MAINE
DAM & NATURAL BARRIER SURVEY
MANUAL

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This project would not have been possible without the assistance and expertise of a number of people who have contributed their time and effort to develop and refine the data forms and protocols for gathering dam and natural barrier data represented here. I would especially like to thank those who went out of their way to review the draft field forms and protocols:

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INSTRUCTIONS FOR COMPLETING FIELD FORMS

DAM SURVEY & NATURAL BARRIER LOG

OVERVIEW

Tens of thousands of miles of streams flow throughout the state of Maine. Many of these streams are blocked by dams and natural obstructions that limit fish movements. We know quite a bit about the over 750 structures currently in Maine's statewide dam database, but we know little or nothing about many hundreds, and perhaps thousands of smaller dams and innumerable natural obstructions throughout the state.

It is essential to know the location and condition of structures in our streams in order to improve habitat connectivity in Maine. The Maine *Dam & Natural Barrier Survey* has been designed to collect information to help evaluate the impact of barriers on streams. An array of state and federal agencies and nonprofit organizations are helping to survey existing barriers in our streams to allow us to make better decisions about possible improvements to restore habitat across the state. The goal is to use volunteers and professionals involved primarily in the protection and restoration of fish habitat to collect data that feeds into a statewide inventory of barriers. Once we know which of these barriers most limit the movement of fish and terrestrial species, we can then use our data to set priorities for habitat restoration.

This document is meant as a practical guide to the completion of the *Dam & Natural Barrier Survey* form used to assess stream barriers. Highly specialized knowledge and tools are not required, but anyone undertaking such surveys should be trained by one of the organizations sponsoring the surveys to ensure that they will provide data that is consistent with that collected by others across the state.

SAFETY

Streams can be hazardous places to work, so take good care to sensibly evaluate risks before you begin to survey dams and natural obstructions. While our efforts to record data about in-stream structures are important, they are not as important as your life and limb. These surveys will work best with two people to make measurements easier, but also to provide help if needed.

Take measurements seriously and carefully, but also know that estimates may be necessary. Avoid wading into even small streams at high flows or pools of unknown depths, and take care scaling steep and rocky embankments. There are usually ways to make effective estimates of barrier dimensions without risking harm. Using an accurate laser rangefinder is one way to measure with less risk. Otherwise, you should make reasonable estimates, if possible based on partial measurements to improve accuracy.

EQUIPMENT

To collect data on dams and natural barriers, you will need a few essential pieces of equipment for measuring and recording:

Stream Maps – for planning areas to survey, and to record sites assessed
Dam Survey and Natural Barrier forms – Best printed on waterproof paper
GPS Receiver – Set to collect data in WGS84 datum, and UTM Meters coordinates
Digital Camera – with sufficient battery power for a full day of surveying, and capable of storing approximately 100 low resolution images (less than one million pixels each, even as low as 640 x 480 pixels, for a final stored size of 150 – 300 kilobytes each)
Measuring Tapes
30 Meter or 100 Foot Reel Tape – For measuring structure lengths
Pocket Tape / Rod – 7 foot/2 meter or longer metal tape for shorter dimensions
Measuring Rod – Marked at 1 meter or 3 feet for measuring pool depths
Clipboard
Pencils & Erasers

Additional equipment recommended based on equipment availability, funding, survey crew, stream size and climate:

Clinometer (or Hand Level) – to take a level sight to a survey rod when measuring water surface elevations at natural barriers
Surveyor's Leveling Rod – to take depth (and some other) measurements – best if lightweight but tough enough to be leaned on when needed; 8 – 15 feet (3-5 meters)
Laser Rangefinder – to safely take measurements without crossing dam structures or streams – should be accurate to within one foot for adequate data accuracy.
Waders or Hipboots – to stay dry, insulate from cold water and minimize abrasions
Sun Protection – Hat, sunglasses and sunscreen as needed

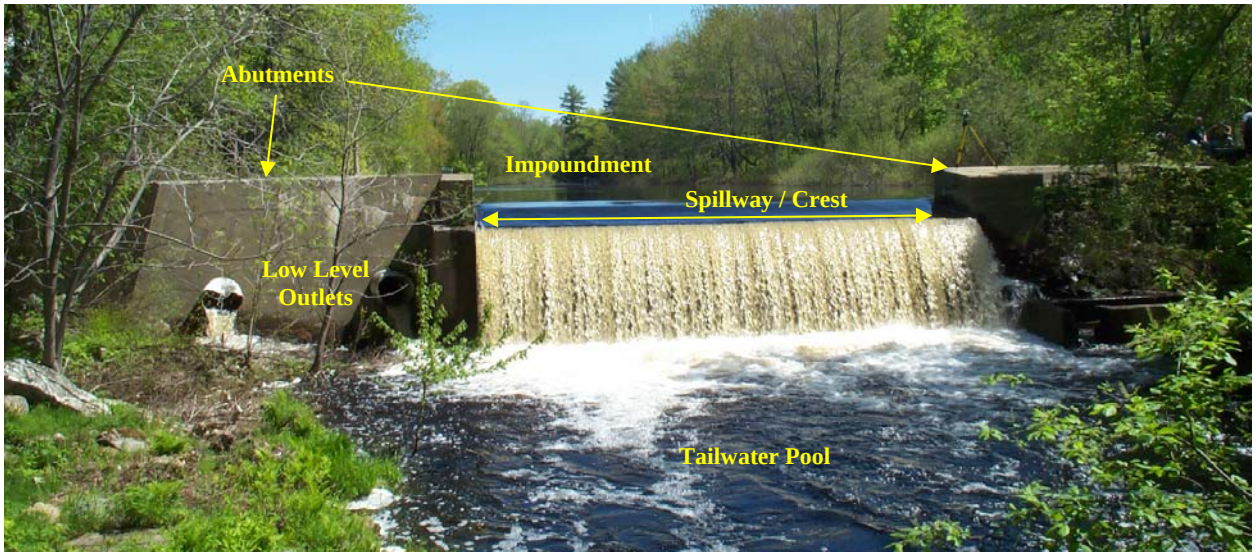
SHADED BOXES

Shaded boxes on the survey form serve to visually divide data elements to make it easier to follow, and are not meant to imply greater importance over data in unshaded areas.

DAM SURVEY

SITE IDENTIFICATION

Refer to the large photograph below for dam features to help you to identify similar features in the field. Note that each dam will be different from another, and that many will have additional features not shown here, while others will be much simpler. For examples of just a few small and moderate sized dams, see the smaller photos below.



Begin entering data for each item as explained in the list below, taking care to complete each and every item.

Date – Date that the site was surveyed (in the form *mm*/*dd*/*yy*).

Time – Approximate local time in 12-hour format that the site was surveyed.

Sequence # – Record as an integer the order in which this site was surveyed in relation to others surveyed on this date (i.e., 1, 2, 3, etc.).

Site ID – Unique numeric or alpha-numeric identification code used to identify the survey site for the organization responsible. For example, the U.S. Fish and Wildlife Service Gulf of Maine Coastal Program may choose to identify sites it surveys with a simple integer sequence number that would uniquely identify each site surveyed on a particular day by a particular surveyor from that organization (i.e., 1, 2, 3, …, 100, etc.). Alternatively, they may choose a more complex code using an abbreviation of the organization followed by the date, the lead surveyor's initials and a sequence number for the sites surveyed (e.g., GOMCP060107JW1 would indicate the first site surveyed on June 1,2007 by Jed Wright of that office). Such a numbering system helps to maintain the uniqueness of each site's identifier, though it is redundant of other data elements.

Observer(s) – Name(s) of site evaluator(s), comprised of at least a first initial and last name.

Organization – Name of the organization sponsoring or conducting the survey.

Stream – Provide the name of the stream or river, generally relying on names agreed upon on U.S. Geological Survey topographic maps. Use *Unnamed* if the waterway is not named or *Unknown* if you are not sure. If a different local name is also in use, provide that in parentheses.

Tributary to – Name of the stream or river into which the surveyed stream flows. This is especially helpful when surveying streams that are unnamed or for which a name is not known. If this stream has no name, enter *Unnamed*, and if you cannot locate a name enter *Unknown*.

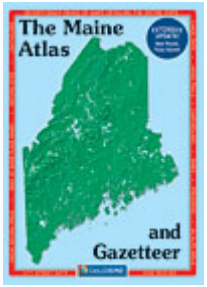
Town – Town where the survey takes place.

GPS Coordinates – Use a GPS (Global Positioning System) receiver to provide the coordinates for the structure location. Be sure the unit is set to collect positions in the UTM (Universal Transverse Mercator) Zone 19 North Meters coordinate system in the Datum normally referred to as WGS84 (World Geodetic System of 1984). Your GPS receiver may only refer to the coordinate system as UTM and may set the zone automatically. Refer to your receiver's manual to properly set the coordinate system.

Enter coordinates in the blanks provided for Easting, then Northing, rounding to the nearest whole meter. Note that Easting coordinates are always composed of six digits in Maine, though in some GPS receivers there will be a leading zero as the first digit. In the field form this leading zero has already been entered. Northing coordinates are always composed of seven digits in Maine. These coordinates are simply the number of meters in each direction from the southwest corner (coordinates 0 E / 0 N) of a rectangle that defines the extent of

UTM Zone 19 North.

DeLorme Atlas Data – Referring to *The Maine Atlas and Gazetteer* published by DeLorme, enter the Map number from the bottom of the page (the same as the number on the statewide map grid on the back of the atlas) in the first blank, and enter the map grid reference in the second, listing the letter followed by the number read from the border of the map (e.g., A4 as in the map image below). The letters run down the sides, numbers on the top.



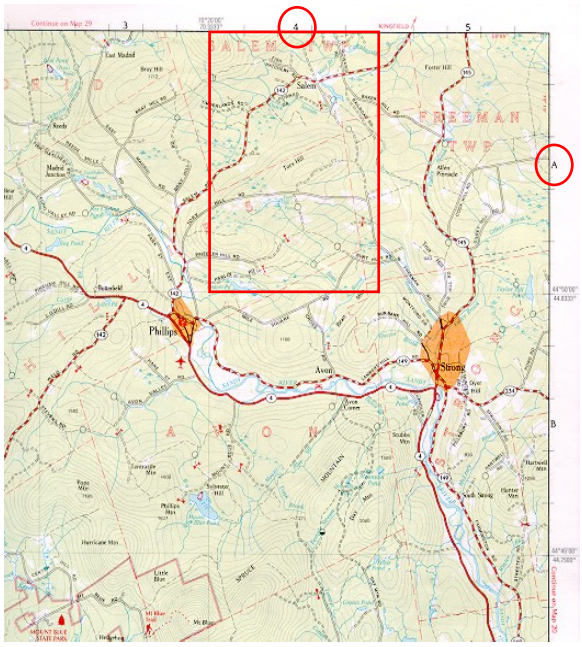


Photo IDs – Digital photographs are an extremely useful tool to use in assessing potential fish passage barriers. When you are taking photos, be sure to use the date/time stamp to code each photo if possible, and record the ID number from the camera of each photo in the appropriate blank for each perspective listed on the form. It is important to set the camera to record in low resolution so that the photographs do not take up too much space when downloaded for storage. There are several possible standards to use for photo resolution. If your camera provides resolution settings in pixel dimensions, you can set your camera to record at 640 x 480, which totals approximately 300,000 pixels. If your camera only operates on the basis of total number of pixels, something between 300,000 and 1 million (1 *megapixel*) is appropriate. If your camera only has settings of low, medium and high, take a low resolution photo, download it, and look at it on your computer screen. If you can make out details in the image reasonably well, and the file takes up roughly 200-300 kilobytes of storage space, that is a good setting to use. It is this file size of approximately 200-300 kilobytes that you should shoot for to minimize the overall storage of the thousands of images we expect to gather in our surveys across Maine.

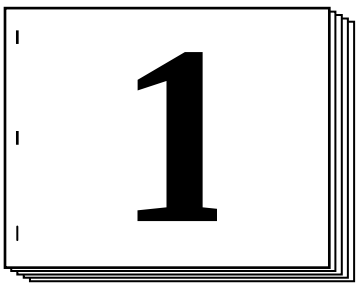
The four photos needed to adequately document each dam provide valuable information about the dam structure and the stream above and below the dam. The *Upstream Face* photo is meant to show the dam structure from the upstream side, while the *Upstream View* photo is meant to show the impoundment or stream looking upstream from the dam. It is best to show

some portion of the dam in this view to give perspective to the photo. Likewise the *Downstream Face* and *Downstream View* photos should show the same features on the downstream side of the dam. If there is a fishway, take a photo of it, and record that photo number in the space provided. Additional photos might show particular dam features or broader perspective around the area of the dam. Though not recommended, if only two photographs were to be taken at a site, *Upstream Face* and *Downstream Face* images would be essential, and most useful if they take in some of the stream and its banks upstream and downstream of the dam.

Enter multiple photo IDs for particular perspectives as space allows. See below for photo examples.

	Site 1	**Site2**	**Site 3**
Upstream Face			
Upstream View			
Downstream Face			
Downstream View			

A simple way to know which photos were taken at a particular site is to create a "book" of 8.5 " x 11 " numbered pages (on waterproof paper) that represent the *Sequence #* of each site. The first photo at a site should be taken *of the page* with the correct *Sequence #* in the book. Subsequent photos of the site will come after this sequence number photo and before that of the next site, keeping photos organized when downloading and renaming them later.



At the end of each day of surveying, the photos should be downloaded and renamed to ensure that they represent the correct sites. Photo names should explicitly code them as associated with the particular site surveyed and the perspective they represent. For instance, if the SiteID is 100, the photos of the *Upstream Face* and *Upstream View* should be named *100-UpstreamFace* and *100-UpstreamView*, and those of the *Downstream Face* and *Downstream View* should be named *100-DownstreamFace* and *100-DownstreamView*. Likewise, natural barrier photos should be named *100-UpstreamSide* and *100-DownstreamSide*. If multiple photos are taken from the same perspective, they should be coded with *A, B, C* after the name to indicate additional photos (e.g., *100-UpstreamFaceA, 100-UpstreamFaceB*).

Flow Conditions – Record the general level of flow in the stream channel, low, moderate, high, or none. Record *No Flow* if there is no sign of flowing water, but only isolated pools. To record *High Flow*, the stream flow should be noticeably high relative to the stream banks. Obviously, there should have been a recent or ongoing rain event causing the high flows. It is very likely you will have great difficulty taking measurements safely in these conditions—BE CAREFUL!

The most difficulty will probably come in judging between low and moderate flows. In part, you will need to judge by how much or little rain has fallen in recent days and weeks. More important, though, is to look at the bed and banks of the stream to assess flows based on how much of the stream bed and possibly aquatic or bank vegetation is covered by water (perhaps indicating moderate flow) or exposed (probably indicating low flow).

DAM DIMENSIONS

Here you will begin to collect data about the dam structure, its features, and the setting in which it operates.

Dimensions – First, check whether the dimensional data you are gathering is *Measured* or *Estimated*. Next, select the units with which you are measuring, *Feet & Tenths* (of feet), *Feet & Inches*, or *Meters*. Check again to be sure that all of your measurement equipment uses the same units.

Structure Length – Measure the length of the entire hardened dam structure to the outside of any abutments, not just the length of the spillway or dam crest over which water flows. For some small dams this may not equal the full bankfull channel width*.

* The width of the stream channel at the point where overbank flooding occurs. Bankfull flows are those that create and maintain channel form, including bed, banks and floodplain. These flows occur anywhere from every six to eighteen months in most streams.

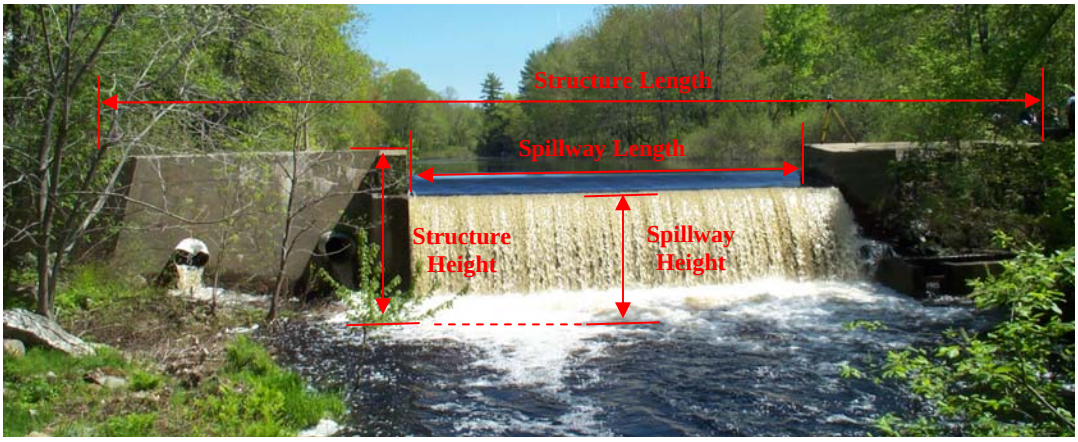
Spillway Length – Measure the length of the spillway out to any abutments. For some small dams without obvious abutments, this may equal the *Dam Length*. For spillways composed of multiple sections separated by structural piers, calculate the total length less the thickness of the separating structures.

Structure Height – Measure the height of the dam structure, from the bottom or *toe* of the structure up to and including the top of any abutments. Try to determine the bottom elevation as best you can as an approximation of the bottom of the original stream channel in that location. For some small dams without obvious abutments, the structure

height will be equal to the spillway height. Do NOT include additional structural elements above the abutments such as railings or gate control mechanisms.

Spillway Height – Measure the height of the lowest point on the spillway from the bottom or *toe* of the dam. Try to determine the bottom elevation as best you can as an approximation of the bottom of the original stream channel in that location.

See the image below for guidance in making these measurements. Note that you are not expected to be able to measure directly the dimensions below in the locations noted given the relatively high flows shown.



Taking measurements of dams can be difficult even in periods of low flow, so proceed carefully, and make estimates when necessary. If measurements cannot be taken directly, please estimate and write EST after any estimated measurement. If <u>all</u> dimensions are either measured or estimated, check the box provided. You can use the *Site Sketch* area on the back of the field form to record additional dimensions or dam features.

DAM ASSESSMENT

<u>Tailwater Pool</u> – The channel immediately downstream of the dam will normally be wider and deeper than the general run of the stream in this area (not the impoundment); this is the area of the *tailwater* or *plunge pool.* Mark *Yes* if you observe a pool, and note whether the pool depth is less than or greater than 3 feet or 1 meter. Mark *No* if there does not appear to be any widening and deepening of the stream below the dam. Also, note whether the pool depth is measured or estimated by checking the appropriate box.

BE CAREFUL not to enter a pool that may be dangerously deep.

<u>Impoundment</u> – Record the approximate length and width of any area upstream where water is obviously impounded by the dam such that there is an area of still water wider and deeper than the natural stream channel away from the influence of the dam. Check *None* if there is no area of water impounded by the dam. Check *Unknown* if you cannot tell how far the impoundment extends upstream, or if you cannot otherwise determine if there is an impoundment. Record the name of the impoundment if there is one, either found on a USGS topographic map, in the DeLorme atlas, or from local knowledge.

<u>Material</u> – Record the primary type of material used in the dam being surveyed. If the dam is

composed of more than one material such that it is difficult to tell which is constitutes the majority of the dam's structure, check the *Other* option, and record the materials in the blank.

Condition – Note whether any *Breach* exists in the dam, and if so, whether it is a *Partial* breach, or a *Full* breach extending at least the length of the spillway. If the the channel is open, with or without the abutments remaining, check *Open Channel*. If the dam has obvious *Cracks* or *Leaks* check *Yes* in the appropriate box. Describe any of these or other conditions, such as obviously damaged gate control mechanisms, in the *Comments* section as needed.

Spillway Spans Channel – Mark *Partially* if the spillway only covers a portion of the natural stream channel's *Bankfull Width*, mark *Fully* if the spillway runs completely from one bank to the other, and check *Open Channel* if there is no spillway, perhaps only abutments remaining within the *Bankfull Channel Width*. For dams without a well-defined spillway such that water flows across its entire length, consider whether the entire structure spans the full channel width. Note that assessments of *Bankfull Width* are to be made in areas of natural stream channel away from the influence of the dam.

Dam Features – Check any of the listed features evident at the dam site (Select *None* if you find no such features to be sure you have considered this element.):

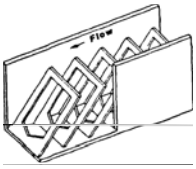
- *Low Level Outlet(s)* – This is normally a feature only on moderate to large dams, and is usually in the form of a pipe exiting the downstream face of the dam off to the side of the spillway. This pipe is intended to release water from relatively low on the upstream face of the dam, normally to allow downstream flow when the upstream water level is below the spillway, and possibly to provide downstream fish passage. (See image on page 5.)
- *Floodgate(s)* – This feature may exist as one or more mechanical doors, valves or other devices that can close off all or part of a spillway, or may exist separately from the spillway. They may also be controlled by stoplogs, often wooden planks, placed in slots to control flow.
- *Flash Boards* – These are normally wooden planks or bulkheads fitted across the length of a spillway to control flow and raise the level of the dam's impoundment. They are often made to break away under high flows.
- *Notch* – A small rectangular opening formed or cut into a dam's spillway to allow downstream passage of fish. It may have a device used to close it off when not needed, or may be left open.

- *Building(s)* – There may be structures at the site which were obviously associated with the dam, such as a mill building, pumphouse or power house, which may have historic significance or current uses.

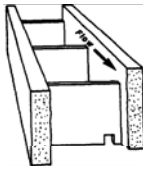
Other features might include those associated with old mill operations, such as a *millrace*, the channel for water to drive a mill wheel, those involving hydroelectric power generation, such as the *intake* and associated gate, or those such as an *auxiliary spillway* providing overflow protection for the dam (set higher than the primary spillway.)

Fishway – Is there a separate or incorporated structure meant to provide fish passage over or around the dam being surveyed? A *Fishway* refers to any structure meant to allow the passage of fish by slowing the velocity of water through the structure, often with a series of baffles or weirs, to provide resting pools, lower jump heights, or sufficiently low velocities to allow passage of one or more target species of fish. Record *None*, or select the type of fishway in place:

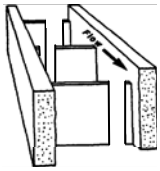
- *Denil* - a fishway comprising one or more sloped channels with baffles (normally wooden) placed at regular intervals to slow flow velocities. There are resting pools between each section of the fishway to conserve the energy of migrating fish.



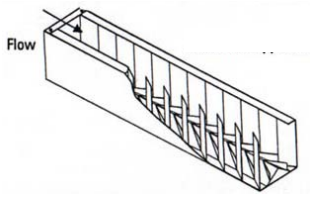
- *Pool-Weir* – composed of one or more sloped channels with weirs placed at intervals to provide resting pools for migrating fish. This type of fishway can also have notched weirs to concentrate lower flows into a smaller area, and are sometimes called pool and chute fishways.



- *Vertical-Slot* – composed of one or more sloped channels with baffles often made of concrete, separating pools; baffles have vertical slots, normally alternating from side to side, through which fish burst from one pool to the next.



- *SteepPass* - a type of Denil fishway developed for use in remote areas of Alaska prefabricated of metal in sections which can be connected on site; it has vanes on its bottom and sides to reduce velocity and provide high air content in flow.



- *Eelway* – composed of a series of small volume pipes, ramps or chutes with Astroturf or other substrate material and low water flow to allow upstream passage of eels.

Fishway Condition – Record elements of the fishway condition by checking one or more of the boxes provided as needed. Missing or damaged baffles or weirs should be obvious from a quick inspection of the fishway. *Cracks* are indicative of some measure of degradation of the dams structure, and *Leaks* may or may not be associated with cracks; some may be evident from water bubbling up at the toe or margins of the dam. Add additional observations to the *Comments* section.

Current Dam Use – Record here any current uses of the dam that are obvious from a brief

view of the site. Mark only *Unknown* unless you are quite sure of your choice(s). *Recreation* is to be marked if you see clear evidence of that use, such as a boat ramp, docks with boats, or active recreation while you are surveying. Only mark *Fire Protection* if you see a dry hydrant used for drawing water from the impoundment for that purpose. *Irrigation* or *Drinking Water Supply* should only be recorded if you know that water is being drawn for those purposes based on signs or other evidence. *Hydropower* use should be obvious from the existence of dam features such as turbine/generator buildings and signs. *Fish & Wildlife* should only be recorded if it is clear that the reason the dam and its impoundment (not a fishway) exist is to benefit fish and wildlife. Likewise, *Scenic* use should be obvious to be selected. These uses would probably have to be clear mainly from signs or local knowledge.

Significant Sediment Source – Is a significant amount of sediment coming from adjacent embankments associated with the dam, or from the stream banks? Record whether the source is providing sediment upstream or downstream of the dam, or both. To judge what is significant, consider whether the sediment entering the stream at the site is altering the character of the stream there and within sight downstream. If the amount of sediment is small enough to be readily transported away from the site, it should not be characterized as significant.

Wildlife Barriers – Are there any physical barriers to wildlife outside of the stream channel associated with the structure? Think here primarily about barriers to the passage of terrestrial creatures attempting to follow along in the direction of the stream channel, not simply crossing the stream.

- *Steep Embankments* means any embankments associated with the structure that would likely impede movement of various amphibious and terrestrial animals.
- *Retaining Walls* refers to vertical walls usually made of concrete, but also *gabions* (rock walls contained by wire mesh in photo at right), that likely prevent passage of wildlife.
- *Fencing* refers to any continuous fencing that might impede the movement of wildlife from one side of the roadway to the other. Remnants of barbed wire would not be sufficient to record, but maintained chain link fence or similar material would.

Comments – Use this section to explain any data element above that require further description or detail. Some dams will likely require explanation here to describe differences from the diagrams offered here, or to allow calculation of the dimensions of the entire structure. You may choose to add here additional information for each dam that is not included above, but would be helpful to your organization's efforts.

Site Sketch –The top section on the back of the Dam Survey form is to be used to make a sketch of the *downstream* dam face. Record the SiteID again at the top of this page. This sketch is meant to provide information about any dam features that are not well recorded on the front of the form, for which more data such as dimensions are needed, or if a photograph, for whatever reason, will not capture all that you would like to capture about the dam. The grid is provided to help draw the dam and its features in correct proportion.

Site Map – The bottom section on the back of the Dam Survey form is to be used to make a sketch map of the dam and its surrounding landscape features. This map is likely more important than the above sketch since that view should be well captured in a photograph. The

grid is provided to help map the dam and its features in correct proportion. Be sure to show the direction of flow.

Add to the map any features that would help to understand the setting of the dam:

- Earthen embankments and berms
- Nearby buildings, especially if obviously associated with the dam
- Some sense of the form, and perhaps the size, of any impoundment upstream
- Form and size of the tailwater pool
- Location and layout of any fishway
- Dam features associated with its use, such as dry hydrant, pump house, boat ramp or dock locations
- Location of any significant sediment sources associated with the dam

NATURAL BARRIER SURVEY LOG

For *natural barriers*, refer to the *Natural Barrier Survey Log* form to record an abbreviated set of data covering the type of barrier, its location, and a brief assessment and description.

Beaver dams and debris jams can be major obstructions to fish passage, though they can also be quite ephemeral. Debris jams in particular may seem to be barriers, though they may often have sufficient flow under and through them to allow most fish species to pass. Natural falls obviously are persistent, though their character as obstructions to fish passage depends very much on their structure, on stream flows, and on the species of fish requiring passage.

Complete each element of the data form for each stream to be surveyed to be sure all data needed are captured; use a separate form for each stream surveyed, and record the start and end GPS points of the area surveyed so a record is kept of where you have searched for barriers.

GENERAL STREAM DATA

Date – Date that the stream was surveyed (in the form *mm*/*dd*/*yy*).

Observer(s) – Name(s) of site evaluator(s), comprised of at least a first initial and last name.

Organization – Name of the organization sponsoring or conducting the survey.

Stream – Provide the name of the stream or river, generally relying on names agreed upon on U.S. Geological Survey topographic maps. Use *Unnamed* if the waterway is not named or *Unknown* if you are not sure. If a different local name is also in use, provide that in parentheses.

Tributary to – Name of the stream or river into which the surveyed stream flows. This is especially helpful when surveying streams that are unnamed or for which a name is not known. If this stream has no name, enter *Unnamed*, and if you can not locate a name enter *Unknown*.

Flow Conditions – Record the general level of flow in the stream channel, low, moderate, high, or none. Record *No Flow* if there is no sign of flowing water, but only isolated pools. To record *High Flow*, the stream flow should be noticeably high relative to the stream banks. Obviously, there should have been a recent or ongoing rain event causing the high flows. It is very likely you will have great difficulty taking measurements safely in these conditions—BE CAREFUL!

The most difficulty will probably come in judging between low and moderate flows. In part, you will need to judge by how much or little rain has fallen in recent days and weeks. More important, though, is to look at the bed and banks of the stream to assess flows based on how much of the stream bed and possibly aquatic or bank vegetation is covered by water (perhaps indicating moderate flow) or exposed (probably indicating low flow).

GPS Start Point - Use a GPS (Global Positioning System) receiver to provide the coordinates for the point on the stream where you begin to search for natural barriers (and dams). Be sure

the unit is set to collect positions in the UTM (Universal Transverse Mercator) Zone 19 North Meters coordinate system in the Datum normally referred to as WGS84 (World Geodetic System of 1984). Your GPS receiver may only refer to the coordinate system as UTM and may set the zone automatically. Refer to your receiver's manual to properly set the coordinate system.

Enter coordinates in the blanks provided for East, then North, rounding to the nearest whole meter. Note that East coordinates are always composed of six digits in Maine, though in some GPS receivers there will be a leading zero as the first digit. In the field form this leading zero has already been entered. North coordinates are always composed of seven digits in Maine. These coordinates are simply the number of meters in each direction from the southwest corner (coordinates 0 E / 0 N) of a rectangle that defines the extent of UTM Zone 19 North.

GPS End Point – When you have completed surveying on a particular stream, or at the end of the day, record the coordinates where you stopped. Having the start and end position of your surveys allows us to know what portions of which streams have been surveyed.

Site ID – Unique numeric or alpha-numeric identification code used to identify the survey site for the organization responsible. For example, the U.S. Fish and Wildlife Service Gulf of Maine Coastal Program may choose to identify sites it surveys with a simple integer sequence number that would uniquely identify each site surveyed on a particular day by a particular surveyor from that organization (i.e., 1, 2, 3, …, 100, etc.). Alternatively, they may choose a more complex code using an abbreviation of the organization followed by the date, the lead surveyor's initials and a sequence number for the sites surveyed (e.g., GOMCP060107JW1 would indicate the first site surveyed on June 1,2007 by Jed Wright of that office). Such a numbering system helps to maintain the uniqueness of each site's identifier, though it is redundant of other data elements.

Sequence # (Seq# on form)– Record as an integer the order in which this site was surveyed in relation to others surveyed on this date (i.e., 1, 2, 3, etc.). This will help to keep track of photographs, and may help to order or locate sites surveyed if needed.

Barrier Type – Record one of the three types of natural barriers found:

Beaver Dam will be composed of woody vegetation with obvious tooth marks on the ends of many pieces. These structures will span the channel.

Debris Jam may be composed of a mixture of large and small trees, logs and much smaller woody debris that has naturally accumulated with few if any signs of beaver cut pieces. Such jams will often extend only part of the way across the channel, and may be passable by fish.

Natural Falls will usually be composed primarily of bedrock ledge, will range in gradient above 7 percent or so, may in some cases be referred to as a cascade or bedrock chute, and may create a noticeable impoundment upstream. Note that even small falls which present unbroken vertical jump barriers of even 6 inches (15 centimeters) to one foot (30 centimeters) across the entire stream channel may serve as obstructions for some species of fish at some flows, so the goal is to survey those sites as well as the larger, more obvious ones.

In areas with a series of small falls in quick succession (nearly continuous), it is best to record a GPS location for the middle of the area and to record a *Water Surface Difference* and *Horizontal Distance* for the entire stream segment; don't try to record every small drop separately.

GPS Coordinates – Record the coordinates of the barrier location. It is best to record the location of the middle of the barrier if you can, but do not risk your safety to get to that position. Recording a position at one end of the barrier will be sufficient in that case.

Full Width / Partial Width – Primarily used for *Debris Jams*, record whether the barrier spans the full channel width, or only part of the channel. *Falls* will always, and *Beaver Dams* will normally be recorded as *Full Width*, unless, as in the case with some beaver dams, they have been partially breached, but still likely present barriers to fish passage.

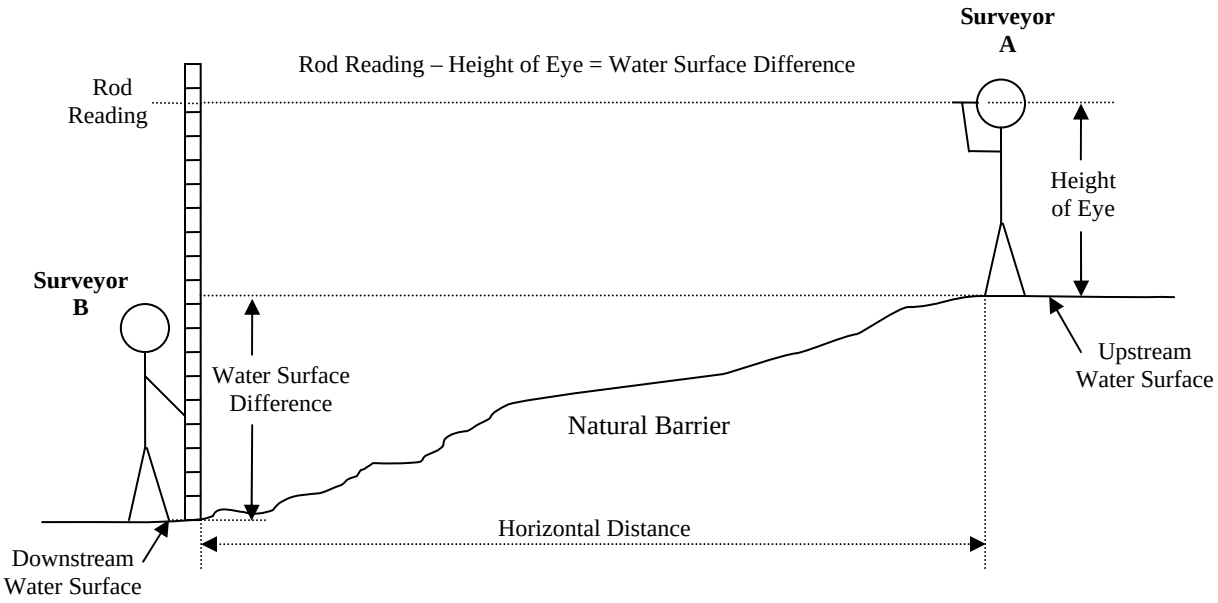
Photo IDs – Record digital photograph IDs here for at least one view of the barrier and two if possible. Begin by taking a photo of the *Sequence Number* (*Seq#*) to help to keep each site's photos organized before renaming them later to identify them with each site (see page 8). The form has two blanks, one for the upstream face (*US Face*) of the barrier, and one for the downstream face (*DS Face*). If only one photo is taken, a photo of the downstream face

taken when looking upstream will usually be best, and be sure it includes some of the surrounding area to put the barrier into context.

As with other photographs taken at barrier sites, you must rename the photos once they have been downloaded to identify them with their particular sites. Photo names should start with the SiteID, then a *dash*, then an abbreviation of the photo view (e.g., *100-USFace*, *100-DSFace*).

Water Surface Difference – Measure (or estimate) the height difference between the water surface on the upstream and downstream sides of the barrier. If you must estimate this height, mark EST after the height. Be sure to mark the units in which you took the measurement or estimated.

The best way to measure the *Water Surface Difference* is usually to measure the height of **surveyor A**'s eye on a survey rod, have **surveyor B** stand so the base of the rod is at the water surface at the downstream edge of the barrier, and then **surveyor A** stands at the water surface on the upstream edge of the feature and sights with a clinometer or hand level along a level line (clinometer reads 0º or 0%) to take an elevation from the survey rod. **Surveyor A**'s height of eye is then subtracted from the elevation read from the rod to give the difference in elevation between the upstream and downstream sides of the feature.



Horizontal Distance – Measure the horizontal distance from the upstream to downstream edge of the natural barrier. In combination with the *Water Surface Difference* measured above, a gradient can later be calculated for the feature.

Description – Write any comments here about the size, placement or condition of the barrier and the adjacent stream channel that might help to determine if this site should be reviewed for possible fish passage problems. Record here any additional data such as additional *Water Surface Difference* measurements for a complex natural falls with significant differences across the stream channel.

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Dam Survey

Date _____ (mm/dd/yy) **Time** ____:____ **Sequence #**_____ **Site ID**

Observer (s) _____ **Organization** _____

Stream _____ **Tributary to** _____ **Town** _____

GPS Coordinates [WGS84 UTM Zone 19N Meters] 0 ☐☐☐☐☐☐ **East** ☐☐☐☐☐☐☐ **North**

DeLorme Atlas Map Page _____ **Grid Reference** _____ Location Description _____

Photo IDs Upstream Face _____ Downstream Face _____ Fishway _____

Upstream View _____ Downstream View _____ Other _____

Flow Conditions ☐ Low Flow ☐ Moderate Flow ☐ High Flow ☐ No Flow

Dimensions ☐ Measured ☐ Estimated **Units ►** ☐ Feet & Tenths ☐ Feet & Inches ☐ Meters

Structure Length _____ **Spillway Length** _____ **Structure Height** _____ **Spillway Height** _____

Tailwater Pool ☐ No ☐ Yes ► **Pool Depth** ☐ < 3 ft / 1 m ☐ > 3 ft / 1 m ► ☐ Pool Depth Estimated

Impoundment Approx. Length _____ ft/m Approx. Width _____ ft/m ☐ None ☐ Unknown

Impoundment Name (if any): _____

Material ☐ Concrete ☐ Earth ☐ Stone ☐ Masonry ☐ Wood ☐ Other _____

Condition **Breach** ☐ Partial ☐ Full ☐ None **Cracks** ☐ Yes ☐ No **Leaks** ☐ Yes ☐ No

Spillway Spans Channel ☐ Partially ☐ Fully ☐ Open Channel (abutments only)

Dam Features ☐ Low Level Outlet(s) ☐ Floodgate(s) ☐ Flash Boards ☐ Notch ☐ Building(s)

☐ None ☐ Other _____

Fishway ☐ None ☐ Denil ☐ Pool-Weir ☐ Vertical Slot ☐ Steeppass ☐ Eelway ☐ Other

Condition ☐ Missing/Damaged Baffles/Weirs ☐ Cracks ☐ Leaks Describe _____

Current Dam Use ☐ Recreation ☐ Fire Protection ☐ Irrigation ☐ Drinking Water Supply ☐ Hydropower

☐ Fish & Wildlife ☐ Scenic ☐ Other _____ ☐ Unknown

☐ **Dam Dewatered** (Impoundment drained)

Significant Sediment Source Associated with Dam ☐ Upstream ☐ Downstream ☐ Both ☐ None ☐ Unknown

Wildlife Barriers ☐ None ☐ Steep Embankments ☐ Retaining Walls ☐ Fencing ☐ Other _____

Comments:

Over ►►►

Site Sketch (Downstream Dam Face):

Site ID

Site Map (Overhead View):

Natural Barrier Survey Log

Date ____________ (mm/dd/yy) **Observer (s)** ________________________ **Organization** ________________________

Stream ____________________________________ **Tributary to** ____

Flow Conditions ☐ Low Flow ☐ Moderate Flow ☐ High Flow ☐ No Flow

GPS Start Point | 0 | | | | | | | **East** | | | | | | | | **North**

GPS End Point | 0 | | | | | | | **East** | | | | | | | | **North**

SiteID: ______________________ **Seq#** _____ **Barrier Type:** ☐ **Beaver Dam** ☐ **Debris Jam** ☐ **Natural Falls**

GPS Coordinates | 0 | | | | | | | **East** | | | | | | | | **North** ☐ **Full Width** ☐ **Partial Width**

Photo ID(s): US Face ________ **DS Face** ________ **Description:**

Water Surface Difference _______ **Horizontal Distance**_____ Circle One: Feet & Tenths / Feet & Inches / Meters

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SiteID: ______________________ **Seq#** _____ **Barrier Type:** ☐ **Beaver Dam** ☐ **Debris Jam** ☐ **Natural Falls**

GPS Coordinates | 0 | | | | | | | **East** | | | | | | | | **North** ☐ **Full Width** ☐ **Partial Width**

Photo ID(s): US Face ________ **DS Face** ________ **Description:**

Water Surface Difference _______ **Horizontal Distance**_____ Circle One: Feet & Tenths / Feet & Inches / Meters

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SiteID: ______________________ **Seq#** _____ **Barrier Type:** ☐ **Beaver Dam** ☐ **Debris Jam** ☐ **Natural Falls**

GPS Coordinates | 0 | | | | | | | **East** | | | | | | | | **North** ☐ **Full Width** ☐ **Partial Width**

Photo ID(s): US Face ________ **DS Face** ________ **Description:**

Water Surface Difference _______ **Horizontal Distance**_____ Circle One: Feet & Tenths / Feet & Inches / Meters

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SiteID: ______________________ **Seq#** _____ **Barrier Type:** ☐ **Beaver Dam** ☐ **Debris Jam** ☐ **Natural Falls**

GPS Coordinates | 0 | | | | | | | **East** | | | | | | | | **North** ☐ **Full Width** ☐ **Partial Width**

Photo ID(s): US Face ________ **DS Face** ________ **Description:**

Water Surface Difference _______ **Horizontal Distance**_____ Circle One: Feet & Tenths / Feet & Inches / Meters

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SiteID: ______________________ **Seq#** _____ **Barrier Type:** ☐ **Beaver Dam** ☐ **Debris Jam** ☐ **Natural Falls**

GPS Coordinates | 0 | | | | | | | **East** | | | | | | | | **North** ☐ **Full Width** ☐ **Partial Width**

Photo ID(s): US Face ________ **DS Face** ________ **Description:**

Water Surface Difference _______ **Horizontal Distance**_____ Circle One: Feet & Tenths / Feet & Inches / Meters

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SiteID: ______________________ **Seq#** _____ **Barrier Type:** ☐ **Beaver Dam** ☐ **Debris Jam** ☐ **Natural Falls**

GPS Coordinates | 0 | | | | | | | **East** | | | | | | | | **North** ☐ **Full Width** ☐ **Partial Width**

Photo ID(s): US Face ________ **DS Face** ________ **Description:**

Water Surface Difference _______ **Horizontal Distance**_____ Circle One: Feet & Tenths / Feet & Inches / Meters

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