial monitoring suggests other potential groundwater flow directions at the site (such as towards the gully that trends to the northwest from the southwest corner of the 32C pad), this will be discussed with the COGCC, and supplemental groundwater monitoring locations will be recommended.

As previously noted, these groundwater monitoring wells will be designed and installed to accomplish the objectives of both the soil remediation program and Form 28 permitting for the facility. As discussed with the COGCC, it is expected that these monitoring wells will be installed with screen lengths of at least 30 feet. The intent of this well design feature is to allow interception of sufficient fractures within the potentially low transmissivity bedrock units to allow reasonable collection of groundwater samples. Schedule 80, nominal 2-inch diameter PVC well casing and well screens will be used based on the installation depths anticipated.

Monitoring well drilling and installation will be performed based on the Golder Technical Procedure provided in Appendix E-3. In preparation for groundwater sampling of the four monitoring wells, it is anticipated that each well will be developed for approximately two hours using air surging techniques.

Groundwater quality sampling will then be performed based on the Golder Technical Guidance (TG-1.2-20) provided in Appendix E-4. This groundwater sampling will be for all groundwater parameters

specified in COGCC Table 910-1, including: 1) benzene, toluene, ethylbenzene, and total xylenes (BTEX); 2) total dissolved solids (TDS), chlorides, and sulfates; and 3) liquid hydrocarbons including condensate and oil. One duplicate groundwater sample will be analyzed for quality control comparisons, and one trip blank will be analyzed for VOCs. Other considerations for the drilling and sampling program include the following.

- When feasible, disposable sampling equipment will be used to collect samples. To avoid cross contamination, non-dedicated sampling equipment will be thoroughly cleaned prior to initiation of sampling activities, and as otherwise necessary based on TG-1.2-20.
- Samples to be submitted for laboratory testing will be placed in laboratory-supplied containers and stored in a cooler containing ice. Sample chain of custody procedures will be based on TG-1.2-20.
- Analytical testing will be performed by Accutest Mountain States, which maintains Colorado and national accreditation programs. EPA SW 846 analytical testing methods will be used in accordance with COGCC requirements.

## 4.0 SITE REMEDIATION

As described below, any impacted soil not meeting COGCC Table 910-1 standards will be removed and remediated/mitigated as appropriate. Design of the ultimate site remediation program will include the following considerations.

- The 32C pond is underlain by well indurated bedrock units that should mitigate contaminant transport from the liner breach area, and may have provided geologic containment of 32C produced water. In addition, the geologic structure at the site (with beds primarily dipping to the northeast and southeast, as described in Section 2.5) would tend to minimize contaminant transport to the west and northwest towards Little Creek.
- The primary analytical objective of site investigations to-date has been quantification of petroleum hydrocarbon and other organic contaminant concentrations near the 32C pond. Because of the volatile nature of these key parameters, the confirmation sampling approach in connection with site remediation must allow retention of any volatile organic compounds that may be present. Laboratory testing performed to date suggests attenuation of these volatile constituents with increasing depth below the pond.
- The ultimate site remediation program will be designed to: 1) minimize damage to the pond 32C liner system, 2) prevent infiltration of surface water into excavated areas, and 3) minimize the volume of materials excavated in connection with 32C remediation.
- Since the site is underlain by well indurated bedrock, it is not feasible to determine the nature and extent of contamination using trenching, Geoprobing, or augering approaches, which is pertinent to the discussion in Section 4.1.

### 4.1 Removal of Contaminated Materials

Based on the considerations noted above, it is proposed that the nature and extent of site contamination be primarily determined while removing materials contaminated from the pond 32C liner breach, using the following approach.

1. Remove an approximate 10 feet by 10 feet section of the 32C liner system, centered on the liner breach area.
2. Screen the exposed subgrade area for contamination based on PID measurements, sample odors, and visual observations.
3. Based on these sample screening results, excavate outward and downward from the liner breach area until there is no indication of significant contamination, with incremental removal of portions of the liner system as necessary.
4. Perform subgrade confirmation testing (Section 4.2) for comparison with background concentrations (Section 4.3) and COGCC Table 910-1 standards.
5. Address the excavated contaminated materials as described in Section 4.4.

Design of the ultimate site remediation program will include specification of structural backfill in excavated areas, reconstruction of the 32C liner and leak detection system, and liner system integrity testing. Prior to implementation of the ultimate site remediation program, MOC may talk with the COGCC about possible interim actions that could be performed to help estimate the extent and volume of contaminated

materials that will need to be addressed. These possible interim assessment actions would only be implemented with COGCC approval.

Any contaminated materials excavated in connection with 32C interim assessment actions or full-scale contamination removal actions (Section 4.0) will be contained to prevent environmental exposures. Depending on the volume and nature of the contaminated materials, containment options could include roll-off containers, a lined area on the pad with an appropriate cover system, or other containment systems that are appropriately protective.

## 4.2 Subgrade Confirmation Testing

The objectives of the subgrade sampling program are to: 1) obtain samples that are representative of contaminated materials present beneath the 32C pond, thereby characterizing the nature of contamination and allowing evaluation of disposal, remediation, and mitigation options; and 2) obtain samples to confirm that the remaining subgrade materials meet COGCC standards based on Table 910-1 and background concentrations. Sample collection will be based on Golder Technical Procedure *TP-1.2-18, Sampling Surface Soil for Chemical Analysis*, which is provided as Appendix E-5. The anticipated sampling and analysis approach is noted below.

- Where PID screening, sample odors, or visual observations indicate that contaminated materials are present in the excavation, four of the most contaminated samples will be laboratory tested for TVPH and BTEX, which are key constituents of the 32C pond produced water. This will allow correlation of the PID field screening results with the TVPH and BTEX laboratory results and evaluation of the nature and extent of contamination. In addition, a duplicate sample will be laboratory tested for TVPH and BTEX as a quality control sample.
- Based on field screening results, the most contaminated sample will be laboratory tested for all soil parameters specified in COGCC Table 910-1, including: 1) BTEX, TVPH, and total extractable petroleum hydrocarbons (TEPH); 2) the 13 semi-volatile organic compounds (SVOCs) listed in Table 910-1; 3) inorganic parameters (electrical conductivity, sodium adsorption ratio, and pH); 4) the 13 metals listed in Table 910-1; and 5) liquid hydrocarbons including condensate and oil. These analyses will allow evaluation of upper-bound contaminant concentrations.
- Four apparently uncontaminated subgrade samples will be tested for TVPH and BTEX and two apparently uncontaminated subgrade samples will be laboratory tested for all soil parameters specified in COGCC Table 910-1. In addition, a duplicate uncontaminated sample will be laboratory tested for the full Table 910-1 list as a quality control sample. These samples will be collected from below the apparent lower extent of contaminated materials, thereby verifying the extent of contamination.
- When feasible, disposable sampling equipment will be used to collect samples. To avoid cross contamination, non-dedicated sampling equipment will be thoroughly cleaned prior to initiation of sampling activities, and as otherwise necessary based on TP-1.2-18.
- Samples to be submitted for laboratory testing will be placed in laboratory-supplied containers and stored in a cooler containing ice. Sample chain of custody procedures will be based on TP-1.2-18.

- Analytical testing will be performed by Accutest Mountain States. EPA SW 846 analytical testing methods will be used in accordance with COGCC requirements.

## 4.3 Background Constituent Concentrations

To allow comparison of constituent concentrations in the excavation with naturally occurring concentrations, two background samples of undisturbed Uinta Formation materials will be collected from undisturbed areas in the vicinity of the 32C pad. These background samples will be laboratory tested for the full COGCC Table 910-1 list.

## 4.4 Contamination Remediation/Mitigation

Potential contamination remediation/mitigation approaches will be discussed with the COGCC, and include the following.

- Inert materials could be added to the excavated contaminated materials to reduce total concentrations to levels consistent with background and acceptable to COGCC. Analytical testing would be performed to confirm compliance with Table 910-1 standards prior to final disposition of the mitigated materials, such as re-use on-site.
- The excavated contaminated materials could be landfarmed on-site to reduce total concentrations to levels consistent with background and acceptable to COGCC. Analytical testing would be performed to confirm compliance with Table 910-1 standards prior to final disposition of the remediated materials, such as re-use on-site.
- The excavated contaminated materials could be transported off-site for disposal at a permitted facility.

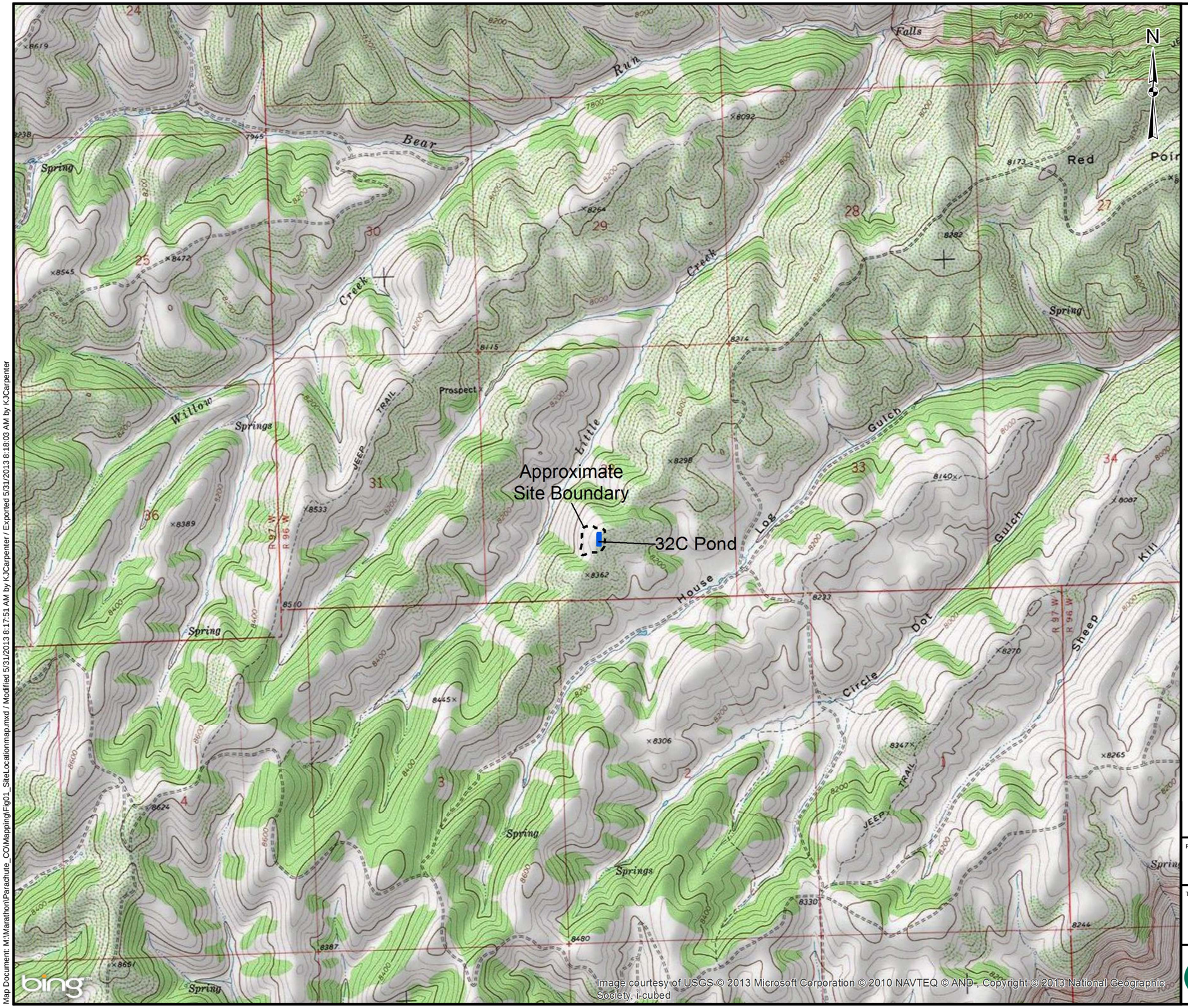
**GOLDER ASSOCIATES INC.**

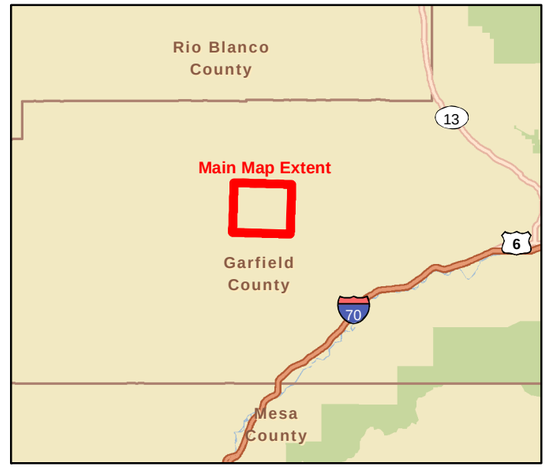
Scott R. Park
Oil and Gas EHS Team Leader

Randy March, P.E., P.G.
Principal Geological Engineer

RM/SP/ds

# FIGURES




## REFERENCES

COORDINATE SYSTEM: NAD 1983 UTM ZONE 12N
TOPOGRAPHIC QUADRANGLE BACKGROUND: IMAGE COURTESY OF USGS © 2013 MICROSOFT CORPORATION © 2010 NAVTEQ © AND COPYRIGHT:© 2013 NATIONAL GEOGRAPHIC SOCIETY, I-CUBED.

2,000 0 2,000
Feet

PROJECT
MARATHON OIL COMPANY
32C PRODUCED WATER POND
GARFIELD COUNTY, COLORADO

TITLE
**SITE LOCATION MAP**

Golder Associates

| | | | | |
|---|---|---|---|---|
| PROJECT NO. 1300253 | | | FILE No. | Fig01_SiteLocationmap.mxd |
| DESIGN | RM | 5/28/2013 | SCALE: AS SHOWN | REV. 0 |
| GIS | KJC | 5/31/2013 | | |
| CHECK | RM | 5/31/2013 | | |
| REVIEW | SP | 5/31/2013 | | |

**FIGURE 1**

Map Document: M:\Marathon\Parachute_CO\Mapping\Fig01_SiteLocationmap.mxd / Modified 5/31/2013 8:17:51 AM by KJCarpenter / Exported 5/31/2013 8:18:03 AM by KJCarpenter

60 0 60
Feet

## LEGEND

★ Approximate Location of Pond Breach

TP-1 Approximate Location of TP-1

16° Strike and Dip of Bedrock Bedding

## REFERENCES

COORDINATE SYSTEM: NAD 1983 UTM ZONE 12N
AERIAL IMAGERY: (C) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS.

PROJECT
MARATHON OIL COMPANY
32C PRODUCED WATER POND
GARFIELD COUNTY, COLORADO

TITLE
# TEST PIT AND GEOLOGIC STRUCTURE MAP

Golder Associates

| PROJECT NO. 1300253 | | | FILE No. Fig02_TestPit&GeologicStructureMap.mxd | |
|---|---|---|---|---|
| DESIGN | RM | 5/28/2013 | SCALE: AS SHOWN | REV. 0 |
| GIS | KJC | 5/31/2013 | | |
| CHECK | RM | 5/31/2013 | | |
| REVIEW | SP | 5/31/2013 | | |

**FIGURE 2**

Map Document: M:\Marathon\Parachute_CO\Mapping\Fig02_TestPit&GeologicStructureMap.mxd / Modified 5/31/2013 8:17:28 AM by KJCarpenter / Exported 5/31/2013 8:17:37 AM by KJCarpenter

## LEGEND

- Approximate Location of Pond Breach
- Proposed Groundwater Monitoring Well Location

## REFERENCES

COORDINATE SYSTEM: NAD 1983 UTM ZONE 12N
AERIAL IMAGERY: (C) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS.

80 0 80
Feet

PROJECT
MARATHON OIL COMPANY
32C PRODUCED WATER POND
GARFIELD COUNTY, COLORADO

TITLE
**PROPOSED GROUNDWATER MONITORING WELLS**

Golder Associates

| | | | | |
|---|---|---|---|---|
| PROJECT NO. 1300253 | | | FILE No. | Fig03_ProposedMW.mxd |
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| CHECK | RM | 5/31/2013 | | |
| REVIEW | SP | 5/31/2013 | | |

**FIGURE 3**

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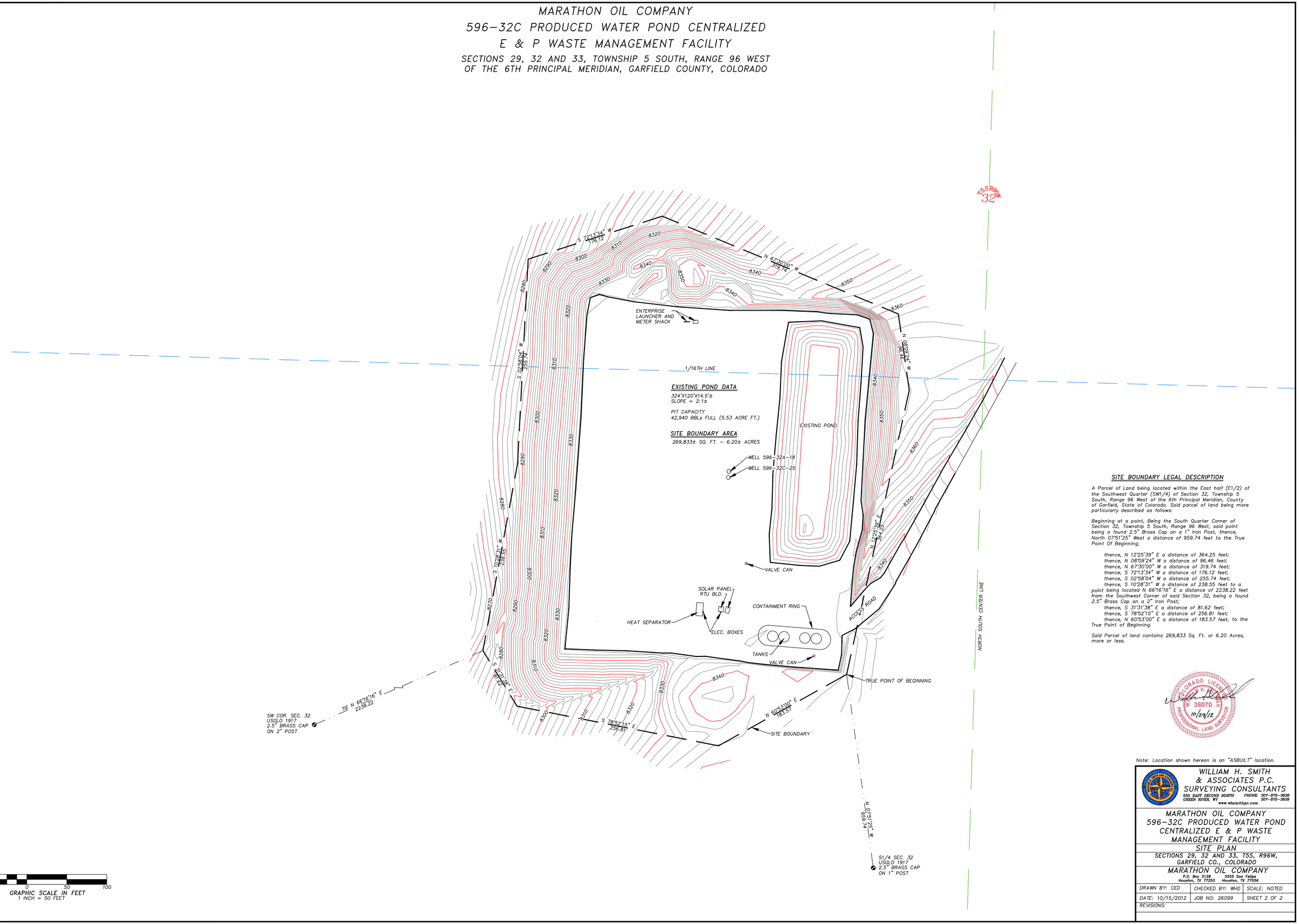
# APPENDIX A
# BACKGROUND INFORMATION

**APPENDIX A-1**

**32C SITE PLAN**

# MARATHON OIL COMPANY
# 596–32C PRODUCED WATER POND CENTRALIZED
# E & P WASTE MANAGEMENT FACILITY

SECTIONS 29, 32 AND 33, TOWNSHIP 5 SOUTH, RANGE 96 WEST
OF THE 6TH PRINCIPAL MERIDIAN, GARFIELD COUNTY, COLORADO




## SITE BOUNDARY LEGAL DESCRIPTION

A Parcel of Land being located within the East half (E1/2) of the Southwest Quarter (SW1/4) of Section 32, Township 5 South, Range 96 West of the 6th Principal Meridian, County of Garfield, State of Colorado. Said parcel of land being more particularly described as follows:

Beginning at a point, Being the South Quarter Corner of Section 32, Township 5 South, Range 96 West, said point being a found 2.5" Brass Cap on a 1" Iron Post, thence, North 07°51'25" West a distance of 959.74 feet to the True Point Of Beginning;

thence, N 12°25'39" E a distance of 364.25 feet;
thence, N 08°09'24" W a distance of 96.46 feet;
thence, N 67°30'00" W a distance of 319.74 feet;
thence, S 72°13'34" W a distance of 176.12 feet;
thence, S 02°58'04" W a distance of 255.74 feet;
thence, S 10°28'31" W a distance of 238.55 feet to a point being located N 66°16'16" E a distance of 2238.22 feet from the Southwest Corner of said Section 32, being a found 2.5" Brass Cap on a 2" Iron Post;
thence, S 31°31'38" E a distance of 81.62 feet;
thence, S 78°52'15" E a distance of 256.81 feet;
thence, N 60°53'00" E a distance of 183.57 feet, to the True Point of Beginning.

Said Parcel of land contains 269,833 Sq. Ft. or 6.20 Acres, more or less.

COLORADO LICENSED WILLIAM H. SMITH 38070 10/24/12 PROFESSIONAL LAND SURVEYOR

Note: Location shown hereon is an "ASBUILT" location.

100 50 0 50 100
GRAPHIC SCALE IN FEET
1 INCH = 50 FEET


WILLIAM H. SMITH & ASSOCIATES P.C.
SURVEYING CONSULTANTS
550 EAST SECOND NORTH
GREEN RIVER, WY
PHONE: 307-875-3638
307-875-3639
www.whsmithpc.com


MARATHON OIL COMPANY
596–32C PRODUCED WATER POND
CENTRALIZED E & P WASTE
MANAGEMENT FACILITY

SITE PLAN

SECTIONS 29, 32 AND 33, T5S, R96W,
GARFIELD CO., COLORADO

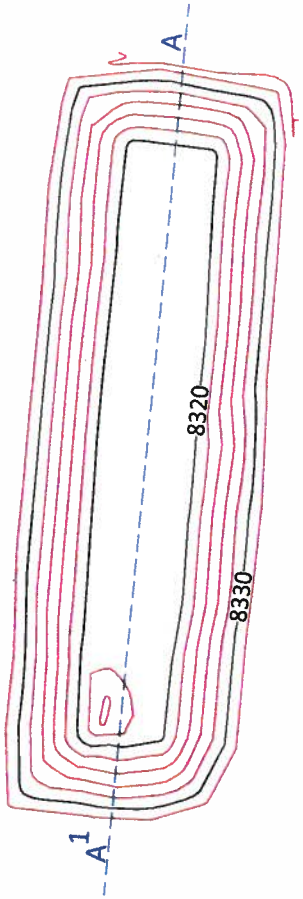
MARATHON OIL COMPANY
P.O. Box 3128 Houston, TX 77253
5555 San Felipe Houston, TX 77056

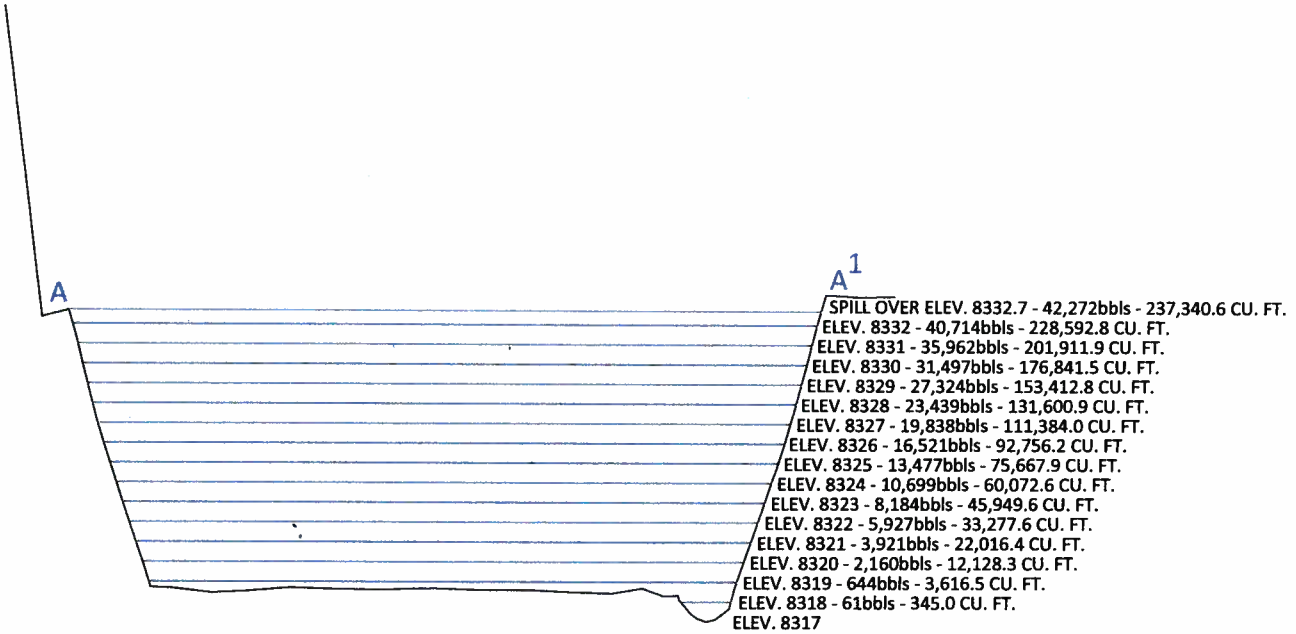
| | | |
|---|---|---|
| DRAWN BY: CED | CHECKED BY: WHD | SCALE: NOTED |
| DATE: 10/15/2012 | JOB NO: 26099 | SHEET 2 OF 2 |
| REVISIONS: | | |

**APPENDIX A-2**

**32C PRODUCED WATER POND AS-BUILT**

## 32C ASBUILT POND INFORMATION




SPILL OVER ELEV. 8332.7 - 42,272bbls - 237,340.6 CU. FT.
ELEV. 8332 - 40,714bbls - 228,592.8 CU. FT.
ELEV. 8331 - 35,962bbls - 201,911.9 CU. FT.
ELEV. 8330 - 31,497bbls - 176,841.5 CU. FT.
ELEV. 8329 - 27,324bbls - 153,412.8 CU. FT.
ELEV. 8328 - 23,439bbls - 131,600.9 CU. FT.
ELEV. 8327 - 19,838bbls - 111,384.0 CU. FT.
ELEV. 8326 - 16,521bbls - 92,756.2 CU. FT.
ELEV. 8325 - 13,477bbls - 75,667.9 CU. FT.
ELEV. 8324 - 10,699bbls - 60,072.6 CU. FT.
ELEV. 8323 - 8,184bbls - 45,949.6 CU. FT.
ELEV. 8322 - 5,927bbls - 33,277.6 CU. FT.
ELEV. 8321 - 3,921bbls - 22,016.4 CU. FT.
ELEV. 8320 - 2,160bbls - 12,128.3 CU. FT.
ELEV. 8319 - 644bbls - 3,616.5 CU. FT.
ELEV. 8318 - 61bbls - 345.0 CU. FT.
ELEV. 8317


WILLIAM H. SMITH
& ASSOCIATES P.C.
SURVEYING CONSULTANTS
650 EAST SECOND NORTH PHONE: 307-875-3638
GREEN RIVER, WY 307-875-3639
www.whsmithpc.com


MARATHON OIL COMPANY
596-32C PRODUCED WATER POND

SECTION 32 T5S, R96W,
GARFIELD CO., COLORADO

MARATHON OIL COMPANY
P.O. Box 3128 5555 San Felipe
Houston, TX 77253 Houston, TX 77056

| | | |
|---|---|---|
| DRAWN BY: DTW | CHECKED BY: WHD | SCALE: 1"=50' |
| DATE: 03/15/2013 | JOB NO: 26099 | SHEET 1 OF 1 |

REVISIONS:

**APPENDIX A-3**

**32C GEOLOGY REPORT**

# Form 28 - Centralized E&P Waste Management Facility
# Permit Application for Facility #335982
# Marathon Oil Company Water Storage Facility
# SE SW Section 32, T5S, R96W, 6th P.M., Garfield County, Colorado

**Rule 908.b (4)**

Topography

The Marathon Oil Company (MOC) Water Storage Facility No. 335982 (facility) is located in the highlands of the Roan Plateau region in central Garfield County, Colorado. The general terrain surrounding the facility undulates between numerous northeast trending drainages that have incised into the underlying bedrock, creating hummocky uplands that parallel the drainages. Local relief between these valleys and surrounding ridges typically range from 200-400 feet. At the proposed site location, the elevation is approximately 8,340 feet above sea level with the elevation in the adjacent drainage to the north (Little Creek) at 8,070 feet above sea level.

**Soils (Rule 908.b (7).A.i)**

The proposed facility is underlain primarily by soil of the Parachute-Irigul complex, 5 to 30 percent slopes. This complex is characterized as a loam to extremely channery loam that ranges in depth between 20 and 40 inches. The soil is well drained with low available water capacity. Water transmitting capacity ranges from moderately low to moderately high (0.06-0.2 in/hr). The parent material of the soil is residuum from weathered bedrock, which typically is composed of siltstone, sandstone, or shale in the vicinity of the proposed facility. Also present on the western extent the proposed facility area is the Parachute-Irigul-Rhone association, 25-50 percent slopes. This association has similar physical and textural characteristics to the Parachute-Irigul complex, although the Rhone member has a greater potential depth (up to 55 inches in thickness) that is derived from colluvium.

**Bedrock Geology (Rule 908.b (7).A.ii)**

The bedrock underlying the proposed facility is composed of interlayered, early Tertiary-age sedimentary units of varying grain-size and composition. The uppermost bedrock unit immediately below the unconsolidated soil in the project area is the late Eocene-age Uinta Formation. In western Colorado, the Uinta Formation is composed of silty sandstone, siltstone and marlstone. The Uinta Formation that can approach 1,000 feet in thickness (Self and others, 2010). Underlying the Uinta Formation is the Parachute Creek member of Eocene-age Green River Formation. The Parachute Creek member, with thicknesses upwards of 1,000 feet, is composed primarily of dolomitic marlstone. Kerogen, a waxy hydrocarbon, also called "oil shale," is present in great abundance within intervals of the Parachute Creek member. Below the Parachute Creek member are the Garden Gulch, Douglas Creek, and Anvil Points member of the Green River Formation. These units are composed of limestone and carbonate-rich

mudstones with intervals of oil shale with varying percentages of kerogen present (Self and others, 2010).

Underlying the Green River Formation are the early Eocene- and Paleocene Wasatch and Fort Union Formations as well as the Cretaceous Mesaverde Group (Robson and Banta, 1995). A bore log of Marathon's well 596-32A-#18, which is located at the project site indicates that the top of the Wasatch Formation was encountered at a depth of 4,720 feet below ground level (bgl), indicating that the combined thickness of the Uinta and Green River Formations exceeds 4,700 feet in the project area (Colorado Oil and Gas Conservation Commission website, accessed October 3rd, 2012).

**Local and Regional Geologic Structures (Rule 908.b (7).A.iii)**

The proposed storage facility is located near the southwestern rim of the Roan Plateau, an upland area demarcated regionally by cliffs over 3,000 feet in height north of the Colorado River valley in Garfield County. The Roan Plateau is situated in the east-central part of the Piceance Basin, a northwest-southeast trending structural depression covering over 7,000 square miles in west-central Colorado. The Piceance Basin lies within the Colorado Plateau physiographic province, a structurally stable, uplifted region of Precambian- to Holocene-age geologic formations noted for high plateaus, thick sequences of Mesozoic stratigraphy, and deeply incised canyons in the Colorado River watershed (USGS, 2004).

The project site is situated on the northeastern limb of the Crystal Creek Anticline (upwarp of strata). The axis of the anticline trends northwest-southeast and the structure plunges into the subsurface about 4 miles northwest of the project area. The anticline is slightly asymmetrical, with steeper dipping strata on the southwest flank (200 feet/mile) as compared to the northeast flank (65 feet/mile) that the project site is situated on. The Douglas Creek Anticline continues northwestward for approximately 19 miles from the northwest terminus of the Crystal Creek Anticline towards the western edge of the Piceance Basin in the Douglas Creek Arch area (Hail, 1992).

No major faults are present in the project area. Two small groups of normal faults are present in the southern extent of the Roan Plateau with one set approximately 15 miles northeast and a second smaller group about 20 miles northwest of the project site (Hail, 1992).

**Geologic Hazards (Rule 908.b (7).A.i)**

Minimal seismic activity near the proposed disposal facility has occurred in recent geologic time. One earthquake of magnitude greater than 5.0 occurred in Garfield County since the early 1960s when proper instrumentation was implemented in the state of Colorado. The epicenter of this earthquake was approximately 17 miles southeast of the project site. A second recorded earthquake greater than 5.0 occurred in Rio Blanco County with an epicenter about 20 miles northwest of the project site. According to the Colorado Geological Survey, no Quaternary-age faults are present in the Roan Plateau area (Widmann and others, 1998). However, the Geologic Map of Colorado (Tweeto, 1979) reveals that a large swath of northeast-southwest

trending normal faults exist in the Cretaceous bedrock near the Douglas Creek Arch and the western fringe of the Piceance Basin. In addition, a series of normal faults trace along the eastern Piceance Basin boundary near the Grand Hogback. Although these faults are not always visible at the surface, this does not preclude the chance of an earthquake happening in the area at some point in the future. According to the Colorado Earthquake Hazard Mitigation Council (2008), "Earthquakes can also occur on faults that do not rupture the ground surface or on faults that are not yet recognized as being hazardous. These so called "random" earthquakes are considered in most hazard analyses to help account for faults that are not apparent at the earth's surface."

No surficial geologic hazards (landslide, mudflow, fan) or soils hazards have been mapped in the immediate vicinity of the proposed disposal facility. The location is not located in an area mapped as a floodplain hazard by the Federal Emergency Management Agency (FEMA). However, because of the natural slope across the property within the northwest-to-southeast oriented drainage, overland flow is possible in the event of an extreme precipitation event. Although records of extreme rainfall events are unavailable for locations on top of the Roan Plateau, climate records since the mid-20th century indicate that the record 24-hour rainfall amounts at Grand Junction, Palisade, and Parachute have not exceeded 2 inches (Western Regional Climate Center, 2011). The duration of these events within a 24 hour period is not known, and it is possible that a short burst of intense rainfall event could cause local overland flow in the watershed that encompasses the project site if a precipitation rate exceeds the infiltration rate of the watershed soils.

The primary limitations for shallow excavations are based on the slopes, the shallow depth to bedrock, and the potential for caving of cut banks. Consideration will be given to the design and construction of this facility to ensure that slopes are graded appropriately to minimize the potential for cutback caving. The suitability of the soils in the project area is identified as being somewhat to very limited in regard to the construction of ponds and embankments. The limitations identified are primarily applicable to unlined water impoundments. Consideration will be given to design and construction characteristics related to the area soil thickness and depth to bedrock to mitigate these limitations. Consideration will also be given to the design and operation of the liner system for the impoundments, which will mitigate potential seepage and leaks.

**Surface Water Features (Rule 908.b (7).B.i)**

Surface water features within two miles of the project site include the northeast-sloping Little Creek to the north and House Log Gulch to the south. The proposed storage facility is located about 1,000 feet south of Little Creek and 2,100 feet north of House Log Gulch and sits approximately 320 feet and 240 feet in elevation above the two creeks, respectively. Both streams are shown on the USGS 1:24,000 topographic map (Circle Dot Gulch Quadrangle) to have perennial flow, although no flow records are available to determine the flow conditions in these drainages. Evaluation of aerial imagery in Google Earth taken in August 2011 shows very little to no flow in the two streams near the proposed storage facility. Willow Creek flows roughly parallel to Little Creek and is about 1.4 miles north of the proposed facility and joins with Bear

Run (1.8 miles north) just before draining off the rim of the Roan Plateau towards West Parachute Creek. Also within 2 miles of the proposed facility, Circle Dot Gulch and Sheep Kill Gulch are south of and roughly parallel to House Log Gulch and drain northeastward towards West Parachute Creek.

Four springs have been mapped within 2 miles of the proposed storage facility on the Circle Dot Gulch Quadrangle topographic map. One mapped spring is located within the House Log Gulch Drainage about 1.2 miles southwest of the proposed storage facility. A second spring is mapped in the source area of Circle Dot Gulch, and two other springs are identified within the Willow Creek drainage northwest of the proposed facility. Each of the identified springs within 2 miles of the project site are located near the upper headwall areas of the drainages previously described. Flow rates and duration of the springs are not presently known.

**Shallow Groundwater and Major Aquifers (Rule 908.b (7).B.ii)**

According to the Colorado Department of Water Resources CDSS Map Viewer, no alluvial aquifers are mapped in the vicinity of the proposed storage facility location. However, as noted in the previous section, springs indicate the presence of shallow groundwater in the area. Over half of the precipitation at higher elevations in the Piceance Basin falls as winter precipitation, of which serves as a groundwater recharge source in the form of snowpack (Taylor, 1987). The residuum material on the Roan Plateau acts as an absorptive veneer that transmits snowmelt as recharge to the underlying bedrock during the spring runoff period (Topper and others, 2003). The shallow groundwater enters the groundwater flow system via the surficial residuum and through downward movement, eventually enters into fractures, joints and other cavities considered secondary porosity in the underlying bedrock aquifer. Based on the surface topography, shallow groundwater movement in materials above the Tertiary bedrock most likely follows the surface gradient towards the east/northeast where the surface drainages empty off the Roan Plateau and into the West Parachute Creek valley. Depth to shallow groundwater can range from less than 20 feet in the narrow drainages and near the identified springs to beyond 100 feet on the divides that separate the drainages. Site specific data for the presence and depth of groundwater at the specific project area should be gathered prior to construction activities. Since the project location is over 200 feet above the nearest drainage and is situated on a local flow divide, it is likely that groundwater is greater than 100 feet in depth below the project site area.

The bedrock aquifer underlying the site is composed of the Uinta Formation and the Parachute Creek Member of the Green River Formation. This aquifer has been named the Uinta-Animas Aquifer by the U.S. Geological Survey (Robson and Banta, 1995) and the Piceance Basin Aquifer by the Colorado Geological Survey (Topper and others, 2003). The Colorado Geological Survey subdivides the aquifer into Upper and Lower Piceance Basin aquifers, with the upper zone composed of the siltstones and sandstones in the Uinta Formation and the upper portion of the Parachute Creek Member. Immediately below this portion of the aquifer is the Mahogany confining unit, a 100 feet to 150 feet thick unit of kerogen-rich shale and marlstone. Beneath this confining unit is the lower portion of the Parachute Creek Member that is considered the Lower Piceance Basin aquifer. The thickness of the Upper and Lower Piceance Basin aquifers are

approximately 500 feet and 600 feet, respectively, in the project area. Robson and Banta (1995) show a potentiometric surface elevation contour of 8,000 feet in the project area, indicating that the saturated zone of the Upper Piceance Basin aquifer is greater than 300 feet below the site but is closer to the land surface in the valley bottoms of Little Creek and House Log Gulch.

Underlying the Upper and Lower Piceance Basin aquifers is a confining unit upwards of 4,000 feet in thickness that includes the lower members of the Green River Formation, the Wasatch Formation and the Fort Union Formation. Beneath this major confining unit is the Cretaceous Mesa Verde Group, which approaches 7,000 feet in thickness near the center of the basin. The Mesa Verde is comprised of inter-layered sandstone, shale, siltstone and coal. The aquifer portions of the group create composite saturated thicknesses of less than 500 to 2,000 feet.

**Water Wells within the Site Boundary (Rule 908.b (7).B.iii)**

No water wells are present within one mile of the proposed storage facility. The nearest wells, designated for monitoring, are approximately 1.5 miles southeast of the project site in the SE 1/4 SE 1/4 of Section 2, T6S, R97W. The three wells, with permit numbers 115873, 115879, 115881, were installed in the Green River Formation in 1980 to depths of 316 feet, 935 feet, and 809 feet below ground level (bgl), respectively. No static water levels from these wells are available. These wells have all since been abandoned and abandonment records are available from the Colorado Division of Water Resources (Colorado Division of Water Resources online Map Viewer, accessed October 4, 2012).

**Hydrologic Properties of Shallow Groundwater and Major Aquifers (Rule 908.b (7).B.iv)**

The permeability of the major formations in the Piceance Basin aquifers is relatively low. Hydraulic conductivity of the Uinta Formation and upper Parachute Creek Member ranges from less than 0.2 feet per day to 1.6 feet per day and a transmissivity of 4,563 to 5,760 gallons per day per foot (gpd/ft). In the lower Piceance Basin aquifer, hydraulic conductivity ranges from less than 0.1 to over 1 foot per day and a transmissivity of 1,945 to 2,842 gpd/ft. Yields in both aquifer units can range from about 1 gallon per minute (gpm) to over 900 gpm. The aquifer units of the Mesa Verde are typically not developed on the Roan Plateau due to economic factors of deep well installation and the availability of water in the overlying Tertiary units (Glover and others, 1998). Permeability of aquifers within the Mesa Verde Group is typically quite low, as hydraulic conductivity values range from 0.0001 to 0.001 ft/d in the project area (Topper and others, 2003).

As described in section (7).B.ii, shallow groundwater movement likely follows the surface topography towards the east/northeast where the surface drainages empty off the Roan Plateau and into the valley of West Parachute Creek. Local groundwater movement near the proposed facility is likely to the north and south towards Little Creek and House Log Gulch, respectively. From these points, groundwater movement shifts northeastward towards the rim of the plateau.

Groundwater movement in the Piceance Basin aquifers (upper and lower) is generally from south to north across the northern province of the Piceance Basin towards the White River

drainage. As previously mentioned, the southern rim of the Roan Plateau has been defined as an area of natural recharge. Groundwater levels (potentiometric surface) in the recharge areas of the Piceance Basin aquifers range from 8,000-8,400 feet and drop to around 6,000 feet on the northern end of the basin in the discharge area of the White River. Across the basin, the flow gradient varies significantly. In the recharge area, the gradient in both the upper and lower aquifer units is generally flat. The gradient steepens north of the project site in southern Rio Blanco County, and it is evident that the Piceance Creek drainage exerts influence on the flow regime as an area of discharge, particularly in the upper aquifer. This gradient pattern indicates upward movement of flow from the lower aquifer upward through the Mahogany zone and the upper aquifer in the drainage area of the Piceance Creek. In other areas where both aquifer units sit above area drainages in elevation, the units emit water via springs that feed tributary streams to the main-stem drainages, such as in the Roan and Parachute Creek valleys (Glover and others, 1998). The project site is included in an area defined by Glover and others (1998) as having "substantial natural recharge" in the northern province of the Piceance Basin. According to the Robson and Banta (1995), the Uinta-Animas aquifer, which contains the geologic units described in the previous section, receives approximately 24,000 acre-feet of recharge annually, and that discharge to surface water features down-gradient in the Piceance Basin approximately equals the annual aquifer recharge rate (Robson and Banta, 1995).

**Site Location in Relation to Nearby Floodplains (Rule 908.b (7).B.v)**

The facility is not within a FEMA flood hazard zone and there are no surface waters subject to COGCC Rule 317B located in the vicinity of the project.

**Existing Shallow Groundwater Quality (Rule 908.b (7).B.vi)**

Baseline groundwater quality sampling should occur prior to facility construction or modification to document pre-development conditions at the project site, as data in the area is currently not available. Regionally, water quality is variable in the Piceance aquifers across the northern province of the basin. The primary water quality concern is dissolved solids, which can exceed 10,000 milligrams (mg/l) per liter in some areas. In the upper aquifer, total dissolved solids (TDS) ranges from less than 500 mg/l in the south (including the proposed disposal site) to over 1,000 mg/l in the northern extent of the basin. In the lower aquifer, TDS values range from less than 1,000 mg/l in the south to over 10,000 mg/l near the White River Basin. Geochemical conditions in the recharge areas of the Tertiary aquifers typically enhance dissolution of calcite and dolomite, a process that enhances loading of TDS as groundwater moves down-gradient towards areas of discharge. TDS values in both aquifers at the project site are typically 1,000 mg/l or less, which are levels still suitable for potable use (Glover and others, 1998).

**Potential for Impacts to Nearby Surface Water and Groundwater (Rule 908.b (7).B.vii)**

As previously described, the proposed storage facility is not located in an area identified as a floodplain and as mentioned in the Geologic Hazards section, is not considered a flood hazard by FEMA. No surface waters subject to COGCC Rule 317B are located near the proposed disposal site, and the area surrounding the proposed disposal facility contains no identifiable

wetlands. The flow status of two nearby drainages (Little Creek and House Log Gulch) are not known as information from USGS Topographic Maps conflicts with evidence from recent aerial imagery in the project area. However, as with most watersheds in the arid west with moderate slopes, heavy runoff events can temporarily create surface flow conditions and an elevated shallow water table at and down-gradient of the proposed facility.

Potential impacts to groundwater would likely involve shallow subsurface flow in the soil and colluvium above the competent underlying bedrock formations at the project site. This local flow would likely follow the pattern of surface topography drainages which orient towards the north and south before ultimately flowing northeast. In a regional sense, the proposed facility exists in a recharge area for the Piceance Basin aquifers that underlie the Roan Plateau. Based on the depth to the water table, the presence of restrictive confining units, the length of travel to regional discharge areas, and the limited domestic/public use of water from these aquifers on the Roan Plateau, very little risk potential exists to the bedrock aquifers from the proposed disposal facility.

The water storage facility has been designed with features that considerably reduce the potential for the facility to impact nearby surface and groundwater. The proposed ponds will have 2- 60 mil synthetic liners that will cover the bottom and interior sides of the pit with edges secured around the pit perimeter. Monitoring wells will also be installed to monitor for any releases from the facility.

**References**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**APPENDIX A-4**

**32C MONTHLY WATER QUALITY DATA**

# Sample Data - 32C Pond - 09GA0337

| Sample Month | M | GRO | DRO | B | T | E | X | H | PWT (32C) | PWT (Pump & Truck) |
|---|---|---|---|---|---|---|---|---|---|---|
| Unit of Measure | mg/l | ug/l | mg/l | ug/l | ug/l | ug/l | ug/l | ug/l | bbl/mo | bbl/mo |
| Jan-12 | 239 | 520000 | 212 | 16200 | 43400 | 3040 | 48700 | 4700 | 628 | 9440 |
| Feb-12 | 197 | 321000 | 134 | 12700 | 28600 | 1920 | 26200 | 2040 | 661 | 9087 |
| Mar-12 | 181 | 148000 | 146 | 12900 | 25600 | 1180 | 18500 | 524 | 542 | 2860 |
| Apr-12 | 525 | 1450000 | 629 | 21800 | 73600 | 5660 | 87800 | 11800 | 621 | 277 |
| May-12 | 486 | 1510000 | 719 | 26700 | 117000 | 12600 | 166000 | 29400 | 576 | 821 |
| Jun-12 | 214 | 391000 | 302 | 11200 | 33000 | 2760 | 37200 | 3140 | 528 | 1590 |
| Jul-12 | 130 | 161000 | 114 | 11000 | 22900 | 948 | 16300 | 930 | 568 | 248 |
| Aug-12 | 72 | 150000 | 106 | 14200 | 24400 | 852 | 13700 | 0 | 461 | 78 |
| Sep-12 | 65 | 128000 | 103 | 13800 | 27800 | 1360 | 23000 | 1100 | 391 | 431 |
| Oct-12 | 73 | 136000 | 200 | 17600 | 35100 | 1340 | 18800 | 1070 | 504 | 954 |
| Nov-12 | 254 | 99500 | 51 | 14700 | 26700 | 882 | 12100 | 0 | 394 | 5439 |
| Dec-12 | 91 | 92300 | 32 | 15800 | 30000 | 832 | 12400 | 296 | 399 | 597 |
| Jan-13 | 116 | 83300 | 319 | 13700 | 29400 | 1240 | 17300 | 762 | 313 | 2383 |
| Feb-13 | 384 | 135000 | 49 | 15000 | 32400 | 1090 | 16700 | 638 | 485 | 7543 |
| Mar-13 | 226 | 109000 | 35 | 14900 | 28500 | 800 | 13400 | 145 | 390 | 5488 |
| Apr-13 | 322 | 119000 | 25 | 17500 | 33800 | 922 | 12500 |  | 399 |  |

# APPENDIX A-5
# 32C LEAK DETECTION WATER QUALITY

# ANALYTICAL SUMMARY REPORT

April 29, 2013

Marathon Oil Company
743 Horizon Court Ste. 220
Grand Junction, CO 81506

Workorder No.: G13040311 Quote ID: G342 - 32C APEN and Pond Complex

Project Name: Produced_Water

Energy Laboratories Inc. Gillette WY received the following 1 sample for Marathon Oil Company on 4/16/2013 for analysis.

| Sample ID | Client Sample ID | Collect Date | Receive Date | Matrix | Test |
|---|---|---|---|---|---|
| G13040311-001 | PW_32C_LDS | 04/12/13 12:00 | 04/16/13 | Aqueous | Conductivity<br>DRO-Liquid-Liquid Extraction<br>Diesel Range Organics<br>Gasoline Range Organics<br>Methanol Waters-Prep<br>Non-Halogenated Organics by GC-FID<br>pH<br>Solids, Total Dissolved<br>Solids, Total Suspended<br>8260-Volatile Organic Compounds-Short List |

The analyses presented in this report were performed by Energy Laboratories, Inc., 400 W. Boxelder Rd., Gillette, WY 82718, unless otherwise noted.

As appropriate, any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these tests results, please call.

Report Approved By:

**CLIENT:** Marathon Oil Company
**Project:** Produced_Water
**Sample Delivery Group:** G13040311

**Report Date:** 04/29/13

# CASE NARRATIVE

Tests associated with analyst identified as ELI-B were subcontracted to Energy Laboratories, 1120 S. 27th St., Billings, MT, EPA Number MT00005.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Site Name:** APEN_09GA0337
**Project:** Produced_Water
**Client Sample ID:** PW_32C_LDS
**Location:**
**Samp FRQ/Type:**
**Lab ID:** G13040311-001

**Report Date:** 04/29/13
**Collection Date:** 04/12/13 12:00
**Date Received:** 04/16/13
**Sampled By:** Zach Toellner
**Matrix:** Aqueous
**Tracking Number:**

| Analyses | Result | Units | RL | Qualifier | Method | Analysis Date / By |
|---|---|---|---|---|---|---|
| **NON-METALS** | | | | | | |
| pH | 6.81 | s.u. | 0.01 | H | A4500-H B | 04/16/13 12:35 / blb |
| Solids, Total Dissolved TDS @ 180 C | 10800 | mg/L | 200 | | A2540 C | 04/17/13 08:57 / blb |
| Solids, Total Suspended TSS @ 105 C | 32 | mg/L | 10 | | A2540 D | 04/17/13 12:46 / blb |
| **NON-HALOGENATED ORGANICS BY GC-FID** | | | | | | |
| Methanol | 283 | mg/L | 1.0 | | SW8015B | 04/17/13 08:38 / eli-b |
| Surr: sec-Butyl Alcohol | 93.0 | %REC | 80-120 | | SW8015B | 04/17/13 08:38 / eli-b |
| **PETROLEUM HYDROCARBONS-VOLATILE** | | | | | | |
| Gasoline Range Organics (GRO) | 11100 | ug/L | 1000 | | SW8015B | 04/23/13 15:18 / eli-b |
| Total Purgeable Hydrocarbons | 11300 | ug/L | 1000 | | SW8015B | 04/23/13 15:18 / eli-b |
| Surr: Trifluorotoluene | 110 | %REC | 70-130 | | SW8015B | 04/23/13 15:18 / eli-b |
| - Note 1: Gasoline Range Organics(GRO) are defined as all hydrocarbons eluting between 2-Methylpentane and 1,2,4-Trimethylbenzene. | | | | | | |
| - Note 2: Total Purgeable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| - The sample was received in the laboratory with a pH > 2. The pH was 5. | | | | | | |
| **PETROLEUM HYDROCARBONS-SEMI-VOLATILE** | | | | | | |
| Diesel Range Organics (DRO) | 11 | mg/L | 3.0 | | SW8015B | 04/20/13 10:16 / eli-b |
| Total Extractable Hydrocarbons | 19 | mg/L | 3.0 | | SW8015B | 04/20/13 10:16 / eli-b |
| Surr: o-Terphenyl | 49.0 | %REC | 50-150 | S | SW8015B | 04/20/13 10:16 / eli-b |
| - Note 1: Diesel Range Organics are defined as all hydrocarbons eluting between C10 and C28. | | | | | | |
| - Note 2: Total Extractable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| - S=Surrogate recovery outside QC advisory limits. The sample contained a layer of sediment that may have strongly adsorbed the surrogate and/or reduced extraction efficiency. | | | | | | |
| **VOLATILE ORGANIC COMPOUNDS** | | | | | | |
| Benzene | 840 | ug/L | 100 | | SW8260B | 04/17/13 16:17 / eli-b |
| Ethylbenzene | 83 | ug/L | 10 | | SW8260B | 04/17/13 15:08 / eli-b |
| Toluene | 1890 | ug/L | 100 | | SW8260B | 04/17/13 16:17 / eli-b |
| m+p-Xylenes | 1940 | ug/L | 100 | | SW8260B | 04/17/13 16:17 / eli-b |
| o-Xylene | 332 | ug/L | 100 | | SW8260B | 04/17/13 16:17 / eli-b |
| Xylenes, Total | 2270 | ug/L | 100 | | SW8260B | 04/17/13 16:17 / eli-b |
| Surr: Dibromofluoromethane | 99.0 | %REC | 77-126 | | SW8260B | 04/17/13 15:08 / eli-b |
| Surr: 1,2-Dichloroethane-d4 | 90.0 | %REC | 70-130 | | SW8260B | 04/17/13 15:08 / eli-b |
| Surr: Toluene-d8 | 104 | %REC | 79-122 | | SW8260B | 04/17/13 15:08 / eli-b |
| Surr: p-Bromofluorobenzene | 99.0 | %REC | 76-127 | | SW8260B | 04/17/13 15:08 / eli-b |
| - The reporting limit reflects a 20 times dilution. The sample was diluted due to sample matrix interference. | | | | | | |
| - The sample was received in the laboratory with a pH > 2. The pH was 7. | | | | | | |

**Report Definitions:**
RL - Analyte reporting limit.
QCL - Quality control limit.
H - Analysis performed past recommended holding time.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
S - Spike recovery outside of advisory limits.

# QA/QC Summary Report

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Project:** Produced_Water

**Report Date:** 04/29/13
**Work Order:** G13040311

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: A2540 C** | | | | | | | | Batch: TDS130417A | |
| **Sample ID: MB-1_130417A** | Method Blank | | | | Run: BAL-MET-AE_130417A | | | 04/17/13 08:54 | |
| Solids, Total Dissolved TDS @ 180 C | ND | mg/L | 5 | | | | | | |
| **Sample ID: LCS-2_130417A** | Laboratory Control Sample | | | | Run: BAL-MET-AE_130417A | | | 04/17/13 08:54 | |
| Solids, Total Dissolved TDS @ 180 C | 1090 | mg/L | 11 | 98 | 90 | 110 | | | |
| **Sample ID: G13040302-001A DUP** | Sample Duplicate | | | | Run: BAL-MET-AE_130417A | | | 04/17/13 08:55 | |
| Solids, Total Dissolved TDS @ 180 C | 530 | mg/L | 16 | | | | 1.7 | 5 | |
| **Sample ID: G13040307-001A MS** | Sample Matrix Spike | | | | Run: BAL-MET-AE_130417A | | | 04/17/13 08:55 | |
| Solids, Total Dissolved TDS @ 180 C | 2830 | mg/L | 33 | 102 | 90 | 110 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Project:** Produced_Water

**Report Date:** 04/29/13
**Work Order:** G13040311

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: A2540 D** | | | | | | | | Batch: 130417_1_SLDS-TSS-W | |
| **Sample ID: MBLK-1_130417** | Method Blank | | | | Run: BAL-MET-AE_130417B | | | 04/17/13 12:46 | |
| Solids, Total Suspended TSS @ 105 C | ND | mg/L | 1 | | | | | | |
| **Sample ID: LCS-1_130417** | Laboratory Control Sample | | | | Run: BAL-MET-AE_130417B | | | 04/17/13 12:46 | |
| Solids, Total Suspended TSS @ 105 C | 87 | mg/L | 10 | 87 | 80 | 120 | | | |
| **Sample ID: G13040311-001ADUP** | Sample Duplicate | | | | Run: BAL-MET-AE_130417B | | | 04/17/13 12:47 | |
| Solids, Total Suspended TSS @ 105 C | 32 | mg/L | 10 | | | | 2.0 | 5 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Project:** Produced_Water

**Report Date:** 04/29/13
**Work Order:** G13040311

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: A4500-H B** | | | | | | | | Analytical Run: PHSC_101-G_130416A | |
| **Sample ID: pH 8** | Initial Calibration Verification Standard | | | | | | | 04/16/13 08:33 | |
| pH | 7.96 | s.u. | 0.010 | 100 | 98 | 102 | | | |
| **Method: A4500-H B** | | | | | | | | Batch: R202918 | |
| **Sample ID: G13040324-006ADUP** | Sample Duplicate | | | | Run: PHSC_101-G_130416A | | | 04/17/13 08:41 | |
| pH | 8.5 | s.u. | 0.010 | | | | 0.4 | 1.5 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 04/28/13
**Project:** Produced_Water
**Work Order:** G13040311

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8260B** | | | | | | | | | Batch: R203104 |
| **Sample ID: lcs041713_** | Laboratory Control Sample | | | | Run: VOA5975C.I_130417A | | | | 04/17/13 11:22 |
| Benzene | 4.72 | ug/L | 1.0 | 94 | 71 | 133 | | | |
| Ethylbenzene | 4.96 | ug/L | 1.0 | 99 | 78 | 131 | | | |
| n-Hexane | 5.16 | ug/L | 1.0 | 103 | 70 | 130 | | | |
| Toluene | 4.96 | ug/L | 1.0 | 99 | 78 | 134 | | | |
| m+p-Xylenes | 10.1 | ug/L | 1.0 | 101 | 78 | 133 | | | |
| o-Xylene | 5.00 | ug/L | 1.0 | 100 | 79 | 136 | | | |
| Surr: 1,2-Dichloroethane-d4 | | | 1.0 | 93 | 70 | 130 | | | |
| Surr: Dibromofluoromethane | | | 1.0 | 101 | 77 | 126 | | | |
| Surr: p-Bromofluorobenzene | | | 1.0 | 98 | 76 | 127 | | | |
| Surr: Toluene-d8 | | | 1.0 | 104 | 79 | 122 | | | |
| **Sample ID: blk041713_** | Method Blank | | | | Run: VOA5975C.I_130417A | | | | 04/17/13 12:35 |
| Benzene | ND | ug/L | 1.0 | | | | | | |
| Ethylbenzene | ND | ug/L | 1.0 | | | | | | |
| n-Hexane | ND | ug/L | 1.0 | | | | | | |
| Toluene | ND | ug/L | 1.0 | | | | | | |
| m+p-Xylenes | ND | ug/L | 1.0 | | | | | | |
| o-Xylene | ND | ug/L | 1.0 | | | | | | |
| Xylenes, Total | ND | ug/L | 1.0 | | | | | | |
| Surr: 1,2-Dichloroethane-d4 | | | 1.0 | 92 | 70 | 130 | | | |
| Surr: Dibromofluoromethane | | | 1.0 | 98 | 77 | 126 | | | |
| Surr: p-Bromofluorobenzene | | | 1.0 | 98 | 76 | 127 | | | |
| Surr: Toluene-d8 | | | 1.0 | 104 | 79 | 122 | | | |
| **Sample ID: G13040311-001Dms** | Sample Matrix Spike | | | | Run: VOA5975C.I_130417A | | | | 04/17/13 16:51 |
| Benzene | 1780 | ug/L | 100 | 94 | 71 | 133 | | | |
| Ethylbenzene | 1060 | ug/L | 100 | 99 | 78 | 131 | | | |
| n-Hexane | 1010 | ug/L | 200 | 101 | 70 | 130 | | | |
| Toluene | 2780 | ug/L | 100 | 89 | 78 | 134 | | | |
| m+p-Xylenes | 3860 | ug/L | 100 | 96 | 78 | 133 | | | |
| o-Xylene | 1330 | ug/L | 100 | 100 | 79 | 136 | | | |
| Surr: 1,2-Dichloroethane-d4 | | | 200 | 98 | 70 | 130 | | | |
| Surr: Dibromofluoromethane | | | 200 | 102 | 77 | 126 | | | |
| Surr: p-Bromofluorobenzene | | | 200 | 97 | 76 | 127 | | | |
| Surr: Toluene-d8 | | | 200 | 102 | 79 | 122 | | | |
| **Sample ID: G13040311-001Dmsd** | Sample Matrix Spike Duplicate | | | | Run: VOA5975C.I_130417A | | | | 04/17/13 17:25 |
| Benzene | 1760 | ug/L | 100 | 92 | 71 | 133 | 0.9 | 20 | |
| Ethylbenzene | 1020 | ug/L | 100 | 95 | 78 | 131 | 3.9 | 20 | |
| n-Hexane | 968 | ug/L | 200 | 97 | 70 | 130 | 4.0 | 20 | |
| Toluene | 2720 | ug/L | 100 | 83 | 78 | 134 | 2.0 | 20 | |
| m+p-Xylenes | 3720 | ug/L | 100 | 89 | 78 | 133 | 3.6 | 20 | |
| o-Xylene | 1300 | ug/L | 100 | 96 | 79 | 136 | 2.4 | 20 | |
| Surr: 1,2-Dichloroethane-d4 | | | 200 | 100 | 70 | 130 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 04/28/13
**Project:** Produced_Water
**Work Order:** G13040311

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8260B** | | | | | | | | | Batch: R203104 |
| **Sample ID: G13040311-001Dmsd** | Sample Matrix Spike Duplicate | | | | Run: VOA5975C.I_130417A | | | | 04/17/13 17:25 |
| Surr: Dibromofluoromethane | | | 200 | 102 | 77 | 126 | | | |
| Surr: p-Bromofluorobenzene | | | 200 | 97 | 76 | 127 | | | |
| Surr: Toluene-d8 | | | 200 | 101 | 79 | 122 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 04/28/13
**Project:** Produced_Water
**Work Order:** G13040311

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Analytical Run: R203554 |
| **Sample ID: CCV_0423VA204r** | Continuing Calibration Verification Standard | | | | | | | | 04/23/13 12:40 |
| Total Purgeable Hydrocarbons | 215 | ug/L | 20 | 108 | 85 | 115 | | | |
| Surr: Trifluorotoluene | | | 1.0 | 111 | 85 | 115 | | | |
| **Method: SW8015B** | | | | | | | | | Batch: R203554 |
| **Sample ID: LCS_0423VA205r** | Laboratory Control Sample | | | | Run: VARIAN2_130423B | | | | 04/23/13 13:11 |
| Total Purgeable Hydrocarbons | 225 | ug/L | 20 | 112 | 70 | 130 | | | |
| Surr: Trifluorotoluene | | | 1.0 | 112 | 70 | 130 | | | |
| **Sample ID: MBLK_0423VA208r** | Method Blank | | | | Run: VARIAN2_130423B | | | | 04/23/13 14:46 |
| Gasoline Range Organics (GRO) | ND | ug/L | 20 | | | | | | |
| Total Purgeable Hydrocarbons | ND | ug/L | 20 | | | | | | |
| Surr: Trifluorotoluene | | | 1.0 | 98 | 70 | 130 | | | |
| **Sample ID: G13040311-001DMS** | Sample Matrix Spike | | | | Run: VARIAN2_130423B | | | | 04/24/13 16:28 |
| Total Purgeable Hydrocarbons | 32700 | ug/L | 2000 | 107 | 70 | 130 | | | |
| Surr: Trifluorotoluene | | | 100 | 116 | 70 | 130 | | | |
| **Sample ID: G13040311-001DMSD** | Sample Matrix Spike Duplicate | | | | Run: VARIAN2_130423B | | | | 04/24/13 17:00 |
| Total Purgeable Hydrocarbons | 33400 | ug/L | 2000 | 110 | 70 | 130 | 2.2 | 20 | |
| Surr: Trifluorotoluene | | | 100 | 115 | 70 | 130 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 04/28/13
**Project:** Produced_Water
**Work Order:** G13040311

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Batch: 70564 |
| **Sample ID: LCS-70564** | Laboratory Control Sample | | | | Run: GCFID-HP2-B_130419B | | | | 04/20/13 02:43 |
| Diesel Range Organics (DRO) | 12.3 | mg/L | 0.30 | 82 | 60 | 140 | | | |
| Total Extractable Hydrocarbons | 12.8 | mg/L | 0.30 | 86 | 60 | 140 | | | |
| Surr: o-Terphenyl | | | 0.0040 | 81 | 50 | 150 | | | |
| **Sample ID: MB-70564** | Method Blank | | | | Run: GCFID-HP2-B_130419B | | | | 04/20/13 03:28 |
| Diesel Range Organics (DRO) | ND | mg/L | 0.30 | | | | | | |
| Total Extractable Hydrocarbons | ND | mg/L | 0.30 | | | | | | |
| Surr: o-Terphenyl | | | 0.0040 | 88 | 50 | 150 | | | |
| **Sample ID: B13041128-002CMS** | Sample Matrix Spike | | | | Run: GCFID-HP2-B_130419B | | | | 04/20/13 04:59 |
| Diesel Range Organics (DRO) | 29.0 | mg/L | 0.62 | 79 | 60 | 140 | | | |
| Total Extractable Hydrocarbons | 31.1 | mg/L | 0.62 | 83 | 60 | 140 | | | |
| Surr: o-Terphenyl | | | 0.0083 | 72 | 50 | 150 | | | |
| **Sample ID: B13041128-002CMSD** | Sample Matrix Spike Duplicate | | | | Run: GCFID-HP2-B_130419B | | | | 04/20/13 05:44 |
| Diesel Range Organics (DRO) | 33.1 | mg/L | 0.62 | 92 | 60 | 140 | 13 | 20 | |
| Total Extractable Hydrocarbons | 35.4 | mg/L | 0.62 | 96 | 60 | 140 | 13 | 20 | |
| Surr: o-Terphenyl | | | 0.0083 | 78 | 50 | 150 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R203277 |
| **Sample ID: CCV_0419HP220r** | Continuing Calibration Verification Standard | | | | | | | | 04/20/13 01:11 |
| Total Extractable Hydrocarbons | 14.7 | mg/L | 0.30 | 98 | 85 | 115 | | | |
| Surr: o-Terphenyl | | | 0.0040 | 96 | 85 | 115 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 04/28/13
**Project:** Produced_Water
**Work Order:** G13040311

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Batch: 70515 |
| **Sample ID: LCS-70515** | Laboratory Control Sample | | | | Run: GCFID-HP1-B_130416A | | | | 04/16/13 09:38 |
| Methanol | 49.4 | mg/L | 1.0 | 99 | 71 | 128 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 96 | 80 | 120 | | | |
| **Sample ID: MB-70515** | Method Blank | | | | Run: GCFID-HP1-B_130416A | | | | 04/16/13 09:59 |
| Methanol | ND | mg/L | 1.0 | | | | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 96 | 80 | 120 | | | |
| **Sample ID: B13041091-001BMS** | Sample Matrix Spike | | | | Run: GCFID-HP1-B_130416A | | | | 04/16/13 12:11 |
| Methanol | 500 | mg/L | 5.0 | 91 | 71 | 128 | | | |
| Surr: sec-Butyl Alcohol | | | 5.0 | 94 | 80 | 120 | | | |
| **Sample ID: B13041091-001BMSD** | Sample Matrix Spike Duplicate | | | | Run: GCFID-HP1-B_130416A | | | | 04/16/13 12:33 |
| Methanol | 497 | mg/L | 5.0 | 90 | 71 | 128 | 0.6 | 20 | |
| Surr: sec-Butyl Alcohol | | | 5.0 | 92 | 80 | 120 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R203056 |
| **Sample ID: CCV_0416HM118r-W** | Continuing Calibration Verification Standard | | | | | | | | 04/17/13 07:54 |
| Methanol | 86.5 | mg/L | 1.0 | 87 | 85 | 115 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 95 | 80 | 120 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# Standard Reporting Procedures

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

# Workorder Receipt Checklist

## Marathon Oil Company G13040311

Login completed by: Amanda Alley
Date Received: 4/16/2013
Reviewed by: BL2000\adegnan
Received by: ala
Reviewed Date: 4/16/2013
Carrier name: FedEx

| | | | |
|---|---|---|---|
| Shipping container/cooler in good condition? | Yes ☑ | No ☐ | Not Present ☐ |
| Custody seals intact on shipping container/cooler? | Yes ☑ | No ☐ | Not Present ☐ |
| Custody seals intact on sample bottles? | Yes ☐ | No ☐ | Not Present ☑ |
| Chain of custody present? | Yes ☑ | No ☐ | |
| Chain of custody signed when relinquished and received? | Yes ☑ | No ☐ | |
| Chain of custody agrees with sample labels? | Yes ☑ | No ☐ | |
| Samples in proper container/bottle? | Yes ☑ | No ☐ | |
| Sample containers intact? | Yes ☑ | No ☐ | |
| Sufficient sample volume for indicated test? | Yes ☑ | No ☐ | |
| All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.) | Yes ☑ | No ☐ | |
| Temp Blank received? | Yes ☐ | No ☑ | Not Applicable ☐ |
| Container/Temp Blank temperature: | 4.1°C On Ice | | |
| Water - VOA vials have zero headspace? | Yes ☑ | No ☐ | No VOA vials submitted ☐ |
| Water - pH acceptable upon receipt? | Yes ☑ | No ☐ | Not Applicable ☐ |

Contact and Corrective Action Comments:

None

# Chain of Custody and Analytical Request Record

ENERGY LABORATORIES

**PLEASE PRINT (Provide as much information as possible.)**





Company Name: Marathon Oil

Project Name, PWS, Permit, Etc.: APEN_09GA0337/Produced_Water

Sample Origin State: CO

EPA/State Compliance: Yes ☒ No ☐

Report Mail Address (Required):
743 Horizon Ct., Suite 220
Grand Junction, CO 81506
❑ No Hard Copy Email:

Contact Name: Zach Toellner

Phone/Fax:

Cell: 970-260-0772

Sampler: (Please Print) Zach Toellner

Invoice Contact & Phone: Stacey Wales 970-244-5725

Purchase Order:

Quote/Bottle Order:

Invoice Address (Required):
743 Horizon Ct., Suite 220
Grand Junction, CO 81506
❑ No Hard Copy Email:

Special Report/Formats:
☐ DW ☒ EDD/EDT (Electronic Data)
☐ POTW/WWTP Format:
☐ State: ☐ LEVEL IV
☒ Other: PDF ☐ NELAC

Number of Containers
Sample Type: A Air, W Water, S Soils/Solids, V Vegetation, B Bioassay, O Other, D DW - Drinking Water

ANALYSIS REQUESTED

| SAMPLE IDENTIFICATION (Name, Location, Interval, etc.) | Collection Date | Collection Time | MATRIX | TSS | TDS | pH | | | | | | | SEE ATTACHED | Standard Turnaround (TAT) | RUSH | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 PW_32C_LDS | 4/12/13 | 12:00 | WW | X | X | X | | | | | | | X | X | | SP |
| 2 | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Shipped by: FedEx

Cooler ID(s):

Receipt Temp 4.1 °C

On Ice: (Y) N

Custody Seal On Bottle: X N; On Cooler: Y N; Intact: Y N; Signature Match: Y N

LABORATORY USE ONLY 13040311

**Custody Record MUST be Signed**

Relinquished by (print): Zach Toellner Date/Time: 4/15/13 11:45am Signature:

Relinquished by (print): Date/Time: Signature:

Sample Disposal: Return to Client: Lab Disposal: X

Received by (print): Date/Time: Signature:

Received by (print): Date/Time: Signature:

**Received by Laboratory:** Date/Time: 4/16/13 10:00 Signature:

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested.
This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.
Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

the self-certification process to demonstrate compliance with emission limits. (Reference: Regulation No. 3, Part B, Section III.E.)

## Periodic Testing Requirements

18. **AIRS Point 001**: The operator shall sample the wastewater inlet to the pond system (or the gun barrel separator tank wastewater outlet) to determine volatile organic compounds (VOC) and hazardous air pollutant (HAP) concentrations, including total hydrocarbons (including gasoline range and diesel range), benzene, toluene, ethylbenzene, xylene, and methanol. These samples shall be analyzed using EPA Method 8260 for benzene, toluene, ethylbenzene, and xylene, and EPA Method 8015 for methanol, gasoline range organics (total volatile hydrocarbons), and diesel range organics (total extractable hydrocarbons).

    A sample of the wastewater inlet to the pond system (or the gun barrel separator tank wastewater outlet) shall be collected and analyzed at a minimum frequency of once per calendar month. Sample results shall be used to calculate emissions as required by Condition 12. If more frequent sampling is conducted, then all samples of the wastewater inlet to the pond collected during the calendar month will be averaged and then used to calculate emissions as specified in Condition 12. Samples shall be collected no less than at least seven (7) days apart. The operator shall maintain records of all sampling events and the records shall be made available to the Division for inspection upon request. The operator shall flag monthly records if any sampling results are noted by the laboratory as beyond QA/QC criteria limits.

## ADDITIONAL REQUIREMENTS

19. A revised Air Pollutant Emission Notice (APEN) shall be filed: (Reference: Regulation No. 3, Part A, II.C)

    a. Annually whenever a significant increase in emissions occurs as follows:

        **For any criteria pollutant:**

        For sources emitting **less than 100 tons per year**, a change in actual emissions of five (5) tons per year or more, above the level reported on the last APEN; or

        **For any non-criteria reportable pollutant:**

        If the emissions increase by 50% or five (5) tons per year, whichever is less, above the level reported on the last APEN submitted to the Division.

    b. Whenever there is a change in the owner or operator of any facility, process, or activity; or

    c. Whenever new control equipment is installed, or whenever a different type of control equipment replaces an existing type of control equipment; or

    d. Whenever a permit limitation must be modified; or

    e. No later than 30 days before the existing APEN expires.

20. Federal regulatory program requirements (i.e. PSD, NANSR or Title V Operating Permit) shall apply to this source at any such time that this source becomes major solely by virtue of a relaxation in any permit condition. Any relaxation that increases the potential to emit above the applicable Federal program threshold will require a full review of the

# APPENDIX B
# SURFACE WATER ANALYTICAL RESULTS

# 596-32C Sampling Points: 4/24 - 5/13 2013

0.5 0 0.25 0.5 Miles

WGS_1984_Web_Mercator_Auxiliary_Sphere
5/22/2013

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.
THIS MAP IS NOT TO BE USED FOR NAVIGATION

## Notes

Sampled by MF and SD of Intertech at MRO selected locations.

# APPENDIX B-1
# APRIL 24, 2013 ANALYSES

# ANALYTICAL SUMMARY REPORT

May 08, 2013

Marathon Oil Company
743 Horizon Court Ste. 220
Grand Junction, CO 81506

Workorder No.: G13040481 Quote ID: G342 - 32C APEN and Pond Complex

Project Name: Surface_Water

Energy Laboratories Inc. Gillette WY received the following 2 samples for Marathon Oil Company on 4/25/2013 for analysis.

| Sample ID | Client Sample ID | Collect Date | Receive Date | Matrix | Test |
|---|---|---|---|---|---|
| G13040481-001 | WT_LC_Upstream | 04/24/13 12:30 | 04/25/13 | Aqueous | Conductivity<br>DRO-Liquid-Liquid Extraction<br>Diesel Range Organics<br>Gasoline Range Organics<br>Methanol Waters-Prep<br>Non-Halogenated Organics by GC-FID<br>pH<br>Solids, Total Dissolved<br>Solids, Total Suspended<br>8260-Volatile Organic Compounds-Short List |
| G13040481-002 | WT_LC_Downstream | 04/24/13 12:45 | 04/25/13 | Aqueous | Same As Above |

The analyses presented in this report were performed by Energy Laboratories, Inc., 400 W. Boxelder Rd., Gillette, WY 82718, unless otherwise noted.

As appropriate, any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these tests results, please call.

Report Approved By:

**CLIENT:** Marathon Oil Company
**Project:** Surface_Water
**Sample Delivery Group:** G13040481

**Report Date:** 05/08/13

# CASE NARRATIVE

Tests associated with analyst identified as ELI-B were subcontracted to Energy Laboratories, 1120 S. 27th St., Billings, MT, EPA Number MT00005.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Site Name:** 32C_Little_Creek
**Project:** Surface_Water
**Client Sample ID:** WT_LC_Upstream
**Location:**
**Samp FRQ/Type:** SP
**Lab ID:** G13040481-001

**Report Date:** 05/08/13
**Collection Date:** 04/24/13 12:30
**Date Received:** 04/25/13
**Sampled By:** Scott Distel
**Matrix:** Aqueous
**Tracking Number:**

| Analyses | Result | Units | RL | Qualifier | Method | Analysis Date / By |
|---|---|---|---|---|---|---|
| **NON-METALS** | | | | | | |
| pH | 8.45 | s.u. | 0.01 | H | A4500-H B | 04/25/13 17:09 / jab |
| Solids, Total Dissolved TDS @ 180 C | 311 | mg/L | 20 | | A2540 C | 04/26/13 09:08 / jab |
| Solids, Total Suspended TSS @ 105 C | ND | mg/L | 10 | | A2540 D | 04/26/13 11:45 / blb |
| **NON-HALOGENATED ORGANICS BY GC-FID** | | | | | | |
| Methanol | ND | mg/L | 1.0 | | SW8015B | 04/29/13 15:02 / eli-b |
| Surr: sec-Butyl Alcohol | 88.0 | %REC | 80-120 | | SW8015B | 04/29/13 15:02 / eli-b |
| **PETROLEUM HYDROCARBONS-VOLATILE** | | | | | | |
| Gasoline Range Organics (GRO) | ND | ug/L | 20 | | SW8015B | 05/05/13 00:47 / eli-b |
| Total Purgeable Hydrocarbons | ND | ug/L | 20 | | SW8015B | 05/05/13 00:47 / eli-b |
| Surr: Trifluorotoluene | 98.0 | %REC | 70-130 | | SW8015B | 05/05/13 00:47 / eli-b |
| - Note 1: Gasoline Range Organics(GRO) are defined as all hydrocarbons eluting between 2-Methylpentane and 1,2,4-Trimethylbenzene. | | | | | | |
| - Note 2: Total Purgeable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **PETROLEUM HYDROCARBONS-SEMI-VOLATILE** | | | | | | |
| Diesel Range Organics (DRO) | ND | mg/L | 0.65 | | SW8015B | 05/01/13 22:33 / eli-b |
| Total Extractable Hydrocarbons | 1.0 | mg/L | 0.65 | | SW8015B | 05/01/13 22:33 / eli-b |
| Surr: o-Terphenyl | 85.0 | %REC | 50-150 | | SW8015B | 05/01/13 22:33 / eli-b |
| - Note 1: Diesel Range Organics are defined as all hydrocarbons eluting between C10 and C28. | | | | | | |
| - Note 2: Total Extractable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **VOLATILE ORGANIC COMPOUNDS** | | | | | | |
| Benzene | ND | ug/L | 1.0 | | SW8260B | 05/02/13 17:07 / eli-b |
| Ethylbenzene | ND | ug/L | 1.0 | | SW8260B | 05/02/13 17:07 / eli-b |
| Toluene | ND | ug/L | 1.0 | | SW8260B | 05/02/13 17:07 / eli-b |
| m+p-Xylenes | ND | ug/L | 1.0 | | SW8260B | 05/02/13 17:07 / eli-b |
| o-Xylene | ND | ug/L | 1.0 | | SW8260B | 05/02/13 17:07 / eli-b |
| Xylenes, Total | ND | ug/L | 1.0 | | SW8260B | 05/02/13 17:07 / eli-b |
| Surr: Dibromofluoromethane | 112 | %REC | 77-126 | | SW8260B | 05/02/13 17:07 / eli-b |
| Surr: 1,2-Dichloroethane-d4 | 111 | %REC | 70-130 | | SW8260B | 05/02/13 17:07 / eli-b |
| Surr: Toluene-d8 | 104 | %REC | 79-122 | | SW8260B | 05/02/13 17:07 / eli-b |
| Surr: p-Bromofluorobenzene | 114 | %REC | 76-127 | | SW8260B | 05/02/13 17:07 / eli-b |

**Report Definitions:**
RL - Analyte reporting limit.
QCL - Quality control limit.
H - Analysis performed past recommended holding time.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Site Name:** 32C_Little_Creek
**Project:** Surface_Water
**Client Sample ID:** WT_LC_Downstream
**Location:**
**Samp FRQ/Type:** SP
**Lab ID:** G13040481-002

**Report Date:** 05/08/13
**Collection Date:** 04/24/13 12:45
**Date Received:** 04/25/13
**Sampled By:** Scott Distel
**Matrix:** Aqueous
**Tracking Number:**

| Analyses | Result | Units | RL | Qualifier | Method | Analysis Date / By |
|---|---|---|---|---|---|---|
| **NON-METALS** | | | | | | |
| pH | 8.50 | s.u. | 0.01 | H | A4500-H B | 04/25/13 17:12 / jab |
| Solids, Total Dissolved TDS @ 180 C | 279 | mg/L | 20 | | A2540 C | 04/26/13 09:08 / jab |
| Solids, Total Suspended TSS @ 105 C | ND | mg/L | 10 | | A2540 D | 04/26/13 11:45 / blb |
| **NON-HALOGENATED ORGANICS BY GC-FID** | | | | | | |
| Methanol | ND | mg/L | 1.0 | | SW8015B | 04/29/13 15:24 / eli-b |
| Surr: sec-Butyl Alcohol | 93.0 | %REC | 80-120 | | SW8015B | 04/29/13 15:24 / eli-b |
| **PETROLEUM HYDROCARBONS-VOLATILE** | | | | | | |
| Gasoline Range Organics (GRO) | ND | ug/L | 20 | | SW8015B | 05/06/13 19:45 / eli-b |
| Total Purgeable Hydrocarbons | ND | ug/L | 20 | | SW8015B | 05/06/13 19:45 / eli-b |
| Surr: Trifluorotoluene | 101 | %REC | 70-130 | | SW8015B | 05/06/13 19:45 / eli-b |
| - Note 1: Gasoline Range Organics(GRO) are defined as all hydrocarbons eluting between 2-Methylpentane and 1,2,4-Trimethylbenzene. | | | | | | |
| - Note 2: Total Purgeable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **PETROLEUM HYDROCARBONS-SEMI-VOLATILE** | | | | | | |
| Diesel Range Organics (DRO) | 0.48 | mg/L | 0.30 | | SW8015B | 05/01/13 23:23 / eli-b |
| Total Extractable Hydrocarbons | 0.93 | mg/L | 0.30 | | SW8015B | 05/01/13 23:23 / eli-b |
| Surr: o-Terphenyl | 83.0 | %REC | 50-150 | | SW8015B | 05/01/13 23:23 / eli-b |
| - Note 1: Diesel Range Organics are defined as all hydrocarbons eluting between C10 and C28. | | | | | | |
| - Note 2: Total Extractable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **VOLATILE ORGANIC COMPOUNDS** | | | | | | |
| Benzene | ND | ug/L | 1.0 | | SW8260B | 05/02/13 17:36 / eli-b |
| Ethylbenzene | ND | ug/L | 1.0 | | SW8260B | 05/02/13 17:36 / eli-b |
| Toluene | ND | ug/L | 1.0 | | SW8260B | 05/02/13 17:36 / eli-b |
| m+p-Xylenes | ND | ug/L | 1.0 | | SW8260B | 05/02/13 17:36 / eli-b |
| o-Xylene | ND | ug/L | 1.0 | | SW8260B | 05/02/13 17:36 / eli-b |
| Xylenes, Total | ND | ug/L | 1.0 | | SW8260B | 05/02/13 17:36 / eli-b |
| Surr: Dibromofluoromethane | 110 | %REC | 77-126 | | SW8260B | 05/02/13 17:36 / eli-b |
| Surr: 1,2-Dichloroethane-d4 | 110 | %REC | 70-130 | | SW8260B | 05/02/13 17:36 / eli-b |
| Surr: Toluene-d8 | 104 | %REC | 79-122 | | SW8260B | 05/02/13 17:36 / eli-b |
| Surr: p-Bromofluorobenzene | 114 | %REC | 76-127 | | SW8260B | 05/02/13 17:36 / eli-b |

**Report Definitions:**
RL - Analyte reporting limit.
QCL - Quality control limit.
H - Analysis performed past recommended holding time.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Project:** Surface_Water

**Report Date:** 05/08/13
**Work Order:** G13040481

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: A2540 C** | | | | | | | | | Batch: TDS130426A |
| **Sample ID: MB-1_130426A** | Method Blank | | | | Run: BAL-MET-AE_130426B | | | | 04/26/13 09:06 |
| Solids, Total Dissolved TDS @ 180 C | 6 | mg/L | 5 | | | | | | |
| **Sample ID: LCS-2_130426A** | Laboratory Control Sample | | | | Run: BAL-MET-AE_130426B | | | | 04/26/13 09:07 |
| Solids, Total Dissolved TDS @ 180 C | 1100 | mg/L | 11 | 98 | 90 | 110 | | | |
| **Sample ID: G13040478-001A DUP** | Sample Duplicate | | | | Run: BAL-MET-AE_130426B | | | | 04/26/13 09:07 |
| Solids, Total Dissolved TDS @ 180 C | 781 | mg/L | 16 | | | | 1.0 | 5 | |
| **Sample ID: G13040478-002A MS** | Sample Matrix Spike | | | | Run: BAL-MET-AE_130426B | | | | 04/26/13 09:08 |
| Solids, Total Dissolved TDS @ 180 C | 1830 | mg/L | 19 | 99 | 90 | 110 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Project:** Surface_Water

**Report Date:** 05/08/13
**Work Order:** G13040481

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** **A2540 D** | | | | | | | | Batch: 130426_1_SLDS-TSS-W | |
| **Sample ID:** **MBLK-1_130426** | Method Blank | | | | Run: BAL-MET-AE_130426A | | | 04/26/13 11:43 | |
| Solids, Total Suspended TSS @ 105 C | ND | mg/L | 1 | | | | | | |
| **Sample ID:** **LCS-1_130426** | Laboratory Control Sample | | | | Run: BAL-MET-AE_130426A | | | 04/26/13 11:44 | |
| Solids, Total Suspended TSS @ 105 C | 91 | mg/L | 10 | 91 | 80 | 120 | | | |
| **Sample ID:** **G13040468-001BDUP** | Sample Duplicate | | | | Run: BAL-MET-AE_130426A | | | 04/26/13 11:44 | |
| Solids, Total Suspended TSS @ 105 C | 150 | mg/L | 10 | | | | 11 | 5 | R |

**Qualifiers:**

RL - Analyte reporting limit.
ND - Not detected at the reporting limit.
R - RPD exceeds advisory limit.

# QA/QC Summary Report

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Report Date:** 05/08/13
**Project:** Surface_Water
**Work Order:** G13040481

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** **A4500-H B** | | | | | | | | Analytical Run: PHSC_101-G_130425A | |
| **Sample ID:** **pH 8** | Initial Calibration Verification Standard | | | | | | | 04/25/13 11:16 | |
| pH | 7.97 | s.u. | 0.010 | 100 | 98 | 102 | | | |
| **Method:** **A4500-H B** | | | | | | | | Batch: R203163 | |
| **Sample ID:** **G13040477-001ADUP** | Sample Duplicate | | | | Run: PHSC_101-G_130425A | | | 04/25/13 16:58 | |
| pH | 7.76 | s.u. | 0.010 | | | | 0.0 | 1.5 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Project:** Surface_Water

**Report Date:** 05/08/13
**Work Order:** G13040481

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8260B** | | | | | | | | | Batch: R203975 |
| **Sample ID: LCS_050213** | Laboratory Control Sample | | | | Run: SV5972.I_130502B | | | | 05/02/13 14:43 |
| Benzene | 5.32 | ug/L | 1.0 | 106 | 71 | 133 | | | |
| Ethylbenzene | 5.36 | ug/L | 1.0 | 107 | 78 | 131 | | | |
| n-Hexane | 5.64 | ug/L | 1.0 | 113 | 70 | 130 | | | |
| Toluene | 5.32 | ug/L | 1.0 | 106 | 78 | 134 | | | |
| m+p-Xylenes | 10.5 | ug/L | 1.0 | 105 | 78 | 133 | | | |
| o-Xylene | 5.28 | ug/L | 1.0 | 106 | 79 | 136 | | | |
| Surr: 1,2-Dichloroethane-d4 | | | 1.0 | 108 | 70 | 130 | | | |
| Surr: Dibromofluoromethane | | | 1.0 | 112 | 77 | 126 | | | |
| Surr: p-Bromofluorobenzene | | | 1.0 | 109 | 76 | 127 | | | |
| Surr: Toluene-d8 | | | 1.0 | 104 | 79 | 122 | | | |
| **Sample ID: BLK_050213** | Method Blank | | | | Run: SV5972.I_130502B | | | | 05/02/13 15:12 |
| Benzene | ND | ug/L | 1.0 | | | | | | |
| Ethylbenzene | ND | ug/L | 1.0 | | | | | | |
| n-Hexane | ND | ug/L | 1.0 | | | | | | |
| Toluene | ND | ug/L | 1.0 | | | | | | |
| m+p-Xylenes | ND | ug/L | 1.0 | | | | | | |
| o-Xylene | ND | ug/L | 1.0 | | | | | | |
| Xylenes, Total | ND | ug/L | 1.0 | | | | | | |
| Surr: 1,2-Dichloroethane-d4 | | | 1.0 | 108 | 70 | 130 | | | |
| Surr: Dibromofluoromethane | | | 1.0 | 108 | 77 | 126 | | | |
| Surr: p-Bromofluorobenzene | | | 1.0 | 113 | 76 | 127 | | | |
| Surr: Toluene-d8 | | | 1.0 | 104 | 79 | 122 | | | |
| **Sample ID: B13042113-001A_MS** | Sample Matrix Spike | | | | Run: SV5972.I_130502B | | | | 05/02/13 22:26 |
| Benzene | 5.52 | ug/L | 1.0 | 110 | 71 | 133 | | | |
| Ethylbenzene | 5.52 | ug/L | 1.0 | 110 | 78 | 131 | | | |
| n-Hexane | 3.80 | ug/L | 1.0 | 76 | 70 | 130 | | | |
| Toluene | 5.64 | ug/L | 1.0 | 113 | 78 | 134 | | | |
| m+p-Xylenes | 10.8 | ug/L | 1.0 | 108 | 78 | 133 | | | |
| o-Xylene | 5.52 | ug/L | 1.0 | 110 | 79 | 136 | | | |
| Surr: 1,2-Dichloroethane-d4 | | | 1.0 | 107 | 70 | 130 | | | |
| Surr: Dibromofluoromethane | | | 1.0 | 103 | 77 | 126 | | | |
| Surr: p-Bromofluorobenzene | | | 1.0 | 110 | 76 | 127 | | | |
| Surr: Toluene-d8 | | | 1.0 | 105 | 79 | 122 | | | |
| **Sample ID: B13042113-001A_MSD** | Sample Matrix Spike Duplicate | | | | Run: SV5972.I_130502B | | | | 05/02/13 22:55 |
| Benzene | 5.40 | ug/L | 1.0 | 108 | 71 | 133 | 2.2 | 20 | |
| Ethylbenzene | 5.44 | ug/L | 1.0 | 109 | 78 | 131 | 1.5 | 20 | |
| n-Hexane | 3.77 | ug/L | 1.0 | 75 | 70 | 130 | 0.8 | 20 | |
| Toluene | 5.48 | ug/L | 1.0 | 110 | 78 | 134 | 2.9 | 20 | |
| m+p-Xylenes | 10.7 | ug/L | 1.0 | 107 | 78 | 133 | 0.7 | 20 | |
| o-Xylene | 5.36 | ug/L | 1.0 | 107 | 79 | 136 | 2.9 | 20 | |
| Surr: 1,2-Dichloroethane-d4 | | | 1.0 | 108 | 70 | 130 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 05/08/13
**Project:** Surface_Water
**Work Order:** G13040481

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8260B** | | | | | | | | | Batch: R203975 |
| **Sample ID: B13042113-001A_MSD** | Sample Matrix Spike Duplicate | | | | Run: SV5972.I_130502B | | | | 05/02/13 22:55 |
| Surr: Dibromofluoromethane | | | 1.0 | 101 | 77 | 126 | | | |
| Surr: p-Bromofluorobenzene | | | 1.0 | 110 | 76 | 127 | | | |
| Surr: Toluene-d8 | | | 1.0 | 104 | 79 | 122 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 05/08/13
**Project:** Surface_Water
**Work Order:** G13040481

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Analytical Run: R204189 |
| **Sample ID: CCV_0506VA213r** | Continuing Calibration Verification Standard | | | | | | | | 05/06/13 16:34 |
| Total Purgeable Hydrocarbons | 213 | ug/L | 20 | 106 | 85 | 115 | | | |
| Surr: Trifluorotoluene | | | 1.0 | 108 | 85 | 115 | | | |
| **Method: SW8015B** | | | | | | | | | Batch: R204189 |
| **Sample ID: LCS_0506VA214r** | Laboratory Control Sample | | | | Run: VARIAN2_130506A | | | | 05/06/13 17:06 |
| Total Purgeable Hydrocarbons | 214 | ug/L | 20 | 107 | 70 | 130 | | | |
| Surr: Trifluorotoluene | | | 1.0 | 107 | 70 | 130 | | | |
| **Sample ID: MBLK_0506VA218r** | Method Blank | | | | Run: VARIAN2_130506A | | | | 05/06/13 19:13 |
| Gasoline Range Organics (GRO) | ND | ug/L | 20 | | | | | | |
| Total Purgeable Hydrocarbons | ND | ug/L | 20 | | | | | | |
| Surr: Trifluorotoluene | | | 1.0 | 89 | 70 | 130 | | | |
| **Sample ID: B13042037-001BMS** | Sample Matrix Spike | | | | Run: VARIAN2_130506A | | | | 05/06/13 21:20 |
| Total Purgeable Hydrocarbons | 18100 | ug/L | 1000 | 99 | 70 | 130 | | | |
| Surr: Trifluorotoluene | | | 50 | 120 | 70 | 130 | | | |
| **Sample ID: B13042037-001BMSD** | Sample Matrix Spike Duplicate | | | | Run: VARIAN2_130506A | | | | 05/06/13 21:51 |
| Total Purgeable Hydrocarbons | 18200 | ug/L | 1000 | 100 | 70 | 130 | 0.4 | 20 | |
| Surr: Trifluorotoluene | | | 50 | 121 | 70 | 130 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R204193 |
| **Sample ID: CCV_0504VA204r** | Continuing Calibration Verification Standard | | | | | | | | 05/04/13 20:30 |
| Total Purgeable Hydrocarbons | 207 | ug/L | 20 | 103 | 85 | 115 | | | |
| Surr: Trifluorotoluene | | | 1.0 | 107 | 85 | 115 | | | |
| **Method: SW8015B** | | | | | | | | | Batch: R204193 |
| **Sample ID: LCS_0504VA205r** | Laboratory Control Sample | | | | Run: VARIAN2_130504A | | | | 05/04/13 21:02 |
| Total Purgeable Hydrocarbons | 213 | ug/L | 20 | 106 | 70 | 130 | | | |
| Surr: Trifluorotoluene | | | 1.0 | 109 | 70 | 130 | | | |
| **Sample ID: MBLK_0504VA207r** | Method Blank | | | | Run: VARIAN2_130504A | | | | 05/04/13 22:07 |
| Gasoline Range Organics (GRO) | ND | ug/L | 20 | | | | | | |
| Total Purgeable Hydrocarbons | ND | ug/L | 20 | | | | | | |
| Surr: Trifluorotoluene | | | 1.0 | 101 | 70 | 130 | | | |
| **Sample ID: B13050323-002KMS** | Sample Matrix Spike | | | | Run: VARIAN2_130504A | | | | 05/04/13 22:39 |
| Total Purgeable Hydrocarbons | 15200 | ug/L | 1000 | 113 | 70 | 130 | | | |
| Surr: Trifluorotoluene | | | 50 | 105 | 70 | 130 | | | |
| **Sample ID: B13050323-002KMSD** | Sample Matrix Spike Duplicate | | | | Run: VARIAN2_130504A | | | | 05/04/13 23:11 |
| Total Purgeable Hydrocarbons | 15800 | ug/L | 1000 | 119 | 70 | 130 | 3.8 | 20 | |
| Surr: Trifluorotoluene | | | 50 | 104 | 70 | 130 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 05/08/13
**Project:** Surface_Water
**Work Order:** G13040481

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Batch: 70840 |
| **Sample ID: LCS-70840** | Laboratory Control Sample | | | | Run: GCFID-FISON-B_130430B | | | | 04/30/13 20:05 |
| Diesel Range Organics (DRO) | 15.5 | mg/L | 0.30 | 103 | 60 | 140 | | | |
| Total Extractable Hydrocarbons | 16.1 | mg/L | 0.30 | 108 | 60 | 140 | | | |
| Surr: o-Terphenyl | | | 0.0040 | 99 | 50 | 150 | | | |
| **Sample ID: MB-70840** | Method Blank | | | | Run: GCFID-FISON-B_130430B | | | | 04/30/13 21:46 |
| Diesel Range Organics (DRO) | ND | mg/L | 0.30 | | | | | | |
| Total Extractable Hydrocarbons | ND | mg/L | 0.30 | | | | | | |
| Surr: o-Terphenyl | | | 0.0040 | 101 | 50 | 150 | | | |
| **Sample ID: B13041901-001AMS** | Sample Matrix Spike | | | | Run: GCFID-FISON-B_130430C | | | | 05/01/13 20:01 |
| Diesel Range Organics (DRO) | 30.2 | mg/L | 6.0 | 87 | 60 | 140 | | | |
| Total Extractable Hydrocarbons | 39.2 | mg/L | 6.0 | 89 | 60 | 140 | | | |
| Surr: o-Terphenyl | | | 0.080 | 82 | 50 | 150 | | | |
| **Sample ID: B13041901-001AMSD** | Sample Matrix Spike Duplicate | | | | Run: GCFID-FISON-B_130430C | | | | 05/01/13 20:51 |
| Diesel Range Organics (DRO) | 33.6 | mg/L | 6.0 | 99 | 60 | 140 | 11 | 20 | |
| Total Extractable Hydrocarbons | 44.4 | mg/L | 6.0 | 107 | 60 | 140 | 13 | 20 | |
| Surr: o-Terphenyl | | | 0.080 | 56 | 50 | 150 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R203923 |
| **Sample ID: CCV_0430FIS31r** | Continuing Calibration Verification Standard | | | | | | | | 05/01/13 16:42 |
| Total Extractable Hydrocarbons | 15.0 | mg/L | 0.30 | 100 | 85 | 115 | | | |
| Surr: o-Terphenyl | | | 0.0040 | 87 | 85 | 115 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 05/08/13
**Project:** Surface_Water
**Work Order:** G13040481

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Batch: 70821 |
| **Sample ID: LCS-70821** | Laboratory Control Sample | | | | Run: GCFID-HP1-B_130429A | | | | 04/29/13 08:57 |
| Methanol | 50.6 | mg/L | 1.0 | 101 | 71 | 128 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 95 | 80 | 120 | | | |
| **Sample ID: MB-70821** | Method Blank | | | | Run: GCFID-HP1-B_130429A | | | | 04/29/13 09:20 |
| Methanol | ND | mg/L | 1.0 | | | | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 93 | 80 | 120 | | | |
| **Sample ID: B13041993-001BMS** | Sample Matrix Spike | | | | Run: GCFID-HP1-B_130429A | | | | 04/29/13 10:05 |
| Methanol | 952 | mg/L | 5.0 | 96 | 71 | 128 | | | |
| Surr: sec-Butyl Alcohol | | | 5.0 | 95 | 80 | 120 | | | |
| **Sample ID: B13041993-001BMSD** | Sample Matrix Spike Duplicate | | | | Run: GCFID-HP1-B_130429A | | | | 04/29/13 10:28 |
| Methanol | 902 | mg/L | 5.0 | 76 | 71 | 128 | 5.4 | 20 | |
| Surr: sec-Butyl Alcohol | | | 5.0 | 93 | 80 | 120 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R203753 |
| **Sample ID: CCV_0429HM103r-W** | Continuing Calibration Verification Standard | | | | | | | | 04/29/13 08:34 |
| Methanol | 92.9 | mg/L | 1.0 | 93 | 85 | 115 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 93 | 80 | 120 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# Standard Reporting Procedures

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

# Workorder Receipt Checklist

## Marathon Oil Company G13040481

Login completed by: Amanda Alley
Date Received: 4/25/2013
Reviewed by: BL2000\kscottruff
Received by: ala
Reviewed Date: 4/25/2013
Carrier name: FedEx

| | | | |
|---|---|---|---|
| Shipping container/cooler in good condition? | Yes ☑ | No ☐ | Not Present ☐ |
| Custody seals intact on shipping container/cooler? | Yes ☑ | No ☐ | Not Present ☐ |
| Custody seals intact on sample bottles? | Yes ☐ | No ☐ | Not Present ☑ |
| Chain of custody present? | Yes ☑ | No ☐ | |
| Chain of custody signed when relinquished and received? | Yes ☑ | No ☐ | |
| Chain of custody agrees with sample labels? | Yes ☑ | No ☐ | |
| Samples in proper container/bottle? | Yes ☑ | No ☐ | |
| Sample containers intact? | Yes ☑ | No ☐ | |
| Sufficient sample volume for indicated test? | Yes ☑ | No ☐ | |
| All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.) | Yes ☑ | No ☐ | |
| Temp Blank received? | Yes ☑ | No ☐ | Not Applicable ☐ |
| Container/Temp Blank temperature: | 1.8°C On Ice | | |
| Water - VOA vials have zero headspace? | Yes ☑ | No ☐ | No VOA vials submitted ☐ |
| Water - pH acceptable upon receipt? | Yes ☑ | No ☐ | Not Applicable ☐ |

Contact and Corrective Action Comments:

None

# Chain of Custody and Analytical Request Record

ENERGY LABORATORIES



**PLEASE PRINT (Provide as much information as possible.)**

Company Name: Marathon Oil

Project Name, PWS, Permit, Etc.: 32C_Little_Creek/Surface_Water

Sample Origin State: CO

EPA/State Compliance: Yes ☒ No ☐

Report Mail Address (Required): 743 Horizon Ct., Suite 220, Grand Junction, CO 81506

Contact Name: Zach Toellner

Phone/Fax:

Cell: (970) 260-0772

Sampler: (Please Print) Scott Distel

❑ No Hard Copy Email:

Invoice Contact & Phone: Stacey Wales (970) 244-5725

Purchase Order:

Quote/Bottle Order:

Invoice Address (Required): 743 Horizon Ct., Suite 220, Grand Junction, CO 81506

❑ No Hard Copy Email:

Special Report/Formats:

☐ DW ☒ EDD/EDT (Electronic Data)
☐ POTW/WWTP Format:
☐ State: ☐ LEVEL IV
☒ Other: PDF ☐ NELAC

ANALYSIS REQUESTED

Number of Containers
Sample Type: A W S V B O DW
Air Water Soils/Solids Vegetation Bioassay Other DW - Drinking Water

| SAMPLE IDENTIFICATION (Name, Location, Interval, etc.) | Collection Date | Collection Time | MATRIX | TSS | TDS | pH | | | | | | | SEE ATTACHED | Standard Turnaround (TAT) | RUSH | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 WT_LC_Upstream | 4/24/13 | 12:30 | 9W | X | X | X | | | | | | | X | X | | SP |
| 2 WT_LC_Downstream | 4/24/13 | 12:45 | 9W | X | X | X | | | | | | | X | X | | SP |
| 3 | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Shipped by: Fed Ex

Cooler ID(s):

Receipt Temp 1.3 °C

On Ice: (Y) N

Custody Seal: On Bottle Y (N) / On Cooler Y N / Intact Y N / Signature Match Y N

LABORATORY USE ONLY 1304048

**Custody Record MUST be Signed**

Relinquished by (print): Scott Distel Date/Time: 4/24/13 @ 16:30 Signature: Scott Distel

Relinquished by (print): Date/Time: Signature:

Sample Disposal: Return to Client: Lab Disposal:

Received by (print): Date/Time: Signature:

Received by (print): Date/Time: Signature:

Received by Laboratory: Date/Time: 4/25/13 10:30 Signature:

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested.
This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.
Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

the self-certification process to demonstrate compliance with emission limits. (Reference: Regulation No. 3, Part B, Section III.E.)

**Periodic Testing Requirements**

18. **AIRS Point 001**: The operator shall sample the wastewater inlet to the pond system (or the gun barrel separator tank wastewater outlet) to determine volatile organic compounds (VOC) and hazardous air pollutant (HAP) concentrations, including total hydrocarbons (including gasoline range and diesel range), benzene, toluene, ethylbenzene, xylene, and methanol. These samples shall be analyzed using EPA Method 8260 for benzene, toluene, ethylbenzene, and xylene, and EPA Method 8015 for methanol, gasoline range organics (total volatile hydrocarbons), and diesel range organics (total extractable hydrocarbons).

A sample of the wastewater inlet to the pond system (or the gun barrel separator tank wastewater outlet) shall be collected and analyzed at a minimum frequency of once per calendar month. Sample results shall be used to calculate emissions as required by Condition 12. If more frequent sampling is conducted, then all samples of the wastewater inlet to the pond collected during the calendar month will be averaged and then used to calculate emissions as specified in Condition 12. Samples shall be collected no less than at least seven (7) days apart. The operator shall maintain records of all sampling events and the records shall be made available to the Division for inspection upon request. The operator shall flag monthly records if any sampling results are noted by the laboratory as beyond QA/QC criteria limits.

**ADDITIONAL REQUIREMENTS**

19. A revised Air Pollutant Emission Notice (APEN) shall be filed: (Reference: Regulation No. 3, Part A, II.C)
    a. Annually whenever a significant increase in emissions occurs as follows:

       **For any criteria pollutant:**

       For sources emitting **less than 100 tons per year**, a change in actual emissions of five (5) tons per year or more, above the level reported on the last APEN; or

       **For any non-criteria reportable pollutant:**

       If the emissions increase by 50% or five (5) tons per year, whichever is less, above the level reported on the last APEN submitted to the Division.

    b. Whenever there is a change in the owner or operator of any facility, process, or activity; or

    c. Whenever new control equipment is installed, or whenever a different type of control equipment replaces an existing type of control equipment; or

    d. Whenever a permit limitation must be modified; or

    e. No later than 30 days before the existing APEN expires.

20. Federal regulatory program requirements (i.e. PSD, NANSR or Title V Operating Permit) shall apply to this source at any such time that this source becomes major solely by virtue of a relaxation in any permit condition. Any relaxation that increases the potential to emit above the applicable Federal program threshold will require a full review of the

Please analyze WT_LC_Upstream and WT_LC_Downstream in accordance with the highlighted Section. Thank you, Jeff Deal

# APPENDIX B-2

# MAY 10, 2013 ANALYSES

# ANALYTICAL SUMMARY REPORT

May 22, 2013

Marathon Oil Company
743 Horizon Court Ste. 220
Grand Junction, CO 81506

Workorder No.: G13050357 Quote ID: G342 - 32C APEN and Pond Complex

Project Name: Surface_Water

Energy Laboratories Inc. Gillette WY received the following 5 samples for Marathon Oil Company on 5/14/2013 for analysis.

| Sample ID | Client Sample ID | Collect Date | Receive Date | Matrix | Test |
|---|---|---|---|---|---|
| G13050357-001 | WT_LC_Upstream2 | 05/10/13 15:45 | 05/14/13 | Aqueous | Conductivity<br>DRO-Liquid-Liquid Extraction<br>Diesel Range Organics<br>Gasoline Range Organics<br>Methanol Waters-Prep<br>Non-Halogenated Organics by GC-FID<br>pH<br>Solids, Total Dissolved<br>Solids, Total Suspended |
| G13050357-002 | WT_LC_Upstream | 05/10/13 16:15 | 05/14/13 | Aqueous | Same As Above |
| G13050357-003 | WT_LC_Downstream | 05/10/13 16:45 | 05/14/13 | Aqueous | Same As Above |
| G13050357-004 | WT_LC_Spring | 05/10/13 17:25 | 05/14/13 | Aqueous | Same As Above |
| G13050357-005 | WT_LR_Pit | 05/10/13 18:15 | 05/14/13 | Aqueous | Same As Above |

The analyses presented in this report were performed by Energy Laboratories, Inc., 400 W. Boxelder Rd., Gillette, WY 82718, unless otherwise noted.

As appropriate, any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these tests results, please call.

Report Approved By:

**CLIENT:** Marathon Oil Company
**Project:** Surface_Water
**Sample Delivery Group:** G13050357

**Report Date:** 05/22/13

# CASE NARRATIVE

Tests associated with analyst identified as ELI-B were subcontracted to Energy Laboratories, 1120 S. 27th St., Billings, MT, EPA Number MT00005.

The samples for Upstream and Pit were not received until 05/16/2013.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Site Name:** 32C_Little_Creek
**Project:** Surface_Water
**Client Sample ID:** WT_LC_Upstream2
**Location:**
**Samp FRQ/Type:**
**Lab ID:** G13050357-001

**Report Date:** 05/22/13
**Collection Date:** 05/10/13 15:45
**Date Received:** 05/14/13
**Sampled By:** Matthew Fought
**Matrix:** Aqueous
**Tracking Number:**

| Analyses | Result | Units | RL | Qualifier | Method | Analysis Date / By |
|---|---|---|---|---|---|---|
| **NON-METALS** | | | | | | |
| pH | 8.36 | s.u. | 0.01 | H | A4500-H B | 05/15/13 12:42 / blb |
| Solids, Total Dissolved TDS @ 180 C | 285 | mg/L | 20 | | A2540 C | 05/16/13 08:40 / blb |
| Solids, Total Suspended TSS @ 105 C | 11 | mg/L | 10 | | A2540 D | 05/16/13 11:54 / jab |
| **NON-HALOGENATED ORGANICS BY GC-FID** | | | | | | |
| Methanol | ND | mg/L | 1.0 | | SW8015B | 05/16/13 09:56 / eli-b |
| Surr: sec-Butyl Alcohol | 96.0 | %REC | 80-120 | | SW8015B | 05/16/13 09:56 / eli-b |
| **PETROLEUM HYDROCARBONS-VOLATILE** | | | | | | |
| Gasoline Range Organics (GRO) | ND | ug/L | 20 | | SW8015B | 05/20/13 13:10 / eli-b |
| Total Purgeable Hydrocarbons | ND | ug/L | 20 | | SW8015B | 05/20/13 13:10 / eli-b |
| Surr: Trifluorotoluene | 91.0 | %REC | 70-130 | | SW8015B | 05/20/13 13:10 / eli-b |
| - Note 1: Gasoline Range Organics(GRO) are defined as all hydrocarbons eluting between 2-Methylpentane and 1,2,4-Trimethylbenzene. | | | | | | |
| - Note 2: Total Purgeable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **PETROLEUM HYDROCARBONS-SEMI-VOLATILE** | | | | | | |
| Diesel Range Organics (DRO) | ND | mg/L | 0.30 | | SW8015B | 05/18/13 16:26 / eli-b |
| Total Extractable Hydrocarbons | 0.52 | mg/L | 0.30 | | SW8015B | 05/18/13 16:26 / eli-b |
| Surr: o-Terphenyl | 67.0 | %REC | 50-150 | | SW8015B | 05/18/13 16:26 / eli-b |
| - Note 1: Diesel Range Organics are defined as all hydrocarbons eluting between C10 and C28. | | | | | | |
| - Note 2: Total Extractable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |

**Report Definitions:**
RL - Analyte reporting limit.
QCL - Quality control limit.
H - Analysis performed past recommended holding time.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Site Name:** 32C_Little_Creek
**Project:** Surface_Water
**Client Sample ID:** WT_LC_Upstream
**Location:**
**Samp FRQ/Type:**
**Lab ID:** G13050357-002

**Report Date:** 05/22/13
**Collection Date:** 05/10/13 16:15
**Date Received:** 05/14/13
**Sampled By:** Matthew Fought
**Matrix:** Aqueous
**Tracking Number:**

| Analyses | Result | Units | RL | Qualifier | Method | Analysis Date / By |
|---|---|---|---|---|---|---|
| **NON-METALS** | | | | | | |
| pH | 8.62 | s.u. | 0.01 | H | A4500-H B | 05/15/13 12:44 / blb |
| Solids, Total Dissolved TDS @ 180 C | 301 | mg/L | 20 | | A2540 C | 05/16/13 08:40 / blb |
| Solids, Total Suspended TSS @ 105 C | 14 | mg/L | 10 | | A2540 D | 05/16/13 11:55 / jab |
| **NON-HALOGENATED ORGANICS BY GC-FID** | | | | | | |
| Methanol | ND | mg/L | 1.0 | | SW8015B | 05/16/13 11:05 / eli-b |
| Surr: sec-Butyl Alcohol | 95.0 | %REC | 80-120 | | SW8015B | 05/16/13 11:05 / eli-b |
| **PETROLEUM HYDROCARBONS-VOLATILE** | | | | | | |
| Gasoline Range Organics (GRO) | ND | ug/L | 20 | | SW8015B | 05/20/13 13:44 / eli-b |
| Total Purgeable Hydrocarbons | ND | ug/L | 20 | | SW8015B | 05/20/13 13:44 / eli-b |
| Surr: Trifluorotoluene | 97.0 | %REC | 70-130 | | SW8015B | 05/20/13 13:44 / eli-b |
| - Note 1: Gasoline Range Organics(GRO) are defined as all hydrocarbons eluting between 2-Methylpentane and 1,2,4-Trimethylbenzene. | | | | | | |
| - Note 2: Total Purgeable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **PETROLEUM HYDROCARBONS-SEMI-VOLATILE** | | | | | | |
| Diesel Range Organics (DRO) | ND | mg/L | 0.30 | | SW8015B | 05/18/13 17:16 / eli-b |
| Total Extractable Hydrocarbons | 0.68 | mg/L | 0.30 | | SW8015B | 05/18/13 17:16 / eli-b |
| Surr: o-Terphenyl | 88.0 | %REC | 50-150 | | SW8015B | 05/18/13 17:16 / eli-b |
| - Note 1: Diesel Range Organics are defined as all hydrocarbons eluting between C10 and C28. | | | | | | |
| - Note 2: Total Extractable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |

**Report Definitions:**
RL - Analyte reporting limit.
QCL - Quality control limit.
H - Analysis performed past recommended holding time.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Site Name:** 32C_Little_Creek
**Project:** Surface_Water
**Client Sample ID:** WT_LC_Downstream
**Location:**
**Samp FRQ/Type:**
**Lab ID:** G13050357-003

**Report Date:** 05/22/13
**Collection Date:** 05/10/13 16:45
**Date Received:** 05/14/13
**Sampled By:** Matthew Fought
**Matrix:** Aqueous
**Tracking Number:**

| Analyses | Result | Units | RL | Qualifier | Method | Analysis Date / By |
|---|---|---|---|---|---|---|
| **NON-METALS** | | | | | | |
| pH | 8.82 | s.u. | 0.01 | H | A4500-H B | 05/15/13 12:47 / blb |
| Solids, Total Dissolved TDS @ 180 C | 277 | mg/L | 20 | | A2540 C | 05/16/13 08:40 / blb |
| Solids, Total Suspended TSS @ 105 C | 11 | mg/L | 10 | | A2540 D | 05/16/13 11:55 / jab |
| **NON-HALOGENATED ORGANICS BY GC-FID** | | | | | | |
| Methanol | ND | mg/L | 1.0 | | SW8015B | 05/16/13 11:28 / eli-b |
| Surr: sec-Butyl Alcohol | 97.0 | %REC | 80-120 | | SW8015B | 05/16/13 11:28 / eli-b |
| **PETROLEUM HYDROCARBONS-VOLATILE** | | | | | | |
| Gasoline Range Organics (GRO) | ND | ug/L | 20 | | SW8015B | 05/20/13 14:19 / eli-b |
| Total Purgeable Hydrocarbons | ND | ug/L | 20 | | SW8015B | 05/20/13 14:19 / eli-b |
| Surr: Trifluorotoluene | 95.0 | %REC | 70-130 | | SW8015B | 05/20/13 14:19 / eli-b |
| - Note 1: Gasoline Range Organics(GRO) are defined as all hydrocarbons eluting between 2-Methylpentane and 1,2,4-Trimethylbenzene. | | | | | | |
| - Note 2: Total Purgeable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **PETROLEUM HYDROCARBONS-SEMI-VOLATILE** | | | | | | |
| Diesel Range Organics (DRO) | ND | mg/L | 0.30 | | SW8015B | 05/18/13 20:33 / eli-b |
| Total Extractable Hydrocarbons | ND | mg/L | 0.30 | | SW8015B | 05/18/13 20:33 / eli-b |
| Surr: o-Terphenyl | 88.0 | %REC | 50-150 | | SW8015B | 05/18/13 20:33 / eli-b |
| - Note 1: Diesel Range Organics are defined as all hydrocarbons eluting between C10 and C28. | | | | | | |
| - Note 2: Total Extractable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |

**Report Definitions:**
RL - Analyte reporting limit.
QCL - Quality control limit.
H - Analysis performed past recommended holding time.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Site Name:** 32C_Little_Creek
**Project:** Surface_Water
**Client Sample ID:** WT_LC_Spring
**Location:**
**Samp FRQ/Type:**
**Lab ID:** G13050357-004

**Report Date:** 05/22/13
**Collection Date:** 05/10/13 17:25
**Date Received:** 05/14/13
**Sampled By:** Matthew Fought
**Matrix:** Aqueous
**Tracking Number:**

| Analyses | Result | Units | RL | Qualifier | Method | Analysis Date / By |
|---|---|---|---|---|---|---|
| **NON-METALS** | | | | | | |
| pH | 7.73 | s.u. | 0.01 | H | A4500-H B | 05/15/13 12:49 / blb |
| Solids, Total Dissolved TDS @ 180 C | 353 | mg/L | 20 | | A2540 C | 05/16/13 08:41 / blb |
| Solids, Total Suspended TSS @ 105 C | ND | mg/L | 10 | | A2540 D | 05/16/13 11:55 / jab |
| **NON-HALOGENATED ORGANICS BY GC-FID** | | | | | | |
| Methanol | ND | mg/L | 1.0 | | SW8015B | 05/16/13 11:50 / eli-b |
| Surr: sec-Butyl Alcohol | 93.0 | %REC | 80-120 | | SW8015B | 05/16/13 11:50 / eli-b |
| **PETROLEUM HYDROCARBONS-VOLATILE** | | | | | | |
| Gasoline Range Organics (GRO) | ND | ug/L | 20 | | SW8015B | 05/20/13 14:53 / eli-b |
| Total Purgeable Hydrocarbons | ND | ug/L | 20 | | SW8015B | 05/20/13 14:53 / eli-b |
| Surr: Trifluorotoluene | 89.0 | %REC | 70-130 | | SW8015B | 05/20/13 14:53 / eli-b |
| - Note 1: Gasoline Range Organics(GRO) are defined as all hydrocarbons eluting between 2-Methylpentane and 1,2,4-Trimethylbenzene. | | | | | | |
| - Note 2: Total Purgeable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **PETROLEUM HYDROCARBONS-SEMI-VOLATILE** | | | | | | |
| Diesel Range Organics (DRO) | ND | mg/L | 0.30 | | SW8015B | 05/18/13 21:23 / eli-b |
| Total Extractable Hydrocarbons | ND | mg/L | 0.30 | | SW8015B | 05/18/13 21:23 / eli-b |
| Surr: o-Terphenyl | 95.0 | %REC | 50-150 | | SW8015B | 05/18/13 21:23 / eli-b |
| - Note 1: Diesel Range Organics are defined as all hydrocarbons eluting between C10 and C28. | | | | | | |
| - Note 2: Total Extractable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |

**Report Definitions:**
RL - Analyte reporting limit.
QCL - Quality control limit.
H - Analysis performed past recommended holding time.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Site Name:** 32C_Little_Creek
**Project:** Surface_Water
**Client Sample ID:** WT_LR_Pit
**Location:**
**Samp FRQ/Type:**
**Lab ID:** G13050357-005

**Report Date:** 05/22/13
**Collection Date:** 05/10/13 18:15
**Date Received:** 05/14/13
**Sampled By:** Matthew Fought
**Matrix:** Aqueous
**Tracking Number:**

| Analyses | Result | Units | RL | Qualifier | Method | Analysis Date / By |
|---|---|---|---|---|---|---|
| **NON-METALS** | | | | | | |
| pH | 7.34 | s.u. | 0.01 | H | A4500-H B | 05/15/13 12:52 / blb |
| Solids, Total Dissolved TDS @ 180 C | 5930 | mg/L | 200 | | A2540 C | 05/16/13 08:41 / blb |
| Solids, Total Suspended TSS @ 105 C | ND | mg/L | 10 | | A2540 D | 05/16/13 11:55 / jab |
| **NON-HALOGENATED ORGANICS BY GC-FID** | | | | | | |
| Methanol | 78 | mg/L | 1.0 | | SW8015B | 05/16/13 12:13 / eli-b |
| Surr: sec-Butyl Alcohol | 91.0 | %REC | 80-120 | | SW8015B | 05/16/13 12:13 / eli-b |
| **PETROLEUM HYDROCARBONS-VOLATILE** | | | | | | |
| Gasoline Range Organics (GRO) | 9320 | ug/L | 400 | | SW8015B | 05/20/13 17:16 / eli-b |
| Total Purgeable Hydrocarbons | 9630 | ug/L | 400 | | SW8015B | 05/20/13 17:16 / eli-b |
| Surr: Trifluorotoluene | 115 | %REC | 70-130 | | SW8015B | 05/20/13 17:16 / eli-b |
| - Note 1: Gasoline Range Organics(GRO) are defined as all hydrocarbons eluting between 2-Methylpentane and 1,2,4-Trimethylbenzene. | | | | | | |
| - Note 2: Total Purgeable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **PETROLEUM HYDROCARBONS-SEMI-VOLATILE** | | | | | | |
| Diesel Range Organics (DRO) | 6.9 | mg/L | 3.0 | | SW8015B | 05/18/13 23:01 / eli-b |
| Total Extractable Hydrocarbons | 13 | mg/L | 3.0 | | SW8015B | 05/18/13 23:01 / eli-b |
| Surr: o-Terphenyl | 82.0 | %REC | 50-150 | | SW8015B | 05/18/13 23:01 / eli-b |
| - Note 1: Diesel Range Organics are defined as all hydrocarbons eluting between C10 and C28. | | | | | | |
| - Note 2: Total Extractable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |

**Report Definitions:**
RL - Analyte reporting limit.
QCL - Quality control limit.
H - Analysis performed past recommended holding time.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Project:** Surface_Water

**Report Date:** 05/22/13
**Work Order:** G13050357

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: A2540 C** | | | | | | | | | Batch: TDS130516A |
| **Sample ID: MB-1_130516A** | Method Blank | | | | Run: BAL-MET-AE_130516B | | | | 05/16/13 08:35 |
| Solids, Total Dissolved TDS @ 180 C | ND | mg/L | 5 | | | | | | |
| **Sample ID: LCS-2_130516A** | Laboratory Control Sample | | | | Run: BAL-MET-AE_130516B | | | | 05/16/13 08:35 |
| Solids, Total Dissolved TDS @ 180 C | 1090 | mg/L | 11 | 98 | 90 | 110 | | | |
| **Sample ID: G13050346-001A MS** | Sample Matrix Spike | | | | Run: BAL-MET-AE_130516B | | | | 05/16/13 08:36 |
| Solids, Total Dissolved TDS @ 180 C | 2340 | mg/L | 37 | 98 | 90 | 110 | | | |
| **Sample ID: G13050353-004A DUP** | Sample Duplicate | | | | Run: BAL-MET-AE_130516B | | | | 05/16/13 08:38 |
| Solids, Total Dissolved TDS @ 180 C | 1190 | mg/L | 16 | | | | 0.8 | 5 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Report Date:** 05/22/13
**Project:** Surface_Water
**Work Order:** G13050357

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** **A2540 D** | | | | | | | | Batch: 130516_1_SLDS-TSS-W | |
| **Sample ID:** **MBLK-1_130516** | Method Blank | | | | Run: BAL-MET-AE_130516A | | | 05/16/13 11:52 | |
| Solids, Total Suspended TSS @ 105 C | ND | mg/L | 1 | | | | | | |
| **Sample ID:** **LCS-1_130516** | Laboratory Control Sample | | | | Run: BAL-MET-AE_130516A | | | 05/16/13 11:52 | |
| Solids, Total Suspended TSS @ 105 C | 90 | mg/L | 10 | 90 | 80 | 120 | | | |
| **Sample ID:** **G13050280-001ADUP** | Sample Duplicate | | | | Run: BAL-MET-AE_130516A | | | 05/16/13 11:52 | |
| Solids, Total Suspended TSS @ 105 C | ND | mg/L | 10 | | | | | 5 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Report Date:** 05/22/13
**Project:** Surface_Water
**Work Order:** G13050357

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** **A4500-H B** | | | | | | | | Analytical Run: PHSC_101-G_130515A | |
| **Sample ID:** **pH 8** | Initial Calibration Verification Standard | | | | | | | 05/15/13 11:19 | |
| pH | 7.98 | s.u. | 0.010 | 100 | 98 | 102 | | | |
| **Method:** **A4500-H B** | | | | | | | | Batch: R203618 | |
| **Sample ID:** **G13050347-002ADUP** | Sample Duplicate | | | | Run: PHSC_101-G_130515A | | | 05/15/13 12:29 | |
| pH | 8.34 | s.u. | 0.010 | | | | 0.0 | 1.5 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 05/21/13
**Project:** Surface_Water
**Work Order:** G13050357

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Analytical Run: R204979 |
| **Sample ID: CCV_0520PE104r** | Continuing Calibration Verification Standard | | | | | | | | 05/20/13 10:49 |
| Total Purgeable Hydrocarbons | 196 | ug/L | 20 | 98 | 85 | 115 | | | |
| Surr: Trifluorotoluene | | | 1.0 | 98 | 85 | 115 | | | |
| **Method: SW8015B** | | | | | | | | | Batch: R204979 |
| **Sample ID: LCS_0520PE105r** | Laboratory Control Sample | | | | Run: PE 1_130520A | | | | 05/20/13 11:23 |
| Total Purgeable Hydrocarbons | 180 | ug/L | 20 | 90 | 70 | 130 | | | |
| Surr: Trifluorotoluene | | | 1.0 | 91 | 70 | 130 | | | |
| **Sample ID: MBLK_0520PE107r** | Method Blank | | | | Run: PE 1_130520A | | | | 05/20/13 12:35 |
| Gasoline Range Organics (GRO) | ND | ug/L | 20 | | | | | | |
| Total Purgeable Hydrocarbons | ND | ug/L | 20 | | | | | | |
| Surr: Trifluorotoluene | | | 1.0 | 83 | 70 | 130 | | | |
| **Sample ID: G13050357-002DMS** | Sample Matrix Spike | | | | Run: PE 1_130520A | | | | 05/20/13 18:59 |
| Total Purgeable Hydrocarbons | 392 | ug/L | 40 | 98 | 70 | 130 | | | |
| Surr: Trifluorotoluene | | | 2.0 | 93 | 70 | 130 | | | |
| **Sample ID: G13050357-002DMSD** | Sample Matrix Spike Duplicate | | | | Run: PE 1_130520A | | | | 05/20/13 19:34 |
| Total Purgeable Hydrocarbons | 360 | ug/L | 40 | 90 | 70 | 130 | 8.4 | 20 | |
| Surr: Trifluorotoluene | | | 2.0 | 89 | 70 | 130 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 05/21/13
**Project:** Surface_Water
**Work Order:** G13050357

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Batch: 71321 |
| **Sample ID: LCS-71321** | Laboratory Control Sample | | | | Run: GCFID-FISON-B_130517A | | | | 05/18/13 09:48 |
| Diesel Range Organics (DRO) | 13.9 | mg/L | 0.30 | 93 | 60 | 140 | | | |
| Total Extractable Hydrocarbons | 14.6 | mg/L | 0.30 | 97 | 60 | 140 | | | |
| Surr: o-Terphenyl | | | 0.0040 | 93 | 50 | 150 | | | |
| **Sample ID: MB-71321** | Method Blank | | | | Run: GCFID-FISON-B_130517A | | | | 05/18/13 10:38 |
| Diesel Range Organics (DRO) | ND | mg/L | 0.30 | | | | | | |
| Total Extractable Hydrocarbons | ND | mg/L | 0.30 | | | | | | |
| Surr: o-Terphenyl | | | 0.0040 | 76 | 50 | 150 | | | |
| **Sample ID: B13051214-002AMS** | Sample Matrix Spike | | | | Run: GCFID-FISON-B_130517A | | | | 05/18/13 13:08 |
| Diesel Range Organics (DRO) | 60.0 | mg/L | 6.1 | 105 | 60 | 140 | | | |
| Total Extractable Hydrocarbons | 127 | mg/L | 6.1 | 140 | 60 | 140 | | | |
| Surr: o-Terphenyl | | | 0.081 | 88 | 50 | 150 | | | |
| **Sample ID: B13051214-002AMSD** | Sample Matrix Spike Duplicate | | | | Run: GCFID-FISON-B_130517A | | | | 05/18/13 13:57 |
| Diesel Range Organics (DRO) | 55.1 | mg/L | 6.1 | 88 | 60 | 140 | 8.6 | 20 | |
| Total Extractable Hydrocarbons | 108 | mg/L | 6.1 | 78 | 60 | 140 | 16 | 20 | |
| Surr: o-Terphenyl | | | 0.081 | 78 | 50 | 150 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R204868 |
| **Sample ID: CCV_0517FIS29r** | Continuing Calibration Verification Standard | | | | | | | | 05/18/13 08:09 |
| Total Extractable Hydrocarbons | 15.5 | mg/L | 0.30 | 103 | 85 | 115 | | | |
| Surr: o-Terphenyl | | | 0.0040 | 92 | 85 | 115 | | | |
| **Sample ID: CCV_0517FIS42r** | Continuing Calibration Verification Standard | | | | | | | | 05/18/13 18:54 |
| Total Extractable Hydrocarbons | 15.6 | mg/L | 0.30 | 104 | 85 | 115 | | | |
| Surr: o-Terphenyl | | | 0.0040 | 92 | 85 | 115 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Project:** Surface_Water

**Report Date:** 05/21/13
**Work Order:** G13050357

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Batch: 71334 |
| **Sample ID: LCS-71334** | Laboratory Control Sample | | | | Run: GCFID-HP1-B_130516A | | | | 05/16/13 09:10 |
| Methanol | 49.4 | mg/L | 1.0 | 99 | 71 | 128 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 96 | 80 | 120 | | | |
| **Sample ID: MB-71334** | Method Blank | | | | Run: GCFID-HP1-B_130516A | | | | 05/16/13 09:33 |
| Methanol | ND | mg/L | 1.0 | | | | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 91 | 80 | 120 | | | |
| **Sample ID: G13050357-001BMS** | Sample Matrix Spike | | | | Run: GCFID-HP1-B_130516A | | | | 05/16/13 10:19 |
| Methanol | 49.4 | mg/L | 1.0 | 94 | 71 | 128 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 88 | 80 | 120 | | | |
| **Sample ID: G13050357-001BMSD** | Sample Matrix Spike Duplicate | | | | Run: GCFID-HP1-B_130516A | | | | 05/16/13 10:41 |
| Methanol | 50.6 | mg/L | 1.0 | 96 | 71 | 128 | 2.3 | 20 | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 93 | 80 | 120 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R204774 |
| **Sample ID: CCV_0516HM105r-W** | Continuing Calibration Verification Standard | | | | | | | | 05/16/13 08:47 |
| Methanol | 90.1 | mg/L | 1.0 | 90 | 85 | 115 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 93 | 80 | 120 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# Standard Reporting Procedures

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

# Workorder Receipt Checklist

## Marathon Oil Company G13050357

Login completed by: Amanda Alley
Date Received: 5/14/2013
Reviewed by: BL2000\kscottruff
Received by: caf
Reviewed Date: 5/15/2013
Carrier name: FedEx

| | | | |
|---|---|---|---|
| Shipping container/cooler in good condition? | Yes ☑ | No ☐ | Not Present ☐ |
| Custody seals intact on shipping container(s)/cooler(s)? | Yes ☑ | No ☐ | Not Present ☐ |
| Custody seals intact on all sample bottles? | Yes ☐ | No ☐ | Not Present ☑ |
| Chain of custody present? | Yes ☑ | No ☐ | |
| Chain of custody signed when relinquished and received? | Yes ☑ | No ☐ | |
| Chain of custody agrees with sample labels? | Yes ☑ | No ☐ | |
| Samples in proper container/bottle? | Yes ☑ | No ☐ | |
| Sample containers intact? | Yes ☑ | No ☐ | |
| Sufficient sample volume for indicated test? | Yes ☑ | No ☐ | |
| All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.) | Yes ☑ | No ☐ | |
| Temp Blank received in all shipping container(s)/cooler(s)? | Yes ☑ | No ☐ | Not Applicable ☐ |
| Container/Temp Blank temperature: | 2.6℃ On Ice | | |
| Water - VOA vials have zero headspace? | Yes ☑ | No ☐ | No VOA vials submitted ☐ |
| Water - pH acceptable upon receipt? | Yes ☑ | No ☐ | Not Applicable ☐ |

Contact and Corrective Action Comments:

None

# Chain of Custody and Analytical Request Record

Page 1 of 1

**PLEASE PRINT- Provide as much information as possible.**

| | | | |
|---|---|---|---|
| Company Name: Marathon oil COMPANY | Project Name, PWS, Permit, Etc.: SURFACE_WATER / 32C_LITTLE_CREEK | Sample Origin State: CO | EPA/State Compliance: Yes ☒ No ☐ |
| Report Mail Address: Marathon oil Company 743 Horizon ct. Suite 220 Grand Jct. CO. 81506 | Contact Name: Zach Toellner Phone/Fax: 970-260-0772 Email: ZToellner@marathonoil.com | | Sampler: (Please Print) Matthew Fought |
| Invoice Address: Marathon oil company 743 Horizon ct. Suite 220 Grand Jct. CO. 81506 | Invoice Contact & Phone: STACY Wales 970-244-5725 | Purchase Order: | Quote/Bottle Order: |

Special Report/Formats – ELI must be notified prior to sample submittal for the following:

- ☐ DW
- ☐ GSA
- ☐ POTW/WWTP
- ☐ State: _____
- ☒ Other: PDF
- ☐ A2LA
- ☒ EDD/EDT (Electronic Data) Format: _____
- ☐ LEVEL IV
- ☐ NELAC

Number of Containers
Sample Type: A W S V B O
Air Water Soils/Solids Vegetation Bioassay Other

ANALYSIS REQUESTED

| SAMPLE IDENTIFICATION (Name, Location, Interval, etc.) | Collection Date | Collection Time | MATRIX | pH | TDS | TSS | METHANOL | GRO | DRO | | | | SEE ATTACHED | Normal Turnaround (TAT) | RUSH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 WT_LC_UPSTREAM2 | 5/10/13 | 15:45 | WTR | X | X | X | X | X | X | | | | | | X |
| 2 WT_LC_UPSTREAM | 5/10/13 | 16:15 | WTR | X | X | X | X | X | X | | | | | | X |
| 3 WT_LC_Downstream | 5/10/13 | 16:45 | WTR | X | X | X | X | X | X | | | | | | X |
| 4 WT_LC_SPRING | 5/10/13 | 17:25 | WTR | X | X | X | X | X | X | | | | | | X |
| 5 WT_LC_Pit | 5/10/13 | 18:15 | WTR | X | X | X | X | X | X | | | | | | X |
| 6 | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | |

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments: RUSH

Shipped by: FedEx

Cooler ID(s):

Receipt Temp 2.6 °C

On Ice: (Yes) No

Custody Seal Intact Signature Match: Y N

LABORATORY USE ONLY 3050357

**Custody Record MUST be Signed**

| | | | | | |
|---|---|---|---|---|---|
| Relinquished by (print): Matthew Fought | Date/Time: 5/13/13 / 10:25 | Signature: Matthew Fought | Received by (print): | Date/Time: | Signature: |
| Relinquished by (print): | Date/Time: | Signature: | Received by (print): | Date/Time: | Signature: |
| Sample Disposal: Return to Client: _____ Lab Disposal: _____ | | | Received by Laboratory: 5/14/13 | Date/Time: 0950 | Signature: |

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested.
This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.
Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

# APPENDIX B-3
# MAY 13, 2013 ANALYSES

Mountain States ACCUTEST LABORATORIES

05/16/13

Technical Report for

Marathon Oil

MOC 32C/ Little Creek Sampling

Accutest Job Number: D46200

Sampling Date: 05/13/13

Report to:

Marathon Oil

zjtoellner@marathonoil.com

ATTN: Zach Toellner

Total number of pages in report: **49**

Test results contained within this data package meet the requirements of the National Environmental Laboratory Accreditation Conference and/or state specific certification programs as applicable.

Scott Heideman
Laboratory Director

Client Service contact: Ann Doerr 303-425-6021

Certifications: CO (CO00049), ID, NE (CO00049), ND (R-027), NJ (CO 0007), OK (D9942), UT (NELAP CO00049), TX (T104704511)

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# Sample Summary

Marathon Oil

**Job No:** D46200

MOC 32C/ Little Creek Sampling

| Sample Number | Collected Date | Time | By | Received | Matrix Code | Type | Client Sample ID |
|---|---|---|---|---|---|---|---|
| D46200-1 | 05/13/13 | 12:25 | SD | 05/14/13 | AQ | Surface Water | SW_LC_UPSTREAM2 |
| D46200-2 | 05/13/13 | 12:45 | SD | 05/14/13 | AQ | Surface Water | SW_LC_UPSTREAM1 |
| D46200-3 | 05/13/13 | 13:05 | SD | 05/14/13 | AQ | Surface Water | SW_LC_DOWNSTREAM1 |
| D46200-4 | 05/13/13 | 13:35 | SD | 05/14/13 | AQ | Surface Water | SW_LC_DOWNSTREAM_SPRING |

# CASE NARRATIVE / CONFORMANCE SUMMARY

| | | | |
|---|---|---|---|
| **Client:** | Marathon Oil | **Job No** | D46200 |
| **Site:** | MOC 32C/ Little Creek Sampling | **Report Date** | 5/16/2013 3:42:39 PM |

On 05/14/2013, 4 sample(s), 0 Trip Blank(s), and 0 Field Blank(s) were received at Accutest Mountain States (AMS) at a temperature of 3.6 °C. The samples were intact and properly preserved, unless noted below. An AMS Job Number of D46200 was assigned to the project. The lab sample ID, client sample ID, and date of sample collection are detailed in the report's Results Summary.

Specified quality control criteria were achieved for this job except as noted below. For more information, please refer to the analytical results and QC summary pages.

## Volatiles by GCMS By Method SW846 8260B

**Matrix** AQ **Batch ID:** V7V1101

- All samples were analyzed within the recommended method holding time.
- All method blanks for this batch meet method specific criteria.
- Sample(s) D46155-1MS, D46156-1DUP were used as the QC samples indicated.

## Volatiles by GC By Method SW846 8015B

**Matrix** AQ **Batch ID:** GFA711

- All samples were analyzed within the recommended method holding time.
- Sample(s) D46200-1MS, D46200-1MSD were used as the QC samples indicated.
- All method blanks for this batch meet method specific criteria.

**Matrix** AQ **Batch ID:** GGA1063

- All samples were analyzed within the recommended method holding time.
- Sample(s) D46054-13MS, D46054-13MSD were used as the QC samples indicated.
- All method blanks for this batch meet method specific criteria.

## Extractables by GC By Method SW846-8015B

**Matrix** AQ **Batch ID:** OP7858

- All samples were extracted and analyzed within the recommended method holding time.
- Sample(s) D46054-10MS, D46054-10MSD were used as the QC samples indicated.
- All method blanks for this batch meet method specific criteria.

## Wet Chemistry By Method SM 2540C-2011

**Matrix** AQ **Batch ID:** GN20183

- All samples were analyzed within the recommended method holding time.
- All method blanks for this batch meet method specific criteria.
- Sample(s) D46200-3DUP were used as the QC samples for the Solids, Total Dissolved analysis.

## Wet Chemistry By Method SM 2540D-2011

| Matrix | AQ | Batch ID: | GN20182 |
|---|---|---|---|

- All samples were analyzed within the recommended method holding time.
- All method blanks for this batch meet method specific criteria.
- Sample(s) D46096-1DUP were used as the QC samples for the Solids, Total Suspended analysis.

## Wet Chemistry By Method SM4500HB+-2011/9040C

| Matrix | AQ | Batch ID: | GN20179 |
|---|---|---|---|

- D46200-1,2,3,4 for pH: Analysis performed past the required 15 minutes from collection time/holding time.

AMS certifies that data reported for samples received, listed on the associated custody chain or analytical task order, were produced to specifications meeting AMS's Quality System precision, accuracy and completeness objectives except as noted.

Estimated non-standard method measurement uncertainty data is available on request, based on quality control bias and implicit for standard methods. Acceptable uncertainty requires tested parameter quality control data to meet method criteria.

AMS is not responsible for data quality assumptions if partial reports are used and recommends that this report be used in its entirety. This report is authorized by AMS indicated via signature on the report cover.

# Summary of Hits



**Job Number:** D46200
**Account:** Marathon Oil
**Project:** MOC 32C/ Little Creek Sampling
**Collected:** 05/13/13



| Lab Sample ID / Analyte | Client Sample ID | Result/ Qual | RL | MDL | Units | Method |
|---|---|---|---|---|---|---|
| **D46200-1** | **SW_LC_UPSTREAM2** | | | | | |
| Solids, Total Dissolved | | 304 | 10 | | mg/l | SM 2540C-2011 |
| Solids, Total Suspended | | 15.0 | 5.0 | | mg/l | SM 2540D-2011 |
| pH [a] | | 8.35 | | | su | SM4500HB+ -2011/9040C |
| **D46200-2** | **SW_LC_UPSTREAM1** | | | | | |
| Solids, Total Dissolved | | 326 | 10 | | mg/l | SM 2540C-2011 |
| Solids, Total Suspended | | 17.0 | 5.0 | | mg/l | SM 2540D-2011 |
| pH [a] | | 8.63 | | | su | SM4500HB+ -2011/9040C |
| **D46200-3** | **SW_LC_DOWNSTREAM1** | | | | | |
| Solids, Total Dissolved | | 306 | 10 | | mg/l | SM 2540C-2011 |
| Solids, Total Suspended | | 14.0 | 5.0 | | mg/l | SM 2540D-2011 |
| pH [a] | | 8.82 | | | su | SM4500HB+ -2011/9040C |
| **D46200-4** | **SW_LC_DOWNSTREAM_SPRING** | | | | | |
| Solids, Total Dissolved | | 388 | 10 | | mg/l | SM 2540C-2011 |
| pH [a] | | 7.66 | | | su | SM4500HB+ -2011/9040C |

(a) Analysis performed past the required 15 minutes from collection time/holding time.

Mountain States ACCUTEST LABORATORIES



## Sample Results

Report of Analysis

# Report of Analysis





**Client Sample ID:** SW_LC_UPSTREAM2
**Lab Sample ID:** D46200-1
**Matrix:** AQ - Surface Water
**Method:** SW846 8260B
**Project:** MOC 32C/ Little Creek Sampling

**Date Sampled:** 05/13/13
**Date Received:** 05/14/13
**Percent Solids:** n/a

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | 7V20219.D | 1 | 05/14/13 | JL | n/a | n/a | V7V1101 |
| Run #2 | | | | | | | |

| | Purge Volume |
|---|---|
| Run #1 | 5.0 ml |
| Run #2 | |

**Purgeable Aromatics**

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| 71-43-2 | Benzene | ND | 0.0010 | 0.00027 | mg/l | |
| 108-88-3 | Toluene | ND | 0.0020 | 0.0010 | mg/l | |
| 100-41-4 | Ethylbenzene | ND | 0.0020 | 0.00033 | mg/l | |
| 1330-20-7 | Xylene (total) | ND | 0.0030 | 0.0020 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 17060-07-0 | 1,2-Dichloroethane-D4 | 101% | | 62-130% |
| 2037-26-5 | Toluene-D8 | 99% | | 70-130% |
| 460-00-4 | 4-Bromofluorobenzene | 92% | | 69-130% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





**Client Sample ID:** SW_LC_UPSTREAM2
**Lab Sample ID:** D46200-1
**Matrix:** AQ - Surface Water
**Method:** SW846 8015B
**Project:** MOC 32C/ Little Creek Sampling

**Date Sampled:** 05/13/13
**Date Received:** 05/14/13
**Percent Solids:** n/a

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | FA11622.D | 1 | 05/16/13 | AV | n/a | n/a | GFA711 |
| Run #2 | | | | | | | |

| | Initial Volume | Final Volume |
|---|---|---|
| Run #1 | 1.0 ml | 1.0 ml |
| Run #2 | | |

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| 67-56-1 | Methanol | ND | 0.50 | 0.40 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 71-36-3 | n-Butyl Alcohol | 94% | | 25-169% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





**Client Sample ID:** SW_LC_UPSTREAM2
**Lab Sample ID:** D46200-1
**Matrix:** AQ - Surface Water
**Method:** SW846 8015B
**Project:** MOC 32C/ Little Creek Sampling

**Date Sampled:** 05/13/13
**Date Received:** 05/14/13
**Percent Solids:** n/a

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | GA18761.D | 1 | 05/14/13 | BR | n/a | n/a | GGA1063 |
| Run #2 | | | | | | | |

| | Purge Volume |
|---|---|
| Run #1 | 5.0 ml |
| Run #2 | |

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| | TPH-GRO (C6-C10) | ND | 0.20 | 0.10 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 120-82-1 | 1,2,4-Trichlorobenzene | 94% | | 60-140% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





**Client Sample ID:** SW_LC_UPSTREAM2
**Lab Sample ID:** D46200-1
**Matrix:** AQ - Surface Water
**Method:** SW846-8015B SW846 3510C
**Project:** MOC 32C/ Little Creek Sampling

**Date Sampled:** 05/13/13
**Date Received:** 05/14/13
**Percent Solids:** n/a

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | FH010237.D | 1 | 05/15/13 | AV | 05/15/13 | OP7858 | GFH572 |
| Run #2 | | | | | | | |

| | Initial Volume | Final Volume |
|---|---|---|
| Run #1 | 1000 ml | 1.0 ml |
| Run #2 | | |

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| | TPH-DRO (C10-C28) | ND | 0.20 | 0.18 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 84-15-1 | o-Terphenyl | 111% | | 20-140% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





| | | | |
|---|---|---|---|
| **Client Sample ID:** | SW_LC_UPSTREAM2 | | |
| **Lab Sample ID:** | D46200-1 | **Date Sampled:** | 05/13/13 |
| **Matrix:** | AQ - Surface Water | **Date Received:** | 05/14/13 |
| | | **Percent Solids:** | n/a |
| **Project:** | MOC 32C/ Little Creek Sampling | | |

**General Chemistry**

| Analyte | Result | RL | Units | DF | Analyzed | By | Method |
|---|---|---|---|---|---|---|---|
| Solids, Total Dissolved | 304 | 10 | mg/l | 1 | 05/15/13 | RW | SM 2540C-2011 |
| Solids, Total Suspended | 15.0 | 5.0 | mg/l | 1 | 05/15/13 | JD | SM 2540D-2011 |
| pH [a] | 8.35 | | su | 1 | 05/14/13 15:15 | KB | SM4500HB+ -2011/9040C |

(a) Analysis performed past the required 15 minutes from collection time/holding time.

RL = Reporting Limit

# Report of Analysis





**Client Sample ID:** SW_LC_UPSTREAM1
**Lab Sample ID:** D46200-2
**Matrix:** AQ - Surface Water
**Method:** SW846 8260B
**Project:** MOC 32C/ Little Creek Sampling

**Date Sampled:** 05/13/13
**Date Received:** 05/14/13
**Percent Solids:** n/a

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | 7V20220.D | 1 | 05/14/13 | JL | n/a | n/a | V7V1101 |
| Run #2 | | | | | | | |

| | Purge Volume |
|---|---|
| Run #1 | 5.0 ml |
| Run #2 | |

**Purgeable Aromatics**

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| 71-43-2 | Benzene | ND | 0.0010 | 0.00027 | mg/l | |
| 108-88-3 | Toluene | ND | 0.0020 | 0.0010 | mg/l | |
| 100-41-4 | Ethylbenzene | ND | 0.0020 | 0.00033 | mg/l | |
| 1330-20-7 | Xylene (total) | ND | 0.0030 | 0.0020 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 17060-07-0 | 1,2-Dichloroethane-D4 | 107% | | 62-130% |
| 2037-26-5 | Toluene-D8 | 99% | | 70-130% |
| 460-00-4 | 4-Bromofluorobenzene | 92% | | 69-130% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





**Client Sample ID:** SW_LC_UPSTREAM1
**Lab Sample ID:** D46200-2
**Matrix:** AQ - Surface Water
**Method:** SW846 8015B
**Project:** MOC 32C/ Little Creek Sampling

**Date Sampled:** 05/13/13
**Date Received:** 05/14/13
**Percent Solids:** n/a

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | FA11623.D | 1 | 05/16/13 | AV | n/a | n/a | GFA711 |
| Run #2 | | | | | | | |

| | Initial Volume | Final Volume |
|---|---|---|
| Run #1 | 1.0 ml | 1.0 ml |
| Run #2 | | |

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| 67-56-1 | Methanol | ND | 0.50 | 0.40 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 71-36-3 | n-Butyl Alcohol | 56% | | 25-169% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





**Client Sample ID:** SW_LC_UPSTREAM1
**Lab Sample ID:** D46200-2
**Matrix:** AQ - Surface Water
**Method:** SW846 8015B
**Project:** MOC 32C/ Little Creek Sampling

**Date Sampled:** 05/13/13
**Date Received:** 05/14/13
**Percent Solids:** n/a

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | GA18762.D | 1 | 05/14/13 | BR | n/a | n/a | GGA1063 |
| Run #2 | | | | | | | |

| | Purge Volume |
|---|---|
| Run #1 | 5.0 ml |
| Run #2 | |

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| | TPH-GRO (C6-C10) | ND | 0.20 | 0.10 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 120-82-1 | 1,2,4-Trichlorobenzene | 94% | | 60-140% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





**Client Sample ID:** SW_LC_UPSTREAM1
**Lab Sample ID:** D46200-2
**Matrix:** AQ - Surface Water
**Method:** SW846-8015B SW846 3510C
**Project:** MOC 32C/ Little Creek Sampling

**Date Sampled:** 05/13/13
**Date Received:** 05/14/13
**Percent Solids:** n/a

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | FH010239.D | 1 | 05/15/13 | AV | 05/15/13 | OP7858 | GFH572 |
| Run #2 | | | | | | | |

| | Initial Volume | Final Volume |
|---|---|---|
| Run #1 | 1000 ml | 1.0 ml |
| Run #2 | | |

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| | TPH-DRO (C10-C28) | ND | 0.20 | 0.18 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 84-15-1 | o-Terphenyl | 108% | | 20-140% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





| | | | |
|---|---|---|---|
| **Client Sample ID:** | SW_LC_UPSTREAM1 | | |
| **Lab Sample ID:** | D46200-2 | **Date Sampled:** | 05/13/13 |
| **Matrix:** | AQ - Surface Water | **Date Received:** | 05/14/13 |
| | | **Percent Solids:** | n/a |
| **Project:** | MOC 32C/ Little Creek Sampling | | |

**General Chemistry**

| Analyte | Result | RL | Units | DF | Analyzed | By | Method |
|---|---|---|---|---|---|---|---|
| Solids, Total Dissolved | 326 | 10 | mg/l | 1 | 05/15/13 | RW | SM 2540C-2011 |
| Solids, Total Suspended | 17.0 | 5.0 | mg/l | 1 | 05/15/13 | JD | SM 2540D-2011 |
| pH [a] | 8.63 | | su | 1 | 05/14/13 15:15 | KB | SM4500HB+ -2011/9040C |

(a) Analysis performed past the required 15 minutes from collection time/holding time.

RL = Reporting Limit

# Report of Analysis





| | | | |
|---|---|---|---|
| **Client Sample ID:** | SW_LC_DOWNSTREAM1 | | |
| **Lab Sample ID:** | D46200-3 | **Date Sampled:** | 05/13/13 |
| **Matrix:** | AQ - Surface Water | **Date Received:** | 05/14/13 |
| **Method:** | SW846 8260B | **Percent Solids:** | n/a |
| **Project:** | MOC 32C/ Little Creek Sampling | | |

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | 7V20221.D | 1 | 05/14/13 | JL | n/a | n/a | V7V1101 |
| Run #2 | | | | | | | |

| | Purge Volume |
|---|---|
| Run #1 | 5.0 ml |
| Run #2 | |

**Purgeable Aromatics**

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| 71-43-2 | Benzene | ND | 0.0010 | 0.00027 | mg/l | |
| 108-88-3 | Toluene | ND | 0.0020 | 0.0010 | mg/l | |
| 100-41-4 | Ethylbenzene | ND | 0.0020 | 0.00033 | mg/l | |
| 1330-20-7 | Xylene (total) | ND | 0.0030 | 0.0020 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 17060-07-0 | 1,2-Dichloroethane-D4 | 105% | | 62-130% |
| 2037-26-5 | Toluene-D8 | 99% | | 70-130% |
| 460-00-4 | 4-Bromofluorobenzene | 92% | | 69-130% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





**Client Sample ID:** SW_LC_DOWNSTREAM1
**Lab Sample ID:** D46200-3
**Matrix:** AQ - Surface Water
**Method:** SW846 8015B
**Project:** MOC 32C/ Little Creek Sampling

**Date Sampled:** 05/13/13
**Date Received:** 05/14/13
**Percent Solids:** n/a

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | FA11624.D | 1 | 05/16/13 | AV | n/a | n/a | GFA711 |
| Run #2 | | | | | | | |

| | Initial Volume | Final Volume |
|---|---|---|
| Run #1 | 1.0 ml | 1.0 ml |
| Run #2 | | |

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| 67-56-1 | Methanol | ND | 0.50 | 0.40 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 71-36-3 | n-Butyl Alcohol | 86% | | 25-169% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





**Client Sample ID:** SW_LC_DOWNSTREAM1
**Lab Sample ID:** D46200-3
**Matrix:** AQ - Surface Water
**Method:** SW846 8015B
**Project:** MOC 32C/ Little Creek Sampling

**Date Sampled:** 05/13/13
**Date Received:** 05/14/13
**Percent Solids:** n/a

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | GA18763.D | 1 | 05/14/13 | BR | n/a | n/a | GGA1063 |
| Run #2 | | | | | | | |

| | Purge Volume |
|---|---|
| Run #1 | 5.0 ml |
| Run #2 | |

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| | TPH-GRO (C6-C10) | ND | 0.20 | 0.10 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 120-82-1 | 1,2,4-Trichlorobenzene | 93% | | 60-140% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





**Client Sample ID:** SW_LC_DOWNSTREAM1
**Lab Sample ID:** D46200-3
**Matrix:** AQ - Surface Water
**Method:** SW846-8015B SW846 3510C
**Project:** MOC 32C/ Little Creek Sampling

**Date Sampled:** 05/13/13
**Date Received:** 05/14/13
**Percent Solids:** n/a

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | FH010241.D | 1 | 05/15/13 | AV | 05/15/13 | OP7858 | GFH572 |
| Run #2 | | | | | | | |

| | Initial Volume | Final Volume |
|---|---|---|
| Run #1 | 1000 ml | 1.0 ml |
| Run #2 | | |

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| | TPH-DRO (C10-C28) | ND | 0.20 | 0.18 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 84-15-1 | o-Terphenyl | 84% | | 20-140% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





| | | | |
|---|---|---|---|
| **Client Sample ID:** | SW_LC_DOWNSTREAM1 | | |
| **Lab Sample ID:** | D46200-3 | **Date Sampled:** | 05/13/13 |
| **Matrix:** | AQ - Surface Water | **Date Received:** | 05/14/13 |
| | | **Percent Solids:** | n/a |
| **Project:** | MOC 32C/ Little Creek Sampling | | |

**General Chemistry**

| Analyte | Result | RL | Units | DF | Analyzed | By | Method |
|---|---|---|---|---|---|---|---|
| Solids, Total Dissolved | 306 | 10 | mg/l | 1 | 05/15/13 | RW | SM 2540C-2011 |
| Solids, Total Suspended | 14.0 | 5.0 | mg/l | 1 | 05/15/13 | JD | SM 2540D-2011 |
| pH [a] | 8.82 | | su | 1 | 05/14/13 15:15 | KB | SM4500HB+ -2011/9040C |

(a) Analysis performed past the required 15 minutes from collection time/holding time.

RL = Reporting Limit

# Report of Analysis





| | | | |
|---|---|---|---|
| **Client Sample ID:** | SW_LC_DOWNSTREAM_SPRING | | |
| **Lab Sample ID:** | D46200-4 | **Date Sampled:** | 05/13/13 |
| **Matrix:** | AQ - Surface Water | **Date Received:** | 05/14/13 |
| **Method:** | SW846 8260B | **Percent Solids:** | n/a |
| **Project:** | MOC 32C/ Little Creek Sampling | | |

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | 7V20222.D | 1 | 05/14/13 | JL | n/a | n/a | V7V1101 |
| Run #2 | | | | | | | |

| | Purge Volume |
|---|---|
| Run #1 | 5.0 ml |
| Run #2 | |

**Purgeable Aromatics**

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| 71-43-2 | Benzene | ND | 0.0010 | 0.00027 | mg/l | |
| 108-88-3 | Toluene | ND | 0.0020 | 0.0010 | mg/l | |
| 100-41-4 | Ethylbenzene | ND | 0.0020 | 0.00033 | mg/l | |
| 1330-20-7 | Xylene (total) | ND | 0.0030 | 0.0020 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 17060-07-0 | 1,2-Dichloroethane-D4 | 105% | | 62-130% |
| 2037-26-5 | Toluene-D8 | 100% | | 70-130% |
| 460-00-4 | 4-Bromofluorobenzene | 93% | | 69-130% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





| | | | |
|---|---|---|---|
| **Client Sample ID:** | SW_LC_DOWNSTREAM_SPRING | | |
| **Lab Sample ID:** | D46200-4 | **Date Sampled:** | 05/13/13 |
| **Matrix:** | AQ - Surface Water | **Date Received:** | 05/14/13 |
| **Method:** | SW846 8015B | **Percent Solids:** | n/a |
| **Project:** | MOC 32C/ Little Creek Sampling | | |

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | FA11625.D | 1 | 05/16/13 | AV | n/a | n/a | GFA711 |
| Run #2 | | | | | | | |

| | Initial Volume | Final Volume |
|---|---|---|
| Run #1 | 1.0 ml | 1.0 ml |
| Run #2 | | |

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| 67-56-1 | Methanol | ND | 0.50 | 0.40 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 71-36-3 | n-Butyl Alcohol | 61% | | 25-169% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





**Client Sample ID:** SW_LC_DOWNSTREAM_SPRING
**Lab Sample ID:** D46200-4
**Matrix:** AQ - Surface Water
**Method:** SW846 8015B
**Project:** MOC 32C/ Little Creek Sampling

**Date Sampled:** 05/13/13
**Date Received:** 05/14/13
**Percent Solids:** n/a

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | GA18764.D | 1 | 05/14/13 | BR | n/a | n/a | GGA1063 |
| Run #2 | | | | | | | |

| | Purge Volume |
|---|---|
| Run #1 | 5.0 ml |
| Run #2 | |

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| | TPH-GRO (C6-C10) | ND | 0.20 | 0.10 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 120-82-1 | 1,2,4-Trichlorobenzene | 94% | | 60-140% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





**Client Sample ID:** SW_LC_DOWNSTREAM_SPRING
**Lab Sample ID:** D46200-4
**Matrix:** AQ - Surface Water
**Method:** SW846-8015B SW846 3510C
**Project:** MOC 32C/ Little Creek Sampling

**Date Sampled:** 05/13/13
**Date Received:** 05/14/13
**Percent Solids:** n/a

| | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| Run #1 | FH010243.D | 1 | 05/15/13 | AV | 05/15/13 | OP7858 | GFH572 |
| Run #2 | | | | | | | |

| | Initial Volume | Final Volume |
|---|---|---|
| Run #1 | 1000 ml | 1.0 ml |
| Run #2 | | |

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| | TPH-DRO (C10-C28) | ND | 0.20 | 0.18 | mg/l | |

| CAS No. | Surrogate Recoveries | Run# 1 | Run# 2 | Limits |
|---|---|---|---|---|
| 84-15-1 | o-Terphenyl | 96% | | 20-140% |

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

# Report of Analysis





| | | | |
|---|---|---|---|
| **Client Sample ID:** | SW_LC_DOWNSTREAM_SPRING | | |
| **Lab Sample ID:** | D46200-4 | **Date Sampled:** | 05/13/13 |
| **Matrix:** | AQ - Surface Water | **Date Received:** | 05/14/13 |
| | | **Percent Solids:** | n/a |
| **Project:** | MOC 32C/ Little Creek Sampling | | |

**General Chemistry**

| Analyte | Result | RL | Units | DF | Analyzed | By | Method |
|---|---|---|---|---|---|---|---|
| Solids, Total Dissolved | 388 | 10 | mg/l | 1 | 05/15/13 | RW | SM 2540C-2011 |
| Solids, Total Suspended | < 5.0 | 5.0 | mg/l | 1 | 05/15/13 | JD | SM 2540D-2011 |
| pH [a] | 7.66 | | su | 1 | 05/14/13 15:15 | KB | SM4500HB+ -2011/9040C |

(a) Analysis performed past the required 15 minutes from collection time/holding time.

RL = Reporting Limit

Mountain States ACCUTEST LABORATORIES



## Misc. Forms

# Custody Documents and Other Forms

Includes the following where applicable:

- Chain of Custody

ACCUTEST LABORATORIES

# CHAIN OF CUSTODY

PAGE 1 OF 1

4036 Youngfield Street, Wheat Ridge, CO 80033
TEL. 303-425-6021 FAX: 303-425-6854
www.accutest.com

FED-EX Tracking #: | Bottle Order Control #:
Accutest Quote #: | Accutest Job #: D46200

**Client / Reporting Information**

Company Name: Marathon Oil Company
Street Address: 743 Horizon Court Suite 220
City: Grand Junction, Colorado
Project Contact: Zach Toellner
Phone #: 970-260-0772
Sampler(s) Name(s): Scott Distel, Intertech

**Project Information**

Project Name: MOC 32C / Little Creek Sampling
Street:
City: State:
Project #:
Client Purchase Order #:
Project Manager:

**Billing Information ( if different from Report to)**

Company Name:
Street Address:
City:
Attention:

**Requested Analysis ( see TEST CODE sheet)**

Please see attached sheet

**Matrix Codes**

DW - Drinking Water
GW - Ground Water
WW - Water
SW - Surface Water
SO - Soil
SL- Sludge
SED-Sediment
OI - Oil
LIQ - Other Liquid
AIR - Air
SOL - Other Solid
WP - Wipe
FB-Field Blank
EB-Equipment Blank
RB- Rinse Blank
TB-Trip Blank

| Accutest Sample # | Field ID / Point of Collection | MEOH/DI Vial # | Collection Date | Collection Time | Sampled by | Matrix | # of bottles | Number of preserved Bottles: HCl | NaOH | HNO3 | H2SO4 | NONE | DI Water | MEOH | ENCORE | | LAB USE ONLY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SW_LC_Upstream2 | | 5/13/13 | 12:25 | SD | SW | 10 | 7 | | | 1 | | | | | Attached | 01 |
| 2 | SW_LC_Upstream1 | | 5/13/13 | 12:45 | SD | SW | 10 | 7 | | | 1 | | | | | Attached | 02 |
| 3 | SW_LC_Downstream1 | | 5/13/13 | 13:05 | SD | SW | 10 | 7 | | | 1 | | | | | Attached | 03 |
| 4 | SW_LC_Downstream_Spring | | 5/13/13 | 13:35 | SD | SW | 10 | 7 | | | 1 | | | | | Attached | 04 |

JM 5/14/13

**Turnaround Time ( Business days)**

- [ ] Std. 15 Business Days
- [ ] Std. 10 Business Days
- [ ] 5 Day RUSH
- [ ] 3 Day Emergency
- [x] 2 Day Emergency
- [ ] 1 Day Emergency
- [ ]

Emergency & Rush T/A data available VIA Lablink

Approved By (Accutest PM): / Date:

**Data Deliverable Information**

- [ ] Commercial "A" (Level 1)
- [ ] Commercial "B" ( Level 2)
- [ ] COMMBN
- [ ] COMMBN+
- [ ]
- [ ] State Forms Required
- [ ] Send Forms to State
- [ ] Report by Fax
- [ ] Report by PDF
- [ ] EDD Format

Commercial "A" = Results Only
Commercial "B" = Results + QC Summary
Commercial BN = Results/QC/Narrative (+ = chromatograms)

**Comments / Special Instructions**

only one bottle for methanol and dro. (JP)
NAB

**Sample Custody must be documented below each time samples change possession, including courier delivery.**

| | | | | | |
|---|---|---|---|---|---|
| Relinquished by Sampler: 1 Scott Distel | Date Time: 5/13/13 @ 16:00 | Received By: 1 [illegible] Service Center | Relinquished By: 2 | Date Time: | Received By: 2 Jacob Porter 5/14/13 1300 |
| Relinquished by Sampler: 3 | Date Time: | Received By: 3 | Relinquished By: 4 | Date Time: | Received By: 4 |
| Relinquished by: 5 | Date Time: | Received By: 5 | Custody Seal # HDC0 [x] Intact [ ] Not Intact | Preserved where applicable [x] | On Ice [x] Cooler Temp. 3.6 |

**D46200: Chain of Custody**
**Page 1 of 2**

# Accutest Laboratories Sample Receipt Summary

**Accutest Job Number:** D46200 **Client:** MARATHON OIL COMPANY **Immediate Client Services Action Required:** No

**Date / Time Received:** 5/14/2013 1:00:00 PM **No. Coolers:** 1 **Client Service Action Required at Login:** No

**Project:** MOC 32C LCS **Airbill #'s:** Hd-CO

| Cooler Security | Y | or | N | | Y | or | N |
|---|---|---|---|---|---|---|---|
| 1. Custody Seals Present: | ☑ | | ☐ | 3. COC Present: | ☑ | | ☐ |
| 2. Custody Seals Intact: | ☑ | | ☐ | 4. Smpl Dates/Time OK | ☑ | | ☐ |

| Cooler Temperature | Y | or | N |
|---|---|---|---|
| 1. Temp criteria achieved: | ☑ | | ☐ |
| 2. Cooler temp verification: | Infared gun | | |
| 3. Cooler media: | Ice (bag) | | |

| Quality Control Preservation | Y | or | N | N/A |
|---|---|---|---|---|
| 1. Trip Blank present / cooler: | ☐ | | ☐ | |
| 2. Trip Blank listed on COC: | ☐ | | ☐ | |
| 3. Samples preserved properly: | ☑ | | ☐ | |
| 4. VOCs headspace free: | ☐ | | ☐ | ☑ |

| Sample Integrity - Documentation | Y | or | N |
|---|---|---|---|
| 1. Sample labels present on bottles: | ☑ | | ☐ |
| 2. Container labeling complete: | ☑ | | ☐ |
| 3. Sample container label / COC agree: | ☑ | | ☐ |

| Sample Integrity - Condition | Y | or | N |
|---|---|---|---|
| 1. Sample recvd within HT: | ☑ | | ☐ |
| 2. All containers accounted for: | ☑ | | ☐ |
| 3. Condition of sample: | Intact | | |

| Sample Integrity - Instructions | Y | or | N | N/A |
|---|---|---|---|---|
| 1. Analysis requested is clear: | ☑ | | ☐ | |
| 2. Bottles received for unspecified tests | ☐ | | ☑ | |
| 3. Sufficient volume rec'd for analysis: | ☑ | | ☐ | |
| 4. Compositing instructions clear: | ☐ | | ☐ | ☑ |
| 5. Filtering instructions clear: | ☐ | | ☐ | ☑ |

Comments

Accutest Laboratories
V:(303) 425-6021

4036 Youngfield Street
F: (303) 425-6854

Wheat Ridge, CO
www/accutest.com



**D46200: Chain of Custody**
**Page 2 of 2**

Mountain States ACCUTEST LABORATORIES



## GC/MS Volatiles

### QC Data Summaries

Includes the following where applicable:

- Method Blank Summaries
- Blank Spike Summaries
- Matrix Spike and Duplicate Summaries

# Method Blank Summary



**Job Number:** D46200
**Account:** MOILCOGJ Marathon Oil
**Project:** MOC 32C/ Little Creek Sampling

| Sample | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| V7V1101-MB | 7V20206.D | 1 | 05/14/13 | JL | n/a | n/a | V7V1101 |



**The QC reported here applies to the following samples:** **Method:** SW846 8260B

D46200-1, D46200-2, D46200-3, D46200-4

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| 71-43-2 | Benzene | ND | 1.0 | 0.27 | ug/l | |
| 100-41-4 | Ethylbenzene | ND | 2.0 | 0.33 | ug/l | |
| 108-88-3 | Toluene | ND | 2.0 | 1.0 | ug/l | |
| 1330-20-7 | Xylene (total) | ND | 3.0 | 2.0 | ug/l | |

| CAS No. | Surrogate Recoveries | | Limits |
|---|---|---|---|
| 17060-07-0 | 1,2-Dichloroethane-D4 | 104% | 62-130% |
| 2037-26-5 | Toluene-D8 | 99% | 70-130% |
| 460-00-4 | 4-Bromofluorobenzene | 95% | 69-130% |

# Blank Spike Summary



**Job Number:** D46200
**Account:** MOILCOGJ Marathon Oil
**Project:** MOC 32C/ Little Creek Sampling

| Sample | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| V7V1101-BS | 7V20207.D | 1 | 05/14/13 | JL | n/a | n/a | V7V1101 |



**The QC reported here applies to the following samples:** **Method:** SW846 8260B

D46200-1, D46200-2, D46200-3, D46200-4

| CAS No. | Compound | Spike ug/l | BSP ug/l | BSP % | Limits |
|---|---|---|---|---|---|
| 71-43-2 | Benzene | 50 | 52.3 | 105 | 70-130 |
| 100-41-4 | Ethylbenzene | 50 | 49.3 | 99 | 70-130 |
| 108-88-3 | Toluene | 50 | 48.7 | 97 | 70-130 |
| 1330-20-7 | Xylene (total) | 150 | 152 | 101 | 70-130 |

| CAS No. | Surrogate Recoveries | BSP | Limits |
|---|---|---|---|
| 17060-07-0 | 1,2-Dichloroethane-D4 | 106% | 62-130% |
| 2037-26-5 | Toluene-D8 | 98% | 70-130% |
| 460-00-4 | 4-Bromofluorobenzene | 104% | 69-130% |

* = Outside of Control Limits.

# Matrix Spike Summary



**Job Number:** D46200
**Account:** MOILCOGJ Marathon Oil
**Project:** MOC 32C/ Little Creek Sampling

| Sample | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| D46155-1MS | 7V20208.D | 1 | 05/14/13 | JL | n/a | n/a | V7V1101 |
| D46155-1 | 7V20209.D | 1 | 05/14/13 | JL | n/a | n/a | V7V1101 |



**The QC reported here applies to the following samples:** **Method:** SW846 8260B

D46200-1, D46200-2, D46200-3, D46200-4

| CAS No. | Compound | D46155-1 ug/l | Q | Spike ug/l | MS ug/l | MS % | Limits |
|---|---|---|---|---|---|---|---|
| 71-43-2 | Benzene | ND | | 50 | 52.3 | 105 | 62-130 |
| 100-41-4 | Ethylbenzene | ND | | 50 | 48.9 | 98 | 63-130 |
| 108-88-3 | Toluene | ND | | 50 | 49.1 | 98 | 60-130 |
| 1330-20-7 | Xylene (total) | ND | | 150 | 152 | 101 | 67-130 |

| CAS No. | Surrogate Recoveries | MS | D46155-1 | Limits |
|---|---|---|---|---|
| 17060-07-0 | 1,2-Dichloroethane-D4 | 104% | 110% | 62-130% |
| 2037-26-5 | Toluene-D8 | 99% | 99% | 70-130% |
| 460-00-4 | 4-Bromofluorobenzene | 104% | 95% | 69-130% |

* = Outside of Control Limits.

# Duplicate Summary



**Job Number:** D46200
**Account:** MOILCOGJ Marathon Oil
**Project:** MOC 32C/ Little Creek Sampling

| Sample | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| D46156-1DUP | 7V20211.D | 1 | 05/14/13 | JL | n/a | n/a | V7V1101 |
| D46156-1 | 7V20210.D | 1 | 05/14/13 | JL | n/a | n/a | V7V1101 |



**The QC reported here applies to the following samples:** **Method:** SW846 8260B

D46200-1, D46200-2, D46200-3, D46200-4

| CAS No. | Compound | D46156-1 ug/l | Q | DUP ug/l | Q | RPD | Limits |
|---|---|---|---|---|---|---|---|
| 71-43-2 | Benzene | ND | | ND | | nc | 30 |
| 100-41-4 | Ethylbenzene | ND | | ND | | nc | 30 |
| 108-88-3 | Toluene | ND | | ND | | nc | 30 |
| 1330-20-7 | Xylene (total) | ND | | ND | | nc | 30 |

| CAS No. | Surrogate Recoveries | DUP | D46156-1 | Limits |
|---|---|---|---|---|
| 17060-07-0 | 1,2-Dichloroethane-D4 | 104% | 105% | 62-130% |
| 2037-26-5 | Toluene-D8 | 99% | 98% | 70-130% |
| 460-00-4 | 4-Bromofluorobenzene | 94% | 94% | 69-130% |

* = Outside of Control Limits.

Mountain States ACCUTEST LABORATORIES

## GC Volatiles

### QC Data Summaries

Includes the following where applicable:

- Method Blank Summaries
- Blank Spike Summaries
- Matrix Spike and Duplicate Summaries

# Method Blank Summary



**Job Number:** D46200
**Account:** MOILCOGJ Marathon Oil
**Project:** MOC 32C/ Little Creek Sampling

| Sample | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| GC3598-MB | FA11617.D | 1 | 05/16/13 | AV | n/a | n/a | GFA711 |

**The QC reported here applies to the following samples:** **Method:** SW846 8015B

D46200-1, D46200-2, D46200-3, D46200-4

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| 67-56-1 | Methanol | ND | 0.50 | 0.40 | mg/l | |

| CAS No. | Surrogate Recoveries | | Limits |
|---|---|---|---|
| 71-36-3 | n-Butyl Alcohol | 87% | 25-169% |

# Method Blank Summary



**Job Number:** D46200
**Account:** MOILCOGJ Marathon Oil
**Project:** MOC 32C/ Little Creek Sampling

| Sample | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| GGA1063-MB | GA18752.D | 1 | 05/14/13 | BR | n/a | n/a | GGA1063 |

**The QC reported here applies to the following samples:** **Method:** SW846 8015B

D46200-1, D46200-2, D46200-3, D46200-4

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| | TPH-GRO (C6-C10) | ND | 0.20 | 0.10 | mg/l | |

| CAS No. | Surrogate Recoveries | | Limits |
|---|---|---|---|
| 120-82-1 | 1,2,4-Trichlorobenzene | 93% | 60-140% |

# Blank Spike Summary



**Job Number:** D46200
**Account:** MOILCOGJ Marathon Oil
**Project:** MOC 32C/ Little Creek Sampling

| Sample | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| GC3598-BS | FA11620.D | 1 | 05/16/13 | AV | n/a | n/a | GFA711 |

**The QC reported here applies to the following samples:** **Method:** SW846 8015B

D46200-1, D46200-2, D46200-3, D46200-4

| CAS No. | Compound | Spike mg/l | BSP mg/l | BSP % | Limits |
|---|---|---|---|---|---|
| 67-56-1 | Methanol | 25 | 20.3 | 81 | 70-130 |

| CAS No. | Surrogate Recoveries | BSP | Limits |
|---|---|---|---|
| 71-36-3 | n-Butyl Alcohol | 85% | 25-169% |

* = Outside of Control Limits.

# Blank Spike Summary



**Job Number:** D46200
**Account:** MOILCOGJ Marathon Oil
**Project:** MOC 32C/ Little Creek Sampling

| Sample | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| GGA1063-BS | GA18753.D | 1 | 05/14/13 | BR | n/a | n/a | GGA1063 |

**The QC reported here applies to the following samples:** **Method:** SW846 8015B

D46200-1, D46200-2, D46200-3, D46200-4

| CAS No. | Compound | Spike mg/l | BSP mg/l | BSP % | Limits |
|---|---|---|---|---|---|
| | TPH-GRO (C6-C10) | 2.2 | 2.19 | 100 | 70-130 |

| CAS No. | Surrogate Recoveries | BSP | Limits |
|---|---|---|---|
| 120-82-1 | 1,2,4-Trichlorobenzene | 99% | 60-140% |

* = Outside of Control Limits.

# Matrix Spike/Matrix Spike Duplicate Summary



**Job Number:** D46200
**Account:** MOILCOGJ Marathon Oil
**Project:** MOC 32C/ Little Creek Sampling

| Sample | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| GC3598-MS | FA11619.D | 1 | 05/16/13 | AV | n/a | n/a | GFA711 |
| GC3598-MSD | FA11621.D | 1 | 05/16/13 | AV | n/a | n/a | GFA711 |
| D46200-1 | FA11622.D | 1 | 05/16/13 | AV | n/a | n/a | GFA711 |

**The QC reported here applies to the following samples:** **Method:** SW846 8015B

D46200-1, D46200-2, D46200-3, D46200-4

| CAS No. | Compound | D46200-1 mg/l | Q | Spike mg/l | MS mg/l | MS % | MSD mg/l | MSD % | RPD | Limits Rec/RPD |
|---|---|---|---|---|---|---|---|---|---|---|
| 67-56-1 | Methanol | ND | | 25 | 22.7 | 91 | 18.8 | 75 | 19 | 25-176/30 |

| CAS No. | Surrogate Recoveries | MS | MSD | D46200-1 | Limits |
|---|---|---|---|---|---|
| 71-36-3 | n-Butyl Alcohol | 94% | 79% | 94% | 25-169% |

* = Outside of Control Limits.

# Matrix Spike/Matrix Spike Duplicate Summary



**Job Number:** D46200
**Account:** MOILCOGJ Marathon Oil
**Project:** MOC 32C/ Little Creek Sampling

| Sample | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| D46054-13MS | GA18758.D | 10 | 05/14/13 | BR | n/a | n/a | GGA1063 |
| D46054-13MSD | GA18759.D | 10 | 05/14/13 | BR | n/a | n/a | GGA1063 |
| D46054-13 | GA18757.D | 10 | 05/14/13 | BR | n/a | n/a | GGA1063 |

**The QC reported here applies to the following samples:** **Method:** SW846 8015B

D46200-1, D46200-2, D46200-3, D46200-4

| CAS No. | Compound | D46054-13 mg/l | Q | Spike mg/l | MS mg/l | MS % | MSD mg/l | MSD % | RPD | Limits Rec/RPD |
|---|---|---|---|---|---|---|---|---|---|---|
| | TPH-GRO (C6-C10) | ND | | 22 | 20.5 | 93 | 19.9 | 90 | 3 | 60-145/30 |

| CAS No. | Surrogate Recoveries | MS | MSD | D46054-13 | Limits |
|---|---|---|---|---|---|
| 120-82-1 | 1,2,4-Trichlorobenzene | 123% | 127% | 118% | 60-140% |

* = Outside of Control Limits.

Mountain States ACCUTEST LABORATORIES

## GC Semi-volatiles

# QC Data Summaries



Includes the following where applicable:

- Method Blank Summaries
- Blank Spike Summaries
- Matrix Spike and Duplicate Summaries

# Method Blank Summary



**Job Number:** D46200
**Account:** MOILCOGJ Marathon Oil
**Project:** MOC 32C/ Little Creek Sampling

| Sample | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| OP7858-MB | FH010227.D | 1 | 05/15/13 | AV | 05/15/13 | OP7858 | GFH572 |

**The QC reported here applies to the following samples:** **Method:** SW846-8015B

D46200-1, D46200-2, D46200-3, D46200-4

| CAS No. | Compound | Result | RL | MDL | Units | Q |
|---|---|---|---|---|---|---|
| | TPH-DRO (C10-C28) | ND | 0.20 | 0.18 | mg/l | |

| CAS No. | Surrogate Recoveries | | Limits |
|---|---|---|---|
| 84-15-1 | o-Terphenyl | 60% | 20-140% |

8.1.1

8

# Blank Spike Summary



**Job Number:** D46200
**Account:** MOILCOGJ Marathon Oil
**Project:** MOC 32C/ Little Creek Sampling

| Sample | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| OP7858-BS | FH010229.D | 1 | 05/15/13 | AV | 05/15/13 | OP7858 | GFH572 |

**The QC reported here applies to the following samples:** **Method:** SW846-8015B

D46200-1, D46200-2, D46200-3, D46200-4

| CAS No. | Compound | Spike mg/l | BSP mg/l | BSP % | Limits |
|---|---|---|---|---|---|
| | TPH-DRO (C10-C28) | 20 | 15.9 | 80 | 36-140 |

| CAS No. | Surrogate Recoveries | BSP | Limits |
|---|---|---|---|
| 84-15-1 | o-Terphenyl | 70% | 20-140% |

8.2.1

8

* = Outside of Control Limits.

# Matrix Spike/Matrix Spike Duplicate Summary



**Job Number:** D46200
**Account:** MOILCOGJ Marathon Oil
**Project:** MOC 32C/ Little Creek Sampling

| Sample | File ID | DF | Analyzed | By | Prep Date | Prep Batch | Analytical Batch |
|---|---|---|---|---|---|---|---|
| OP7858-MS | FH010231.D | 1 | 05/15/13 | AV | 05/15/13 | OP7858 | GFH572 |
| OP7858-MSD | FH010233.D | 1 | 05/15/13 | AV | 05/15/13 | OP7858 | GFH572 |
| D46054-10 | FH010245.D | 1 | 05/16/13 | AV | 05/15/13 | OP7858 | GFH572 |

**The QC reported here applies to the following samples:** **Method:** SW846-8015B

D46200-1, D46200-2, D46200-3, D46200-4

| CAS No. | Compound | D46054-10 mg/l | Q | Spike mg/l | MS mg/l | MS % | MSD mg/l | MSD % | RPD | Limits Rec/RPD |
|---|---|---|---|---|---|---|---|---|---|---|
| | TPH-DRO (C10-C28) | ND | | 20 | 19.4 | 97 | 18.7 | 94 | 4 | 28-140/30 |

| CAS No. | Surrogate Recoveries | MS | MSD | D46054-10 | Limits |
|---|---|---|---|---|---|
| 84-15-1 | o-Terphenyl | 92% | 96% | 48% | 20-140% |

8.3.1

8

* = Outside of Control Limits.

Mountain States ACCUTEST LABORATORIES

General Chemistry

# QC Data Summaries



Includes the following where applicable:

- Method Blank and Blank Spike Summaries
- Duplicate Summaries
- Matrix Spike Summaries

METHOD BLANK AND SPIKE RESULTS SUMMARY
GENERAL CHEMISTRY

Login Number: D46200
Account: MOILCOGJ - Marathon Oil
Project: MOC 32C/ Little Creek Sampling

| Analyte | Batch ID | RL | MB Result | Units | Spike Amount | BSP Result | BSP %Recov | QC Limits |
|---|---|---|---|---|---|---|---|---|
| Solids, Total Dissolved | GN20183 | 10 | 0.0 | mg/l | 400 | 397 | 99.3 | 90-110% |
| Solids, Total Suspended | GN20182 | 5.0 | 0.0 | mg/l | 300 | 289 | 96.3 | 90-110% |
| pH | GN20179 | | | su | 8.00 | 8.02 | 100.2 | 99.3-100.7% |

Associated Samples:
Batch GN20179: D46200-1, D46200-2, D46200-3, D46200-4
Batch GN20182: D46200-1, D46200-2, D46200-3, D46200-4
Batch GN20183: D46200-1, D46200-2, D46200-3, D46200-4
(*) Outside of QC limits

DUPLICATE RESULTS SUMMARY
GENERAL CHEMISTRY

Login Number: D46200
Account: MOILCOGJ - Marathon Oil
Project: MOC 32C/ Little Creek Sampling

| Analyte | Batch ID | QC Sample | Units | Original Result | DUP Result | RPD | QC Limits |
|---|---|---|---|---|---|---|---|
| Solids, Total Dissolved | GN20183 | D46200-3 | mg/l | 306 | 308 | 0.7 | 0-20% |
| Solids, Total Suspended | GN20182 | D46096-1 | mg/l | 320 | 347 | 8.1 | 0-20% |

Associated Samples:
Batch GN20182: D46200-1, D46200-2, D46200-3, D46200-4
Batch GN20183: D46200-1, D46200-2, D46200-3, D46200-4
(*) Outside of QC limits

# APPENDIX C
# SOIL ANALYTICAL RESULTS

# APPENDIX C-1
# INITIAL SOIL ANALYSES

# 32C BLO_LNR Soil Sample Analysis Results

**Samples collected 5/8 and 5/9/2013**

**Analyzed 5/14/2013**

| Sample ID | Depth | $EC_{2:1}$[1] (mmhos/cm) | ECe[2] (mmhos/cm) | pH | VOC (ppm) |
|---|---|---|---|---|---|
| SO_32C_Control | 8-12" | 0.216 | 0.864 | 7.56 | Not Analyzed |
| SO_32C_BLO_LNR_1 | 0-2" | 0.731 | 2.924 | 8.45 | 145 |
| SO_32C_BLO_LNR_2 | 10-12" | 0.799 | 3.196 | 8.33 | 151 |
| SO_32C_BLO_LNR_3 | 14-18" | 0.872 | 3.488 | 8.51 | 192 |
| SO_32C_BLO_LNR_4 | 4' horizontal | 1.077 | 4.308 | 9.28 | 62.7 |
| SO_32C_BLO_LNR_5 | 3.5' vertical | 1.026 | 4.104 | 8.95 | 219.4 |
| **COGCC Table 910-1 Concentrations** | --- | --- | **<4 or 2x Background** | **6-9** | **500** |

[1]$EC_{2:1}$ is the electrical conductivity of a 2-parts distilled water to 1-part soil suspension

[2]ECe is a mathematical derivation that approximates the electrical conductivity that would be expected from a laboratory 1:1 soil paste extract analysis process

**SO_32C_BLO_LNR_1** -This sample was collected at a depth of 0-2" on 05/08/2013 at 15:40

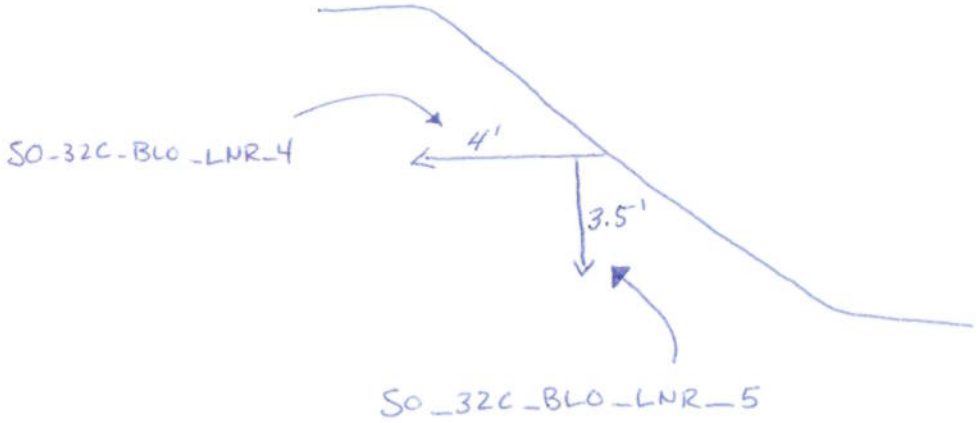
**SO_32C_BLO_LNR_2**-This sample was collected at a depth of 12-14" on 05/08/2013 at 15:55

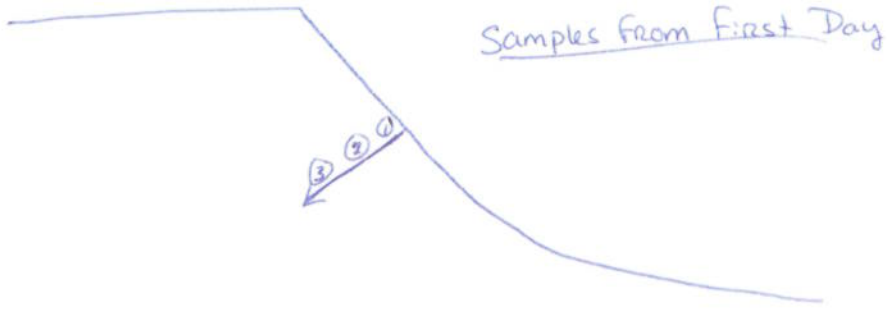
**SO_32C_BLO_LNR_3**-This sample was collected at a depth of 14-18" on 05/08/2013 at 16:10

**SO_32C_BLO_LNR_4**-This sample was collected at a depth of 4' horizontally on 05/09/2013 at 09:45

**SO_32C_BLO_LNR_5**-This sample was collected at a depth of 3.5' vertically on 05/09/2013 at 10:50

**SO_32C_Control**-This sample was collected at a depth of 8-12" on 05/08/2013 at 15:35



**APPENDIX C-2**

**SOIL ANALYTICAL REPORT**

# ANALYTICAL SUMMARY REPORT

May 23, 2013

Marathon Oil Company
743 Horizon Court Ste. 220
Grand Junction, CO 81506

Workorder No.: G13050282

Project Name: Soil_Sampling

Energy Laboratories Inc. Gillette WY received the following 4 samples for Marathon Oil Company on 5/13/2013 for analysis.

| Sample ID | Client Sample ID | Collect Date | Receive Date | Matrix | Test |
|---|---|---|---|---|---|
| G13050282-001 | SO_32C_BLO_LNR_1 | 05/08/13 15:40 | 05/13/13 | Soil | Metals, Saturated Paste<br>Conductivity, Saturated Paste Extract<br>Ultrasonic Extraction<br>Purge & Trap Extraction for Volatile Organics<br>Diesel Range Organics<br>Gasoline Range Organics<br>Water Extraction for Polar Organics<br>Non-Halogenated Organics by GC-FID<br>pH, Saturated Paste<br>Saturated Paste Extraction<br>Sodium Adsorption Ratio<br>Volatile Organics, Methanol Extraction<br>8260-Volatile Organic Compounds - Short List |
| G13050282-002 | SO_32C_BLO_LNR_2 | 05/08/13 15:55 | 05/13/13 | Soil | Same As Above |
| G13050282-003 | SO_32C_CONTROL | 05/08/13 15:35 | 05/13/13 | Soil | Same As Above |
| G13050282-004 | SO_32C_BLO_LNR_3 | 05/08/13 16:10 | 05/13/13 | Soil | Same As Above |

The analyses presented in this report were performed by Energy Laboratories, Inc., 400 W. Boxelder Rd., Gillette, WY 82718, unless otherwise noted.

As appropriate, any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these tests results, please call.

Report Approved By:

**CLIENT:** Marathon Oil Company
**Project:** Soil_Sampling
**Sample Delivery Group:** G13050282

**Revised Date:** 05/23/13
**Report Date:** 05/22/13

# CASE NARRATIVE

Tests associated with analyst identified as ELI-B were subcontracted to Energy Laboratories, 1120 S. 27th St., Billings, MT, EPA Number MT00005.

Tests associated with analyst identified as ELI-H were subcontracted to Energy Laboratories, 3161 E. Lyndale Ave., Helena, MT, EPA Number MT00945.

The reporting limit for Volatile Organic Compound - Benzene has been revised to 0.10 mg/kg as per request via email from Zach Toellner with Marathon Oil.

PLEASE REPLACE IN YOUR SYSTEM AS NECESSARY.

Thank you,

Alyson Degnan
Project Manager

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

| | | | |
|---|---|---|---|
| **Client:** | Marathon Oil Company | **Revised Date:** | 05/23/13 |
| **Site Name:** | 32C_Pond_Complex | **Report Date:** | 05/22/13 |
| **Project:** | Soil_Sampling | **Collection Date:** | 05/08/13 15:40 |
| **Client Sample ID:** | SO_32C_BLO_LNR_1 | **Date Received:** | 05/13/13 |
| **Location:** | | **Sampled By:** | Matthew Fought |
| **Samp FRQ/Type:** | SP | **Matrix:** | Soil |
| **Lab ID:** | G13050282-001 | **Tracking Number:** | |

| Analyses | Result | Units | RL | Qualifier | Method | Analysis Date / By |
|---|---|---|---|---|---|---|
| **PETROLEUM HYDROCARBONS-VOLATILE** | | | | | | |
| Gasoline Range Organics (GRO) | 149 | mg/kg | 8.0 | | SW8015B | 05/17/13 17:43 / eli-b |
| Total Purgeable Hydrocarbons | 585 | mg/kg | 8.0 | | SW8015B | 05/17/13 17:43 / eli-b |
| Surr: Trifluorotoluene | 84.0 | %REC | 70-130 | | SW8015B | 05/17/13 17:43 / eli-b |
| - Note 1: Gasoline Range Organics(GRO) are defined as all hydrocarbons eluting between 2-Methylpentane and 1,2,4-Trimethylbenzene. | | | | | | |
| - Note 2: Total Purgeable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **PETROLEUM HYDROCARBONS-SEMI-VOLATILE** | | | | | | |
| Diesel Range Organics (DRO) | 1590 | mg/kg | 200 | | SW8015B | 05/16/13 03:15 / eli-b |
| Total Extractable Hydrocarbons | 2070 | mg/kg | 200 | | SW8015B | 05/16/13 03:15 / eli-b |
| Surr: o-Terphenyl | 76.0 | %REC | 50-150 | | SW8015B | 05/16/13 03:15 / eli-b |
| - Note 1: Diesel Range Organics are defined as all hydrocarbons eluting between C10 and C28. | | | | | | |
| - Note 2: Total Extractable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **NON-HALOGENATED ORGANICS BY GC-FID** | | | | | | |
| Methanol | ND | mg/kg | 1.0 | | SW8015B | 05/15/13 14:51 / eli-b |
| Surr: sec-Butyl Alcohol | 77.0 | %REC | 73-113 | | SW8015B | 05/15/13 14:51 / eli-b |
| **VOLATILE ORGANIC COMPOUNDS** | | | | | | |
| Benzene | ND | mg/kg | 0.10 | | SW8260B | 05/15/13 14:17 / eli-b |
| Ethylbenzene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 14:17 / eli-b |
| Toluene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 14:17 / eli-b |
| m+p-Xylenes | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 14:17 / eli-b |
| o-Xylene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 14:17 / eli-b |
| Xylenes, Total | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 14:17 / eli-b |
| Surr: p-Bromofluorobenzene | 75.0 | %REC | 78-160 | S | SW8260B | 05/15/13 14:17 / eli-b |
| Surr: Dibromofluoromethane | 80.0 | %REC | 70-132 | | SW8260B | 05/15/13 14:17 / eli-b |
| Surr: 1,2-Dichloroethane-d4 | 68.0 | %REC | 60-136 | | SW8260B | 05/15/13 14:17 / eli-b |
| Surr: Toluene-d8 | 88.0 | %REC | 75-138 | | SW8260B | 05/15/13 14:17 / eli-b |
| **SATURATED PASTE EXTRACT** | | | | | | |
| pH, sat. paste | 7.7 | s.u. | 0.1 | | ASAM10-3.2 | 05/17/13 09:13 / eli-h |
| Conductivity, sat. paste | 3.8 | mmhos/cm | 0.1 | | ASAM10-3 | 05/20/13 07:25 / eli-h |
| Calcium, sat. paste | 1.08 | meq/L | 0.05 | | SW6010B | 05/20/13 19:00 / eli-h |
| Magnesium, sat. paste | 0.22 | meq/L | 0.08 | | SW6010B | 05/21/13 19:08 / eli-h |
| Sodium, sat. paste | 33.3 | meq/L | 0.09 | D | SW6010B | 05/20/13 19:00 / eli-h |
| Sodium Adsorption Ratio (SAR) | 47.0 | unitless | 0.1 | | USDA20b | 05/22/13 10:22 / eli-h |

**Report Definitions:**

RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
S - Spike recovery outside of advisory limits.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Site Name:** 32C_Pond_Complex
**Project:** Soil_Sampling
**Client Sample ID:** SO_32C_BLO_LNR_2
**Location:**
**Samp FRQ/Type:** SP
**Lab ID:** G13050282-002

**Revised Date:** 05/23/13
**Report Date:** 05/22/13
**Collection Date:** 05/08/13 15:55
**Date Received:** 05/13/13
**Sampled By:** Matthew Fought
**Matrix:** Soil
**Tracking Number:**

| Analyses | Result | Units | RL | Qualifier | Method | Analysis Date / By |
|---|---|---|---|---|---|---|
| **PETROLEUM HYDROCARBONS-VOLATILE** | | | | | | |
| Gasoline Range Organics (GRO) | 210 | mg/kg | 20 | | SW8015B | 05/18/13 12:20 / eli-b |
| Total Purgeable Hydrocarbons | 953 | mg/kg | 20 | | SW8015B | 05/18/13 12:20 / eli-b |
| Surr: Trifluorotoluene | 83.0 | %REC | 70-130 | | SW8015B | 05/18/13 12:20 / eli-b |
| - Note 1: Gasoline Range Organics(GRO) are defined as all hydrocarbons eluting between 2-Methylpentane and 1,2,4-Trimethylbenzene. | | | | | | |
| - Note 2: Total Purgeable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **PETROLEUM HYDROCARBONS-SEMI-VOLATILE** | | | | | | |
| Diesel Range Organics (DRO) | 1620 | mg/kg | 200 | | SW8015B | 05/18/13 05:41 / eli-b |
| Total Extractable Hydrocarbons | 1930 | mg/kg | 200 | | SW8015B | 05/18/13 05:41 / eli-b |
| Surr: o-Terphenyl | 78.0 | %REC | 50-150 | | SW8015B | 05/18/13 05:41 / eli-b |
| - Note 1: Diesel Range Organics are defined as all hydrocarbons eluting between C10 and C28. | | | | | | |
| - Note 2: Total Extractable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **NON-HALOGENATED ORGANICS BY GC-FID** | | | | | | |
| Methanol | ND | mg/kg | 1.0 | | SW8015B | 05/15/13 15:14 / eli-b |
| Surr: sec-Butyl Alcohol | 78.0 | %REC | 73-113 | | SW8015B | 05/15/13 15:14 / eli-b |
| **VOLATILE ORGANIC COMPOUNDS** | | | | | | |
| Benzene | ND | mg/kg | 0.10 | | SW8260B | 05/15/13 14:44 / eli-b |
| Ethylbenzene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 14:44 / eli-b |
| Toluene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 14:44 / eli-b |
| m+p-Xylenes | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 14:44 / eli-b |
| o-Xylene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 14:44 / eli-b |
| Xylenes, Total | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 14:44 / eli-b |
| Surr: p-Bromofluorobenzene | 91.0 | %REC | 78-160 | | SW8260B | 05/15/13 14:44 / eli-b |
| Surr: Dibromofluoromethane | 100 | %REC | 70-132 | | SW8260B | 05/15/13 14:44 / eli-b |
| Surr: 1,2-Dichloroethane-d4 | 86.0 | %REC | 60-136 | | SW8260B | 05/15/13 14:44 / eli-b |
| Surr: Toluene-d8 | 118 | %REC | 75-138 | | SW8260B | 05/15/13 14:44 / eli-b |
| **SATURATED PASTE EXTRACT** | | | | | | |
| pH, sat. paste | 7.6 | s.u. | 0.1 | | ASAM10-3.2 | 05/17/13 09:14 / eli-h |
| Conductivity, sat. paste | 3.5 | mmhos/cm | 0.1 | | ASAM10-3 | 05/20/13 07:26 / eli-h |
| Calcium, sat. paste | 0.90 | meq/L | 0.05 | | SW6010B | 05/20/13 19:03 / eli-h |
| Magnesium, sat. paste | 0.19 | meq/L | 0.08 | | SW6010B | 05/21/13 19:12 / eli-h |
| Sodium, sat. paste | 32.0 | meq/L | 0.09 | D | SW6010B | 05/20/13 19:03 / eli-h |
| Sodium Adsorption Ratio (SAR) | 48.4 | unitless | 0.1 | | USDA20b | 05/22/13 10:22 / eli-h |

**Report Definitions:**
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

| | | | |
|---|---|---|---|
| **Client:** | Marathon Oil Company | **Revised Date:** | 05/23/13 |
| **Site Name:** | 32C_Pond_Complex | **Report Date:** | 05/22/13 |
| **Project:** | Soil_Sampling | **Collection Date:** | 05/08/13 15:35 |
| **Client Sample ID:** | SO_32C_CONTROL | **Date Received:** | 05/13/13 |
| **Location:** | | **Sampled By:** | Matthew Fought |
| **Samp FRQ/Type:** | SP | **Matrix:** | Soil |
| **Lab ID:** | G13050282-003 | **Tracking Number:** | |

| Analyses | Result | Units | RL | Qualifier | Method | Analysis Date / By |
|---|---|---|---|---|---|---|
| **PETROLEUM HYDROCARBONS-VOLATILE** | | | | | | |
| Gasoline Range Organics (GRO) | ND | mg/kg | 2.0 | | SW8015B | 05/16/13 19:37 / eli-b |
| Total Purgeable Hydrocarbons | ND | mg/kg | 2.0 | | SW8015B | 05/16/13 19:37 / eli-b |
| Surr: Trifluorotoluene | 92.0 | %REC | 70-130 | | SW8015B | 05/16/13 19:37 / eli-b |
| - Note 1: Gasoline Range Organics(GRO) are defined as all hydrocarbons eluting between 2-Methylpentane and 1,2,4-Trimethylbenzene. | | | | | | |
| - Note 2: Total Purgeable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **PETROLEUM HYDROCARBONS-SEMI-VOLATILE** | | | | | | |
| Diesel Range Organics (DRO) | ND | mg/kg | 10 | | SW8015B | 05/15/13 21:25 / eli-b |
| Total Extractable Hydrocarbons | 16 | mg/kg | 10 | | SW8015B | 05/15/13 21:25 / eli-b |
| Surr: o-Terphenyl | 81.0 | %REC | 50-150 | | SW8015B | 05/15/13 21:25 / eli-b |
| - Note 1: Diesel Range Organics are defined as all hydrocarbons eluting between C10 and C28. | | | | | | |
| - Note 2: Total Extractable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **NON-HALOGENATED ORGANICS BY GC-FID** | | | | | | |
| Methanol | ND | mg/kg | 1.0 | | SW8015B | 05/15/13 11:26 / eli-b |
| Surr: sec-Butyl Alcohol | 85.0 | %REC | 73-113 | | SW8015B | 05/15/13 11:26 / eli-b |
| **VOLATILE ORGANIC COMPOUNDS** | | | | | | |
| Benzene | ND | mg/kg | 0.10 | | SW8260B | 05/15/13 15:11 / eli-b |
| Ethylbenzene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 15:11 / eli-b |
| Toluene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 15:11 / eli-b |
| m+p-Xylenes | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 15:11 / eli-b |
| o-Xylene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 15:11 / eli-b |
| Xylenes, Total | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 15:11 / eli-b |
| Surr: p-Bromofluorobenzene | 111 | %REC | 78-160 | | SW8260B | 05/15/13 15:11 / eli-b |
| Surr: Dibromofluoromethane | 69.0 | %REC | 70-132 | S | SW8260B | 05/15/13 15:11 / eli-b |
| Surr: 1,2-Dichloroethane-d4 | 60.0 | %REC | 60-136 | | SW8260B | 05/15/13 15:11 / eli-b |
| Surr: Toluene-d8 | 88.0 | %REC | 75-138 | | SW8260B | 05/15/13 15:11 / eli-b |
| **SATURATED PASTE EXTRACT** | | | | | | |
| pH, sat. paste | 6.9 | s.u. | 0.1 | | ASAM10-3.2 | 05/17/13 09:15 / eli-h |
| Conductivity, sat. paste | 0.7 | mmhos/cm | 0.1 | | ASAM10-3 | 05/20/13 07:27 / eli-h |
| Calcium, sat. paste | 2.22 | meq/L | 0.05 | | SW6010B | 05/20/13 19:13 / eli-h |
| Magnesium, sat. paste | 0.70 | meq/L | 0.08 | | SW6010B | 05/21/13 19:15 / eli-h |
| Sodium, sat. paste | 3.20 | meq/L | 0.09 | D | SW6010B | 05/20/13 19:13 / eli-h |
| Sodium Adsorption Ratio (SAR) | 2.8 | unitless | 0.1 | | USDA20b | 05/22/13 10:22 / eli-h |

**Report Definitions:**

RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
S - Spike recovery outside of advisory limits.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

| | | | |
|---|---|---|---|
| **Client:** | Marathon Oil Company | **Revised Date:** | 05/23/13 |
| **Site Name:** | 32C_Pond_Complex | **Report Date:** | 05/22/13 |
| **Project:** | Soil_Sampling | **Collection Date:** | 05/08/13 16:10 |
| **Client Sample ID:** | SO_32C_BLO_LNR_3 | **Date Received:** | 05/13/13 |
| **Location:** | | **Sampled By:** | Matthew Fought |
| **Samp FRQ/Type:** | SP | **Matrix:** | Soil |
| **Lab ID:** | G13050282-004 | **Tracking Number:** | |

| Analyses | Result | Units | RL | Qualifier | Method | Analysis Date / By |
|---|---|---|---|---|---|---|
| **PETROLEUM HYDROCARBONS-VOLATILE** | | | | | | |
| Gasoline Range Organics (GRO) | 166 | mg/kg | 20 | | SW8015B | 05/18/13 15:12 / eli-b |
| Total Purgeable Hydrocarbons | 821 | mg/kg | 20 | | SW8015B | 05/18/13 15:12 / eli-b |
| Surr: Trifluorotoluene | 84.0 | %REC | 70-130 | | SW8015B | 05/18/13 15:12 / eli-b |
| - Note 1: Gasoline Range Organics(GRO) are defined as all hydrocarbons eluting between 2-Methylpentane and 1,2,4-Trimethylbenzene. | | | | | | |
| - Note 2: Total Purgeable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **PETROLEUM HYDROCARBONS-SEMI-VOLATILE** | | | | | | |
| Diesel Range Organics (DRO) | 1430 | mg/kg | 200 | | SW8015B | 05/18/13 04:52 / eli-b |
| Total Extractable Hydrocarbons | 1650 | mg/kg | 200 | | SW8015B | 05/18/13 04:52 / eli-b |
| Surr: o-Terphenyl | 81.0 | %REC | 50-150 | | SW8015B | 05/18/13 04:52 / eli-b |
| - Note 1: Diesel Range Organics are defined as all hydrocarbons eluting between C10 and C28. | | | | | | |
| - Note 2: Total Extractable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **NON-HALOGENATED ORGANICS BY GC-FID** | | | | | | |
| Methanol | ND | mg/kg | 1.0 | | SW8015B | 05/15/13 11:50 / eli-b |
| Surr: sec-Butyl Alcohol | 74.0 | %REC | 73-113 | | SW8015B | 05/15/13 11:50 / eli-b |
| **VOLATILE ORGANIC COMPOUNDS** | | | | | | |
| Benzene | ND | mg/kg | 0.10 | | SW8260B | 05/17/13 19:19 / eli-b |
| Ethylbenzene | ND | mg/kg | 0.20 | | SW8260B | 05/17/13 19:19 / eli-b |
| Toluene | ND | mg/kg | 0.20 | | SW8260B | 05/17/13 19:19 / eli-b |
| m+p-Xylenes | ND | mg/kg | 0.20 | | SW8260B | 05/17/13 19:19 / eli-b |
| o-Xylene | ND | mg/kg | 0.20 | | SW8260B | 05/17/13 19:19 / eli-b |
| Xylenes, Total | ND | mg/kg | 0.20 | | SW8260B | 05/17/13 19:19 / eli-b |
| Surr: p-Bromofluorobenzene | 108 | %REC | 78-160 | | SW8260B | 05/17/13 19:19 / eli-b |
| Surr: Dibromofluoromethane | 92.0 | %REC | 70-132 | | SW8260B | 05/17/13 19:19 / eli-b |
| Surr: 1,2-Dichloroethane-d4 | 103 | %REC | 60-136 | | SW8260B | 05/17/13 19:19 / eli-b |
| Surr: Toluene-d8 | 102 | %REC | 75-138 | | SW8260B | 05/17/13 19:19 / eli-b |
| **SATURATED PASTE EXTRACT** | | | | | | |
| pH, sat. paste | 7.5 | s.u. | 0.1 | | ASAM10-3.2 | 05/17/13 09:15 / eli-h |
| Conductivity, sat. paste | 4.3 | mmhos/cm | 0.1 | | ASAM10-3 | 05/20/13 07:28 / eli-h |
| Calcium, sat. paste | 1.27 | meq/L | 0.05 | | SW6010B | 05/20/13 19:16 / eli-h |
| Magnesium, sat. paste | 0.27 | meq/L | 0.08 | | SW6010B | 05/21/13 19:18 / eli-h |
| Sodium, sat. paste | 37.4 | meq/L | 0.09 | D | SW6010B | 05/20/13 19:16 / eli-h |
| Sodium Adsorption Ratio (SAR) | 47.2 | unitless | 0.1 | | USDA20b | 05/22/13 10:22 / eli-h |

**Report Definitions:**
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Helena, MT Branch

**Client:** Marathon Oil Company
**Project:** Soil_Sampling

**Report Date:** 05/22/13
**Work Order:** G13050282

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** **ASAM10-3** | | | | | | | | Analytical Run: SOIL EC_130520A | |
| **Sample ID:** **CCV1_1_130516_1** | Continuing Calibration Verification Standard | | | | | | | | 05/20/13 06:50 |
| Conductivity, sat. paste | 4.77 | mmhos/cm | 0.10 | 95 | 90 | 110 | | | |
| **Sample ID:** **ICV_1_130516_1** | Initial Calibration Verification Standard | | | | | | | | 05/20/13 06:50 |
| Conductivity, sat. paste | 19.8 | mmhos/cm | 0.10 | 99 | 90 | 110 | | | |
| **Sample ID:** **CCV_6_130516_1** | Continuing Calibration Verification Standard | | | | | | | | 05/20/13 07:17 |
| Conductivity, sat. paste | 1.36 | mmhos/cm | 0.10 | 97 | 90 | 110 | | | |
| **Sample ID:** **ICV_1_130508_1** | Initial Calibration Verification Standard | | | | | | | | 05/16/13 10:16 |
| Conductivity, sat. paste | 20.6 | mmhos/cm | 0.10 | 103 | 90 | 110 | | | |
| **Method:** **ASAM10-3** | | | | | | | | Batch: 130517_1_COND-S-PASTE | |
| **Sample ID:** **LCS-20345** | Laboratory Control Sample | | | | Run: SOIL EC_130520A | | | | 05/20/13 07:21 |
| Conductivity, sat. paste | 4.30 | mmhos/cm | 0.10 | 90 | 80 | 120 | | | |
| **Sample ID:** **G13050282-004BDUP** | Sample Duplicate | | | | Run: SOIL EC_130520A | | | | 05/20/13 07:29 |
| Conductivity, sat. paste | 4.05 | mmhos/cm | 0.10 | | | | 5.9 | 20 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Helena, MT Branch

**Client:** Marathon Oil Company
**Project:** Soil_Sampling

**Report Date:** 05/22/13
**Work Order:** G13050282

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: ASAM10-3.2** | | | | | | | | Analytical Run: SOIL PH METER_130520A | |
| **Sample ID: CCV_1_130517_1** | Continuing Calibration Verification Standard | | | | | | | | 05/17/13 09:06 |
| pH, sat. paste | 6.99 | s.u. | 0.10 | 100 | 98.6 | 101.4 | | | |
| **Sample ID: CCV1_1_130517_1** | Continuing Calibration Verification Standard | | | | | | | | 05/17/13 09:06 |
| pH, sat. paste | 4.00 | s.u. | 0.10 | 100 | 97.5 | 102.5 | | | |
| **Sample ID: ICV_1_130517_1** | Initial Calibration Verification Standard | | | | | | | | 05/17/13 09:07 |
| pH, sat. paste | 10.0 | s.u. | 0.10 | 100 | 99 | 101 | | | |
| **Sample ID: ICV_1_130516_1** | Initial Calibration Verification Standard | | | | | | | | 05/17/13 08:19 |
| pH, sat. paste | 9.99 | s.u. | 0.10 | 100 | 99 | 101 | | | |
| **Method: ASAM10-3.2** | | | | | | | | | Batch: 20345 |
| **Sample ID: LCS-20345** | Laboratory Control Sample | | | | Run: SOIL PH METER_130520A | | | | 05/17/13 09:09 |
| pH, sat. paste | 7.50 | s.u. | 0.10 | 99 | 95 | 105 | | | |
| **Sample ID: G13050282-004BDUP** | Sample Duplicate | | | | Run: SOIL PH METER_130520A | | | | 05/17/13 09:16 |
| pH, sat. paste | 7.50 | s.u. | 0.10 | | | | 0.1 | 30 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Helena, MT Branch

**Client:** Marathon Oil Company
**Project:** Soil_Sampling

**Report Date:** 05/22/13
**Work Order:** G13050282

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** **E200.7** | | | | | | | | Analytical Run: ICP1-HE_130520B | |
| **Sample ID:** **ICV** | Initial Calibration Verification Standard | | | | | | | 05/20/13 14:04 | |
| Calcium | 40.0 | mg/L | 1.0 | 100 | 90 | 110 | | | |
| Sodium | 39.2 | mg/L | 1.0 | 98 | 90 | 110 | | | |
| **Sample ID:** **ICSA** | Interference Check Sample A | | | | | | | 05/20/13 14:37 | |
| Calcium | 509 | mg/L | 1.0 | 102 | 80 | 120 | | | |
| Sodium | 0.0188 | mg/L | 1.0 | | 0 | 0 | | | |
| **Sample ID:** **ICSAB** | Interference Check Sample AB | | | | | | | 05/20/13 14:43 | |
| Calcium | 531 | mg/L | 1.0 | 106 | 80 | 120 | | | |
| Sodium | 21.5 | mg/L | 1.0 | 108 | 80 | 120 | | | |
| **Method:** **E200.7** | | | | | | | | Analytical Run: ICP1-HE_130521A | |
| **Sample ID:** **ICV** | Initial Calibration Verification Standard | | | | | | | 05/21/13 12:11 | |
| Magnesium | 40.2 | mg/L | 1.0 | 101 | 90 | 110 | | | |
| **Sample ID:** **ICSA** | Interference Check Sample A | | | | | | | 05/21/13 12:31 | |
| Magnesium | 549 | mg/L | 1.0 | 110 | 80 | 120 | | | |
| **Sample ID:** **ICSAB** | Interference Check Sample AB | | | | | | | 05/21/13 12:34 | |
| Magnesium | 550 | mg/L | 1.0 | 110 | 80 | 120 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Helena, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 05/22/13
**Project:** Soil_Sampling
**Work Order:** G13050282

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW6010B** | | | | | | | | | Batch: 20345 |
| **Sample ID: MB-20345** | Method Blank | | | | Run: ICP1-HE_130521A | | | | 05/21/13 18:28 |
| Calcium | ND | mg/L | 0.01 | | | | | | |
| Magnesium | ND | mg/L | 0.01 | | | | | | |
| Sodium | 0.4 | mg/L | 0.09 | | | | | | |
| Calcium, sat. paste | ND | meq/L | 0.0007 | | | | | | |
| Magnesium, sat. paste | ND | meq/L | 0.001 | | | | | | |
| Sodium, sat. paste | 0.02 | meq/L | 0.004 | | | | | | |
| **Sample ID: LCS-20345** | Laboratory Control Sample | | | | Run: ICP1-HE_130521A | | | | 05/21/13 18:31 |
| Calcium | 325 | mg/L | 1.0 | 78 | 70 | 130 | | | |
| Magnesium | 120 | mg/L | 1.0 | 70 | 70 | 130 | | | |
| Sodium | 331 | mg/L | 2.0 | 77 | 70 | 130 | | | |
| Calcium, sat. paste | 16.2 | meq/L | 0.050 | 78 | 70 | 130 | | | |
| Magnesium, sat. paste | 9.88 | meq/L | 0.082 | 70 | 70 | 130 | | | |
| Sodium, sat. paste | 14.4 | meq/L | 0.087 | 77 | 70 | 130 | | | |
| **Sample ID: H13050250-001BMS2** | Sample Matrix Spike | | | | Run: ICP1-HE_130521A | | | | 05/21/13 18:50 |
| Calcium | 480 | mg/L | 1.1 | 81 | 70 | 130 | | | |
| Magnesium | 406 | mg/L | 1.0 | 81 | 70 | 130 | | | |
| Sodium | 2340 | mg/L | 4.1 | 104 | 70 | 130 | | | |
| Calcium, sat. paste | 24.0 | meq/L | 0.055 | 81 | 70 | 130 | | | |
| Magnesium, sat. paste | 33.4 | meq/L | 0.082 | 81 | 70 | 130 | | | |
| Sodium, sat. paste | 102 | meq/L | 0.18 | 104 | 70 | 130 | | | |
| **Sample ID: H13050250-001BMSD2** | Sample Matrix Spike Duplicate | | | | Run: ICP1-HE_130521A | | | | 05/21/13 18:53 |
| Calcium | 548 | mg/L | 1.1 | 94 | 70 | 130 | 13 | 20 | |
| Magnesium | 489 | mg/L | 1.0 | 98 | 70 | 130 | 19 | 20 | |
| Sodium | 2390 | mg/L | 4.1 | 114 | 70 | 130 | 2.2 | 20 | |
| Calcium, sat. paste | 27.3 | meq/L | 0.055 | 94 | 70 | 130 | 13 | 20 | |
| Magnesium, sat. paste | 40.2 | meq/L | 0.082 | 98 | 70 | 130 | 19 | 20 | |
| Sodium, sat. paste | 104 | meq/L | 0.18 | 114 | 70 | 130 | 2.2 | 20 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Helena, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 05/22/13
**Project:** Soil_Sampling
**Work Order:** G13050282

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: USDA20b** | | | | | | | | | Batch: R88491 |
| **Sample ID: LCS-20285** | Laboratory Control Sample | | | | Run: MISC SOILS_130522A | | | | 05/22/13 10:06 |
| Sodium Adsorption Ratio (SAR) | 4.72 | unitless | 0.10 | 106 | 80 | 120 | | | |
| **Sample ID: G13050282-004BDUP** | Sample Duplicate | | | | Run: MISC SOILS_130522A | | | | 05/22/13 10:22 |
| Sodium Adsorption Ratio (SAR) | 45.7 | unitless | 0.10 | | | | 3.3 | 30 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Revised Date:** 05/23/13
**Report Date:** 05/21/13
**Work Order:** G13050282

**Client:** Marathon Oil Company
**Project:** Soil_Sampling

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8260B** | | | | | | | | | Batch: 71312 |
| **Sample ID: lcs-71312** | Laboratory Control Sample | | | | Run: CS5972A.I_130515A | | | | 05/15/13 12:03 |
| Benzene | 0.952 | mg/kg | 0.20 | 95 | 70 | 127 | | | |
| Ethylbenzene | 1.09 | mg/kg | 0.20 | 109 | 74 | 136 | | | |
| Toluene | 0.944 | mg/kg | 0.20 | 94 | 73 | 137 | | | |
| m+p-Xylenes | 2.14 | mg/kg | 0.20 | 107 | 75 | 136 | | | |
| o-Xylene | 1.01 | mg/kg | 0.20 | 101 | 72 | 134 | | | |
| Surr: 1,2-Dichloroethane-d4 | | | 0.20 | 68 | 60 | 136 | | | |
| Surr: Dibromofluoromethane | | | 0.20 | 78 | 70 | 132 | | | |
| Surr: p-Bromofluorobenzene | | | 0.20 | 115 | 78 | 160 | | | |
| Surr: Toluene-d8 | | | 0.20 | 90 | 75 | 138 | | | |
| **Sample ID: mb-71312** | Method Blank | | | | Run: CS5972A.I_130515A | | | | 05/15/13 12:56 |
| Benzene | ND | mg/kg | 0.10 | | | | | | |
| Ethylbenzene | ND | mg/kg | 0.10 | | | | | | |
| Toluene | ND | mg/kg | 0.10 | | | | | | |
| m+p-Xylenes | ND | mg/kg | 0.20 | | | | | | |
| o-Xylene | ND | mg/kg | 0.10 | | | | | | |
| Xylenes, Total | ND | mg/kg | 0.10 | | | | | | |
| Surr: 1,2-Dichloroethane-d4 | | | 0.10 | 74 | 60 | 136 | | | |
| Surr: Dibromofluoromethane | | | 0.10 | 84 | 70 | 132 | | | |
| Surr: p-Bromofluorobenzene | | | 0.10 | 123 | 78 | 160 | | | |
| Surr: Toluene-d8 | | | 0.10 | 92 | 75 | 138 | | | |
| **Sample ID: G13050282-001Ams** | Sample Matrix Spike | | | | Run: CS5972A.I_130515A | | | | 05/15/13 15:38 |
| Benzene | 0.856 | mg/kg | 0.20 | 86 | 70 | 127 | | | |
| Ethylbenzene | 0.984 | mg/kg | 0.20 | 98 | 74 | 136 | | | |
| Toluene | 0.880 | mg/kg | 0.20 | 88 | 73 | 137 | | | |
| m+p-Xylenes | 1.93 | mg/kg | 0.20 | 96 | 75 | 136 | | | |
| o-Xylene | 0.952 | mg/kg | 0.20 | 95 | 72 | 134 | | | |
| Surr: 1,2-Dichloroethane-d4 | | | 0.20 | 61 | 60 | 136 | | | |
| Surr: Dibromofluoromethane | | | 0.20 | 71 | 70 | 132 | | | |
| Surr: p-Bromofluorobenzene | | | 0.20 | 104 | 78 | 160 | | | |
| Surr: Toluene-d8 | | | 0.20 | 83 | 75 | 138 | | | |
| **Sample ID: G13050282-001Amsd** | Sample Matrix Spike Duplicate | | | | Run: CS5972A.I_130515A | | | | 05/15/13 16:04 |
| Benzene | 0.960 | mg/kg | 0.20 | 96 | 70 | 127 | 11 | 20 | |
| Ethylbenzene | 1.08 | mg/kg | 0.20 | 108 | 74 | 136 | 9.3 | 20 | |
| Toluene | 1.03 | mg/kg | 0.20 | 103 | 73 | 137 | 16 | 20 | |
| m+p-Xylenes | 2.16 | mg/kg | 0.20 | 108 | 75 | 136 | 11 | 20 | |
| o-Xylene | 1.06 | mg/kg | 0.20 | 106 | 72 | 134 | 11 | 20 | |
| Surr: 1,2-Dichloroethane-d4 | | | 0.20 | 68 | 60 | 136 | | | |
| Surr: Dibromofluoromethane | | | 0.20 | 80 | 70 | 132 | | | |
| Surr: p-Bromofluorobenzene | | | 0.20 | 107 | 78 | 160 | | | |
| Surr: Toluene-d8 | | | 0.20 | 96 | 75 | 138 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 05/20/13
**Project:** Soil_Sampling
**Work Order:** G13050282

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Batch: 71314 |
| **Sample ID: LCS-71314** | Laboratory Control Sample | | | | Run: PE 1_130515B | | | | 05/16/13 12:15 |
| Total Purgeable Hydrocarbons | 21.0 | mg/kg | 2.0 | 105 | 70 | 130 | | | |
| Surr: Trifluorotoluene | | | 0.10 | 108 | 70 | 130 | | | |
| **Sample ID: MB-71314** | Method Blank | | | | Run: PE 1_130515B | | | | 05/16/13 13:24 |
| Gasoline Range Organics (GRO) | ND | mg/kg | 2.0 | | | | | | |
| Total Purgeable Hydrocarbons | ND | mg/kg | 2.0 | | | | | | |
| Surr: Trifluorotoluene | | | 0.10 | 92 | 70 | 130 | | | |
| **Sample ID: B13051081-001AMS** | Sample Matrix Spike | | | | Run: PE 1_130515B | | | | 05/16/13 14:40 |
| Total Purgeable Hydrocarbons | 43.6 | mg/kg | 2.0 | 87 | 70 | 130 | | | |
| Surr: Trifluorotoluene | | | 0.10 | 104 | 70 | 130 | | | |
| **Sample ID: B13051081-001AMSD** | Sample Matrix Spike Duplicate | | | | Run: PE 1_130515B | | | | 05/16/13 15:17 |
| Total Purgeable Hydrocarbons | 44.3 | mg/kg | 2.0 | 89 | 70 | 130 | 1.4 | 20 | |
| Surr: Trifluorotoluene | | | 0.10 | 107 | 70 | 130 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R204817 |
| **Sample ID: CCV_0515PE140r** | Continuing Calibration Verification Standard | | | | | | | | 05/16/13 11:25 |
| Total Purgeable Hydrocarbons | 19.9 | mg/kg | 2.0 | 100 | 85 | 115 | | | |
| Surr: Trifluorotoluene | | | 0.10 | 97 | 85 | 115 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R204933 |
| **Sample ID: CCV_0517PE103r** | Continuing Calibration Verification Standard | | | | | | | | 05/17/13 11:50 |
| Total Purgeable Hydrocarbons | 19.4 | mg/kg | 2.0 | 97 | 85 | 115 | | | |
| Surr: Trifluorotoluene | | | 0.10 | 98 | 85 | 115 | | | |
| **Sample ID: CCV_0517PE142r** | Continuing Calibration Verification Standard | | | | | | | | 05/18/13 11:11 |
| Total Purgeable Hydrocarbons | 21.0 | mg/kg | 2.0 | 105 | 85 | 115 | | | |
| Surr: Trifluorotoluene | | | 0.10 | 95 | 85 | 115 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 05/20/13
**Project:** Soil_Sampling
**Work Order:** G13050282

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Batch: 71235 |
| **Sample ID: LCS-71235** | Laboratory Control Sample | | | | Run: GCFID-FISON-B_130513B | | | | 05/13/13 23:22 |
| Diesel Range Organics (DRO) | 455 | mg/kg | 10 | 91 | 60 | 140 | | | |
| Total Extractable Hydrocarbons | 479 | mg/kg | 10 | 96 | 60 | 140 | | | |
| Surr: o-Terphenyl | | | 0.17 | 86 | 50 | 150 | | | |
| **Sample ID: MB-71235** | Method Blank | | | | Run: GCFID-FISON-B_130513B | | | | 05/14/13 01:02 |
| Diesel Range Organics (DRO) | ND | mg/kg | 10 | | | | | | |
| Total Extractable Hydrocarbons | ND | mg/kg | 10 | | | | | | |
| Surr: o-Terphenyl | | | 0.17 | 86 | 50 | 150 | | | |
| **Sample ID: B13051004-001AMS** | Sample Matrix Spike | | | | Run: GCFID-FISON-B_130513B | | | | 05/14/13 02:41 |
| Diesel Range Organics (DRO) | 782 | mg/kg | 10 | 94 | 60 | 140 | | | |
| Total Extractable Hydrocarbons | 896 | mg/kg | 10 | 101 | 60 | 140 | | | |
| Surr: o-Terphenyl | | | 0.17 | 84 | 50 | 150 | | | |
| **Sample ID: B13051004-001AMSD** | Sample Matrix Spike Duplicate | | | | Run: GCFID-FISON-B_130513B | | | | 05/14/13 03:31 |
| Diesel Range Organics (DRO) | 836 | mg/kg | 10 | 105 | 60 | 140 | 6.7 | 20 | |
| Total Extractable Hydrocarbons | 967 | mg/kg | 10 | 115 | 60 | 140 | 7.6 | 20 | |
| Surr: o-Terphenyl | | | 0.17 | 91 | 50 | 150 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R204758 |
| **Sample ID: CCV_0515FIS15r** | Continuing Calibration Verification Standard | | | | | | | | 05/15/13 19:45 |
| Total Extractable Hydrocarbons | 514 | mg/kg | 10 | 103 | 85 | 115 | | | |
| Surr: o-Terphenyl | | | 0.17 | 97 | 85 | 115 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R204911 |
| **Sample ID: CCV_0517FIS23r** | Continuing Calibration Verification Standard | | | | | | | | 05/18/13 03:13 |
| Total Extractable Hydrocarbons | 517 | mg/kg | 10 | 103 | 85 | 115 | | | |
| Surr: o-Terphenyl | | | 0.17 | 96 | 85 | 115 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Project:** Soil_Sampling

**Report Date:** 05/20/13
**Work Order:** G13050282

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Batch: 71287 |
| **Sample ID: LCS-71287** | Laboratory Control Sample | | | | Run: GCFID-HP1-B_130514A | | | | 05/15/13 09:09 |
| Methanol | 48.1 | mg/kg | 1.0 | 96 | 71 | 126 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 92 | 73 | 113 | | | |
| **Sample ID: MB-71287** | Method Blank | | | | Run: GCFID-HP1-B_130514A | | | | 05/15/13 09:32 |
| Methanol | ND | mg/kg | 1.0 | | | | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 96 | 73 | 113 | | | |
| **Sample ID: G13050282-004AMS** | Sample Matrix Spike | | | | Run: GCFID-HP1-B_130514A | | | | 05/15/13 14:06 |
| Methanol | 44.3 | mg/kg | 1.0 | 89 | 71 | 126 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 74 | 73 | 113 | | | |
| **Sample ID: G13050282-004AMSD** | Sample Matrix Spike Duplicate | | | | Run: GCFID-HP1-B_130514A | | | | 05/15/13 15:37 |
| Methanol | 43.7 | mg/kg | 1.0 | 87 | 71 | 126 | 1.5 | 20 | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 77 | 73 | 113 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R204715 |
| **Sample ID: CCV_0514HM119r-W** | Continuing Calibration Verification Standard | | | | | | | | 05/15/13 08:48 |
| Methanol | 87.5 | mg/kg | 1.0 | 87 | 85 | 115 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 97 | 80 | 120 | | | |
| **Sample ID: CCV_0514HM138r-W** | Continuing Calibration Verification Standard | | | | | | | | 05/15/13 15:58 |
| Methanol | 87.0 | mg/kg | 1.0 | 87 | 85 | 115 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 94 | 80 | 120 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# Standard Reporting Procedures

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

# Workorder Receipt Checklist

## Marathon Oil Company G13050282

Login completed by: Amanda Alley
Date Received: 5/13/2013
Reviewed by: BL2000\kscottruff
Received by: caf
Reviewed Date: 5/13/2013
Carrier name: FedEx

| | | | |
|---|---|---|---|
| Shipping container/cooler in good condition? | Yes ☑ | No ☐ | Not Present ☐ |
| Custody seals intact on shipping container(s)/cooler(s)? | Yes ☑ | No ☐ | Not Present ☐ |
| Custody seals intact on all sample bottles? | Yes ☐ | No ☐ | Not Present ☑ |
| Chain of custody present? | Yes ☑ | No ☐ | |
| Chain of custody signed when relinquished and received? | Yes ☑ | No ☐ | |
| Chain of custody agrees with sample labels? | Yes ☑ | No ☐ | |
| Samples in proper container/bottle? | Yes ☑ | No ☐ | |
| Sample containers intact? | Yes ☑ | No ☐ | |
| Sufficient sample volume for indicated test? | Yes ☑ | No ☐ | |
| All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.) | Yes ☑ | No ☐ | |
| Temp Blank received in all shipping container(s)/cooler(s)? | Yes ☐ | No ☐ | Not Applicable ☑ |
| Container/Temp Blank temperature: | ℃ | | |
| Water - VOA vials have zero headspace? | Yes ☐ | No ☐ | No VOA vials submitted ☑ |
| Water - pH acceptable upon receipt? | Yes ☐ | No ☐ | Not Applicable ☑ |

Contact and Corrective Action Comments:

None

# Chain of Custody and Analytical Request Record

Page 1 of 1

PLEASE PRINT- Provide as much information as possible.

| | | | |
|---|---|---|---|
| Company Name: Marathon Oil Company | Project Name, PWS, Permit, Etc.: 32C_Pond_Complex/Soil | Sample Origin State: CO | EPA/State Compliance: Yes ☑ No ☐ |
| Report Mail Address: Marathon Oil Company, 743 Horizon Court, Suite 220, Grand Junction, CO 81506 | Contact Name: Zach Toellner; Phone/Fax: (970) 260-0772; Email: zjtoellner@marathonoil.c | | Sampler: (Please Print) Matthew Fousht |
| Invoice Address: Marathon Oil Company, 743 Horizon Court, Suite 220, Grand Junction, CO 81506 | Invoice Contact & Phone: Stacey Wales (970) 244-5725 | Purchase Order: | Quote/Bottle Order: |

Special Report/Formats – ELI must be notified prior to sample submittal for the following:

- ☐ DW
- ☐ GSA
- ☐ POTW/WWTP
- ☐ State: _____
- ☑ Other: PDF
- ☐ A2LA
- ☑ EDD/EDT (Electronic Data) Format: _____
- ☐ LEVEL IV
- ☐ NELAC

Number of Containers; Sample Type: A W S V B O; Air Water Soils/Solids Vegetation Bioassay Other

ANALYSIS REQUESTED

| SAMPLE IDENTIFICATION (Name, Location, Interval, etc.) | Collection Date | Collection Time | MATRIX | GRO | DRO | BTEX | Methanol | Electrical Conductivity | Sodium Adsorption Ratio | pH | | | SEE ATTACHED | Normal Turnaround (TAT) | RUSH | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 SO_32C_BLO_LNR_1 | 5/8/13 | 15:40 | 4S | X | X | X | X | X | X | X | | | | | X | SP |
| 2 SO_32C_BLO_LNR_2 | 5/8/13 | 15:55 | 4S | X | X | X | X | X | X | X | | | | | X | SP |
| 3 SO_32C_CONTROL | 5/8/13 | 15:35 | 4S | X | X | X | X | X | X | X | | | | | X | SP |
| 4 SO_32C_BLO-LNR-3 | 5/8/13 | 16:10 | 4S | X | X | X | X | X | X | X | | | | | X | SP |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |

Contact ELI prior to RUSH sample submittal for charges and scheduling – See Instruction Page

Comments: RUSH

Shipped by: Fedex

Cooler ID(s):

Receipt Temp: NA °C

On Ice: Yes No

Custody Seal: Y N

Intact: Y N

Signature Match: Y N

LABORATORY USE ONLY: 1305292

**Custody Record MUST be Signed**

| | | | | | |
|---|---|---|---|---|---|
| Relinquished by (print): Matthew Fousht | Date/Time: 5/9/13 | Signature: Matthew Fousht | Received by (print): | Date/Time: | Signature: |
| Relinquished by (print): | Date/Time: | Signature: | Received by (print): | Date/Time: | Signature: |
| Sample Disposal: Return to Client: _____ | Lab Disposal: X | | Received by Laboratory: | Date/Time: 5/13/13 | Signature: 0958 |

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested.
This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.
Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

# ANALYTICAL SUMMARY REPORT

May 23, 2013

Marathon Oil Company
743 Horizon Court Ste. 220
Grand Junction, CO 81506

Workorder No.: G13050281

Project Name: Soil_Sampling

Energy Laboratories Inc. Gillette WY received the following 2 samples for Marathon Oil Company on 5/13/2013 for analysis.

| Sample ID | Client Sample ID | Collect Date | Receive Date | Matrix | Test |
|---|---|---|---|---|---|
| G13050281-001 | SO_32C_BLO_LNR_4 | 05/09/13 9:45 | 05/13/13 | Soil | Metals, Saturated Paste<br>Conductivity, Saturated Paste Extract<br>Ultrasonic Extraction<br>Purge & Trap Extraction for Volatile Organics<br>Diesel Range Organics<br>Gasoline Range Organics<br>Water Extraction for Polar Organics<br>Non-Halogenated Organics by GC-FID<br>pH, Saturated Paste<br>Saturated Paste Extraction<br>Sodium Adsorption Ratio<br>Volatile Organics, Methanol Extraction<br>8260-Volatile Organic Compounds - Short List |
| G13050281-002 | SO_32C_BLO_LNR_5 | 05/09/13 10:50 | 05/13/13 | Soil | Same As Above |

The analyses presented in this report were performed by Energy Laboratories, Inc., 400 W. Boxelder Rd., Gillette, WY 82718, unless otherwise noted.

As appropriate, any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these tests results, please call.

Report Approved By:

**CLIENT:** Marathon Oil Company
**Project:** Soil_Sampling
**Sample Delivery Group:** G13050281

**Revised Date:** 05/23/13
**Report Date:** 05/22/13

# CASE NARRATIVE

Tests associated with analyst identified as ELI-B were subcontracted to Energy Laboratories, 1120 S. 27th St., Billings, MT, EPA Number MT00005.

Tests associated with analyst identified as ELI-H were subcontracted to Energy Laboratories, 3161 E. Lyndale Ave., Helena, MT, EPA Number MT00945.

The reporting limit for Volatile Organic Compound - Benzene has been revised to 0.10 mg/kg as per request via email from Zach Toellner with Marathon Oil.

PLEASE REPLACE IN YOUR SYSTEM AS NECESSARY.

Thank you,

Alyson Degnan
Project Manager

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

| | | | |
|---|---|---|---|
| **Client:** | Marathon Oil Company | **Revised Date:** | 05/23/13 |
| **Site Name:** | 32C_Pond_Complex | **Report Date:** | 05/22/13 |
| **Project:** | Soil_Sampling | **Collection Date:** | 05/09/13 09:45 |
| **Client Sample ID:** | SO_32C_BLO_LNR_4 | **Date Received:** | 05/13/13 |
| **Location:** | | **Sampled By:** | Matthew Fought |
| **Samp FRQ/Type:** | | **Matrix:** | Soil |
| **Lab ID:** | G13050281-001 | **Tracking Number:** | |

| Analyses | Result | Units | RL | Qualifier | Method | Analysis Date / By |
|---|---|---|---|---|---|---|
| **PETROLEUM HYDROCARBONS-VOLATILE** | | | | | | |
| Gasoline Range Organics (GRO) | 23 | mg/kg | 4.0 | | SW8015B | 05/17/13 13:33 / eli-b |
| Total Purgeable Hydrocarbons | 149 | mg/kg | 4.0 | | SW8015B | 05/17/13 13:33 / eli-b |
| Surr: Trifluorotoluene | 77.0 | %REC | 70-130 | | SW8015B | 05/17/13 13:33 / eli-b |
| - Note 1: Gasoline Range Organics(GRO) are defined as all hydrocarbons eluting between 2-Methylpentane and 1,2,4-Trimethylbenzene. | | | | | | |
| - Note 2: Total Purgeable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **PETROLEUM HYDROCARBONS-SEMI-VOLATILE** | | | | | | |
| Diesel Range Organics (DRO) | 342 | mg/kg | 200 | | SW8015B | 05/16/13 04:56 / eli-b |
| Total Extractable Hydrocarbons | 566 | mg/kg | 200 | | SW8015B | 05/16/13 04:56 / eli-b |
| Surr: o-Terphenyl | 79.0 | %REC | 50-150 | | SW8015B | 05/16/13 04:56 / eli-b |
| - Note 1: Diesel Range Organics are defined as all hydrocarbons eluting between C10 and C28. | | | | | | |
| - Note 2: Total Extractable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **NON-HALOGENATED ORGANICS BY GC-FID** | | | | | | |
| Methanol | ND | mg/kg | 1.0 | | SW8015B | 05/15/13 09:55 / eli-b |
| Surr: sec-Butyl Alcohol | 76.0 | %REC | 73-113 | | SW8015B | 05/15/13 09:55 / eli-b |
| **VOLATILE ORGANIC COMPOUNDS** | | | | | | |
| Benzene | ND | mg/kg | 0.10 | | SW8260B | 05/15/13 13:23 / eli-b |
| Ethylbenzene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 13:23 / eli-b |
| Toluene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 13:23 / eli-b |
| m+p-Xylenes | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 13:23 / eli-b |
| o-Xylene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 13:23 / eli-b |
| Xylenes, Total | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 13:23 / eli-b |
| Surr: p-Bromofluorobenzene | 102 | %REC | 78-160 | | SW8260B | 05/15/13 13:23 / eli-b |
| Surr: Dibromofluoromethane | 73.0 | %REC | 70-132 | | SW8260B | 05/15/13 13:23 / eli-b |
| Surr: 1,2-Dichloroethane-d4 | 66.0 | %REC | 60-136 | | SW8260B | 05/15/13 13:23 / eli-b |
| Surr: Toluene-d8 | 85.0 | %REC | 75-138 | | SW8260B | 05/15/13 13:23 / eli-b |
| **SATURATED PASTE EXTRACT** | | | | | | |
| pH, sat. paste | 8.0 | s.u. | 0.1 | | ASAM10-3.2 | 05/17/13 09:12 / eli-h |
| Conductivity, sat. paste | 2.9 | mmhos/cm | 0.1 | | ASAM10-3 | 05/20/13 07:24 / eli-h |
| Calcium, sat. paste | 0.74 | meq/L | 0.05 | | SW6010B | 05/20/13 18:54 / eli-h |
| Magnesium, sat. paste | 0.22 | meq/L | 0.08 | | SW6010B | 05/21/13 19:02 / eli-h |
| Sodium, sat. paste | 24.3 | meq/L | 0.09 | D | SW6010B | 05/20/13 18:54 / eli-h |
| Sodium Adsorption Ratio (SAR) | 38.7 | unitless | 0.1 | | USDA20b | 05/22/13 10:22 / eli-h |

**Report Definitions:**
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Marathon Oil Company
**Site Name:** 32C_Pond_Complex
**Project:** Soil_Sampling
**Client Sample ID:** SO_32C_BLO_LNR_5
**Location:**
**Samp FRQ/Type:**
**Lab ID:** G13050281-002

**Revised Date:** 05/23/13
**Report Date:** 05/22/13
**Collection Date:** 05/09/13 10:50
**Date Received:** 05/13/13
**Sampled By:** Matthew Fought
**Matrix:** Soil
**Tracking Number:**

| Analyses | Result | Units | RL | Qualifier | Method | Analysis Date / By |
|---|---|---|---|---|---|---|
| **PETROLEUM HYDROCARBONS-VOLATILE** | | | | | | |
| Gasoline Range Organics (GRO) | 53 | mg/kg | 4.0 | | SW8015B | 05/17/13 15:17 / eli-b |
| Total Purgeable Hydrocarbons | 237 | mg/kg | 4.0 | | SW8015B | 05/17/13 15:17 / eli-b |
| Surr: Trifluorotoluene | 75.0 | %REC | 70-130 | | SW8015B | 05/17/13 15:17 / eli-b |
| - Note 1: Gasoline Range Organics(GRO) are defined as all hydrocarbons eluting between 2-Methylpentane and 1,2,4-Trimethylbenzene. | | | | | | |
| - Note 2: Total Purgeable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **PETROLEUM HYDROCARBONS-SEMI-VOLATILE** | | | | | | |
| Diesel Range Organics (DRO) | 641 | mg/kg | 200 | | SW8015B | 05/16/13 05:45 / eli-b |
| Total Extractable Hydrocarbons | 962 | mg/kg | 200 | | SW8015B | 05/16/13 05:45 / eli-b |
| Surr: o-Terphenyl | 74.0 | %REC | 50-150 | | SW8015B | 05/16/13 05:45 / eli-b |
| - Note 1: Diesel Range Organics are defined as all hydrocarbons eluting between C10 and C28. | | | | | | |
| - Note 2: Total Extractable Hydrocarbons are defined as the total hydrocarbon response regardless of elution time. | | | | | | |
| **NON-HALOGENATED ORGANICS BY GC-FID** | | | | | | |
| Methanol | ND | mg/kg | 1.0 | | SW8015B | 05/15/13 10:18 / eli-b |
| Surr: sec-Butyl Alcohol | 74.0 | %REC | 73-113 | | SW8015B | 05/15/13 10:18 / eli-b |
| **VOLATILE ORGANIC COMPOUNDS** | | | | | | |
| Benzene | ND | mg/kg | 0.10 | | SW8260B | 05/15/13 13:50 / eli-b |
| Ethylbenzene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 13:50 / eli-b |
| Toluene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 13:50 / eli-b |
| m+p-Xylenes | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 13:50 / eli-b |
| o-Xylene | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 13:50 / eli-b |
| Xylenes, Total | ND | mg/kg | 0.20 | | SW8260B | 05/15/13 13:50 / eli-b |
| Surr: p-Bromofluorobenzene | 112 | %REC | 78-160 | | SW8260B | 05/15/13 13:50 / eli-b |
| Surr: Dibromofluoromethane | 78.0 | %REC | 70-132 | | SW8260B | 05/15/13 13:50 / eli-b |
| Surr: 1,2-Dichloroethane-d4 | 69.0 | %REC | 60-136 | | SW8260B | 05/15/13 13:50 / eli-b |
| Surr: Toluene-d8 | 85.0 | %REC | 75-138 | | SW8260B | 05/15/13 13:50 / eli-b |
| **SATURATED PASTE EXTRACT** | | | | | | |
| pH, sat. paste | 7.8 | s.u. | 0.1 | | ASAM10-3.2 | 05/17/13 09:12 / eli-h |
| Conductivity, sat. paste | 3.2 | mmhos/cm | 0.1 | | ASAM10-3 | 05/20/13 07:25 / eli-h |
| Calcium, sat. paste | 0.73 | meq/L | 0.05 | | SW6010B | 05/20/13 18:57 / eli-h |
| Magnesium, sat. paste | 0.20 | meq/L | 0.08 | | SW6010B | 05/21/13 19:05 / eli-h |
| Sodium, sat. paste | 25.8 | meq/L | 0.09 | D | SW6010B | 05/20/13 18:57 / eli-h |
| Sodium Adsorption Ratio (SAR) | 43.2 | unitless | 0.1 | | USDA20b | 05/22/13 10:22 / eli-h |

**Report Definitions:**
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Helena, MT Branch

**Client:** Marathon Oil Company
**Project:** Soil_Sampling

**Report Date:** 05/22/13
**Work Order:** G13050281

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** **ASAM10-3** | | | | | | | | Analytical Run: SOIL EC_130520A | |
| **Sample ID:** **CCV1_1_130516_1** | Continuing Calibration Verification Standard | | | | | | | | 05/20/13 06:50 |
| Conductivity, sat. paste | 4.77 | mmhos/cm | 0.10 | 95 | 90 | 110 | | | |
| **Sample ID:** **ICV_1_130516_1** | Initial Calibration Verification Standard | | | | | | | | 05/20/13 06:50 |
| Conductivity, sat. paste | 19.8 | mmhos/cm | 0.10 | 99 | 90 | 110 | | | |
| **Sample ID:** **CCV_6_130516_1** | Continuing Calibration Verification Standard | | | | | | | | 05/20/13 07:17 |
| Conductivity, sat. paste | 1.36 | mmhos/cm | 0.10 | 97 | 90 | 110 | | | |
| **Sample ID:** **ICV_1_130508_1** | Initial Calibration Verification Standard | | | | | | | | 05/16/13 10:16 |
| Conductivity, sat. paste | 20.6 | mmhos/cm | 0.10 | 103 | 90 | 110 | | | |
| **Method:** **ASAM10-3** | | | | | | | | Batch: 130517_1_COND-S-PASTE | |
| **Sample ID:** **LCS-20345** | Laboratory Control Sample | | | | Run: SOIL EC_130520A | | | | 05/20/13 07:21 |
| Conductivity, sat. paste | 4.30 | mmhos/cm | 0.10 | 90 | 80 | 120 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Helena, MT Branch

**Client:** Marathon Oil Company
**Project:** Soil_Sampling

**Report Date:** 05/22/13
**Work Order:** G13050281

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: ASAM10-3.2** | | | | | | | | Analytical Run: SOIL PH METER_130520A | |
| **Sample ID: CCV_1_130517_1** | Continuing Calibration Verification Standard | | | | | | | | 05/17/13 09:06 |
| pH, sat. paste | 6.99 | s.u. | 0.10 | 100 | 98.6 | 101.4 | | | |
| **Sample ID: CCV1_1_130517_1** | Continuing Calibration Verification Standard | | | | | | | | 05/17/13 09:06 |
| pH, sat. paste | 4.00 | s.u. | 0.10 | 100 | 97.5 | 102.5 | | | |
| **Sample ID: ICV_1_130517_1** | Initial Calibration Verification Standard | | | | | | | | 05/17/13 09:07 |
| pH, sat. paste | 10.0 | s.u. | 0.10 | 100 | 99 | 101 | | | |
| **Sample ID: ICV_1_130516_1** | Initial Calibration Verification Standard | | | | | | | | 05/17/13 08:19 |
| pH, sat. paste | 9.99 | s.u. | 0.10 | 100 | 99 | 101 | | | |
| **Method: ASAM10-3.2** | | | | | | | | | Batch: 20345 |
| **Sample ID: LCS-20345** | Laboratory Control Sample | | | | Run: SOIL PH METER_130520A | | | | 05/17/13 09:09 |
| pH, sat. paste | 7.50 | s.u. | 0.10 | 99 | 95 | 105 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Helena, MT Branch

**Client:** Marathon Oil Company
**Project:** Soil_Sampling

**Report Date:** 05/22/13
**Work Order:** G13050281

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** **E200.7** | | | | | | | | Analytical Run: ICP1-HE_130520B | |
| **Sample ID:** **ICV** | Initial Calibration Verification Standard | | | | | | | 05/20/13 14:04 | |
| Calcium | 40.0 | mg/L | 1.0 | 100 | 90 | 110 | | | |
| Sodium | 39.2 | mg/L | 1.0 | 98 | 90 | 110 | | | |
| **Sample ID:** **ICSA** | Interference Check Sample A | | | | | | | 05/20/13 14:37 | |
| Calcium | 509 | mg/L | 1.0 | 102 | 80 | 120 | | | |
| Sodium | 0.0188 | mg/L | 1.0 | | 0 | 0 | | | |
| **Sample ID:** **ICSAB** | Interference Check Sample AB | | | | | | | 05/20/13 14:43 | |
| Calcium | 531 | mg/L | 1.0 | 106 | 80 | 120 | | | |
| Sodium | 21.5 | mg/L | 1.0 | 108 | 80 | 120 | | | |
| **Method:** **E200.7** | | | | | | | | Analytical Run: ICP1-HE_130521A | |
| **Sample ID:** **ICV** | Initial Calibration Verification Standard | | | | | | | 05/21/13 12:11 | |
| Magnesium | 40.2 | mg/L | 1.0 | 101 | 90 | 110 | | | |
| **Sample ID:** **ICSA** | Interference Check Sample A | | | | | | | 05/21/13 12:31 | |
| Magnesium | 549 | mg/L | 1.0 | 110 | 80 | 120 | | | |
| **Sample ID:** **ICSAB** | Interference Check Sample AB | | | | | | | 05/21/13 12:34 | |
| Magnesium | 550 | mg/L | 1.0 | 110 | 80 | 120 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Helena, MT Branch

**Client:** Marathon Oil Company
**Project:** Soil_Sampling

**Report Date:** 05/22/13
**Work Order:** G13050281

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW6010B** | | | | | | | | | Batch: 20345 |
| **Sample ID: MB-20345** | Method Blank | | | | Run: ICP1-HE_130521A | | | | 05/21/13 18:28 |
| Calcium | ND | mg/L | 0.01 | | | | | | |
| Magnesium | ND | mg/L | 0.01 | | | | | | |
| Sodium | 0.4 | mg/L | 0.09 | | | | | | |
| Calcium, sat. paste | ND | meq/L | 0.0007 | | | | | | |
| Magnesium, sat. paste | ND | meq/L | 0.001 | | | | | | |
| Sodium, sat. paste | 0.02 | meq/L | 0.004 | | | | | | |
| **Sample ID: LCS-20345** | Laboratory Control Sample | | | | Run: ICP1-HE_130521A | | | | 05/21/13 18:31 |
| Calcium | 325 | mg/L | 1.0 | 78 | 70 | 130 | | | |
| Magnesium | 120 | mg/L | 1.0 | 70 | 70 | 130 | | | |
| Sodium | 331 | mg/L | 2.0 | 77 | 70 | 130 | | | |
| Calcium, sat. paste | 16.2 | meq/L | 0.050 | 78 | 70 | 130 | | | |
| Magnesium, sat. paste | 9.88 | meq/L | 0.082 | 70 | 70 | 130 | | | |
| Sodium, sat. paste | 14.4 | meq/L | 0.087 | 77 | 70 | 130 | | | |
| **Sample ID: H13050250-001BMS2** | Sample Matrix Spike | | | | Run: ICP1-HE_130521A | | | | 05/21/13 18:50 |
| Calcium | 480 | mg/L | 1.1 | 81 | 70 | 130 | | | |
| Magnesium | 406 | mg/L | 1.0 | 81 | 70 | 130 | | | |
| Sodium | 2340 | mg/L | 4.1 | 104 | 70 | 130 | | | |
| Calcium, sat. paste | 24.0 | meq/L | 0.055 | 81 | 70 | 130 | | | |
| Magnesium, sat. paste | 33.4 | meq/L | 0.082 | 81 | 70 | 130 | | | |
| Sodium, sat. paste | 102 | meq/L | 0.18 | 104 | 70 | 130 | | | |
| **Sample ID: H13050250-001BMSD2** | Sample Matrix Spike Duplicate | | | | Run: ICP1-HE_130521A | | | | 05/21/13 18:53 |
| Calcium | 548 | mg/L | 1.1 | 94 | 70 | 130 | 13 | 20 | |
| Magnesium | 489 | mg/L | 1.0 | 98 | 70 | 130 | 19 | 20 | |
| Sodium | 2390 | mg/L | 4.1 | 114 | 70 | 130 | 2.2 | 20 | |
| Calcium, sat. paste | 27.3 | meq/L | 0.055 | 94 | 70 | 130 | 13 | 20 | |
| Magnesium, sat. paste | 40.2 | meq/L | 0.082 | 98 | 70 | 130 | 19 | 20 | |
| Sodium, sat. paste | 104 | meq/L | 0.18 | 114 | 70 | 130 | 2.2 | 20 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Helena, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 05/22/13
**Project:** Soil_Sampling
**Work Order:** G13050281

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** **USDA20b** | | | | | | | | | Batch: R88491 |
| **Sample ID:** **LCS-20285** | Laboratory Control Sample | | | | Run: MISC SOILS_130522A | | | | 05/22/13 10:06 |
| Sodium Adsorption Ratio (SAR) | 4.72 | unitless | 0.10 | 106 | 80 | 120 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Revised Date:** 05/23/13
**Report Date:** 05/20/13
**Work Order:** G13050281

**Client:** Marathon Oil Company
**Project:** Soil_Sampling

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8260B** | | | | | | | | | Batch: 71312 |
| **Sample ID: lcs-71312** | Laboratory Control Sample | | | | Run: CS5972A.I_130515A | | | | 05/15/13 12:03 |
| Benzene | 0.952 | mg/kg | 0.20 | 95 | 70 | 127 | | | |
| Ethylbenzene | 1.09 | mg/kg | 0.20 | 109 | 74 | 136 | | | |
| Toluene | 0.944 | mg/kg | 0.20 | 94 | 73 | 137 | | | |
| m+p-Xylenes | 2.14 | mg/kg | 0.20 | 107 | 75 | 136 | | | |
| o-Xylene | 1.01 | mg/kg | 0.20 | 101 | 72 | 134 | | | |
| Surr: 1,2-Dichloroethane-d4 | | | 0.20 | 68 | 60 | 136 | | | |
| Surr: Dibromofluoromethane | | | 0.20 | 78 | 70 | 132 | | | |
| Surr: p-Bromofluorobenzene | | | 0.20 | 115 | 78 | 160 | | | |
| Surr: Toluene-d8 | | | 0.20 | 90 | 75 | 138 | | | |
| **Sample ID: mb-71312** | Method Blank | | | | Run: CS5972A.I_130515A | | | | 05/15/13 12:56 |
| Benzene | ND | mg/kg | 0.10 | | | | | | |
| Ethylbenzene | ND | mg/kg | 0.10 | | | | | | |
| Toluene | ND | mg/kg | 0.10 | | | | | | |
| m+p-Xylenes | ND | mg/kg | 0.20 | | | | | | |
| o-Xylene | ND | mg/kg | 0.10 | | | | | | |
| Xylenes, Total | ND | mg/kg | 0.10 | | | | | | |
| Surr: 1,2-Dichloroethane-d4 | | | 0.10 | 74 | 60 | 136 | | | |
| Surr: Dibromofluoromethane | | | 0.10 | 84 | 70 | 132 | | | |
| Surr: p-Bromofluorobenzene | | | 0.10 | 123 | 78 | 160 | | | |
| Surr: Toluene-d8 | | | 0.10 | 92 | 75 | 138 | | | |
| **Sample ID: b13051078-001ams** | Sample Matrix Spike | | | | Run: CS5972A.I_130515A | | | | 05/15/13 15:38 |
| Benzene | 0.856 | mg/kg | 0.20 | 86 | 70 | 127 | | | |
| Ethylbenzene | 0.984 | mg/kg | 0.20 | 98 | 74 | 136 | | | |
| Toluene | 0.880 | mg/kg | 0.20 | 88 | 73 | 137 | | | |
| m+p-Xylenes | 1.93 | mg/kg | 0.20 | 96 | 75 | 136 | | | |
| o-Xylene | 0.952 | mg/kg | 0.20 | 95 | 72 | 134 | | | |
| Surr: 1,2-Dichloroethane-d4 | | | 0.20 | 61 | 60 | 136 | | | |
| Surr: Dibromofluoromethane | | | 0.20 | 71 | 70 | 132 | | | |
| Surr: p-Bromofluorobenzene | | | 0.20 | 104 | 78 | 160 | | | |
| Surr: Toluene-d8 | | | 0.20 | 83 | 75 | 138 | | | |
| **Sample ID: b13051078-001amsd** | Sample Matrix Spike Duplicate | | | | Run: CS5972A.I_130515A | | | | 05/15/13 16:04 |
| Benzene | 0.960 | mg/kg | 0.20 | 96 | 70 | 127 | 11 | 20 | |
| Ethylbenzene | 1.08 | mg/kg | 0.20 | 108 | 74 | 136 | 9.3 | 20 | |
| Toluene | 1.03 | mg/kg | 0.20 | 103 | 73 | 137 | 16 | 20 | |
| m+p-Xylenes | 2.16 | mg/kg | 0.20 | 108 | 75 | 136 | 11 | 20 | |
| o-Xylene | 1.06 | mg/kg | 0.20 | 106 | 72 | 134 | 11 | 20 | |
| Surr: 1,2-Dichloroethane-d4 | | | 0.20 | 68 | 60 | 136 | | | |
| Surr: Dibromofluoromethane | | | 0.20 | 80 | 70 | 132 | | | |
| Surr: p-Bromofluorobenzene | | | 0.20 | 107 | 78 | 160 | | | |
| Surr: Toluene-d8 | | | 0.20 | 96 | 75 | 138 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 05/20/13
**Project:** Soil_Sampling
**Work Order:** G13050281

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Batch: 71314 |
| **Sample ID: LCS-71314** | Laboratory Control Sample | | | | Run: PE 1_130515B | | | | 05/16/13 12:15 |
| Total Purgeable Hydrocarbons | 21.0 | mg/kg | 2.0 | 105 | 70 | 130 | | | |
| Surr: Trifluorotoluene | | | 0.10 | 108 | 70 | 130 | | | |
| **Sample ID: MB-71314** | Method Blank | | | | Run: PE 1_130515B | | | | 05/16/13 13:24 |
| Gasoline Range Organics (GRO) | ND | mg/kg | 2.0 | | | | | | |
| Total Purgeable Hydrocarbons | ND | mg/kg | 2.0 | | | | | | |
| Surr: Trifluorotoluene | | | 0.10 | 92 | 70 | 130 | | | |
| **Sample ID: B13051081-001AMS** | Sample Matrix Spike | | | | Run: PE 1_130515B | | | | 05/16/13 14:40 |
| Total Purgeable Hydrocarbons | 43.6 | mg/kg | 2.0 | 87 | 70 | 130 | | | |
| Surr: Trifluorotoluene | | | 0.10 | 104 | 70 | 130 | | | |
| **Sample ID: B13051081-001AMSD** | Sample Matrix Spike Duplicate | | | | Run: PE 1_130515B | | | | 05/16/13 15:17 |
| Total Purgeable Hydrocarbons | 44.3 | mg/kg | 2.0 | 89 | 70 | 130 | 1.4 | 20 | |
| Surr: Trifluorotoluene | | | 0.10 | 107 | 70 | 130 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R204933 |
| **Sample ID: CCV_0517PE103r** | Continuing Calibration Verification Standard | | | | | | | | 05/17/13 11:50 |
| Total Purgeable Hydrocarbons | 19.4 | mg/kg | 2.0 | 97 | 85 | 115 | | | |
| Surr: Trifluorotoluene | | | 0.10 | 98 | 85 | 115 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Report Date:** 05/20/13
**Project:** Soil_Sampling
**Work Order:** G13050281

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Batch: 71235 |
| **Sample ID: LCS-71235** | Laboratory Control Sample | | | | Run: GCFID-FISON-B_130513B | | | | 05/13/13 23:22 |
| Diesel Range Organics (DRO) | 455 | mg/kg | 10 | 91 | 60 | 140 | | | |
| Total Extractable Hydrocarbons | 479 | mg/kg | 10 | 96 | 60 | 140 | | | |
| Surr: o-Terphenyl | | | 0.17 | 86 | 50 | 150 | | | |
| **Sample ID: MB-71235** | Method Blank | | | | Run: GCFID-FISON-B_130513B | | | | 05/14/13 01:02 |
| Diesel Range Organics (DRO) | ND | mg/kg | 10 | | | | | | |
| Total Extractable Hydrocarbons | ND | mg/kg | 10 | | | | | | |
| Surr: o-Terphenyl | | | 0.17 | 86 | 50 | 150 | | | |
| **Sample ID: B13051004-001AMS** | Sample Matrix Spike | | | | Run: GCFID-FISON-B_130513B | | | | 05/14/13 02:41 |
| Diesel Range Organics (DRO) | 782 | mg/kg | 10 | 94 | 60 | 140 | | | |
| Total Extractable Hydrocarbons | 896 | mg/kg | 10 | 101 | 60 | 140 | | | |
| Surr: o-Terphenyl | | | 0.17 | 84 | 50 | 150 | | | |
| **Sample ID: B13051004-001AMSD** | Sample Matrix Spike Duplicate | | | | Run: GCFID-FISON-B_130513B | | | | 05/14/13 03:31 |
| Diesel Range Organics (DRO) | 836 | mg/kg | 10 | 105 | 60 | 140 | 6.7 | 20 | |
| Total Extractable Hydrocarbons | 967 | mg/kg | 10 | 115 | 60 | 140 | 7.6 | 20 | |
| Surr: o-Terphenyl | | | 0.17 | 91 | 50 | 150 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R204758 |
| **Sample ID: CCV_0515FIS15r** | Continuing Calibration Verification Standard | | | | | | | | 05/15/13 19:45 |
| Total Extractable Hydrocarbons | 514 | mg/kg | 10 | 103 | 85 | 115 | | | |
| Surr: o-Terphenyl | | | 0.17 | 97 | 85 | 115 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

Prepared by Billings, MT Branch

**Client:** Marathon Oil Company
**Project:** Soil_Sampling

**Report Date:** 05/20/13
**Work Order:** G13050281

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: SW8015B** | | | | | | | | | Batch: 71287 |
| **Sample ID: LCS-71287** | Laboratory Control Sample | | | | Run: GCFID-HP1-B_130514A | | | | 05/15/13 09:09 |
| Methanol | 48.1 | mg/kg | 1.0 | 96 | 71 | 126 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 92 | 73 | 113 | | | |
| **Sample ID: MB-71287** | Method Blank | | | | Run: GCFID-HP1-B_130514A | | | | 05/15/13 09:32 |
| Methanol | ND | mg/kg | 1.0 | | | | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 96 | 73 | 113 | | | |
| **Sample ID: B13051078-004AMS** | Sample Matrix Spike | | | | Run: GCFID-HP1-B_130514A | | | | 05/15/13 14:06 |
| Methanol | 44.3 | mg/kg | 1.0 | 89 | 71 | 126 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 74 | 73 | 113 | | | |
| **Sample ID: B13051078-004AMSD** | Sample Matrix Spike Duplicate | | | | Run: GCFID-HP1-B_130514A | | | | 05/15/13 15:37 |
| Methanol | 43.7 | mg/kg | 1.0 | 87 | 71 | 126 | 1.5 | 20 | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 77 | 73 | 113 | | | |
| **Method: SW8015B** | | | | | | | | | Analytical Run: R204715 |
| **Sample ID: CCV_0514HM119r-W** | Continuing Calibration Verification Standard | | | | | | | | 05/15/13 08:48 |
| Methanol | 87.5 | mg/kg | 1.0 | 87 | 85 | 115 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 97 | 80 | 120 | | | |
| **Sample ID: CCV_0514HM138r-W** | Continuing Calibration Verification Standard | | | | | | | | 05/15/13 15:58 |
| Methanol | 87.0 | mg/kg | 1.0 | 87 | 85 | 115 | | | |
| Surr: sec-Butyl Alcohol | | | 1.0 | 94 | 80 | 120 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# Standard Reporting Procedures

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

# Workorder Receipt Checklist

## Marathon Oil Company G13050281

Login completed by: Amanda Alley
Date Received: 5/13/2013
Reviewed by: BL2000\kscottruff
Received by: caf
Reviewed Date: 5/13/2013
Carrier name: FedEx

| | | | |
|---|---|---|---|
| Shipping container/cooler in good condition? | Yes ☑ | No ☐ | Not Present ☐ |
| Custody seals intact on shipping container(s)/cooler(s)? | Yes ☑ | No ☐ | Not Present ☐ |
| Custody seals intact on all sample bottles? | Yes ☐ | No ☐ | Not Present ☑ |
| Chain of custody present? | Yes ☑ | No ☐ | |
| Chain of custody signed when relinquished and received? | Yes ☑ | No ☐ | |
| Chain of custody agrees with sample labels? | Yes ☐ | No ☑ | |
| Samples in proper container/bottle? | Yes ☑ | No ☐ | |
| Sample containers intact? | Yes ☑ | No ☐ | |
| Sufficient sample volume for indicated test? | Yes ☑ | No ☐ | |
| All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.) | Yes ☑ | No ☐ | |
| Temp Blank received in all shipping container(s)/cooler(s)? | Yes ☐ | No ☐ | Not Applicable ☑ |
| Container/Temp Blank temperature: | ℃ | | |
| Water - VOA vials have zero headspace? | Yes ☐ | No ☐ | No VOA vials submitted ☑ |
| Water - pH acceptable upon receipt? | Yes ☐ | No ☐ | Not Applicable ☑ |

Contact and Corrective Action Comments:

The collection times on the sample jars is reversed from what was documented on the COC. Tracey Archer contacted Matthew Fought and confirmed that the collection times on the sample jars is correct. Tla 5/22/2013

# Chain of Custody and Analytical Request Record

Page _____ of _____

**PLEASE PRINT (Provide as much information as possible.)**



Company Name: Marathon Oil Company

Project Name, PWS, Permit, Etc.: 32C – Pond_complex/soil

Sample Origin State: CO

EPA/State Compliance: Yes ☑ No ☐

Report Mail Address (Required): Marathon Oil Company, 743 Horizon court, suite 220, Grand Jct. CO. 81506

Contact Name: Zach Toellner

Phone/Fax: (970)260-0772

Cell: Email: ztoellner@Marathon oil.com

Sampler: (Please Print) Matthew Fought

❑ No Hard Copy Email:

Invoice Contact & Phone: (970)244-5725

Purchase Order:

Quote/Bottle Order:

Invoice Address (Required): Marathon oil Company, 743 Horizon court suit 220, Grand Jct. CO. 81506

❑ No Hard Copy Email:

Special Report/Formats:

☐ DW ☑ EDD/EDT (Electronic Data)
☐ POTW/WWTP Format:
☐ State: ☐ LEVEL IV
☑ Other: PDF ☐ NELAC

Number of Containers
Sample Type: A Water S Soils/Solids V Vegetation B Bioassay O Other DW - Drinking Water

ANALYSIS REQUESTED

| SAMPLE IDENTIFICATION (Name, Location, Interval, etc.) | Collection Date | Collection Time | MATRIX | DRO | GRO | BTEX | Methanol | Electrical Conductivity | SAR | pH | | | SEE ATTACHED | Standard Turnaround (TAT) | RUSH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 SO-32C-BLO-LNR-4 | 5/9/13 | 10:50 | 4S | X | X | X | X | X | X | X | | | | | X |
| 2 SO-32C-BLO-LNR-5 | 5/9/13 | 9:45 | 4S | X | X | X | X | X | X | X | | | | | X |
| 3 | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | |

R U S H

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments: **RUSH**

Shipped by: fedex

Cooler ID(s):

Receipt Temp N/A °C

On Ice: Y N

Custody Seal: On Bottle Y N; On Cooler Y N

Intact Y N

Signature Match Y N

LABORATORY USE ONLY 1305028I

**Custody Record MUST be Signed**

Relinquished by (print): Matthew Fought Date/Time: 5/10/13 11:00 AM Signature:

Relinquished by (print): Date/Time: Signature:

Sample Disposal: Return to Client: _____ Lab Disposal: _____

Received by (print): Date/Time: Signature:

Received by (print): Date/Time: Signature:

Received by Laboratory: Date/Time: 5/13/13 0949 Signature:

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested.
This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.
Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

# APPENDIX D
# TEST PIT INVESTIGATIONS

**APPENDIX D-1**

**MAY 20, 2013 DAILY REPORT**

Golder Associates
2809 East Harmony Road, Suite 310
Fort Collins, CO USA 80528
Tel: (970) 484-3857

| | |
|---|---|
| **DATE:** 5/20/2013 | **JOB NO:** 130-0253 |
| **PROJECT:** 32C Evaporation Pond Investigation | |
| **LOCATION:** Garfield County, CO | |
| **CONTRACTOR:** Metcalf | **OWNER:** Marathon Oil Co. |
| **WEATHER:** Overcast, intermittent light rain, moderate winds. | **TEMP:** ~40F - 45F |

## Golder Personnel:

Ryan Becker

## Excavation Activities:

Metcalf began excavation of test pits TP-1 and TP-2 using a CAT 329E excavator with teeth on the bucket. Excavation of both test pits was terminated at depths of approximately 4.5 to 5 feet below ground surface (bgs) due to trackhoe refusal from encountering well indurated bedrock. In both test pits, materials between depths of 0 to 4 feet bgs was weathered silty sandstone. Metcalf backfilled both test pits using spoils materials that were removed during excavation activities. Representative photos of the primary excavation activities are attached to this report.

## Sampling Activities:

Golder collected three samples from TP-1 (between 1 and 4 feet bgs) and six samples from TP-2 (between 1 and 3 feet bgs). Golder also collected a sample from a spoils stockpile containing soils from underneath the 32C pond geomembrane.

## Testing Activities:

Golder performed PID testing on all samples that were collected. None of the test pit samples registered on the PID. The sample of material obtained from beneath the pond geomembrane had a PID reading of 55 ppm.

## Meetings and Discussions:

Golder received safety orientation upon arrival at the Marathon Parachute office.

When the trackhoe encountered refusal in TP-1 and TP-2, Golder, Marathon, and Metcalf met to discuss the situation. Metcalf stated that the CAT 329E excavator would not be able to excavate deeper, and that Metcalf would need to obtain a second excavator with a rock-hammer attachment to break the bedrock in order to continue excavation activities.

**Date:** _____

**Signature:** _____
Ryan Becker, Staff Scientist

**Photos:**

CAT 329E trackhoe excavating TP-1.

**Date:** _____

**Signature:** _____

Ryan Becker, Staff Scientist

Side profile of TP-1 to a total depth of 5 feet bgs.

Excavation of TP-2.

Side profile of TP-2 at a total depth of approximately 4.5 feet bgs.

**Date:** _____

**Signature:** _____

Ryan Becker, Staff Scientist

Backfilled excavation area.

**Date:** _____

**Signature:** _____

Ryan Becker, Staff Scientist

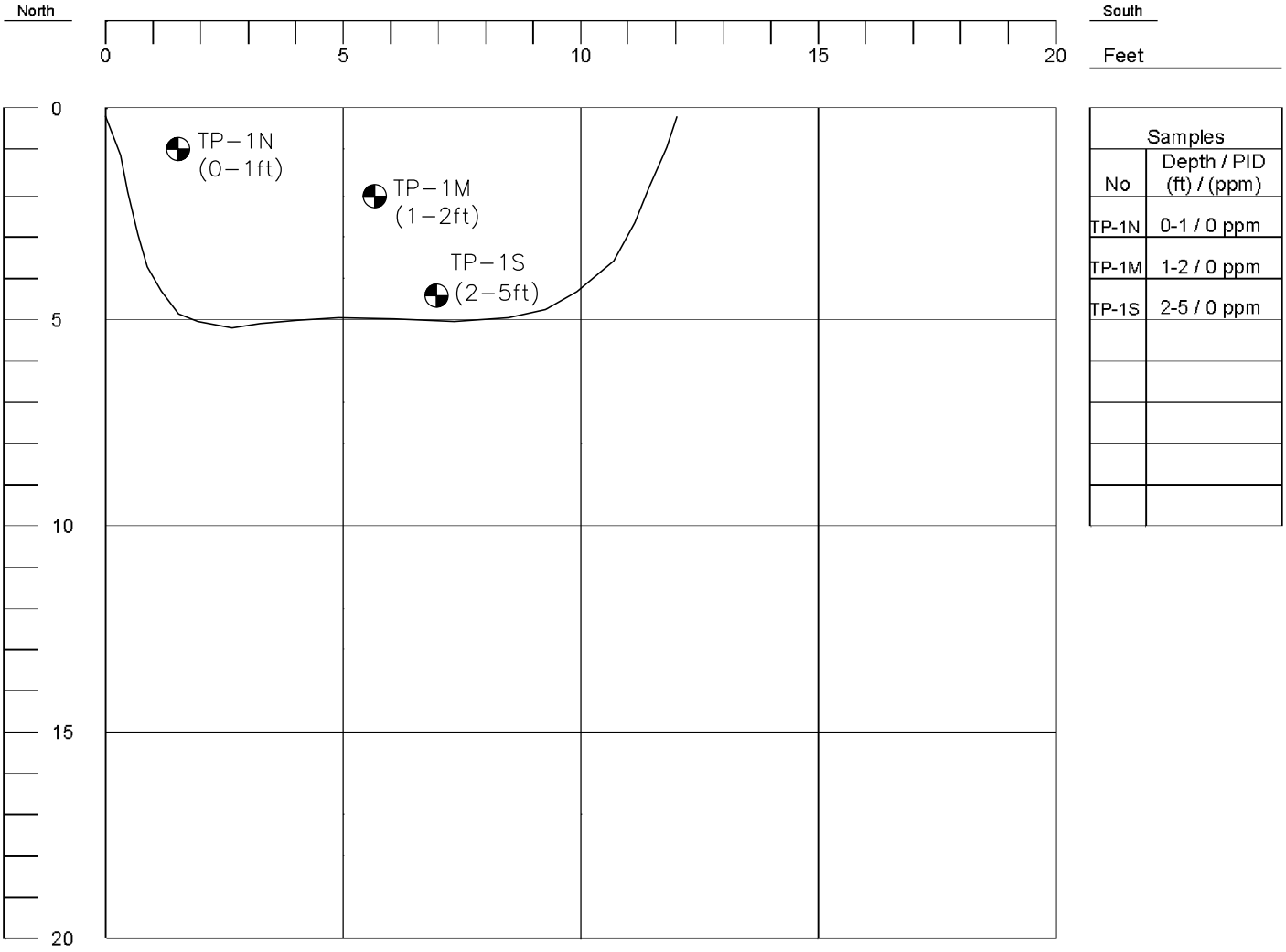
**APPENDIX D-2**

**TEST PIT LOGS**

# TP-1 TEST PIT LOG

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Temp: | 40° F | Weather: | Light rain | Engineer: | R. Becker | Operator: | - |
| Equipment: | CAT 329E Trackhoe | | | Contractor | Metcalf | | |
| Location | Pad 32C | | | Elevation | - | Datum | - |

| | |
|---|---|
| Test Pit: | TP-1 |
| Date | 5/20/13 |
| Job No. | 130-0253 |




| Samples | |
|---|---|
| No | Depth / PID (ft) / (ppm) |
| TP-1N | 0-1 / 0 ppm |
| TP-1M | 1-2 / 0 ppm |
| TP-1S | 2-5 / 0 ppm |
| | |
| | |
| | |
| | |
| | |

| Sample Descriptions and Excavation Notes | | Time | Depth of Hole | Depth to Waterline |
|---|---|---|---|---|
| 11:30 | Begin excavation of TP-1<br>0'-4' weathered silty sandstone<br>4'-5' shale bedrock | 11:45 | 5.0 ft. | Dry |
| 11:45 | Trackhoe refusal; contractor cannot excavate further | | | |
| 12:05 | Backfilling completed (used spoils from excavation) | | | |

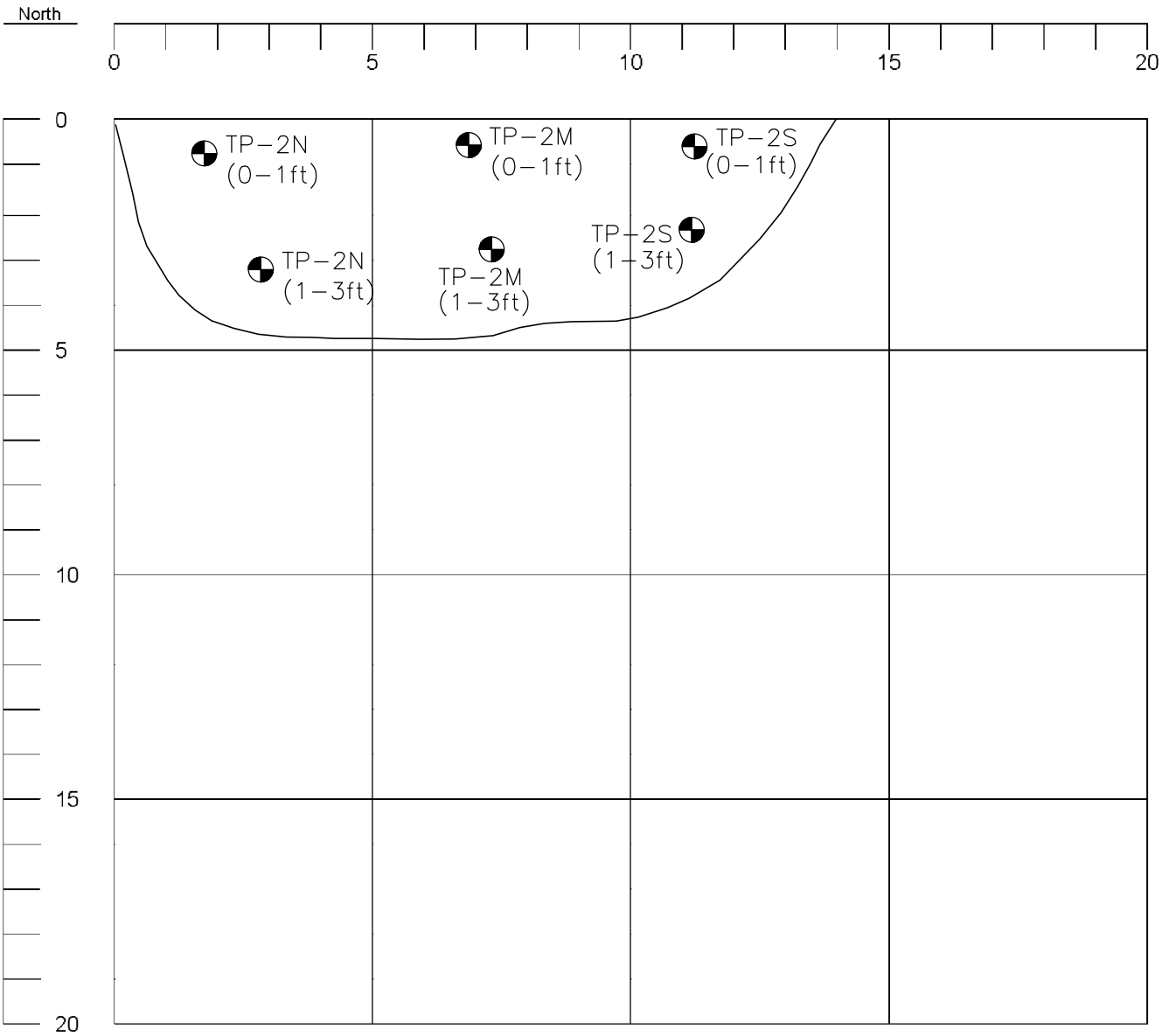
Special Notes:

No PID detections

# TP-2 TEST PIT LOG

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Temp: | 40° F | Weather: | Light rain | Engineer: | R. Becker | Operator: | - |
| Equipment: | CAT 329E Trackhoe | | | Contractor | Metcalf | | |
| Location | Pad 32C | | | Elevation | - | Datum | - |

| | |
|---|---|
| Test Pit: | TP-2 |
| Date | 5/20/13 |
| Job No. | 130-0253 |




| Samples | |
|---|---|
| No | Depth / PID (ft) / (ppm) |
| TP-2N | 0-1 / 0 ppm |
| TP-2M | 0-1 / 0 ppm |
| TP-2S | 0-1 / 0 ppm |
| TP-2N | 1-3 / 0 ppm |
| TP-2M | 1-3 / 0 ppm |
| TP-2S | 1-3 / 0 ppm |
| | |
| | |

| | Sample Descriptions and Excavation Notes |
|---|---|
| 12:15 | Begin excavation of TP-2<br>0'-4' weathered silty sandstone<br>4'-4.5' shale bedrock |
| 12:25 | Trackhoe refusal; contractor cannot excavate further |
| 12:35 | Completed backfilling with spoils from excavation |

| Time | Depth of Hole | Depth to Waterline |
|---|---|---|
| 12:25 | 4.5 ft. | Dry |
| | | |
| | | |
| | | |
| | | |
| | | |

Special Notes:

No PID detections

# APPENDIX E
# GOLDER TECHNICAL PROCEDURES

# APPENDIX E-1
# TECHNICAL PROCEDURE FOR SURFACE WATER SAMPLING

Golder Associates

# Technical Procedure

Number: TP 1.2-26, Revision 0
Title: SURFACE WATER SAMPLING METHODS

| Prepared by | Approved by | Approved by | Effective Date | Rev. Level |
|---|---|---|---|---|
| | | | 5/1/98 | 0 |
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## 1. PURPOSE

This document describes the sampling protocols used by Golder Associates to collect surface water samples. It contains sampling instructions and information concerning appropriate containers, preservation, and handling of water quality samples.

## 2. APPLICABILITY

This technical procedure is applicable to any persons involved in the collection of surface water samples. It is applicable to all geographic areas.

## 3. DEFINITIONS

### 3.1 Analytical Request Form

Standard form provided by analytical laboratories. This form is filled out by the person collecting samples and is used to indicate how each sample is to be analyzed. This form is often combined with the Chain-of-Custody Form in a single document.

### 3.2 Chain-of-Custody Form

Standard form used to track the movement of sample containers from the time they leave the field until they arrive at the specified laboratory. The Chain-of-Custody form provides a clear record of sample transport and handling, thereby reducing the risk of sample loss during transport. This form may be combined with the Analytical Request Form in a single document.

### 3.3 Chemical Analysis

Analytical procedure used to measure the *amount* of a certain compound, or group of compounds, present in a sample.

### 3.4 Preservatives

Preservatives are used to maintain sample integrity from the time a sample is collected until it is analyzed. Sample preservation may involve adding acid or other fixatives to collected waters or simply keeping them refrigerated. Sample-specific requirements are outlined in this document (Table 1); preservatives, when required, are provided by the analytical laboratory.

### 3.5 Sample Bottles

Sample bottles are containers specifically designed and prepared for storing liquid samples. Sample bottle type, material, size, and type of lid are specific for particular groups of analytes. Sample bottles must be properly cleaned and prepared by a laboratory or the manufacturer. Table 1 summarizes bottle type and preparation requirements.

## 3.6 Surface Water Sample

A surface water sample is defined as water acquired from a surface water body for chemical analyses that is representative of surface water within the cross-section of a lake, stream, or river being sampled.

## 3.7 Quality Assurance/Quality Control (QA/QC)

Quality Assurance refers to a detailed protocol used to produce high quality products, while Quality Control refers to the process by which this protocol is tested to ensure that final products are of the specified quality. With reference to water sampling, QA protocol includes the use trained personnel, proper sampling methods, clean containers and equipment, proper sample preservation and transportation and detailed documentation of the entire process; field, travel and other assorted test blanks are used for Quality Control testing.

## 3.8 Sample Types

### 3.8.1 Grab Samples

Sample containing water collected during a single sampling event (i.e., water taken from a given place at a given time).

### 3.8.2 Composite Samples

Sample containing a mixture of water collected from multiple locations or from different times at the same location.

### 3.8.3 Equipment Blanks

Equipment blanks are used to detect contamination from sampling equipment. They are prepared by rinsing precleaned equipment with deionized water and collecting the rinsate into an appropriate container.

### 3.8.4 Field Blanks

Field blanks are used to detect contamination during sample collection and transport. They are prepared during a sampling event by filling the appropriate container with deionized water. Field blanks are usually used in situations where there is reason to suspect that contamination will occur during sample collection and transport.

### 3.8.5 Travel Blanks

Travel blanks detect sample contamination during transport. Travel blanks consist of pre-filled bottles provided by the analytical lab. They accompany empty sample bottles to the field site,

where they are left intact and unopened inside the shipping cooler. The unopened travel blanks are then returned to the analytical lab to be analyzed along with collected samples.

### 3.8.6 Field Spikes

Field spikes are used to measure the performance of the complete analytical system, including sample handling, preservation and storage, as well as interference from the sample matrix. To generate a field spike, field personnel fill the usual sampling container with sample, leaving a small amount of space at the top. They then add a specified amount of the chemical or compound of interest to the bottle and submit it with the rest of the samples. In general, field spikes are not recommended due to the logistical difficulties of transporting concentrated solutions in the field. If there is reason to doubt the performance of the sampling system, then a separate study involving field spikes should be carried out.

### 3.8.7 Standard Reference Samples

Standard reference samples, or blind QA samples, are samples of known concentration that are submitted to the analytical lab as a normal sample. The lab is not informed about the identity of the sample until after all analyses are complete.

### 3.8.8 Replicate Samples

Replicate samples are used to evaluate within-site variation. Replicate samples are collected by filling multiple containers at a single site. They are labeled and preserved individually and are submitted separately to the analytical laboratory. Check the field sampling plan (FSP) for the number of replicate samples required per sampling site.

### 3.8.9 Split Samples

Split samples are used to check analytical variation. A single sample (e.g. grab) is collected and is split into two sample containers. These are labeled and preserved individually and are submitted separately to the analytical laboratory.

## 4. REFERENCES AND SUGGESTED READING

ASTM, 1994, *Annual Book of Standards, Volume 04.08, 1994*, American Society of Testing and Materials, Philadelphia, PA.

Clesceri, L.S., A.E. Greenberg and R.R. Trussell. 1989. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington, D.C.

Feldt, L., Editor, 1987, *A Compendium of Superfund Field Operations Methods*, U.S. Environmental Protection Agency Report No. 9355.0-14, Washington, D.C.

Golder Associates Inc. Quality Procedure QP-11.1, "Calibration and Maintenance of Measuring and Test Equipment."

Golder Associates Inc. Technical Procedure TP-1.2-23, "Chain of Custody."

U.S. Department of the Interior, 1977, National Handbook of recommended methods for water-data acquisition, Reston, VA.

U.S. EPA, 1994, *U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganics Data Review*, EPA 540/R-94/013, U.S. EPA Office of Emergency and Remedial Response, Washington, D.C.

U.S. Geological Survey, 1982, Measurement and Computation of Streamflow: Volume 1 and 2. Washington, D.C.

U.S. EPA, 1986, *Test Methods for Evaluating Solid Waste - (SW-846)*, 3rd Edition (Final Update III, December 1996), U.S. EPA/Office of Solid Waste, Washington, D.C.

40 CFR 136, U.S. EPA, *Guidelines Establishing Test Procedures for the Analysis of Pollutants.* Title 40 Part 136 of the Code of Federal Regulations.

# 5. DISCUSSION

## 5.1 Sampling Procedures

Samples are collected as representative pieces of a larger puzzle. Ideally, they should describe all of the characteristics of the larger body from which they originate, which, by its very definition, is too large to analyze directly. As a result, it is very important to follow a well-organized sampling plan and to preserve sample integrity throughout the collection and transportation process.

### 5.1.1 General Practices

Usually, analytical laboratories will provide pre-cleaned sample containers, shipping containers, required forms for sample submission and specific sample shipping instructions. It is important to check with the lab that these arrangements have been made. Similarly, field crews should familiarize themselves with the FSP before initiating a sampling program. By reviewing the instructions, personnel can ensure that they have all of the equipment they require to fulfill the objectives of the sampling program. Field crews will also then be aware of the types of samples they are being asked to collect, be they grab samples, composite samples or QA/QC test blanks. Finally, sample crews should organize themselves such that samples will be collected and shipped during the early part of the work week to avoid delays caused by weekend shipping or make specific arrangements with laboratories to receive samples on the weekend.

**Sampling Locations.** General sampling locations are described in FSP. However, field crews will have a certain degree of freedom in choosing the exact locations from which to take the samples. When selecting these sites, personnel should consider the layout of the local

environment, project objectives and personal safety. They should then choose areas that are both easily accessible and representative of the target waterbody or waterbodies.

Once sampling sites have been identified, they must be described relative to permanent landmarks, such as groundwater wells, outfalls or distinctive landscape features; measuring the distance from permanent landmarks to each site with an appropriate compass heading is recommended. Ideally, one should try to use the Global Positioning System (GPS), but locations can also be recorded as the perpendicular distance from the shoreline and the distance upstream or downstream of a permanent landmark.

**Sample Collection.** Where possible, start sampling at the least contaminated site (i.e., the reference site) and move from there to the more contaminated areas.

If sampling equipment must be used, then it must be cleaned before and after use. This may involve rinsing with ambient water, cleaning with soap and water, acid washing, rinsing with organic solvents or pure water, or a combination of these. Refer to the FSP for details.

Each sample bottle must be labeled at the time of collection with either waterproof, permanent marker or using pre-printed waterproof labels. See section 5.3.2 for details of label format.

When sampling, it is important to rinse sample containers 3 times before taking a sample. Rinse each bottle by partially filling it with ambient water, loosely attaching the cap and shaking the bottle; drain the water and repeat the process. As a general rule, rinse plastic bottles unless instructed otherwise by the analytical laboratory. Bottles that already contain the appropriate preservatives and containers for the following analyses should *not* be rinsed prior to taking the sample:

- volatile organic compounds (VOCs), including total volatile hydrocarbons (TVH),
- total extractable hydrocarbons (TEH),
- BTEX (benzene, toluene, ethylbenzene and xylene)
- total petroleum hydrocarbons (TPH; includes TVH, TEH and BTEX); and
- bacteriological testing (e.g., fecal coliforms).

Carefully fill sample containers, without splashing, leaving only enough space for preservatives (if required - see Table 1 ). Be sure to keep hands and fingers downstream of bottle opening and sample upstream of bridges, boats and yourself to prevent sample contamination. The samples will be collected in flowing water, unless otherwise specified in the FSP, from areas where the flow is well mixed. If no preservatives need to be added, completely fill the bottles and cap tightly. There should be as little air in the containers as possible, as it can affect sample integrity.

Whenever possible, fill sample containers directly from the source, without using an intermediate container to transfer the sample. This avoids potential sample contamination due to carry-over from one sample to the next. Also, take care to avoid contaminating sample

waters through contact with rubber, oil, gasoline and other machinery fluids, metal-based paints, cigarette ash, paper tissues and other such material.

Sample bottles should then be stored appropriately (Table 1). In most cases, this will involve keeping the sample cool (4°C) and dark. Samples should never be allowed to freeze and should be shipped as soon as possible to the appropriate analytical lab, in coolers with reusable ice packs. Avoid using bags of ice purchased from convenience stores; the water that leaks out of these bags as the ice melts may ruin sample labels.

Chain-of-Custody and Analytical Request forms must accompany all samples (one set of forms per sample shipment). Prior to shipping, the person submitting the sample should inform the analytical lab by telephone, e-mail, or fax that the samples will be arriving. As well, he or she should check back later to confirm arrival of the samples and to explain analysis requests if needed.

### 5.1.2 Sampling for Metals

When collecting samples for a metals analysis, it is important that sample waters do not come into contact with any metal products. Samples for metals analysis also have other stringent collection and preservation requirements (Table 1). For example, waters collected for dissolved metal analysis have to be field-filtered using a 0.45 $\mu$m polycarbonate or cellulose acetate filter and then preserved with acid. Field-filtering should be conducted as soon as possible after sampling. If field-filtering is not possible, then acid preservatives should not be added and the laboratory should be notified to filter the sample as soon as possible after sample receipt.

Field crews need to be aware of these restrictions to ensure that samples are taken correctly and that they maintain their integrity until they can be analyzed. Special sampling and preservation instructions should be included in the FSP.

### 5.1.3 Sampling for Organic Chemicals

In addition to the general principles outlined above, there are specific protocols associated with sampling for organic measurements. As described above, sample bottles should *not* be rinsed prior to taking samples for certain organics analyses. It is also very important to completely fill each bottle, as certain organics will volatilize into the overlying air space and will be lost after opening the bottle. Finally, proper containers must be used when sampling for organics, since some bottles will release or absorb organic compounds when filled with water. Generally, glass containers are used, but certain tests may require other materials; be sure to obtain the appropriate sample bottles from the analytical laboratory and refer to the FSP.

## 5.2 Sample Documentation

Proper sample documentation is important because lack of careful documentation can lead to misunderstandings and questionable test results. Components of proper documentation of field activities are described below.

### 5.2.1 Field Notebooks

Field notebooks must be kept, describing all field activities. Format of field notes and information to be recorded should follow Golder Associates' specific guidelines. During the field survey, field notes must be maintained in a permanent, safe location at the field site where samples are collected. If possible, new entries in the field note book should be photocopied at the end of each field day and copies should be stored in a safe place.

### 5.2.2 Sample Labels

Sample labels must contain the following information:

- Sample identifier (name of site or sample code);
- Date (written as day/month/year; month abbreviated as three letters) and time (24 hour clock) of collection;
- Initials of collector; and
- Analysis requested (this is usually done by the analytical laboratory in the form of a code on the sample bottle).

Fill out labels at the time of collection using waterproof ink and affix a label to each sample container. Plastic bottles may be labeled by writing directly on the bottle using a waterproof marker; however, this approach is not recommended if samples are transported over long distances (friction may rub label off) or if bags of ice are used to keep the samples cool (water may damage label information).

### 5.2.3 Custody Seals

Numbered seals should be used (when required by the FSP) to detect tampering with samples in transit. Attach the seal in a way that it is necessary to break it to open the cooler containing the samples. The number on the custody seal should be recorded in the field note book and on the Chain-of-Custody and Analytical Request forms

### 5.2.4 Chain-of-Custody Forms and Analytical Request Forms

Chain-of-Custody and Analytical Request forms must accompany all samples submitted for analysis in accordance with procedure TP1.2-23, "Chain of Custody". These forms are usually combined as a single document. An example of Golder Associates' combined Chain-of-Custody and Analytical Request Form is provided in Exhibit 1.

The combined form must be filled out completely and the white and yellow copies should be sent along with the samples being submitted. Field personnel should retain the pink copy after it is signed by the shipper. Depending on the shipping container, these forms can either be enclosed inside the sealed container or attached firmly to the outside of the container. In either

case, it is advisable to enclose the forms within a waterproof plastic bag to guard against damage. It is important that each person having custody or control of the samples identify themselves on this form. This means the person collecting the sample; intermediate persons involved in packaging, storing or transporting the sample; and the person accepting the sample on behalf of the analytical lab must all be identified.

### 5.3 Sample QA/QC

The main goal of sample QA/QC is to monitor for various sources of contamination during sample collection, transport and analysis. This process will involve the use of field, travel and other test blanks. QA/QC programs are designed on a project-specific basis. Details of individual QA/QC programs are described in the FSP.

## 6. EQUIPMENT AND MATERIALS

### 6.1 Sampling

The following is a list of sampling equipment generally recommended for surface water sampling:

- Pre-cleaned sample bottles and required preservatives (usually supplied by the analytical laboratory)
- Coolers and reusable ice packs
- Waterproof labels and permanent markers
- Sampling equipment (e.g. Kemmerer or Van Dorn bottles)

### 6.2 Site Location and Sample Documentation

For proper sample site identification and sample documentation, field crews may need:

- Bound, water-proof field logbooks
- Maps
- Air photos
- Indelible ink pens and pencils
- Long tape measure
- Survey flagging tape
- Compass
- GPS unit
- Combined Analytical Request and Chain-of-Custody forms

## 6.3 Health and Safety

The following health and safety equipment is recommended for surface water sampling:

- Waders and waterproof gloves
- Heavy socks, warm pants, rain gear and other articles of clothing suitable for prolonged water work
- Extra set of clothes
- First aid kit
- Approved personal floatation device for deep water or boat work

S:/groups/qa/1p3-1024/TP1_2-26.doc

TABLE 1

SAMPLE CONTAINER CODES, TYPES, VOLUMES, PREPARATION,
SPECIAL HANDLING, PRESERVATION, HOLDING TIMES


| Analysis | Cont. Code | Containers, Water | Handling and Preservation | Holding Time |
|---|---|---|---|---|
| Volatile Organics | V | 2, 40ml glass vial teflon lined septum | Store 4±2°C; handle upwind from equip. Fumes, no headspace permitted; Pres with HCl to pH <2 for volatile aromatics | 7 days<br>14 days (HCl pres.) |
| Base/Neutral and Acid Extractable Organics | SV | 2, 1 liter amber glass, teflon lined cap | Store 4±2°C; handle upwind from equip. fumes; no contact with plastics, gloves | 7 days until extraction<br>40 days thereafter |
| Organochlorine Pesticides and PCBs | P | 2, 1 liter amber glass, teflon lined cap | Store 4±2°C; handle upwind from equip. fumes; no contact with plastics, gloves | 7 days until extraction<br>40 days thereafter |
| Herbicides | H | 2, 1 liter amber glass, teflon lined cap | Store 4±2°C; handle upwind from equip. fumes; no contact with plastic, gloves | 7 days until extraction<br>40 days thereafter |
| Total Fuel Hydrocarbons (Fuel Fingerprint) | TH | 1, 125 ml amber glass, teflon lined septum | Store 4±2°C; handle upwind from equip. fumes, no headspace permitted; pres with HCl to pH <2 | 14 days |
| Total Petroleum Hydrocarbons or Oil and Grease | OG | 1, 1 liter glass, teflon lined cap | Store 4±2°C; handle upwind from equip. fumes, no contact with gloves or plastics; pres with HCl to pH <2 | 28 days |
| Cyanide (total) | CN | 1,1 liter plastic | Store 4±2°C; pres with NaOH to pH >12 | 14 days |
| Sulfide (total) | S | 1, 1 liter plastic | Store 4±2°C; pres with ZnOAC/NaOH to pH >12 | 7 days |
| Chloride, Sulfate, pH Conductivity and Total Dissolved Solids | MA | 1,1 liter plastic | Store 4±2°C. | 28 days (Chloride, sulfate and conductivity)<br>Analyze on-site (pH)<br>7 days (TDS) |

TABLE 1

SAMPLE CONTAINER CODES, TYPES, VOLUMES, PREPARATION,
SPECIAL HANDLING, PRESERVATION, HOLDING TIMES,


| Analysis | Cont. Code | Containers, Water | Handling and Preservation | Holding Time |
|---|---|---|---|---|
| Major Cations and Metals | TM | 1,1 liter plastic | 0.45 um filter, pres with $HNO_3$ to pH <2 | 6 months (28 days for mercury) |
| Gamma Emitting Radionuclides | GR | 2, 1 liter plastic | 0.45 um filter, pres with $HNO_3$ to pH <2 | 6 months (record exact date/time of sampling for calculation of half-life decay) |
| Alpha Emitting Radionuclides | AR | 2, 1 liter plastic | 0.45 um filter, pres with $HNO_3$ to pH <2 | 6 months (record exact date/time of sampling for calculation of half-life decay) |
| Beta Emitting Radionuclides | BR | 2, 1 liter plastic | 0.45 um filter, pres with $HNO_3$ to pH <2 | 6 months (record exact date/time of sampling for calculation of half-life decay) |
| Total Phosphorus, Ammonia-N, Nitrate/nitrite-N, COD and TOC | TP | 1, 1 liter plastic | Store 4±2°C; pres with $H_2SO_4$ to pH <2, store in dark | 28 days |
| Orthophosphate | OP | 1, 1 liter plastic | 0.45 um filter, store 4±2°C | 48 hours |

## CHAIN OF CUSTODY RECORD

| PROJ. NO. | SITE/LOCATION | | | | | NO. OF CON-TAINERS | AMOUNT/ PRESERVATIVE | | | | | | | SEAL NO. | SEAL INTACT ? (Y or N) | REMARKS (with initials) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLERS: *(Signature)* | | | | | | | | | | | | | | | | |
| STA. NO. | DATE | TIME | SAMPLE TYPE | MEDIA | SAMPLE IDENTIFICATION | | | | | | | | | | | |
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| Relinquished by: *(Signature/Firm)* | Date/Time | Received by: *(Signature/Firm)* | Relinquished by: *(Signature/Firm)* | Date/Time | Received by: *(Signature/Firm)* |
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| Relinquished by: *(Signature/Firm)* | Date/Time | Received by: *(Signature/Firm)* | Date/Time | Remarks (attachments if necessary) | |

EXHIBIT **1**

**CHAIN OF CUSTODY FORM**

DEPUE/SURFACE WATER/L

PROJECT NO. 953 8222.3.3 DRAWING NO. 77288 DATE 3/23/98 DRAWN BY EA

**Golder Associates**

# APPENDIX E-2

# TECHNICAL PROCEDURE FOR ROCK CORE DRILLING AND SAMPLING

Golder Associates

# Technical Procedure

Number: TP-1.2-1
Title: ROCK CORE DRILLING AND SAMPLING

| Prepared by | Approved by | Approved by | Effective Date | Rev. Level |
|---|---|---|---|---|
| D P Findley 31 May 96 | | 2-1-96 | 6-7-96 | -2- |
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TP-1.2-1
Revision Level -2-
RECORD OF REVISIONS

| Section | Description of Revision |
|---|---|
| 5. | Added rock conditions to first sentence |
| 7.4 | Added (surface-set bits) |
| 8.3 | 3rd bullet Whipping of drill rods, added low viscosity drilling fluid |
| | 9th bullet Blocked bit, added concentric spin marks |
| 8.4 | 4th bullet clarified for rinse requirements |
| 8.5 & Exhibit A | Changed Procedure Alteration Checklist to Field Change Request |

## 1. PURPOSE

The purpose of this technical procedure is to establish uniform and consistent core drilling techniques which will optimize core sample recovery.

## 2. APPLICABILITY

This technical procedure is applicable to all Golder Associates Inc. representatives engaged in subsurface investigations utilizing rock core drilling.

## 3. DEFINITIONS

### 3.1 Contaminated Site

A contaminated site is defined as a location at which an environmental investigation is being conducted for the purpose of determining the existence or extent of hazardous waste or groundwater contamination.

## 4. REFERENCES

4.1 Golder Associates Inc. Technical Procedure TP-1.2-2, "Geotechnical Rock Core Logging"

4.2 Russell, B.F., J.M. Hubbell, and S.C. Minkin, "Drilling and Sampling Procedures to Minimize Borehole Cross-Contamination", Idaho National Engineering Laboratory.

4.3 "Standard Practice for Diamond Core Drilling for Site Investigation", ASTM D-2113.

## 5. DISCUSSION

Drilling and sampling programs are employed to obtain information for the assessment of the rock conditions, hydrogeologic, chemical, and physical characteristics and conditions of a particular site. The quality of the site characterization hinges on the integrity of the samples obtained and the data derived from them. It is imperative that consistent procedures for rock core drilling are followed in an effort to obtain the highest quality core samples and data possible. The quality of the core is a function of the equipment used and the skill of the driller when drilling and handling the core. The requirements of each project will dictate which type of drill rig and coring tools should be used. It is important to exercise care in handling of the core while still in the core barrel and during removal, logging, and storage.

## 6. RESPONSIBILITIES

### 6.1 Project Manager

The Project Manager is responsible for the overall management of the core drilling and sampling project, but may delegate responsibilities to other qualified team members. Duties include design of the core drilling and sampling program, location of boreholes and coring intervals, approving all variations from established procedures, ensuring that all necessary contractual agreements are established with the client and any contractors (and that contractors fully understand the specific conditions and limitations of the site), preparing the scope of work, and briefing all field personnel on the specific requirements of the project

### 6.2 Geologist/Field Engineer

The Geologist/Field Engineer is responsible for all on-site activities related to core drilling and sampling. These activities include: ensuring that core samples of adequate quality are obtained, documenting variations from standard procedures, logging core, ensuring sample integrity in storage and transportation to the laboratory for testing, and reviewing the daily drilling report with the drilling contractor. The Geologist/Field Engineer shall develop an understanding of the ultimate goal of the investigation in order to adequately record needed information and be able to make sound decisions in case of unforeseen circumstances.

## 7. EQUIPMENT OR MATERIALS

### 7.1 Logging Equipment

Equipment and materials needed to properly log core samples are listed in TP-1.2-2, "Geotechnical Rock Core Logging."

### 7.2 Drill Rig

The type of drill rig used for rock coring projects will depend on the location and limitations of the job site. Selection of drill rig type and the drilling subcontractor shall be established by the Project Manager or the client.

### 7.3 Core Barrel

The type of core barrel to be used on a geotechnical project should be specified by the Project Manager. Single tube and rigid double tube barrels are inappropriate for geotechnical sampling, and shall not generally be used. Conventional core barrels require that the drill rod be pulled out of the hole to recover the core after each run. Wireline systems, however, enable the core to be recovered without pulling the drill rods, and may be much more suitable for deeper holes, or for use when sample contamination is a concern.

### 7.3.1 Swivel-Type Double Tube Barrels

Swivel-type double tube barrels are constructed with a bearing at the top of the inner tube so that the inner liner remains almost stationary as the drill rods and outer barrel are rotated and advanced. Drilling fluid bypasses the core lifter and passes directly out of the bit. The core is protected from erosion due to drill fluid and from grinding due to rotation. This core barrel produces good core recovery under a wide range of conditions.

While swivel-type double tube barrels enable good recovery, the core must be removed from the inner tube before it can be inspected and logged. There are two types of inner barrels in use; solid and split.

Split inner tubes are preferred for geotechnical sampling. They are split longitudinally so that they can be separated after core recovery. This enables the core to be inspected and logged while it is still in one half of the split tube, resulting in a minimum of core disturbance.

Solid tubes are the least conducive to geotechnical sampling, as core removal often results in disturbance and damage to any but the most durable core. If there is no alternative coring system available, core shall be removed from the core tube by inserting a plug in the top end of the tube and using the mud pump to push the core out of the tube into a core tray.

### 7.3.2 Triple Tube Core Barrels

Triple tube core barrels should be used for projects where logging and sampling of core in as close to an undisturbed condition as possible is an important consideration. Triple tube core barrels have three nested core tubes for maximum core recovery and minimum disturbance. They are similar to swivel-type double tube systems in construction except that an additional inner liner or sleeve is nested within the inner tube. A plug or piston is incorporated into the top of the inner tube so that the inner liner can be pumped out. Split liner sleeves can be made from chrome plated steel, enabling logging and sampling in the field. Disposable solid clear plastic liners are also available to enable immediate examination and maximum protection for transportation of the core; such liners are appropriate for coring on projects where cross-contamination of samples is a concern.

### 7.3.3 Wireline Systems

Wireline systems enable recovery of the inner core tube without the need to pull the drill rods. They are constructed like a swivel-type double or triple tube barrel except that a latching mechanism is incorporated to hold the inner tube in place during coring. The inner tube is emplaced through the drill rods and latched into the outer barrel prior to each core run. The inner tube assembly has a shut-off valve which stops fluid circulation and increases pump pressure when the core blocks off (a feature which prevents loss of core). When the core run is completed, an overshot attached to the wireline is lowered down the drill rods

and latches onto the spearhead on top of the inner tube assembly. This releases the inner tube from the outer barrel and enables the inner tube to be hoisted to the surface on the wireline.

### 7.4 Core Bits

Core bits are made with differing configurations for use in a variety of rock types. The cutting surface may be set with diamonds (surface-set bits), impregnated with small diamond particles, inserted with tungsten carbide slugs or strips, hard-faced with various hard surfacing materials, or furnished in sawtooth form; all as appropriate to the formation being cored. Bit matrix material, crown shape, water-way type, location and number of water ways, diamond size and carat weight, and bit facing materials shall be configured for general purpose work unless otherwise dictated by the requirements of the drilling project.

The Geologist/Field Engineer shall observe the condition of the core bit to be used. Worn or damaged bits can impede drilling and damage core samples.

### 7.5 Drilling Fluids

The primary functions of drilling fluids are to cool the bit and core barrel and to remove cuttings from the borehole. This can be accomplished with air or water circulated through the barrel and borehole. A secondary function, which on many drilling projects can be critical, is to support the borehole wall against caving. Drilling fluids such as a mud or a foaming agent are used for this additional purpose. These agents may also improve cutting removal due to their weight or chemical properties. Water based bentonite mud is the most common drilling fluid in use.

The type of drilling fluid used on a rock coring project will depend on the depth of drilling, formations to be drilled through, subsurface conditions encountered, and environmental requirements. Any restriction in the type of drilling fluid to be used should be defined by the Project Manager in the driller's subcontractor through communications with the client.

## 8. PROCEDURES

### 8.1 Project Briefing and Site Preparation

The Project Manager shall ensure that all Golder Associates and Contractor personnel are briefed on the importance of proper drilling and sampling techniques, health and safety requirements, and issues addressed in this technical procedure and in the work plan or instruction. All personnel shall be advised that unanticipated conditions may necessitate changes in standard and accepted procedures as outlined in this technical procedure; all such changes must be authorized and documented as noted in 8.5 below.

It must be emphasized that the Geologist/Field Engineer is in the position of representing Golder Associates and the interests of the client, and is, therefore, responsible for ensuring that contract specifications are met and the quality of work meets acceptable standards. Prior to drilling, the Geologist/Field Engineer should check over the type and condition of drilling equipment, and document any observations in the Record of Drillhole form (see Exhibit B, TP-1.2-2) and/or field logbook. A checklist follows:

- Core barrel:
  - Note type
  - Note length
  - Check straightness
  - Inner and outer barrels must be free to rotate as designed
  - Core catcher must be clean, free rotating, and tapered inward

- Core bit:
  - Note type (record serial number, if available)
  - Note conditions (diamonds should look and feel sharp or prickly to touch)

- Drill rod
  - Note lengths
  - Check straightness

- Drill rig
  - Note type, manufacturer, and model number used
  - Verify levelness of drill pad
  - Check general stability of drill pad
  - Verify any inclination of hole and record angle

- Check all other pertinent equipment, record information as appropriate
  - pumps
  - water truck
  - other

**8.2 Drilling and Sampling**

The Geologist/Field Engineer should work with the driller to ensure recovery of core samples that have suffered a minimum of disturbance with a maximum of core recovery. Notes shall be kept in a daily log regarding the nature of drilling problems encountered and the depth at which they occurred. Deviations from standard procedures should be noted; see Section 8.5 below. The Geologist/Field Engineer is responsible for ensuring that the job proceeds as specified in this technical procedure and as outlined in the work plan or instruction. In the event that the integrity of the core samples are being compromised by procedures or the

equipment employed being used, the Geologist/Field Engineer shall request appropriate changes or stop work.

When working on an environmental investigation, extreme caution should be taken to guard against the possibility of sample contamination. The project work plan or instructions should be followed as closely as possible on these and all projects, especially where coring intervals and specific sampling methods are identified.

The Geologist/Field Engineer should take care in handling the core when removing it from the core barrel, and shall emphasize the same degree of care to the driller. Core logging, marking, boxing, and storage shall be in compliance with procedure TP-1.2-2, "Geotechnical Rock Core Logging."

**8.3 Poor Recovery**

Core losses are an important indication of potentially poor geotechnical conditions since they commonly occur in weak or highly fractured zones. Poor recovery makes it difficult to adequately characterize the rock mass.

If poor recovery is observed, the Geologist/Field Engineer shall ensure that the necessary steps are taken to make improvements. Such measures include: checking rig, core barrel, and core bit operation; cleaning out the boring before proceeding; modifying the drilling speed or pressure; or drilling shortened core runs.

Several factors affect core recovery. The following list outlines causes of poor recovery and shall be considered when looking for a means to remedy the situation.

- Drilling for footage: A penetration rate that is too fast can damage the core. Often drilling contracts are written on a footage basis, which may place the driller at odds with the field representative when drilling becomes difficult. It is important, however, for the geologist/field engineer to remember that the purpose of the coring job is to obtain good quality information on the core.

- Broken, soft, or unconsolidated formations: Loss may be caused by the drilling fluid washing away the formation as it is drilled, but before it can enter the core barrel. The core could be subject to grinding due to fractured rock wedging in the core barrel, thus blocking the bit. Failure of the lifter to hold the broken material in the barrel while the core is being pulled can also occur.

- Whipping of drill rods: Worn guides or low viscosity drilling fluid may allow the drill rods to whip, causing the core bit to vibrate. This can grind up the core or reduce its diameter, which may make it difficult for the core catcher to retain the core in the barrel while it is being pulled.

- Improper rotation speed: Sometimes slow rotation speeds will cause vibrations in the drill rod which can break down the formation and result in core loss.

- Excessive bit or fluid (air, water, or mud) pressure: High pressures may wash away weak, soft, or unconsolidated material, preventing it from entering the core barrel. Discharge at the top of the casing should be observed for evidence of destruction to the core. Rock chips instead of powdered rock indicates washing and excessive bit pressure.

- Insufficient pump pressure: If the pump pressure is too low the bit will become clogged, reducing core recovery.

- Rotation of the inner core barrel: This may cause the ends of pieces of the core within the barrel to grind against each other, wearing away adjacent lengths. Careful inspection of core will disclose this condition. The core barrel should be taken apart and repaired.

- Cavities, joints, or seams: Weak planes within a formation can cause the core to break, allowing it to wash away before it moves into the core barrel or grind up and fall out of the core barrel during removal.

- Blocked bit: When a piece of core becomes wedged in the bit so that it rotates with the bit rather than passing into the core barrel without rotation, the bit is said to be blocked. When drilling is continued with a blocked bit, core is destroyed due to grinding. Core that shows rounded edges or concentric spin marks was almost certainly damaged either by a blocked bit or rotation of the inner core barrel.

- Full core barrel: Continuation of drilling after the core barrel is full can damage or destroy the core.

**8.4 Decontamination of Drilling Equipment**

For geotechnical investigations at non-contaminated sites, drilling equipment should be cleaned by brushing or scraping and steam-cleaning with non-phosphate detergent. For geotechnical investigations at contaminated sites, or other types of environmental site investigations, however, drilling equipment must be thoroughly cleaned to avoid cross-sample contamination. Any piece of equipment which poses the threat of contaminating a core sample by coming into contact with the air, drilling mud or foam, or the sample shall be cleaned prior to obtaining each sample. This includes drill rods, coring tools, and sampling tools. General drilling equipment, as specified in the project plan, shall be decontaminated prior to use on another borehole. Unless specified otherwise in the project plan, tools and equipment shall be decontaminated by the following regimen:

- removal of large pieces of material by brushing or scraping;
- high pressure, high temperature steam cleaning with non-phosphate detergent;
- wash with distilled de-ionized water;
- rinse with methanol (if required or specified by project work plans); and a
- second rinse with distilled de-ionized water.

On a site with known or suspected contamination with hazardous waste, decontamination shall take place in a specified decontamination area. Cuttings and material removed from the equipment should be sealed in barrels for disposal. Wash and rinse fluids shall be collected for appropriate disposal. Responsibility for disposal shall be defined in the governing project work plans or instructions.

**8.5 Field Change Request**

Variation from established procedure requirements may be necessary due to unique circumstances encountered on individual projects. All variations from established procedures shall be documented on a Field Change Request form (Exhibit A) and reviewed by the Project Manager and the QA Manager.

The Project Manager may authorize individual Geologist/Field Engineers to initiate variations as necessary. If possible, the request for variation shall be reviewed by the Project Manager and the QA Manager prior to implementation. If prior review is not possible, and if authorized by Project Manager, the variation may be implemented immediately at the direction of the Geologist/Field Engineer, provided that the Project Manager is notified of the variation within 24 hours of implementation, and the Field Change Request is forwarded to the Project Manager and QA Manager for review within 2 working days of implementation. If the variation is unacceptable to either reviewer, the activity shall be reperformed or action shall be taken as indicated in the Comments section of the Field Change Request.

All completed Field Change Requests shall be maintained in project records.

# FIELD CHANGE REQUEST

Golder Associates

Job/Task Number: _____

Other Affected Documents: _____

Requested Change: _____

Reason for Change: _____

Change Requested by: _____ Date _____

Reviewed by: _____ Date _____
GAI Project Manager

Comments: _____

Reviewed by: _____ Date _____
GAI QA Manager

Comments: _____

# APPENDIX E-3
# TECHNICAL GUIDANCE FOR MONITORING WELL DRILLING AND INSTALLATION

# TECHNICAL GUIDELINE FOR MONITORING WELL DRILLING AND INSTALLATION TG-1.2-12

Rev. #8
8/20/2009

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# TG-1.2-12 Monitoring Well Drilling and Installation

## 1.0 PURPOSE

This document establishes uniform guidelines for the selection of materials and installation of monitoring wells or piezometers in unconsolidated and consolidated deposits.

## 2.0 APPLICABILITY

This technical guideline is applicable to all field personnel involved with the design and installation and abandonment of groundwater monitoring wells and piezometers. This document should be read in conjunction with any and all regulatory, workplan, order, client specific, or other project-specific guidelines.

## 3.0 DEFINITIONS

### 3.1. Monitoring Wells / Piezometers

A monitoring well is a well completed within a specific zone of interest, of sufficient diameter and construction to allow sampling and/or pump testing. A piezometer is typically a smaller diameter than a monitoring well, and is screened within a specific zone of interest, of sufficient diameter and construction to allow potentiometric measurements.

### 3.2. Bentonite

Bentonite is an expanding sodium bentonite clay used to seal the annular space between the production casing and the wall of the borehole. Calcium bentonite may be more appropriate in calcium-rich environments due to reduced cation exchange potential. Bentonite is also added to drilling circulation fluid on "mud" rotary rings to increase fluid viscosity and to transport drill cuttings to the surface more effectively. Additional information is provided in sections 7.2.6 through 7.2.10 and 7.2.13.

### 3.3. Casing, or "Drive" Casing

Drive casing is a pipe used to line a borehole to prohibit caving and/or prevent direct flow from the formation into the borehole. Hollow stem augers may be considered as analogous in function to drive casing for the purposes of this Technical Guideline.

### 3.4. Grout

Grout is a cement and/or bentonite mixture, originally fluid enough to be pumped through pipes, and used to seal casing within a borehole. Specifications are given in Section 7.2.6 and 7.2.7 below.

### 3.5. Well Screen

A well screen is a manufactured "wire"-wrapped, slotted or otherwise porous pipe which allows the flow of water from the formation into the well. Additional information is provided in section 7.2.1.

### 3.6. Monitoring Interval

The monitoring interval is the only zone in which groundwater can enter the well.

## 3.7. Centralizers

Centralizers are “basket-like” frames typically made of stainless steel that attach to the exterior of the casing, and whose radial metal bands keep the casing centralized in the borehole. Additional information is provided in section 7.2.2.

## 3.8. Riser Pipe

Riser pipe extends from the top of the screened interval to a short distance above ground surface (typically 2-3 feet).

## 3.9. Filter Pack/Sand Pack

Filter Pack/Sand Pack is material (typically granular) that is either placed on the exterior of the screen before installation, or pumped into the annulus between the screen and borehole wall after installation. Filter Pack/Sand Pack protects the screen, prevents clogging, and enhances flow into the well.

# 4.0 DISCUSSION

In order to generate quality data using these guidelines, it is incumbent on the field personnel to have reviewed these and other appropriate guidelines. This document should also be read in conjunction with any and all regulatory requirements, site-specific work plans, administrative orders, and client- specific or other project-specific procedures.

# 5.0 RESPONSIBILITIES

## 5.1. Field Supervisors

Field Supervisors are responsible for overseeing well installation in compliance with all project specific guidelines. The Field Supervisors are responsible for ensuring that the drilling contractors complete and submit all requirements (permit applications, well installation reports, etc.) before and after well installation. They must review and approve daily work reports and/or notes, and they must maintain daily borehole logs, well construction forms, etc.

## 5.2. Project Manager

The Project Manager shall be responsible for:

- Selecting location of the boreholes at the site and determining depth and the various design details of the monitoring well completion;
- Selection and contracting of services of drilling subcontractors;
- Scheduling;
- Assurance that appropriate equipment and materials are available to accomplish the task;
- Providing guidelines or specific work instructions for technical requirements beyond the scope of the applicable technical guidelines;
- The completion of drilling operations and well installations to the satisfaction of Golder's standards of operation and the clients' requirements; and
- Preparation of all reports and project deliverables.

## 5.3. Project Director/Principal-In-Charge

The Project Director shall be responsible for agreeing on design details outside the scope of this document and overall quality of project deliverables.

# 6.0 EQUIPMENT AND MATERIALS

## 6.1. Drilling Equipment

The following equipment may be used on most well drilling and installation jobs:

- A suitable drill rig (usually auger, cable tool, rotary, or direct push) with all equipment and accessories required for completing the job. The drill rig should be examined to determine the general condition, how well it has been maintained, and the general cleanliness of the drill rig and equipment. The drilling equipment should be relatively free of at least mineral oils, grease, hydraulic fluids, drilling mud, etc. Rig condition and corrective actions must be documented in the field log;
- A steam cleaner for cleaning drilling equipment between holes with associated wash rinse solutions (e.g., alkonox), storage tanks, brushes, and other equipment as necessary to capture and contain decontamination solutions;
- Additional equipment that may be required for drilling such as water trucks, drive casing, booster compressors, mud pumps, appropriate bits and sampling equipment (if required), additional support vehicles and equipment, etc.;
- Sampling equipment (core barrels, split-spoons, drive tubes, etc.) if needed; and
- A grout pump, mixer, and suitable clean tremie pipe, line, or pressure-grout system.

## 6.2. Field Engineering Equipment and Logs

The following equipment is suggested for documenting the construction of groundwater monitoring wells:

- Clipboard;
- Indelible ink pens and pencils;
- Engineering tape measure with 0.01 foot or, for some jobs, metric increments;
- Weighted engineering tape for sounding well material depth. The length of tape should be suitable for total anticipated well depth (check the accuracy of the weighted tape);
- Electric water level measuring tape suitable for total anticipated depth of borehole;
- Interface probe suitable for total anticipated depth of borehole;
- Color charts for soil comparison;
- 10% hydrochloric acid solution for calcareous deposits;
- Suitable containers for collecting samples of well construction materials;
- Sample containers for soil samples;
- Sample containers, cooler, etc. for chemical laboratory samples;

- Field Notebooks;
- History of Hole forms (Exhibit A);
- Borehole Log forms (Exhibit B);
- Monitoring Well Construction Forms (Exhibit C);
- Field Change Request (Exhibit D);
- Well development instrumentation, multi-parameter meter and calibration standards (meter should be capable of measuring pH, specific conductance, redox, dissolved oxygen and temperature);
- Turbidity meter and calibration standards; and
- Flow-through cell for collection of field measurements.

## 6.3. Health and Safety Equipment

All required equipment as shown by the Health and Safety Plan:

- Fire Extinguisher;
- First Aid Kit;
- Hard hat while drilling or near a drill rig- or pump truck;
- Steel-toed, and possibly steel-shanked, chemical resistant, or leather, or rubber boots;
- Suitable clothing that could include long sleeve shirts, long pants, etc.;
- Tyvek, other protective clothing, and respiratory protection devices as required by applicable site health and safety plans;
- Protective eyewear;
- Monitoring equipment as required by applicable health and safety plans; and
- Hearing protection while drilling or near a drill rig or pump truck.

# 7.0 PROCEDURE

## 7.1. Regulatory Considerations

In most states, both monitoring well and piezometer installation and their abandonment is specifically regulated by local, state, or regional regulations, laws and guidelines that pertain to the drilling, installation and abandonment of monitoring wells. In addition there may be client specific requirements. All such client and regulatory requirements must be reviewed before designing, drilling, and installing monitoring wells or piezometers. At a minimum, the following actions must be taken:

- Initiate start cards, permits, or other documents, certifications, and fees that may be required to drill and install monitoring wells or piezometers;
- Ensure that monitoring wells and piezometers will be drilled, installed and abandoned by an entity that meets all requirements (e.g., licenses) for conducting operations in that particular location;

- Initiate utility location process and document the location of all utilities before drilling, including both underground and overhead utilities. Check local codes for safety equipment (i.e., traffic codes, fire codes, etc.) required around drill rig during operation within city limits. Check that additional permits such as excavation or cultural reviews are not required, and be sure that overhead utilities will not interfere with the standing drilling rig; and
- Ensure that all follow up well or piezometer installation and abandonment reports required by appropriate agencies are completed by the drilling subcontractor and/or Golder and submitted. Obtain copies of all well and piezometer reports submitted by subcontractor for project files.

## 7.2. Materials

### 7.2.1. Well Screen

The well screen shall normally consist of machine slotted or "wire" wrapped, schedule 40 or 80 (ASTM-D1785) PVC pipe with flush joint threads. Both slotted and "wire" wrapped schedule 40 PVC are typically available at short notice. The use of other materials such as stainless steel or porous organic polymers may be required for certain situations where PVC may be reactive, may inhibit the collection of representative groundwater samples, may allow excess siltation, or may not be mechanically strong enough for a particular application. Use of alternative materials shall be specified by the Project Manager or by site-, regulatory-, or client- specific work documents.

Minimum requirements are identified below:

- A flush threaded bottom plug shall be installed securely in order to withstand all installation and development pressures without becoming damaged or dislodged, assuming (as is true in most cases) that the internal to be screened is at the bottom of the borehole.
- As a general rule, screen length should be the minimum necessary to achieve the objective for monitoring. The lengths of screens shall be determined by the Project Manager based on the site hydrogeology and other project-specific requirements. Screened interval, at or near the water table, will often be 5 to 20 feet in length (taking into account any annual fluctuations in the water table – particularly if monitoring for light non-aqueous phase liquids). Wells completed at depth below the water table will usually be completed with a 3-, 5-, or 10-foot screen.
- All flush joint threads shall be sealed with any specified and supplied manufactured o-ring seals; Teflon tape shall be applied to the male threaded ends if the pipe is not equipped with o-rings. Riveted, screwed or glued joints shall not be permitted without agreement of the Project Director.
- The slot size will typically be 0.010 or in some cases 0.020-inches. The slot size shall be specified by the Project Manager and be determined relative to the formation particle size and the filter pack grain size. The use of a 0.006 or 0.008 slot size, or porous polymer screen should be considered in all cases where low turbidity is required and a properly designed sand-pack cannot be calculated for use with a 0.010 slot size.
- The screens shall typically have been factory cleaned to remove all oils, greases, solvents, waxes, etc. used in the manufacturing process and shall be individually wrapped and sealed or collectively stored and sealed in boxes from the factory.

### 7.2.2. Centralizers (Optional)

If required by the Project Manger or project work plans, friction or bolt-on style centralizers of appropriate material (typically stainless steel) shall be used. Deeper monitoring wells (i.e., >50' depth) will usually

benefit from centralizers if the well is installed in a borehole several times the diameter of the pipe and screen. Centralizers are typically not required for installing monitoring wells through auger flights.

### 7.2.3. Riser Pipe

The riser pipe shall typically consist of schedule 40 PVC or stainless steel with flush joint threads; the interval between joints shall be five to twenty feet. Minimum typical requirements are itemized below:

- A threaded cap or slip cap shall be provided for the top of the riser.
- All flush joint threads will be sealed with the supplied manufactured o-ring seals; Teflon tape shall be applied to the male threaded ends if the pipe is not equipped with o-rings.
- Riveted or glued joints shall not be permitted unless agreed by the Project Director.
- The riser pipe shall typically have been factory cleaned to remove all oils, greases, solvents, waxes, etc. used in the manufacturing process and shall be individually wrapped and sealed or collectively stored and sealed in boxes from the factory.

### 7.2.4. Steel Casing

In the event that a well requires permanent steel casing for hole stability or contamination seclusion, the following typical minimum requirements shall apply:

- The minimum inside diameter of steel casing shall be 4 inches in diameter larger than the nominal diameter of the well screen and riser (specific spacing requirements may be required by state regulations).
- The minimum wall thickness of steel casing shall be 0.125 inches; thicker casing may be required by state regulations or good engineering practice.
- The ends of sections of casing shall be threaded or beveled for welding or shall be designed to screw together.
- The casing should be in good condition and not out of round.
- The steel casing should be steam cleaned before use.

### 7.2.5. Filter Pack/Sand Pack

The filter pack/sand pack shall consist of dry, uniform, and well rounded grains of silica sand. The size of the sand grains will be selected by the Field Supervisor based on the water-bearing aquifer formation characteristics and the size of the screen slots. The sand shall be packaged in sacks typically with polyethylene liners and be clearly labeled as to manufacturer and mesh size of sand.

### 7.2.6. Cement/Bentonite Grout

Cement/Bentonite grout shall consist of a mixture of Portland Cement with 3-5% bentonite by weight added to help expand the cement on setting, thus providing a tighter seal. No other additives to the cement shall be permitted. Cement shall be Portland Cement Type I or Type II meeting ASTM C 150. The use of Hi Early Type III Cement is prohibited. Bentonite shall be powdered, typically sodium, bentonite furnished in sacks without additives; calcium bentonite may be used in certain calcium-rich environments. Water used during the installation operation for mixing cement/Bentonite grout shall be

obtained from a potable source or alternate source of known chemical quality designated by the Field Supervisor.

Cement shall be mixed with water in the proportions of five to six gallons of water per 94-lb sack of cement. Three to five pounds of bentonite powder shall be added to the mix for each sack of cement used. The grout shall be thoroughly mixed with a paddle type mechanical mixer or by circulating the mix through a pump until all lumps are removed. Grout which is lumpy shall be rejected.

### 7.2.7. Bentonite Grout

Bentonite grout shall be made from a bentonite powder and/or granules for use below the water table. The bentonite grout shall typically have a specific gravity of 2.5, a dry bulk density of 55 lb/ft$^3$, and a pH of 9 to 10.5. Bentonite grout shall be mixed and used according to manufacturer's specifications and recommendations, and when mixed, will have a thick batter-like consistency. Bentonite shall be powdered or granular (8-20 mesh) sodium bentonite furnished in sacks without additives. Water used during installation operations for mixing bentonite grout shall be obtained from a potable source of known chemical quality identified by the Field Supervisor. The grout shall be thoroughly mixed with a paddle type mechanical mixed or by circulating the mix through a pump until all lumps are removed. Grout which is lumpy shall be rejected.

### 7.2.8. Volclay

Volclay is a trade name bentonite product that is modified with an initiator to increase the solids and set strength of the grout. The grout remains pumpable up to 2 hours but should be placed as soon after mixing is completed as possible. It sets up after 8-24 hours with final cure 24-72 hours after placement. The normal mix is 2.1 pounds of Volclay to 1 gallon of water. 14.3 pounds of Volclay mixed with 6.7 gallons of water yields 1 cubic foot of grout. A 50-pound bag of Volclay with the 2-pound bag of initiator mixed with about 24 gallons of water makes up about 3.5 cubic feet of grout. Because of potential desiccation and shrinkage, volclay shall only be used for sealing within water-saturated environments.

### 7.2.9. Pure Gold

Pure Gold is a trade name bentonite product that is an organic-free high-solids bentonite clay grout that has been tested and is certified to be free of contaminants. A 50-pound bag of Pure Gold grout is mixed with 14 gallons of water to yield approximately 2.2 cubic feet of grout. The grout should have density of 10.2 lbs/gal. Because of potential desiccation and shrinkage, pure gold shall only be used for sealing within water-saturated environments.

### 7.2.10. Bentonite Pellets/Chips

The two- to five- foot seal above the filter sand usually consists of bentonite pellets. Bentonite pellets will usually be a nominal 1/4- or 3/8-in. diameter round, or cylindrical pellets or chips consisting of untreated sodium bentonite, packaged in plastic buckets or plastic lined sacks. Each sack or bucket shall be clearly labeled as to the pellet size. The dry bulk density shall be at least 80 lbs/ft$^3$. The diameter of the pellets or chips shall be less than one-half the width of the annular space into which they are to be placed. In some cases, and in particular when set in an unsaturated zone, the pellets/chips should be partly hydrated either before placement in the hole or periodically during placement.

### 7.2.11. Fine Sand Seals

Under certain circumstances when setting the seal in the unsaturated zone, the use of a fine sand seal may replace the bentonite pellet seal. The use of a fine sand seal must be approved by the Project

Manager. The sand used in these cases must be graded as fine (based on the Unified Soil Classification System), and must be a significantly finer grade of sand than used for the sand filter pack.

### 7.2.12. Concrete

Concrete, when used in monitoring well construction, shall be composed of either pre-mixed, bagged concrete, or a mix of six sacks of cement per cubic yard. Neither additives nor borehole cuttings shall be mixed with the concrete. The concrete pad is not usually steel reinforced. Concrete shall be mixed in accordance with manufacturer's specifications; water must be from an approved source with known chemical quality. The construction of the concrete monument pad/surface seal is shown on Figure 8-2.

### 7.2.13. Drilling Fluid

Drilling fluid circulates through the drill string, out the bit, and up the annulus to cool the bit and remove cuttings from the hole. Air is circulated on air-rotary rigs, while water or drilling "mud," usually comprised of a water/bentonite slurry, is used on mud rotary rigs. The viscosity of drilling fluid increases from air to water to "mud" as does its ability to transport cuttings to the surface. The viscosity of bentonite drilling "mud" is dependent upon the concentration of bentonite in the fluid, and is measured with a viscosity funnel.

## 7.3. Well Borehole Drilling

### 7.3.1. General Precautions

Water used for mixing cement or bentonite grout or used down hole during drilling should typically be chemically characterized, particularly for the analytes of interest at the site. The Project Manager or Task Leader must approve the water source before use. All bentonite and cement must be pure. Additives either contained in these materials or to be added to the mixture must be approved in writing by the Project Manager. All well screens and well casings should be factory cleaned and sealed or decontaminated prior to use. The seal must not be opened until use. The casing should not be allowed to touch the ground while installing. All down-hole drilling equipment must be decontaminated and cleaned prior to use on a borehole and before being demobilized from the site as noted in Section 7.3.4. below. The decontamination typically includes steam cleaning with a non-phosphate detergent (e.g., Alconox) followed by rinsing with water from an approved potable tap water source. The tap water rinse must be thorough to remove all detergent and grit. All wash solution will be captured and tested prior to disposal. The disposal of decontamination fluids shall be in accordance with the requirements of the appropriate state or federal agency.

### 7.3.2. Documentation

The Field Supervisor shall be responsible for ensuring that the drilling subcontractor completes and submits any required documentation before and following installation of the well or piezometer, required by regulators. All such records shall be reviewed and approved by the Golder Project Manager prior to submittal and copies of these documents shall be retained for the project files.

The Field supervisor(s) shall be responsible for maintaining a daily borehole log that shall be forwarded to the Task Leader on a daily basis. This log shall be a continuous, chronological log for each borehole/well/piezometer and should include, but not be limited to the following information: Date, well number, drillers name and company, depth and drilling characteristics of each stratigraphic unit drilled, the depth and thickness of each stratigraphic and water bearing zone encountered, any moist zones encountered, the time work starts and stops each day (and the hours spent at each task), time and durations of all shutdowns, depths of collected samples, method of drilling and any problems encountered, size of drill bit used, size, amount and type of any temporary or permanent casing used,

amount of water yielded or lost during drilling, type and amount of any drilling additives used, and the type and amount of any lubricants, if any, used on the drilling equipment and the types and quantities of any well construction materials used.

All significant drilling events during the installation of each monitoring well shall be documented daily on a form or in a bound field book. The documentation shall include the time that the events occurred; particular emphasis shall be placed on documenting the production hours and hours delayed in production, with appropriate explanations. Notes on the weather conditions and drilling personnel shall also be recorded. During completion, all backfilled materials and depths of well screens will be sounded with a measuring tape with attached weight on the sounding end. Well completion details shall be recorded on the Monitoring Well Installation Log (Exhibit C) by field staff. All information presented on the Monitoring Well Installation Log shall be recorded, or N/A for Not Available or Not Applicable entered as appropriate.

### 7.3.3. Initial Equipment Evaluation and Inspection

As soon as possible after the drill rig arrives on site, and certainly prior to beginning the drilling operation or decontamination of the drill rig, inspect and evaluate the drilling equipment supplied by the drilling subcontractor. The equipment should appear to be in good working condition, be maintained properly, and be the proper equipment specified for the job. Lifting cables, fittings, and ropes should be inspected for excessive wear or other signs of weakness. Field personnel should examine the rig for any oil or other fluid leaks that may be hard to detect after the drill rig has been decontaminated. If leaks are detected, discuss them with the subcontractor and arrange for them to be repaired or arrange for other means of containing the leaks around the well site. Inspect all equipment to be used by the subcontractor; this is the time to have arrangements made to get missing equipment to the site.

### 7.3.4. Decontamination of the Drill Rig and Drill Equipment

The drilling rig and all equipment in contact with soil materials or borehole fluids shall typically be steam cleaned (high pressure at 80 psi and high temperature at +180° F is acceptable) between each borehole. The subcontractor shall normally supply the equipment necessary for this decontamination. Fittings shall be carefully greased or lubed with vegetable oil and fluids carefully added to the drill rig before cleaning. Decontamination shall be conducted at an approved clean location outside the immediate drilling site. Any hazardous materials removed from the equipment must be contained to prevent the spread or release of such materials. Tools and sampling equipment (e.g., split spoon sampler, submersible pumps) to be used for soil sampling or aquifer testing shall generally be decontaminated by steam-cleaning. However, at the Project Manager or Task Leader's direction, the following additional decontamination method may be required: clean by wiping or scrubbing off visible particulate matter; wash with a laboratory-grade non-phosphate detergent (e.g., Alconox), rinse with clean water and isopropyl alcohol; and final rinse with HPLC-grade distilled/deionized water. The detergent, isopropyl alcohol (where necessary), and distilled water will usually be provided by Golder. All other decontamination equipment (e.g., brushes, clean water, buckets, steam cleaner) shall normally be provided by the subcontractor.

### 7.3.5. Setting up the Drill Rig

Drill rig set up shall be planned with the subcontractor. The prevalent wind direction should be accounted for if the rig will require a preferred orientation for extra cooling or to prevent exhaust from drifting over the decon or sample prep areas. The plan should account for the direction the dust or cuttings will be blown and the direction that will be downwind of the borehole if the borehole is likely to emit volatile organic vapors. The plan should account for the direction in which the water produced during the drilling operations will flow. The drill rig shall be set up by the subcontractor using levels to insure that the borehole is as plumb as possible. The verticality of the kelly or mast should be determined in two

directions: side to side and fore and aft. Ensure that the drill rig is adequately blocked below the jacks so that the rig is stable and minimum damage occurs to the land surface. Very fragile surfaces such as a sod yard should typically be protected using sheets of plywood to protect the land surface. Cut a hole in one sheet of plywood the size of the borehole for placing directly over the hole and place other sheets as needed around the site.

Confirm that the rig mast will be clear of all overhead power lines prior to hoisting the mast.

### 7.3.6. Borehole Size and Drilling Methods

The borehole size will be partly determined by the anticipated drilling requirements to reach the anticipated depth, e.g., will temporary casing need to be driven with the possibility of telescoping casing if refusal is encountered. The borehole size will also be determined by the completion size of the final well production casing/riser pipe and by the state or other regulatory requirements governing the size of the annular space around production and surface casing. The drill hole size and drilling methods will be determined by the Project Manager; methods may be selected from those provided in TG-1.4-5, "Drilling Sampling, and Logging of Soils", or TG-1.2-1, "Rock Core Drilling and Sampling".

### 7.3.7. Capture of Drill Cuttings and Groundwater

The soil or rock cuttings produced during the drilling operations and any groundwater produced by drilling below the water table may have to be captured if contaminants are anticipated or the site does not allow for the disposal of clean drill cuttings around the drill site. Unless otherwise directed by the Project Manager, the drill cuttings and groundwater should be captured in 55-gallon drums. The borehole number and depths of the cuttings contained in each drum should be noted in permanent paint on the side of the drum and on the lid. The soils and water can then be tested for the presence of the targeted contaminants. If the contaminants are detected, then the drummed cuttings and water must be disposed of in a proper manner as directed by state or other regulatory agencies. It is usually preferred to have the subcontractor move all the 55 gallon drums to a drum storage location that is secure and has been approved by the client/landowner.

Drill cuttings should be monitored continuously for changes in color, lithology, etc. Lothologic variations and the depths they occurred should be recorded on the Monitoring Well Installation Log (Exhibit C).

### 7.3.8. Verifying the Completed Borehole

Once the borehole has been completed, verify the final depth and determine how clean the borehole is by lowering and retrieving a weighted engineering tape to the total depth of the well. Lower a water level measuring probe down the borehole and record the water level in the borehole following completion of the borehole in compliance with procedure TG-1.4-6, "Water Level Measurement". If non-aqueous phase liquids are found or anticipated, an interface probe should be used to measure the thickness(es) of the non-aqueous liquids. If the borehole is to stand for any period of time before completion of the well, reprobe the borehole to determine the total depth and the water level within the borehole just prior to completion of the well. It is generally a poor practice to allow a borehole to stand open very long if there is the possibility of part of the borehole caving. At the Project Manager's direction, the stratigraphic sequence encountered in the borehole may be verified by geophysical logging. A variety of probes are available for stratigraphic, hydrogeologic and borehole geometry determinations. Geophysical logging equipment will require the same diligence in decontamination to prevent the potential introduction of contaminants into the borehole or well.

## 7.4. Well Installation

### 7.4.1. General Requirements

A properly completed well or piezometer should exhibit the following characteristics:

- The only portion of the completed well which will have well screen and a filter-pack/ sand pack should be adjacent to the particular water-bearing zone to be monitored.
- All other sections, except within 5 feet of land surface, should be sealed with a bentonite or cement/bentonite type grout. The liquid slurry grouts will be placed by pumping the grout through a tremie pipe to the appropriate locations, or, if bentonite pellets are used, the pellets will be properly rehydrated and compacted in place. Alternately in certain circumstances, a fine sand seal may be used in lieu of the bentonite seal.
- The uppermost 5 feet or more (or to below frost line) of the borehole annulus will typically be filled with a cement grout for a surface seal, stability in freezing weather, and for supporting protective surface monuments.

See Figure 8-1 for a typical well installation.

### 7.4.2. Evaluation of the Borehole

Compare the final completed borehole and the stratigraphic log of the samples or cuttings to the anticipated design for the monitoring well. Compare the strata to what was anticipated and verify that the depth is adequate. If the desired monitored interval is above the bottom of the borehole, the borehole must be backfilled with a low permeability grout. The grout shall be tremied slightly below the final depth of the well to the bottom of the borehole and the tremie pipe should be close to the bottom of the hole such that the grout is forced up from the bottom. The auger flights or steel casing shall be pulled or hammered out of the hole in five foot increments. This procedure should be repeated until the bottom of the drive casing or auger flights and top of the grout are equivalent to the bottom elevation of the desired monitoring interval.

The grout should be allowed to set prior to placing the gravel/sand pack and well casing/screen to establish a solid foundation. If bentonite grout does not harden adequately to permit a firm foundation for supporting the well, then a cement/bentonite grout should be used and allowed to harden. **Bentonite and/or cement grout should never be allowed to harden while the drive casing is in contact.** Care must be taken with cement and cement grouts. Cement can alter the pH of the groundwater that it comes in contact with. The best practice is to try and keep cement from being in direct contact with the sandpack of the monitored interval.

### 7.4.3. Assembly of Well Screen and Riser

The well screen including the bottom plug shall be clean and free of contamination immediately prior to assembly. Take precautions to ensure that grease, oil, or other contaminants do not contact the well screen. All workers handling the well screen shall wear a new pair of cotton or synthetic gloves. The male threaded part of each joint shall be wrapped with Teflon tape if not equipped with o-rings. Joints shall be tightened by hand; however, if necessary, clean pipe or chain wrenches may be utilized if care is exercised not to cut or damage the casing.

### 7.4.4. Setting the Well Screen and Riser String

The well screen shall be lowered to the predetermined level and held in position by suspending the string of riser pipe or if the string tends to float, by manipulating the hydraulic ram on the drill rig. On deep holes where the weight of the string riser pipe is significantly greater than the flotation force, care shall be taken to keep the riser pipe plumb. The riser shall typically extend above the ground at least three feet, and may be trimmed to the proper length after the grout is in place. If the plumbness of the riser is especially critical or the well is extremely deep, a probe or "dummy" should be lowered down the inside of the riser to verify that the riser is not kinked. The screen and riser string should be suspended from the surface as much as possible during completion, rather than sitting in the borehole, to avoid damaging the screen. At the Project Manager's direction or if required by project work plans, centralizers shall be placed typically at about 20-40 feet apart throughout the riser interval.

### 7.4.5. Placement of the Filter Pack

The volume of sand required to fill the annular space between the well screen and the wall of the borehole shall be computed by subtracting the volume of the well-screen from the borehole volume of the screened interval and then carefully measured to confirm. The sand pack shall typically extend three to five feet above the uppermost row of slots in the well screen except where limited separation between aquifers occurs (check state regulations). The well screen shall be centered in the well hole and temporary casing by suspending the well screen and riser string and/or using centralizers. At the Project Manager's direction or if required by project work plans, centralizers shall be placed typically at 20-40 feet apart through the screen interval.

While holding the riser pipe with the drill rig, the temporary casing or hollow stem augers shall be carefully withdrawn such that the lowermost point on the casing is exactly at the top of the sand packed portion of the well. This may be accomplished in increments; however, after each increment, a weighted engineering tape shall be inserted and lowered to ascertain that the sand pack has not been raised or lowered during casing withdrawal operation. If necessary the sand pack shall be tamped back into place.

### 7.4.6. Placement of the Bentonite Seal

A volume of pellets or chips to create a seal typically 3 to 5 feet long should be computed and measured out for introduction into the annular space. The bentonite pellets or chips may be placed by either tremieing the pellets to the required interval or hand pouring the pellets into the annular space at the top of the well. Tremieing of the pellets is usually done on deeper completions or if specifically required in the well completion specifications. **Extreme care must be exercised and the pellets or chips slowly introduced into the annular space to prevent bridging above the level to be completed**. **In addition, the bottom of the casing must be maintained above the uppermost level of the pellets to avoid locking the well casing**. If the bentonite seal is being constructed above the water level in the borehole, exactly five gallons of water per a 5-gallon bucket of pellets or bag of bentonite chips should be slowly poured into the annular space to rehydrate the bentonite. A weighted seal tamper should be lowered down the annulus and used to tamp the pellets or chips into a cohesive mass of clay.

### 7.4.7. Grouting the Annular Seal

A sample of the final grout shall be collected in a suitable container just prior to ordering the grout injection. The volume of grout, either bentonite or cement/bentonite, required to completely fill the annular space between the seal and the ground surface shall be prepared in the proportions specified in Section 7.2. The volume shall include a quantity to compensate for losses during injection and due to borehole irregularities. All hoses, tubes pipes, water swivels, drill rods, tremie pipes, or other passageways through which the grout will be pumped shall have an inside diameter of at least 0.5 inches.

The grout shall be injected via a side discharge tremie pipe with its opening temporarily set immediately above the bentonite seal. The grout shall be pumped into the tremie pipe continuously until it flows out of the annulus at the surface. Any temporary casing if used or auger flights shall be removed immediately and in advance of the time when the grout begins to set. Casing removal and injection may proceed concurrently provided the top of the column of grout is always at least twenty feet above the bottom of the casing and provided injection is not interrupted. If casing removal does not commence until grout injection is completed, then additional grout shall be periodically poured into the annular space so as to maintain a continuous column of grout up to the ground surface. Grout which has overflowed the well hole shall be carefully removed so as to prevent the formation of horizontal projections (mushrooming) which may be subject to frost heave. The well shall not be disturbed for 48 hours to permit the grout to gain sufficient strength.

### 7.4.8. Placement of Protective Well Monument, Concrete Pad/Seal

A well protector as shown in Figures 8-1 and 8-2 shall typically be constructed before the grout has set. The well protector shall be positioned and maintained in a plumb position with temporary braces as required. An eight inch clearance between the top of the riser and the well protector shall typically be maintained for the sampler. A 1/4 inch diameter hole shall usually be drilled in the well protector 6 inches above the ground surface to permit water to drain out of the annular space. Coarse sand and/or pea gravel shall be placed in the annular space at least 6 inches above the hole to prevent insects from entering through the drilled hole. A 4-inch thick concrete pad shall be constructed around the protective monument. The pad should be approximately 2 to 3 feet in radius and should slope slightly away from the monument on all sides. Three protective "bumper" posts may be installed evenly spaced around the well at a 3 to 5 foot radius. Each post should be flagged and/or painted for improved visibility. If the monument is to be painted, the monument shall be painted before placing it in the grout.

A permanent, weatherproof, well identifier shall be affixed to the outside of the protective well monument (check state regulations for monitoring well labeling requirements).

## 7.5. Well Development and Acceptance

This section covers the development of a newly constructed well and the measurement of the well characteristics.

### 7.5.1. Pumps and Accessories for Well Development

All wells shall be developed to produce representative formation water. This section describes the approved pumps and accessories to be used in development of monitoring wells. All pumps and other devices used in well development shall be clean and free of oil, grease, solvents, or any other contaminants.

#### 7.5.1.1. Submersible Pumps

Submersible pumps shall include electric motor powered or pneumatic units. If a submersible pump is utilized for well development, it shall be of a type and capacity such that it can pump water from the well continuously for a period of at least five minutes without shutting off. Backpressure or other methods may be utilized to accomplish the desired rate of pumping. The pump shall be capable of being turned on and off instantaneously to create surging in the well. In almost all cases the pump shall not be fitted with a backflow check valve.

### 7.5.1.2. Bladder Pumps

A bladder or diaphragm pump shall operate by compressed air cycling to inflate and deflate a diaphragm which creates a pumping action. They should be of sufficient capacity to influence the monitored zone.

### 7.5.1.3. Jet Pumps

Jet pumps use the Venturi principle to create subatmospheric pressure to allow the pump to be used below a depth at which suction alone would not normally lift the water. Jet pumps approved for well development shall be capable of pumping at least 3 gpm continuously when installed in the well or piezometer.

### 7.5.1.4. Bailers

**Bailers shall not be used for well or piezometer development** except after an approved submersible bladder, jet or suction pump has been installed in the well or compressed air or bottled nitrogen has been used, and/or the rate of well recovery is so slow that these methods are ineffective. Small diameter wells may also require bailing for development due to the limited access of the casing diameter.

### 7.5.1.5. Compressed Air

Compressed air supplied by an engine-driven compressor equipped with an approved oil filter and trap may be used provided the source of compressed air is capable of evacuating 50 percent of the column of water from the well once every minute.

### 7.5.1.6. Bottled Nitrogen

Bottled nitrogen may be used provided a regulator is employed and the system is capable of evacuating 50 percent of the column water from the well once every minute.

## 7.5.2. Well Development

Well development should begin after the monitoring well is completely installed and prior to water sampling. Development should be continued until representative water, free of the drilling fluids, cuttings, or other materials introduced during well construction is obtained. Representative water is assumed to have been obtained when pH, temperature, and specific conductivity readings stabilize and the water is visually clear of suspended solids (verify whether or not local regulations have development criteria for turbidity measurements). The minimum duration of well development should vary in accordance with the method used to develop the well. For example, surging and pumping the well may provide a stable, sediment free sample in a matter of minutes; whereas, bailing the well may require several hours of continuous effort to obtain a clear sample. The duration of well development and the pH, temperature, and specific conductivity readings should be recorded in the daily log and on the Monitoring Well Installation Log (Exhibit C) by the Field Supervisor.

Purged groundwater shall be captured and contained in 55 gallon steel drums or suitable vessel(s), if a reasonable potential exists for the groundwater to contain hazardous substances as directed by the Project Manager or as specified in the project work documents.

If required, each drum or vessel containing captured purge water shall be properly labeled with a weather proof label as to the contents, the well(s) from which the contained purge water originated and the date on which the contents were generated. Storage of the containers shall be as specified in the project work documents or as directed by the Project Manager.

Captured and contained purge water shall be characterized for discharge, treatment and/or disposal. Characterization of the captured and contained purge water should be specified in the project work documents or by the Project Manager, but could rely on site knowledge, the analytical results of groundwater samples associated with each container, or could involve direct sampling and analyses of the contained water.

The requirements and options available for discharge, treatment and/or disposal are dependent upon many variables such as chemical consistency, local and state regulations and location of site. Discharge, treatment and/or disposal of captured and contained purge water must be in accordance with local, state and Federal regulations and shall be specified in the project work documents.

Water levels should be measured from ground surface or the concrete pad at the base of the well monument.

### 7.5.3. Well Recovery Test

A recovery test shall typically be performed immediately after development. Readings shall be taken at appropriate intervals (usually one minute or less) until the well has recovered to within 90% of its static water level. The extremely long recovery periods of some wells may prohibit carrying this test out to its completion; the decision to terminate shall be noted and justified on the Well Installation Log.

### 7.5.4. Well Acceptance

The final completed well shall be probed using a weighted engineering tape to determine that the well is unobstructed to total depth. A 10-foot rigid cylinder 1 standard size smaller than nominal well casing size can be lowered to the total depth of the well and retrieved to verify straightness of the well for tool access.

A well will be accepted by the Field Supervisor when development has been completed in accordance with these specifications, and the required drilling subcontractor's documentation has been furnished to Golder.

## 7.6. Site Cleanup

The Staging area, decontamination area, each well site and any other areas used during the well installation program shall be cleaned up by the subcontractor and inspected by the Field Supervisor. Unless agreed with the client, all trash should be removed; the 55-gallon drums of cuttings shall be organized into a temporary storage area and any concrete or asphalt that has been covered with mud shall be washed off. Cut or torn asphalt areas will be patched by the subcontractor using a cold patch material. Try to restore the area as much as possible to the condition before the well installation program.

## 7.7. Field Change Request

Variation from established procedure requirements may be necessary due to unique circumstances encountered on individual projects. All variations from established procedures shall be documented on a Field Change Request (Exhibit D) and reviewed by the Project Manager and the Project Director.

The Project Manager may authorize individual Field Supervisors to initiate necessary variations. If possible, the request for variation shall be reviewed by the Project Manager prior to implementation. If prior review is not possible, the variation may be implemented immediately at the direction of the Field Supervisor, provided that the Project Manager is notified of the variation within 24 hours of the implementation, and the Field Change Request is forwarded to the Project Manager within 2 working days of implementation. If the variation is unacceptable to either reviewer, the activity shall be

reperformed or action shall be taken as indicated in the Comments section of the reviewed Field Change Request. All completed Field Change Requests shall be maintained in project records.

## 7.8. Well Location

The level of accuracy required for horizontal well location and elevation shall be specified by the Project Manager or applicable project plans. At a minimum, well locations shall be approximated with tape and compass from known permanent landmarks. However, locations may be measured by alternate methods such as (1) triangulated with compass bearings; (2) by GPS if of sufficient accuracy; and (3) geodetic survey using standard survey techniques. Elevation of the riser casing shall be approximated. A licensed surveyor, if required, shall maintain 3rd order precision and accuracy. The surveyed point for the well riser shall be the highest point on the riser casing with the slip cap removed. That point shall be marked on the riser casing.

## 8.0 REFERENCED GUIDELINES

Golder Associates Inc. Technical Guideline TG-1.2-1, "Rock Core Drilling and Sampling."

Golder Associates Inc. Technical Guideline TG-1.2-5, "Drilling, Sampling, and Logging of Soils."

Golder Associates Inc. Technical Guideline TG-1.4-6, "Water Level Measurement."

## 9.0 ADDITIONAL REFERENCES, GUIDELINES AND PROCEDURES

ASTM D 1785 - Threaded, Flush Couplings on PVC Pipe.

Golder Associates Inc. Technical Guideline TG-1.2-20 “Collection of Groundwater Quality Samples”
Golder Associates Inc. Quality Procedure QP-1, "Calibration and Maintenance of Measuring and Test Equipment."

Golder Associates Inc. Technical Guideline TG-1.2-23, "Chain of Custody."

Golder Associates Technical Guideline TG-2.3-3, “Headspace Analysis Using the Organic Vapor Analyzer”

Golder Associates Technical Guideline TG-1.1-2, "Geodetic Surveys."

Federal and/or State Regulations and Guidance

CFR 264/265 Subpart F

Resource Conservation and Recovery Act (RCRA) Ground-Water Monitoring

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

Applicable State Standard Operating Procedure

EXHIBIT A

**Golder Associates**

# HISTORY OF HOLE

Job No. _____ Sheet _____ of _____

Geologist _____ Date _____ Boring No. _____

Driller _____ Surface Elevation _____ Weather _____ Temp _____

Contractor _____ Drill Fluid _____ _____ To _____

Location _____ Type of Barrel _____ Casing Size _____ Core Size _____

| BEGINNING OF SHIFT | END OF SHIFT |
|---|---|
| Time _____ Depth of Hole _____ | Time _____ Hrs Productive _____ Hrs. Delayed _____ |
| Depth to WL _____ Depth of Casing _____ | Depth of Hole _____ Depth of Casing _____ Depth to WL _____ |

Checked by:

EXHIBIT B

Golder Associates

# Field Boring Log

DEPTH HOLE _____ JOB NO. _____ PROJECT _____ BORING NO. _____

DEPTH SOIL DRILL _____ GA INSP. _____ DRILLING METHOD _____ SHEET _____ OF _____

DEPTH ROCK CORE _____ WEATHER _____ DRILLING COMPANY _____ SURFACE ELEV. _____

NO. DIST. SA. ___ UD. SA. ___ TEMP. _____ DRILL RIG _____ DRILLER _____ DATUM _____

DEPTH WL. _____ HRS. PROD. _____ WT. SAMPLER HAMMER _____ DROP _____ STARTED _____ / _____ (TIME / DATE)

TIME WL. _____ HRS. DELAYED _____ WT. CASING HAMMER _____ DROP _____ COMPLETED _____ / _____

## SAMPLE TYPES

| | |
|---|---|
| A.S. | AUGER SAMPLE |
| C.S. | CHUNK SAMPLE |
| D.O. | DRIVE OPEN |
| D.S. | DENISON SAMPLE |
| P.S. | PITCHER SAMPLE |
| R.C. | ROCK CORE |
| S.T. | SLOTTED TUBE |
| T.O. | THIN-WALLED, OPEN |
| T.P. | THIN-WALLED, PISTON |
| W.S. | WASH SAMPLE |

## ABBREVIATIONS

| | |
|---|---|
| BL | BLACK |
| BR | BROWN |
| C | COARSE |
| CA | CASING |
| CL | CLAY |
| CLY | CLAYEY |
| F | FINE |
| FRAG | FRAGMENTS |
| GL | GRAVEL |
| LYD | LAYERED |
| LI | LITTLE |
| M | MEDIUM |
| MIC | MICACEOUS |
| MOT | MOTTLED |
| NP | NON-PLASTIC |
| OG | ORANGE |
| ORG | ORGANIC |
| PH | PRESSURE-HYDRAULIC |
| PM | PRESSURE-MANUAL |
| R | RED |
| RES | RESIDUAL |
| RX | ROCK |
| SA | SAMPLE |
| SAT | SATURATED |
| SD | SAND |
| SI | SILT |
| SLY | SILTY |
| SM | SOME |
| TR | TRACE |
| WL | WATER LEVEL |
| WH | WEIGHT OF HAMMER |
| Y | YELLOW |

## SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" 0 - 5% "SOME" 12 - 30%

"LITTLE" 5 - 12% "AND" 30-50%

| RELATIVE DENSITY | | BLOWS | CONSISTENCY | | FINGER PRESSURE |
|---|---|---|---|---|---|
| VERY LOOSE | VLS | 0-4 | VERY SOFT | VS | EXTRUDES |
| LOOSE | LS | 4-10 | SOFT | S | MOLDS EASILY |
| COMPACT | CP | 10-30 | FIRM | FM | MOLDS |
| DENSE | DN | 30-50 | STIFF | ST | THUMB INDENTS |
| VERY DENSE | VDN | 50 | VERY STIFF | VST | THUMBNAIL INDENT |
| | | | HARD | H | RESISTS THUMBNAIL |

| ELEV. / DEPTH | DESCRIPTION | BLOWS / FT | | SAMPLES NO. | TYPE | HAMM. BLOWS PER 6 IN (FORCE) | REC / ATT | DEPTH | SAMPLE DESCRIPTION AND BORING NOTES |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

EXHIBIT C

# MONITORING WELL INSTALLATION LOG

JOB NO. _____ PROJECT _____ WELL NO. _____ SHEET _____ OF _____

GA INSP. _____ DRILLING METHOD _____ GROUND ELEV. _____ WATER DEPTH _____

WEATHER _____ DRILLING COMPANY _____ COLLAR ELEV. _____ DATE/TIME _____

TEMP. _____ DRILL RIG _____ DRILLER _____ STARTED _____ (TIME / DATE) COMPLETED _____ (TIME / DATE)

## MATERIALS INVENTORY

WELL CASING _____ in. dia. _____ l.f. | WELL SCREEN _____ in. dia. _____ l.f. | BENTONITE SEAL _____

CASING TYPE _____ | SCREEN TYPE _____ | INSTALLATION METHOD _____

JOINT TYPE _____ | SLOT SIZE _____ | FILTER PACK QTY. _____

GROUT QUANTITY _____ | CENTRALIZERS _____ | FILTER PACK TYPE _____

GROUT TYPE _____ | DRILLING MUD TYPE _____ | INSTALLATION METHOD _____

| ELEV./DEPTH | SOIL/ROCK DESCRIPTION | WELL SKETCH | INSTALLATION NOTES |
|---|---|---|---|
| | GROUND SURFACE | | |
| 0.0 | | | |

WELL DEVELOPMENT NOTES

EXHIBIT D

# FIELD CHANGE REQUEST

Golder Associates

Job/Task Number: _____

Other Affected Documents: _____

Requested Change: _____

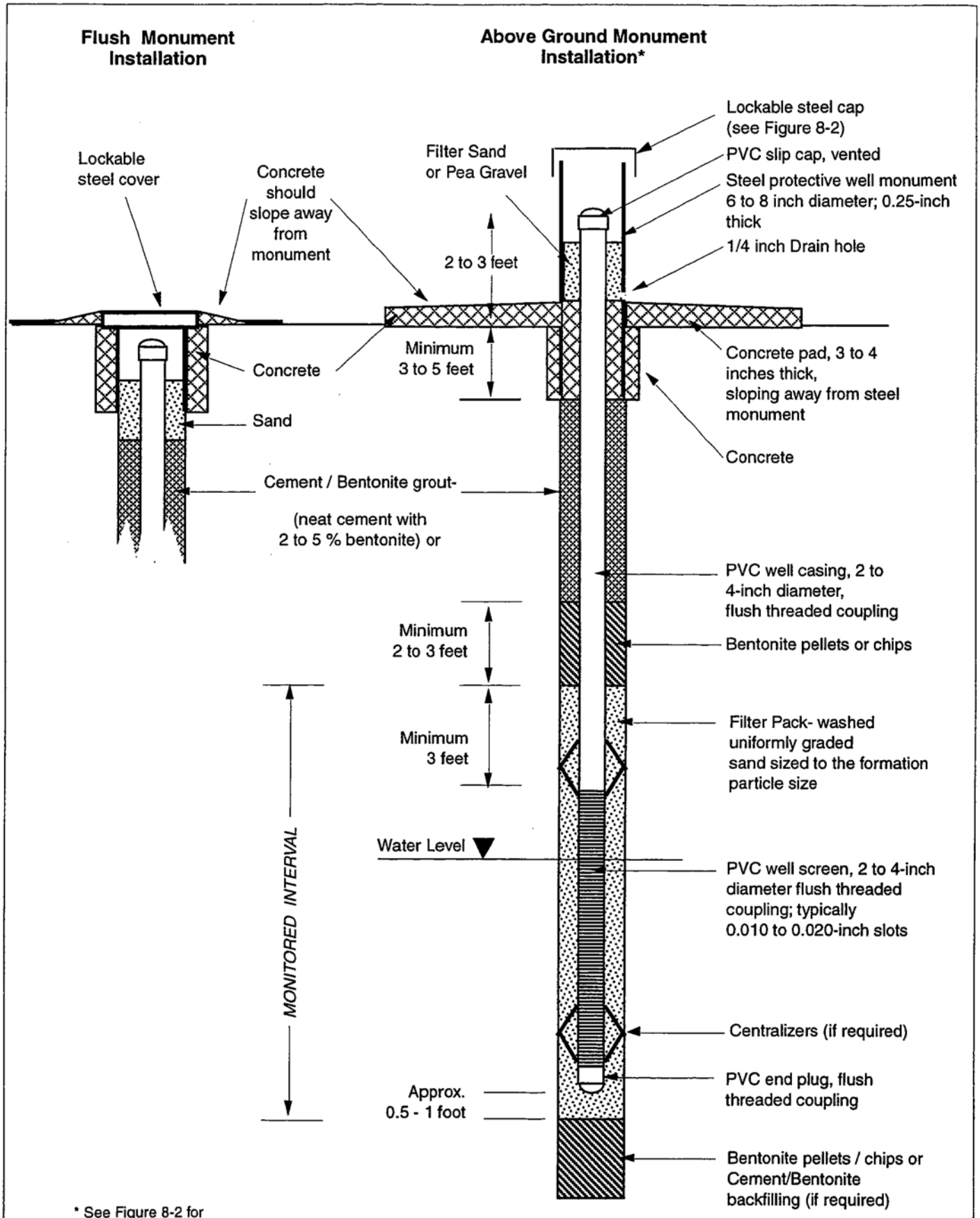
Reason for Change: _____

Change Requested by: _____ Date _____

Reviewed by: _____ Date _____
GAI Project Manager

Comments: _____

FIGURE 8-1




* See Figure 8-2 for protective cap and monument details

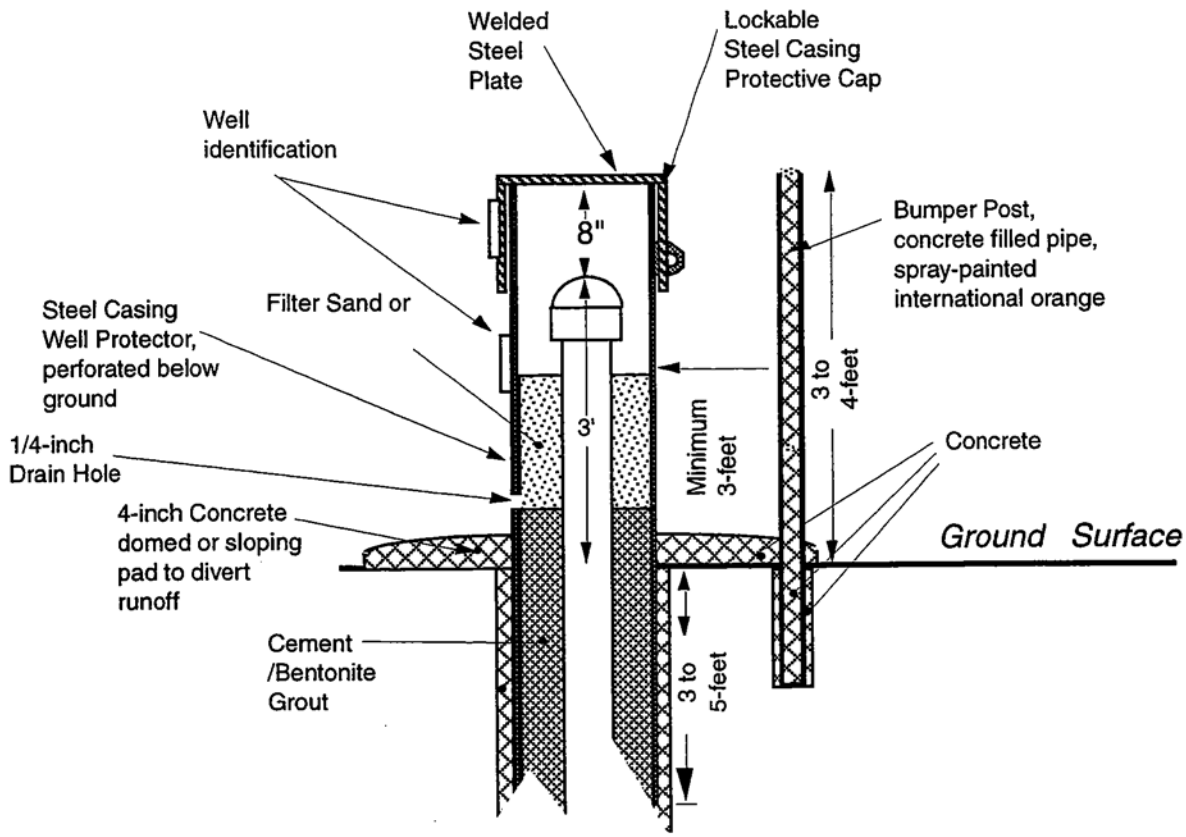
Not To Scale

FIGURE **8-1**

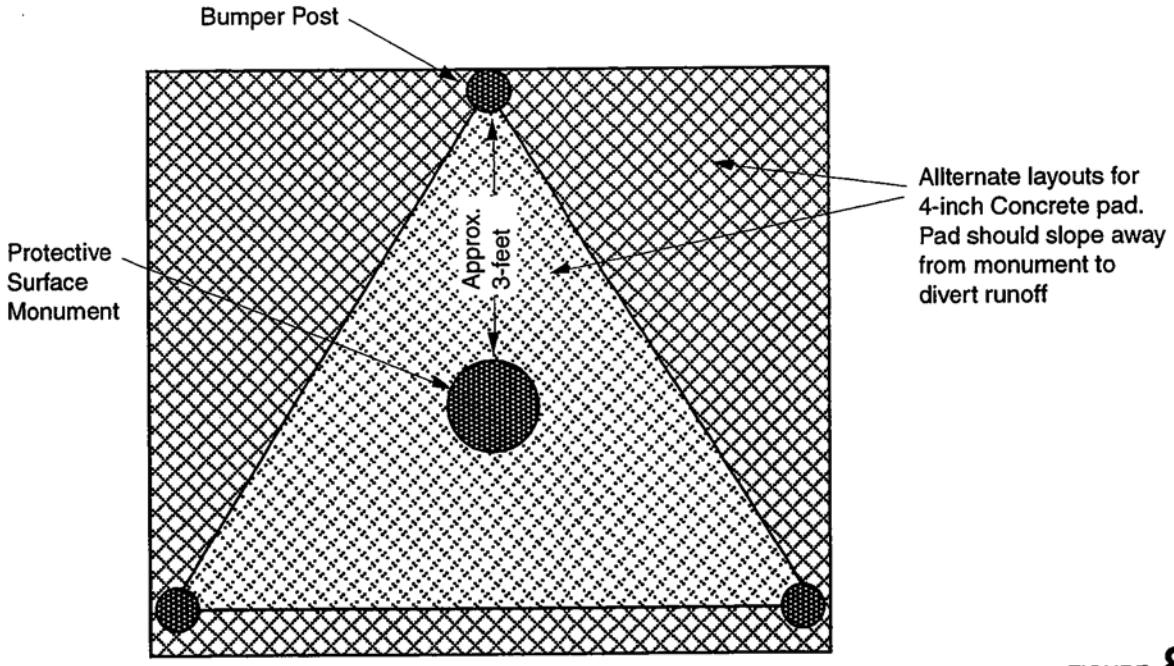
**TYPICAL MONITORING WELL INSTALLATION**

**Golder Associates**

FIGURE 8-2




Cross Section
**Protective Above-Ground Monument**




Plan View
**Protective Monument and Pad**

FIGURE **8-2**
**PROTECTIVE MONUMENT DETAILS**

# APPENDIX E-4

# TECHNICAL GUIDANCE FOR COLLECTION OF GROUNDWATER QUALITY SAMPLES

# TECHNICAL GUIDELINE FOR COLLECTION OF GROUNDWATER QUALITY SAMPLES TG-1.2-20

Rev. #3
8/20/2009

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EXHIBIT D Field Report Form
EXHIBIT E Sample Integrity Data Sheet
EXHIBIT F Field Change Request Form

# TG-1.2-20 Collection of groundwater quality samples

## 1.0 PURPOSE

This technical training guideline establishes a standard methodology for collecting groundwater samples for chemical analysis that are representative of aquifer water quality.

## 2.0 APPLICABILITY

This technical training guideline is applicable to field personnel engaged in the collection of groundwater samples from wells for purposes of chemical analysis. This document should be read in conjunction with any and all regulatory, workplan, order, client specific, and other project-specific guidelines.

## 3.0 DEFINITIONS

### 3.1. Dedicated Pump System

A dedicated pump system is a permanently installed device for removing water from a well. The system is not removed from the well and does not have the potential to become cross-contaminated between uses.

### 3.2. Well Bore Storage Volume

Well bore storage volume is defined as the volume of water enclosed by the well casing and screen gravel/sand pack at equilibrium.

### 3.3. Bailer

A bailer is a tubular device with a check-valve at the top and/or bottom for collecting and removing groundwater from wells.

### 3.4. Non-Dedicated Sampling Apparatus

Non-dedicated sampling apparatus is sampling equipment that may contact groundwater samples from more than one well. This term is also used to describe equipment that is only used for sampling a single well, but is removed from the well and could potentially become contaminated.

### 3.5. Groundwater Sample

A groundwater sample is defined as water acquired from a well for analyses of chemical or biological parameters that is representative of groundwater within the aquifer or the portion of the groundwater in the subsurface being sampled.

### 3.6. Positive Pressure Pump

A positive pressure pump is a device for removing water from a well by forcing water to the surface through positive pressure when operated below the well's water level. A positive pressure pump may be operated electrically, mechanically, or by gas pressure. Submersible impeller, bladder, and check valve pumps are common types of positive pressure pumps.

### 3.7. Negative Pressure Pump

A negative pressure pump is a device for removing groundwater from a well by suction (negative pressure). Peristaltic and centripetal pumps are common types of negative pressure pumps. The limitation for lifting water by suction is usually 20 to 25 feet. These pumps are typically only acceptable

for non-volatile analytes and analytes that are not affected by aeration or changes in pH or pressure. They are useful as purging devices for shallow groundwater wells.

### 3.8. Sample Bottles

Sample bottles are containers specifically designed and prepared for storing aliquots of a sample. Sample container type, material, size, and type of lid are specific for particular groups of analytes. Sample bottles must typically be properly cleaned and prepared by a certified laboratory.

### 3.9. Acceptable Material

Acceptable materials are defined as the only materials that are allowed to contact groundwater samples, and are dependent on the analytes being tested.

### 3.10. Permissible Pump

Permissible pumps are defined as pump systems that have acceptable effects on water quality when used to obtain groundwater samples from wells. The use of permissible pumps is dependent on the analyses being conducted on the acquired samples. The parts of permissible pumps that will contact the groundwater sample contain only acceptable materials.

## 4.0 DISCUSSION

In order to generate appropriate, quality data using these guidelines, it is incumbent on the field personnel to have reviewed these guidelines as well as other referenced and/or pertinent technical guidelines. This document should be read in conjunction with any and all regulatory requirements, site-specific work plans, administrative orders, and client- specific or other project-specific guidelines.

Groundwater samples shall be collected in quantities and types as directed by the Project Manager and project work documents. If applicable, sampling or monitoring shall be conducted for any potential floating immiscible layers prior to well purging and sampling. All instruments used for field analyses shall be calibrated in accordance with appropriate guidelines. The guidelines in Golder Associates Quality Procedure QP-1, "Calibration and Maintenance of Measuring and Test Equipment" may be applicable, however it is important to be familiar with local regulatory and project-specific requirements.

All non-dedicated sampling equipment shall be decontaminated before and after each use. If directed by the Project Manager or as specified in project work documents, purge water and decontamination fluids shall be captured and contained for disposal. Samples shall be collected in properly prepared containers of the appropriate size and type (see Table 1). All samples shall be appropriately labeled and sealed (see Exhibit A) an appropriate groundwater sample collection forms (Exhibit B) must be used to document raw field information for each sample. Chain of custody (see Exhibit C) shall be maintained in accordance with guideline TG-1.2-23, "Chain of Custody." The Field Report Form (see Exhibit D) and Sample Integrity Data Sheet (see Exhibit E) and bound field notebooks shall be used to document daily site activities and sample collection. All variations from established guideline shall be documented on the Field Change Request (see Exhibit F) and shall be approved by the Project Manager.

## 5.0 RESPONSIBILITIES

### 5.1. Sampling Technician

The Sampling Technician is responsible for sample collection, sample custody in the field, preservation, field testing, total and accurate completion of data sheets, sample shipment and delivery of data to the Project Manager, all as described in this technical guideline.

## 5.2. Task Leader

The Task Leader is responsible for supervising Sampling Technicians. Supervision includes ensuring that samples are collected, documented, preserved, field analyzed, handled and shipped to the appropriate laboratory as specified in project work documents and this technical guideline. In many cases, the Task Leader will also fill the role of the Sampling Technician.

## 5.3. Project Manager

The Project Manager has overall management responsibilities for the project, is responsible for designing the sampling program, for arranging the logistics of the program, and for providing any required clarifications in the use of this guideline.

# 6.0 EQUIPMENT AND MATERIALS

If wells are equipped with permissible and dedicated pump systems, equipment to operate the dedicated pump systems (i.e., air compressor, compressed air or nitrogen cylinders, electric generator, etc.); non-dedicated sampling apparatus such as surface discharge tubing and valving; or bailer(s) for sampling free floating product may be necessary.

If wells do not have permissible and dedicated pump systems, permissible pump systems or bailers and accessories of small enough diameter to enter the wells will be necessary. All equipment that could contact the sample shall be made of acceptable materials.

Additional supplies should include: sample bottles, properly cleaned and prepared by a certified laboratory with preservatives appropriate for the parameters to be sampled.

Field test equipment

- multi parameter meter and calibration standards (meter should be capable of measuring pH, specific conductance, redox, dissolved oxygen and temperature);
- turbidity meter and calibration standards;
- flow through cell for collection of field measurements;
- Filtration apparatus (0.45 micron and prefilter), if necessary;
- Depth to water measuring device;
- Interface probe if necessary;
- Well specifications;
- Sample labels and seals (Exhibit A);
- Groundwater Sample Collection Forms (Exhibit B);
- Chain of Custody Forms (Exhibit C);
- Field Report Forms (Exhibit D);
- Sample Integrity Data Sheet (Exhibit E);
- Coolers and ice packs or wet ice contained in zippered plastic bags;
- HPLC/distilled/deionized/Type II water as necessary;

- Isopropyl alcohol;
- 1% solution of trace metal grade nitric acid;
- Cleaning equipment and solutions;
- Indelible ink pens;
- Field notebooks;
- Container(s) for capturing, containing, treating and measuring waste decontamination solutions, if necessary;
- OVA or OVM with accessories and calibration gases;
- As required, 55 gallon steel drums fitted with bung holes, or suitable vessels(s) for containing purged groundwater;
- Field Change Request (Exhibit F);and
- Appropriate PPE, notably suitable gloves for handling samples. Various gloves may react to potential contaminants, so glove selection should be made carefully prior to mobilizing to the field.

## 7.0 GUIDELINE

## 7.1. General Considerations

### 7.1.1. Regulatory Considerations

At most locations, groundwater sampling and the characterization and disposal of purge fluids are specifically regulated by local, or state regulations, or may have client specific requirements. All such client and regulatory requirements must be reviewed before groundwater sampling. At a minimum, the following actions must be taken:

Ensure that groundwater sampling is performed by an entity that meets all requirements for conducting such operations in that particular location; and

Ensure that all follow up well reports required by appropriate agencies are submitted to the appropriate authorities or in some cases that we have informed the client of such requirements.

### 7.1.2. Decontamination

All non-dedicated sampling equipment that may contact the sample must be decontaminated before and after each use. Non-dedicated pumps or bailers require decontamination of internal and external parts prior to being lowered into the well. Non-dedicated equipment shall typically first be washed with clean tap water (whose chemistry is known and acceptable), non-phosphate detergent (e.g., Alconox), and rinsed with clean tap water. For inorganic analytes 1% nitric acid solution shall be used for a second rinse. For organic analytes, reagent-grade isopropyl alcohol is often used for the second rinse. A final rinse with HPLC/distilled/deionized/Type II water shall complete the decontamination. At a minimum, all acid and isopropyl alcohol wash solutions must be captured (see Section 7.4.2).

### 7.1.3. Sample Quantities, Types, and Documentation

Samples shall be collected in quantities and types as directed by the Project Manager or as specified in the project work documents. The Field Report Form (Exhibit D) or field notebook and the Sample Integrity Data Sheet (Exhibit E) shall be used to document daily site activities and sample collection (see Section 7.5). Samples shall be transferred to the analytical laboratory under formal chain of custody, which shall be documented (Exhibit C) and maintained in accordance with guideline TG-1.2-23, "Chain of Custody".

### 7.1.4. Sample Containers

Table 1 provides a summary of the typical type and minimum size of the sample bottles, preservation, storage/handling requirements, and maximum holding times for some common chemical analyses performed on groundwater samples for environmental investigations. All sample bottles must be properly cleaned and prepared by a certified laboratory. All groundwater samples shall be labeled and typically sealed (see Section 7.5) and immediately placed in coolers that have been pre-cooled to 4°C or less and that have securely closed lids for storage and transport. Samples must be received by the analytical laboratory in sufficient time to conduct the requested analyses within the specified holding time. All samples should be placed on ice and stored at 4°C immediately following sampling unless otherwise indicated in the site-specific work plan.

### 7.1.5. Acceptable Materials

The choice of materials used in the construction of sampling devices should be based upon knowledge of what analytes may be present in the sampling environment and how the sample material may interact.

Typically acceptable materials that may contact groundwater sample are stainless steel and fluorocarbon resin (Teflon, PTFE, FEP, or PFA). Glass is an acceptable material for contacting some samples. Plastics (PVC, polyethylene, polypropylene, tygon) are an acceptable material for contacting some samples, often when the analyses are for inorganic analytes (metals, radionuclides, anions, cations).

### 7.1.6. Sample Acquisition

Groundwater samples shall typically be removed from the well with the use of a permissible pump or bailer. Electric positive-pressure pumps made of acceptable materials as defined in Section 3.0 are permissible to use for acquiring any groundwater sample. Gaseous, typically air or nitrogen pressure activated positive-pressure pumps made of acceptable materials are permissible to use for acquiring any groundwater sample if the gas does not contact the sample. Positive-pressure pumps operated by mechanically forcing water through check valves are often permissible for acquiring any groundwater samples. Bailers made of acceptable materials are permissible for acquiring groundwater samples in some circumstances.

Peristaltic pumps and air-lift pumps are not preferred for acquiring groundwater samples but are often permissible when samples are to be analyzed for analytes that are not affected by aeration, and are not affected by changes in pH or pressure.

Other types of pumps (peristaltic, centrifugal, air lift, recirculation, etc.) may typically be used for purging groundwater from wells prior to sample acquisition, if: (1) pump materials contacting well water are acceptable; (2) pumping does not aerate or change the pH of the remaining well water; and (3) pumped water does not mix with remaining well water during pumping or after the pumping is stopped.

The appropriate pump should be selected by the Project Manager prior to mobilizing to the field.

## 7.2. Groundwater Sample Acquisition

### 7.2.1. Floating or Sinking Non-Aqueous Fluids

Groundwater shall be examined for the presence of any floating or sinking non-aqueous fluids, in unknown situations or where they may be potentially present, at the direction of the Project Manager. If detected, they shall be sampled prior to purging any water from the well. An interface probe is often used for this purpose along with measurement of the liquid/water level. Guideline TG-1.4-6, "Water Level Measurement" may be applicable. A bailer (preferably with a check valve at the bottom only and made of transparent Teflon or glass) may be lowered into the well to retrieve a sample of floating non-aqueous fluid. The bailer shall not become completely submerged. A sample of sinking non-aqueous fluid can often be obtained using a stainless steel device designed specifically for discrete interval sampling. If a non-aqueous fluid is sampled, it may be transferred to a 40 ml or 125 ml glass vial with an air-tight, Teflon-lined septum cap. The sample shall not be filtered or preserved with additives, but shall typically be placed in a metal can with vermiculite and then in a cooler that has been pre-cooled to 4°C and secured for storage and transport. There are often very stringent requirements for transport of such samples.

### 7.2.2. Purging the Well

It is often preferable to conduct well purging using a low flow/low stress methodology. Purging shall be conducted by starting the pump at its lowest setting and slowly increasing the pumping rate until flow occurs (typically flow rates on the order of 0.1 to 0.4 l/min). Ideally at this pumping rate, there should be a minimum level of water level drawdown (generally less than 10 cm). Monitor and record the pumping rate and water level as appropriate during purging. During purging, monitor indicator field parameters (e.g., turbidity, temperature, specific conductance, pH, ORP, DO) every three to five minutes. Purging is considered complete and sampling may begin when the indicator parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken on 3 to 5–minute intervals, are within the following tolerance:

- Turbidity (within 10% and preferably less than 5 NTU);
- Temperature (within 0.5 degrees C);
- Specific conductance (within 10%);
- pH (within 0.1 stnd pH units);
- ORP (within 10%); and
- DO (within 10%).

If the low flow/low stress methodology is not used, the pump or bailer shall be used and operated in accordance with the manufacturer's operational manual. Before collecting the actual groundwater sample field parameters of at least pH, redox, temperature, and specific conductivity should come to stabilize or approach asymptotical values. In general this will require that a minimum of three (3) well bore storage volumes of water shall be purged from the well by pumping. Calculate this volume by measuring the depth to water and subtracting this depth from the total depth of the well. If a gravel/sand pack surrounds the screen the pore volume of the gravel/sand pack (assume a porosity of 25 percent if unknown) shall be added to the total well volume. While purging water from the well, parameters specified by the Project Manager will be monitored.

A flow-through cell is advantageous for the monitoring of field indicators. Typically, if the parameters are within the ranges specified above, then the water has stabilized. Rarely are more than ten well volumes removed before sampling using these criteria. If the parameters of interest in the investigation include VOCs, care must be taken to ensure that purging does not induce degassing within the well. Where the well screen and sand pack are completely below the water table, the rate of purging should be controlled such that it does not draw the water level in the well below the top of the well screen. Where the well screen and sandpack are intersected by the groundwater level, the rate of purging should correspond with the rate of sampling, if continuous sampling methods are used. Large drawdowns in water table wells should be avoided. Purged groundwater that has a reasonable potential of containing hazardous substances shall be captured and characterized prior to discharge or disposal (see Section 7.4.1). Where a low yielding well is encountered, the Project Manager shall be contacted for direction (see Section 7.6).

### 7.2.3. Samples for Major Cation, Metal and Metallic Radionuclide Analyses

Samples for major cations and metallic radionuclide analyses are sometimes filtered immediately or within two hours after acquisition. However, most projects require that samples for cations are not filtered. Filtration is best accomplished with the use of an in-line filter system in which the sample is directly fed from the discharge port of permissible positive-pressure pump through the filter and into the appropriate sample bottle. A less preferred but acceptable method is the collection of an adequate amount of sample from a permissible positive-pressure pump or bailer into a properly cleaned and prepared high-density linear polyethylene or glass prefiltration bottle. The prefiltration bottle does not contain any chemical preservative. Aliquots shall be immediately fed through the filter and collected directly into the appropriate sample bottle. The final filter pore size should typically be 0.45 microns. (Note: New filters made of material specified by the Project Manager shall be used for each sample and the filter system must be decontaminated before and after each sample.) These groundwater samples shall be preserved with nitric acid (HNO3) to a pH less than 2. A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is less than 2.

An unfiltered aliquot of a sample can typically be obtained (in addition to the filtered aliquot) directly from a permissible positive-pressure pump discharge port or from the bailer into appropriate sample bottles (see Table 1) and preserved with nitric acid to a pH less than 2. Note that for various cations, including chromium VI, no acid and typically no other chemical preservative is added to the aliquot.

### 7.2.4. Samples for Semi-Volatile Organics Including Extractable Base-Neutral/Acid Compounds, Phenolic Compounds, Pesticides, PCBs and Herbicides

Samples for semi-volatile organics including extractable base-neutral/acid compounds, phenolic compounds, PCBs, pesticides, or herbicides analyses shall typically be collected directly from a positive-pressure pump discharge port or bailer in appropriate sample bottles often with a Teflon lined lid and in some cases an appropriate chemical preservative. Sample should not be allowed to overflow the sample bottle and in the vast majority of cases shall not be filtered unless specified in a project-specific work plan.

### 7.2.5. Samples for Purgeable Volatile Organics

Samples for purgeable volatile organics are obtained before samples for other analytes have been acquired for each well. In wells with low productivity, volatile organics should be the first samples taken, unless otherwise directed by the Project Manager. Samples for purgeable volatile organics shall typically be obtained from the well using a permissible positive-pressure pump or bailer and shall be collected directly from the pump discharge tube or bailer into properly cleaned and prepared 40 ml vial.

The sample should not be allowed to overflow the sample bottle as this may remove acid preservative that is usually added at the laboratory either prior to sample shipment to the field or by field staff before filling the vials. The pH of the aliquot should be checked if acid preservative is used and the buffering capacity of the groundwater is high or unknown or more turbid than usual from a carbonate rich strata. A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is less that specified by the methodology for acid preserved samples – often less than pH 2.

Air contact and sample agitation should be minimized. Pumping rates should be significantly reduced during sampling for volatile organics to reduce potential agitation of the sample. These samples shall not be filtered or preserved except as noted below. The bottle should be filled until there is a convex meniscus to facilitate an airtight seal when capped. Immediately after collection, a Teflon lined silicon septum cap shall be placed Teflon side down tightened onto the vial. There should be no air bubbles remaining within the vial once the cap has been fastened; if air is present, a new sample shall be taken by the same guideline.

Samples for many volatile methods are preserved with hydrochloric acid (HCl) to increase holding time. However, in some waters the acid will react with the sample producing bubbles due to production of carbon dioxide or sulfur compounds. If bubbles are found due to reactions with the acid, contact the Project Manager if this eventuality has not been described in the work plan. The Project Manager may require that samples are taken without acid preservative with the resulting shorter holding times. In this case a new unpreserved vial should be used. An unpreserved sample vial can be obtained by pouring the acid out of a preserved vial if no unpreserved vials are available. It is unlikely that the remaining acid will be sufficient to produce bubbles. However, if bubbles are still found one may slowly fill and empty the vial once or more times to remove the remaining acid. Samples that are not preserved should be noted as such on both the bottle labels and the Chain of Custody documents.

### 7.2.6. Samples for Cyanide Analyses

Samples for cyanide analyses shall be collected directly into appropriate sample bottles from the bailer or the port of a permissible positive-pressure pump. Samples shall not be filtered nor shall they be allowed to overflow the sample bottle. A pre-preserved bottle is typically made available. Otherwise, samples shall be immediately preserved with sodium hydroxide (NaOH) to a pH greater than 12. A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is greater than pH 12.

### 7.2.7. Samples for Major Anion and Biological Oxygen Demand (BOD) Analyses

Samples for major anions (chloride, fluoride, sulfate, alkalinity, acidity, total silica, bromide) and for biological oxygen demand shall be collected directly into appropriate sample bottles from the port of the pump or from the bailer. These samples do not require filtration, but may be filtered if explicitly required in the sampling plan. Chemical preservatives shall only be added as required by the method.

### 7.2.8. Samples for Total Phosphate and Orthophosphate Analyses

Groundwater samples for total phosphate and orthophosphate analyses shall typically be immediately filtered after initial sample acquisition. However, these parameters often are specified to be taken without filtration. Filtration is best accomplished with an in-line system in which a positive-pressure pump discharge port feeds groundwater directly through the filter system into an appropriate sample bottle. A less preferred but acceptable method to obtain a filtered sample is to collect a liter of sample from a permissible positive-pressure pump or bailer in a properly cleaned and prepared high-density

polyethylene or glass bottle, and then immediately feed the sample through a filter system (e.g., syringe filters) which discharges into the appropriate sample bottle. This process should be completed within two hours; otherwise, the results will be suspect. The final filter pore size shall typically be 0.45 micron. (Note: New filters made of most any material must be used for each sample and the filter system must be decontaminated before and after each use.) Samples shall be immediately placed on ice and preserved by cooling to 4°C or lower.

### 7.2.9. Samples for Total Phosphorus, Nitrogen Compounds, Chemical Oxygen Demand, Total Organic Carbon, and Total Organic Halogen Analyses

Groundwater samples for total phosphorus, nitrogen compounds, chemical oxygen demand, and total organic carbon analyses shall be collected directly into appropriate sample bottles from a permissible positive pressure pump discharge port or from the bailer. These samples shall not be filtered and shall be chemically preserved as required by the various methods.

### 7.2.10. Samples for Analysis of Total Dissolved Solids

Groundwater samples for analyses of total dissolved solids shall be immediately filtered in the field by methods discussed in Section 7.2.3 above or collected without filtration depending on sampling plan, and put directly into an appropriate sample bottle. Samples shall not be preserved with chemicals.

### 7.2.11. Samples for Oil and Grease or Hydrocarbons

Groundwater samples for oil and grease or hydrocarbons shall be collected directly into the appropriate sample container from the discharge port of a permissible positive pressure pump or from the bailer. These samples shall not be filtered and in some cases shall be preserved with hydrochloride acid (HCL, 1 + 1 Vol/Vol) to a pH less than 2. A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is less than 2. Do not preserve with sulfuric acid due to potential interferences in the analytical procedure from co-extraction of elemental sulfur.

### 7.2.12. Samples for Fuel Fingerprinting

Groundwater sample for fuel fingerprinting shall be collected directly into the appropriate sample container using a permissible positive pressure pump or bailer and shall be collected directly from the pump discharge tube or bailer. Some guidelines require that the sample be allowed to overflow approximately 2 to 3 sample container volumes minimizing agitation and contact with air. These samples shall not be filtered but typically must be preserved to a pH <2 with HCL (1:1 vol/vol). A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is less than 2. The sample container is then often capped with a Teflon lined silicon septum cap excluding all headspace. Otherwise the sample is often split into two or three aliquots for different analyses as dictated in the sampling plan or as specified by the Project Manager.

## 7.3. Field Analyses

### 7.3.1. Calibration of Instruments

All instruments used for field analyses shall be calibrated in accordance with guidelines required by the sampling and analysis plan; or by the most strict single guideline or combination of guidelines compiled from procedure QP-1, "Calibration and Maintenance of Measuring and Test Equipment;" or by the method or manufacturer's procedure. Only equipment with a calibration tag showing a validity date later than the anticipated date of use shall be taken to the field unless, as is usual, field calibration is performed. Each

instrument should be accompanied by a copy of the manufacturer's operation manual and appropriate instrument calibration records.

### 7.3.2. Water Temperature

A meter and a flow though cell are the preferred tools for measuring this parameter. The meter shall be calibrated in accordance with the sampling plan, and if more stringent, with the manufacturer's procedures (provided with the instrument). If a meter is unavailable, a thermometer shall be used to measure the temperature of the water on an aliquot of purged water obtained just before sampling. The thermometer reading shall be allowed to stabilize and shall be recorded to the nearest 0.5°C. The thermometer shall be rinsed with distilled/deionized water before and after each use.

### 7.3.3. pH Measurement

A meter and a flow though cell are the preferred tools for measuring this parameter. Alternately, a pH meter may be used to measure the pH of the sample on an aliquot of purged water that was obtained just before sampling. Measurements shall be made immediately on the obtained aliquot. (Note: If possible, measure pH continuously on the purged water in an air-space free and closed flow-through system.) Calibration shall be in accordance with the sampling plan or, if more stringent, with the manufacturer's procedures (provided with the instrument). At a minimum, calibration shall be performed at the beginning and ending of each day's use and every four hours in between. Calibration shall be performed with standardized buffered pH solutions and conducted as required by the more stringent of the sampling plan or manufacturer's specifications. Typically, the probe shall be thoroughly rinsed with distilled/deionized water after each sample when using a flow through cell or after each sample reading when the probe is placed in a discrete aliquot of sample. The pH shall be recorded to one-hundredth, if the meter is stable enough of a pH unit.

### 7.3.4. Conductivity Measurement

A meter and a flow though cell are the preferred tools for measuring this parameter. Alternately, a conductivity probe may be used for conductivity measurement on an aliquot of purged water obtained just before sampling. Measurements shall be made as soon as possible on the obtained aliquot. The meter shall be calibrated in accordance with sampling plan or, if more stringent with the manufacturer's procedures (provided with the instrument) with standardized calibration solutions. It is preferable to have a range of calibration solutions that bracket the site conductivity range. At a minimum calibration shall be performed at the beginning and ending of each day's use and every four hours in between. The conductivity shall typically be recorded to two significant figures and rarely more than three significant figures. The temperature of the sample at the time of conductivity measurement shall also be recorded. The probe must be thoroughly rinsed with distilled/deionized water before and after each use. It is imperative that the Sampling Technician record the correct units in which the conductivity measurements were taken.

### 7.3.5. Dissolved Oxygen Measurement

A meter and a flow though cell are the preferred tools for measuring this parameter. Alternately, a dissolved oxygen meter is used to measure dissolved oxygen (DO) in water samples. This test should be at best considered a rough estimation with most meters as the measurements are subject to a number of environmental interferences that may affect the results. Measurements shall be made immediately on aliquots obtained just before sample acquisition. (Note: If possible, measure DO continuously on the purge water in a closed flow-through system.)

The meter shall be calibrated in accordance with the sampling plan or, if more stringent, with the manufacturer's procedures (provided with the instrument). Any salinity adjustment shall be made to the approximate salinity of the water (one may use knowledge of the subsurface or some conductivity meters or dedicated salinity meters to obtain the salinity of the water). The probe must be thoroughly rinsed with distilled/deionized water before and after each use. Measurements shall typically be recorded to the nearest 0.1 ppm concentration.

### 7.3.6. Turbidity Measurements

A turbidity meter shall typically be used to make turbidity measurements on aliquots of water samples obtained just before sample acquisition. Measurements shall be made as soon as possible on the obtained aliquot. Operation and calibration shall be in accordance with the sampling plan or, if more stringent, with the manufacturer's procedures (provided with the instrument). It is preferable to have a range of calibration solutions that bracket the site turbidity range. At a minimum calibration shall be performed at the beginning and ending of each day's use and every four hours in between. Calibration shall be performed with calibration solution specified for the project. Measurements shall be recorded to the nearest 0.1 NTU when less than 1 NTU; the nearest 1 NTU when between 1 and 10 NTU; and the nearest 10 NTU when between 10 and 100 NTU.

### 7.3.7. Redox Potential Measurements

A meter and a flow though cell is a preferred way to measure this parameter. Alternately, a redox meter may be used to obtain redox potential measurements. However, there are many other ways to measure redox couples. When a meter is used the reading should be obtained on an aliquot of purged water that was obtained just before sampling. Measurements shall be made immediately on the obtained aliquot. (Note: The best results using a redox meter usually come from measuring the redox on the purged water in an air-space free and closed flow-through system.) Calibration and operation shall be in accordance with the sampling plan and if more stringent with the manufacturer's procedures (provided with the instrument). It is preferable to have a range of calibration solutions that bracket the site redox potential range. At a minimum calibration shall be performed at the beginning and ending of each day's use and every four hours in between. Calibration shall be performed with calibration solution specified for the project. Typically, the probe shall be thoroughly rinsed with distilled/deionized water after each sample when using a flow through cell or after each sample reading when the probe is placed in a discrete aliquot of sample. The redox using a probe shall be recorded in millivolts to the number of significant figures required by the sampling plan - which is typically three significant figures.

## 7.4. Capture and Disposal of Purge Water and Decontamination Solutions

### 7.4.1. Purge Water

Purged groundwater shall be handled as specified in the sampling plan. Typically purge water will be captured and contained in 55-gallon steel drums or suitable vessel(s). If required, each drum or tank containing captured purge water shall be properly labeled with a weather proof label as to the contents, the well(s) from which the contained purge water originated and the date in which the contents were generated. Storage of the drums or tanks shall be as specified in the project work documents or as directed by the Project Manager. In many cases there is specific wording required for the labels and this should be found in the sampling plan.

Captured and contained purge water shall be characterized for discharge, treatment and/or disposal. Characterization of the captured and contained purge water should be specified in the sampling plan or other project work documents or by the Project Manager, but could rely on site knowledge, the analytical results of groundwater samples associated with each drum or other vessel, or could involve direct sampling and analyses of the contained water.

The requirements and options available for discharge, treatment and/or disposal are dependent upon many variables such as client requirements, chemical consistency, local and state and other regulations and location of site. Discharge, treatment and/or disposal of captured and contained purge water must be in accordance with all applicable requirements such as, but not limited to, client specific procedures. Local, state and Federal regulations and shall be specified in the sampling plan or in other project work documents.

### 7.4.2. Decontamination Waste Solutions

Decontamination waste solutions that are generated during groundwater sampling include: spent detergent wash solutions; spent tap water rinses; any spent acid or alkali rinses, any spent organic (such as isopropyl alcohol) rinses; and spent final distilled/deionized water rinses. All decontamination waste solutions shall be captured and contained in appropriately sized vessels as required by the sampling plan or other project documentation. In any cases where this is not clear, the Project Manager shall be contacted so they can determine (with input from others as needed) whether spent decontamination solutions require capture and containment.

Captured and contained decontamination waste solutions shall be subject to requirements of the sampling plan or other project documentation. These are often generally the same guidelines as described for purge water. A noteworthy typical requirement is that all acid and alkali solutions shall be neutralized prior to discharge or disposal.

## 7.5. Documentation

Documentation for sampling groundwater includes labeling sample bottles; and other requirements as specified by the sampling plan or other project documentation. These further requirements often include project field notebooks, Sample Integrity Data Sheets, Field Report Forms, and Chain of Custody Records; additional documentation requirements may warrant securing individual samples or sample coolers with chain of custody seals.

### 7.5.1. Sample Labels

Samples shall be immediately labeled (see Exhibit A for an example label). Labels shall be water proof. Information shall be recorded on each label with indelible ink. All blanks shall be filled in (N/A if not applicable). Groundwater sample designations will be as specified in the project work documents or by the Project Manager. At a minimum the following information is required upon the label: Site name, sample ID, parameter(s) to be tested, sample date and time, sampler's initials, chemical preservative, if used.

### 7.5.2. Groundwater Sample Collection Forms

Groundwater Sample Collection Forms (Exhibit B) are used by the Sampling Technician to document the official raw field information for each sample that will be chemically analyzed. All blanks shall be filled in (N/A if not applicable). The original must be submitted as soon as possible to the Project Manager. Copies must be sent to the Task Leader (if appropriate).

### 7.5.3. Chain of Custody Records

Chain-of-Custody Records (Exhibit C) will be used to record the custody and transfer of samples in accordance with guideline TG-1.2-23, "Chain of Custody." These forms shall be filled in completely (N/A if not applicable). Tamper-proof Seals (Exhibit A) shall be placed on either sample bottles or shipping coolers. The seal number shall be recorded on the Chain of Custody Form. The original form must accompany the samples to the analytical laboratory to be completed and returned to Golder in the

analytical data report. A copy of the Chain of Custody Record documenting the transfer of samples from the field must be submitted to the Project Manager.

### 7.5.4. Field Report Forms

Field Report Forms (Exhibit D) or project field notebooks shall be used by the Sampling Technician to record daily activities. Data shall be recorded on the Field Report Form in chronological format. The time of each recorded event shall be included. The original Field Report Form must be submitted as soon as possible to the Project Manager. Copies must be given to the Task Leader.

### 7.5.5. Sample Integrity Data Sheet

Sample Interity Data Sheets (Exhibit E) shall be used by the Sampling Technician to record raw field information for each sample that will be chemically analyzed. This data sheet can be used as a supplement to but not in lieu of a groundwater sample collection form. The original must be submitted as soon as possible to the Project Manager. Copies must be given to the Task Leader.

## 7.6. Field Change Request

Variation from established guideline requirements may be necessary due to unique circumstances encountered on individual projects. All variations from established guidelines shall be documented on Field Change Request (Exhibit F) and reviewed by the Project Manager.

In lieu of requirements in the sampling plan or other project documentation, the Project Manager may authorize individual staff to initiate variations as necessary. If practical, the request for variation must be reviewed by the Project Manager or their designee prior to implementation. All completed Field Change Requests will be maintained in project records.

## 8.0 REFERENCED GUIDELINES

Golder Associates Inc. Quality Procedure QP-1, "Calibration and Maintenance of Measuring and Test Equipment."

Golder Associates Inc. Technical Guideline TG-1.2-23, "Chain of Custody."

Golder Associates Inc. Technical Guideline TG-1.4-6, "Water Level Measurement."

## 9.0 ADDITIONAL GUIDELINES AND PROCEDURES

Wood, W.W. (1976), "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," Techniques of Water-Resources Investigations of the United States Geological Survey, Book 1, Collection of Water Data by Direct Measurement, Chapter D2.

U.S. EPA, 1986, Test Methods for Evaluating Solid Waste - (SW-846), 3rd Edition (Final Update III, December 1996), U.S. EPA/Office of Solid Waste, Washington, D.C.

40 CFR 136, U.S. EPA, Guidelines Establishing Test Procedures for the Analysis of Pollutants. Title 40 Part 136 of the Code of Federal Regulations.

U.S. EPA, 1986, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document, U.S. EPA/Office of Solid Waste, Washington D.C.

40 CFR 141, U.S. EPA, National Primary Drinking Water Regulations, Title 40, Part 141 of the Code of Federal Regulations.

Various EPA Region and State Standard Operating Procedures

Golder Associates Technical Guideline TG-2.3-3, “Headspace Analysis Using the Organic Vapor Analyzer”

TABLE 1

TABLE 1

SAMPLE CONTAINER CODES, TYPES, VOLUMES, PREPARATION,
SPECIAL HANDLING, PRESERVATION, HOLDING TIMES
Page 1 of 2

| Analysis | Cont. Code | Containers, Water | Handling and Preservation | Holding Time |
|---|---|---|---|---|
| Volatile Organics | V | 2, 40ml glass vial teflon lined septum | Store 4±2°C; handle upwind from euip. Fumes, no headspace permitted; Pres with HCl to pH <2 for volatile aromatics | 7 days<br>14 days (HCl pres.) |
| Base/Neutral and Acid Extractable Organics | SV | 2, 1 liter amber glass, teflon lined cap | Store 4±2°C; handle upwind from equip. fumes; no contact with plastics, gloves | 7 days until extraction<br>40 days thereafter |
| Organiochlroine Pesticides and PCBs | P | 2, 1 liter amber glass, teflon lined cap | Store 4±2°C; handle upwind from equip. fumes; no contact with plastics, gloves | 7 days until extraction<br>40 days thereafter |
| Herbicides | H | 2, 1 liter amber glass, teflon lined cap | Store 4±2°C; handle upwind from equip. fumes; no contact with plastic, gloves | 7 days until extraction<br>40 days thereafter |
| Total Fuel Hydrocarbons (Fuel Fingerprint) | TH | 1, 125 ml amber glass, teflon lined septum | Store 4±2°C; handle upwind from equip. fumes, no headspace permitted; pres with HCl to pH <2 | 14 days |
| Total Petroleum Hydrocarbons or Oil and Grease | OG | 1, 1 liter glass, teflon lined cap | Store 4±2°C; handle upwind from equip. fumes, no contact with gloves or plastics; pres with HCl to pH <2 | 28 days |
| Cyanide (total) | CN | 1,1 liter plastic | Store 4±2°C; pres with NaOH to pH >12 | 14 days |
| Suflide (total) | S | 1, 1 liter plastic | Store 4±2°C; pres with ZnOAC/NaOH to pH >12 | 7 days |
| Chloride, Sulfate, pH Conductivity and Total Dissolved Solids | MA | 1,1 liter plastic | Store 4±2°C. | 28 days (Chloride, sulfate and conductivity)<br>Analyze on-site (pH)<br>7 days (TDS) |

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TABLE 1

SAMPLE CONTAINER CODES, TYPES, VOLUMES, PREPARATION,
SPECIAL HANDLING, PRESERVATION, HOLDING TIMES,


| Analysis | Cont. Code | Containers, Water | Handling and Preservation | Holding Time |
|---|---|---|---|---|
| Major Cations and Metals (Except Mercury) | TM | 1,1 liter plastic | 0.45 um filter, pres with $HNO_3$ to pH <2 | 6 months |
| Mercury | HG | 1, 500 ml plastic | 0.45 um filter, pres with $HNO_3$ to pH <2 | 28 days |
| Gamma Emitting Radionuclides | GR | 2, 1 liter plastic | 0.45 um filter, pres with $HNO_3$ to pH <2 | 6 months (record exact date/time of sampling for calculation of half-life decay) |
| Alpha Emitting Radionuclides | AR | 2, 1 liter plastic | 0.45 um filter, pres with $HNO_3$ to pH <2 | 6 months (record exact date/time of sampling for calculation of half-life decay) |
| Beta Emitting Radionuclides | BR | 2, 1 liter plastic | 0.45 um filter, pres with $HNO_3$ to pH <2 | 6 months (record exact date/time of sampling for calculation of half-life decay) |
| Total Phosphorus, Ammonia-N, Nitrate/nitrite-N, COD and TOC | TP | 1, 1 liter plastic | Store 4±2°C; pres with $H_2SO_4$ to pH <2, store in dark | 28 days |
| Orthophosphate | OP | 1, 1 liter plastic | 0.45 um filter, store 4±2°C | 48 hours |

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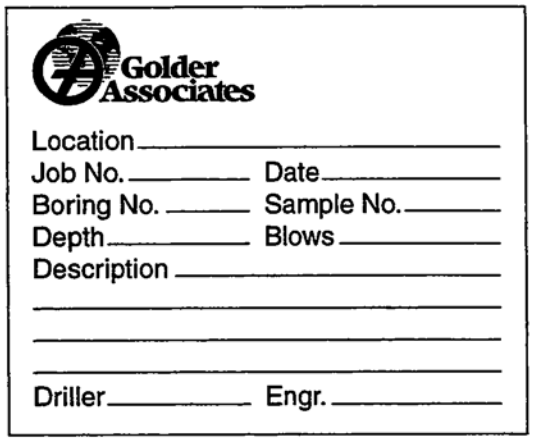
EXHIBIT A




**Sample Label**

**Tamper Proof Seal**

**SAMPLE LABELS**

EXHIBIT B

# WATER SAMPLE FIELD INFORMATION FORM

Site:

Location:

Project Number:

Sampling Team:

**Sample Point ID:** **(well)**

Purging Device: **Teflon Bailer & Nylon Rope**

Depth to water before purging (ft-bmp) Date: Time:

Sounded well depth (ft-bmp) PID reading (ppm)

As-built well depth (ft-bmp)

Casing Volume Calculation

| Casing diameter (in) | 2" | 4" | 6" | 8" |
|---|---|---|---|---|
| Casing volume (gal) | 0.163 gal/ft | 0.653 gal/ft | 1.47 gal/ft | 2.61 gal/ft |

Volume purged (gal) Time Start: Time Finish:

Depth to water after purging (ft-bmp) Purge Calc:

Remarks:

WELL INSPECTION (Circle Y or N)

| | | | |
|---|---|---|---|
| Is well location correct on map? | Y or N | Is the well locked? | Y or N |
| Is well located in a dry area? | Y or N | Is the lock in good condition? | Y or N |
| Is well readily accessible? | Y or N | Is the well vented? | Y or N |
| Is well legibly labeled? | Y or N | Does casing have weep hole? | Y or N |
| Is well protected with posts? | Y or N | Does well have dedicated bailer? | Y or N |
| Is casing free of kinks/bends? | Y or N | Does well have dedicated pump? | Y or N |
| Is protective casing secure? | Y or N | Is equip. in good condition? | Y or N |

Remarks:

| FIELD MEASUREMENTS | | | | | | | Units | Calibration Notes |
|---|---|---|---|---|---|---|---|---|
| Time | 1) | 2) | 3) | 4) | 5) | | | |
| Temp. | 1) | 2) | 3) | 4) | 5) | | **ºC** | **Calibration time:** |
| pH | 1) | 2) | 3) | 4) | 5) | | **std. units** | **Serial#:** |
| Sp. Cond | 1) | 2) | 3) | 4) | 5) | | **mS/cm** | |
| Turbidity | 1) | 2) | 3) | 4) | 5) | | **ntu** | |
| D.O. | 1) | 2) | 3) | 4) | 5) | | **mg/l** | |
| Redox | 1) | 2) | 3) | 4) | 5) | | **mV** | |
| DTW | 1) | 2) | 3) | 4) | 5) | | **ft-bmp** | |
| Volume | 1) | 2) | 3) | 4) | 5) | | **gallons** | |

Sample Collection Notes:

Weather conditions at time of sampling:

Sample characteristics:

Sample date / time: Method of sample collection: **Teflon Bailer & Nylon Rope**

Analytical Parameters:

Signature: Company: **Golder Associates Inc.** Date:

NJ Certification #03027

# LOW FLOW GROUNDWATER PURGE/SAMPLE FIELD INFORMATION FORM

Site _____

Location: _____

Project Number: _____ Meter/Type/Serial #: _____

**MONITORING WELL ID:** _____ Meter Calibrated @: _____

Depth to Water Prior to Purging [ft-bmp]: _____ Sampling Date/Time: _____

Well Casing Diameter [in]: _____ Sampler(s): _____

Start Time (purging): _____ Sampling Device: _____

Purging Device: _____ Sampling Purge Rate: _____

Pump intake setting: _____ Sample Characteristics: _____

Well Screen Interval: _____ PID Measurement of Well Headspace (ppm): _____

As-Built Construction Well Depth [ft-bmp]: _____ Analytical Parameters: _____

Sounded Well Depth [ft-bmp]: _____ _____

Weather Conditions:_____ Fe+2 result (field measurement):_____PPM

| **Time** [hh:mm] | **Temperature** [°C] | **pH** [std] | **Specific Conductance** **Circle One** [S/m] or [mS/cm] | **Turbidity** [ntu] | **Dissolved Oxygen** [mg/l] | **Redox Potential** **Note - Indicate if (+) or (-)** [mV] | **Depth To Water** [ft-bmp] | **Volume Purged** [liters] | **Approximate Purge Rate** [ml/min] | **Observations** (PID readings, sample characteristics, equipment problems, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|
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**Comments:**

Signature:

EXHIBIT C

# CHAIN OF CUSTODY RECORD

| PROJ. NO. | SITE / LOCATION |
|---|---|
| SAMPLERS: *(Signature)* | |

| STA. NO. | DATE | TIME | SAMPLE TYPE | MEDIA | SAMPLE IDENTIFICATION | NO. OF CONTAINERS | AMOUNT / PRESERVATIVE | | | | | | SEAL NO. | SEAL INTACT? (Y or N) | REMARKS (with initials) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| Relinquished by: *(Signature/Firm)* | Date / Time | Received by: *(Signature/Firm)* | Date / Time | Remarks (attachments if necessary) | |
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EXHIBIT D

**GOLDER ASSOCIATES**

| | |
|---|---|
| DATE | JOB NO |
| PROJECT | |
| LOCATION | |
| CONTRACTOR | OWNER |
| WEATHER | TEMP °at AM<br>°at PM |
| PRESENT AT SITE | |
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TO _____

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THE FOLLOWING WAS NOTED.

COPIES TO _____

_____

# FIELD REPORT

SIGNED _____

EXHIBIT E

## SAMPLE INTEGRITY DATA SHEET

Plant/Site _____ Project No. _____

Site Location _____ Sample ID _____

Sampling Location _____

_____

Technical Procedure Reference(s) _____

Type of Sampler _____

Date _____ Time _____

Media _____ Station _____

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

_____

_____

_____

Sample Description _____

_____

_____

Field Measurements on Sample (pH, conductivity, etc.) _____

_____

_____

_____

| Aliquot Amount | Container | Preservation/Amount |
|---|---|---|
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Sampler (signature) _____ Date _____

Supervisor (signature) _____ Date _____

Golder Associates Inc.

EXHIBIT F

## FIELD CHANGE REQUEST

Golder Associates

Job/Task Number: _____

Procedure Reference: _____

Other Affected Documents: _____

Requested Change: _____

Reason for Change: _____

Change Requested by: _____ Date _____

Reviewed by: _____ Date _____
Project Manager

Comments: _____

# APPENDIX E-5

# TECHNICAL PROCEDURE FOR SAMPLING SURFACE SOIL FOR CHEMICAL ANALYSIS

Golder Associates

# Technical Procedure

Number: TP-1.2-18
Title: SAMPLING SURFACE SOIL FOR CHEMICAL ANALYSIS

| Prepared by | Approved by | Approved by | Effective Date | Rev. Level |
|---|---|---|---|---|
| 9/4/96 | 9/4/96 | 9-4-96 | 9-12-96 | -5- |
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## 1. PURPOSE

This technical procedure establishes uniform methods for sampling surface soils for chemical analysis.

## 2. APPLICABILITY

This Technical Procedure shall be used by all Golder Associates Inc. (Golder) personnel sampling surface soils for chemical analysis.

## 3. DEFINITIONS

### 3.1 Surface Soil

Surface soil is defined as consolidated soil on the land surface or as exposed by an excavation or boring within twenty (20) feet of the land surface.

### 3.2 Sampling Interval

The sampling interval is defined as the stratigraphic depth represented by the soil sample.

### 3.3 In Situ Soils

The term in-situ soils refers to soils as they occur in place within the soil column.

## 4. REFERENCES

Golder Associates Technical Procedure TP-1.2-23, "Chain of Custody."

Golder Associates Technical Procedure TP-1.1-2, "Geodetic Surveys."

## 5. DISCUSSION

None

## 6. RESPONSIBILITIES

### 6.1 Sampling Technician

The Sampling Technician is responsible for completing the sampling assignment in accordance with this Technical Procedure and governing project plans or instructions.

### 6.2 Task Leader

The Task Leader is responsible, within the guidelines of governing plans or instructions, for determining which soils shall be sampled and for monitoring the sampling process to ensure that procedures and documentation are in accordance with this document.

### 6.3 Project Manager

The Project Manager or a qualified designee is responsible for determining the type of chemical analyses to be performed on soil samples, and for defining such requirements to project staff through appropriate plans or instructions.

## 7. EQUIPMENT AND MATERIALS

- Brunton compass, 0° to 360° divisions;
- site map and clipboard;
- bound field logbook or field report forms (Exhibit A);
- assorted standard field equipment (e.g., hammers, post-hole digger, shovel, hand auger) for exposing soils to be sampled;
- measuring tape;
- engineer's rule (six feet long, with 0.10 foot graduations);
- indelible ink pens;
- two-inch wood stakes and colored flagging material;
- if required, sampling equipment appropriate for soils to be analyzed for non-volatile constituents; all such equipment shall be metal (steel, stainless steel or aluminum) and may include hand augers, hand scoops, sampling thiefs, sampling dredges, core samplers, or sampling triers. If volatile constituents are to be analyzed in the soil samples, sampling equipment shall be designed to minimize exposure to the atmosphere. As an example, a metal drive tube appropriate for the size of the soil particles and slightly smaller in diameter than the wide-mouth glass sample bottles may be used, with appropriate sample extraction accessories;
- sample bottles, sized appropriately for the desired sample and soil particle size;
- Chain of Custody records, seals, and sample labels as required by procedure TP-1.2-23, "Chain of Custody";
- appropriate decontamination solutions such as organic free distilled/deionized water, non-phosphate detergent, tap water;
- decontamination equipment such as brushes and sprayers, and drums or applicable plan or containers for capturing decontamination waste solution; and

- thermometer controlled in accordance with Golder's quality procedure for calibration of measuring and test equipment.

## 8. PROCEDURE

### 8.1 Sample Location

Location mapping shall be to the level of detail required by the applicable plan or instructions, and sound engineering and geologic practice. If the base map for the sampling site is of sufficient accuracy, the sample location may be approximated within a 10' radius and physically identified by a wood stake marker. If the base map does not have the required accuracy, locations shall be described by either (1) tape measurement from three permanent features identifiable on the base map; (2) measured along a compass bearing from a permanent feature; or (3) triangulated with compass bearings from three permanent features identifiable on the base map. Compasses may be used only when the site does not contain magnetic or large metal objects. The locations so derived will be identified by a wood stake marker with test pit designation, and recorded as described in Section 8.2. When required by project directive, all location markers will be geodetically surveyed in accordance with TP-1.1-2, "Geodetic Surveys."

### 8.2 Documentation

Final sample location, sample types and numbers, and relevant sampling events (including on-site personnel and all visitors) shall be recorded on Field Report forms (Exhibit A) or bound field logbooks. Events shall be recorded chronologically, with the time of each event noted.

### 8.3 Decontamination

All sampling equipment shall be decontaminated prior to the start of sampling activities and between each use. Unless other decontamination procedures are specified in the project plans or instructions, the following steps will be followed. The sampling equipment shall be washed with non-phosphate detergent solution. Brushes shall be used to aid in removing all visible soil or grit. A tap water rinse shall be used to thoroughly remove all detergent solution. The final rinse shall be with organic free distilled/deionized water. All waste wash solutions shall be captured and disposed of in the manner defined by the applicable project plan or instruction, in compliance with applicable regulatory requirements.

### 8.4 Sampling

The soils to be sampled shall be exposed prior to sample acquisition. If the upper six inches of soils are to be sampled, then surface vegetation shall be removed. If samples are to represent discrete depth intervals below land surface, then overlying soils shall be removed by a shovel, post-hole digger, hand auger, or other appropriate method to the desired interval. For loose watery sediments from stream bottoms, a pond sampler, sampling dredge, pail, or ladle can be used. The sediment sample should be allowed to settle and the extra water decanted prior to transferring samples to containers. For cohesive wet or dry stream-bottom samples, a vertical-pipe, sampling dredge, or core sampler can be used and driven into the stream bed to the

selected depth. An in-situ soil sample shall be obtained from the desired sampling interval. If the required analyses do not include volatile constituents, an in-situ soil sample can be obtained using a hand scoop, hand auger, sampling thief, or sampling trier. The soils shall be visually inspected and immediately put into the appropriate sample bottle as required by the governing project plan or instruction. No preservatives shall be added to the sample.

If soils are to be analyzed for volatile constituents, the sample shall be obtained from the desired interval using a drive tube sampler. Contact between the atmosphere and the sample must be minimized; the drive tube sampler shall be driven into the materials with a hammer, and the sample extruded directly into the appropriate sample bottle. An air-tight cap shall be immediately placed on the sample bottle; no preservatives shall be added.

If a backhoe is used to expose sampling intervals for analysis of volatile constituents, a hand auger or drive tube may be used to sample the test pit walls or floor when the test pit is less than four (4) feet deep. If the test pit is greater than four (4) feet, a relatively undisturbed sample may be obtained from the backhoe bucket using a drive tube sampler.

### 8.5 Composite Samples

If soil sample composites are to be established, equal volumes of individual samples shall be added together for the composite sample. At least three small, equal sized samples from several points within a five foot radius shall be collected. Samples will be placed into a clean, decontaminated stainless steel container and each portion will be stirred together into one composite. The composite sample shall be given an individual sample number, and the sample number of each contributing sample recorded in the field logbook or Field Report form.

### 8.6 Sample Labeling, Handling, and Shipment

Samples shall be immediately labeled, sealed with a tamper-proof seal and relevant data recorded on individual Chain of Custody forms as required by TP-1.2-23, "Chain of Custody." Samples shall be placed in a chilled cooler at approximately 4° C, $\pm$ 2°C, as soon as possible. A thermometer shall be placed in the cooler for temperature monitoring purposes. The cooler shall remain in sight of the Sampling Technician at all times, or be kept in locked storage, as required by TP-1.2-23.

Samples shall be forwarded to the analytical laboratory accompanied by the Chain of Custody record, in compliance with TP-1.2-23 requirements. When samples are ready for shipment, the Task Leader shall release the sample to the carrier, who shall also sign the custody form. The Chain of Custody form is in triplicate. One copy of the form shall be retained by the Task Leader; the original form and the remaining copy shall be shipped with the sample. Upon receipt at the laboratory, the laboratory custodian shall verify the integrity and identification of the sample, sign the form, and return the original copy to the Task Leader or Project Manager. All originals shall be retained in the project records.

### 8.7 Site Restoration

Any excavation or hole made to obtain samples shall be backfilled with the excess material removed from the hole, unless other requirements are invoked by governing plans or instructions.

### 8.8 Field Change Request

Variation from established procedure requirements may be necessary due to unique circumstances encountered on individual projects. All variations from established procedures shall be documented on a Field Change Request form (Exhibit B) and reviewed by the Project Manager and the QA Manager.

The Project Manager may authorize individual Field Engineers to initiate variations as necessary. If practical, the request for variation shall be reviewed by the Project Manager and the QA Manager prior to implementation. If prior review is not possible, the variation may be implemented immediately at the direction of the Field Engineer, provided that the Project Manager is notified of the variation within 24 hours of implementation, and the Field Change Request is forwarded to the Project Manager and QA Manager for review within 2 working days of implementation. If the variation is unacceptable to either reviewer, the activity shall be reperformed or action shall be taken as indicated in the Comments section of the Field Change Request form.

All completed Field Change Request forms shall be maintained in the project records.

GOLDER ASSOCIATES
4104 148th Avenue NE
Redmond, Washington 98052

(206) 883-0777

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|---|---|
| DATE | JOB NO |
| PROJECT | |
| LOCATION | |
| CONTRACTOR | OWNER |
| WEATHER | TEMP °at AM<br>°at PM |
| PRESENT AT SITE | |
| | |
| | |

TO _____

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THE FOLLOWING WAS NOTED:

COPIES TO _____

_____

# FIELD REPORT

SIGNED _____

EXHIBIT **A**
**FIELD REPORT**
TP 1.2-18

PROJECT NO. IP3 1024 DRAWING NO. 48020 DATE 1/18/94 DRAWN BY TK

Golder Associates

# FIELD CHANGE REQUEST

Golder Associates

Job/Task Number: _____

Other Affected Documents: _____

Requested Change: _____

Reason for Change: _____

Change Requested by: _____ Date _____

Reviewed by: _____ Date _____
GAI Project Manager

Comments: _____

Reviewed by: _____ Date _____
GAI QA Manager

Comments: _____

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.


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|---|---|
| Africa | + 27 11 254 4800 |
| Asia | + 852 2562 3658 |
| Australasia | + 61 3 8862 3500 |
| Europe | + 356 21 42 30 20 |
| North America | + 1 800 275 3281 |
| South America | + 55 21 3095 9500 |

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Golder Associates

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