Snow Pits

Book Name:

Pit ID	Date

INSTRUCTIONS AND REFERENCE	
1	Approach pit on single trail and leave on same trail when finished
2	Fill out data sheet header and take photo of header so that subsequent photos can be identified
3	Record new snow measurements with SWE tube & scale, note any melt evidence; then clear interval board & reset
4	Carefully excavate shaded face about 1 meter from prior pit - leave area as undisturbed as possible
5	Place ruler or depth probe on pit wall; instances where snow depth varies - record ruler height at density profile location
6	Take pit wall photo with both cameras; take site photos N, E, S, W, and overhead canopy in order
7	Measure LWC with A2 WISe sensor in dual profile, record permittivity
8	Simultaneously take temperature profile, record start and end time & measure density in dual profile top to bottom; shovel fresh face of wall as needed
9	Record stratigraphy layers, grain size & type, hand hardness, and manual wetness; shovel fresh face of wall as needed
#	Fill in all data and initial check list on second page - ***Leave no blanks!*** Use a dash (-) to indicate no data recorded
#	Take photos of completed Pit and Pit Sheets with regular camera
#	Backfill pit with snow - leave pole marker on edge of disturbed snow near measurement face

Snow Grains	
Grain Type	***Letter code***
Surface Hoar	**SH**
Precipitation Particles	**PP**
Decomposing & Fragmented	**DF**
Rounded Grains	**RG**
Faceted Crystals (incl. depth hoar)	**FC**
Melt Forms	**MF**
Ice Formations	**IF**
Melt-Freeze Crust	**MFcr**
Graupel	**PPgp**
Near-Surface Facets	**FCsf**

Hand Hardness			
Manual Test	***Code***	***Description***	***Force (N)***
Fist	**F**	very soft	0-50
4 Finger	**4F**	soft	50-175
1 Finger	**1F**	medium	175-390
Pencil (blunt end)	**P**	hard	390-715
Knife	**K**	very hard	715-1200
Ice	**I**	ice	>1200

Manual Snow Wetness		
Test	***Description***	***Code***
Dry	Will not pack	**D**
Moist	Sticks together	**M**
Wet	Perfect snowballs	**W**
Very Wet	Water can be squeezed out	**V**
Soaked	Water drains freely	**S**

Perform Hand Hardness and Manual Snow Wetness measurements with gloved hand.

Snow Pit Sheet Explanations	
Header	
Location	Regional scale site description
Site	Local scale site description (i.e study plot area)
Pit ID	<site code>_<YYYYMMDD>; site code is 2-letter stateID, 2-letter locationID, 2-letter siteID
Date	M/D/YY, e.g. 2/7/17
Time	Time that pit wall was opened. Military Local Time, (e.g. 1425 MST)
Observers	Write first initial & last name of each person, e.g. D. Smith , J. Jones
Snow Depth	Total snow depth value from ruler or probe on pit wall; record depth value at density profile loc.
UTME	UTM easting - use value from your GPS
UTMN	UTM northing - use value from your GPS
Zone	One or two digits UTM zone (e.g. 12) - use GPS value; if available record uncertainty
Temp profile times	Start and end times of the temperature profile
Comments/Notes	Anything of interest or use that doesn't fit in another category, for example:
	Small streambed in bottom of pit
	Ice layers from 83-67 cm made sampling difficult
Density	
Height above ground	Top - greatest value level with surface on ruler. Bottom - ground contact with ruler (0 cm)
Density	Density measurements are taken every 10 cm from surface (e.g. 93-83, 83-73, 73-63,...,13-3)
	Weigh empty density cutter, record weight; tare empty cutter prior to first measurement
	At profile base, try to get measurement as close to ground as possible (e.g. 11-1)
Profile A	Density from first sample in dual profile (gram value from scale - e.g. 323)
Profile B	Density from second sample. If different by more than 10%, take extra density sample
Liquid Water Content	
LWC Serial #	The serial number of the A2 WISe LWC sensor.
Profile A	LWC probe measurement in the middle of the 10cm interval (e.g. if 10cm interval is 107-97cm, then make LWC measurement at 102 cm). Quick Guide: 1- power the device; 2 - Press Air button to calibrate air frequency to permittivity of 1 (device is dry and free of snow); 3 - Press Check button to validate calibration; 4 - Place sampler into the snowpack; 5 - Press Check button to acquire data 6 - Record permittivity; 7 - Skip density estimate and proceed to next sample. Note: permittivity here is the general term for both relative permittivity and the dielectric constant (k=ε/ε_o)
Profile B	Same as for Profile A, but for second sample at same height.
Temperature	
Height above ground	Measure at snow surface under shaded shovel handle, then continue with 10 cm increments on even tens (e.g. 93, 90, 80, 70,…,0)
Temperature	Read digital thermometer and record to tenth of a degree Celsius (e.g. -5.2) Do NOT use F. Second thermometer is a spare, only use 1 for profile measurements.
Stratigraphy	
Height above ground	Height of distinct layer boundaries. Will not match density heights (e.g. 93-77)
	Bottom of one layer should be same as top of the next layer; leave no area unaccounted for
Grain size	Place an 'X' in the box for the appropriate grain size category
Grain type	Letter code - see Sheet 2
Hand hardness	Letter code - see Sheet 2
Manual wetness	Letter code - see Sheet 2; Used gloved hand.
Stratigraphy comments	Any useful information that will help in interpretation
	e.g. Lens is discontinuous and varies in thickness (2-15 mm)

Snow Pit Sheet Explanations	
Header	
Location / Site / Pit ID	Same as sheet 1, but FILL THIS OUT! This will keep these sheets together in database
Observers	Same as sheet 1, but FILL THIS OUT! This will keep these sheets together in database
Date / Time	Same as sheet 1, but FILL THIS OUT! This will keep these sheets together in database
Check list	Note taker should initial who performed each item as it is completed
Environment	
Weather Description	Comments not addressed in boxes below - e.g. high cirrus; cloud cover changing rapidly; air temperature dropping steadily; wind increasing, etc.
Precipitation	None - no atmospheric deposition - there may be blowing snow, but no snowfall
	Very Light: occasional snowflake up to ~ 0.5 cm per hour accumulation
	Light: ~ 1 cm per hour accumulation
	Moderate: ~ 2 cm per hour accumulation
	Heavy: ~ 5 cm per hour accumulation
Sky	CLEAR: no clouds
	FEW: up to 1/4 of sky covered by clouds
	SCATTERED: partly cloudy; 3/8 - 4/8 of sky covered by clouds
	BROKEN: Mostly cloudy; more than half but not all of sky covered by clouds
	OVERCAST: sky is completely covered by clouds
Wind	CALM: no air motion
	LIGHT: light to gentle breeze; flags and twigs in motion
	MODERATE: fresh breeze; small trees sway; flags stretched; snow begins to drift
	STRONG: strong breeze; whole trees in motion
	EXTREME: gale force or higher
Ground condition	Frozen: any loose dirt crumbles or remains in place
	Moist: mud forms while working in pit
	Saturated: water pools at bottom of pit
Ground roughness	Smooth < 5 cm variability; Rough 5 - 20 cm; Rugged > 20 cm, rocks, deadfall, etc.
Ground vegetation	Note that there may be one or more categories present - circle all that apply
	Bare - little or no vegetation - duff, exposed soil or rock surface
	Grass - any grass, forb or sedge
	Shrub - any bush or shrub with woody stem
	Deadfall - significant sticks, logs, or dead trees on or near ground
Height of ground vegetation	Measure avgerage veg height and record in box below veg type (one height/veg type)
	Grass - height if penetrating snowpack, thickness of mat if compressed
Tree canopy	Rough categories looking straight overhead from pit site
Interval Board	
	Make 3 depth and SWE measurements using a small SWE tube & spring scale
	"Yes" if any evidence of melt exists, either on surface or within/below snow on the board
	Compute the density (ρ) column from SWE (mm) and Depth (cm). $\rho = SWE/Depth * 100$
Additional Data Collection	
Other field observers at pit	Note any other insturment activity going on in addition to standard snow pit
Data Set Types	Core (CR): largely consistent with other campaign sites (i.e. depths, Federal Sampler)
	Site Infrastructure (SI): fixed long-term instrumentation (e.g. tower radar, temp. array)
	Remote Sensing (RS): grd-based operated airborne instrument (e.g. SfM, thermal-IR)
	Coincident (CI): opportunistic data collection from specialized grd-based instrumentation (e.g. GB-radar, SSA, SMP)

Location (Regional):	**Date** (yyyy-mm-dd):	**Observers** (first initial & last name):		**Comments/Notes:**
			Temperature profile times	
Site (Study Plot):	**Time** (pit opened):		**START** | **END**	

Pit ID: (unique id, e.g. 2-letter: state, loc, site)	**HS (cm)**	**LWC serial #**	**UTME:**	**UTMN:**	**Zone:** (two digit)	**GPS device & uncertainty:**

Density				**LWC**		**Temperature**	
Height above ground	Density profile A	Density profile B	Extra Density	Permittivity profile A	Permittivity profile B	Height above ground	*T*
top (cm) - bottom (cm)	kg/m^3	kg/m^3	kg/m^3	(unitless)	(unitless)	(cm)	^oC
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Stratigraphy									
Height above ground	Grain Size (place 'X' in column)					Grain Type	Hand Hardness	Manual Wetness	Stratigraphy Comments
top (cm) - bottom (cm)	< 1 mm	1-2 mm	2-4 mm	4-6 mm	> 6 mm				
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Location:	Observers:	Weather Description:
Site:	**Time:**	
Pit ID:	**Date:**	

Precip Rate (circle one)	None	Very Light	Light	Moderate	Heavy	
Precip Type	Rain	Snow	Graupel	Hail		
Sky (circle one)	Clear	Few (< ¼ of sky)	Scattered (¼ - ½ of sky)	Broken (> ½ of sky)	Overcast (complete cover)	
Wind (circle one)	Calm	Light	Moderate	Strong	Extreme	
Ground Condition (circle one)		Frozen	Moist	Saturated		
Ground Roughness (circle one)		Smooth (< 5 cm)	Rough (5-20 cm)	Rugged (>20cm)		
Ground Vegetation (circle one or more)		Bare	Grass	Shrub	Deadfall	
Height of Ground Vegetation (if present, enter avg. height below veg type)			cm	cm	cm	
Tree Canopy (circle one)		No Trees	Sparse (5-20%)	Open (20-70%)	Closed (>70%)	

Checklist
Initial with observer that performed each item

Checklist				
	Metadata in Headers		Grain Size Measurements	
	Photos of Pit Wall & Site		Grain Type Measurements	
	Density Profile		Hand Hardness / Wetness Profile	
	A2 WISe LWC Profile		Weather Observations	
	Temperature Profile		Ground & Vegetation Observations	
	Interval Board Measurements		Photos of Pit Sheets	
	Predominant Note Taker		Backfill Pit & Restake Pit Marker	

Interval board measurements (use SWE tube)

	Depth (cm)	SWE (mm)	ρ (kg/m^3)
Sample A			
Sample B			
Sample C			
Evidence of Melt?		Yes	No

Additional Data Collection

Observation: (e.g. SSA, SMP, GPR, depth, radar)	**Observer:**	**Instrument-ID:**	**Additional Notes:**

Location (Regional):		**Date** (yyyy-mm-dd):	**Observers** (first initial & last name):					**Comments/Notes:**
						Temperature profile times		
Site (Study Plot):		**Time** (pit opened):				**START**	**END**	
Pit ID: (unique id, e.g. 2-letter: state, loc, site)	**HS (cm)**	**LWC serial #**	**UTME:**	**UTMN:**	**Zone:** (two digit)	**GPS device & uncertainty:**		

Density				**LWC**		**Temperature**	
Height above ground	Density profile A	Density profile B	Extra Density	Permittivity profile A	Permittivity profile B	Height above ground	*T*
top (cm) - bottom (cm)	kg/m^3	kg/m^3	kg/m^3	(unitless)	(unitless)	(cm)	°C
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Location:	Observers:	Weather Description:
Site:	**Time:**	
Pit ID:	**Date:**	

Precip Rate (circle one)	None	Very Light	Light	Moderate	Heavy	
Precip Type	Rain	Snow	Graupel	Hail		
Sky (circle one)	Clear	Few (< ¼ of sky)	Scattered (¼ - ½ of sky)	Broken (> ½ of sky)	Overcast (complete cover)	
Wind (circle one)	Calm	Light	Moderate	Strong	Extreme	
Ground Condition (circle one)		Frozen	Moist	Saturated		
Ground Roughness (circle one)		Smooth (< 5 cm)	Rough (5-20 cm)	Rugged (>20cm)		
Ground Vegetation (circle one or more)		Bare	Grass	Shrub	Deadfall	
Height of Ground Vegetation (if present, enter avg. height below veg type)			cm	cm	cm	
Tree Canopy (circle one)		No Trees	Sparse (5-20%)	Open (20-70%)	Closed (>70%)	

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	Predominant Note Taker		Backfill Pit & Restake Pit Marker	

Interval board measurements (use SWE tube)

	Depth (cm)	SWE (mm)	ρ (kg/m^3)
Sample A			
Sample B			
Sample C			
Evidence of Melt?		Yes	No

Additional Data Collection

Observation: (e.g. SSA, SMP, GPR, depth, radar)	**Observer:**	**Instrument-ID:**	**Additional Notes:**

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Wind (circle one)	Calm	Light	Moderate	Strong	Extreme	
Ground Condition (circle one)		Frozen	Moist	Saturated		
Ground Roughness (circle one)		Smooth (< 5 cm)	Rough (5-20 cm)	Rugged (>20cm)		
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Height of Ground Vegetation (if present, enter avg. height below veg type)			cm	cm	cm	
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Initial with observer that performed each item

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	Temperature Profile		Ground & Vegetation Observations	
	Interval Board Measurements		Photos of Pit Sheets	
	Predominant Note Taker		Backfill Pit & Restake Pit Marker	

Interval board measurements (use SWE tube)

	Depth (cm)	SWE (mm)	ρ (kg/m^3)
Sample A			
Sample B			
Sample C			
Evidence of Melt?		Yes	No

Additional Data Collection

Observation: (e.g. SSA, SMP, GPR, depth, radar)	**Observer:**	**Instrument-ID:**	**Additional Notes:**