Toklat Basin Permafrost Index Site Monitoring 2013

Investigators Annual Report
Collection, post-processing, and presentation of RTK GPS data for thermokarst monitoring in the Toklat Basin, Denali National Park and Preserve

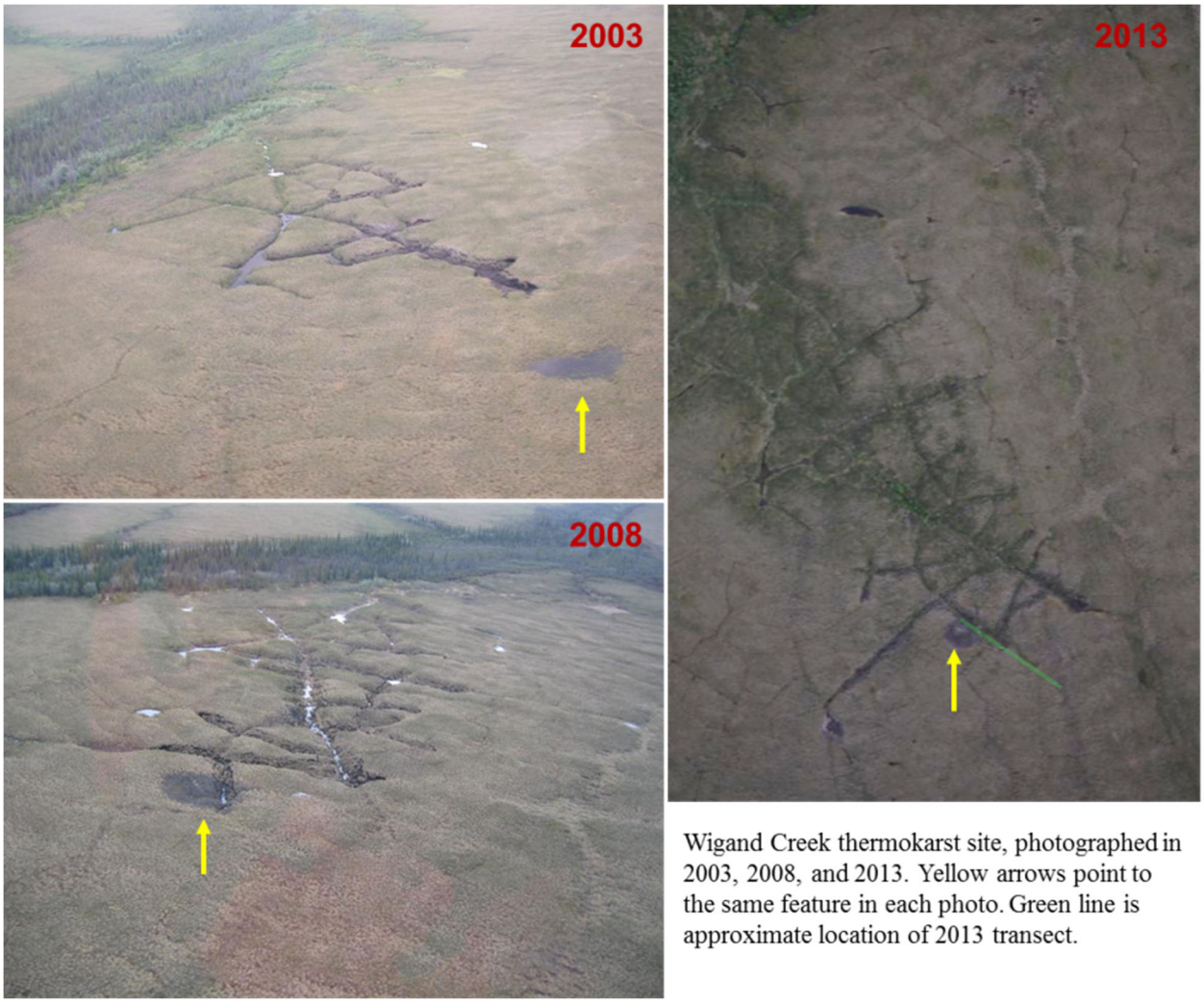
Prepared by Nadine Reitman and David Schirokauer
October 2013

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SUMMARY

In 2013, Denali park staff teamed up with University of Florida professor Ted Schuur to implement the first season of permafrost index site monitoring in the Park. This report describes, in detail, the field and office based efforts associated with this investigation. Ten thermokarst sites, places where permafrost is melting, were previously identified in the Toklat Basin. The sites were photographed in July 2013 from a plane, facilitating comparisons from 2003 and 2008 when some sites were visited and photographed via helicopter. The research team visited six sites for further study. At each site one or two transects were measured from within the active thermokarst to outside of it. Thaw depth, a vegetation index (NDVI), height and species of the tallest shrub, and organic layer depth were measured every five meters along each transect. The transects were measured with a real time kinematic (RTK) GPS system to get precise spatial and elevation data. These surveys can be repeated in order to monitor and document thermokarst development and evolution in future years. Melting permafrost is an indicator of climate change in the region. As permafrost melts, stable tundra ecosystems evolve into wetlands and / or shrub lands, altering the types of species that can survive and thrive in the area.



Wigand Creek thermokarst site, photographed in 2003, 2008, and 2013. Yellow arrows point to the same feature in each photo. Green line is approximate location of 2013 transect.

SAVING AND ACCESSING DATA

All data are saved to the Permafrost folder on Denali NP's the T drive and to the Denali Permafrost Google Account.

2013 data are located here: T:\ResMgmt\WAGS\Permafrost\2013 Monitoring

Google Account: Access at gmail.com and click "Drive" on the top bar after signing in.
Username - **denalipermafrost**
Password - **permafr0st**

All data are available on the T drive and Google Drive, including:
- 2013 data (T location: ResMgmt\WAGS\Permafrost\2013 Monitoring)
  - GIS data
  - GPS data (both raw and processed)
  - Overflight photos
  - 2013 Monitoring Protocol
  - Alaska RTK User Guide
  - Denali RTK SOP
- Photos of all known thermokarst sites in the Toklat Basin organized by site and year (T location: ResMgmt\WAGS\Permafrost\2013 Monitoring\Site Photos Organized)

GPS DATA COLLECTION

*For complete monitoring protocol of non-GPS data, see **2013 Monitoring Protocol** on Google Drive or T drive.*

Follow general RTK directions in Denali RTK Standard Operating Procedure.
- Denali RTK SOP available at T:\ResMgmt\WAGS\Geology\GIS_GPS\RTK_PPK
- Alaska RTK User Guide available on Google Drive account or Permafrost\2013 Monitoring T drive folder
- Use DENA's Trimble R6 RTK GPS system if available. AKRO's Trimble R8 RTK system was used in 2013.

SPECIFIC SETUP FOR PERMAFROST MONITORING

Field RTK Gear Check List (assumes using helicopter to access sites)
- ☐ Base and Rover Units (in orange padded rectangles which are on shelf upstairs)
  - ☐ 2 small antennas
  - ☐ 2 batteries for base and rover units
  - ☐ 2-4 extra batteries
- Base Station Set Up
  - ☐ Base station tripod
  - ☐ Tribrach (triangular level piece with viewer) with black disk insert attached
  - ☐ 0.25 meter yellow pole
  - ☐ Cowbell battery
  - ☐ Cord to attach cowbell battery to base unit
  - ☐ Measuring tape
- Rover Set Up
  - ☐ 2 carbon fiber surveying rods that screw together
  - ☐ Tripod legs for surveying rod (only bring if can use a lightweight pair. Ask Rob Burrows about his setup.)
  - ☐ Controller (with stylus or pencil)
  - ☐ Holder for controller
  - ☐ Level attachment for rover pole
- ☐ Permafrost monitoring protocol and Denali RTK SOP
- ☐ Field notebook and pencil
- ☐ Transect tapes (at least 2)

Before Fieldwork

- Charge the controller, cowbell battery, and rover/base batteries
- Load the JOB file with measured transect points onto the controller (follow procedure in Denali RTK SOP)
  - Copy and paste JOB file from T drive (T:\ResMgmt\WAGS\Permafrost\2013 Monitoring\JOB exports\2013AllData) to controller (Controller drive\Trimble Data\jp or other "user login ID" folder)
- When entering *Project Height*, note that *6.565 sft* (or 2 m) assumes the pointed tip is *on* the rover pole. Adjust height accordingly. In 2013, project height set to 2m. Pointed tip not used.

NOTE: Practice loading and navigating to points before going into the field. It can be hard to get everything working properly and in the correct coordinate system.

Base Tripod Set Up

- Set up base and tripod near the helicopter landing, but not so close that it's in the rotor wash zone.
- Get the base going ASAP upon arrival. It's best to lest the base record data for at least 2 hours.
- Base Antenna Height: measure from the *top of the tundra* to the *bottom of the base unit*. Record this number. (It's needed for starting the base survey and useful during post-processing)

Job Set Up

- On controller, select *Jobs* | *Open Job* and select the job created with transect points pre-loaded.
- Coordinate system (under Properties box) is already set if opening a job.
- For a new job select properties according to Denali RTK SOP.

Base Survey Set Up

- Turn on base and let run for at least 7 minutes before starting the survey.
- Survey style is *RTK + Opus + Internal*
- Name the base point "LocationDateBase" (ex: Boundary2013Base)
- Use *HERE* for base location.
- Enter *Antenna Height* measured from top of tundra to bottom of base unit
- Record date and time when base survey is started and ended. This is very useful in keeping data straight since there will be multiple base surveys each day.

Collecting Data

- Do not use pointed tip on end of rover pole. Let flat bottom of rover pole fall naturally into tundra at each point.
- Navigate to transect end points using *Stakeout* feature on the controller and pre-loaded points. (See RTK SOP)
- Place flags at each end of transect and run transect tapes between them.
- Place flag every 5 meters along transect.
- Record an *Observed control point* (3 minute measurement) at start (0 m) and end (50 or 100 m) of each transect
- Record a *Topo Point* (5 second measurement) every 5 meters along transect.
- Do intermediate points (as topo points) if time allows
- Name topo points "SiteName TransectNumber – point" Examples: wigandcrk1-1, wigandcrk1-18
  - *NOTE: points names are not meters, i.e., the last point for a 100 m transect is sitename1-20*
- Name control points "SiteName TransectNumber-start/end". Examples: lef2-start, lef2-end

POST-PROCESSING RTK GPS DATA

Follow the Denali RTK SOP for post-processing RTK data using an OPUS solution. Any specifics for permafrost data are described below.

1. **Convert raw data files to Rinex format for OPUS.**
   - Need to do this process for each base data file (there should be one for each site). Rinex can batch process.

2. **Send base data to OPUS 48 hours to one week after surveying and wait to get a solution**
   - Need to repeat this process for each base data file.

3. **Load JOB file into Trimble Business Center**
   - Open Trimble Business Center and select **File | New Project**. Choose **Survey Feet**.
   - Set Project Coordinates and significant digits

- Load .JOB files for each site in one TBC project

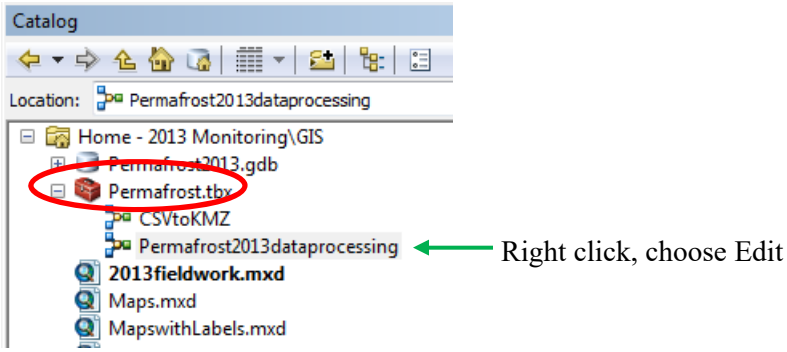
4. **Update base position with OPUS solution in Trimble Business Center**
   - Need to update position for each base individually.
   - TBC will only update the positions for the points associated with each individual base. (i.e. can put multiple sites in one project)

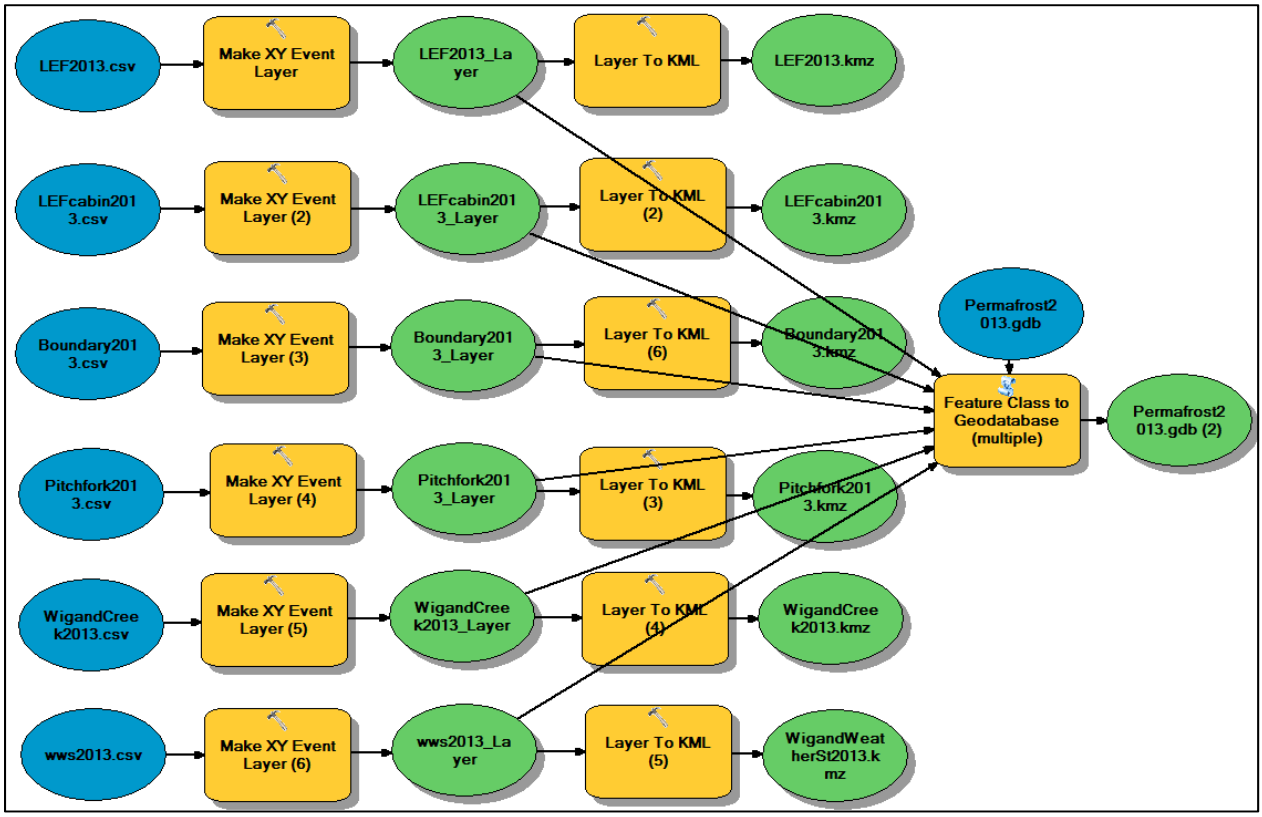
5. **Export data from Trimble Business Center for GIS**
   - Export all data into one .CSV file, or do each site individually. Making separate .CSVs (and GIS layers later on) will make labeling and displaying data in ArcMap easier, but requires keeping track of 6+ different files.

6. **Load data into GIS and view in Arc and Google Earth (this can be done in ArcMap or ModelBuilder)**

Processing data in Model Builder:

- ModelBuilder model from 2013 is called **Permafrost2013dataprocessing** in the **Permafrost.tbx** toolbox.
- It's located on the T drive here: **T:\ResMgmt\WAGS\Permafrost\2013 Monitoring\GIS**
- To open the model, open **ArcCatalog**, navigate to the **Permafrost.tbx** toolbox and expand it, right click **Permafrost2013dataprocessing**, and choose **Edit**

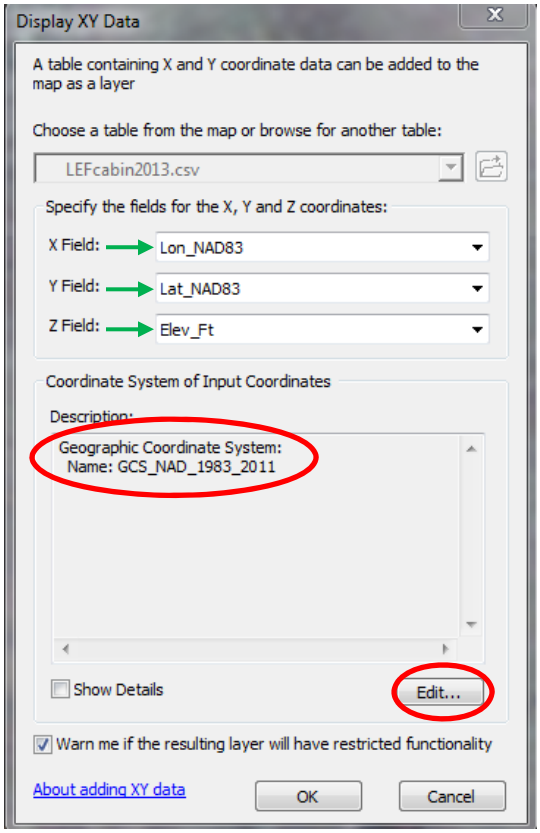




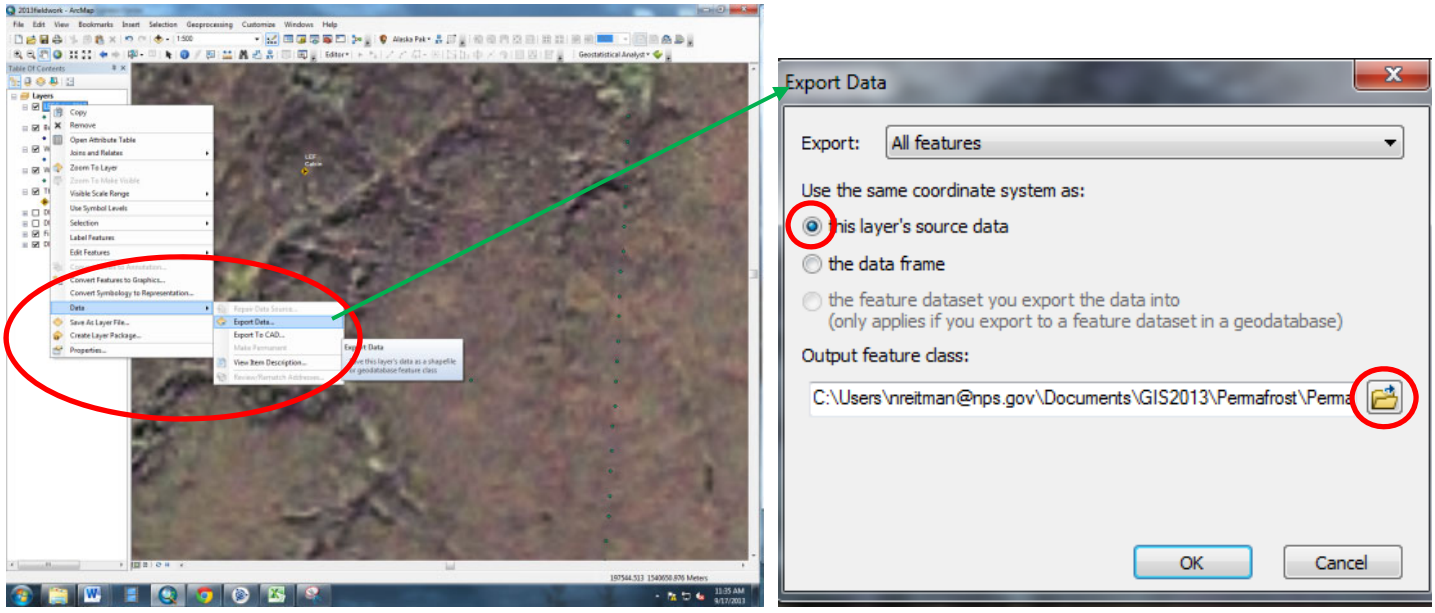
2013 ModelBuilder model.

Processing data in ArcMap:

- Open ArcMap to a new (or already set up) project
- Load CSV file(s) of data
- Right click on CSV and choose **Display XY Data**
  - X = Lon, Y = Lat, Z = Elevation/Height
  - Click "Edit" under "Coordinate System of Input Coordinates" and choose:
    Geographic Coordinate Systems | North America | NAD 1983 (2011)
  - Click OK



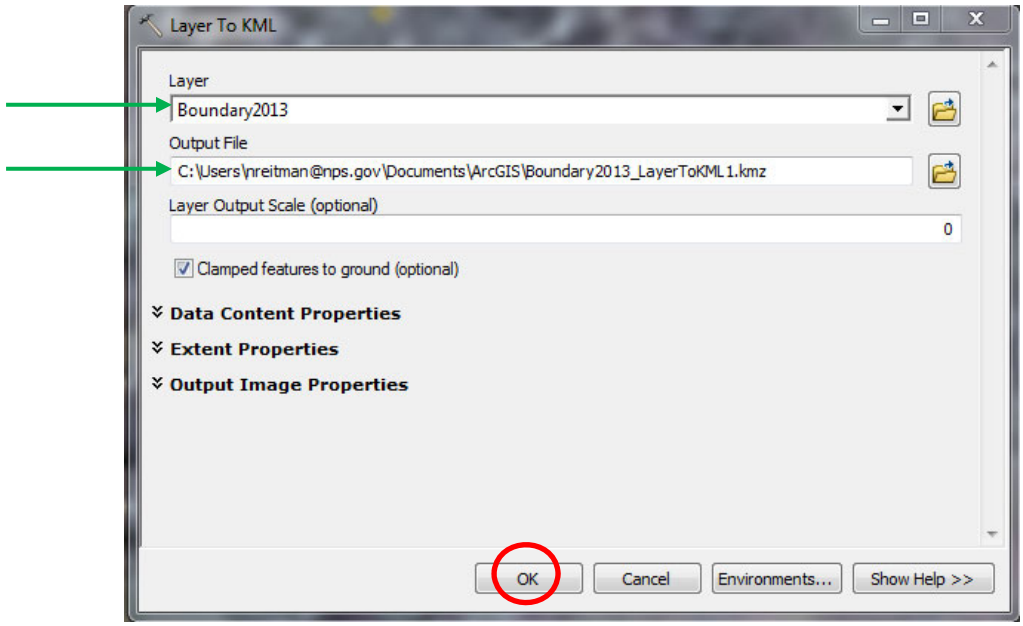
- Right click new layer added to the map and choose **Data | Export Data**. Export box pops up.



  - Click  and choose **Save as Type | File and Personal Geodatabase feature classes**.

- Create a new geodatabase named PermafrostYEAR.gdb.
- 2013 data are located T:\ResMgmt\WAGS\Permafrost\2013 Monitoring\GIS\Permafrost2013.gdb
- Save data as SiteNameYear (ex: Boundary2013)

- Export data as a KMZ to view in Google Earth
  - Search "KML" in ArcMap search and choose "Layer To KML" by double-clicking. Box pops up.



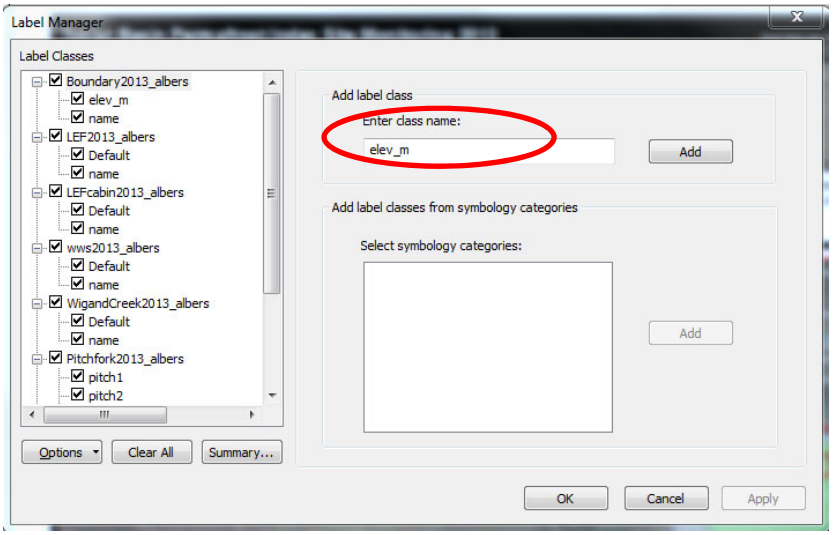
  - Drag and drop or select data layer in Layer box
  - Navigate to desired output location
  - Click OK

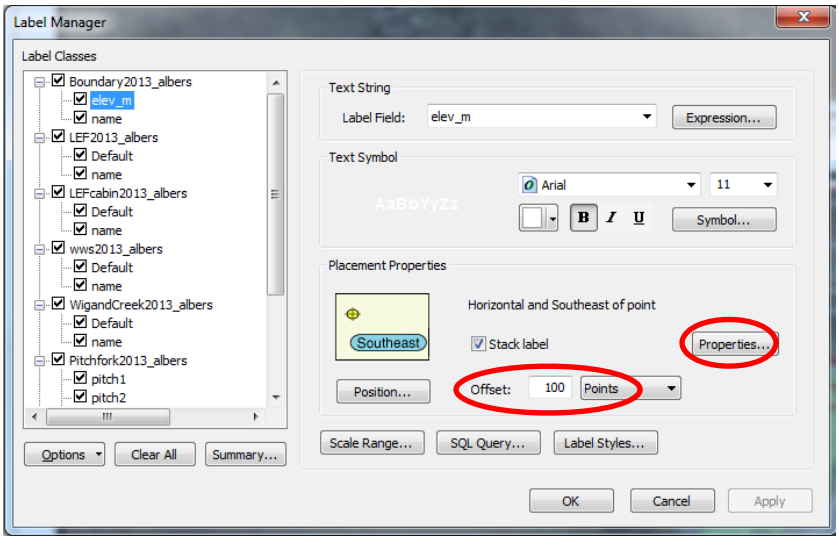
DATA PRESENTATION

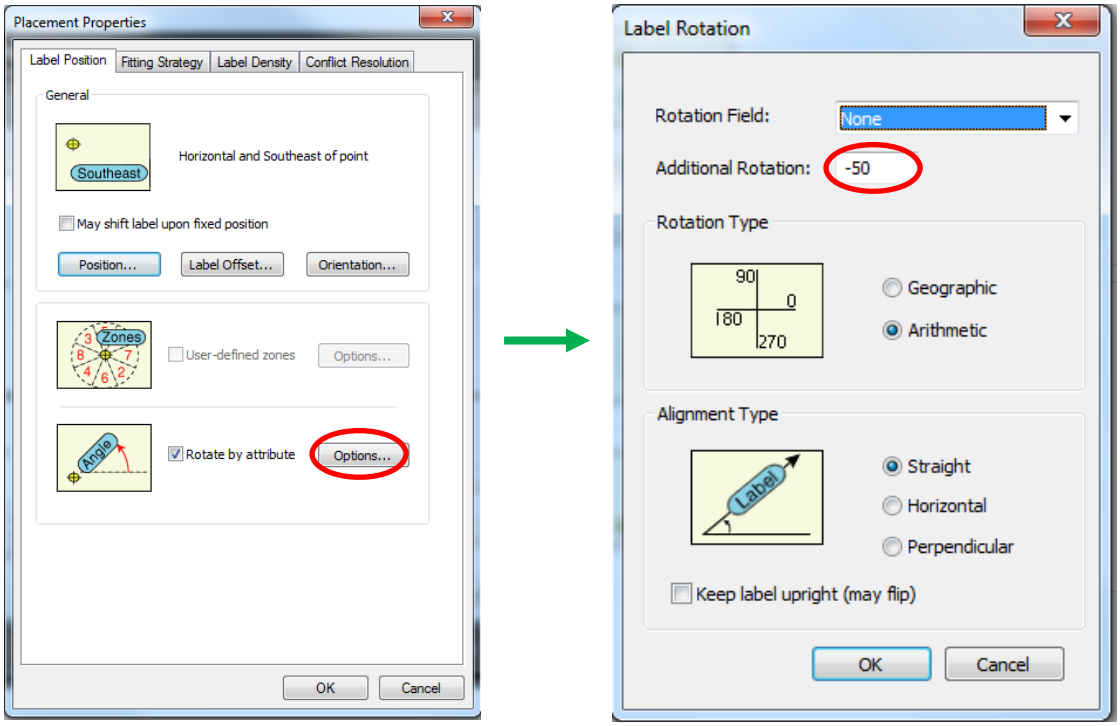
Make maps of surveyed sites in ArcMap

- Map templates are located in T:\ResMgmt\WAGS\Permafrost\2013 Monitoring\GIS
- The .mxd files "Maps" and "MapswithLabels" were used in 2013
- 2013 maps located in: T:\ResMgmt\WAGS\Permafrost\2013 Monitoring\Map JPGs and in Appendix below
- Scales: In = 1:1,000 Out = 1:2,500
- Background imagery: DENA IKONOS IFSAR Mosaic Dataset - True Color
- Labels: open "Labeling" toolbar and click "Label manager" button 

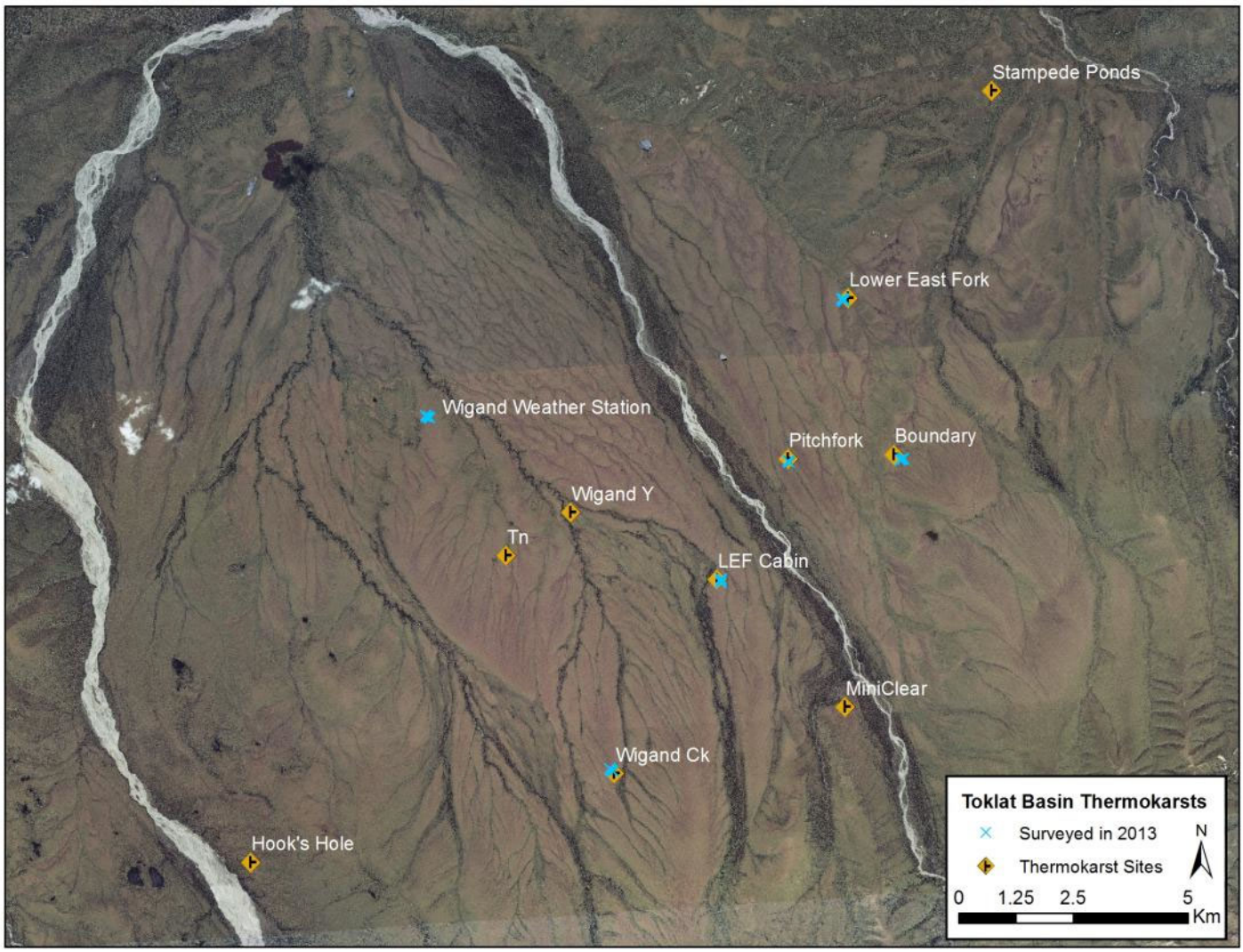
to set properties
  - Click name of layer to label and enter a name in "Enter class name" box. Do for elevation and point name.
  - Click on a Class Name and click the "Properties" button
  - Placement Properties window opens. Click the "Options" button in the "Rotate by Attributes" section
  - Label Rotation window opens. Rotation Field = None. Put a number in the box for "Additional Rotation"
  - Offset from the point can be set in the Label Manager window
  - Repeat this process for other label class in the layer, using the opposite amount of rotation.

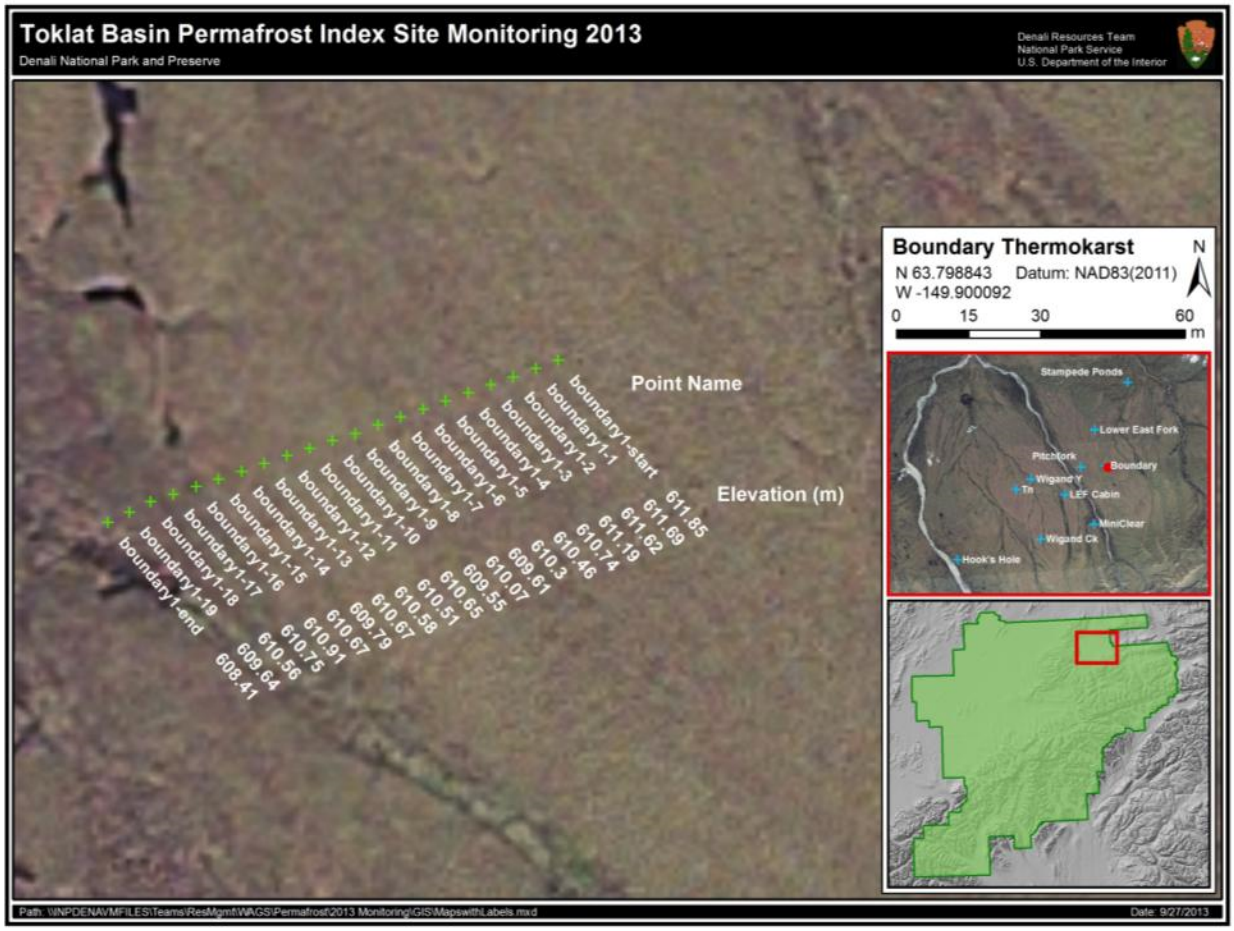

Label Manager
Label Classes
Boundary2013_albers
elev_m
name
LEF2013_albers
Default
name
LEFcabin2013_albers
Default
name
wws2013_albers
Default
name
WigandCreek2013_albers
Default
name
Pitchfork2013_albers
pitch1
pitch2
Add label class
Enter class name:
elev_m
Add
Add label classes from symbology categories
Select symbology categories:
Add
Options
Clear All
Summary...
OK
Cancel
Apply

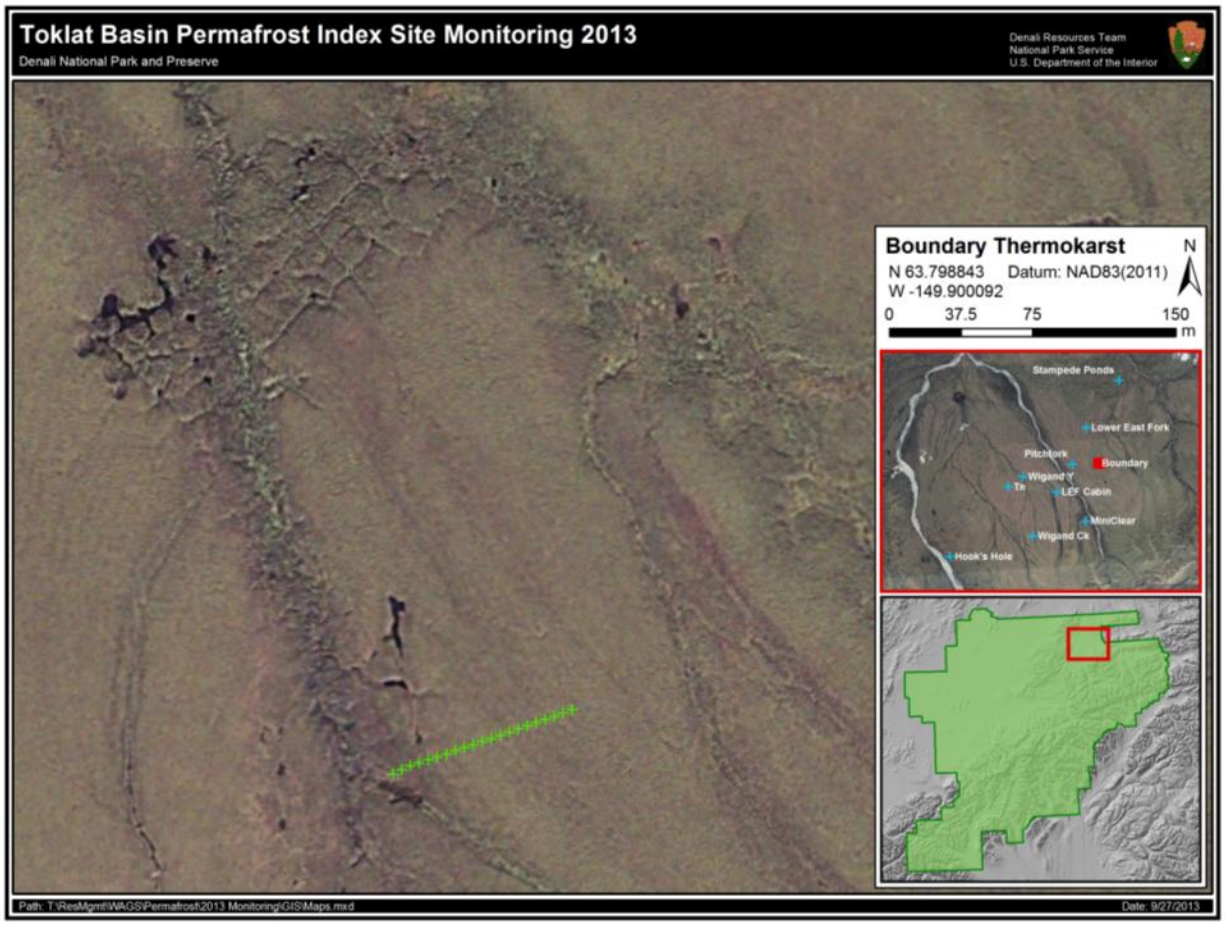

Label Manager
Label Classes
Boundary2013_albers
elev_m
name
LEF2013_albers
Default
name
LEFcabin2013_albers
Default
name
wws2013_albers
Default
name
WigandCreek2013_albers
Default
name
Pitchfork2013_albers
pitch1
pitch2
Text String
Label Field:
elev_m
Expression...
Text Symbol
Arial
11
AaBbYyZz
Symbol...
Placement Properties
Southeast
Horizontal and Southeast of point
Stack label
Properties...
Position...
Offset:
100
Points
Scale Range...
SQL Query...
Label Styles...
Options
Clear All
Summary...
OK
Cancel
Apply

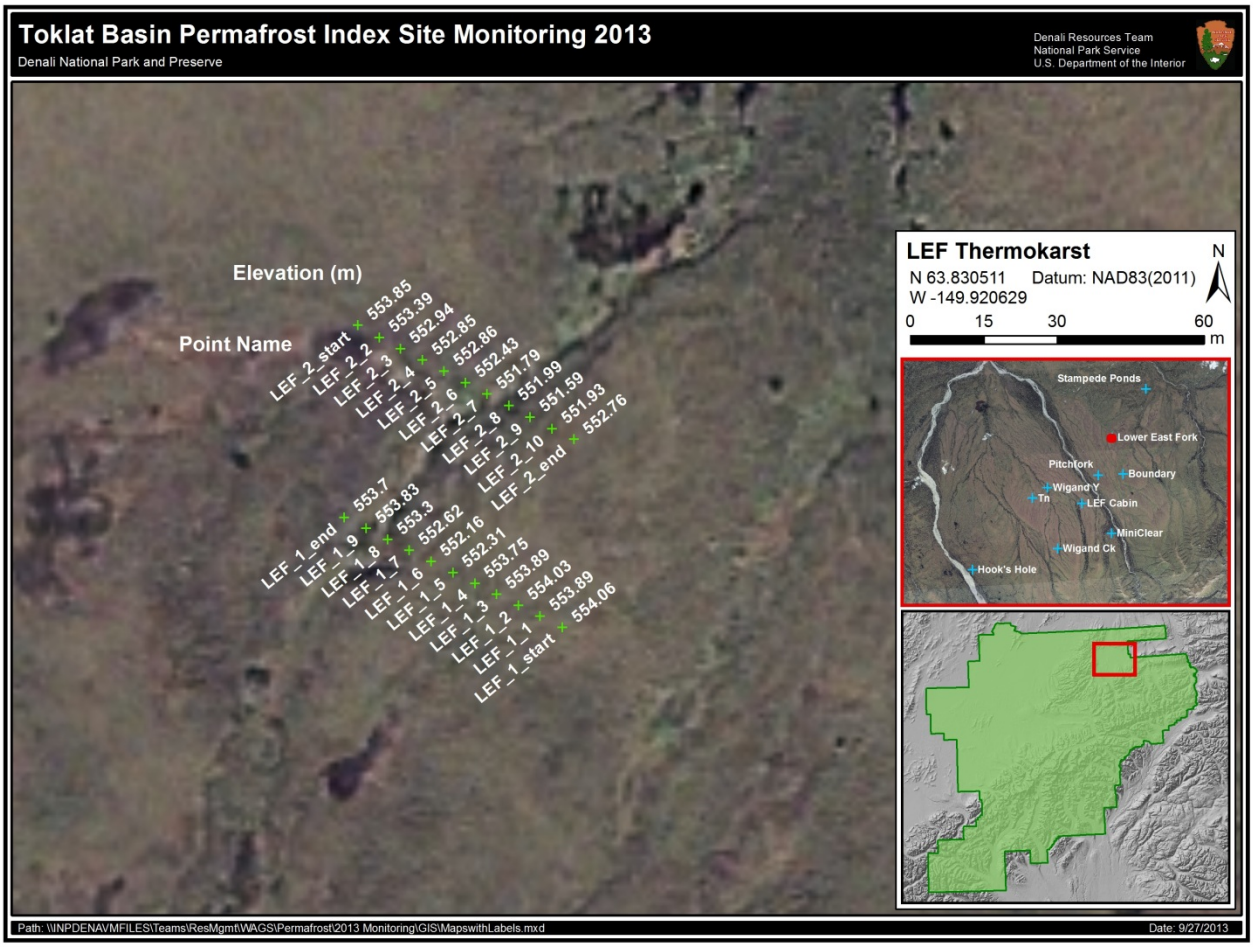

Placement Properties
Label Position
Fitting Strategy
Label Density
Conflict Resolution
General
Southeast
Horizontal and Southeast of point
May shift label upon fixed position
Position...
Label Offset...
Orientation...
Zones
User-defined zones
Options...
Angle
Rotate by attribute
Options...
OK
Cancel
Label Rotation
Rotation Field:
None
Additional Rotation:
-50
Rotation Type
90
0
180
270
Geographic
Arithmetic
Alignment Type
Label
Straight
Horizontal
Perpendicular
Keep label upright (may flip)
OK
Cancel

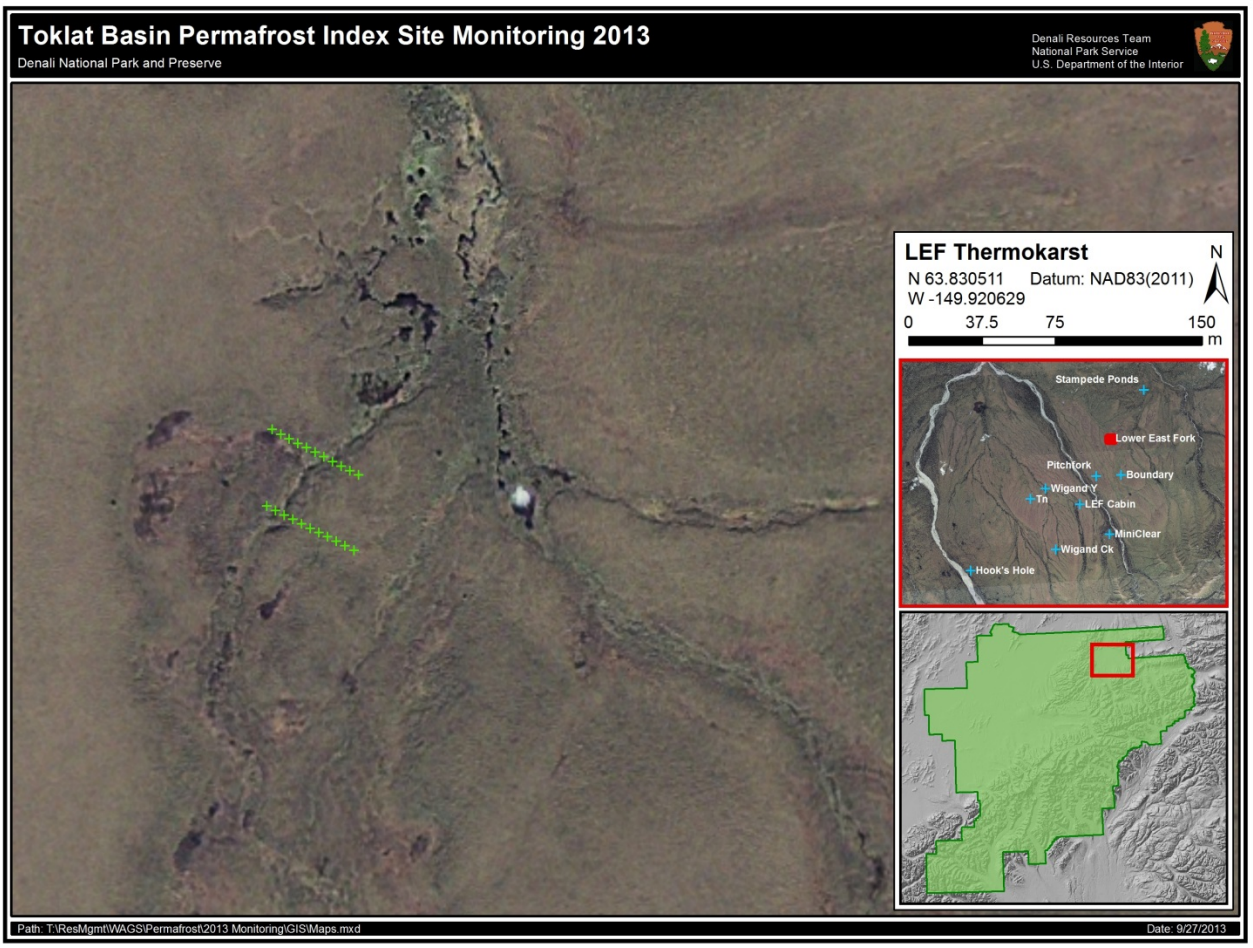
APPENDIX: 2013 MAPS

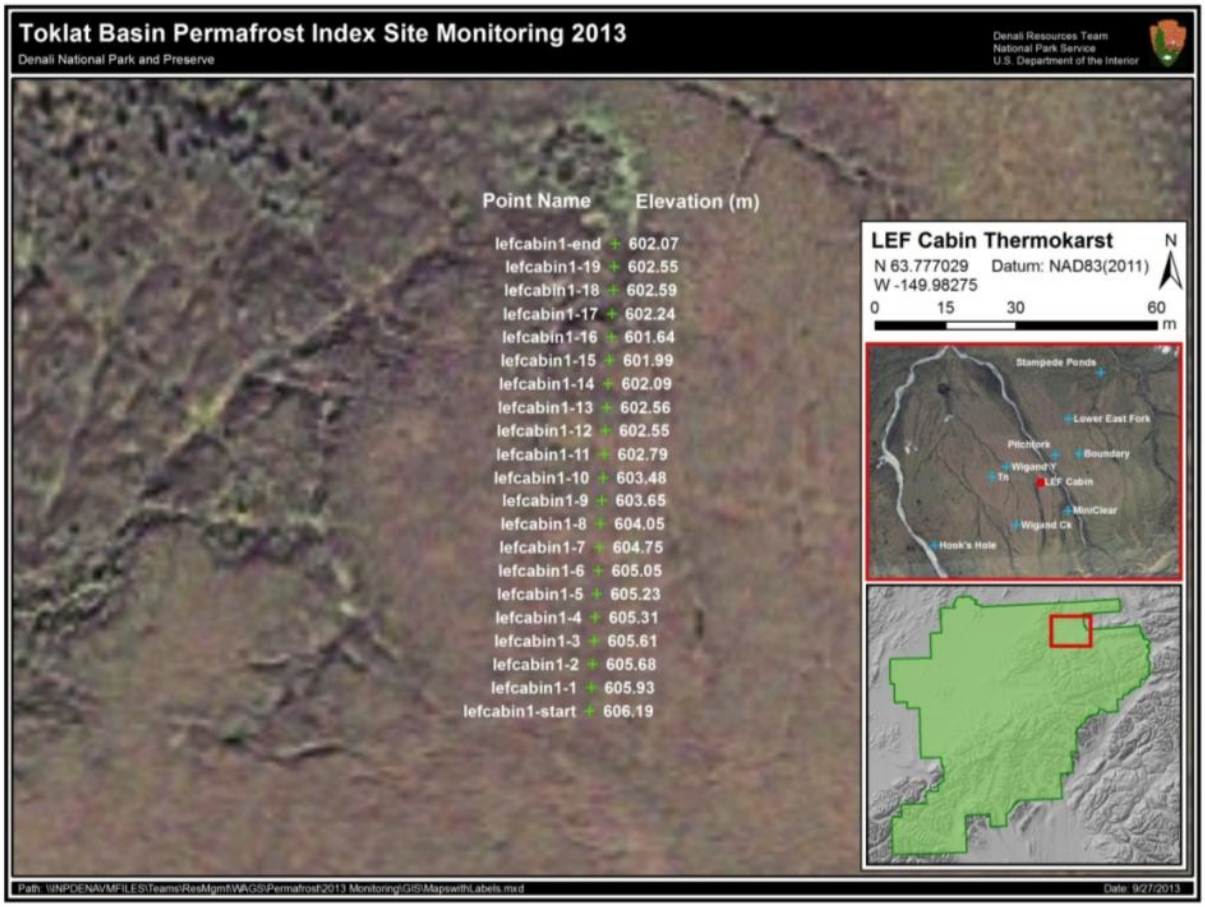


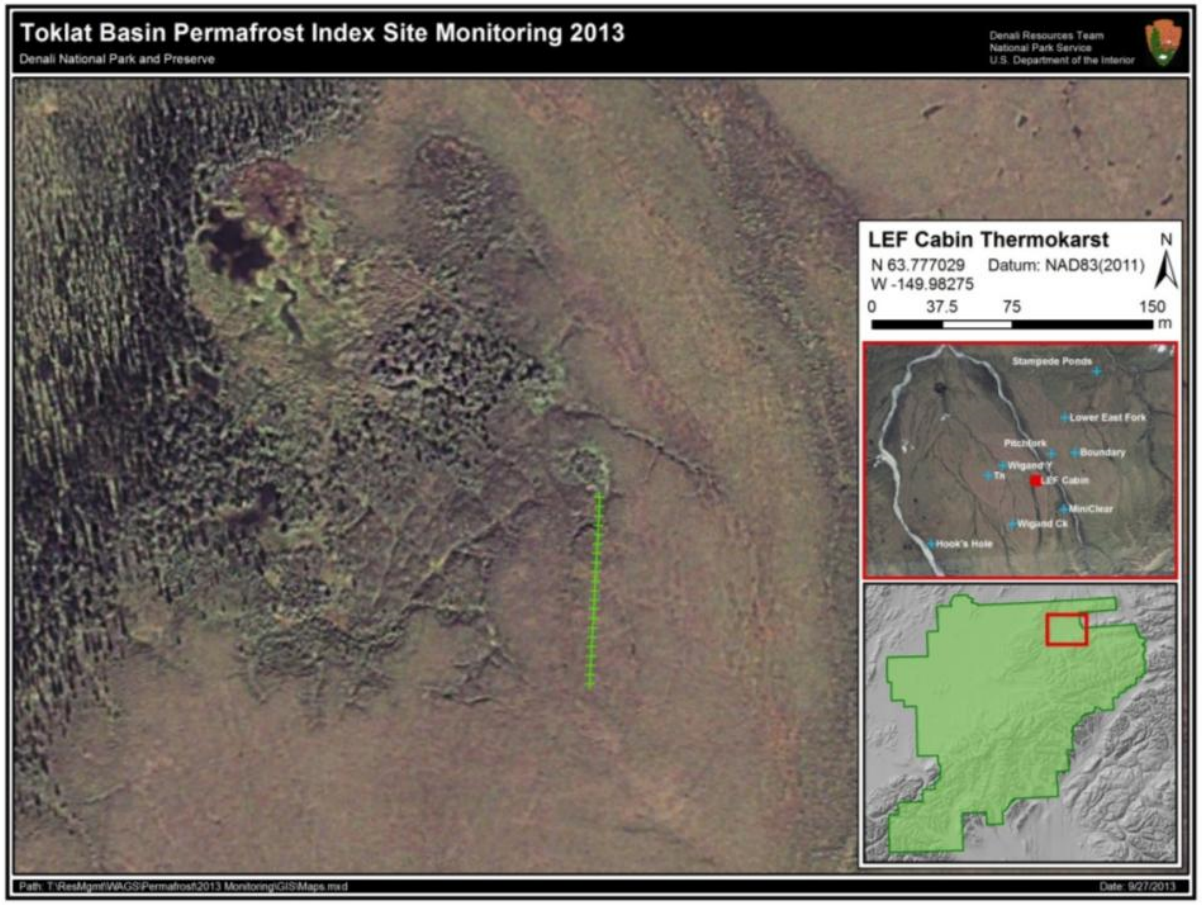

Toklat Basin Permafrost Index Site Monitoring 2013
Denali National Park and Preserve
Denali Resources Team
National Park Service
U.S. Department of the Interior
Point Name
Elevation (m)
boundary1-start 611.85
boundary1-1 611.69
boundary1-2 611.62
boundary1-3 611.19
boundary1-4 610.74
boundary1-5 610.46
boundary1-6 610.3
boundary1-7 609.61
boundary1-8 610.07
boundary1-9 609.55
boundary1-10 610.65
boundary1-11 610.51
boundary1-12 610.58
boundary1-13 610.67
boundary1-14 609.79
boundary1-15 610.67
boundary1-16 610.91
boundary1-17 610.75
boundary1-18 610.56
boundary1-19 609.64
boundary1-end 608.41
Boundary Thermokarst
N 63.798843 Datum: NAD83(2011)
W -149.900092
0 15 30 60
m
N
Stampede Ponds
Lower East Fork
Pitchfork
Boundary
Wigand Y
Tn
LEF Cabin
MiniClear
Wigand Ck
Hook's Hole
Path: \\NPDENAVMFILES\Teams\ResMgmt\WAGS\Permafrost\2013 Monitoring\GIS\MapswithLabels.mxd
Date: 9/27/2013

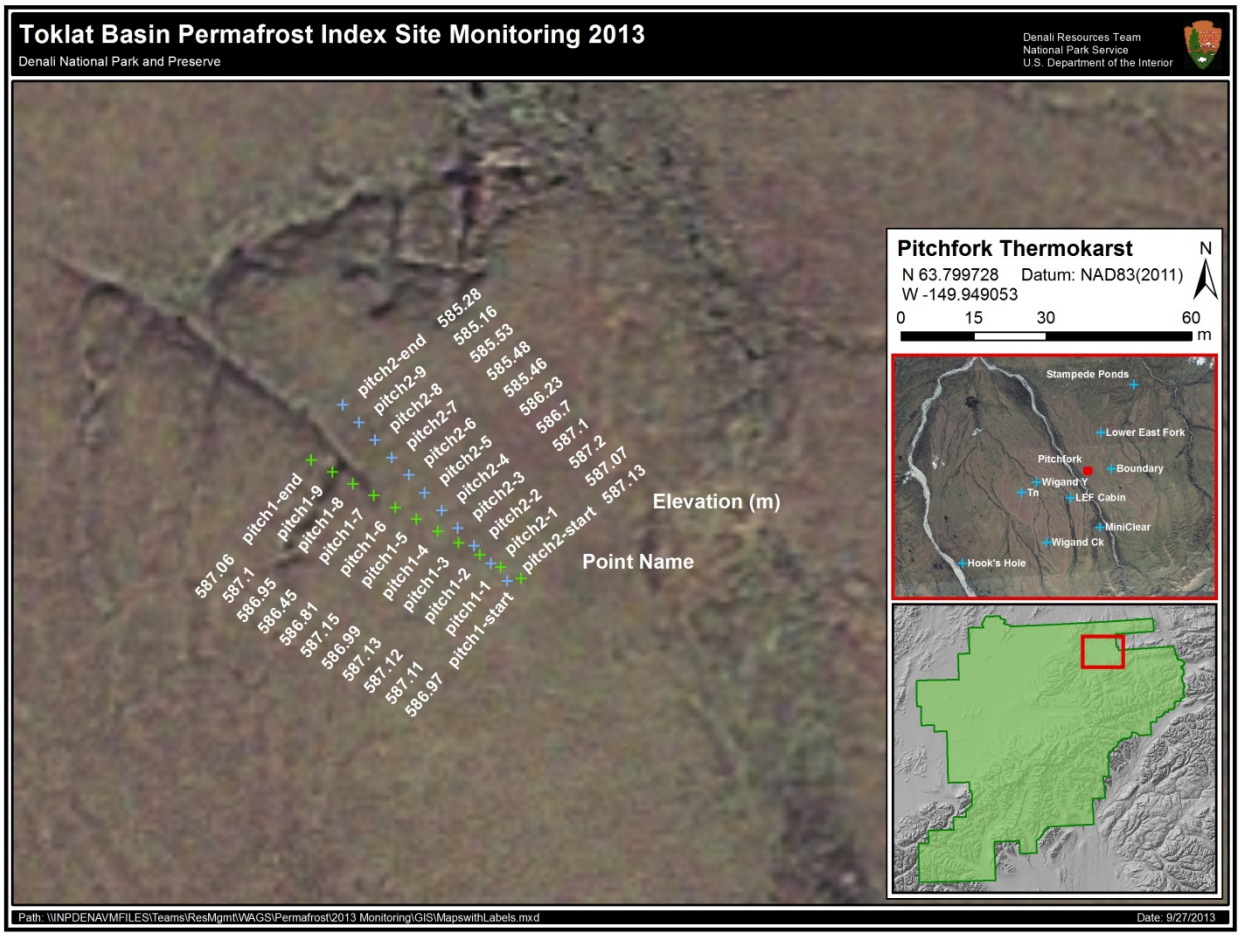

Toklat Basin Permafrost Index Site Monitoring 2013
Denali National Park and Preserve
Denali Resources Team
National Park Service
U.S. Department of the Interior
Boundary Thermokarst
N 63.798843 Datum: NAD83(2011)
W -149.900092
0 37.5 75 150
m
N
Stampede Ponds
Lower East Fork
Pitchfork
Boundary
Wigand Y
Tn
LEF Cabin
MiniClear
Wigand Ck
Hook's Hole
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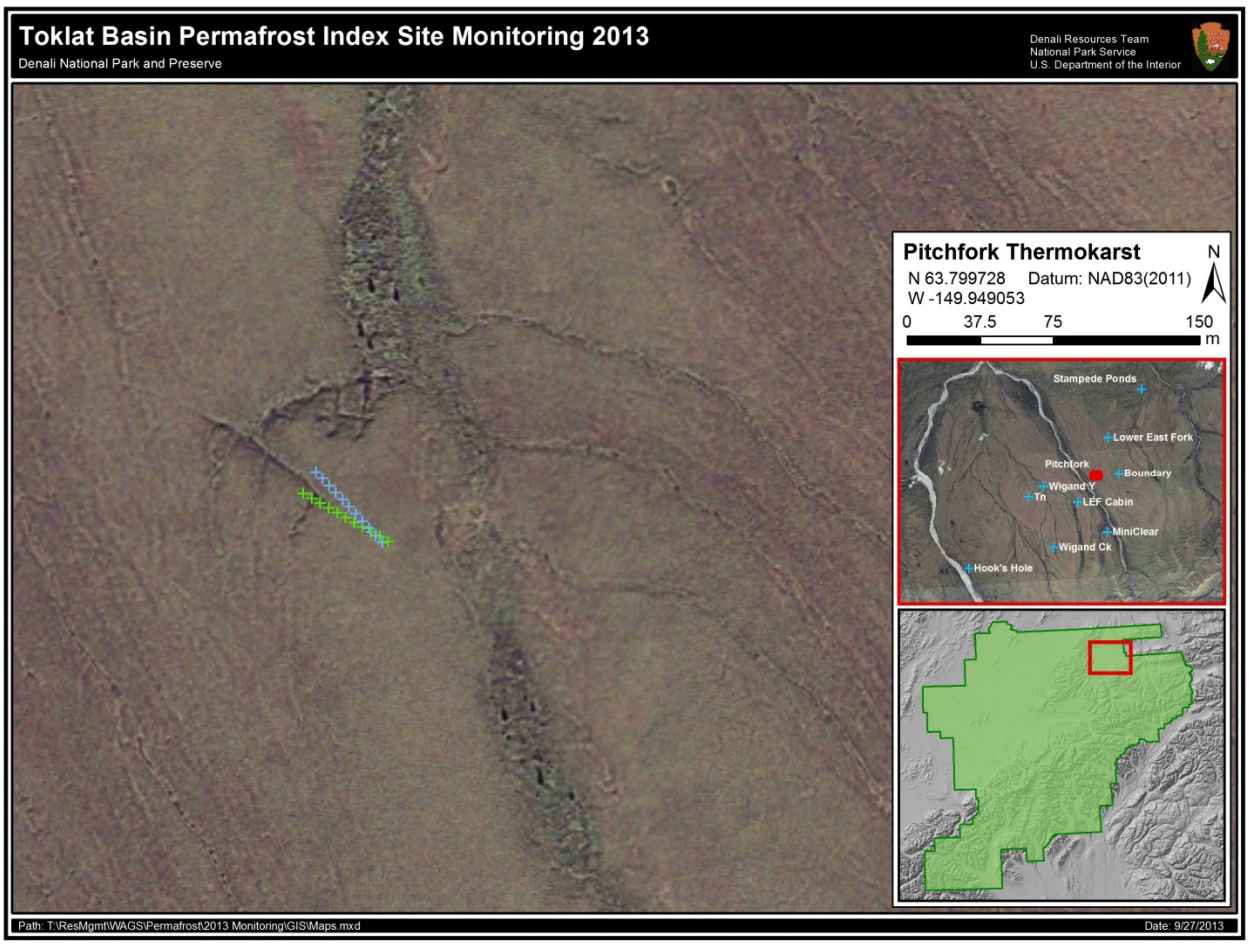

Toklat Basin Permafrost Index Site Monitoring 2013
Denali National Park and Preserve
Denali Resources Team
National Park Service
U.S. Department of the Interior
Elevation (m)
Point Name
LEF_2_start 553.85
LEF_2_2 553.39
LEF_2_3 552.94
LEF_2_4 552.85
LEF_2_5 552.86
LEF_2_6 552.43
LEF_2_7 551.79
LEF_2_8 551.99
LEF_2_9 551.59
LEF_2_10 551.93
LEF_2_end 552.76
LEF_1_end 553.7
LEF_1_9 553.83
LEF_1_8 553.3
LEF_1_7 552.62
LEF_1_6 552.16
LEF_1_5 552.31
LEF_1_4 553.75
LEF_1_3 553.89
LEF_1_2 554.03
LEF_1_1 553.89
LEF_1_start 554.06
LEF Thermokarst
N 63.830511 Datum: NAD83(2011)
W -149.920629
N
0 15 30 60
m
Stampede Ponds
Lower East Fork
Pitchfork
Boundary
Wigand Y
Tn
LEF Cabin
MiniClear
Wigand Ck
Hook's Hole
Path: \\INPDENAVMFILES\Teams\ResMgmt\WAGS\Permafrost\2013 Monitoring\GIS\MapswithLabels.mxd
Date: 9/27/2013

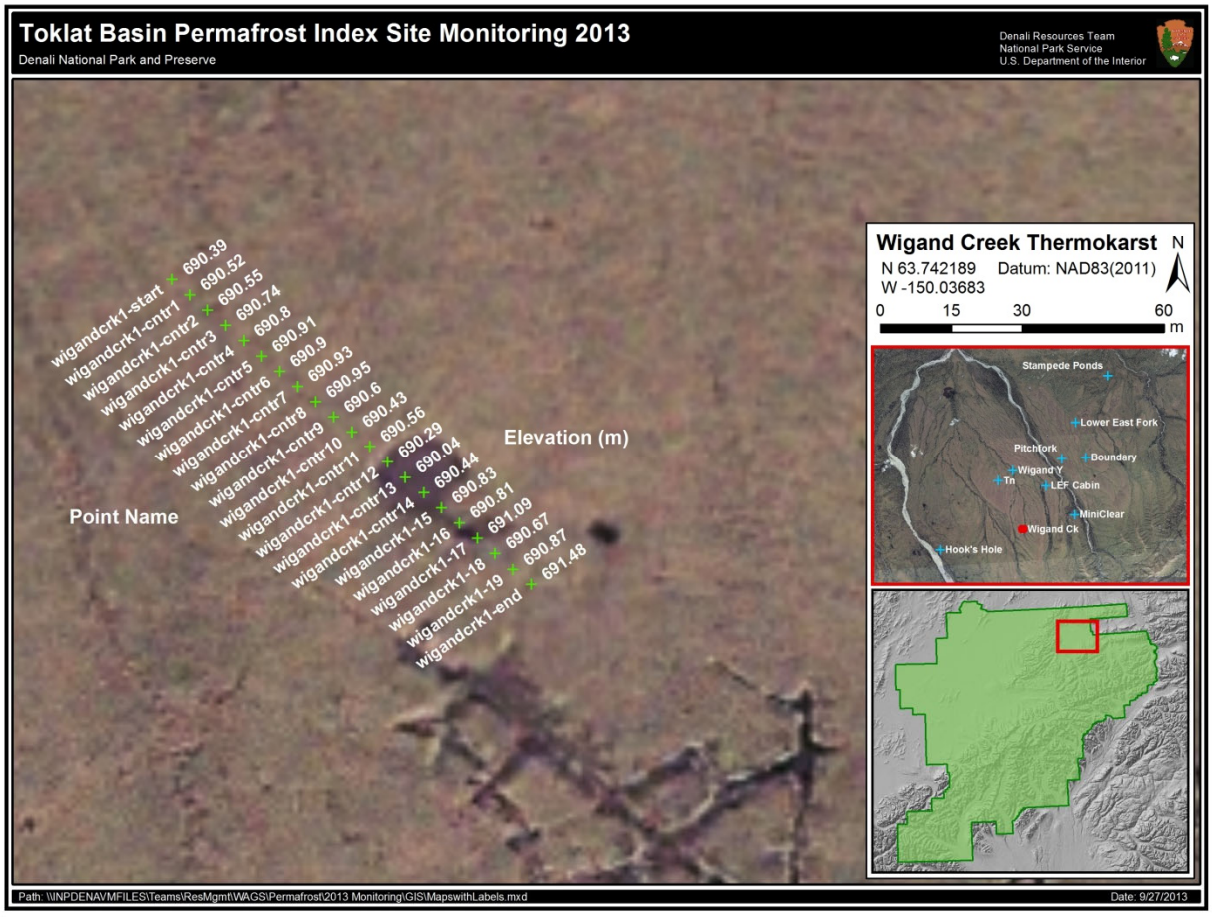

Toklat Basin Permafrost Index Site Monitoring 2013
Denali National Park and Preserve
Denali Resources Team
National Park Service
U.S. Department of the Interior
LEF Thermokarst
N 63.830511 Datum: NAD83(2011)
W -149.920629
N
0 37.5 75 150
m
Stampede Ponds
Lower East Fork
Pitchfork
Boundary
Wigand Y
Tn
LEF Cabin
MiniClear
Wigand Ck
Hook's Hole
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Date: 9/27/2013

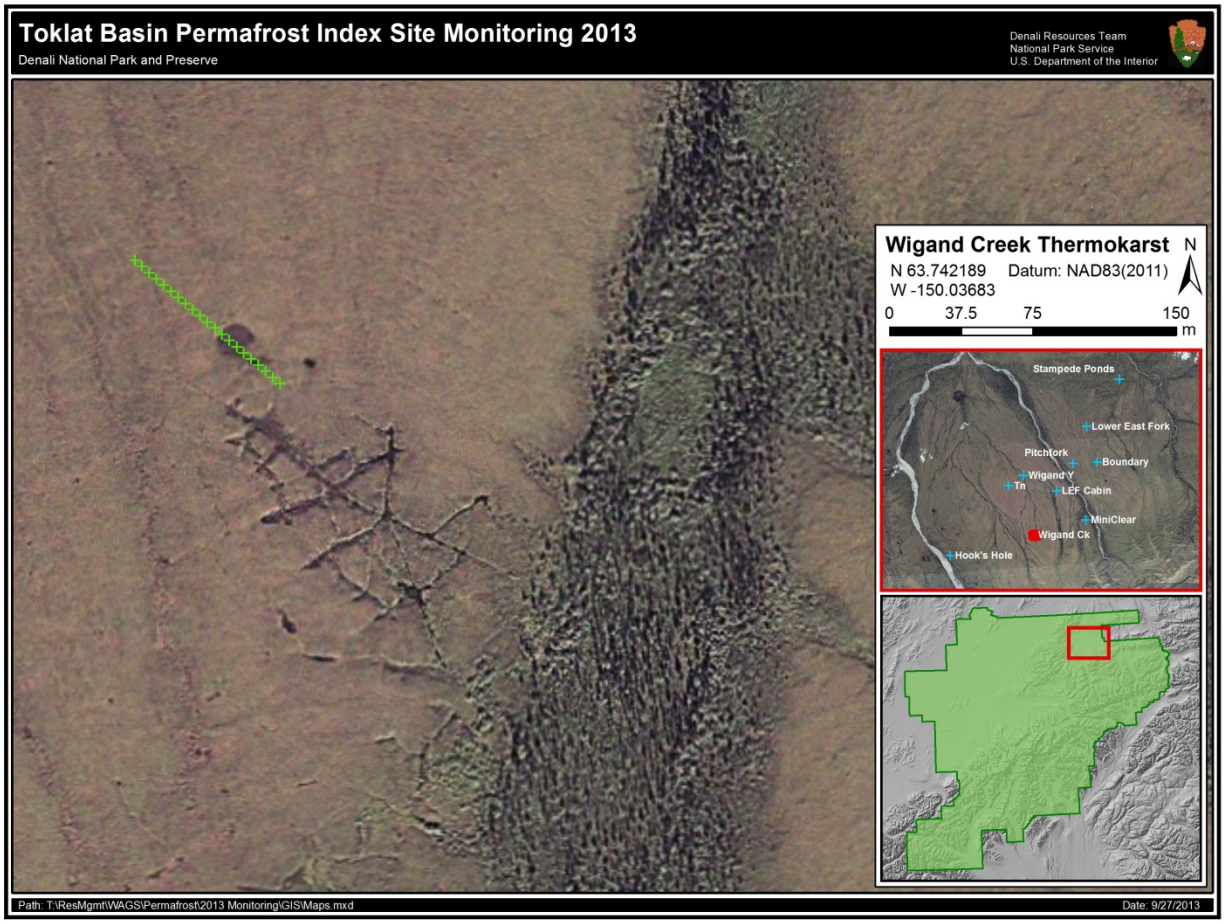

Toklat Basin Permafrost Index Site Monitoring 2013
Denali National Park and Preserve
Denali Resources Team
National Park Service
U.S. Department of the Interior
Point Name Elevation (m)
lefcabin1-end 602.07
lefcabin1-19 602.55
lefcabin1-18 602.59
lefcabin1-17 602.24
lefcabin1-16 601.64
lefcabin1-15 601.99
lefcabin1-14 602.09
lefcabin1-13 602.56
lefcabin1-12 602.55
lefcabin1-11 602.79
lefcabin1-10 603.48
lefcabin1-9 603.65
lefcabin1-8 604.05
lefcabin1-7 604.75
lefcabin1-6 605.05
lefcabin1-5 605.23
lefcabin1-4 605.31
lefcabin1-3 605.61
lefcabin1-2 605.68
lefcabin1-1 605.93
lefcabin1-start 606.19
LEF Cabin Thermokarst
N 63.777029
W -149.98275
Datum: NAD83(2011)
N
0 15 30 60
m
Stampede Ponds
Lower East Fork
Pitchfork
Boundary
Wigand Y
Tn
LEF Cabin
MiniClear
Wigand Ck
Hook's Hole
Path: \\NPDENAVMFILES\Teams\ResMgmt\WAGS\Permafrost\2013 Monitoring\GIS\MapswithLabels.mxd
Date: 9/27/2013

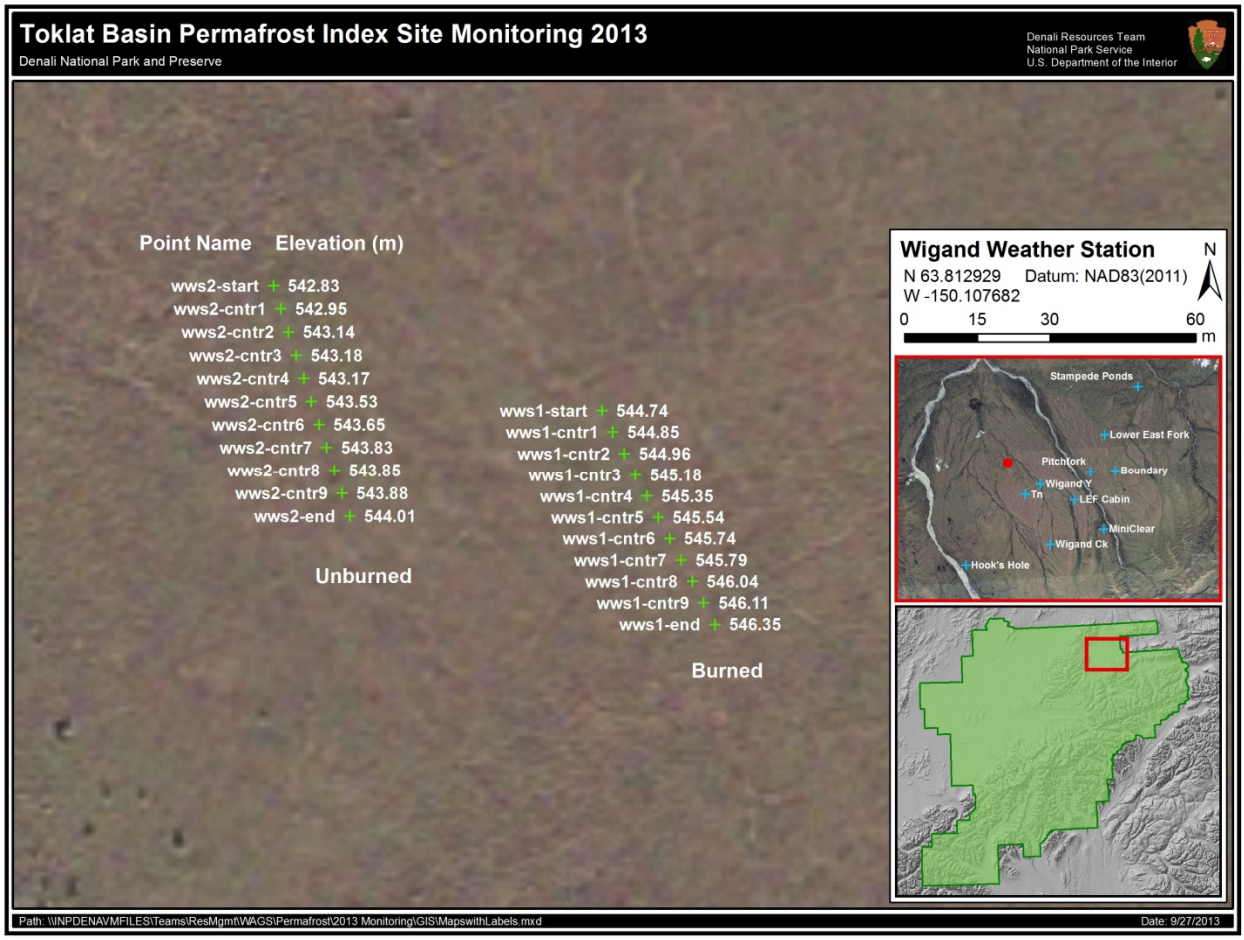

Toklat Basin Permafrost Index Site Monitoring 2013
Denali National Park and Preserve
Denali Resources Team
National Park Service
U.S. Department of the Interior
LEF Cabin Thermokarst
N 63.777029
W -149.98275
Datum: NAD83(2011)
N
0 37.5 75 150
m
Stampede Ponds
Lower East Fork
Pitchfork
Boundary
Wigand Y
Tn
LEF Cabin
MiniClear
Wigand Ck
Hook's Hole
Path: T:\ResMgmt\WAGS\Permafrost\2013 Monitoring\GIS\Maps.mxd
Date: 9/27/2013

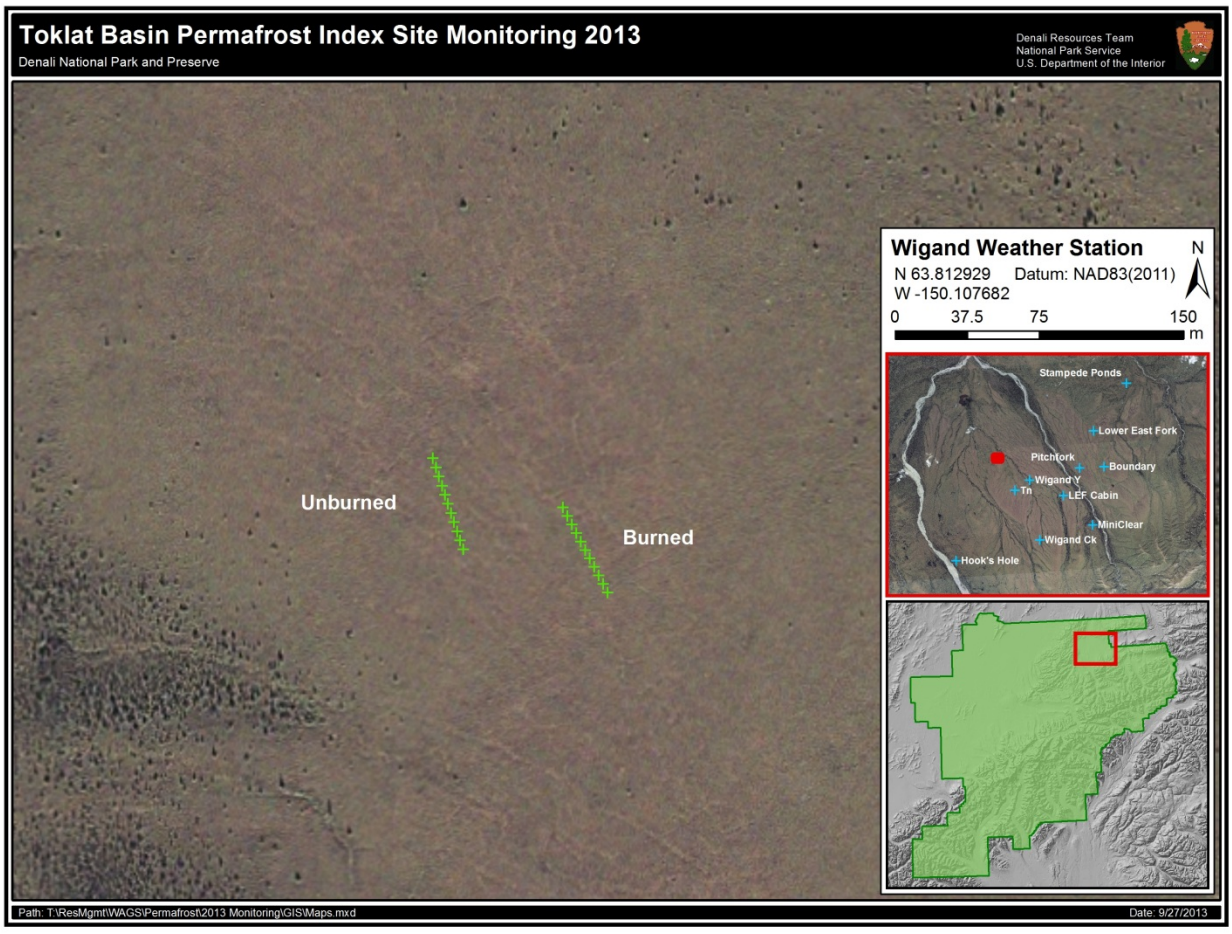

Toklat Basin Permafrost Index Site Monitoring 2013
Denali National Park and Preserve
Denali Resources Team
National Park Service
U.S. Department of the Interior
Pitchfork Thermokarst
N 63.799728 Datum: NAD83(2011)
W -149.949053
0 15 30 60
m
N
Elevation (m)
Point Name
pitch2-end 585.28
pitch2-9 585.16
pitch2-8 585.53
pitch2-7 585.48
pitch2-6 585.46
pitch2-5 586.23
pitch2-4 586.7
pitch2-3 587.1
pitch2-2 587.2
pitch2-1 587.07
pitch2-start 587.13
pitch1-end 587.06
pitch1-9 587.1
pitch1-8 586.95
pitch1-7 586.45
pitch1-6 586.81
pitch1-5 587.15
pitch1-4 586.99
pitch1-3 587.13
pitch1-2 587.12
pitch1-1 587.11
pitch1-start 586.97
Stampede Ponds
Lower East Fork
Pitchfork
Boundary
Wigand Y
Tn
LEF Cabin
MiniClear
Wigand Ck
Hook's Hole
Path: \\INPDENAVMFILES\Teams\ResMgmt\WAGS\Permafrost\2013 Monitoring\GIS\MapswithLabels.mxd
Date: 9/27/2013


Toklat Basin Permafrost Index Site Monitoring 2013
Denali National Park and Preserve
Denali Resources Team
National Park Service
U.S. Department of the Interior
Pitchfork Thermokarst
N 63.799728 Datum: NAD83(2011)
W -149.949053
0 37.5 75 150
m
N
Stampede Ponds
Lower East Fork
Pitchfork
Boundary
Wigand Y
Tn
LEF Cabin
MiniClear
Wigand Ck
Hook's Hole
Path: T:\ResMgmt\WAGS\Permafrost\2013 Monitoring\GIS\Maps.mxd
Date: 9/27/2013


Toklat Basin Permafrost Index Site Monitoring 2013
Denali National Park and Preserve
Denali Resources Team
National Park Service
U.S. Department of the Interior
Point Name
Elevation (m)
wigandcrk1-start 690.39
wigandcrk1-cntr1 690.52
wigandcrk1-cntr2 690.55
wigandcrk1-cntr3 690.74
wigandcrk1-cntr4 690.8
wigandcrk1-cntr5 690.91
wigandcrk1-cntr6 690.9
wigandcrk1-cntr7 690.93
wigandcrk1-cntr8 690.95
wigandcrk1-cntr9 690.6
wigandcrk1-cntr10 690.43
wigandcrk1-cntr11 690.56
wigandcrk1-cntr12 690.29
wigandcrk1-cntr13 690.04
wigandcrk1-cntr14 690.44
wigandcrk1-15 690.83
wigandcrk1-16 690.81
wigandcrk1-17 691.09
wigandcrk1-18 690.67
wigandcrk1-19 690.87
wigandcrk1-end 691.48
Wigand Creek Thermokarst
N 63.742189 Datum: NAD83(2011)
W -150.03683
N
0 15 30 60
m
Stampede Ponds
Lower East Fork
Pitchfork
Boundary
Wigand Y
Tn
LEF Cabin
MiniClear
Wigand Ck
Hook's Hole
Path: \\INPDENAVMFILES\Teams\ResMgmt\WAGS\Permafrost\2013 Monitoring\GIS\MapswithLabels.mxd
Date: 9/27/2013


Toklat Basin Permafrost Index Site Monitoring 2013
Denali National Park and Preserve
Denali Resources Team
National Park Service
U.S. Department of the Interior
Wigand Creek Thermokarst
N 63.742189 Datum: NAD83(2011)
W -150.03683
N
0 37.5 75 150
m
Stampede Ponds
Lower East Fork
Pitchfork
Boundary
Wigand Y
Tn
LEF Cabin
MiniClear
Wigand Ck
Hook's Hole
Path: T:\ResMgmt\WAGS\Permafrost\2013 Monitoring\GIS\Maps.mxd
Date: 9/27/2013


Toklat Basin Permafrost Index Site Monitoring 2013
Denali National Park and Preserve
Denali Resources Team
National Park Service
U.S. Department of the Interior
Point Name Elevation (m)
wws2-start + 542.83
wws2-cntr1 + 542.95
wws2-cntr2 + 543.14
wws2-cntr3 + 543.18
wws2-cntr4 + 543.17
wws2-cntr5 + 543.53
wws2-cntr6 + 543.65
wws2-cntr7 + 543.83
wws2-cntr8 + 543.85
wws2-cntr9 + 543.88
wws2-end + 544.01
Unburned
wws1-start + 544.74
wws1-cntr1 + 544.85
wws1-cntr2 + 544.96
wws1-cntr3 + 545.18
wws1-cntr4 + 545.35
wws1-cntr5 + 545.54
wws1-cntr6 + 545.74
wws1-cntr7 + 545.79
wws1-cntr8 + 546.04
wws1-cntr9 + 546.11
wws1-end + 546.35
Burned
Wigand Weather Station
N 63.812929 Datum: NAD83(2011)
W -150.107682
N
0 15 30 60
m
Stampede Ponds
Lower East Fork
Pitchfork
Boundary
Wigand Y
Tn
LEF Cabin
MiniClear
Wigand Ck
Hook's Hole
Path: \\INPDENAVMFILES\Teams\ResMgmt\WAGS\Permafrost\2013 Monitoring\GIS\MapswithLabels.mxd
Date: 9/27/2013


Toklat Basin Permafrost Index Site Monitoring 2013
Denali National Park and Preserve
Denali Resources Team
National Park Service
U.S. Department of the Interior
Unburned
Burned
Wigand Weather Station
N 63.812929 Datum: NAD83(2011)
W -150.107682
N
0 37.5 75 150
m
Stampede Ponds
Lower East Fork
Pitchfork
Boundary
Wigand Y
Tn
LEF Cabin
MiniClear
Wigand Ck
Hook's Hole
Path: T:\ResMgmt\WAGS\Permafrost\2013 Monitoring\GIS\Maps.mxd
Date: 9/27/2013