



Proposed BMPs

**WWE**

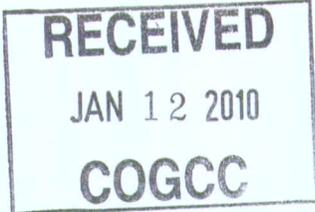
**Wright Water Engineers, Inc.**

2:2094062

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November 6, 2009



**Via E-mail: [william.f.dennison@exxonmobil.com](mailto:william.f.dennison@exxonmobil.com) and U.S. Mail**

Mr. Frank Dennison  
ExxonMobil Production Company  
396 West Greens Road, Rm. 613B  
Houston, TX 77067

Re: Well Pad FRU 197-21A—Hydrology Evaluation and Conceptual Drainage Design

Dear Frank:

Wright Water Engineers, Inc. (WWE) has been asked by Exxon Mobil Corporation to evaluate the sizing requirements and conceptual design for a drainage diversion channel at well pad FRU 197-21A. The FRU 197-21A well pad site is located in Rio Blanco County along an unnamed tributary to Piceance Creek. The pad site is located on the western edge of the Piceance Creek valley bottom and is approximately 13,000 feet north of where Ryan Gulch (and County Road 24) intersect Piceance Creek. The access road to the well pad site, which is approximately 12,200 feet long and is located north and west of the well pad, was also evaluated in terms of locations and sizes of culverts.

The drainage features were evaluated and sized to convey flows up to the 25-year, 24-hour storm event. In addition, the estimated peak flow rates for the 10-year, 24-hour and 100-year, 24-hour storm events were also calculated for comparison purposes regarding the range of runoff rates for storms of varying magnitude.

As part of the review, it was confirmed that the proposed well pad location is not located in the regulatory floodplain as designated on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM).

**ESTIMATED PEAK FLOW RATES**

Peak flow rates for the design storm events were calculated using the HEC-HMS model for six basins that drain to the FRU 197-21A site. The drainage basins are shown on Figure 1. Model input parameters included a Soil Conservation Service (SCS) Curve Number of 70 and an SCS Type II storm.

Storm depth values used in the model were derived from the National Oceanic and Atmospheric Agency Atlas 2, Volume III. For the 10-year, 25-year, and 100-year 24-hour storms, the storm depths are 1.8 inches, 2.1 inches, and 2.6 inches, respectively.

Because of the potential for debris flow for storms of the magnitude being evaluated, a 35 percent bulking factor was added to the model-estimated clear water flow rates. Table 1 provides a summary of the estimated peak flow rates (including bulking factor) for each of the basins and for each of the three storm events evaluated. The values in Table 1 are not routed flow rates; the values are provided to indicate the magnitude of runoff generated from each of the basins. However, for the purpose of sizing drainage features, routed flow rates at specific design points are provided in Table 2.

**Table 1. Estimated Peak Flow Rates Generated by Basin**

Drainage Basin	Basin Area (acres)	Peak Flow Rate (cfs) <sup>(1)</sup>		
		10-Year, 24-Hr	25-Year, 24-Hr	100-Year, 24-Hr
A	310	20	36	72
B	195	13	23	47
C	382	21	38	74
D	55	6	12	26
E	68	7	14	29
F	87	8	15	32

Note: (1) Peak flow rate includes 35 percent bulking factor to account for debris flow.

**Table 2. Estimated Peak Flow Rates Routed Through Design Points**

Design Point	Contributing Basins (Location)	Routed Peak Flow Rate (cfs) <sup>(1)</sup>		
		10-Year, 24-Hr	25-Year, 24-Hr	100-Year, 24-Hr
1	Basin A (Culvert)	20	36	72
2	Basins B+C (Culvert)	33	59	117
3	Basin E (Culvert)	8	15	32
4	Basins A+B+C+D+E+F (Diversion channel west of well pad)	62	110	219

Note: (1) Peak flow rate includes 35 percent bulking factor to account for debris flow.

## **SIZING OF CONVEYANCE STRUCTURES**

Using the estimated routed flow rates presented in Table 2, sizing requirements were evaluated for the following drainage features:

### Design Point 1

- Culvert under access road at Design Point 1 – The design flow rate at design point 1 (comprised of runoff from Basin A only) is approximately 36 cfs. Two 24-inch diameter culverts, with a slope of 2.0 percent, will convey the design flow rate.
- Roadside ditch 1 (downgradient from Design Point 1) – The roadside ditch on the north side of the proposed access road and immediately downgradient from design point 1 can convey the design flow with a triangular cross-section, a minimum depth of 2.5 feet, side slopes of 3:1 (H:V), and a longitudinal slope of approximately 4 percent.

### Design Point 2

- Culvert under access road at Design Point 2 – The design flow rate at design point 2 (comprised of routed flows from Basins B and C combined) is approximately 59 cfs. Two 30-inch diameter culverts, with a slope of 2.0 percent, will convey the design flow rate.

### Design Point 3

- Culvert under access road at Design Point 3 – The design flow rate at design point 2 (comprised of runoff from Basin F) is approximately 15 cfs. One 24-inch diameter culvert, with a slope of 2.0 percent, will convey the design flow rate.
- Roadside ditch 2 (uphill from Design Point 3) – The roadside ditch on the north side of the proposed access road, uphill from from design point 3 can convey the design flow with a triangular cross-section, a minimum depth of 2.5 feet, side slopes of 4:1 (H:V), and a longitudinal slope that varies with the road, with a minimum slope of approximately 0.4 percent.

### Design Point 4

- Diversion channel downgradient from Design Point 4 – The design flow rate at design point 4 (comprised of routed flows from Basins A, B, C, D, E and F combined) is approximately 111 cfs. The design flow will be intercepted in a diversion ditch to route flows around the west side of the well pad. The diversion ditch is divided into four contiguous reaches, as shown on Figure 3 and described below:

- Diversion channel 1 is a 220 foot-long trapezoidal channel, with a bottom width of 6 feet, channel sideslopes of 4:1 (H:V), and a depth of 2.7 feet that intercepts flow in the valley bottom and routes it to the west side of the well pad. This configuration provides approximately 1 foot of freeboard during the 25-year, 24-hour design storm. Because of the channel's slope (1.6 percent), the flow velocity will require the use of channel armoring. Gabion mattresses (6-inches thick) will be used to protect the channel. The downstream end of this reach will have a gabion rundown section that is approximately 35 feet long with a 7 percent slope and a gabion energy dissipation feature in the channel.
- Diversion channel 2 is a 120 foot-long trapezoidal channel, with a bottom width of 6 feet, channel sideslopes of 4:1 (H:V), and a depth that varies from 3 feet to over 5 feet, depending on the adjacent topography. This configuration provides more than 1 foot of freeboard during the 25-year, 24-hour design storm for most of this reach (a minimum of 0.8 feet of freeboard is provided in the shallowest section of the channel). This reach of channel will be graded to maintain a longitudinal slope of 0.6 percent, thereby reducing flow velocities and eliminating the need for rock armoring. Erosion control blankets will be installed in the channel in accordance with the manufacturer's recommendations.
- Diversion channel 3 is a 250 foot-long rectangular channel, with a bottom width of 6 feet, vertical sideslopes, and depth that of 3 feet. This configuration provides 1 foot of freeboard during the 25-year, 24-hour design storm. The longitudinal slope of the channel is approximately 4 percent in this reach, resulting in flow velocities that require channel armoring. Gabion mattresses (6-inches thick) will be used to protect the channel bottom and gabion baskets (with a cross section 3 feet tall x 3 feet wide) will be used for the channel walls. In addition to providing erosion protection, the vertical channel walls reduce the top width of the channel, which is necessary because of the steep hillside that rises to the west in this area.
- Diversion channel 4 is a 155 foot-long trapezoidal channel, with the same channel geometry as diversion channel 2, except the depth ranges from 3 feet at the upgradient (northern) end and tapers down to 0 feet at the downgradient end, south of the southwest corner of the well pad. This reach of channel will be graded to maintain a slope of 0.6 percent, thereby reducing flow velocities and eliminating the need for rock armoring. Erosion control blankets will be installed in accordance with the manufacturer's recommendations. An anchored gabion energy dissipation structure will disperse the flow at the downgradient end of the channel, uphill from the Colorado Department of Wildlife boundary line.

#### Other Features

- Roadside ditch 3 is a 1.5 foot-deep ditch with triangular cross-section located along the road north of the well pad to divert runoff from the easternmost portion of Basin F.

## OTHER CONSIDERATIONS

### 100-Year Storm Event

The capacity of the diversion channel on the west side of the well pad was compared with the estimated peak flow rates for the 100-year, 24-hour event. Because of the freeboard provided for the 25-year, 24-hour design storm, the diversion channel provides sufficient capacity to convey the estimated 100-year, 24-hour peak clear water flow (162 cfs). However, the channel is not sized to convey the entire 100-year, 24-hour flow if a 35 percent bulking factor is added (219 cfs).

### Excavation Spoil Material

The spoil material from the channel excavation, which is to be deposited on the downhill side of the channel, is not to be relied upon as part of the channel embankment and is therefore not counted as part of the calculated channel depth shown on the grading plan (Figure 3). The spoil material should be compacted in place by the construction vehicles at the site to reduce the amount of erosion. If track equipment is used, the track cleat marks should be perpendicular to the runoff flow direction.

Please do not hesitate to call if you have any questions.

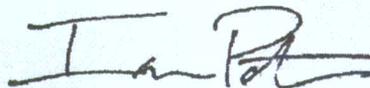
Sincerely,

WRIGHT WATER ENGINEERS, INC.



By \_\_\_\_\_

Diana K. Woods  
Water Resources Project Designer



By \_\_\_\_\_

Ian Paton, P.E.  
Senior Engineer

Attachments: Figures 1, 2 and 3



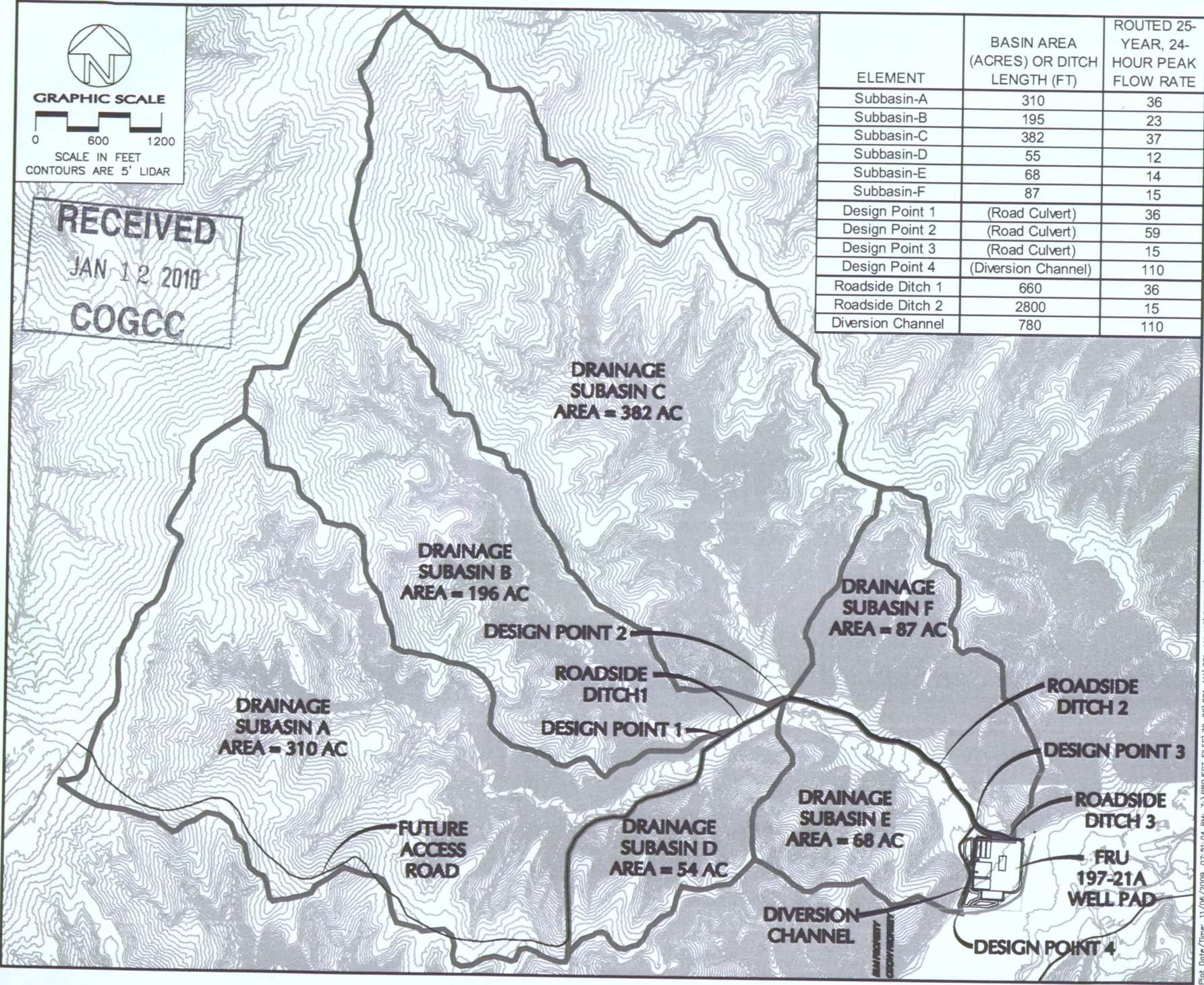
GRAPHIC SCALE



SCALE IN FEET  
CONTOURS ARE 5' LIDAR

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ELEMENT	BASIN AREA (ACRES) OR DITCH LENGTH (FT)	ROUTED 25-YEAR, 24-HOUR PEAK FLOW RATE
Subbasin-A	310	36
Subbasin-B	195	23
Subbasin-C	382	37
Subbasin-D	55	12
Subbasin-E	68	14
Subbasin-F	87	15
Design Point 1	(Road Culvert)	36
Design Point 2	(Road Culvert)	59
Design Point 3	(Road Culvert)	15
Design Point 4	(Diversion Channel)	110
Roadside Ditch 1	660	36
Roadside Ditch 2	2800	15
Diversion Channel	780	110



FIGURE

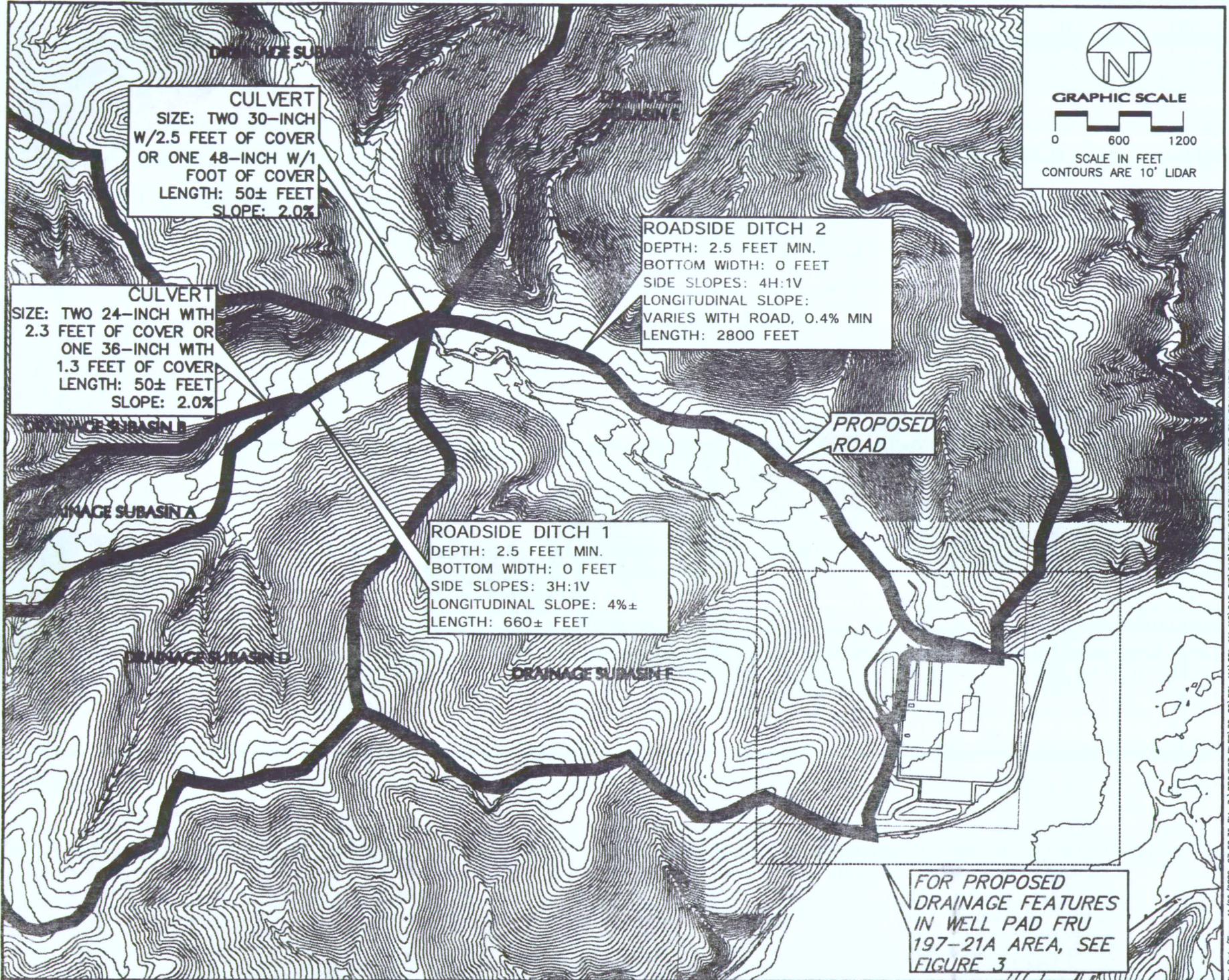
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REVISION:  
1 DKW 11/06/09

EXXONMOBIL PICEANCE  
SECTION 21, TOWNSHIP 1S, RANGE 97W  
FRU 197-21A  
DRAINAGE BASINS

**WWE**  
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Plot Date/Time: 11/26/2009, 07:51:04 PM, Z:\PROJECT FILES\72-99\801-111\801-111.412\CAD-05\CAD\TASK 006\DRAWING\FRU197-21A\_DRAINAGE.DWG - FIG1

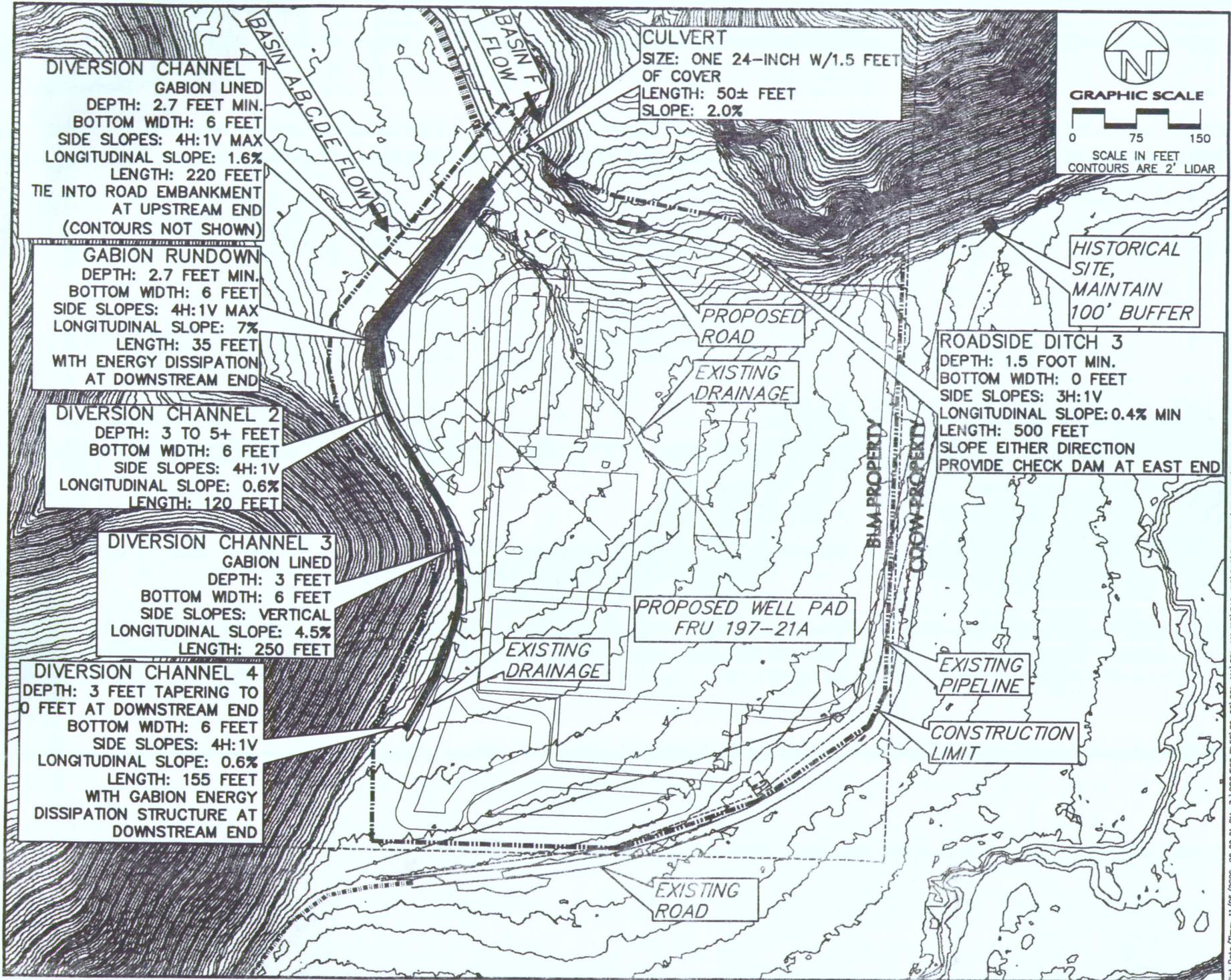


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**EXXONMOBIL PICEANCE**  
 SECTION 21, TOWNSHIP 1S, RANGE 97W  
**FRU 197-21A**  
**PROPOSED DRAINAGE FEATURES**

REVISION:	FIGURE
1 DKW 11/06/09	2



FIGURE

3

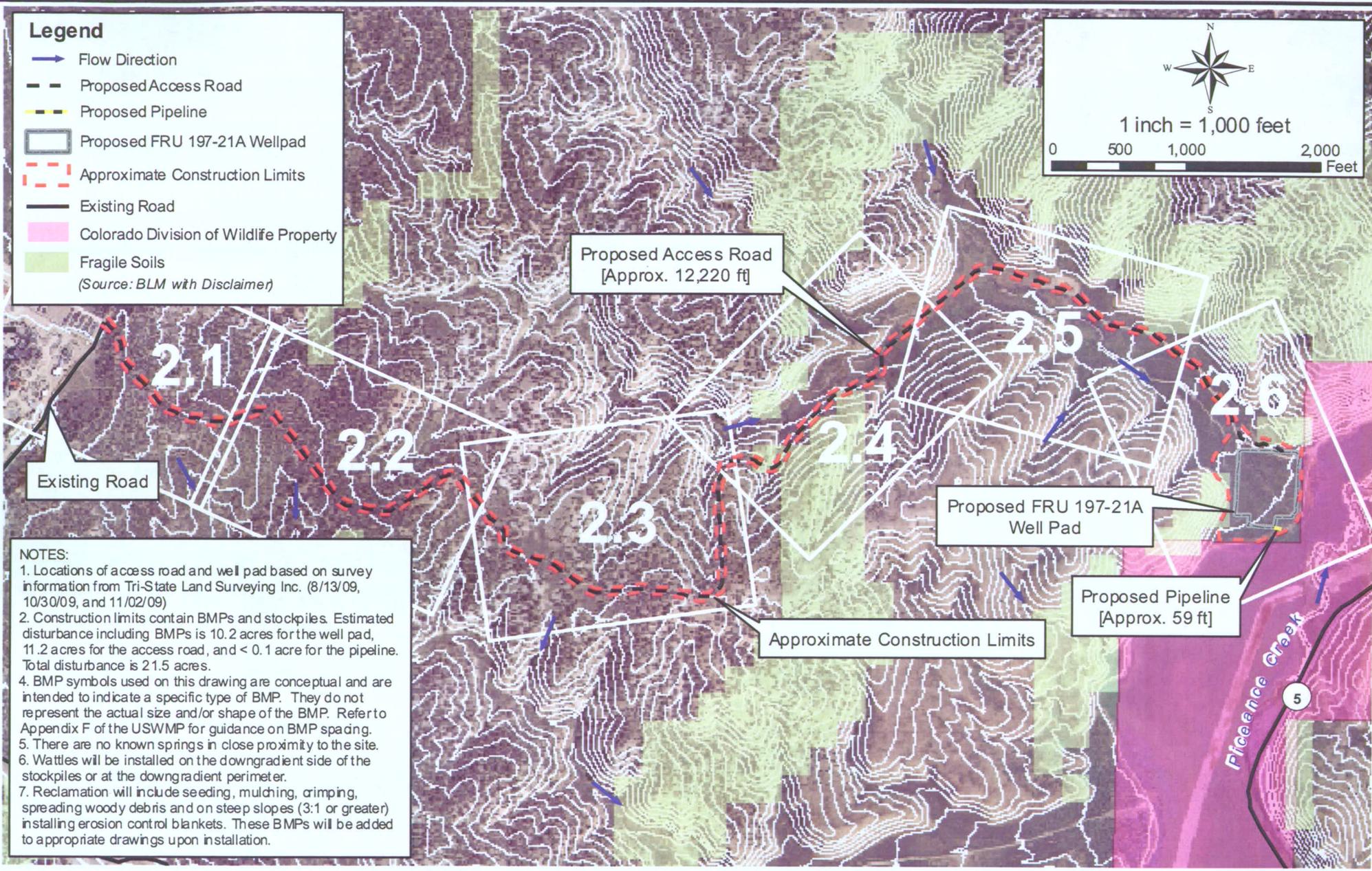
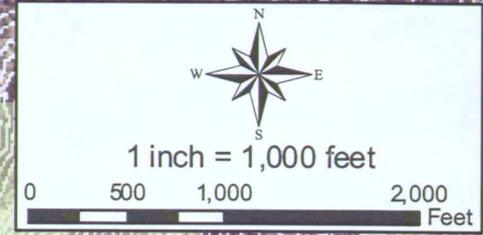
REVISION:

1	DKW 09/16/09
2	DKW 11/06/09

EXXONMOBIL PICEANCE  
 SECTION 21, TOWNSHIP 1S, RANGE 97W  
**FRU 197-21A**  
 PROPOSED DRAINAGE FEATURES AT WELLPAD

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- Legend**
- Flow Direction
  - - - Proposed Access Road
  - - - Proposed Pipeline
  - Proposed FRU 197-21A Wellpad
  - - - Approximate Construction Limits
  - Existing Road
  - Colorado Division of Wildlife Property
  - Fragile Soils  
*(Source: BLM with Disclaimer)*



**NOTES:**

1. Locations of access road and well pad based on survey information from Tri-State Land Surveying Inc. (8/13/09, 10/30/09, and 11/02/09)
2. Construction limits contain BMPs and stockpiles. Estimated disturbance including BMPs is 10.2 acres for the well pad, 11.2 acres for the access road, and < 0.1 acre for the pipeline. Total disturbance is 21.5 acres.
4. BMP symbols used on this drawing are conceptual and are intended to indicate a specific type of BMP. They do not represent the actual size and/or shape of the BMP. Refer to Appendix F of the USWMP for guidance on BMP spacing.
5. There are no known springs in close proximity to the site.
6. Wattles will be installed on the downgradient side of the stockpiles or at the downgradient perimeter.
7. Reclamation will include seeding, mulching, crimping, spreading woody debris and on steep slopes (3:1 or greater) installing erosion control blankets. These BMPs will be added to appropriate drawings upon installation.

10/20/09 GIS: Z:\Project Files\72-99\801-111\801-111.412\CAD-CIS\GIS\Task\_006\Figure 2.mxd

Photo Source: Lidar 2007

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**FREEDOM UNIT 197-21A**  
 APPROXIMATE CONSTRUCTION LIMIT,  
 SOIL DISTURBANCE, AND BMP INDEX MAP  
 SECTIONS 16, 17, 20 & 21, TOWNSHIP 1S, RANGE 97W

PROJECT NO.  
 801-111.412  
 TASK 6

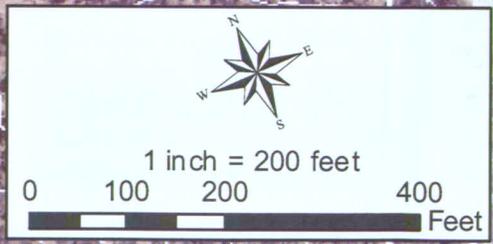
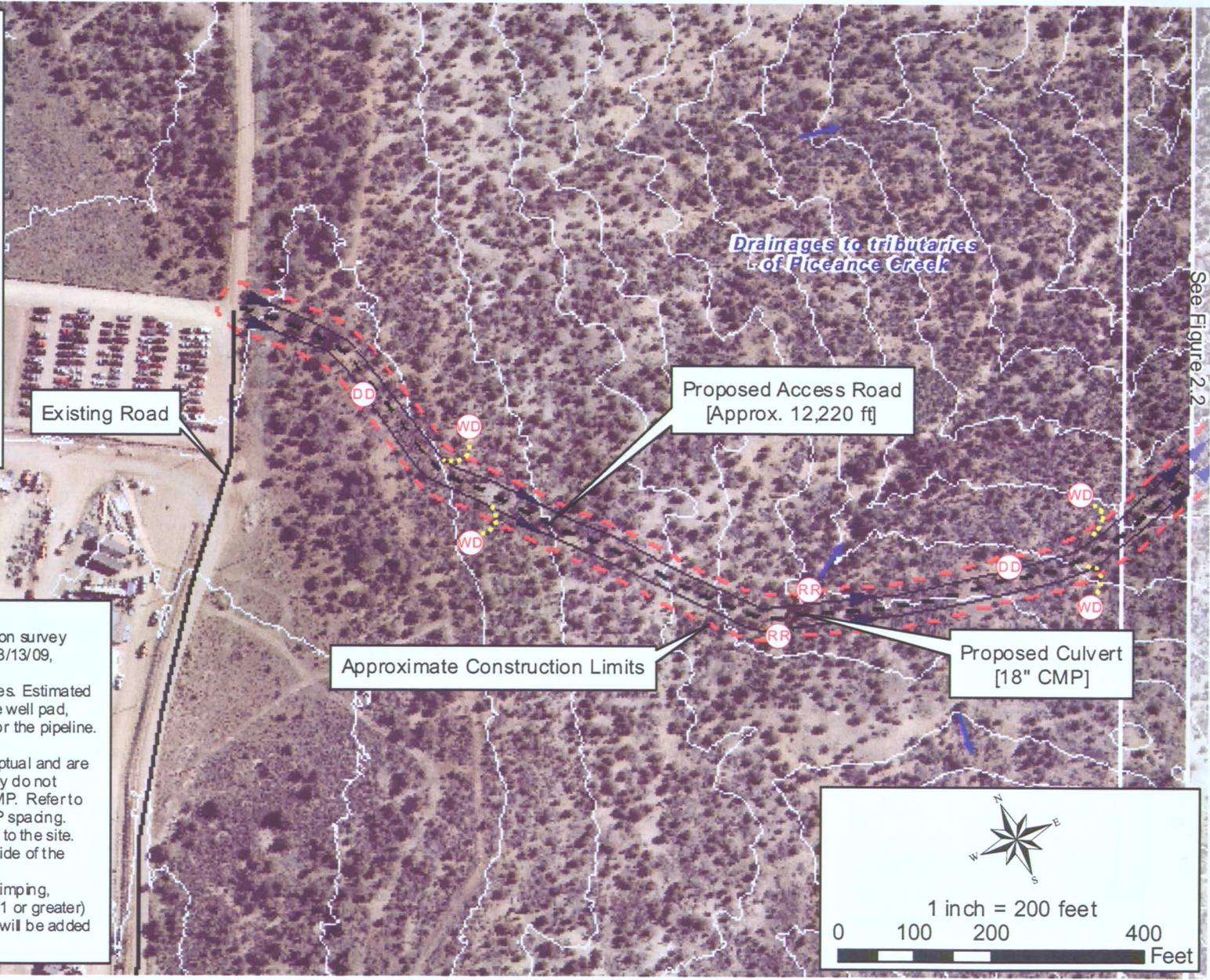
FIGURE  
 2.0

**Legend**

-  Flow Direction
  -  Energy Dissipater
  -  Wing Ditch
  -  Drainage Ditch
  -  Wattle
  -  Proposed Culvert
  -  Rip Rap
  -  Proposed Pipeline
  -  Proposed Access Road
  -  Proposed FRU 197-21A Wellpad
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  -  Existing Road
  -  Colorado Division of Wildlife Property
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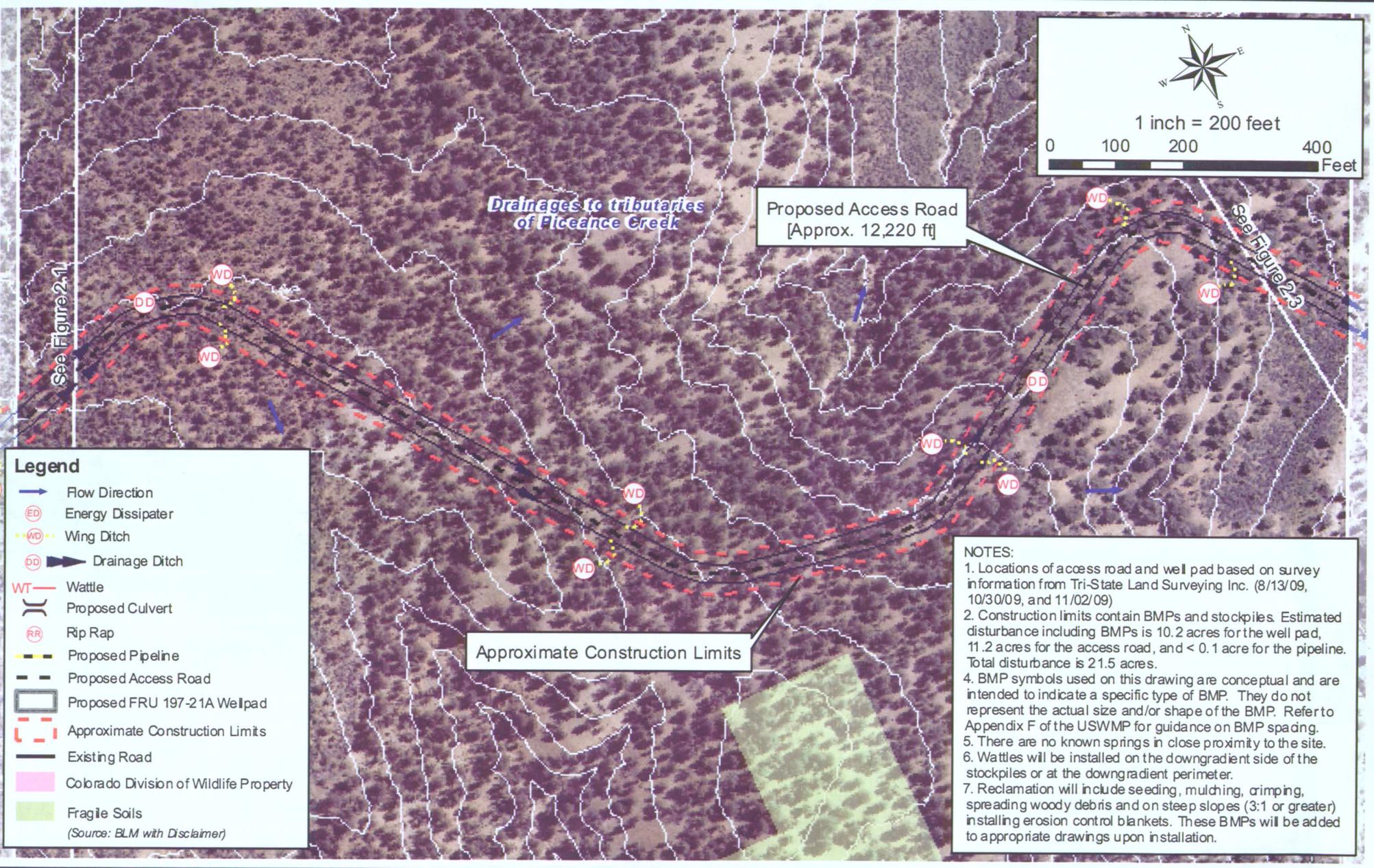
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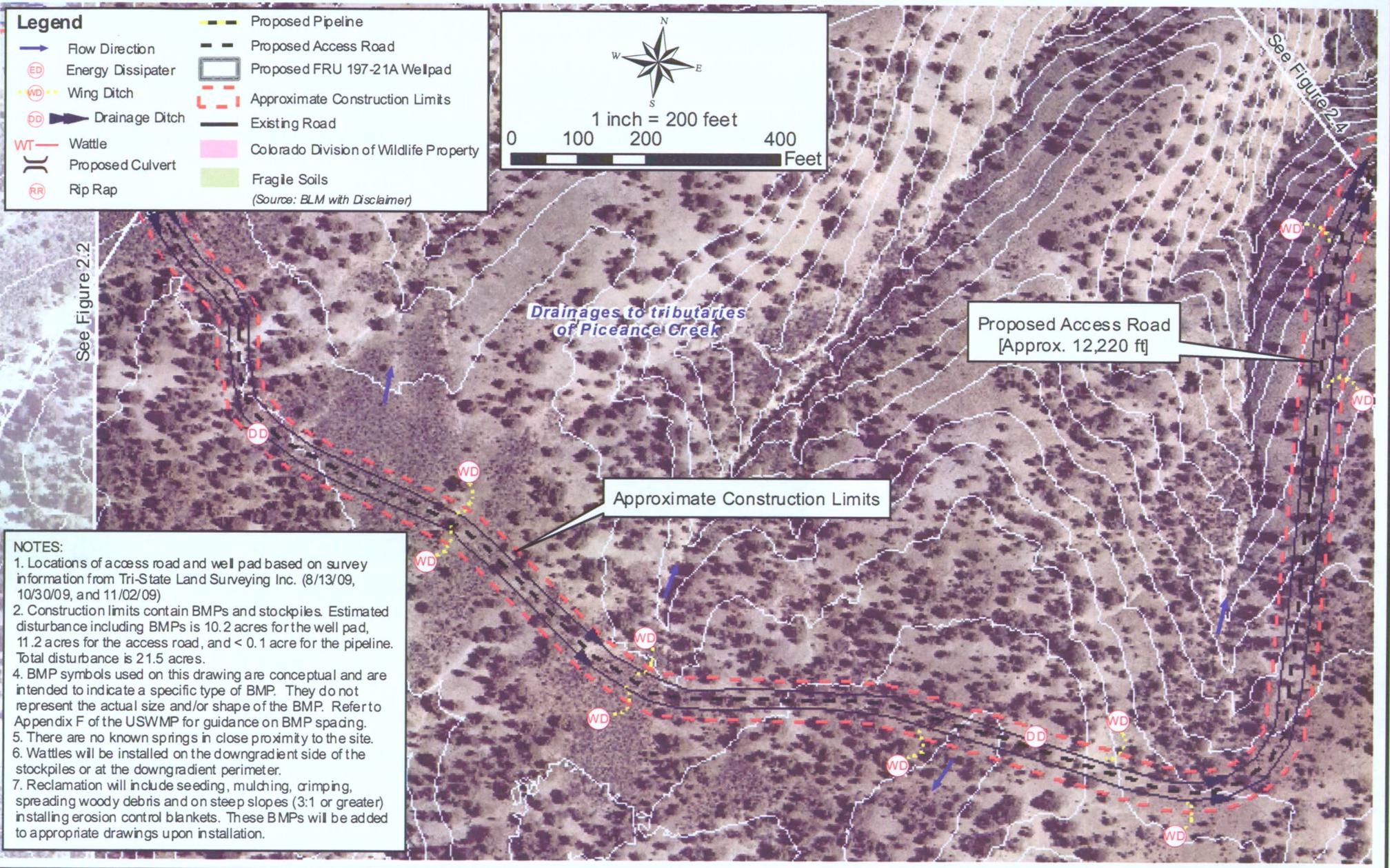


See Figure 2.2

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	<p>0/20/09 GIS; Z:\Project Files\72-99\801-111\801-111.412\CAD-GIS\GIS\Task 006\Figure 2.1.mxd</p>			



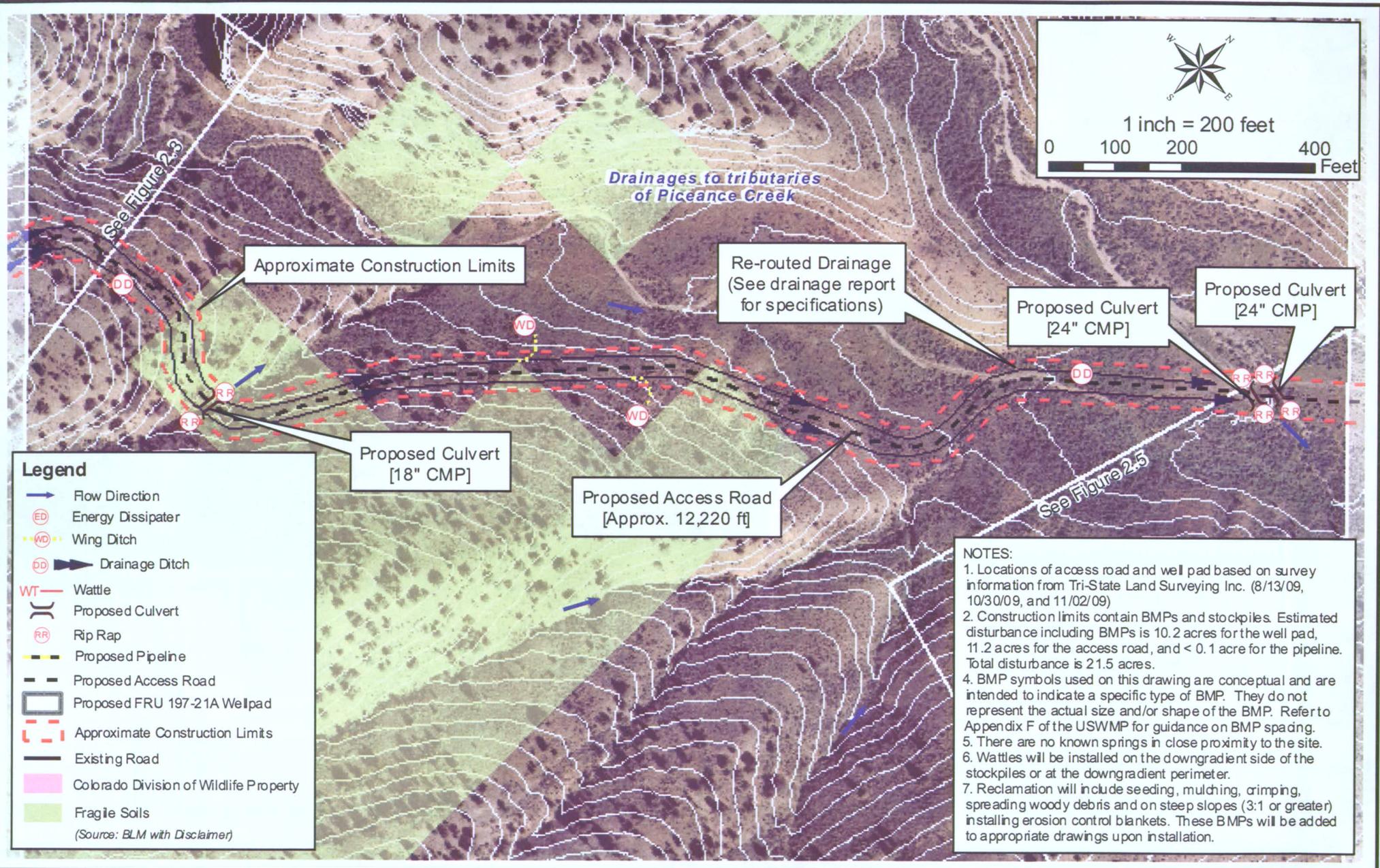
 <b>WRIGHT WATER ENGINEERS, INC.</b> 2490 W 26TH AVE 100A DENVER, CO. 80211 (303) 480-1700	<div style="border: 2px solid black; padding: 5px;"> <p><b>RECEIVED</b></p> <p>JAN 12 2010</p> <p><b>COGCC</b></p> </div>	<p>RIO BLANCO COUNTY, COLORADO</p> <p><b>EXXON MOBIL CORPORATION</b></p> <p><b>FREEDOM UNIT 197-21A</b></p> <p><b>APPROXIMATE CONSTRUCTION LIMIT,</b></p> <p><b>SOIL DISTURBANCE, AND BMP MAP</b></p> <p>SECTIONS 16, 17, 20 &amp; 21, TOWNSHIP 1S, RANGE 97W</p>	<p>PROJECT NO.</p> <p>801-111.412</p> <p>TASK 6</p>	<p>FIGURE</p> <p>2.2</p>
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Photo Source: Lidar 2007

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- Legend**
- Flow Direction
  - ⊙ Energy Dissipater
  - ⊙ Wing Ditch
  - ⊙ Drainage Ditch
  - WT Wattle
  - ⊂ Proposed Culvert
  - ⊙ Rip Rap
  - Proposed Pipeline
  - - - Proposed Access Road
  - Proposed FRU 197-21A Wellpad
  - - - Approximate Construction Limits
  - Existing Road
  - ▭ Colorado Division of Wildlife Property
  - ▭ Fragile Soils
- (Source: BLM with Disclaimer)*

- NOTES:**
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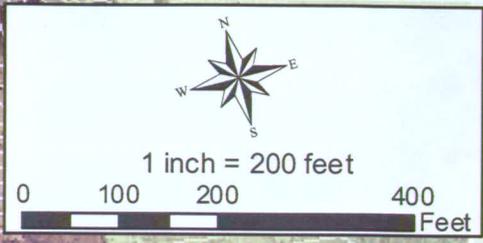
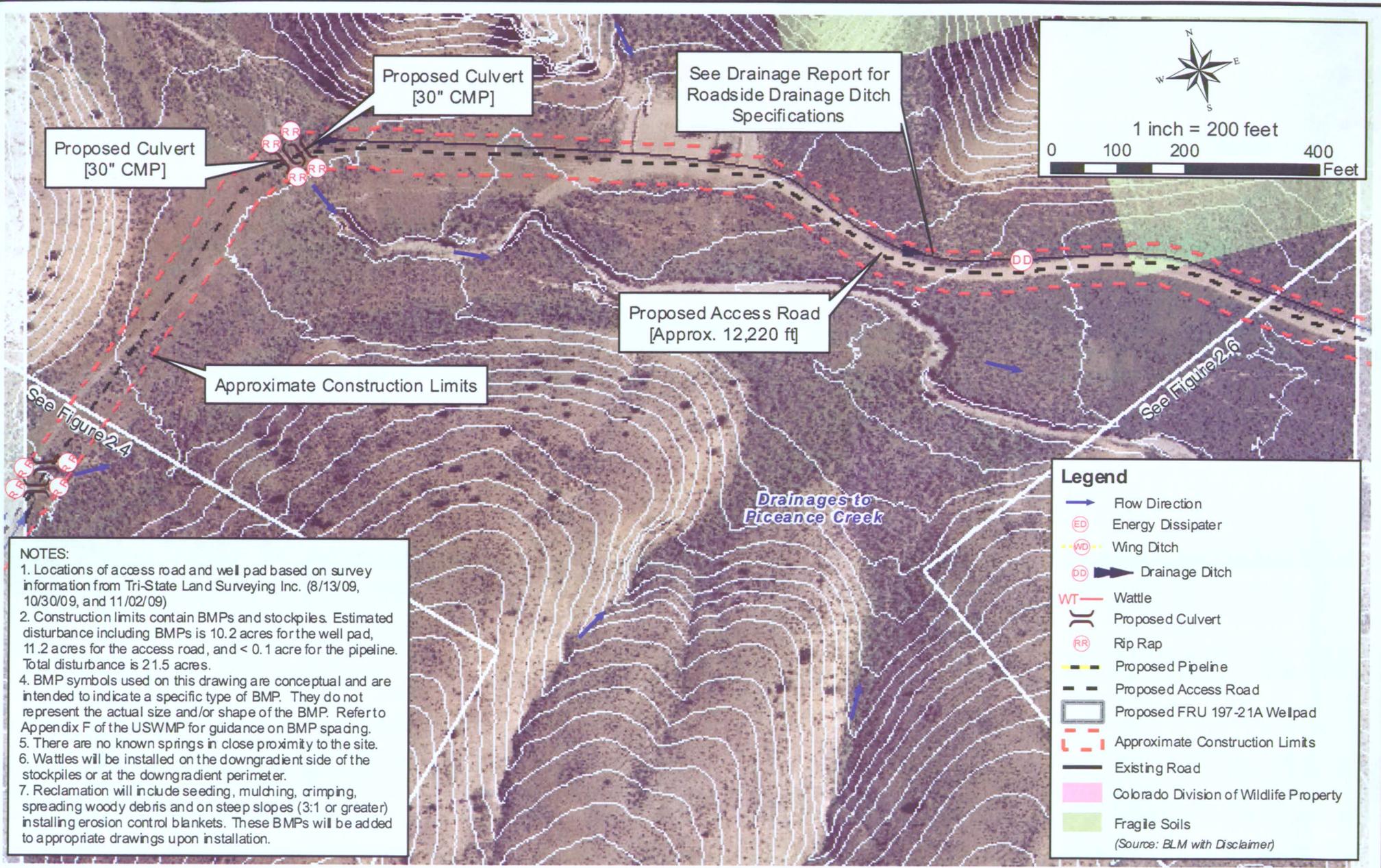
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 SECTIONS 16, 17, 20 & 21, TOWNSHIP 1S, RANGE 97W

PROJECT NO.  
 801-111.412  
 TASK 6

FIGURE  
 2.4



**NOTES:**

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Legend	
	Flow Direction
	Energy Dissipater
	Wing Ditch
	Drainage Ditch
	Wattle
	Proposed Culvert
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	Approximate Construction Limits
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	Fragile Soils
<i>(Source: BLM with Disclaimer)</i>	

10/20/09 GIS: Z:\Project Files\72-99\801-111\801-111.412\CAD-GIS\GIS\Task 006\Figure 2.5.mxd Photo Source: Lidar 2007

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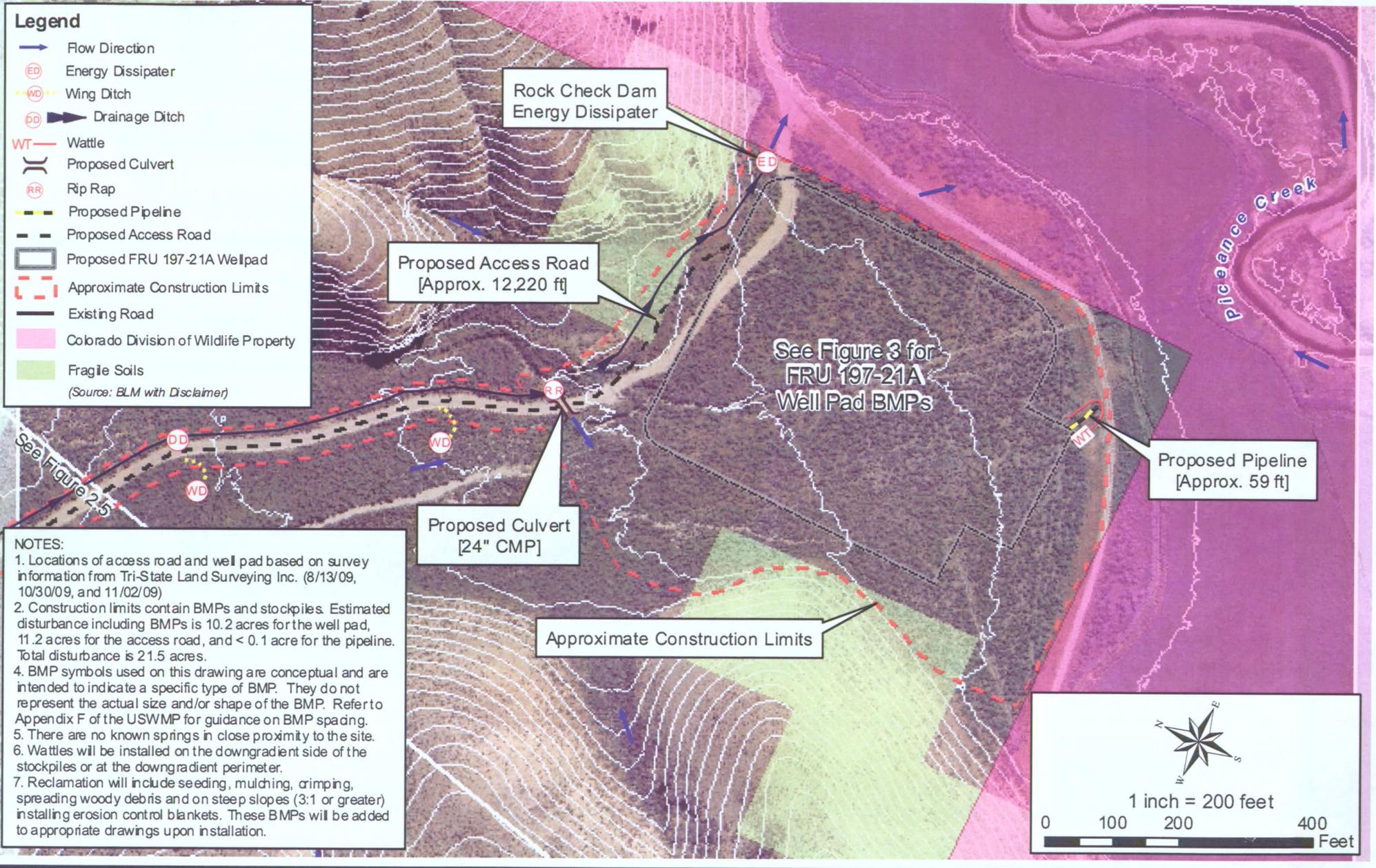
RIO BLANCO COUNTY, COLORADO  
**EXXON MOBIL CORPORATION**  
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PROJECT NO.  
 801-111.412  
 TASK 6

FIGURE  
 2.5

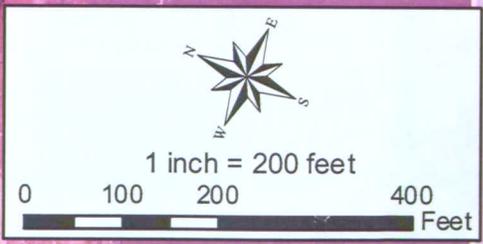
**Legend**

-  Flow Direction
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*(Source: BLM with Disclaimer)*



See Figure 3 for  
FRU 197-21A  
Well Pad BMPs

- NOTES:**
1. Locations of access road and well pad based on survey information from Tri-State Land Surveying Inc. (8/13/09, 10/30/09, and 11/02/09)
  2. Construction limits contain BMPs and stockpiles. Estimated disturbance including BMPs is 10.2 acres for the well pad, 11.2 acres for the access road, and < 0.1 acre for the pipeline. Total disturbance is 21.5 acres.
  4. BMP symbols used on this drawing are conceptual and are intended to indicate a specific type of BMP. They do not represent the actual size and/or shape of the BMP. Refer to Appendix F of the USWMP for guidance on BMP spacing.
  5. There are no known springs in close proximity to the site.
  6. Wattles will be installed on the downgradient side of the stockpiles or at the downgradient perimeter.
  7. Reclamation will include seeding, mulching, crimping, spreading woody debris and on steep slopes (3:1 or greater) installing erosion control blankets. These BMPs will be added to appropriate drawings upon installation.



10/20/09 GIS: Z:\Project Files\72-99\801-111\801-111.412\CAD-GIS\GIS\Task006\Figure 2.6.mxd Photo Source: Lidar 2007

**WWE**  
**WRIGHT WATER ENGINEERS, INC.**  
 2490 W 26TH AVE 100A  
 DENVER, CO. 80211  
 (303) 480-1700

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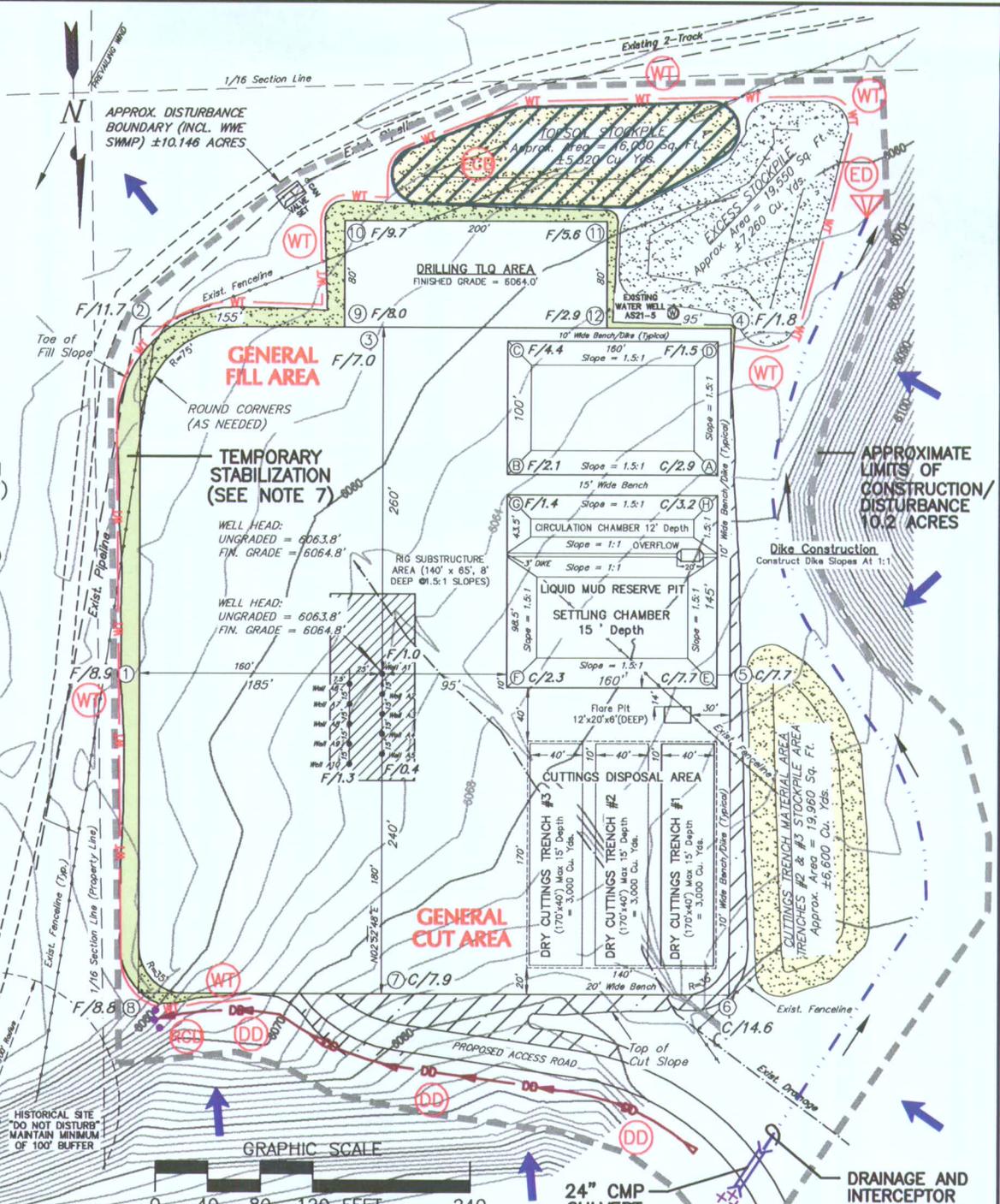
RIO BLANCO COUNTY, COLORADO  
**EXXON MOBIL CORPORATION**  
**FREEDOM UNIT 197-21A**  
 APPROXIMATE CONSTRUCTION LIMIT,  
 SOIL DISTURBANCE, AND BMP MAP  
 SECTIONS 16, 17, 20 & 21, TOWNSHIP 1S, RANGE 97W

PROJECT NO.  
 801-111.412  
 TASK 6

FIGURE  
 2.6

**LEGEND**

- ROCK CHECK DAM
- RIP RAP
- DRAINAGE DITCH
- WATTLE
- ENERGY DISSIPATER
- STOCKPILE MANAGEMENT
- TEMPORARY STABILIZATION (SEE NOTE 7)
- EROSION CONTROL BLANKET AND TEMPORARY SEEDING
- CULVERT
- FLOW DIRECTION
- APPROXIMATE CONSTRUCTION LIMITS FOR THE WELL PAD



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**NOTES**

1. LOCATIONS OF WELL PAD FEATURES ARE BASED ON SURVEY INFORMATION FROM TRI STATE LAND SURVEYING, INC. (10/24/09).
2. CUT MATERIAL IS RE-USED AS FILL MATERIAL OR WASTED ON SITE.
3. BMP SYMBOLS USED ON DRAWING ARE CONCEPTUAL AND ARE INTENDED TO INDICATE A SPECIFIC TYPE OF BMP. THEY DO NOT REPRESENT THE ACTUAL SIZE AND OR SHAPE OF THE BMP. REFER TO APPENDIX F OF THE USWMP FOR GUIDANCE ON BMP SPACING.
4. CONTOURS REPRESENT PRE-CONSTRUCTION ELEVATIONS.
5. WELL PAD WILL BE CONSTRUCTED TO BE RELATIVELY FLAT WITH SIDE SLOPES. SIDE SLOPES ARE INDICATED BY FILL AND CUT ELEVATIONS.
6. THERE ARE NO KNOWN SPRINGS IN CLOSE PROXIMITY TO THIS SITE. PICEANCE CREEK IS LOCATED APPROX. 300 FT. TO THE EAST OF THE WELL PAD.
7. REQUIREMENTS FOR TEMPORARY STABILIZATION WILL BE DETERMINED IN THE FIELD, IT WILL BE BASED PRIMARILY ON ROCK CONTENT AND SLOPE.
8. PERIMETER BMPs WILL BE PLACED AS CLOSE TO THE TOE OF THE SLOPE AS FEASIBLE WHILE MAINTAINING ADEQUATE ROOM FOR OPERATION OF CONSTRUCTION EQUIPMENT BETWEEN THE TOE OF SLOPE AND THE LIMITS OF DISTURBANCE.

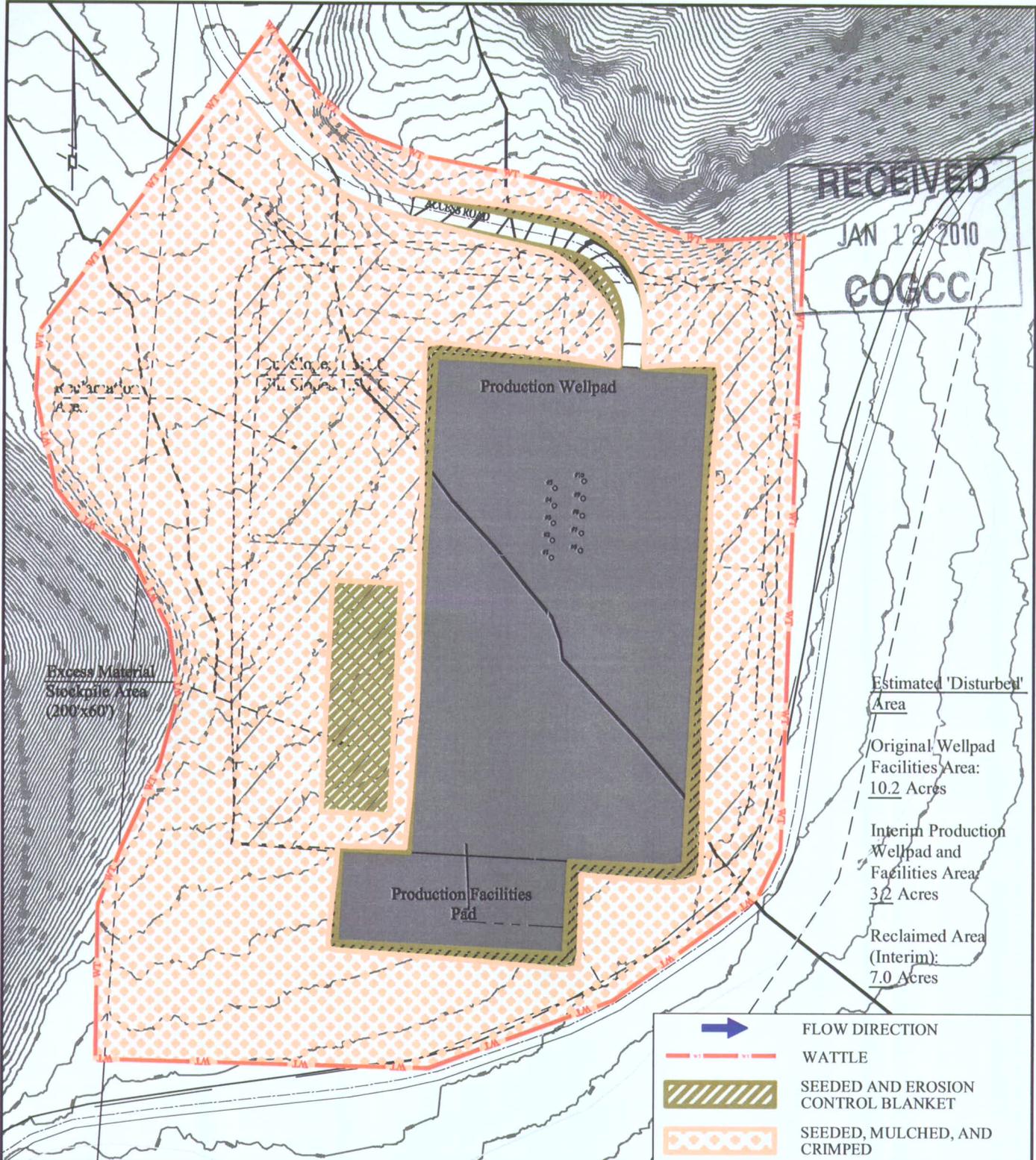
Plot Date/Time: 11/08/2009, 05:12:33 PM; Z:\PROJECT FILES\72-99\801-111\801-111.412\CAD-GS\CAD\TASK 008\FIGURE 3-FRU 197-21A (10-24-09).DWG-FIGURE 3

**WWE**  
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**EXXON MOBIL CORPORATION**  
 SECTION 21, TOWNSHIP 1S, RANGE 97W  
**FRU 197-21A**  
**PROPOSED BMPs ISWMP DRAWING**

REVISION:	FIGURE
-	3

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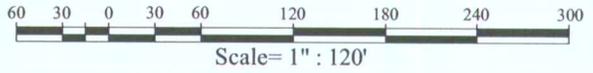
Estimated 'Disturbed' Area  
 Original Wellpad Facilities Area: 10.2 Acres  
 Interim Production Wellpad and Facilities Area: 3.2 Acres  
 Reclaimed Area (Interim): 7.0 Acres

- FLOW DIRECTION
- WATTLE
- SEEDED AND EROSION CONTROL BLANKET
- SEEDED, MULCHED, AND CRIMPED

**NOTES:**

1. Reference Tri State Land Surveying Inc. grading plan dated 07-22-08 and 10-24-09.
2. Reclaimed area to be regraded to achieve approximate original contours. Original contours are shown for reference.
3. Perimeter BMPs (e.g. wattles) will remain in place as needed until final stabilization is achieved.
4. If field conditions dictate Hydromulch will be used. If Hydromulch used, seed will be applied first (at double the seed rate) then the Hydromulch will be applied.

SOURCE: EXXONMOBIL  
 FRU 197-21A - Interim Reclamation Plan  
 Date: May 15, 2009  
 Dwg No. WP197-21A-09-002



Plot Date/Time: 10/29/2009, 02:31:49 PM; Z:\PROJECT FILES\72-99\801-111\801-111.412\CAD-GIS\CAD\_TASK 008\FIGURE 5-FRU 197-21A-09-002.DWG-FIGURE 5

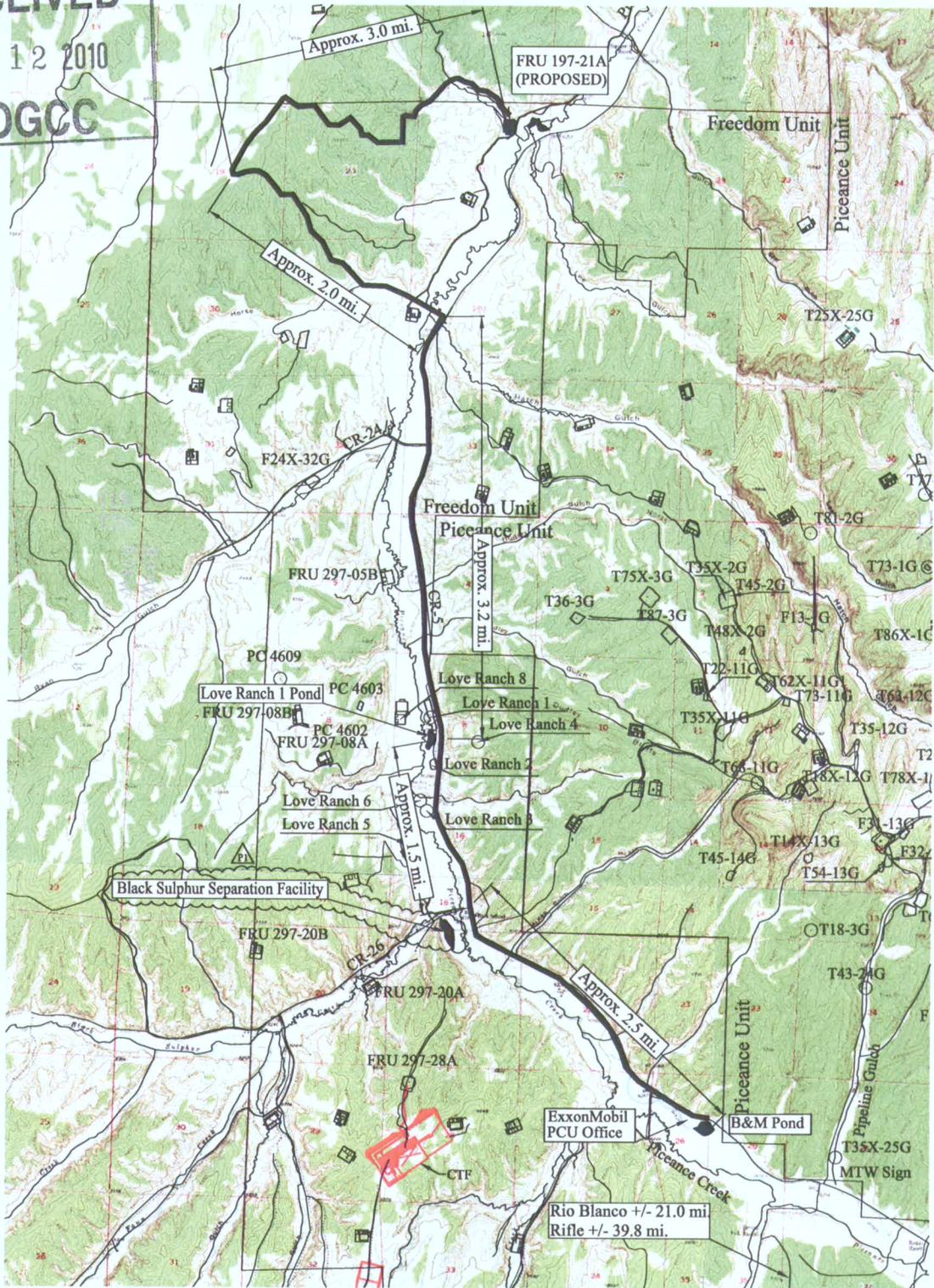


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EXXON MOBIL CORPORATION  
 SECTION 21, TOWNSHIP 1S, RANGE 97W  
**FRU 197-21A**  
 INTERIM RECLAMATION PLAN

REVISION:			FIGURE
-	-	-	5

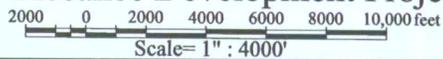
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**NOTES:**

1. Reference USGS quadrangles titled Square S Ranch, Greasewood Gulch, Rock School, and Jessup Gulch.
2. Contour Interval is 20' for all background maps.
3. Coordinates are NAD27, US State plane, CO north zone 0501.
4. Streams shown thus:
5. Existing Roads shown thus:
6. Proposed Water Haul Route shown thus:

**Water Haul Routes - FRU 197-21A**  
**Section 21, T1S, R97W, 6th P.M.**  
**Piceance Development Project**



REV.	DATE	REVISION DESCRIPTION	ENG.	DRAWN	CHECKED	APPROVED
P1	19 Oct 09	Add PWDD Source	---	CEL	CEL	WFD
P	14 MAY 09	Preliminary	---	CEL	CEL	WFD

**EXXONMOBIL**

Drawn by: CEL      Checked by: CEL

Date: May 14, 2009      Scale: 1" : 4000'

Dwg No. WP197-21A-09-003