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## Chapter 3

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## Data Site Selection



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*Cover photo: Buck Flat SNOTEL site, Utah (NRCS)*

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# Chapter 3

# Data Site Selection

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**622.0300 Introduction**

Data used in the development of the snowpack reports and water supply forecasts are collected using a network of manually measured snow courses, aerial markers, and automated sites referred to as “snow telemetry (SNOTEL) sites.” Data collection site locations should represent hydrologic and meteorological conditions of the watershed. Locations selected for the installation of new sites should be optimal for providing data that contributes to the accuracy of basin water supply forecasts. New data collection site installations intended to increase forecast accuracy should be prioritized.

Each data collection site in the network is unique, and the factors to be considered for each site installation vary depending upon purposes of the site. Evaluation of physical site characteristics (e.g., slope, aspect, exposure, vegetative cover, geographical area representation, access, and footprint), communication characteristics (e.g., telemetry and solar window), security, and aesthetics provide valuable information for site selection. The availability of additional meteorological data (required input for the water supply forecasts) provides additional important site selection information. Manual data site selection should always take into account conversion of the site, as manual data collection sites are often converted to automated collection sites.

Site selection is a key component to obtaining a quality dataset that meets data collection needs. This chapter provides guidance on selecting optimal data collection site locations.

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**622.0301 Site purpose**

The first step in site selection is to define the hydrologic and climatic monitoring objectives of the site. The primary purpose of the Snow Survey and Water Supply Forecasting (SSWSF) network is to collect high-elevation hydrometeorological data. These data are analyzed and used to develop water supply forecasts, which enable agricultural water users and other water management groups to plan for efficient water management.

The value of the data collected extends beyond the SSWSF program, and often a site can serve multiple purposes. Automated SNOTEL sites are highly versatile and lend themselves to collection of a wide variety of data.

Long-term automated climatic data are also used to support many resource management issues and decisions nationwide. These issues include, but are not limited to, drought monitoring, crop irrigation requirements, flood potential, watershed health, environmental monitoring, soil moisture accounting, and various engineering applications.

Appendix A contains a list of purposes and considerations that can be used in evaluating new site locations and sensors installed. This list can also be used as a worksheet to document a site purpose.

## 622.0302 Types of data collection sites

Data are collected using aerial markers, snow courses, and automated SNOTEL stations.

### (a) Snow courses

Snow courses (fig. 3-1) are locations where manual snow measurements are taken at certain times during the winter season to determine the actual depth and water content of the snowpack. A snow course that is only measured once during the winter season is referred to as a “basin index point.” Snow courses consist of a variable number of individual sample points, typically 5 to 10, with evenly spaced intervals between points. The snow course is generally identified by standard snow course marker signs.

**Figure 3-1** Snow courses—data are collected manually from multiple sample points along the snow course



### (b) Aerial markers

Aerial markers (fig. 3-2) are used in remote mountainous locations that are difficult to access in the winter. They consist of one measuring point marked by a pipe with cross members that can be easily observed by aircraft. Aerial markers are used to measure depth of snow to estimate snow water equivalency.

### (c) SNOTEL stations

SNOTEL stations (fig. 3-3) automatically collect hydrometeorological data and transmit the data to a central database at the National Water and Climate Center (NWCC). Standard data collected at a SNOTEL station are snow water equivalence, snow depth, total precipitation, and air temperature.

**Figure 3-2** Aerial markers—data are observed manually from an aircraft because aerial markers are typically located in extremely remote locations with hazardous terrain



## 622.0303 Site characteristics

Once the purposes of the data collection site are identified, the next step is to evaluate the landscape characteristics as well as the site-specific characteristics of the location being considered for installation of the site.

### (a) Geographical area representation

If the primary purpose of the site is to improve a water supply forecast, then the site should represent the area contributing the majority of the runoff of interest. The melt out and resulting runoff from various geographic “zones” within a watershed vary differently depending on the zones characteristics. The geographic area can determine the amount of water, when the water is supplied, duration of melt out, how rapid the runoff will occur, and much more.

Analysis techniques, such as basin area-precipitation modeling, are used to determine the contributing zones of a watershed and help determine the representativeness of the proposed site. The following information is needed for such basin analysis:

- elevation distribution map
- area/elevation curve
- precipitation distribution map
- identification of significant precipitation zones
- precipitation distribution table
- snow cover map
- transient snow zone on the map
- potential rain/snow transition zones
- aspect analysis of watershed at a minimum of the eight primary aspects
- soil map (generalized) or geology map
- existing site correlation to objective of purpose
- land use information
- land ownership

### (b) Other meteorological data collection networks

Accurate water supply forecasting requires data collection from non-NRCS sites. The accuracy of a water supply forecast is verified by comparing the forecast to streamflow from the U.S. Geological Survey (USGS) gaging station data.

Reservoirs change the hydrology of a watershed. The reliability of a forecast may be dependent upon reservoir operations (inflow/outflow) within the watershed.

Meteorological data from non-NRCS sites may provide valuable data to determine if wind speed and direction or temperatures are contributing to a melting snowpack and runoff.

Data collection from non-NRCS sites and added to forecast procedures can produce small but important increases in forecast accuracy.

When selecting locations for new sites, it is important to be aware of other data collection networks in order to fill data gaps and data voids and increase the accuracy and reliability of the water supply forecasts.

**Figure 3-3** SNOTEL stations—snowpack and other hydrometeorological data are collected remotely and automatically transmitted to a central database



### (c) Specific site characteristics

There are some specific characteristics that must be considered in locating a snow survey data collection site.

#### (i) Slope

Locate SNOTEL sites and snow courses on slopes less than 10 percent. Avoid areas that have the potential to be affected by avalanche hazard, ponding water, or snow creep. These hazards can damage or destroy equipment and eliminate the usefulness of the data.

#### (ii) Aspect

Aspect influences snow deposition and melt out. Northern aspects are more desirable as snow typically persists for a longer period of time on northern aspects. Snow on a watershed slope with a southern aspect will melt sooner than on slope with a predominantly northern aspect. If the snow on the site melts before the snow in the watershed, it may not provide data that is readily used in water supply forecast equations.

#### (iii) Exposure

Wind is a major consideration when determining site location. Wind transports snow and rain into and out of an area, which affects the geographical area representation. Site selection should minimize exposure to prevailing wind patterns, as well as microclimatic conditions that might cause excessive wind deposition and/or scour in relation to surrounding areas. Wind has the potential to damage structures, sensors, and other equipment of a SNOTEL site, which then require costly repairs and potential loss of the data stream.

#### (iv) Vegetation

Site selection of SSWSF sites should be representative of the vegetation of the watershed. Generally, the vegetative canopy should not cover the sensors. Locations that require trees to be removed for the site to be suitable may also require special permissions or permits to cut the trees. Removal of large trees may change the hydrology of the site affecting the suitability of the site. Long-term maintenance should be able to maintain the vegetation reflecting the initial conditions.

#### (v) Physical access

Each site requires motorized year-round access for installation, operation, and maintenance. Sites that

are not situated close to a road may require helicopter access.

If helicopter access is required, a safe landing zone (LZ) must be established and maintained. If an LZ cannot be established at the site, it should be close enough to allow easy transport of equipment to the site by foot.

Winter ground access routes should avoid avalanche paths and other hazardous land features.

A plan for long-term site access should be established. Long-term access is required to each site. This plan should include allowable methods of transportation, access routes, maintenance plans, and any foreseeable changes to the maintenance or land ownership that could affect site access. Access to sites in or near a potential new or expanded wilderness or roadless area should be carefully reviewed to ensure long-term access. Methods of access shall be described in the land owner permits and may require special considerations (i.e., guarded gates, locked gates, key card entry).

#### (vi) Site footprint

Sites should be sized to accommodate the necessary equipment that will be placed at the sites. Each of the components of a site has an ecological footprint that must be considered, as well as the potential interaction with other sensors.

The SNOTEL site footprint consists of two main areas:

- Data collection and transmission area

The data collection and transmission area should be located in a high runoff-producing area. A small meadow or scattered timber with a very slight slope will generally be acceptable. Exposure to solar energy is important for recharge of batteries using solar panels. The data collection and transmission area is usually no more than 200 feet in diameter and contains the physical components of the SNOTEL site. Physical components with a footprint include the snow pillow, snow precipitation gage, instrument shelter, soil moisture and temperature sensors, antenna towers, solar panels, and fencing.

- Buffer zone

A buffer zone is established to protect the SNOTEL site from logging or other activities that could alter the hydrologic characteristics of the site. Typically, a 400-foot zone surrounding the data site is adequate.

**(vii) Telemetry window**

The selected site should provide a telemetry window sufficient to communicate with established receivers. Proximity to mountains, box canyons, or other barriers, both naturally occurring and constructed, can preclude a site from consideration. Vegetation may also affect telemetry transmission.

**(viii) Solar window**

The selected site should provide a solar window sufficient to power an automated site throughout the year. A minimum solar window should include enough southern exposure so that the panel will receive sunlight even during the winter solstice. Often, multiple solar panels need to be mounted facing various directions to provide adequate power to keep the battery system charged.

**(ix) Security considerations**

Landowner operations (such as future timber sales, thinning operations, road or building construction, and grazing of livestock) may adversely impact data collection sites. Choose sites that limit adverse impacts of landowner operations.

The potential for vandalism should be evaluated. The proximity of a site to a city, hunting, trails (hiking, skiing, snow mobile), or camp sites may increase the amount of vandalism. Choose site locations away from these areas. Strategic gates or berms may limit unwanted access.

Wildlife and/or rodents can damage the site. Site components should include measures to limit wildlife or rodent damage.

**(x) Aesthetics**

In sensitive areas, such as national parks and public lands, consideration should be given to the visual impact of the station on park visitors and public land users such as hikers, backpackers, motorists, and others.

## 622.0304 Site authorizations and documentation

The NRCS does not generally own the land where a data collection site is installed. A deed, special use permit, easement, or cooperative agreement may be required. Site authorizations should ensure use of the site as a permanent installation to assure continuity of data.

The boundaries of the site authorization should address the footprint needed for data collection as well as a buffer zone (usually described as having a 200- or 400-ft radius).

## 622.0305 Legal requirements

The National Environmental Policy Act (NEPA) is a law that was passed by Congress in 1969 and signed into law on January 1, 1970. NEPA requires that Federal agencies consider the environmental effects or impacts of proposed Federal actions.

Part 650.6 of 7 CFR identifies the Snow Survey and Water Supply Forecasting Program (data gathering and interpretation) as categorically excluded from detailed review under NEPA.

This categorical exclusion under NEPA does not relinquish the responsibility of the NRCS to comply with mandatory consultations associated with the National Historic Preservation Act (NHPA) and implementing regulations and Endangered Species Act (ESA) and implementing regulations. These two statutes and their regulations provide clear analytical processes for exempting practices or classes of actions and apply independently of NEPA to an action.

An environmental evaluation (EE) is required on all new sites to identify extraordinary circumstances that might lead to significant individual or cumulative impacts. Actions that have potential for significant impacts on the human environment are not categorically excluded.

NRCS Form CPA-52, Environmental Evaluation Worksheet, is used to document the evaluation. File documentation in the snow survey site file.

### (a) Threatened and endangered species

Consult with the State biologist to determine if threatened and endangered (T & E) species are present and to perform the EE. If T & E species are present at a proposed site, an alternative location should be considered.

Review the EE for extraordinary circumstances. If there are no extraordinary circumstances, no additional documentation is needed. If there are extraordinary circumstances and the action has not been sufficiently analyzed in an existing NEPA document, the State biologist will provide guidance on how to proceed.

Document any special considerations for T & E species on Form NRCS CPA-52.

### (b) Cultural resources

NRCS policy is to avoid any impact to cultural resources. Installation of a new snow survey site consists of ground-disturbing activities (e.g., holes dug for soil sensors, foundations of structures, etc.), which are considered undertakings by the NHPA and require evaluation. Consult with an NRCS archaeologist if the site is on private land, or an archaeologist from the lead agency if the site is on public land. Additional consultation with the State Historic Preservation Officer may be required.

Document any special considerations for cultural resources on a Form NRCS CPA-52. If cultural resources are present at a proposed site, an alternative location should be considered.

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## 622.0306 References

Endangered Species Act. 7 U.S.C. Part 136, 16 U.S.C. Part 1531.

National Environmental Protection Act. 42 U.S.C. Section 4321–4347.

National Historic Preservation Act. 16 U.S.C. 470 et seq.

U.S. Federal Register. 2008. Title 7, Agricultural Chapter VI, Part 612, Snow surveys and water supply forecast. 7 CFR ch. VI.



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## Appendix A

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# Purposes of and Considerations for Evaluating New Site Locations

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Purpose for site installation—Use the following information in the evaluation of new site locations and documenting site purposes.

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| <b>Purpose</b>                | <b>Considerations</b>   |
|-------------------------------|---|
| Water supply volume forecasts | Types of forecasts: <ul style="list-style-type: none"><li>• Regression equations</li><li>• Graphical procedures</li></ul> Water supply forecast users and uses: <ul style="list-style-type: none"><li>• Irrigation districts</li><li>• Power companies</li><li>• Banks and other lending institutions</li><li>• Crop insurance agencies</li><li>• Farmers and ranchers</li><li>• Legal water issue resolution</li><li>• Governments (i.e., cities, towns, States, Tribal Nations, national, international)</li><li>• Commodity futures markets</li><li>• Agricultural products businesses</li><li>• Wildlife habitat management</li></ul> |
| Watershed modeling            | Model types: <ul style="list-style-type: none"><li>• Hydrologic</li><li>• Watershed</li><li>• Water quality</li><li>• Soil erosion</li><li>• Wildlife</li></ul> Model purposes: <ul style="list-style-type: none"><li>• Water budgets</li><li>• Floodplain delineation</li><li>• Natural resources assessment</li><li>• Water temperature modeling</li><li>• Nutrient transport/risk assessment</li><li>• Pesticide transport/risk assessment</li><li>• Soil erosion reduction</li><li>• Wildlife habitat improvement</li></ul>   |
| Flood forecasting             | Types of warning information: <ul style="list-style-type: none"><li>• Rapid increase in precipitation</li><li>• Rapid decrease in snow water equivalent (SWE)</li><li>• Rapid decrease in snow depth, without a decrease in SWE</li></ul> Flood forecast users and uses: <ul style="list-style-type: none"><li>• National Weather Service, Federal Emergency Management Agency, U.S. Army Corps of Engineers, Bureau of Land Management, U.S. Bureau of Reclamation, and other government agencies (local, State, national, and international)</li><li>• Reservoir operators</li><li>• News media</li><li>• Private citizens</li></ul>    |

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| Purpose                                | Considerations   |
|--|--|
| Low flow forecasts—water rights issues | <p>Types of low-flow forecasts:</p> <ul style="list-style-type: none"> <li>• What is the date when a stream will go below a given flow?</li> <li>• On a certain date, what will the flow be?</li> <li>• During a certain period of time (beyond the normal volume forecasts), what will the volume be for a specified stream?</li> </ul> <p>Low-flow forecast users and uses:</p> <ul style="list-style-type: none"> <li>• Irrigation districts</li> <li>• Crop insurance agencies</li> <li>• Banks and lending institutions</li> <li>• Drought management people</li> <li>• Fish and wildlife people</li> <li>• Commodity futures market</li> <li>• Businesses who buy or sell agricultural products</li> </ul> |
| Avalanche warning                      | <p>Information needed:</p> <ul style="list-style-type: none"> <li>• Snow depth</li> <li>• Snow water equivalent</li> <li>• Precipitation (quantity, form, rate)</li> <li>• Air temperature</li> <li>• Snow temperature</li> <li>• Wind speed and direction</li> <li>• Relative humidity</li> </ul> <p>Users and uses of the information:</p> <ul style="list-style-type: none"> <li>• Avalanche forecasters</li> <li>• Snowmobilers</li> <li>• Backcountry skiers and hikers</li> <li>• Highway departments</li> <li>• Search and rescue</li> <li>• Developed ski areas</li> </ul>   |
| Recreation                             | <p>Information needed:</p> <ul style="list-style-type: none"> <li>• Snow depth</li> <li>• Snow density</li> <li>• How much “new” snow</li> <li>• Air temperature (maximum, minimum, average)</li> <li>• Snow line</li> <li>• Streamflow (peak flow, low flow, duration, timing, volume)</li> </ul> <p>Users and uses of the information:</p> <ul style="list-style-type: none"> <li>• Skiers</li> <li>• Backpackers</li> <li>• Hiking trail maintenance</li> <li>• Hunters and anglers</li> <li>• Snowmobilers</li> <li>• Whitewater rafters</li> </ul>  |

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| <b>Purpose</b>       | <b>Considerations</b>  |
|----------------------|--|
| Wildlife information | Information needed: <ul style="list-style-type: none"><li>• Snow depth</li><li>• Snow water equivalent</li><li>• Precipitation (daily, weekly, monthly, annually)</li><li>• Air temperature (maximum, minimum, average)</li><li>• Soil temperature</li></ul> Information users and uses: <ul style="list-style-type: none"><li>• Fish and wildlife agencies</li><li>• Environmental and conservation organizations</li><li>• Hunters and anglers</li><li>• Photographers</li><li>• Outfitters and guides</li><li>• Hunters and anglers</li></ul> |

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