

TECHNICAL MEMORANDUM

DATE: January 17, 2017 **PROJECT NO.** 350.0065.001

TO: Sara Sparks, U.S. EPA
Keith Large, Montana DEQ

FROM: Adam Johnson, NewFields Project Hydrogeologist

Cc: David Tooke, NewFields Project Coordinator
Chris Cerquone, NewFields Principal in Charge
Steve Hamilton, WestRock
Brent Sasser, International Paper
Ray Stillwell, M2Green Redevelopment

SUBJECT: **March 2016 Aerial Survey, High-Resolution Aerial Imagery, and Topographic Data
Former Frenchtown Mill Site, Missoula County, Montana**

INTRODUCTION

This technical memorandum presents topographic information and composite orthophotographic aerial imagery obtained and processed by NewFields during a March 2016 aerial survey of the Former Frenchtown Mill Property (Site). The Site is located north of Fairbanks Lane and west of Mullan Road in Missoula County, Montana (**Figure 1**), and has the physical address of 14377 Pulp Mill Road, Missoula, Montana. The Site is approximately 3,150 acres.

The aerial survey was completed in accordance with the U.S. Environmental Protection Agency (EPA)-approved Remedial Investigation Work Plan (RIWP) (NewFields, 2015) on behalf of International Paper Company, M2Green Redevelopment, LLC, and WestRock CP, LLC, collectively referred to hereafter as the potentially responsible parties (PRPs).

OBJECTIVES

The objectives of the aerial survey were to: 1) provide current aerial imagery to support the remedial investigation, and 2) obtain data needed to produce a topographic model and to determine surface elevations for the locations of surface soil samples, test pits, soil borings, sediment samples, and surface water samples collected as part of the remedial investigation at the site. Geographic data are currently being used in ongoing site investigations and will be useful for future studies.

DATA COLLECTION METHODS

Aerial imagery and topographic data were obtained using a device mounted to a small fixed-wing aircraft that combines two cameras and a Global Positioning System (GPS). This type of technology is



suitable for collecting information over large areas such as the 3,200-acre former Frenchtown mill site (Johnson et al., 2016). To perform the survey, the aircraft flew flight paths which were pre-planned by NewFields over the project area (**Figure 2**) at an elevation of approximately 1,400 feet above ground level. During the flight, the device captured overlapping georeferenced images (photographs whose positions were precisely known). The images obtained were standard RGB (red, green, blue) photographs that captured visible light. Eight ground control points (GCPs) were established by NewFields on March 9, 2016 and surveyed by a professional land surveyor (Territorial Landworks, Inc., or TLI, of Missoula, Montana). GCP locations were used to calibrate and validate the aerial survey information collected. Conventional surveying of the GCPs was completed on April 13, 2016; aerial data collection activities were carried out on March 30, 2016.

DATA PROCESSING METHODS

Following aerial data collection, NewFields refined and compiled flight information and aerial imagery using post-processing software. Photogrammetry (the use of aerial photography to measure distances between objects) was a key component of the processing phase. Using photogrammetry and the RGB imagery, which consisted of hundreds of images, NewFields generated a surface elevation model (SEM) and a geometrically-corrected composite aerial image (orthomosaic) of the Site. SEM and orthomosaic imagery are presented using a Geographic Information System (GIS) and computer-aided design (CAD). A point cloud (set of geographic data points) was developed and used to develop an elevation grid from which contours were created.

QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

NewFields followed QA/QC protocols throughout the data collection and processing phases of the air-based survey. The accuracy standards for this project were designed to meet the National Standard for Spatial Data Accuracy (NSSDA) developed by the Federal Geographic Data Committee (1998). The horizontal accuracy of NewFields' aerial surveys is typically within 1 to 2 times the spatial resolution of the aerial survey data (which, in this case, is approximately 2 inches), and the vertical accuracy is within 2 to 3 times the spatial resolution of the aerial survey data. This level of accuracy, which often permits 1 foot contours to be produced according to the NSSDA guidelines, may not be achievable in all circumstances depending on the configuration of the ground surface. Lower-resolution surface models may result for cases where the natural surface includes structures or areas with sharp vertical transitions. At the Frenchtown site, accuracy was lower in some areas with steeper slopes, such as pond berms and building structures.

DATA CALIBRATION AND VALIDATION

NewFields used horizontal and vertical data from eight GCPs that were evenly distributed throughout the flight area (**Figure 2**) to calibrate the elevation data collected by the RGB camera device. TLI (a professional land survey firm) validated the elevation data using a total of 126 pre-existing surveyed GCPs. These GCPs do not include any of the eight GCPs used for calibration. As shown in **Attachment B**,



TLI's validation process determined a vertical accuracy of approximately 30 inches. Using the difference in spatial resolution between vertical and horizontal measurements, NewFields conservatively estimates the horizontal accuracy to be approximately 8 inches. After TLI validated the elevation values, NewFields reprocessed the data using the existing surveyed 134 GCPs and then developed site contours as presented below.

RESULTS

The aerial survey effort produced topographic contours with a 2-foot contour interval (**Figure 3**) and orthophotographic aerial imagery with a spatial (horizontal) resolution of approximately 2 inches (**Figure 4**). The topography is available as an AutoCAD file at the following link: <https://newfields.sharefile.com/d/fe0084973a554412>

The validated elevation data were used to obtain surface elevations for all surface soil, test pit, and boring locations as well as sediment and surface water locations sampled during the remedial investigation. This information was presented in NewFields (2016). The SEM can also be used to provide elevation data for future investigation and remediation activity at the Frenchtown site.

DISCUSSION

March 30, 2016 flight data were collected at a spatial resolution of 2 inches. The site-wide vertical accuracy obtained using the aerial survey data collected at the Frenchtown Site is approximately 30 inches. The surface elevation model accuracy was less than ideal due to multiple low-accuracy areas corresponding with site features such as structures, trees, and vegetation. Also, shadows, reflections, areas with poor contrast along dike slopes, and water features make it difficult for the software to derive accurate elevations from the photogrammetric data.



REFERENCES

Federal Geographic Data Committee, Subcommittee for Base Cartographic Data. 1998. Geospatial Positioning Accuracy Standards Part 3: National Standard for Spatial Data Accuracy. FGDC-STD-007.3-1998. Accessed December 2016 at <https://www.fgdc.gov/standards/projects/accuracy/part3/chapter3>

Johnson, A.N., Martin, P., Burkhalter, C., Krieger, G., Balge, Z, and Lutes, K. 2016. New Remote Sensing Systems for Improved Planning and Management of Tailings Storage Facilities. Proceedings of the Tailings and Mine Waste 2016 Conference. Keystone, Colorado. October 5.

NewFields, 2016. Preliminary Data Summary Report, November/December 2015 Sampling Event, Smurfit Stone/Frenchtown Mill, Missoula County, Montana. Version 2. September.

NewFields. (2015). Remedial Investigation Work Plan, Smurfit Stone/Frenchtown Mill, Missoula County, Montana. Prepared for International Paper Company, M2Green Redevelopment, LLC, and WestRock CP, LLC. Missoula, MT.

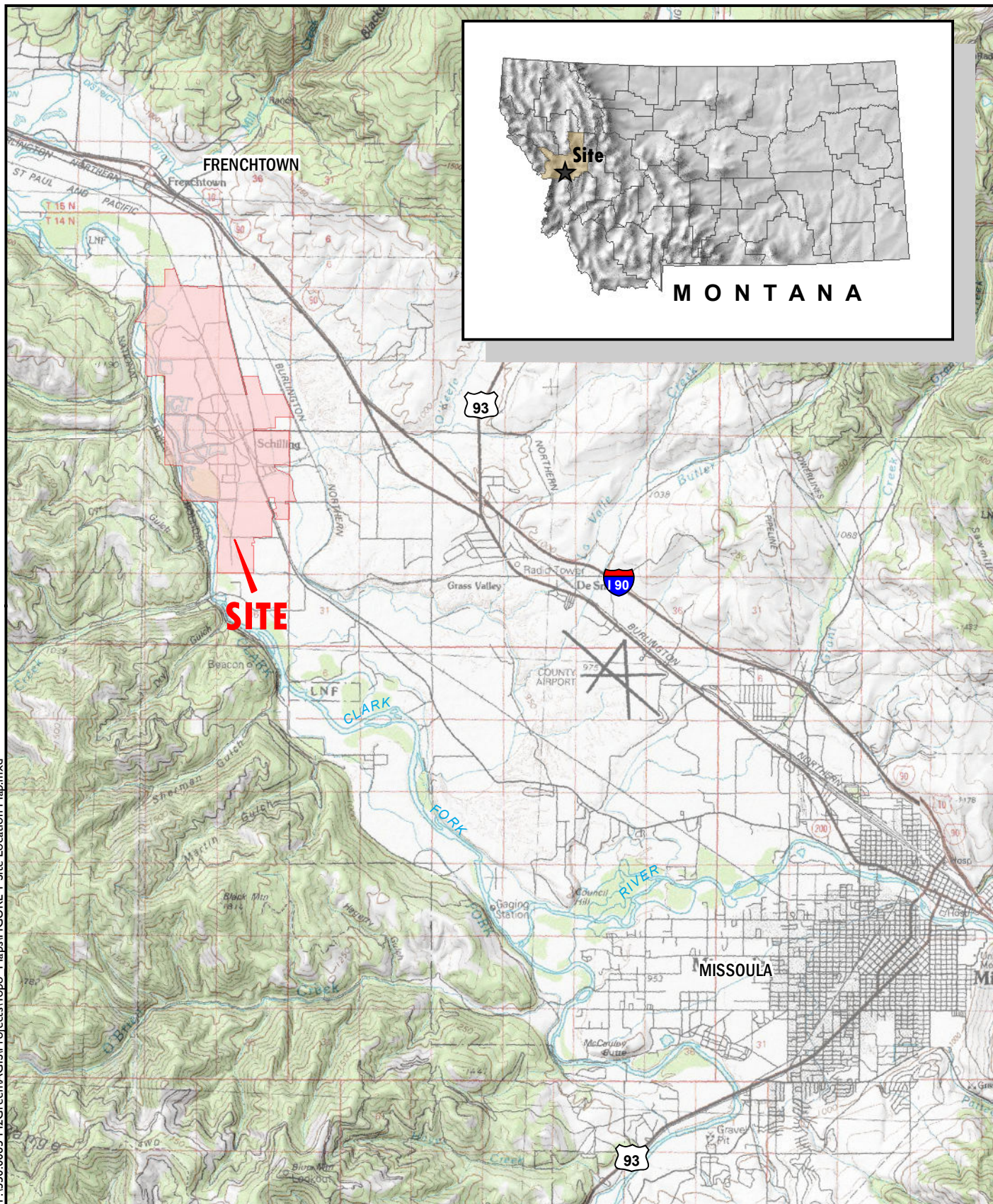
ATTACHMENTS

Attachment A (Figures)	Figure 1: Site Location Map
	Figure 2: Aerial Survey Project Area with Ground Control Points
	Figure 3: 10-foot Topographic Contours with Hill shade
	Figure 4: Orthophotographic Image
Attachment B	Surface Verification, Former Frenchtown Mill Site. Prepared by Territorial Landworks, Inc. September 14, 2016.

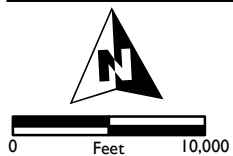
Attachment A

Figures

P:\350.0065 M2Green\AGIS\Projects\Topo Maps\FIGURE 1 Site Location Map.mxd

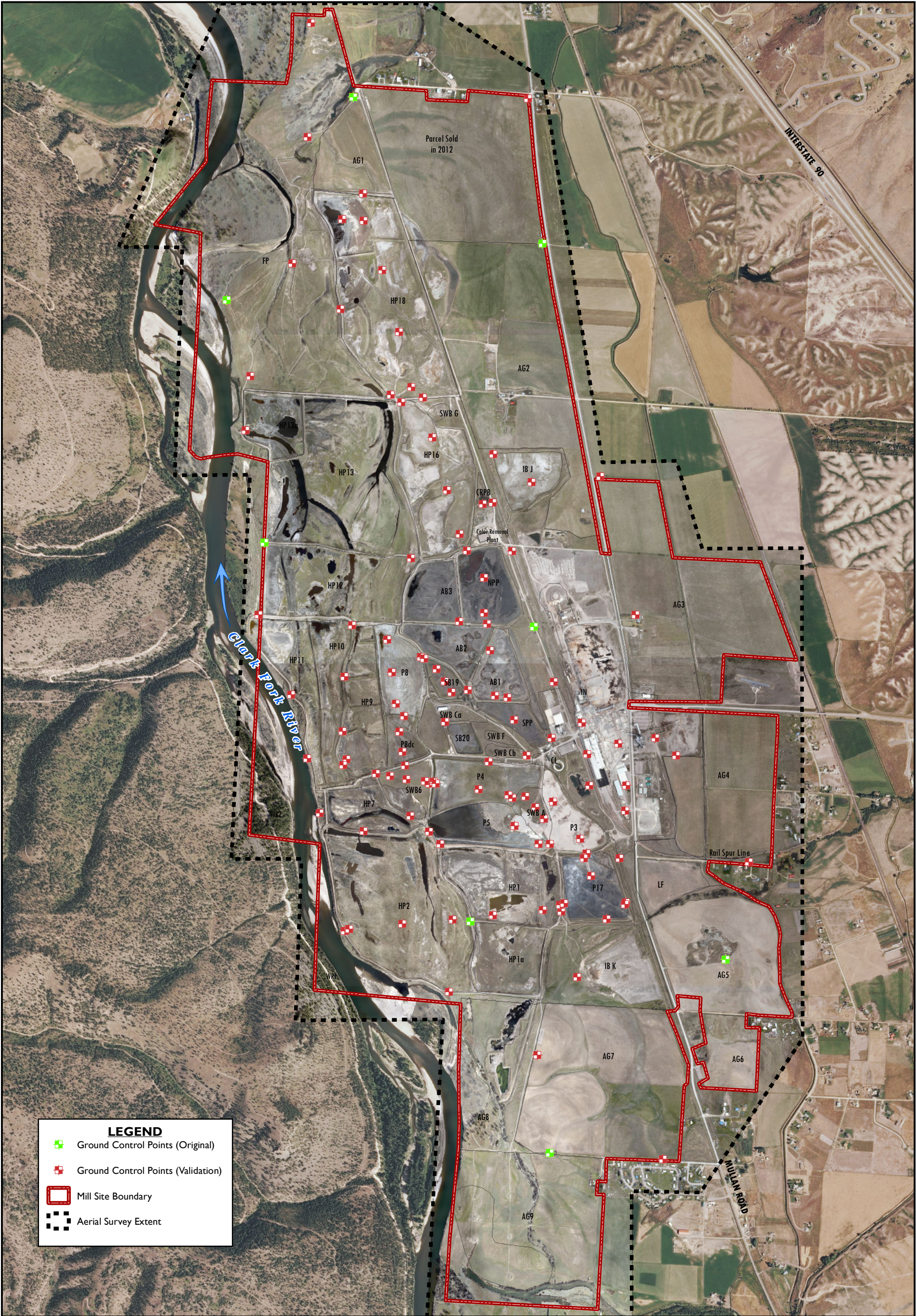


Source: Montana USGS 100K Topographic Map

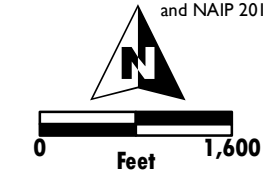


NewFields

Site Location Map
Former Frenchtown Mill Site
Missoula County, Montana
FIGURE 1

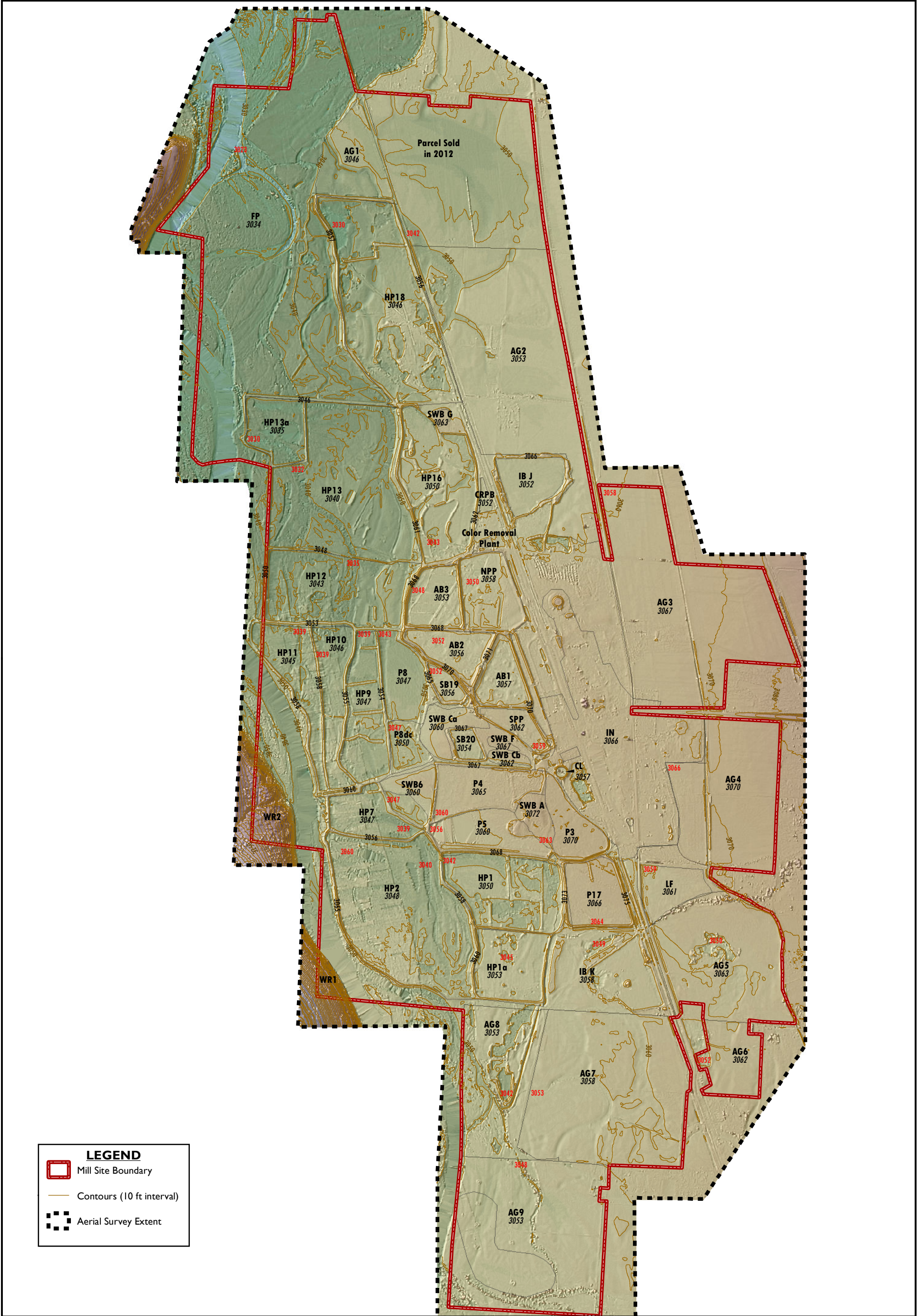


Aerial Photo Source: Newfields 2016 Aerial Survey and NAIP 2011

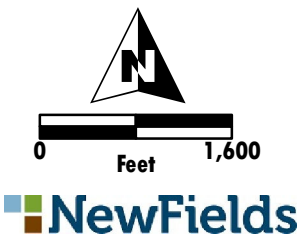


NewFields

Ground Control Points
Former Frenchtown Mill Site
Missoula County, Montana
FIGURE 2



Source: Newfields 2016 Aerial Survey



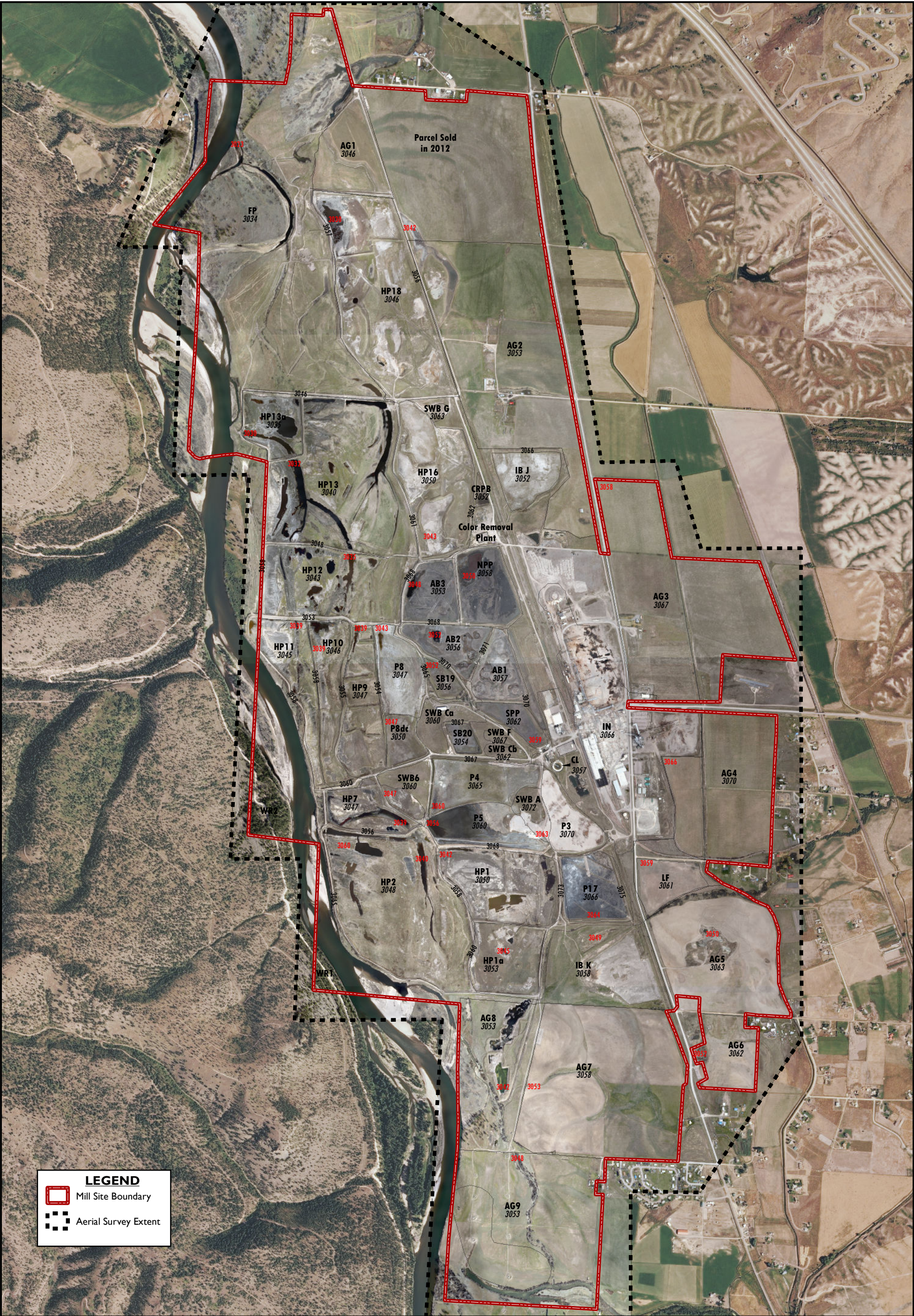
- AG9** Basin or Parcel
3053 Approximate Average Bottom of Basin/Parcel Elevation
3053 Approximate Average Top of Dike Elevation
3053 Approximate Low Point Elevation of Basin/Parcel
3050 Contour Elevation
All elevations in feet above mean sea level

- AG - Agricultural Land
AB - Aeration Stabilization Basin
CFR - Clark Fork River
CRPB - Color Removal Plant Basin
CL - Clarifier
FP - Floodplain Area
HP - Holding or Storage Pond
IB - Rapid Infiltration Basin

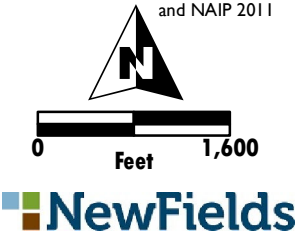
Notes

- LF - Land farm
IN - Industrial Area
NPP - North Polishing Pond
OU - Operable Unit
P - Settling Pond
SB - Spoils Basin
SPP - South Polishing Pond
SWB - Solid Waste Basin
WR - West of the Clark Fork River

Topographic Map
Former Frenchtown Mill Site
Missoula County, Montana
FIGURE 3



Aerial Photo Source: Newfields 2016 Aerial Survey
and NAIP 2011



NewFields

AG9 Basin or Parcel
3053 Approximate Average Bottom of Basin/Parcel Elevation
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3053 Approximate Low Point Elevation of Basin/Parcel
All elevations in feet above mean sea level

Notes

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FP - Floodplain Area
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LF - Land farm
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WR - West of the Clark Fork River

Aerial Imagery
Former Frenchtown Mill Site
Missoula County, Montana
FIGURE 4

Attachment B

Surface Verification



September 14, 2016

Newfields
David Tooke
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Missoula, MT 59802

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RE: Surface Verification
Former Frenchtown Mill Site

Territorial Landworks certifies the surface elevation model provided by Newfield base on aerial photography with a 95% confidence to +/- 2.5 feet. This is based on a comparison of 134 points with surveyed elevations and the elevations of the surface.

Unrestrained Results

Range of Surface Deltas	-5.37 : 4.64
Mean	0.95
Standard Deviation based on a Sample	1.49
Median	0.93
95 Percentile	3.42
Confidence range	-2.49 : 4.35

Results with Outliers Removed (Outlier being defined as 4 time the standard deviation)

Range of Surface Deltas	-3.91 : 4.64
Mean	1.04
Standard Deviation based on a Sample	1.28
Median	0.96
95 Percentile	3.42
Confidence range	-2.49 : 4.35

Adjusted Results (Adjusting the Surface elevation up 0.96 to set the Median at Zero.)

Range of Surface Deltas	-4.86 : 3.67
Mean	0.08
Standard Deviation based on a Sample	1.28
Median	0.00
95 Percentile	2.47
Confidence range	-2.5: 2.5

Sincerely,
Territorial-Landworks, Inc.

Hugh Thompson, P.L.S.
Project Manager

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Cert.doc