Appendix E

Relevant DFO Factsheets

FACTSHEET

Effects of Silt on Fish and Fish Habitat

Department of Fisheries and Oceans

Silt refers to the fine grained sediment particles which are sometimes transported in the water column. Turbidity is a term used to refer to the "cloudiness" created in the water column by the suspended sediment (silt) particles.

Some of the adverse impacts of suspended sediment include:

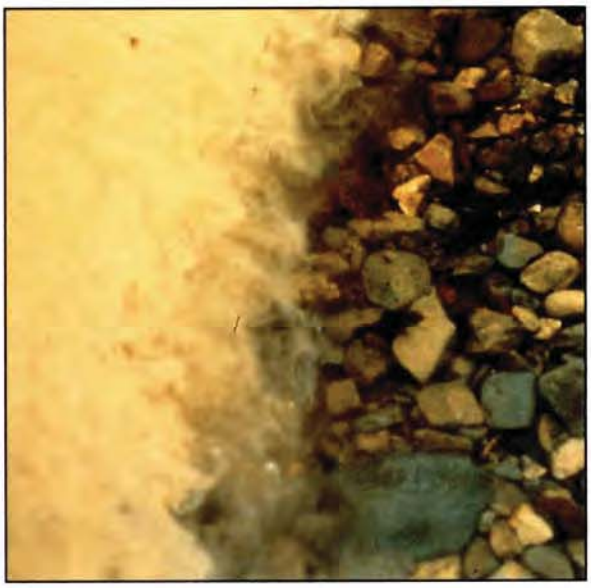
- Abrasion of gill membranes.
- Impairment of feeding due to increased turbidity (salmon and trout are visual feeders).
- Fatal impacts to small aquatic animals which are food organisms for trout and salmon.

Some effects of deposited silt particles include:

- Clogging of small spaces between gravel particles preventing the free flow of oxygenated water and removal of waste products from developing eggs deposited in the gravels. This often causes suffocation and egg mortalities and may leave such gravel beds unsuitable for future deposition of eggs.
- Destruction of the habitat of small stream bottom dwelling animals that provide food for trout and salmon.
- Elimination of sheltered areas between boulders and gravel particles which are important features for juvenile fish.

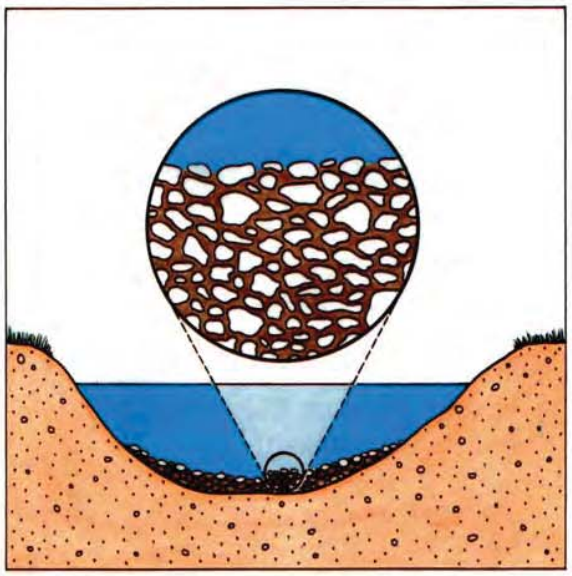
Silt can enter a waterbody as a result of:

- Erosion of exposed soils, often as a result of disturbance by man (eg. improper stream crossings or instream works such as utilization of stream beds as traffic routes by heavy equipment).
- Release of fine particles from some sort of mechanical process (i.e. mine tailings or rock crushing).

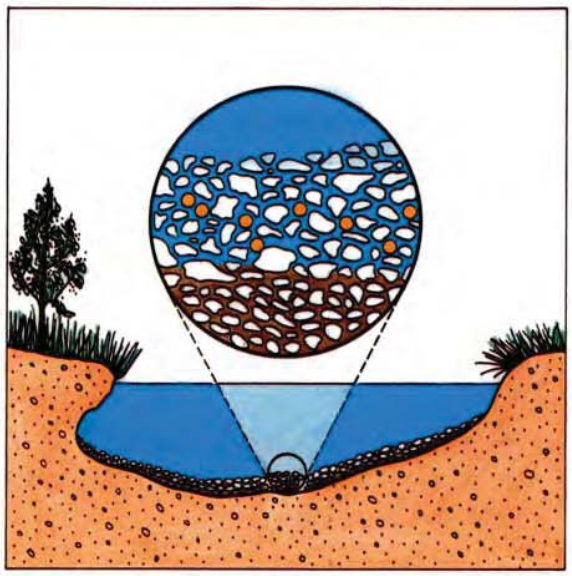


Effects of Silt on Fish and Fish Habitat

For most construction or development projects which cause production of silt, there are methods which are effective for removing suspended sediment from site water and preventing it from entering streams or lakes. Specific methods are outlined in other DFO fact sheets in this series.



Silted gravel stream bottom.



Clean gravel stream bottom.

This Fact Sheet does not constitute DFO approval; other mitigative strategies may be required. The proponent is advised to contact all other appropriate regulatory agencies.

For more information contact the nearest Department of Fisheries and Oceans office.

Fisheries and Oceans Pêches et Océans

Canada

FACTSHEET

Ditching

Department of Fisheries and Oceans

CONDITIONS WHERE APPLICABLE

All roads require proper drainage in order to support traffic. The manner in which ditching is carried out not only affects drainage, but fish habitat as well.

CONSIDERATIONS

- Roadside ditches, particularly new ditches, can transport large volumes of silt and sediment. If this material is discharged into streams it adversely affects fish and other aquatic life.

IMPLEMENTATION PROCEDURES

In order to avoid damage to fish habitat, the following measures should be implemented:

- Cross drainage culverts and take-off ditches should be incorporated to carry water away from the road and into the surrounding vegetation, where sediments can be filtered from the water.
- In addition to take-off ditches, road side ditches with long slopes may require checkdams to reduce flow velocity, control erosion, and prevent siltation of nearby streams.
- Where the topography does not permit the construction of take-off ditches, settling basins should be used to trap silt before it enters nearby streams.
- Where ditches have been excavated in areas with erosion prone soils, the ditches should be immediately lined with non-erodible material.

MAINTENANCE

- Maintenance of drainage ditches includes regular inspection and the removal of accumulated sediments.

REFERENCES

Anon. 1988. Erosion and Sediment Control - Handbook for Construction Sites. N.S. Dept. of the Environment.

Anon. 1990. Environmental Guidelines for Access Roads and Water Crossings. Ontario Ministry of Natural Resources. 64p.

McCubbin, R.N. et al. 1990.(Revised) Resource Road Construction - Fish Habitat Protection Guidelines. DFO. 78p.

FACTSHEET

Temporary Fording Sites

Department of Fisheries and Oceans

CONDITIONS WHERE APPLICABLE

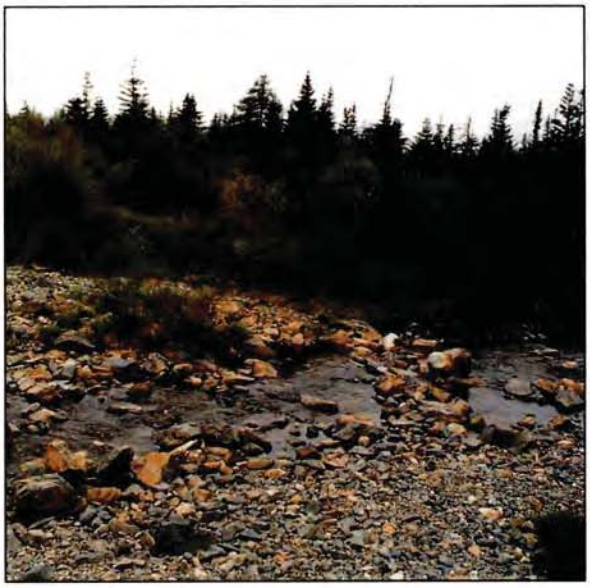
Where there is a need for infrequent crossings and a suitable site exists, fording or travelling through a water course, may be an acceptable method of crossing streams.

CONSIDERATIONS

- Approaches to the crossing site should be stable and have low slope.
- The streambed at the proposed crossing site should consist of bedrock or large rubble material. Known spawning areas must be avoided.
- All activity must be conducted in such a manner that silt does not enter streams.
- Equipment must be mechanically sound to avoid leaks of oil, gas and/or hydraulic fluids.
- Crossings should be restricted to a single location.
- Fords should be constructed and used during the driest time of the year.

IMPLEMENTATION PROCEDURES

- Crossings should be at right angles to the stream.
- Approaches may be stabilized by using non-erodable materials, such as corduroy, brush mats, or clean stone materials.



MAINTENANCE

- The fording site should be monitored to ensure that the approaches to the site are not eroding. If erosion is taking place the appropriate corrective action should be taken.

ABANDONMENT

- When the fording site is no longer required, the stream channel and banks should be restored to their original condition. Any wheel ruts or other damage that may cause siltation in the stream must also be repaired to prevent silt from being discharged into the stream.

REFERENCES

Anon. 1990. Environmental Guidelines for Access Roads and Water Crossings. Ontario Ministry of Natural Resources. 64p.

McCubbin, R.N. et al. 1990.(Revised) Resource Road Construction - Fish Habitat Protection Guidelines. DFO. 78p.

FACTSHEET

Filter Fabric

Department of Fisheries and Oceans

CONDITIONS WHERE APPLICABLE

This type of temporary barrier is commonly referred to as a silt fence or filter fabric dam. Its purpose is to prevent silt from entering waterbodies. These structures are not designed for long term control of siltation. Filter fabric should not be used in natural watercourse. It can be used in ditches and to surround a disturbed site to control site water runoff.

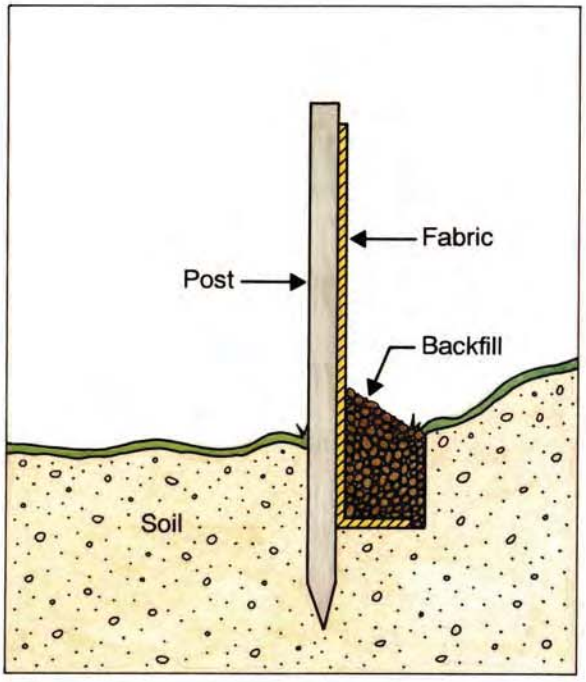
CONSIDERATIONS

- More than one filter fabric dam may be required.
- Filter fabric is designed for temporary use only.
- Further stabilization of disturbed areas may be required prior to filter fabric removal.

IMPLEMENTATION PROCEDURES

- For ditch installations filter fabric should be keyed in to the ditch bottom and sides a minimum of four inches.
- Keying in may be accomplished by excavating a minimum 4" x 4" trench in the ditch bottom and sides.

Wooden stakes should be installed a maximum of 1m apart on the downstream side of the trench and filter fabric attached to the upstream side of the stakes. The trench should then be backfilled. Installation for other disturbed areas should be similar with respect to trenching, stakes and backfilling.



MAINTENANCE

- Clean out accumulated silt at regular intervals as required and dispose of material so that it cannot subequently run into any waterbodies containing fish.

Filter Fabric

- Repair or replace any damaged section(s) of fabric as well as any undercut or end flow areas where water flows freely around the filter fabric.

ABANDONMENT

- Filter fabric should not be removed until all site work has been completed and disturbed areas stabilized.
- Ensure all accumulated silt is removed and disposed of in an appropriate manner prior to removing fabric.
- All materials should be disposed of at an approved dumpsite.

Failure to key the dam into the ditch sides allowed water to wash around the dam.

REFERENCES

Anon. 1988. Erosion and Sediment Control - Handbook for Construction Sites. N.S. Dept. of the Environment.

FACTSHEET

Rock Check Dam

Department of Fisheries and Oceans • Newfoundland Region

CONDITIONS WHERE APPLICABLE

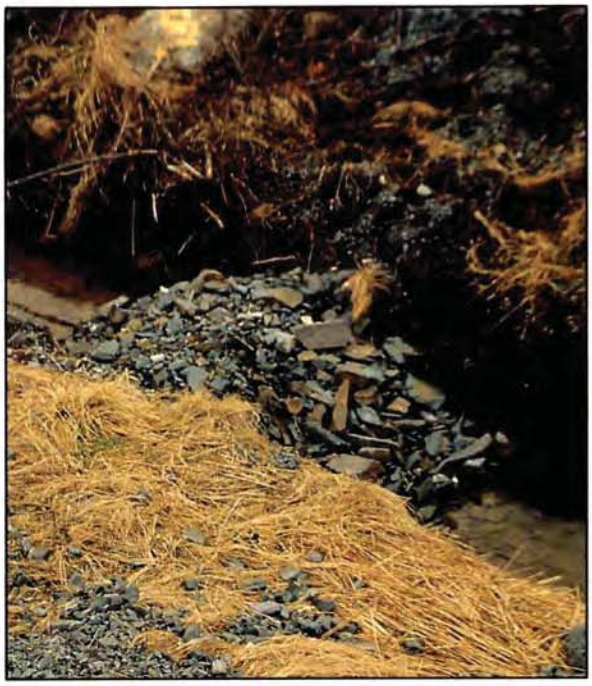
Rock check dams can be used to prevent erosion and control siltation arising from roadside ditches.

CONSIDERATIONS

- These structures must never be used in natural watercourses.
- They can be constructed of locally available materials.
- Rock dams are relatively easy and economical to construct.
- If only larger stones are available, the dam should be lined with impermeable material.
- More than one dam may be necessary.

IMPLEMENTATION PROCEDURES

- Where drainage areas are larger and/or slopes are greater, 100 - 150 mm (4-6in) stones should be used to protect the back and sides of the dam.
- The center of the dam must be lower than the sides.
- The ends of the dam should be stabilized with rip-rap.



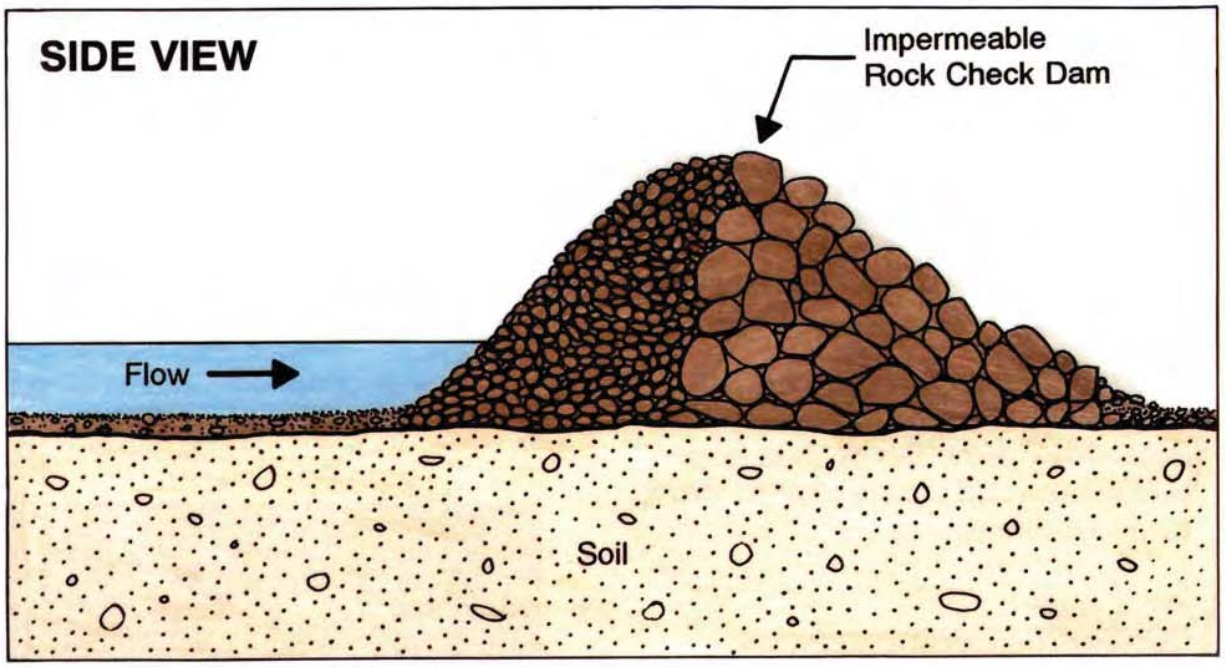
MAINTENANCE

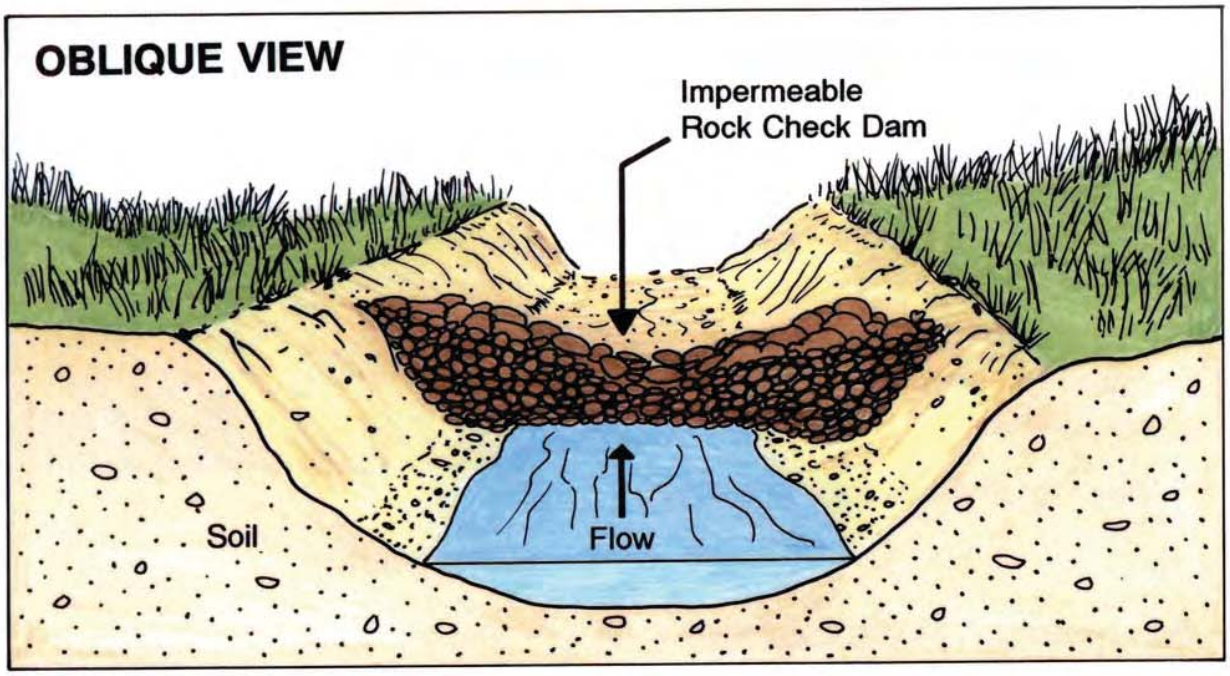
- The dam should be regularly inspected, and accumulations of sediment removed.

REFERENCES

Anon. 1988. Erosion and Sediment Control - Handbook for Construction Sites. N.S. Dept. of the Environment.

Rock Check Dam





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For more information contact the nearest Department of Fisheries and Oceans office.

Fisheries and Oceans Pêches et Océans

Canada

FACTSHEET

Temporary Bridges

Department of Fisheries and Oceans

CONDITIONS WHERE APPLICABLE

Temporary bridges are constructed to cross waterways on a short term basis, primarily for forestry and mineral exploration, where more permanent structures cannot be justified.

CONSIDERATIONS

- Construction must be carried out in such a manner that silt does not enter the stream.
- The instream use of heavy equipment should be avoided.
- Bridges can be installed where the stream banks are stable and have low slope.

IMPLEMENTATION PROCEDURES

- Bridges are constructed of two sets of 5 meter long logs (3 - 5 in a set), and two bedlogs.
- The logs in each section are lashed together on the ends with chain.
- In preparation for the installation, some brush may have to be removed from the crossing site.
- A forwarder transports the bridge to the site, and installs the bridge by:

1. Placing the bedlogs on the stream banks, parallel to the stream.

2. Placing each section of the bridge.

Temporary Bridges

3. Stabilizing the approaches with slash.

MAINTENANCE

- Approaches to the bridge should be maintained regularly by placing additional slash to prevent erosion.

ABANDONMENT

- When the bridge is no longer required, the bridge sections are removed. The bedlogs are maintained in place to prevent further disruption of the stream banks.
- When the structure is removed, wheel ruts and any other damage that may cause siltation in the stream should be repaired.

REFERENCES

Anon. 1990. Environmental Guidelines for Access Roads and Water Crossings. Ontario Ministry of Natural Resources. 64p.

Brathwaite, Glen C. 1992. Woodlot Roads Stream Crossings. Canada/N.S. Cooperation Agreement for Forestry Development. 34p.

McCubbin, R.N. et al. 1990. (Revised) Resource Road Construction - Fish Habitat Protection Guidelines. DFO. 78p.

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For more information contact the nearest Department of Fisheries and Oceans office.

FACTSHEET

Resource Road Construction

Department of Fisheries and Oceans

CONDITIONS WHERE APPLICABLE

Resource access roads are constructed to provide access to forestry or mineral resources.

CONSIDERATIONS

- Resource roads should be located and built in an environmentally sound manner. The implications of such roads on fish habitat should be considered.
- The road layout should be planned such that the number of stream crossings is minimized.

IMPLEMENTATION PROCEDURES

- Where road construction takes place adjacent to a watercourse, a buffer zone of undisturbed vegetation should be maintained between the road and the stream.
- Aggregate materials for road building must not be removed from any stream.
- Side casting should be carried out in such a manner that sediment does not enter any stream.
- Roadside ditches should end blindly in vegetated areas, never directly into a stream.

- Right-of-ways should not be grubbed within 30 metres of stream crossings.
- Siltation control measures, such as sediment traps and check dams should be installed.

MAINTENANCE

The level of maintenance required for resource roads is dependent on the road's use at any given time.

- Regular inspections should be carried out to ensure that culverts and take-off ditches are maintaining proper drainage.
- Roads should be graded and properly crowned to shed water.

Resource Road Construction

- Sediment control measures should receive regular maintenance.

ABANDONMENT

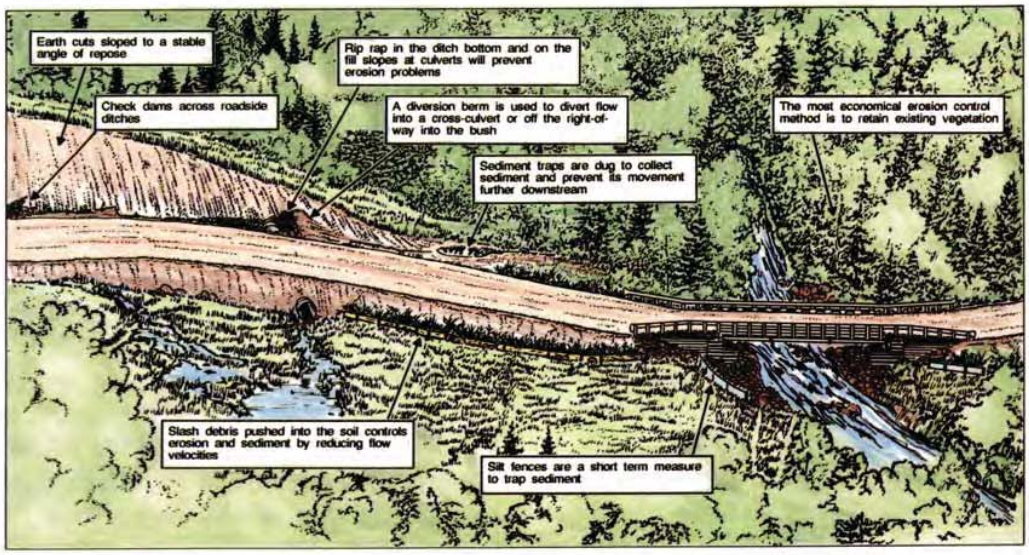
- Consideration should be given to regeneration of the road right-of-way to make the area productive for growing trees and to prevent erosion.
- Surface erosion can be controlled with water bars or transverse ditches excavated across the road surface. These ditches intercept surface run-off and deflect it off the road surface and into the surrounding vegetation.
- Bridges and culverts that require ongoing maintenance should be removed when the road is abandoned. Permanent maintenance free structures should be left in place.

REFERENCES

Anon. 1990. Environmental Guidelines for Access Road Construction and Water Crossings. Ontario Ministry of Natural Resources. 64p.

Brathwaite, Glen C. 1992. Woodlot Roads Stream Crossings. Canada/N.S. Cooperation Agreement for Forestry Development. 34p.

McCubbin, R.N. et. al. 1990. (Revised) Resource Roads Construction - Fish Habitat Protection Guidelines. DFO. 78p.



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For more information contact the nearest Department of Fisheries and Oceans office.

FACTSHEET

Instream Work in the Dry
Cofferdams

Department of Fisheries and Oceans

CONDITIONS WHERE APPLICABLE

A cofferdam usually consists of a double row of sand bags with plastic placed between the rows. They are used to isolate stream sections from stream flow to carry out work under dry conditions. Cofferdams can be used alone (for example to isolate work areas along stream margins from stream flow) or in conjunction with pumps to conduct work(s) within stream channels. If possible, cofferdams should only be used in streams during periods when streamflow is low.

CONSIDERATIONS

- Cofferdams sometimes leak, allowing water to enter work areas. In these circumstances the use of a pump to remove silted water contained within cofferdams is necessary to prevent siltation of downstream areas.
- Cofferdams should be sufficiently high to prevent overtopping in the event of sudden increases in water levels.
- Cofferdams should be removed from streams when no longer required.
- If pumps are used to route streams around cofferdams for more than one day their operation should be monitored during periods when no work is occurring at worksites.

Instream work in the dry using cofferdams.

Cofferdam isolating stream margin work area from stream flow.

Instream Work in the Dry - Cofferdams

IMPLEMENTATION PROCEDURES

- In cases where it is necessary to carry out work within a stream channel a cofferdam should be first placed into the stream at or above the upstream limit of the work area. A pump should be placed upstream of this cofferdam to pump streamflow around the work area and back into the stream. A second cofferdam can then be placed into the stream at or below the downstream limit of the work area, thereby isolating the work area from streamflow and permitting work to be carried out in the dry.
- In order to prevent silt from entering the stream a second pump is used to remove silted water from the work area inside the cofferdams. This silted water should be treated by discharging to settling basins, vegetated areas or sediment traps prior to release to streams.

MAINTENANCE

- Sand bags damaged during the course of a work should be replaced.
- Care should be taken to seal leaks in cofferdams.

ABANDONMENT

- Cofferdams should not be removed from streams until instream work areas have been fully stabilized.
- All cofferdam materials should be removed from the stream and disposed of at an approved dump area.

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For more information contact the nearest Department of Fisheries and Oceans office.

Fisheries and Oceans Pêches et Océans

Canada

FACTSHEET

Streambank Stabilization

Department of Fisheries and Oceans

CONDITIONS WHERE APPLICABLE

Streambank stabilization is appropriate where:

- An area of streambank is undergoing "natural" erosion and causing deposition of sediments in spawning and rearing habitat downstream.
- An area of streambank has been disrupted or destroyed during the conduct of a work or undertaking and the area in question requires "rebuilding".

Stream bank stabilization using rip rap and hydroseed.

CONSIDERATIONS

- Rip rap, the usual material type employed for riverbank stabilization, should be clean, free of fine materials, and of sufficient size to resist displacement during peak flood events.
- Stream banks to be stabilized or rebuilt should be shaped so that they are at a stable slope.
- Gabion baskets can be used as an alternative to rip rap where bank slopes are not at a stable angle of repose.
- Streambank stabilization should not result in a decrease in the cross sectional width of streams.

Rebuilt stream banks - rip rap, sod and natural vegetation.

Streambank Stabilization

IMPLEMENTATION PROCEDURES

- Rip rap or gabion basket placement should be carried out in the dry (e.g. using cofferdams consisting of double walls of sand bags with plastic placed between the walls to isolate streambank areas from streamflow) The planting of trees (e.g. alders, willows) and other vegetation (for example grass, small shrubs, etc.) on streambanks can enhance stabilization measures.

- Stabilization materials used should be placed from the toe of the bank slope to a height on the streambanks equal to the anticipated high water level or to the top of the bank slope, as appropriate.

- The effectiveness of streambank stabilization can be increased if the top of bank slopes are seeded, sodded, or hydroseeded in conjunction with the placement of rock, rip rap, or gabions.

- In river sections where the stream channel meanders particular care should be exercised in stabilizing the outside bends of meanders since such areas are subject to increased erosion pressures.

MAINTENANCE

- Once stream banks have been properly restored maintenance is not often required.

ABANDONMENT

- Excess materials left over from stream bank rehabilitation and cofferdam materials, etc. should be disposed of at an approved dump site.

This Fact Sheet does not constitute DFO approval; other mitigative strategies may be required. The proponent is advised to contact all other appropriate regulatory agencies.

For more information contact the nearest
Department of Fisheries and Oceans office.

FACTSHEET

Instream Work in the Dry
Temporary Diversion

Department of Fisheries and Oceans

CONDITIONS WHERE APPLICABLE

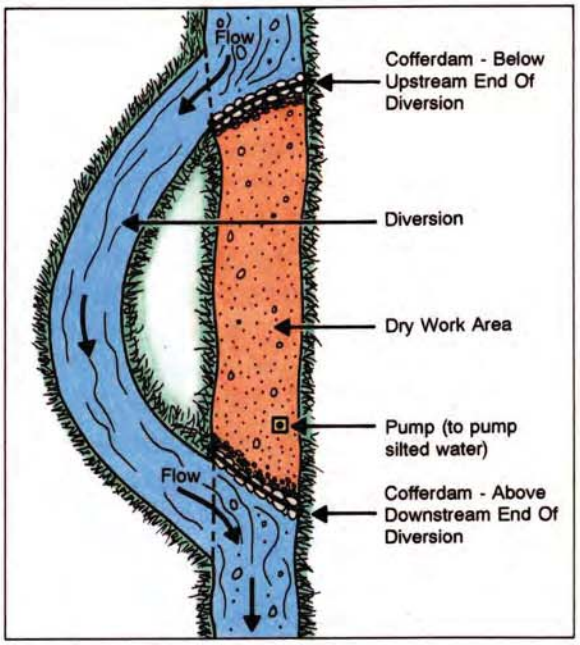
A temporary diversion is used to conduct instream work in the dry. This method is usually limited only by the availability of space within which to construct a diversion.

CONSIDERATIONS

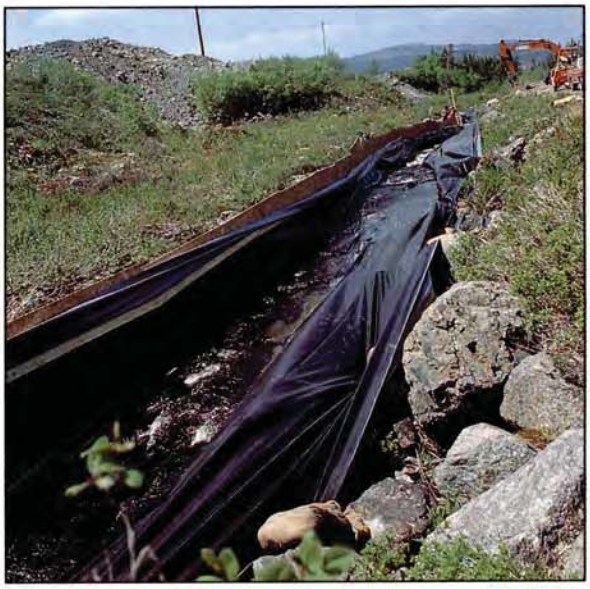
- Constant maintenance of diversion channels may be required.
- Care must be exercised in the excavation of the diversion channel to ensure that it is capable of accommodating peak flows from the stream which is being diverted.
- A pump is usually required to remove silted site water arising in dewatered work areas.

IMPLEMENTATION PROCEDURES

- Temporary diversions should be excavated from the downstream end toward the upstream point of diversion, where a "plug" of earth should be left to prevent the entry of streamflow into the diversion channel before it is stabilized. Strong plastic sheathing can be used to line the channel bottom and slopes. This sheathing should be weighted down with crushed stone and staked into the top of the channel slopes. Once



Temporary diversion.



Temporary diversion - channel liner.

Instream Work in the Dry - Temporary Diversion

the channel has been lined and the lining secured, the "plug" of earth referred to earlier can be removed.

- A cofferdam (recommended double walls of sand bags with plastic placed between the walls) should then be placed immediately below the upstream point of diversion to re-route the flow of water into the diversion. Another cofferdam should then be placed immediately above the downstream point of diversion to isolate the work area and prevent silted water from escaping into the stream. In this manner the work area is effectively isolated from the stream and instream work can proceed in the dry. Silted water arising within the work area should be treated by discharging to vegetated areas, sediment traps or settling basins.

MAINTENANCE

- Plastic used to line the diversion must be kept in a good state of repair.

- Care must be exercised to ensure that streamflow does not get under or behind the channel liner and cause erosion of the channel banks and subsequent downstream siltation.

- At increased water levels and velocities it may be necessary to further secure the channel liner.

ABANDONMENT

- The diversion should be filled in and stabilized when no longer in use.

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For more information contact the nearest
Department of Fisheries and Oceans office.

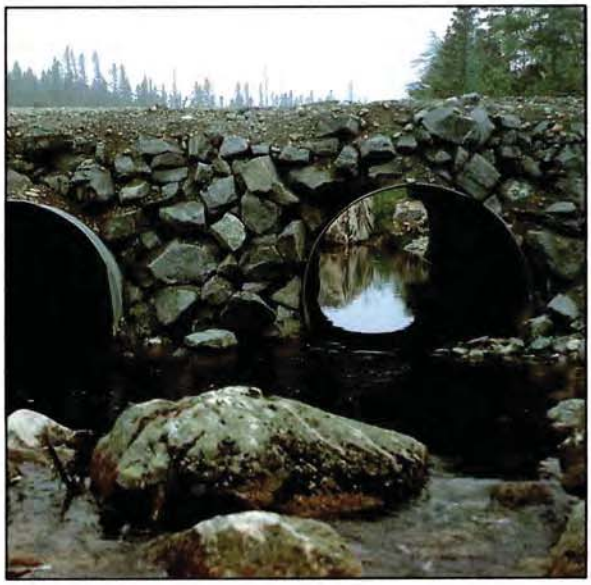
FACTSHEET

Culvert Stabilization

Department of Fisheries and Oceans

CONDITIONS WHERE APPLICABLE

Stabilization of culvert inlets and outlets should be undertaken when culverts are installed. This prevents the erosion of materials from around culverts and subsequent downstream siltation and possible loss of the culverts due to washouts.



Culvert rip rap stabilization.

CONSIDERATIONS

- Materials used for stabilization purposes should be clean and non erodible (e.g. blasted rock, or rip rap, or gabion baskets).
- Materials used for stabilization should completely cover unstabilized materials (e.g. road fill, gravel) at culvert inlets and outlets.
- Fill slopes should be stable to ensure that roadbed materials do not enter watercourses.

Stabilization of culvert outlets - rip rap.

IMPLEMENTATION PROCEDURES

- When a culvert has been installed gabions, rip rap, or large, clean rock should be placed at the culvert inlets and outlets. All materials used for stabilization should be of sufficient size to prevent erosion under anticipated operating levels for the culvert.

Culvert Stabilization

MAINTENANCE

- Culverts should be inspected regularly to assess the adequacy of stabilization measures. Areas from which stabilization materials have become dislodged should be repaired.

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For more information contact the nearest Department of Fisheries and Oceans office.

Fisheries and Oceans Pêches et Océans

Canada

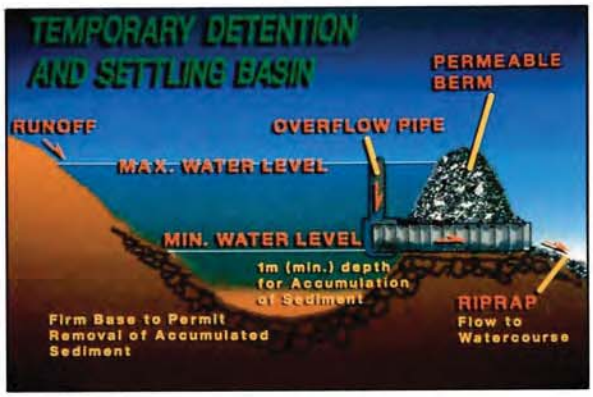
FACTSHEET

Temporary Settling (Detention) Basins

Department of Fisheries and Oceans

CONDITIONS WHERE APPLICABLE

These basins are used (on a relatively short term basis) for the treatment of silted water prior to release to water-courses.



Settling basin construction details.

CONSIDERATIONS

- These basins are often most effective when they are constructed so that their length is four times their width.
- The bottoms of settling basins should be lined (e.g. with plastic).
- Settling basins are often most effective when several are used in series.

Settling basin lined with plastic.

IMPLEMENTATION PROCEDURES

- A pipe should be installed near the top of a settling basin in such a manner that it discharges water from the top of the water column. There are a number of alternatives to this method of settling basin construction involving the use of various detention devices such as pre-cast manholes, and utilizing natural topographic features.

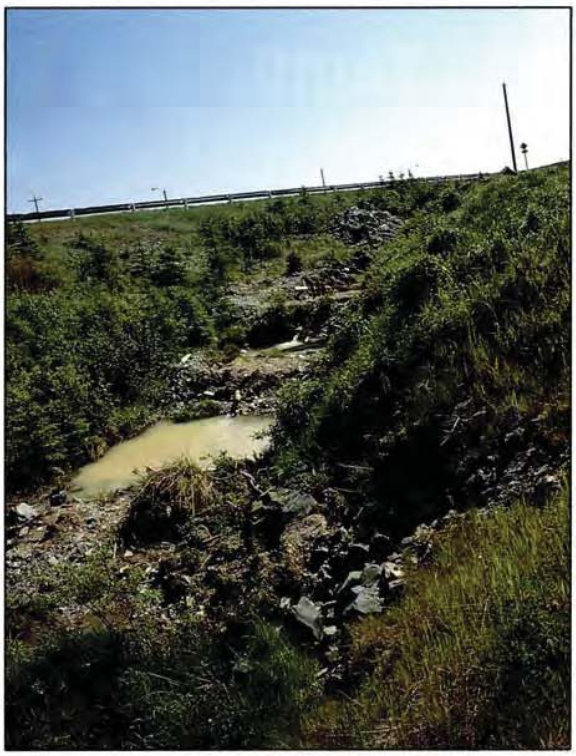
Temporary Settling (Detention) Basins

MAINTENANCE

- It may be necessary to remove and dispose of accumulated sediment from settling basins in order to maintain their operating capacity.

ABANDONMENT

- Settling basins should be filled in and stabilized when no longer required.



Series of rough settling basins intended for short term use.

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Fisheries and Oceans Pêches et Océans

Canada

FACTSHEET

Freshwater Salmonid Habitat Requirements

Department of Fisheries and Oceans

CONDITIONS WHERE APPLICABLE

Fish habitat is defined as those parts of the environment on which fish depend, directly or indirectly, in order to carry out their life processes. This includes spawning grounds, rearing habitat, migration and feeding areas.

SPAWNING AREAS

Salmonids require a stretch of stream with clean gravel and good water flow. This type of habitat is most often found in headwater areas (the uppermost stream reaches), where there is typically finer substrates and relatively stable water flows. However, salmonids also spawn in the lower reaches of streams. For successful spawning, salmonids require clean, stable gravel of 1 cm to 15 cm in diameter depending on fish size. These stream conditions provide a stable supply of clean, cool, well oxygenated water for the successful incubation of eggs deposited in the gravels, and rearing of young.

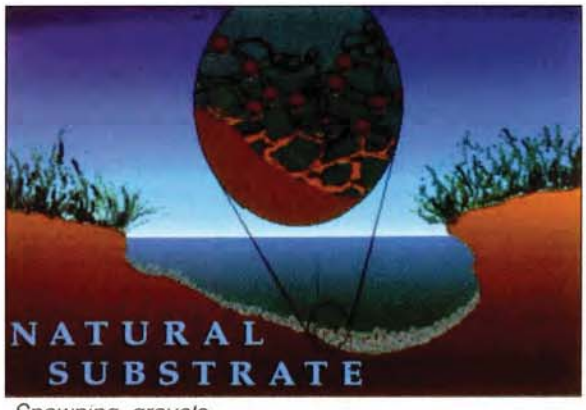
REARING AREAS

Rearing habitat varies from areas of low stream velocity and small substrate to areas of larger (cobble/boulder) substrate and higher velocities. Streams supporting successful salmonid populations are usually associated with a high proportion of riffles and pools, thus offering a variety of habitat cover types. Shelter is provided by undercut banks, deep pools, turbulence, rocky areas, instream debris, and overhanging (riparian) vegetation.

MIGRATION AREAS

Migration areas consist of stream reaches that provide corridors for fish movement from one area of the watershed to another or, for anadromous (sea-run) salmonids, access to and from the sea. Migration areas must permit fish movement to critical habitats. The lack of barriers to migration in the main stream and tributaries, as well as adequate water flow are essential.

Spawning habitat.



Spawning gravels.

Freshwater Salmonid Habitat Requirements

FEEDING AREAS

Insect life is the major food supply for salmonids. The available food supply of a stream depends on clean, cool, well oxygenated water flowing over a clean bottom of gravel, cobble or boulders.

Salmonids are primarily sight feeders and water clarity influences feeding ability. Streams must be clear enough to permit sunlight to penetrate and permit adequate algal growth which, in turn, maintain a healthy aquatic insect population as a food supply for fish. Beneath the surface of a stream, among the rocks and boulders, there is an abundance of insects in their immature forms. A variety of stream bottom materials is required for production of aquatic insects. Insects falling into the stream from overhanging vegetation also provide food for salmonids.

Riffle area containing rearing, spawning and feeding habitat.

Optimum fish production is contingent upon a combination of a variety of conditions, including adequate food supply, suitable dissolved oxygen levels, cool stream temperatures, shelter (cover), and clear, clean water.

The above factors combine to make salmon and trout very sensitive to various environmental changes. These factors are all necessary to support a productive salmonid population. Loss of any one of these critical habitat components usually results in severe reductions or total loss of salmonid stocks from a given area.

This Fact Sheet does not constitute DFO approval; other mitigative strategies may be required. The proponent is advised to contact all other appropriate regulatory agencies.

For more information contact the nearest Department of Fisheries and Oceans office.

Fisheries and Oceans Pêches et Océans

Canada

FACTSHEET

Freshwater Intake End-Of-Pipe Fish Screen

Department of Fisheries and Oceans

CONDITIONS WHERE APPLICABLE

Fish protection should be provided for activities involving extraction of fresh water. An intake should be screened to prevent potential losses of fish due to entrainment or impingement. Entrainment occurs when an organism is drawn into a water intake and cannot escape. Impingement occurs when an entrapped organism is held in contact with the intake screen and is unable to free itself.

CONSIDERATIONS

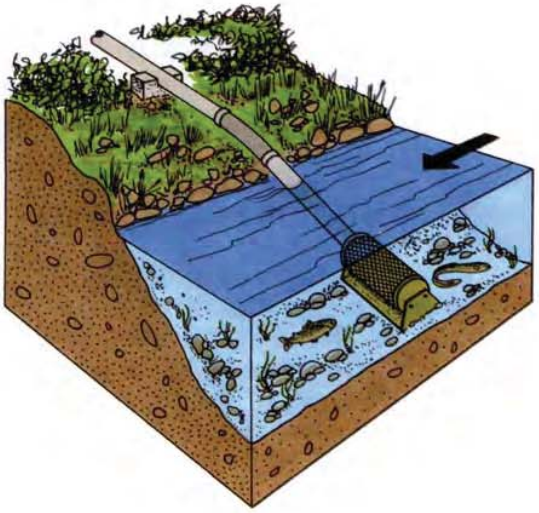
- For small permanent and temporary freshwater withdrawals up to 125 litres/second (L/s) (2000 US gallons per minute (gpm)), associated with irrigation, construction, small municipal and private water supplies, etc., end-of-pipe intake screen designs are often used for the protection of fish.
- Open screen area requirements for freshwater intake end-of-pipe fish screens differ depending upon swimming mode (i.e., subcarangiform - fish that swim like trout/salmon; or anguilliform - fish that swim like an eel).
- Freshwater fish of 25 mm (i.e., fry stage) or more in length should be protected from entrainment and impingement due to water extraction activities, unless site-specific circumstances, as addressed with DFO, indicate otherwise.

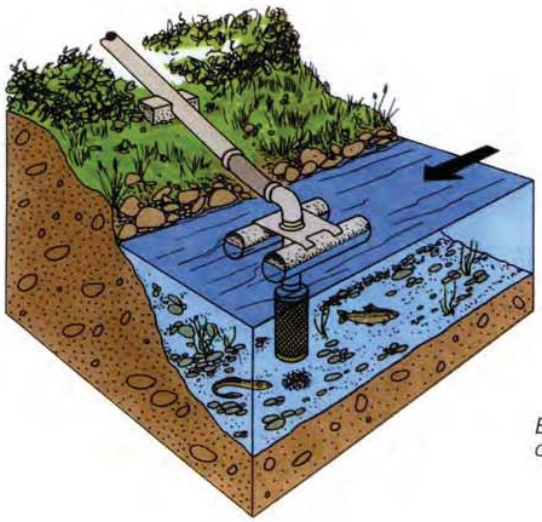
IMPLEMENTATION PROCEDURES

- The required screen area (i.e., the area of all open spaces on the screen available for the free flow of water) varies depending upon rate of water withdrawal. The narrowest dimension of any opening on the screen, regardless of opening shape, for fish of 25 mm is estimated at 2.54 mm. DFO should be contacted regarding specific requirements.
- Screen openings may be round, square, rectangular, or any combination thereof, and should not have any protrusions that could injure fish.
- Where possible, screens should be located in areas and depths of water with low concentrations of fish throughout the year, away from natural or constructed structures which may attract fish that are migrating/spawning or in rearing habitat, and at a minimum of 300 mm above the bottom of the watercourse/ waterbody to prevent entrainment of sediment and aquatic organisms associated with the bottom area.
- The screen face should be oriented in the same direction as the flow.
- Flow should be evenly distributed over the screen surface.
- Heavier cages or trash racks can be fabricated out of bar or grating to protect the finer fish screen, especially in areas of debris movement.

Freshwater Intake End-Of-Pipe Fish Screen

- DFO should be contacted regarding proposed water withdrawal activities prior to start-up.





Examples of typical applications and features of end-of-pipe screens.

MAINTENANCE

- Regular maintenance should be provided, including the removal, inspection, and cleaning of screens to prevent debris fouling and impingement of fish.
- Pumps should be shutdown when fish screens are removed for inspection and cleaning.

ABANDONMENT

- Consideration should be given to the removal of the intake screen and associated infrastructure.

For more specific technical information refer to:

Department of Fisheries and Oceans. 1995. Freshwater Intake End-of-Pipe Fish Screen Guideline. Communications Directorate, Department of Fisheries and Oceans.

This Fact Sheet does not constitute DFO approval; other mitigative strategies may be required. The proponent is advised to contact all other appropriate regulatory agencies.

For more information contact the nearest Department of Fisheries and Oceans office.

FACTSHEET

Stream Clean-up

Department of Fisheries and Oceans

CONDITIONS WHERE APPLICABLE

Stream clean-up is sometimes required in streams that have had man made materials introduced into them from various activities/sources. These materials could cause the following problems:

- obstructions to fish migration
- scouring of the natural stream bottom sometimes removing spawning gravels or causing siltation of spawning gravels downstream
- alteration of the natural flow of a stream resulting in streambank erosion or excessive water velocities preventing fish migration
- filling in of the natural bottom substrate resulting in the loss of access to suitable fish spawning/rearing habitat.

Instream barriers to fish migration.

CONSIDERATIONS

- Trees, bushes, shrubs, weeds or tall grasses should not be removed along any streambank. In addition, mats of floating algae or vegetation should not be removed from any section of the stream. These important habitat features provide shade and cover for fish, keeping water temperatures cool, providing insect food for fish and offering protection from predators.

- Woody debris which is not causing any apparent damage to the bottom substrate may be left in place as it provides cover for fish. As woody debris decomposes it becomes a food source for small microorganisms and invertebrates which, in turn, are eaten by trout and young salmon. Decomposition also renews the energy cycle with nutrients.

Overhanging vegetation should not be removed.

- Activities associated with stream clean-up must not alter the flow characteristics of the stream as this may cause streambank erosion, bottom scouring and possible downstream deposition of sediments.

Stream Clean-up

In addition, increased water velocities may act as a barrier to fish migration.

- Streambanks must not be disturbed such that underlying soils are exposed. This could cause silt to enter the stream resulting in a loss of fish habitat. Any streambank that is disturbed should be immediately stabilized by re-vegetating. (See Factsheet # 11 regarding streambank stabilization).

IMPLEMENTATION PROCEDURES

- Instream activity should be scheduled to take place between June 1 and September 30, in order to reduce impacts to fish habitat during fish spawning and incubation periods.
- Instream debris should be removed by hand. Heavy equipment should not be used instream.
- All necessary measures must be taken to avoid the release of silt into the stream. (See Factsheets # 6, 7, 10 and 17 regarding measures to control silt).
- The natural stream bottom substrate must not be altered or disturbed in any way.
- Instream clean-up activities should be carried out during times of low flow.
- All surplus or waste material should be removed from the project area and disposed of at an approved dump-site.
- DFO should be consulted regarding any stream clean-up project prior to start-up.

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For more information contact the nearest Department of Fisheries and Oceans office.

Fisheries and Oceans Pêches et Océans

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FACTSHEET

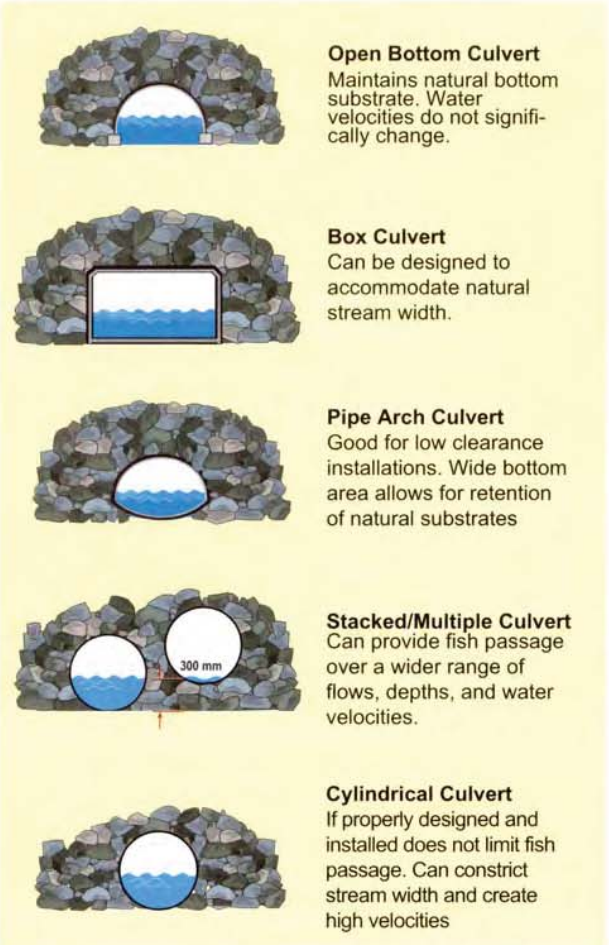
Culvert Installations

Department of Fisheries and Oceans

CONDITIONS WHERE APPLICABLE

Culverts are the most commonly used method for providing access over a watercourse, and particularly for small and medium sized streams. Several types of culverts are used including; open bottom/bottomless arch, pipe arch, box, and circular/cylindrical. Box type culverts are generally made from wood or concrete while other types are made from plastic, concrete or, most commonly, corrugated steel. Figure 1 identifies various culvert shapes.

Figure 1 Culvert Shapes



Open Bottom Culvert
Maintains natural bottom substrate. Water velocities do not significally change.

Box Culvert
Can be designed to accommodate natural stream width.

Pipe Arch Culvert
Good for low clearance installations. Wide bottom area allows for retention of natural substrates

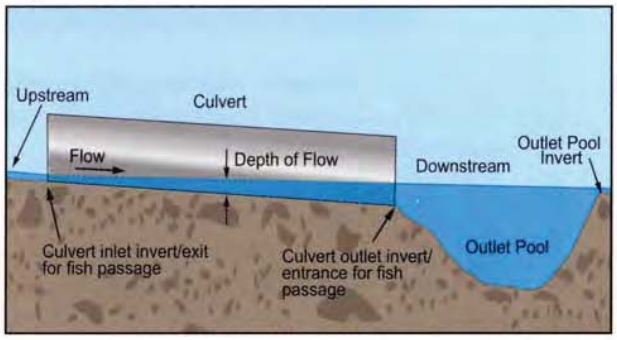
Stacked/Multiple Culvert
Can provide fish passage over a wider range of flows, depths, and water velocities.

Cylindrical Culvert
If properly designed and installed does not limit fish passage. Can constrict stream width and create high velocities

CONSIDERATIONS

- Sufficient depth of flow and appropriate water velocities for fish passage should be provided in culvert installations.
- Culvert size should be based on the capacity to handle peak flows. It may be necessary to have a hydrologic and hydraulic analysis performed in order to determine the correct size of the culvert to be used. The hydrologic analysis is used to determine the peak flow and the hydraulic analysis is used to calculate the capacity of the culvert to adequately pass the peak flows.
- The type of culvert selected and installed should minimize potential impacts on fish habitat, maintain fish passage, and sufficiently accommodate watercourse flows. To the extent possible, natural stream conditions (i.e., widths, habitat, etc.) should be maintained. Figure 2 illustrates some common terms associated with culvert crossings.

Figure 2. General Culvert Terms



- Natural bottom substrate and hydraulic capacity of watercourses are best maintained using open bottom/bottomless arch culverts; these are the preferred type of culvert crossings.

Culvert Installations

- Footings for open bottom culverts should be installed outside the normal wetted perimeter of the watercourse and tied into the bedrock or sufficiently stabilized to prevent erosion around the footing or undermining.

- For installation of cylindrical culverts in fish bearing streams, a minimum culvert diameter of 1000 mm should be provided and designed/sized according to site specific considerations.

- Cylindrical culverts should be installed to simulate open bottom or pipe arch culverts. Culverts up to 2000 mm in diameter should be countersunk a depth of 300 mm below the streambed elevation. Culverts with diameters exceeding 2000 mm should be countersunk a minimum of 15% of the diameter below the streambed elevation. Note: Countersinking reduces the hydraulic capacity of the culvert, therefore the required diameter of the culvert must be adjusted accordingly (Figure 3).

Figure 3. Countersunk Culvert

- Culverts should be aligned parallel to the existing natural channel and located on a straight stream section of uniform gradient.

- The culvert should be placed on firm ground and be countersunk to the appropriate depth. In sites where soft foundations are present the unsuitable material should be removed and replaced by clean granular material to prevent the culvert from sagging. Water movement under or around a culvert installation should be prevented through the use of headwalls, or other means, as necessary.

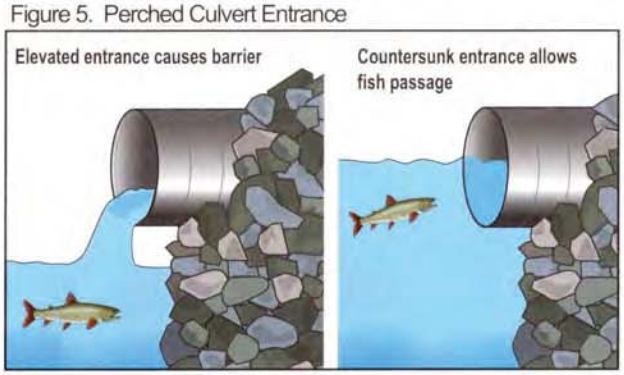
- A culvert should extend beyond the upstream and downstream toe of the fill (eg., a minimum of 300 mm, see Figure 7).

- For multiple culvert installations the culvert intended to provide fish passage should be placed in the deepest part of the channel and be countersunk to the required depth. The remaining culvert(s) should be placed a minimum of 300 mm above the invert of the fish passage culvert. (Figure 4).

Figure 4. Multiple Culvert Installation

- Culverts should be sufficiently sized and installed such that scouring of the outlet streambed does not occur as a result of increased water velocities in the culvert. Elevated culvert entrances can cause scouring which may create an obstruction for migrating fish (Figure 5).

Figure 5. Perched Culvert Entrance



- A minimum water depth of 200 mm should be provided throughout the culvert length. To maintain this water depth at low flow periods an entrance/ downstream pool can be constructed. In some cases, an upstream pool may also be necessary.

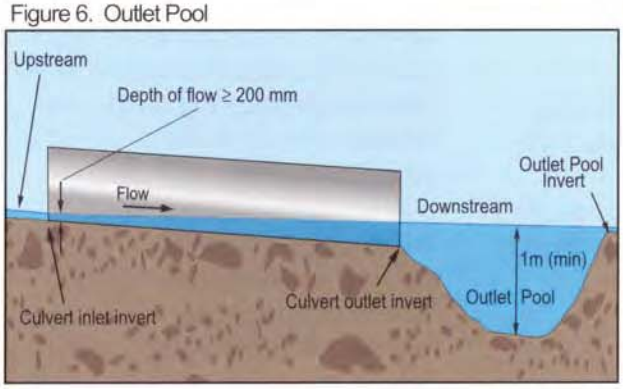
Culvert Installations

- The invert of the pool outlet should be at an elevation that maintains a minimum of 200 mm of water depth up to the inlet or upstream end of the culvert (Figure 6).

- The culvert slope should follow the existing streambed slope where possible. Excessive culvert slope, reduced culvert capacity due to countersinking and maintenance of the 200 mm minimum depth of flow, and back watering due to the creation of an outlet pool should be considered when selecting the required culvert diameter to allow fish passage and pass peak flows.

- Pools should be designed so that there is a smooth transition of flow from the culvert to the natural stream width.

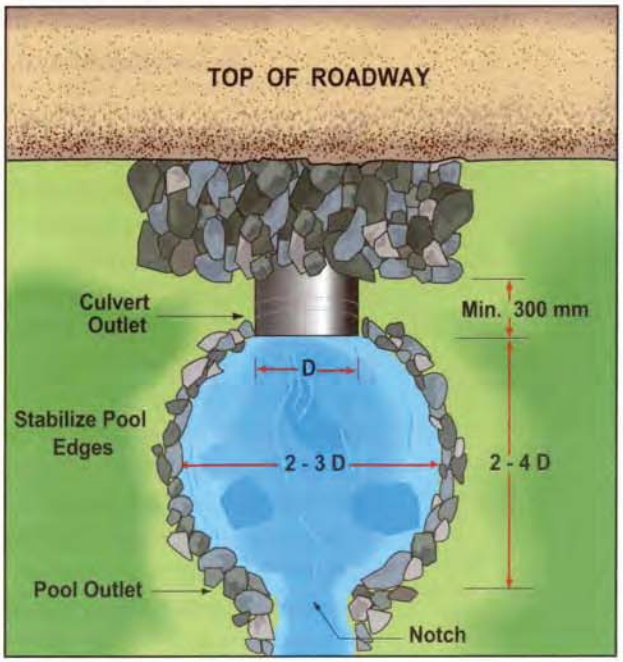
Figure 6. Outlet Pool



- The natural streambed elevation should be used as the pool outlet invert; however, depending on site specific conditions, a pool outlet may need to be constructed. It is essential that the invert elevation of the pool outlet be stable and, if necessary, well maintained to ensure a minimum water level in the culvert. Clean, non-erodible riprap or gabions should be used to stabilize the pool. The pool outlet may need to be v-notched to enable fish passage at low flow periods. More than one pool may be required.

- Pools should be pear shaped and sized such that: pool length = 2 to 4 times culvert diameter; pool width = 2 to 3 times culvert diameter; pool depth = 0.5 times the culvert diameter, 1 metre minimum. (Figure 7). The culvert diameter referred to the above is that of the fish passage culvert.

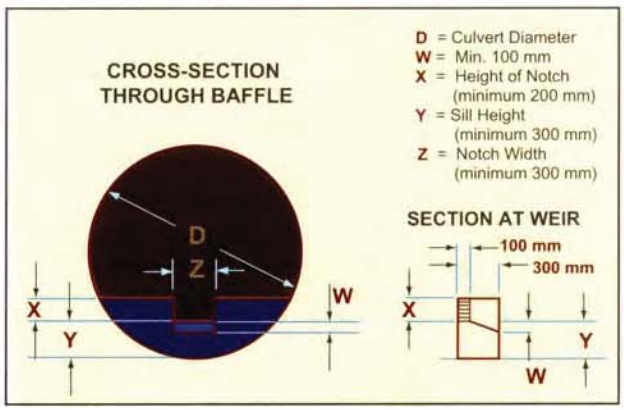
Figure 7. Pool Sizing



- For stacked/multiple culverts, pools should be installed with the fish passage culvert orientated to the centre of the pool to allow for a smooth transition of water from the culvert to the watercourse.

- Depending on site-specific conditions (eg., steep slopes, long crossings, constricted streams resulting in high water velocities, etc.), baffles/weirs may need to be installed in the fish passage culvert. Baffles/weirs can provide an adequate depth of flow and reduce the water velocity in the culvert in order to facilitate fish passage. Baffle dimensions should be provided as per Figure 8.

Figure 8. Baffle Sizing



Culvert Installations

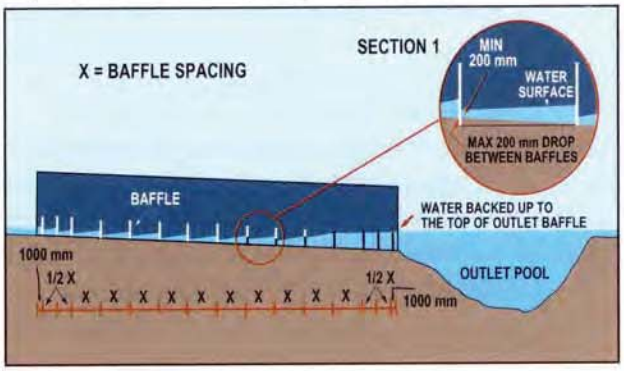
- A minimum depth of flow of 200 mm should be provided throughout the culvert and baffled sections. The drops between adjacent baffles should be a maximum of 200 mm.

- Baffles should be placed approximately 1 metre from the inlet and outlet ends of the culvert, the next baffles should be placed at 1/2 the baffle spacing. The remaining baffle spacing should be determined by using the low flow (flow at the time of fish migration, i.e., lesser of flow at 90% exceedance via flow duration analysis or the 7 day, 10 year low flow) as a basis for meeting the above depth of flow and drop between baffles criteria. Baffle spacing should also provide a pool volume large enough to dissipate the kinetic energy produced by the water falling over the weir; and consider high flows (i.e., 10% exceedence based on flow duration) during the fish migration period. Baffle spacing is illustrated in Figure 9.

- The invert elevation of the outlet pool should be set to back water up to the top of the outlet baffle.

- The upstream culvert invert, in some site specific situations, can be countersunk to facilitate depth of flow provided that the head differential is accounted for.

Figure 9. Culvert Baffle Spacing Requirements



Maintenance

Culvert installations should be suitably stabilized to prevent erosion, seepage, and undermining and maintained in good repair and operating condition.

Special Considerations

Modifications of the above criteria/guidance in consultation with the Department of Fisheries and Oceans may be required to address the passage of fish species other than salmon, brook trout, and brown trout in culvert installations.

This factsheet concerning culvert installations is generic and has been developed to apply to a variety of different circumstances. Some site specific situations may warrant modification of the above guidance, as deemed appropriate and in consultation with the appropriate Area Habitat Biologist. In some site specific situations, a professional engineer and/or biologist should be consulted.

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For more information contact the nearest
Department of Fisheries and Oceans office