Mitigation Guide for the Protection of Fishes and Fish Habitat to Accompany the Species at Risk Recovery Potential Assessments Conducted by Fisheries and Oceans Canada (DFO) in Central and Arctic Region

Version 1.0

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MITIGATION GUIDE FOR THE PROTECTION OF FISHES AND FISH HABITAT TO ACCOMPANY THE SPECIES AT RISK RECOVERY POTENTIAL ASSESSMENTS CONDUCTED BY FISHERIES AND OCEANS CANADA (DFO) IN CENTRAL AND ARCTIC REGION

VERSION 1.0

by

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Coker, G.A., Ming, D.L., and Mandrak, N.E. 2010. Mitigation guide for the protection of fishes and fish habitat to accompany the species at risk recovery potential assessments conducted by Fisheries and Oceans Canada (DFO) in Central and Arctic Region. Version 1.0. Can. Manuscr. Rep. Fish. Aquat. Sci. 2904: vi + 40 p.

This document was developed to accompany the Recovery Potential Assessments (RPA) for aquatic species at risk conducted by Fisheries and Oceans Canada (DFO) in Central and Arctic Region. One of the required components of the RPA is to identify mitigation strategies and alternative activities that would protect species at risk against identified threats. Threats to species at risk are identified in: COSEWIC species status reports; DFO pre-COSEWIC assessments; DFO RPAs; and, recovery strategies and management plans.

This document identifies example alternative and mitigation measures to activities that threaten fishes and fish habitat, including species at risk. In conjunction with the RPA, recovery teams can use these generic examples to determine if there are appropriate mitigation actions for activities that may threaten aquatic species at risk. A list of all unique mitigation measures, with associated coded pathway links, is also provided.

RÉSUMÉ

Coker, G.A., Ming, D.L., and Mandrak, N.E. 2010. Mitigation guide for the protection of fishes and fish habitat to accompany the species at risk recovery potential assessments conducted by Fisheries and Oceans Canada (DFO) in Central and Arctic Region. Version 1.0. Can. Manuscr. Rep. Fish. Aquat. Sci. 2904: vi + 40 p.

Le présent document a été préparé pour accompagner les évaluations du potentiel de rétablissement (EPR) des espèces aquatiques en péril, réalisées par Pêches et Océans Canada (MPO) dans la région du Centre et de l'Arctique. La définition de stratégies d'atténuation et le développement d'activités de rechange, visant à protéger les espèces en péril contre des menaces signalées, représentent l'une des composantes obligatoires de l'EPR. Les menaces aux espèces en péril sont décrites dans les documents suivants : les rapports de situation du COSEPAC sur des espèces; les évaluations préalables à celles du COSEPAC du MPO; les EPR du MPO; les stratégies de rétablissement et les plans de gestion.

Dans ce document, on cite des exemples de mesures d'atténuation et autres à prendre en situation de menace au poisson, y compris les espèces en péril, et à l'habitat du poisson. Ces exemples génériques, utilisés de pair avec l'EPR, permettraient aux équipes de rétablissement de déterminer des mesures d'atténuation convenables en situation de menaces possibles aux espèces aquatiques en péril. Une liste de l'ensemble des mesures d'atténuation uniques et les liens pour les chemins d'accès codés connexes y sont également fournis.

PREFACE

Note to Users: The development of this guidance document was funded by the Species at Risk (SAR) program in the Central and Arctic Region (C&A) of DFO. It is intended for the use of DFO and is subject to revision at any time. Please check with the C&A SAR program to ensure that you are using the most current version available of this guide.

This guide has been developed to provide supplementary information for the Species at Risk Recovery Potential Assessments conducted by Fisheries and Oceans Canada (DFO) in Central and Arctic Region.

INTRODUCTION

The purposes of the federal *Species at Risk Act* (SARA) are to prevent wildlife species from being Extirpated or becoming Extinct (Section 6), to provide for the recovery of wildlife species that are Extirpated, Endangered or Threatened as a result of human activity (Sections 37 to 55), and to manage species of Special Concern to prevent them from becoming Endangered or Threatened (Sections 65 to 72). Currently, several fishes and mussels are among the identified species at risk (SAR) on Schedule 1 of the SARA, which is the legal list of species at risk in Canada (Sections 27 to 31). To obtain a current list of fish and mussel species listed on Schedule 1 of the SARA, refer to the SARA registry website (http://www.sararegistry.gc.ca).

The Minister of Fisheries and Oceans Canada (DFO) is the competent minister responsible for aquatic species at risk other than individuals in, or on, federal lands administered by the Parks Canada Agency. Once a species is listed under the SARA, prohibitions against the killing, harming, harassing or taking of individuals and against the damage or destruction of their residence apply (Sections 32 to 36). The Act also requires that recovery strategies, action plans and management plans be developed for all listed species (Sections 37 to 55). Recovery strategies and action plans should include the identification of critical habitat. Once identified, critical habitat is protected from destruction (Sections 56 to 64).

There is a permitting provision in the Act to allow activities that might otherwise be prohibited to occur if: i) they are scientific research related to the conservation of the species; ii) they are beneficial to the species; or, iii) affecting the species is incidental to the carrying out of the activity. This provision includes strict preconditions that must be met before permits can be issued (Sections 73 to 78). To the extent possible, DFO Fish Habitat Management (FHM) will administer its *Fisheries Act* and *Species at Risk Act* responsibilities in an integrated manner, in accordance with the Practitioner's Guide to the *Species at Risk Act* (SARA) for Habitat Management Staff (DFO 2007). Works or undertakings that may contravene the SARA prohibitions may be authorized, providing they do not compromise or conflict with SARA recovery strategies or plans, and the SARA permitting preconditions have been met. There may also be provincial and/or municipal and/or Conservation Authority legislation or policies that also pertain to species at risk, such as the *Endangered Species Act* (2007) in Ontario.

The SARA changes the way federal environmental assessments consider species at risk. The SARA amends the definition of "environmental effect" in the *Canadian Environmental Assessment Act* (CEAA) to include species at risk, residence and critical habitat (Section 137). Therefore, projects that require an environmental assessment under CEAA will have to take into account the project's effects on listed wildlife species and their critical habitats. In addition, during an environmental assessment, responsible authorities are required to notify competent ministers if a species at risk is adversely affected by the project and to ensure the implementation of mitigation and monitoring of effects on species at risk.

A species Recovery Potential Assessment (RPA) process exists within DFO to provide the scientific advice required to meet the various requirements of the SARA. One

aspect of an RPA is to help determine whether a species can sustain any harm without jeopardizing its survival and/or recovery as well as list mitigation measures and alternative activities that can be used to protect the species. In the case of a species that has not yet been listed under SARA, the RPA provides scientific advice to consider during the listing decision process. The RPA documents are being completed by DFO Science for Endangered and Threatened fish and mussel species listed, or being considered for listing, under SARA in the Central and Arctic Region (C&A). These documents will be peer reviewed and published as Research Documents by the Canadian Science Advisory Secretariat.

PURPOSE

This document was developed to provide information that would accompany the RPAs for aquatic species at risk. One of the required components of the RPA is to identify alternative activities and mitigation strategies that would protect SAR against identified threats. Threats to species at risk are described in Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status reports, DFO pre-COSEWIC assessments, RPAs, and recovery strategies and management plans. Threats related to habitat are often identified for freshwater fish and mussel species at risk, and these threats may be related to a number of development activities such as water crossings, pipeline construction and drain maintenance activities. In conjunction with the RPA, recovery teams can use these generic examples to determine if there are alternatives to activities that may threaten aquatic species at risk or if there are appropriate mitigation actions.

The set of alternatives and mitigation measures provided in this document are not only applicable to SAR, but could also be applied to other fish and mussel species not listed under SARA. Alternative activities and mitigation measures are described in general terms and can be used by Fish Habitat Management staff when reviewing development projects proposed in, and around, water under the *Fisheries Act* and SARA. It is not the intent of this document to provide a comprehensive list of alternative activities and/or mitigation strategies with exact wording for transfer into *Fisheries Act* Authorizations or Letters of Advice issued by Fish Habitat Management staff in C&A. Depending on the site-specific conditions of a proposed development project, alternatives or mitigations not listed in this document may be required to ensure that fishes and fish habitat are protected. Fish Habitat Management staff should refer to standard wording that has been developed internally and specifically for *Fisheries Act* Authorizations or Letters of Advice when approving a development project under the *Fisheries Act* and SARA.

APPROACH

The DFO Risk Management Framework (RMF) approach was used as a basis for building the list of generic mitigation measures. For more information on the RMF refer to DFO's Practitioner's Guide to the Risk Management Framework for DFO Habitat

Management Staff Version 1.0 (DFO 2006). In the RPA documents, habitat-related threats are linked to the DFO FHM Pathways of Effect (PoE). In this document, each pathway link in the 18 PoE diagrams was coded (e.g., 1-1, 1-2) and assigned a mitigation measure. This process was conducted in-parallel with a careful examination of the "Mitigation Measures Master Table" and the modified PoE diagrams of the MTO/DFO/OMNR Protocol (MTO 2006), providing alternative or additional mitigation details and terminology to further refine the list of mitigation measures. The mitigation measures are purposely generic, as a list that attempted to address all variations of project types would be overly complex and inherently incomplete.

HOW TO USE THIS DOCUMENT

This document is intended to be used in conjunction with RPAs to adequately identify appropriate mitigation and monitoring measures for aquatic species at risk. Alternatively, if this document is to be used to assist in project review for fish and fish habitat, determine which PoEs and associated mitigation measures are applicable to the proposed development project under review by Habitat Management staff. The mitigation measures used for an individual project can be modified to ensure that they are appropriate for site-specific project requirements. Again, note that the mitigation measures are purposely generic, as a list that attempted to address all variations of project types would be overly complex and incomplete

MITIGATION STRATEGIES

ALTERNATIVE ACTIVITIES

A key approach used by FHM staff to protect fishes and fish habitat, including aquatic species at risk, from development activities includes encouraging proponents to redesign their project, to select an alternate site, or to mitigate potential damages using other reliable techniques, such as by installing adequate sediment and erosion control equipment (DFO 1986). Table 1 does not provide a comprehensive list of alternative activities, but is intended to provide examples of alternative activities that could be used as a mitigation strategy to significantly reduce the potential impacts of a project proposed in and around water.

OPERATIONAL STATEMENTS

A source of accepted mitigation measures that can be used to protect fishes and fish habitat are contained within DFO Operational Statements. These were developed as part of an initiative to streamline the DFO review and approval process for lower risk projects. The Operational Statements inform a proponent about how to protect fishes and fish habitat and to comply with the *Fisheries Act* by providing "bottom line" advice for different types of low risk activities. The Operational Statements describe the

conditions and the measures to be incorporated into a project in order to avoid negative impacts to fishes and fish habitat, allowing the project to proceed without a DFO review if the conditions and measures to protect fishes and fish habitat listed in the applicable Operational Statement are carried out. These Operational Statements are often regionally specific, and provide advice ranging from the salvage of sunken logs or the building of docks, to the construction of clear-span bridges, temporary stream crossings, and the laying of underwater cables. Activities covered by Operational Statements that may impact SAR have conditions that exclude their use in areas where the SAR are found (e.g., Operational Statement for dredging cannot be used where mussel SAR are found). Operational Statements can be found under Habitat Management in the main DFO website (http://www.dfo-mpo.gc.ca/).

MITIGATION MEASURES BASED ON PoE DIAGRAMS

The mitigation measures outlined in the following tables are for activities that are not covered by an Operational Statement. For 18 DFO Pathway of Effect (PoE) diagrams, each pathway link has been coded (e.g., 1-1, 1-2) and assigned a mitigation measure. The PoE diagrams are taken from DFO's Practitioner's Guide to the Risk Management Framework for DFO Habitat Management Staff Version 1 (DFO 2006).

The PoE diagrams for the master pathways are provided in Figures 1 and 2. Individual PoE diagrams (Figures 3-20) and the generic mitigation measures associated with them (Tables 2-19) are presented. A list of all mitigation measures is provided in Appendix A.

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Clarke, K.D., Pratt, T.C., Randall, R.G., Scruton, D.A., and Smokorowski, K.E. 2008. Validation of the flow management pathway: effects of altered flow on fish habitat and fishes downstream from a hydropower dam. Can. Tech. Rep. Fish. Aquat. Sci. 2784: vi + 111 p.

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MTO (Ministry of Transportation of Ontario). 2006. Environmental guide for fish and fish habitat, Section 6: Impact assessment and mitigation, Appendix 6C-Modified pathways of effects diagrams. October 2006.

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Table 1. Examples of typical activities and associated impacts, with corresponding alternative activities that can significantly reduce the potential impacts.

Activities/Potential Impacts	**Alternative Activities**
Construction of bridge with in-water piers, or that potentially destabilizes the stream banks.	Construction of a clear-span bridge that has no in-water component, or encroaches upon the stream bank, or negatively affects riparian vegetation. Refer to Ontario Operational Statement, “Clear-span bridges”.
Construction of pipeline or a cable crossing using a traditional trench excavation across the watercourse.	Avoid direct disturbance to the streambed and banks by digging bell holes on either side of the watercourse, and then boring under the streambed. Refer to Ontario Operational Statement, “Punch and Bore Crossings”.
Rock fill coffer dam construction can have a relatively large footprint, and potentially can expose aquatic habitats to siltation during coffer dam placement and removal.	Use a sheet pile coffer dam. Footprint is relatively small, and does not require the placement and removal of granular or soil/clay materials into the watercourse.
Construction of hydroelectric generating stations (GS) usually include a deep excavation adjacent to the receiving waterbody and an associated tailrace that requires contouring into that waterbody for the efficient discharge of flow. These are often constructed as one, which requires the use of a large coffer dam intruding into the receiving water body and displacing habitat for about two years. The often lengthy installation and removal of the coffer dam requires the use of silt curtains, and can expose the waterbody to the risk of the release of sediment or other deleterious substances.	Phased construction of a GS can significantly reduce the duration and extent of habitat disruption. The deep excavation of the powerhouse can occur as Phase 1, using the natural shoreline as a coffer dam, which, depending upon the native shoreline material, may require reinforcement with a sheet steel piling or other material. Once the powerhouse is ready, water can be released into the pit to the same level as the receiving waterbody. In Phase 2, an effective silt curtain (heavy chains along bottom) can isolate the extent of the tailrace, and then the tailrace can be excavated in-water and the shoreline plug removed. Timing of Phase 2 is critical to avoid the sensitive life stages of native fishes, and have regard to river flow conditions. This can reduce the duration of any disruption from years, to months or weeks, and reduce the extent of the disruption by the width of the coffer dam at a minimum. In most cases, the excavation of the tailrace will be no more disruptive or require more mitigation than the placement and removal of coffer dams.

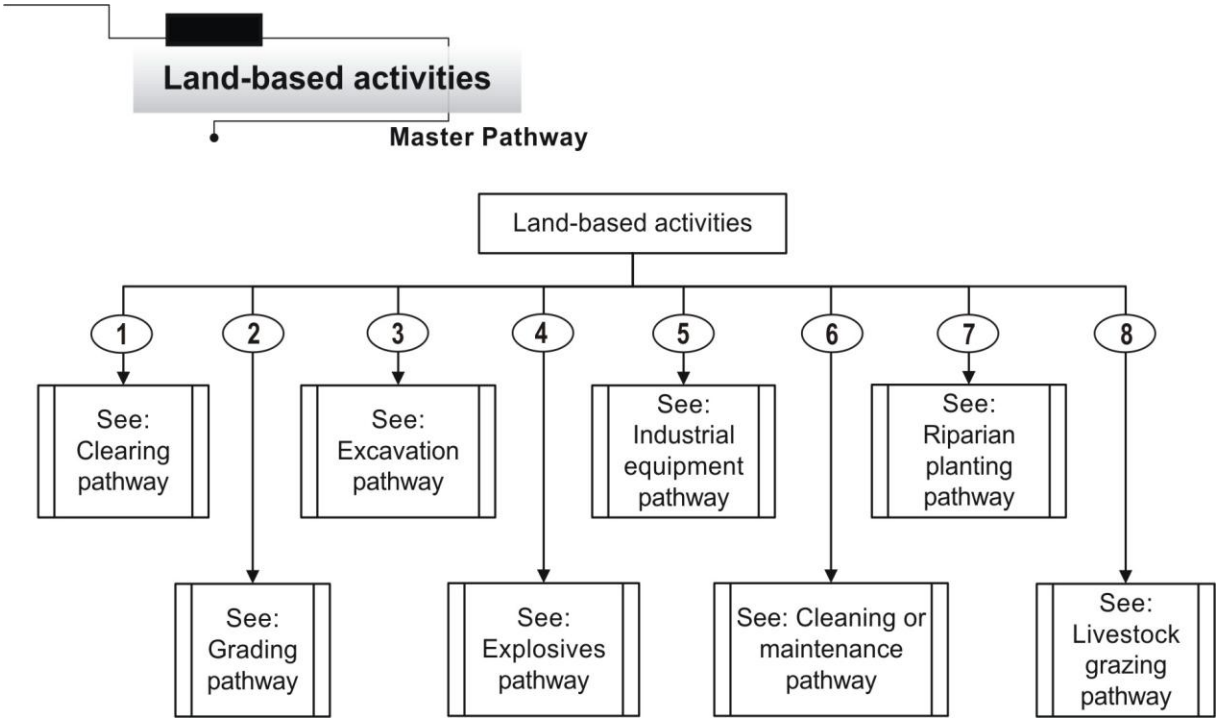


Figure 1. Master Pathway PoE Diagram: Land-based activities.

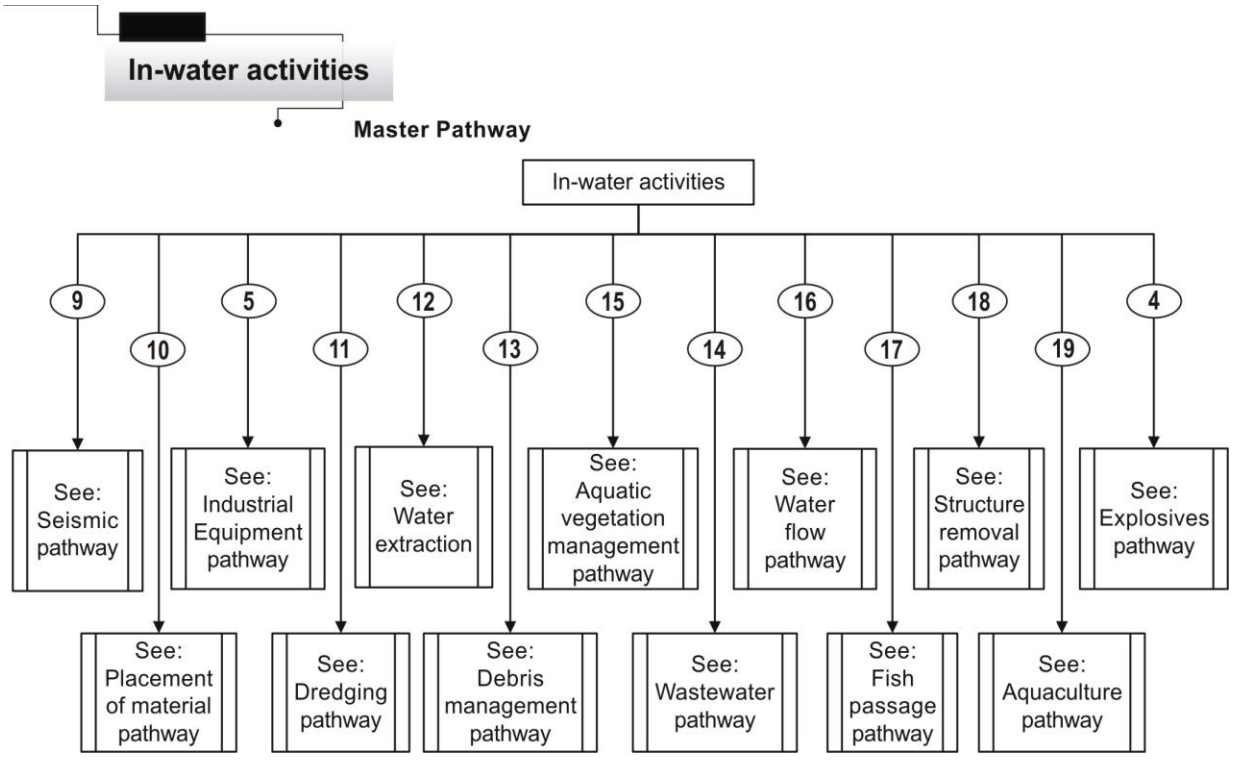


Figure 2. Master Pathway PoE Diagram: In-water activities.

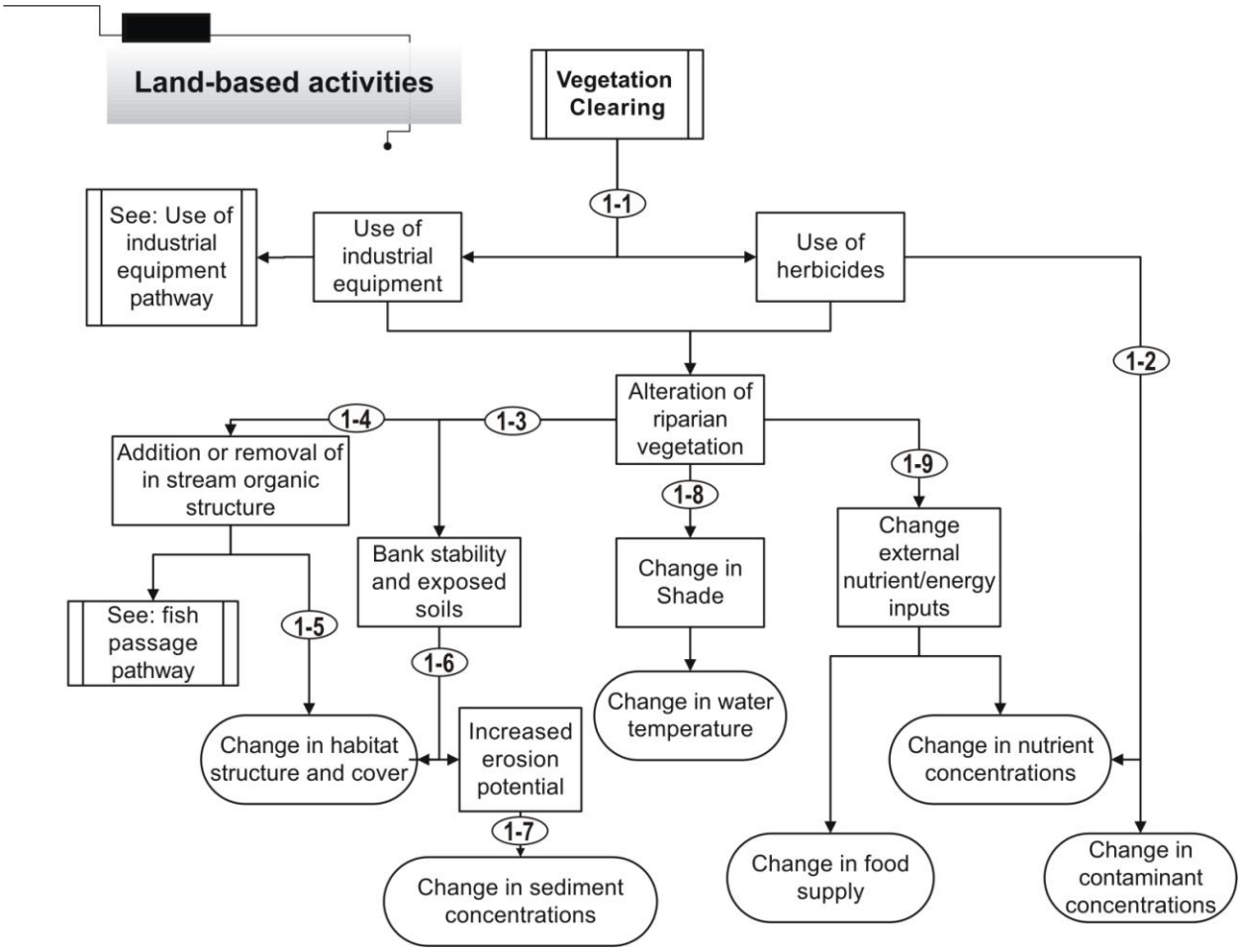


Figure 3. PoE Diagram 1 - Vegetation clearing.

Table 2. Mitigation measures based on PoE Diagram 1 - Vegetation clearing.

Link	Mitigation
1-1	Minimize riparian vegetation removals. If removal is unavoidable use proper clearing techniques and protect retained vegetation.
	Prohibit or limit access to banks or areas adjacent to waterbodies, to the extent required to protect the structural integrity of banks or shorelines.
	Seasonal timing to minimize impacts.
1-2	Use only specified amounts and types of fertilizer in areas draining to waterbodies. Avoid use of chemical dust suppressants, pesticides and herbicides in areas draining to waterbodies.
	Seasonal timing to minimize impacts.
1-3	Riparian vegetation plantings. Design and implement vegetation rehabilitation plan following construction/disturbance to re-plant riparian vegetation to pre-construction or better condition (e.g., trees for shade to cool water and provide overhead cover). • usually includes re-instatement of native soils or replacement with topsoil/suitable planting medium. • may include soil/seedbank salvage, vegetation transplant or bio-engineering (e.g., live stakes, cuttings) techniques. • typically only native species compatible with site conditions are used.
1-4	Dispose or temporarily store all materials used or generated (e.g., organics, soils, woody debris, temporary stockpiles, construction debris) during site preparation, construction and clean-up in a manner that mitigates their entry to waterbody.
1-5	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.
1-6	Prohibit or limit access to banks or areas adjacent to waterbodies, to the extent required to protect the structural integrity of banks or shorelines.
	Stabilize/reinforce stream banks using tree and shrub plantings, root wads, boulders, vortex weirs, etc.
	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).
1-7	Treatment of dewatering (or other) discharge water by sediment settling ponds, filter bags, etc.
	In-water silt curtains to contain suspended sediments.
1-8	Selective or phased vegetation removal or species management to maintain or reduce shade on stream and provide specialized riparian communities or habitats. This may be desirable for the management of certain species, such as Redside Dace, salmonids, or warmwater species at risk.
1-9	Use only specified amounts and types of fertilizer in areas draining to waterbodies. Avoid use of chemical dust suppressants, pesticides and herbicides in areas draining to waterbodies.
	Riparian vegetation plantings. Design and implement vegetation rehabilitation plan following construction/disturbance to re-plant riparian vegetation to pre-construction or better condition (e.g., trees for shade to cool water and provide overhead cover). • usually includes re-instatement of native soils or replacement with topsoil/suitable planting medium. • may include soil/seedbank salvage, vegetation transplant or bio-engineering (e.g., live stakes, cuttings) techniques. • typically only native species compatible with site conditions are used.
	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).

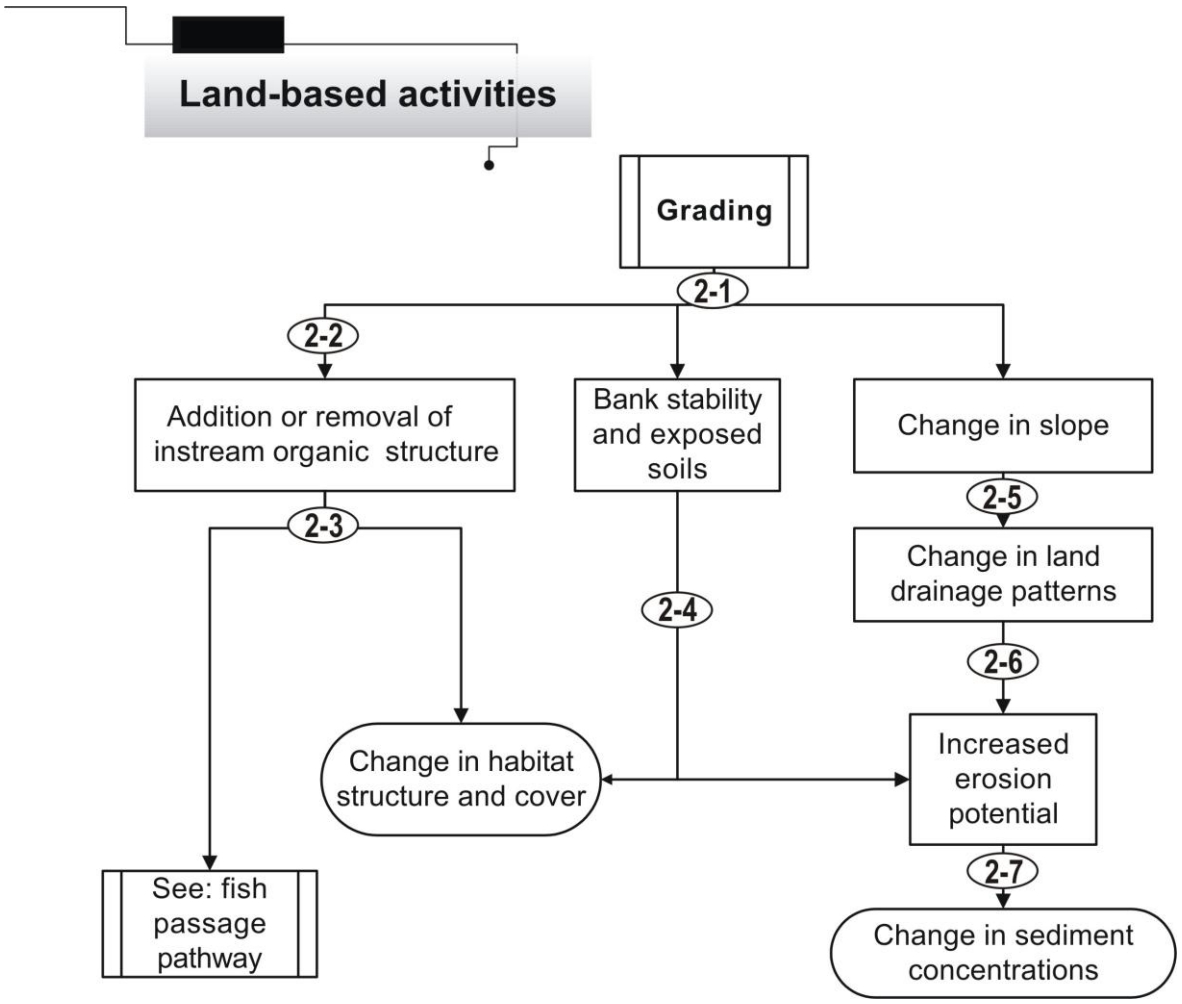


Figure 4. PoE Diagram 2 - Grading.

Table 3. Mitigation measures based on PoE Diagram 2 -Grading.

Link	Mitigation
2-1	Prohibit or limit access to banks or areas adjacent to waterbodies, to the extent required to protect the structural integrity of banks or shorelines.
	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).
2-2	Dispose or temporarily store all materials used or generated (e.g., organics, soils, woody debris, temporary stockpiles, construction debris) during site preparation, construction and clean-up in a manner that mitigates their entry to waterbody.
2-3	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.
2-4	Stabilize/reinforce stream banks using tree and shrub plantings, root wads, boulders, vortex weirs, etc.
2-5	Stabilize exposed soils (targeted planting of specialized vegetation treatments, add structure to steep slopes, use of commercial seed mats, perforated soil cloth, etc.).
2-6	Avoid or minimize diversion of surface and groundwater drainage to or from a waterbody (do not divert across watershed boundaries).
2-7	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).

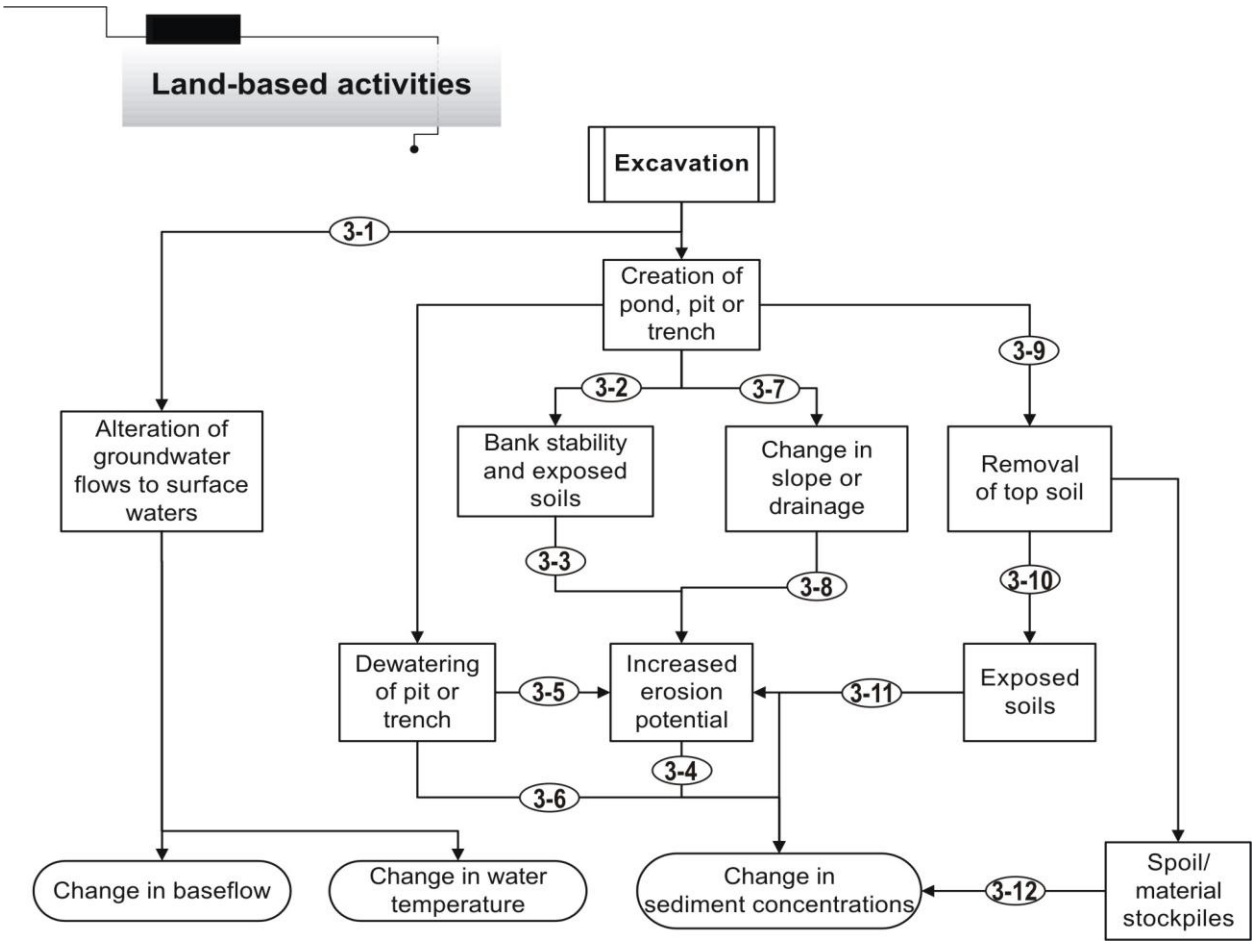


Figure 5. PoE Diagram 3 - Excavation.

Table 4. Mitigation measures based on PoE Diagram 3 - Excavation.

Link	Mitigation
3-1	Avoid or minimize diversion of surface and groundwater drainage to or from a waterbody (do not divert across watershed boundaries).
3-2	Riparian vegetation plantings. Design and implement vegetation rehabilitation plan following construction/disturbance to re-plant riparian vegetation to pre-construction or better condition (e.g., trees for shade to cool water and provide overhead cover). • usually includes re-instatement of native soils or replacement with topsoil/suitable planting medium. • may include soil/seedbank salvage, vegetation transplant or bio-engineering (e.g., live stakes, cuttings) techniques. • typically only native species compatible with site conditions are used.
	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).
3-3	Stabilize exposed soils (targeted planting of specialized vegetation treatments, add structure to steep slopes, use of commercial seed mats, perforated soil cloth, etc.).
	Stabilize/reinforce stream banks using tree and shrub plantings, root wads, boulders, vortex weirs, etc.
3-4	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling pond, in-water silt curtains to contain suspended sediments).
3-5	Energy dissipation measures.
3-6	Treatment of dewatering (or other) discharge water by sediment settling ponds, filter bags, etc.
3-7	Avoid or minimize diversion of surface and groundwater drainage to or from a waterbody (do not divert across watershed boundaries).
3-8	Stabilize exposed soils (targeted planting of specialized vegetation treatments, add structure to steep slopes, use of commercial seed mats, perforated soil cloth, etc.).
3-9	Minimize riparian vegetation removals. If removal is unavoidable use proper clearing techniques and protect retained vegetation.
3-10	Riparian vegetation plantings. Design and implement vegetation rehabilitation plan following construction/disturbance to re-plant riparian vegetation to pre-construction or better condition (e.g., trees for shade to cool water and provide overhead cover). • usually includes re-instatement of native soils or replacement with topsoil/suitable planting medium. • may include soil/seedbank salvage, vegetation transplant or bio-engineering (e.g., live stakes, cuttings) techniques. • typically only native species compatible with site conditions are used.
3-11	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).
3-12	Dispose or temporarily store all materials used or generated (e.g., organics, soils, woody debris, temporary stockpiles, construction debris) during site preparation, construction and clean-up in a manner that mitigates their entry to waterbody.

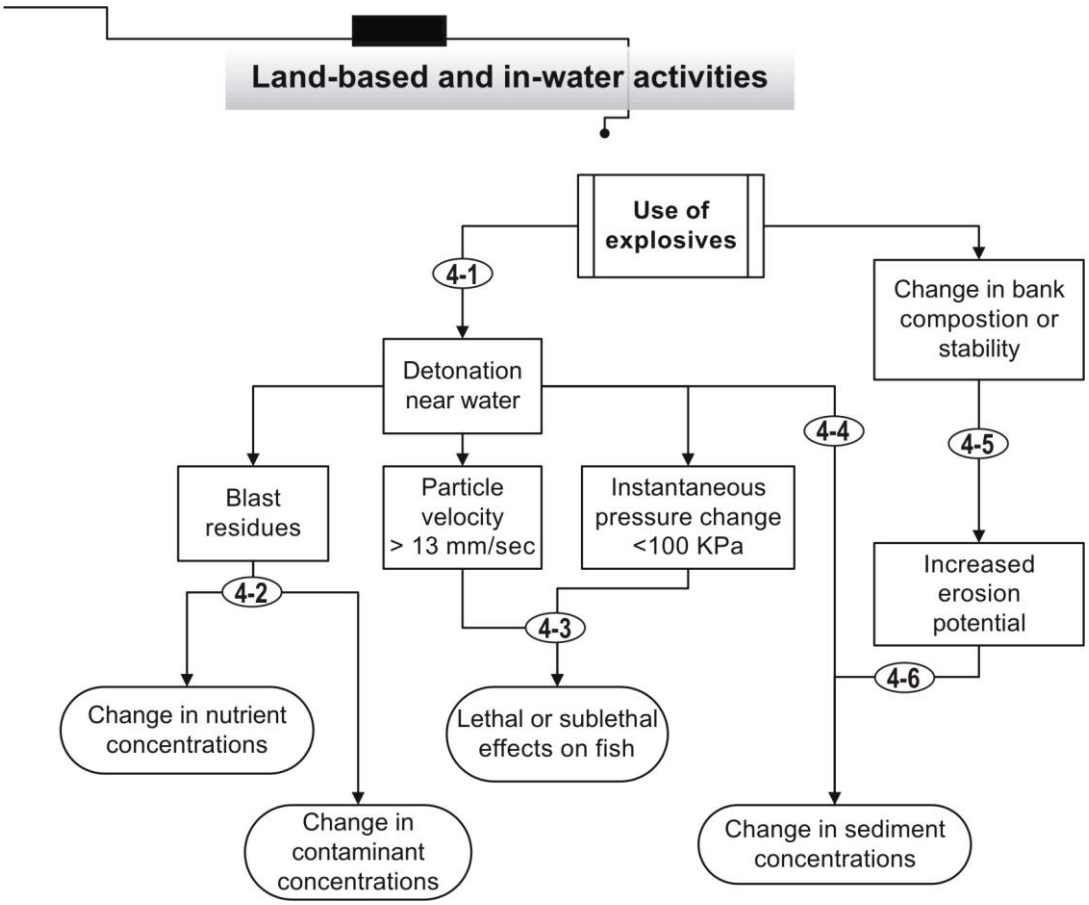


Figure 6. PoE Diagram 4 - Use of explosives.

Table 5. Mitigation measures based on PoE Diagram 4 - Use of explosives.

Link	Mitigation
4-1	Operational constraint for blasting. Implement requirements and limitations for the use of confined explosives, in or near, fisheries waters.
4-2	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).
	In-water silt curtains to contain suspended sediments.
4-3	Seasonal timing to minimize impacts.
	Avoid impacts to fishes by excluding, moving, or frightening fishes away. Must be undertaken using proper handling techniques and strategies that will avoid or minimize stress.
4-4	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).
	In-water silt curtains to contain suspended sediments.
4-5	Stabilize/reinforce stream banks using tree and shrub plantings, root wads, boulders, vortex weirs, etc.
4-6	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).

Refer to Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky 1998).

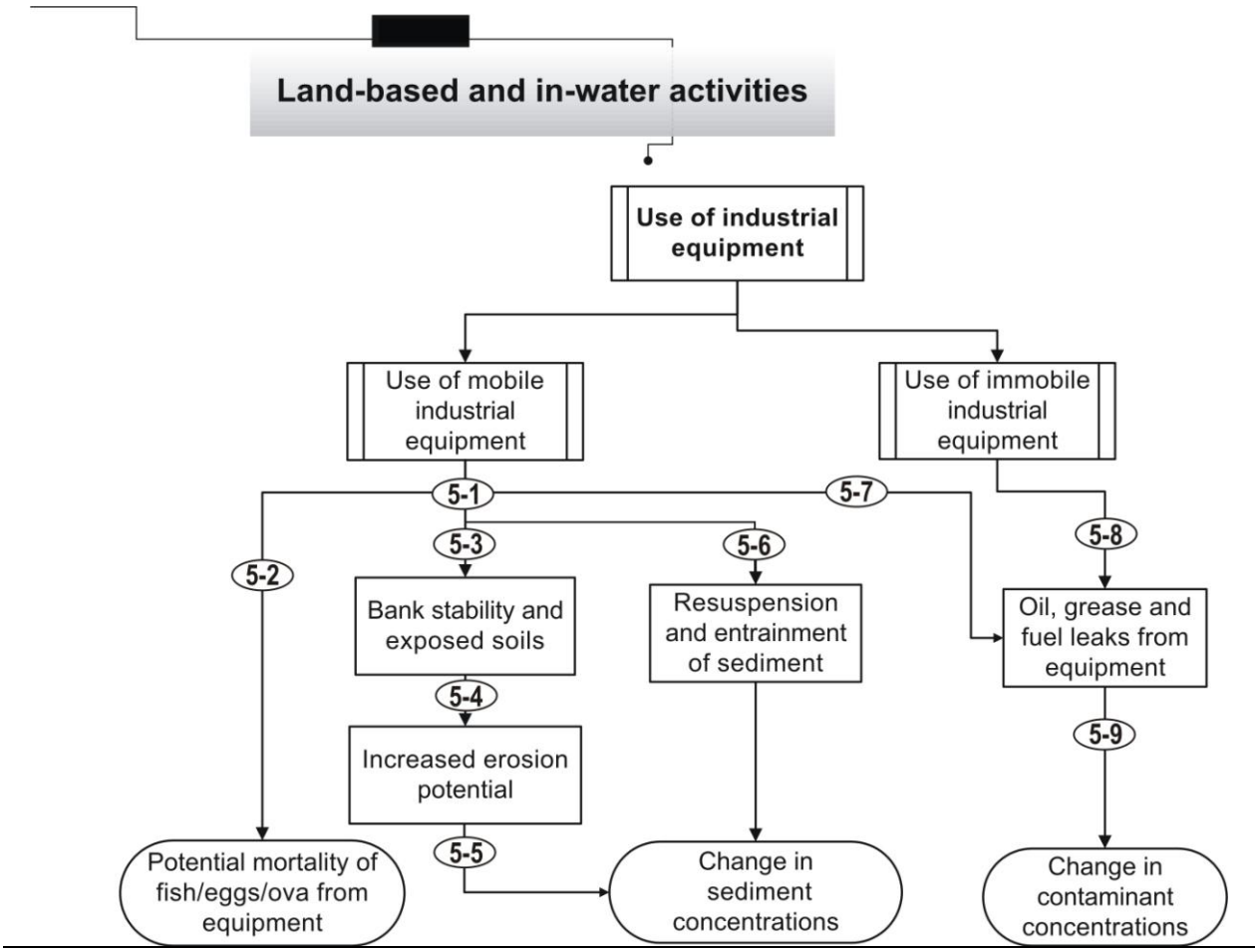


Figure 7. PoE Diagram 5 - Use of industrial equipment.

Table 6. Mitigation measures based on PoE Diagram 5 - Use of industrial equipment.

Link	Mitigation
5-1	Prohibit or limit access to banks or areas adjacent to waterbodies, to the extent required to protect the structural integrity of banks or shorelines.
5-2	Seasonal timing to minimize impacts.
	Avoid impacts to fishes by excluding, moving, or frightening fishes away. Must be undertaken using proper handling techniques and strategies that will avoid or minimize stress.
5-3	Riparian vegetation plantings. Design and implement vegetation rehabilitation plan following construction/disturbance to re-plant riparian vegetation to pre-construction or better condition (e.g., trees for shade to cool water and provide overhead cover). • usually includes re-instatement of native soils or replacement with topsoil/suitable planting medium. • may include soil/seedbank salvage, vegetation transplant or bio-engineering (e.g., live stakes, cuttings) techniques. • typically only native species compatible with site conditions are used.
	Stabilize exposed soils (targeted planting of specialized vegetation treatments, add structure to steep slopes, use of commercial seed mats, perforated soil cloth, etc.).
	Stabilize/reinforce stream banks using tree and shrub plantings, root wads, boulders, vortex weirs, etc.
5-4	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).
5-5	In-water silt curtains to contain suspended sediments.
5-6	Design and implement isolation/containment plan to isolate temporary in-water work zones to maintain clean flow downstream/around the work zone at all times. The design should: • use only clean materials free of suspendable matter for temporary coffer dams. • situate or otherwise manage flow withdrawal and discharge (e.g., see dewatering discharge) so as to prevent erosion and sediment release to the waterbody. • ensure the work zone is stabilized to the extent practical against the impacts of high flow events during the work period. • remove fish from isolated in-water work zones if necessary
5-7	Vehicle and equipment re-fuelling and maintenance shall be conducted away from the water. Any part of equipment entering the water shall be free of fluid leaks and externally cleaned/degreased to mitigate any deleterious substance from entering the water.
5-8	Vehicle and equipment re-fuelling and maintenance shall be conducted away from the water. Any part of equipment entering the water shall be free of fluid leaks and externally cleaned/degreased to mitigate any deleterious substance from entering the water.
5-9	Spill containment plan.

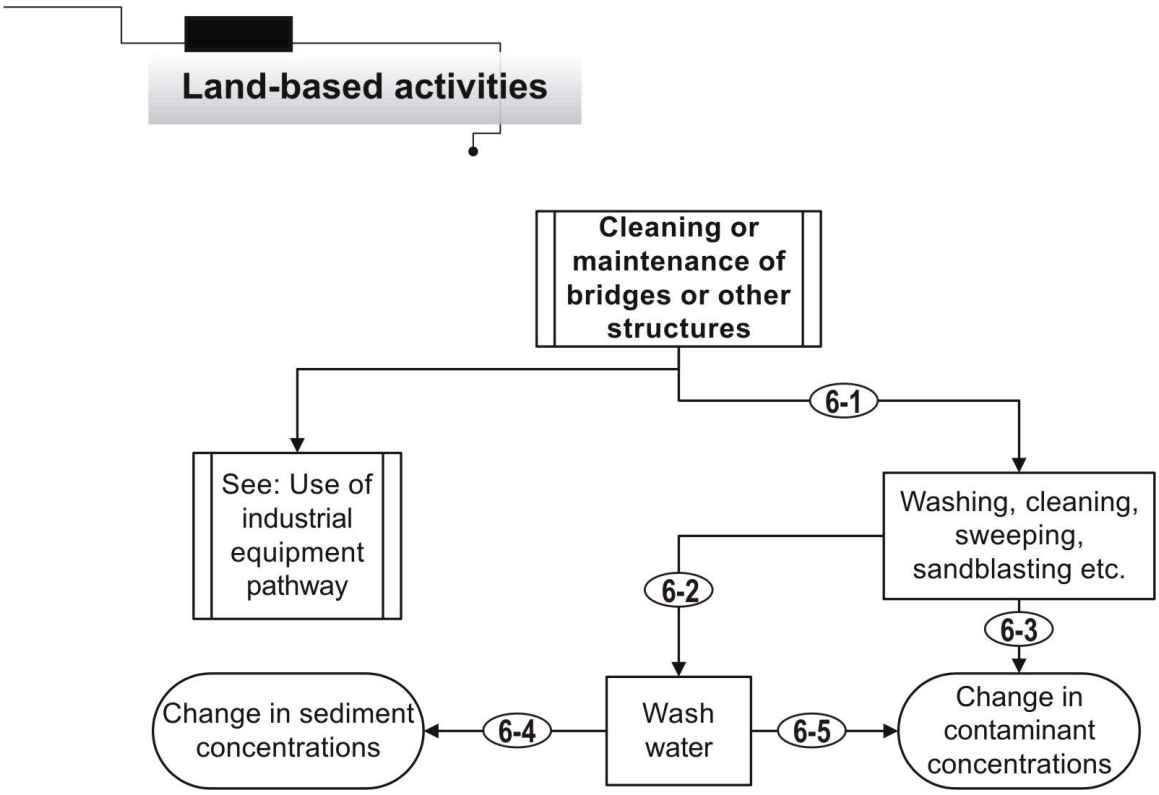


Figure 8. PoE Diagram 6 - Cleaning or maintenance of bridges or other structures.

Table 7. Mitigation measures based on PoE Diagram 6 - Cleaning or maintenance of bridges or other structures.

Link	Mitigation
6-1	Seasonal timing to minimize impacts.
	Containment plan to keep dust, particulate scrubbings, blast sand, air-borne contaminants, and other potentially deleterious substances from entering the waterbody. This is used to avoid the necessity of dewatering.
6-2	Spill containment plan.
6-3	Containment plan to keep dust, particulate scrubbings, blast sand, air-borne contaminants, and other potentially deleterious substances from entering the waterbody. This is used to avoid the necessity of dewatering.
6-4	Treatment of dewatering (or other) discharge water by sediment settling ponds, filter bags, etc.
	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).
6-5	Treatment of dewatering (or other) discharge water by sediment settling ponds, filter bags, etc.
	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).

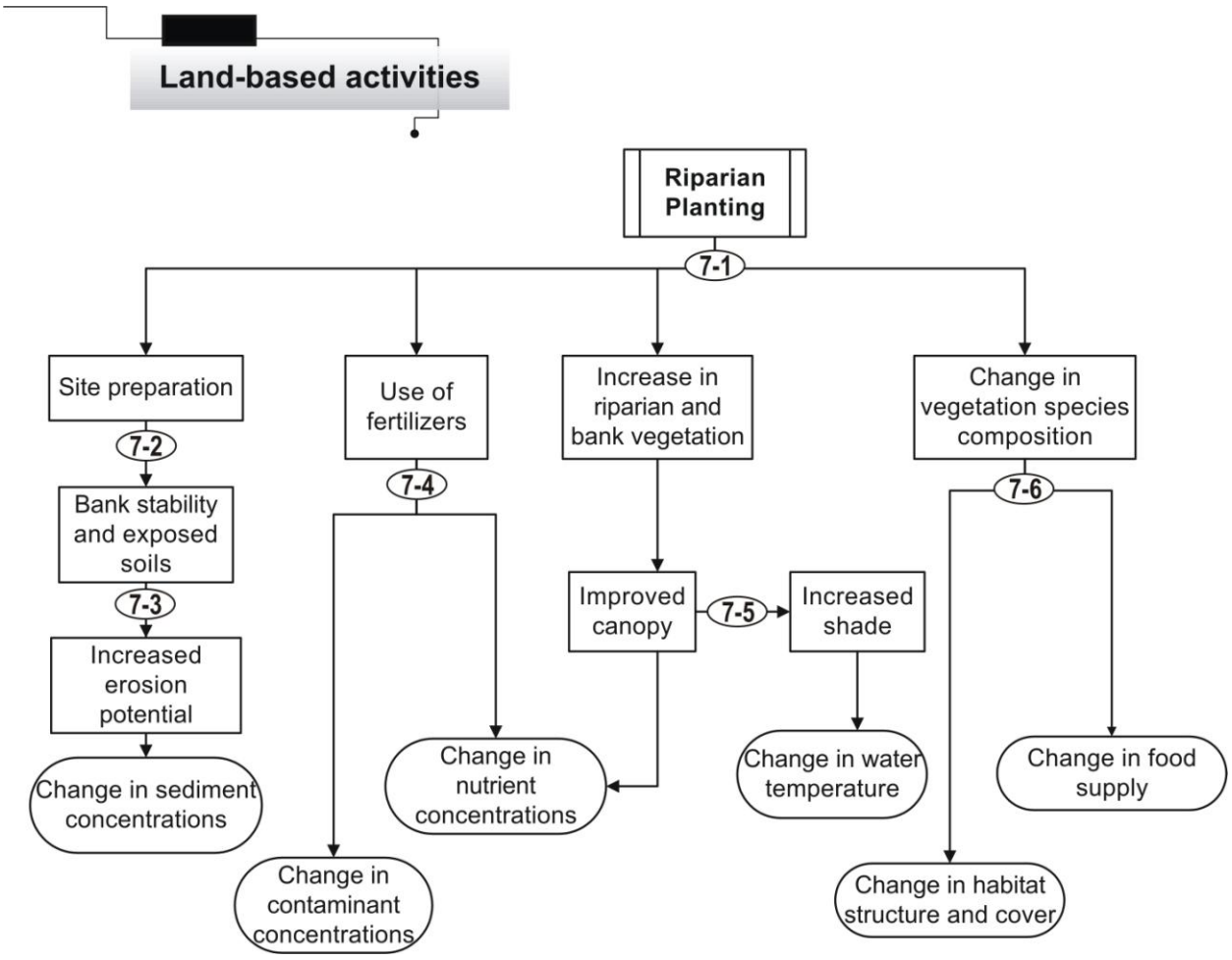


Figure 9. PoE Diagram 7 - Riparian planting.

Table 8. Mitigation measures based on PoE Diagram 7 - Riparian planting

Link	Mitigation
7-1	Seasonal timing to minimize impacts.
7-2	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).
7-3	Stabilize exposed soils (targeted planting of specialized vegetation treatments, add structure to steep slopes, use of commercial seed mats, perforated soil cloth, etc.).
	Stabilize/reinforce stream banks using tree and shrub plantings, root wads, boulders, vortex weirs, etc.
7-4	Use only specified amounts and types of fertilizer in areas draining to waterbodies. Avoid use of chemical dust suppressants, pesticides and herbicides in areas draining to waterbodies.
7-5	Selective or phased vegetation removal or species management to maintain or reduce shade on stream and provide specialized riparian communities or habitats. This may be desirable for the management of certain species, such as Redside Dace, salmonids, or warmwater species at risk.
7-6	Selective or phased vegetation removal or species management to maintain or reduce shade on stream and provide specialized riparian communities or habitats. This may be desirable for the management of certain species, such as Redside Dace, salmonids, or warmwater species at risk.

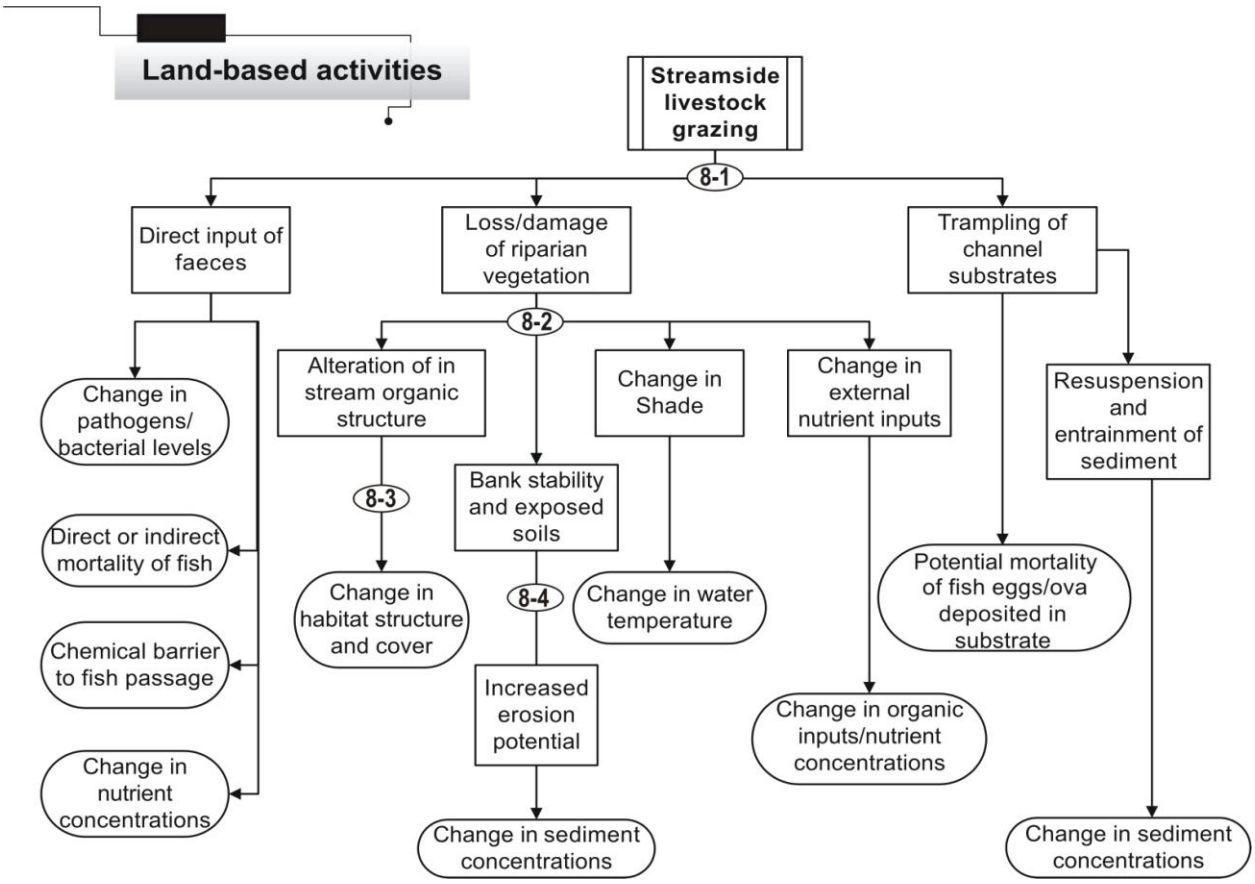


Figure 10. PoE Diagram 8 - Streamside livestock grazing.

Table 9. Mitigation measures based on PoE Diagram 8 - Streamside livestock grazing.

Link	Mitigation
8-1	Prohibit or limit access to banks or areas adjacent to waterbodies, to the extent required to protect the structural integrity of banks or shorelines.
8-2	Riparian vegetation plantings. Design and implement vegetation rehabilitation plan following construction/disturbance to re-plant riparian vegetation to pre-construction or better condition (e.g., trees for shade to cool water and provide overhead cover). • usually includes re-instatement of native soils or replacement with topsoil/suitable planting medium. • may include soil/seedbank salvage, vegetation transplant or bio-engineering (e.g., live stakes, cuttings) techniques. • typically only native species compatible with site conditions are used.
8-3	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.
8-4	Stabilize exposed soils (targeted planting of specialized vegetation treatments, add structure to steep slopes, use of commercial seed mats, perforated soil cloth, etc.).
	Stabilize/reinforce stream banks using tree and shrub plantings, root wads, boulders, vortex weirs, etc.

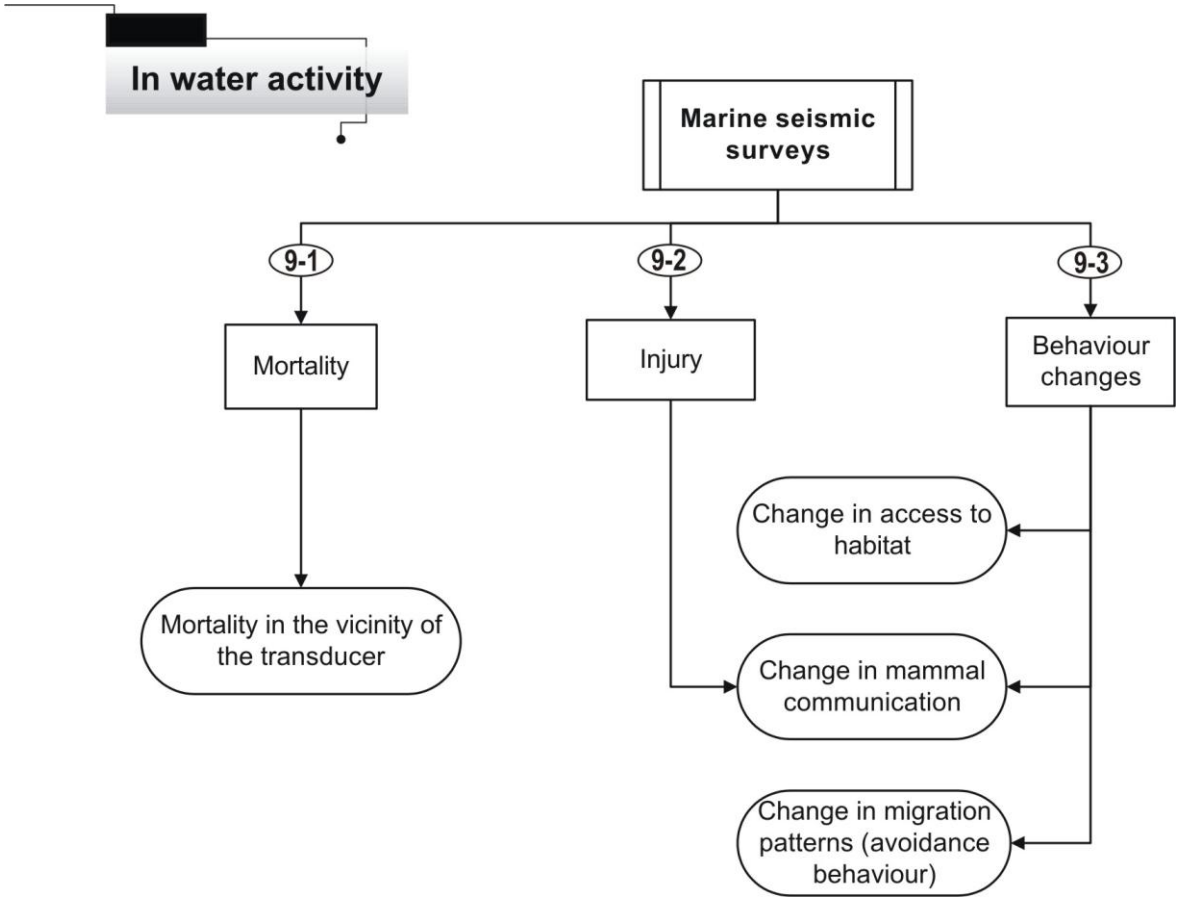


Figure 11. PoE Diagram 9 - Marine seismic surveys.

Table 10. Mitigation measures based on PoE Diagram 9 - Marine seismic surveys.

Link	Mitigation
9-1	Seasonal timing to minimize impacts.
	Avoid impacts to fishes by excluding, moving, or frightening fishes away. Must be undertaken using proper handling techniques and strategies that will avoid or minimize stress.
9-2	Seasonal timing to minimize impacts.
	Avoid impacts to fishes by excluding, moving, or frightening fishes away. Must be undertaken using proper handling techniques and strategies that will avoid or minimize stress.
9-3	Seasonal timing to minimize impacts.

Refer to the Standard Operating Procedure “Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment” at http://www.dfo-mpo.gc.ca/ oceans-habitat/oceans/im-gi/seismic-sismique/statement-enonce_e.asp .

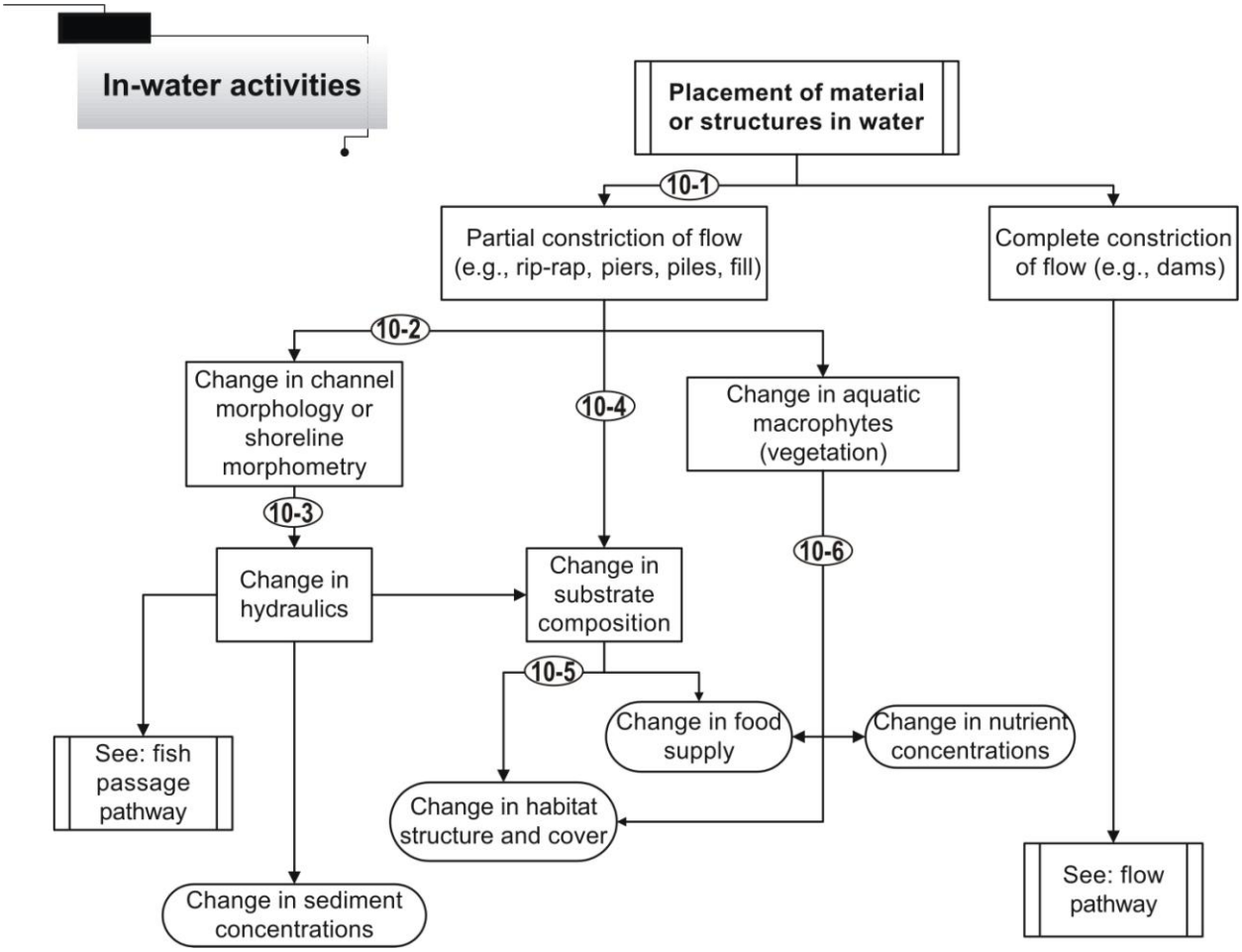


Figure 12. PoE Diagram 10 - Placement of material or structures in water.

Table 11. Mitigation measures based on PoE Diagram 10 - Placement of material or structures in water.

Link	Mitigation
10-1	Reduce or eliminate constriction of flow through structure design. Design and situate piers and abutments to avoid or otherwise minimize encroachment into waterbody, and avoid sensitive habitats. Design bridge or culvert to not affect existing or natural flow regimes. Design and install culverts to prevent creation of barriers to fish movement, and maintain bankfull channel functions and habitat functions to the extent possible, includes: • embedment. • re-instatement of low flow channel and native substrates. • proper sizing, maintaining channel slope.
10-2	Rehabilitation of stream morphology and substrate to pre-disturbance condition or better.
	Adjust channel morphology to maintain appropriate hydraulics (e.g., addition of riffles to slow upstream velocities; modification of width and/or depth to adjust velocities).
10-3	Adjust channel morphology to maintain appropriate hydraulics (e.g., addition of riffles to slow upstream velocities; modification of width and/or depth to adjust velocities).
10-4	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.
	Rehabilitation of stream morphology and substrate to pre-disturbance condition or better.
10-5	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.
10-6	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.

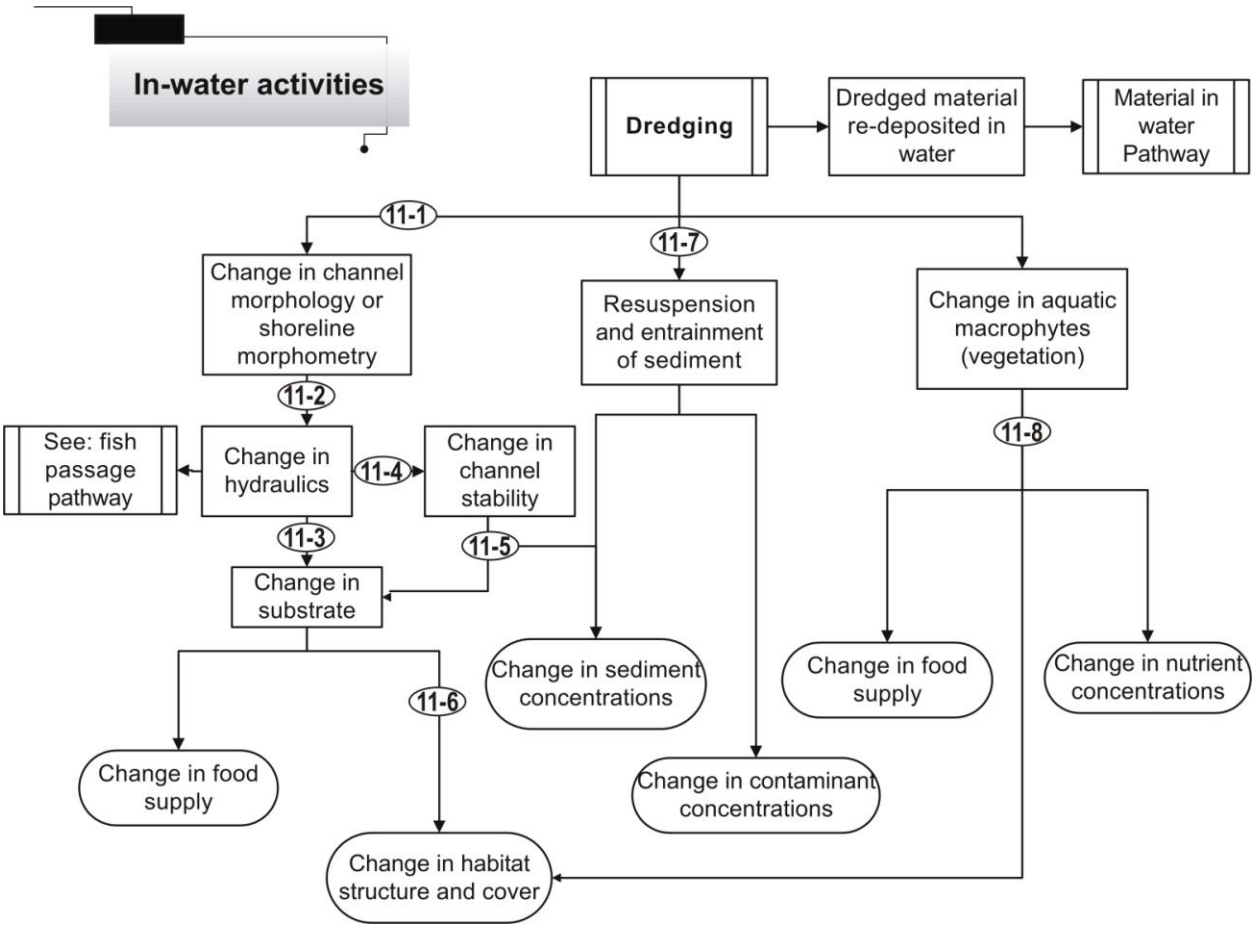


Figure 13. PoE Diagram 11 - Dredging.

Table 12. Mitigation measures based on PoE Diagram 11 - Dredging.

Link	Mitigation
11-1	Rehabilitation of stream morphology and substrate to pre-disturbance condition or better.
	Stabilize/reinforce stream banks using tree and shrub plantings, root wads, boulders, vortex weirs, etc.
11-2	Adjust channel morphology to maintain appropriate hydraulics (e.g., addition of riffles to slow upstream velocities; modification of width and/or depth to adjust velocities).
11-3	Rehabilitation of stream morphology and substrate to pre-disturbance condition or better.
11-4	Stabilize/reinforce stream banks using tree and shrub plantings, root wads, boulders, vortex weirs, etc.
11-5	Rehabilitation of stream morphology and substrate to pre-disturbance condition or better.
11-6	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.
11-7	Design and implement isolation/containment plan to isolate temporary in-water work zones to maintain clean flow downstream/around the work zone at all times. The design should: • use only clean materials free of suspendable matter for temporary coffer dams. • situate or otherwise manage flow withdrawal and discharge (e.g., see dewatering discharge) so as to prevent erosion and sediment release to the waterbody. • ensure the work zone is stabilized to the extent practical against the impacts of high flow events during the work period. • remove fish from isolated in-water work zones if necessary.
11-8	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.

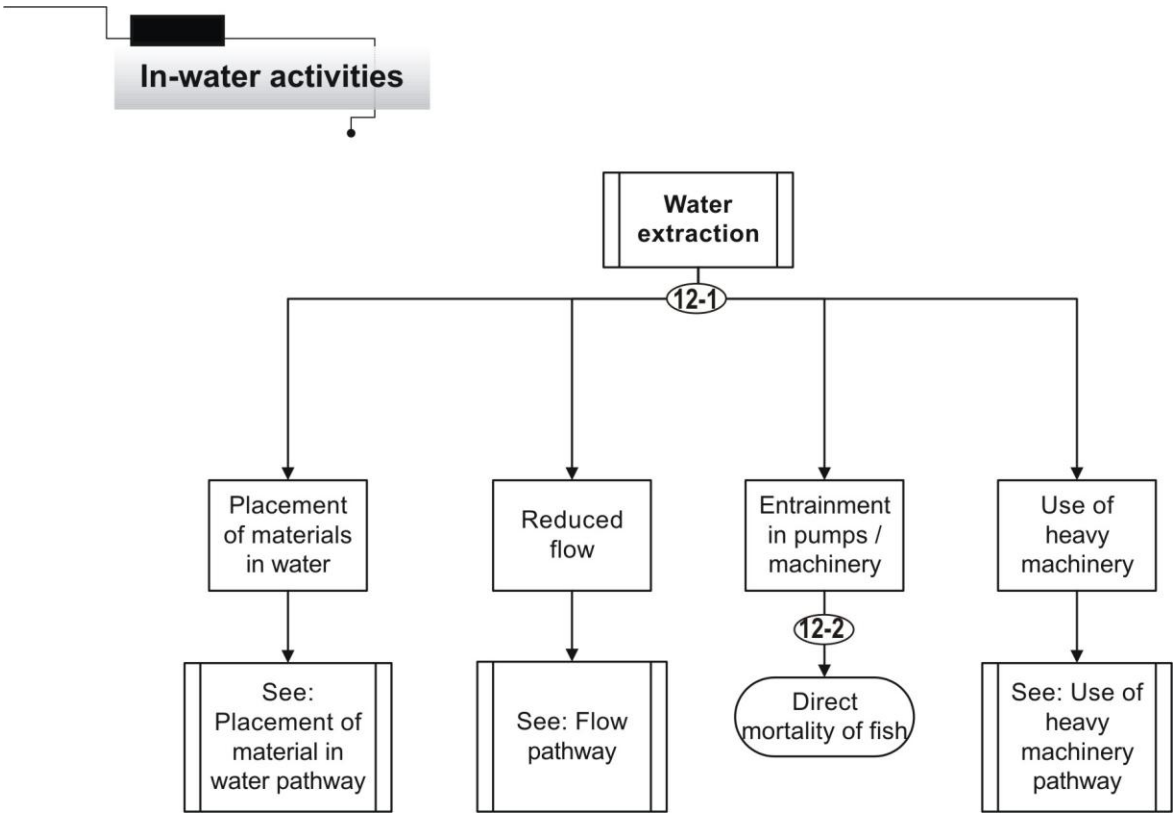


Figure 14. PoE Diagram 12 - Water extraction.

Table 13. Mitigation measures based on PoE Diagram 12 - Water extraction.

Link	Mitigation
12-1	Design and implement isolation/containment plan to isolate temporary in-water work zones to maintain clean flow downstream/around the work zone at all times. The design should: • use only clean materials free of suspendable matter for temporary coffer dams. • situate or otherwise manage flow withdrawal and discharge (e.g., see dewatering discharge) so as to prevent erosion and sediment release to the waterbody. • ensure the work zone is stabilized to the extent practical against the impacts of high flow events during the work period. • remove fish from isolated in-water work zones if necessary.
	Screens to prevent entrainment of fishes into water intakes.
	Treatment of dewatering (or other) discharge water by sediment settling ponds, filter bags, etc.
	Energy dissipation measures.
	Seasonal timing to minimize impacts.
12-2	Screens to prevent entrainment of fishes into water intakes.

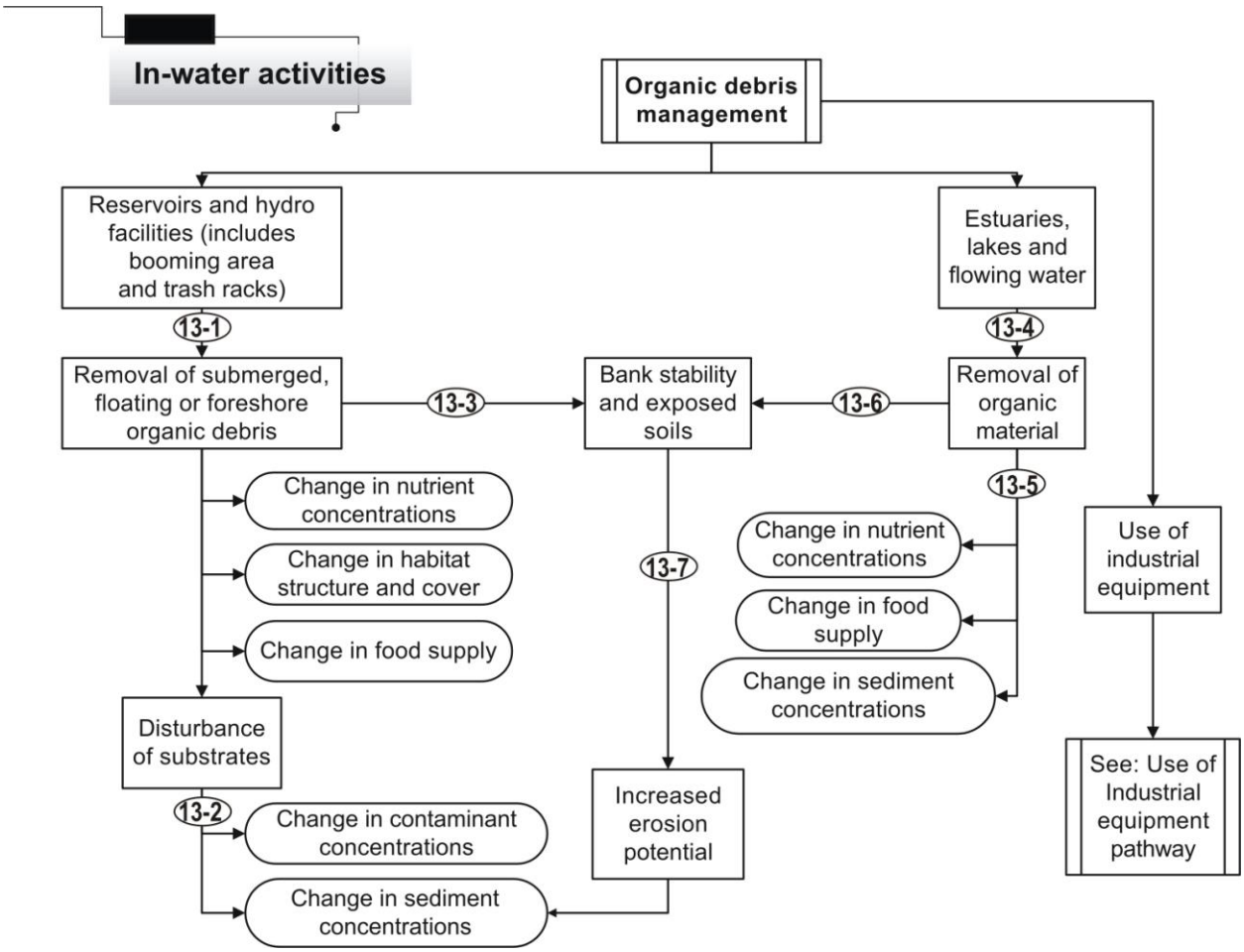


Figure 15. PoE Diagram 13 - Organic debris management.

Table 14. Mitigation measures based on PoE Diagram 13 - Organic debris management.

Link	Mitigation
13-1	Prohibit or limit access to banks or areas adjacent to waterbodies, to the extent required to protect the structural integrity of banks or shorelines.
	Seasonal timing to minimize impacts.
13-2	Rehabilitation of stream morphology and substrate to pre-disturbance condition or better.
13-3	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.
	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).
13-4	Prohibit or limit access to banks or areas adjacent to waterbodies, to the extent required to protect the structural integrity of banks or shorelines.
	Seasonal timing to minimize impacts.
13-5	Riparian vegetation plantings. Design and implement vegetation rehabilitation plan following construction/disturbance to re-plant riparian vegetation to pre-construction or better condition (e.g., trees for shade to cool water and provide overhead cover). • usually includes re-instatement of native soils or replacement with topsoil/suitable planting medium. • may include soil/seedbank salvage, vegetation transplant or bio-engineering (e.g., live stakes, cuttings) techniques. • typically only native species compatible with site conditions are used.
	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.
13-6	Riparian vegetation plantings. Design and implement vegetation rehabilitation plan following construction/disturbance to re-plant riparian vegetation to pre-construction or better condition (e.g., trees for shade to cool water and provide overhead cover). • usually includes re-instatement of native soils or replacement with topsoil/suitable planting medium. • may include soil/seedbank salvage, vegetation transplant or bio-engineering (e.g., live stakes, cuttings) techniques. • typically only native species compatible with site conditions are used.
	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.
	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).
13-7	Stabilize exposed soils (targeted planting of specialized vegetation treatments, add structure to steep slopes, use of commercial seed mats, perforated soil cloth).
	Stabilize/reinforce stream banks using tree and shrub plantings, root wads, boulders, vortex weirs, etc.

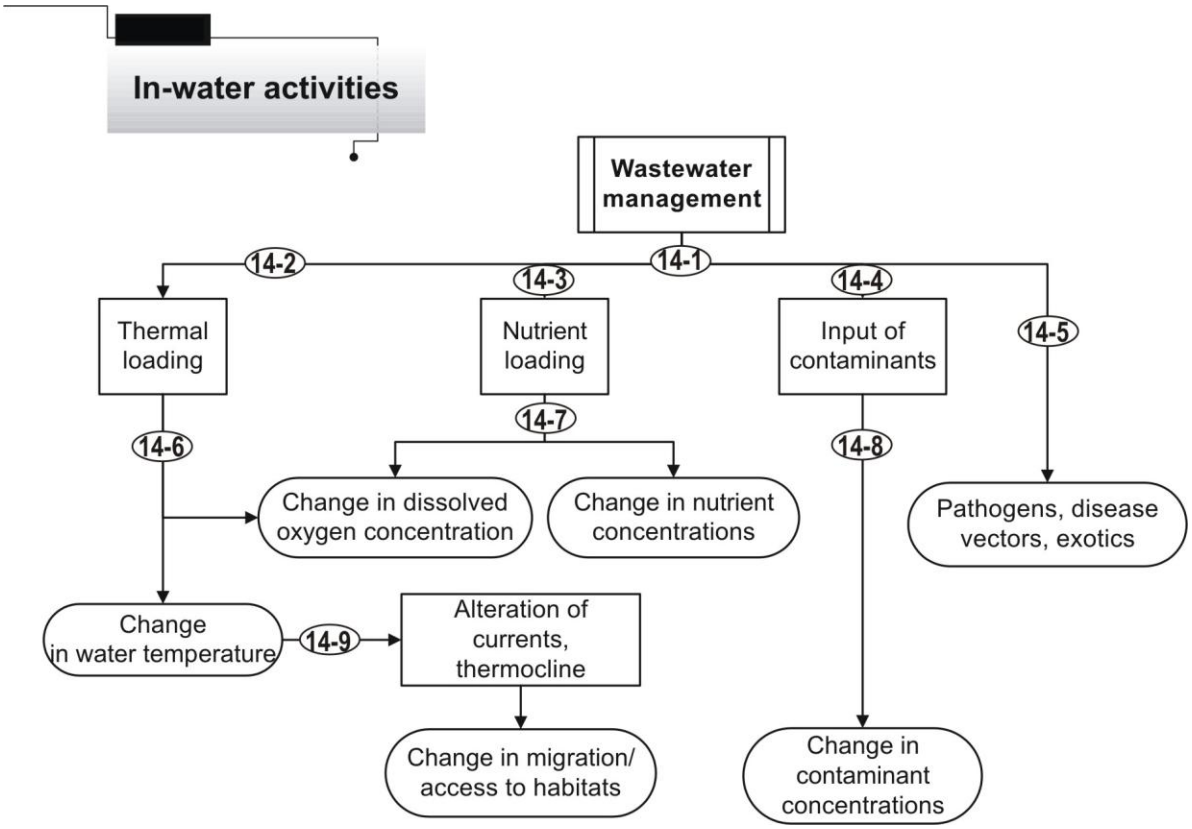


Figure 16. PoE Diagram 14 - Wastewater management.

Table 15. Mitigation measures based on PoE Diagram 14 - Wastewater management.

Link	Mitigation
14-1	Stormwater management.
	Avoid or minimize diversion of surface and groundwater drainage to or from a waterbody (do not divert across watershed boundaries).
	Treatment of dewatering (or other) discharge water by sediment settling ponds, filter bags, etc.
	Energy dissipation measures.
14-2	Wastewater cooling strategies (e.g., cooling towers, ponds, sprinklers, underground piping).
14-3	Wastewater nutrient removal strategies (e.g., wastewater treatment facilities, constructed wetlands, soil leaching systems).
14-4	Wastewater contaminant removal strategies (e.g., wastewater treatment facilities, constructed wetlands, soil leaching systems).
14-5	Wastewater sterilization techniques (e.g., chemical, UV).
14-6	Increase dilution or dilution rate of effluent (e.g., discharge location, effluent diffuser).
14-7	Increase dilution or dilution rate of effluent (e.g., discharge location, effluent diffuser).
14-8	Increase dilution or dilution rate of effluent (e.g., discharge location, effluent diffuser).
14-9	Seasonal timing to minimize impacts.

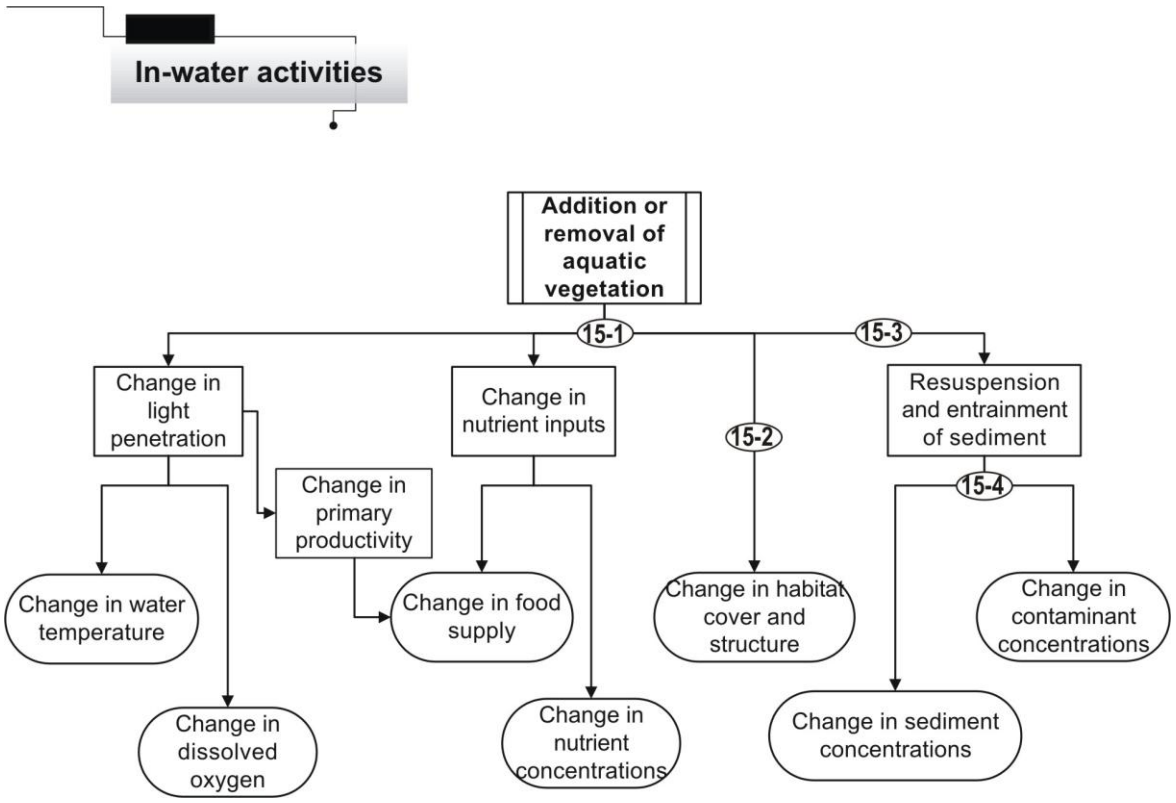
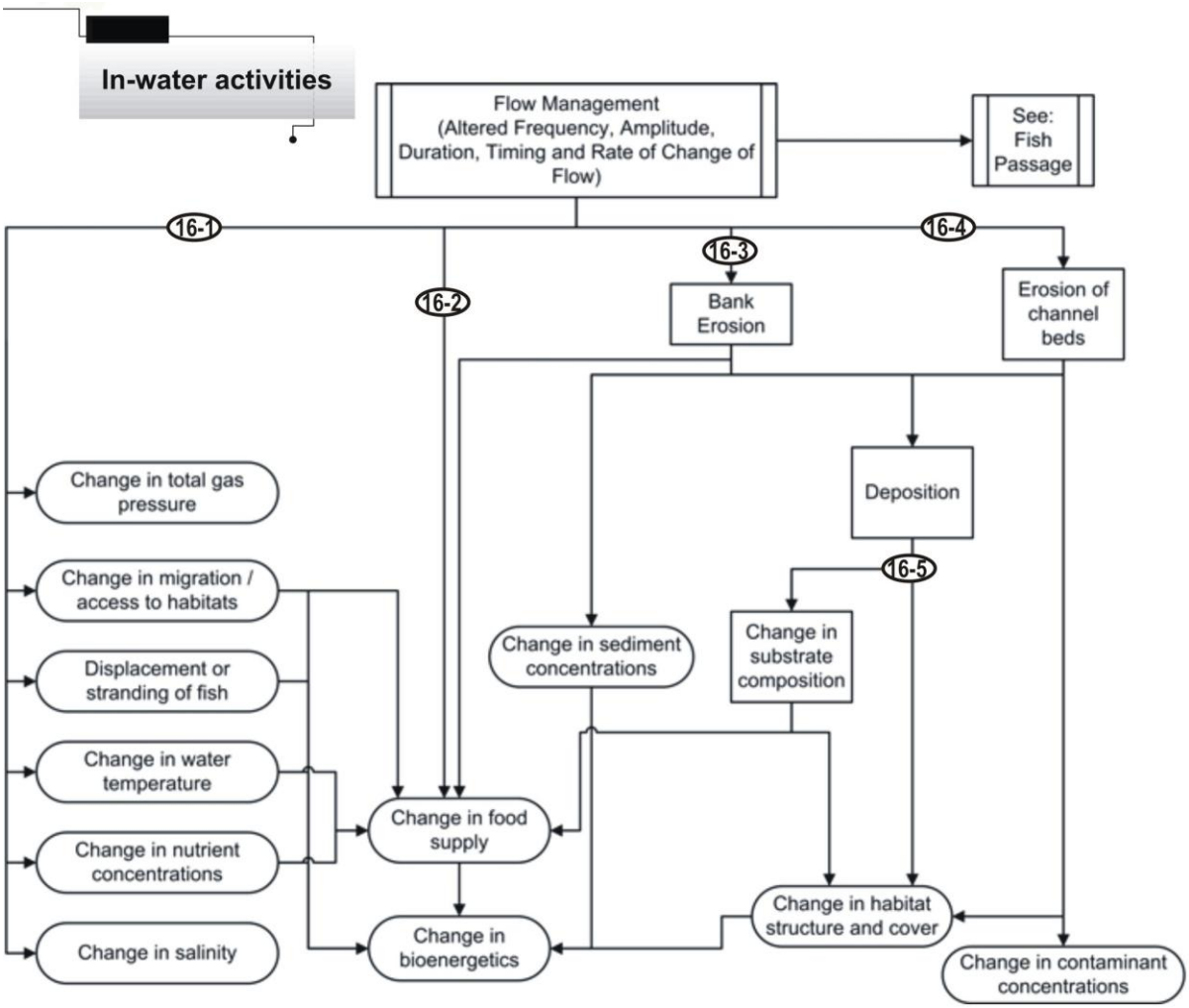


Figure 17. PoE Diagram 15 - Addition or removal of aquatic vegetation.

Table 16. Mitigation measures based on PoE Diagram 15 - Addition or removal of aquatic vegetation.

Link	Mitigation
15-1	Riparian vegetation plantings. Design and implement vegetation rehabilitation plan following construction/disturbance to re-plant riparian vegetation to pre-construction or better condition (e.g., trees for shade to cool water and provide overhead cover). • usually includes re-instatement of native soils or replacement with topsoil/suitable planting medium. • may include soil/seedbank salvage, vegetation transplant or bio-engineering (e.g., live stakes, cuttings) techniques. • typically only native species compatible with site conditions are used.
	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.
	Seasonal timing to minimize impacts.
15-2	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.
15-3	Design and implement isolation/containment plan to isolate temporary in-water work zones to maintain clean flow downstream/around the work zone at all times. The design should: • use only clean materials free of suspendable matter for temporary coffer dams. • situate or otherwise manage flow withdrawal and discharge (e.g., see dewatering discharge) so as to prevent erosion and sediment release to the waterbody. • ensure the work zone is stabilized to the extent practical against the impacts of high flow events during the work period. • remove fish from isolated in-water work zones if necessary.
15-4	In-water silt curtains to contain suspended sediments.



(Modified from "Change in timing duration and frequency of flow" (Clarke et al. 2008))

Figure 18. PoE Diagram 16 - Flow management.

Table 17. Mitigation measures based on PoE Diagram 16 - Flow management.

Link	Mitigation
16-1	Seasonal timing to minimize impacts.
	Dam design or operation to allow passage and minimize risk for fish passing upstream or downstream of a dam (e.g., downstream migration diversion methods, turbines that exhibit low fish mortality, spillways designed to pass fish safely. Upstream migration via fish ladders, bypass channels).
	Dam design, operation or mitigation (e.g., destratification systems) to reduce or eliminate effects upon downstream water chemistry, water temperature, total gas pressure, or flow regime.
	Flow management (e.g., minimum flows, seasonal flow augmentation, flushing flows) for specific aquatic habitat management goals or to mitigate other effects of flow management.
16-2	Stormwater management.
	Avoid or minimize diversion of surface and groundwater drainage to or from a waterbody (do not divert across watershed boundaries).
	Reduce or eliminate constriction of flow through structure design. Design and site piers and abutments to avoid or otherwise minimize encroachment into waterbody, and avoid sensitive habitats. Design bridge or culvert to not affect existing or natural flow regimes. Design and install culverts to prevent creation of barriers to fish movement, and maintain bankfull channel functions and habitat functions to the extent possible, includes: • embedment. • re-instatement of low flow channel and native substrates. • proper sizing, maintaining channel slope.
	Natural channel design principles used for new watercourse sections.
	Flow management (e.g., minimum flows, seasonal flow augmentation, flushing flows) for specific aquatic habitat management goals or to mitigate other effects of flow management.
16-3	Riparian vegetation plantings. Design and implement vegetation rehabilitation plan following construction/disturbance to re-plant riparian vegetation to pre-construction or better condition (e.g., trees for shade to cool water and provide overhead cover). • usually includes re-instatement of native soils or replacement with topsoil/suitable planting medium. • may include soil/seedbank salvage, vegetation transplant or bio-engineering (e.g., live stakes, cuttings) techniques. • typically only native species compatible with site conditions are used.
	Adjust channel morphology to maintain appropriate hydraulics (e.g., addition of riffles to slow upstream velocities; modification of width and/or depth to adjust velocities).
	Natural channel design principles used for new watercourse sections.
	Stabilize/reinforce stream banks using tree and shrub plantings, root wads, boulders, vortex weirs, etc.
	Energy dissipation measures.
16-4	Adjust channel morphology to maintain appropriate hydraulics (e.g., addition of riffles to slow upstream velocities; modification of width and/or depth to adjust velocities).
	Natural channel design principles used for new watercourse sections.
	Energy dissipation measures.
16-5	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.
	Rehabilitation of stream morphology and substrate to pre-disturbance condition or better.
	Adjust channel morphology to maintain appropriate hydraulics (e.g., addition of riffles to slow upstream velocities; modification of width and/or depth to adjust velocities).
	Flow management (e.g., minimum flows, seasonal flow augmentation, flushing flows) for specific aquatic habitat management goals or to mitigate other effects of flow management.

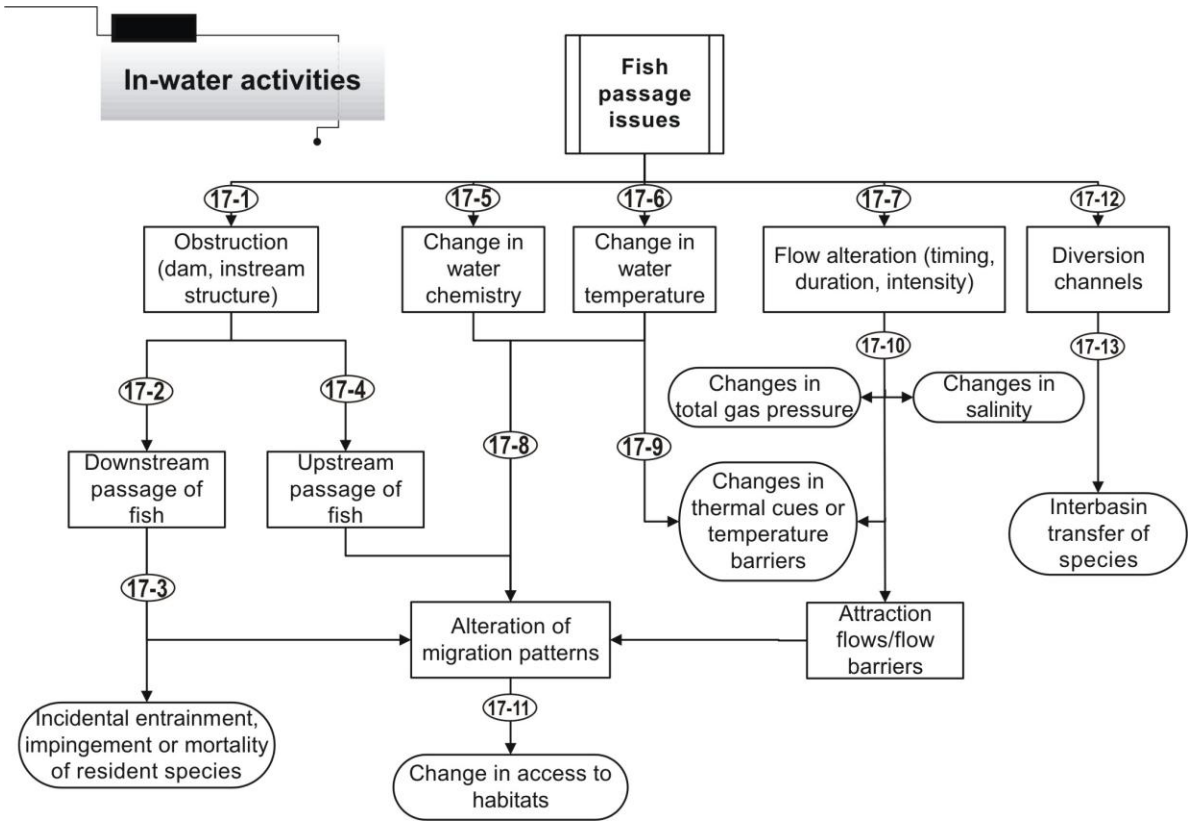


Figure 19. PoE Diagram 17 - Fish passage issues.

Table 18. Mitigation measures based on PoE Diagram 17 - Fish passage issues.

Link	Mitigation
17-1	Reduce or eliminate constriction of flow through structure design. Design and site piers and abutments to avoid or otherwise minimize encroachment into waterbody, and avoid sensitive habitats. Design bridge or culvert to not affect existing or natural flow regimes. Design and install culverts to prevent creation of barriers to fish movement, and maintain bankfull channel functions and habitat functions to the extent possible, includes: • embedment. • re-instatement of low flow channel and native substrates. • proper sizing, maintaining channel slope.
17-2	Seasonal timing to minimize impacts.
	Dam design or operation to allow passage and minimize risk for fish passing upstream or downstream of a dam (e.g., downstream migration diversion methods, turbines that exhibit low fish mortality, spillways designed to pass fish safely, upstream migration via fish ladders, bypass channels).
	Flow management (e.g., minimum flows, seasonal flow augmentation, flushing flows) for specific aquatic habitat management goals or to mitigate other effects of flow management.
17-3	Screens to prevent entrainment of fishes into water intakes.
17-4	Seasonal timing to minimize impacts.
	Dam design or operation to allow passage and minimize risk for fish passing upstream or downstream of a dam (e.g., downstream migration diversion methods, turbines that exhibit low fish mortality, spillways designed to pass fish safely, upstream migration via fish ladders, bypass channels).
	Flow management (e.g., minimum flows, seasonal flow augmentation, flushing flows) for specific aquatic habitat management goals or to mitigate other effects of flow management.
17-5	Stormwater management.
	Dam design, operation or mitigation (e.g., destratification systems) to reduce or eliminate effects upon downstream water chemistry, water temperature, total gas pressure, or flow regime.
17-6	Stormwater management.
	Dam design, operation or mitigation (e.g., destratification systems) to reduce or eliminate effects upon downstream water chemistry, water temperature, total gas pressure, or flow regime.
17-7	Stormwater management.
	Avoid or minimize diversion of surface and groundwater drainage to or from a waterbody (do not divert across watershed boundaries).
17-8	Seasonal timing to minimize impacts.
17-9	Seasonal timing to minimize impacts.
17-10	Seasonal timing to minimize impacts.
	Flow management (e.g., minimum flows, seasonal flow augmentation, flushing flows) for specific aquatic habitat management goals or to mitigate other effects of flow management.
17-11	Create additional or replacement critical or limiting habitats.
17-12	Natural channel design principles used for new watercourse sections.
	Design and implement isolation/containment plan to isolate temporary in-water work zones to maintain clean flow downstream/around the work zone at all times. The design should: • use only clean materials free of suspendable matter for temporary coffer dams. • situate or otherwise manage flow withdrawal and discharge (e.g., see dewatering discharge) so as to prevent erosion and sediment release to the waterbody. • ensure the work zone is stabilized to the extent practical against the impacts of high flow events during the work period. • remove fish from isolated in-water work zones if necessary.
17-13	Avoid or minimize diversion of surface and groundwater drainage to or from a waterbody (do not divert across watershed boundaries).

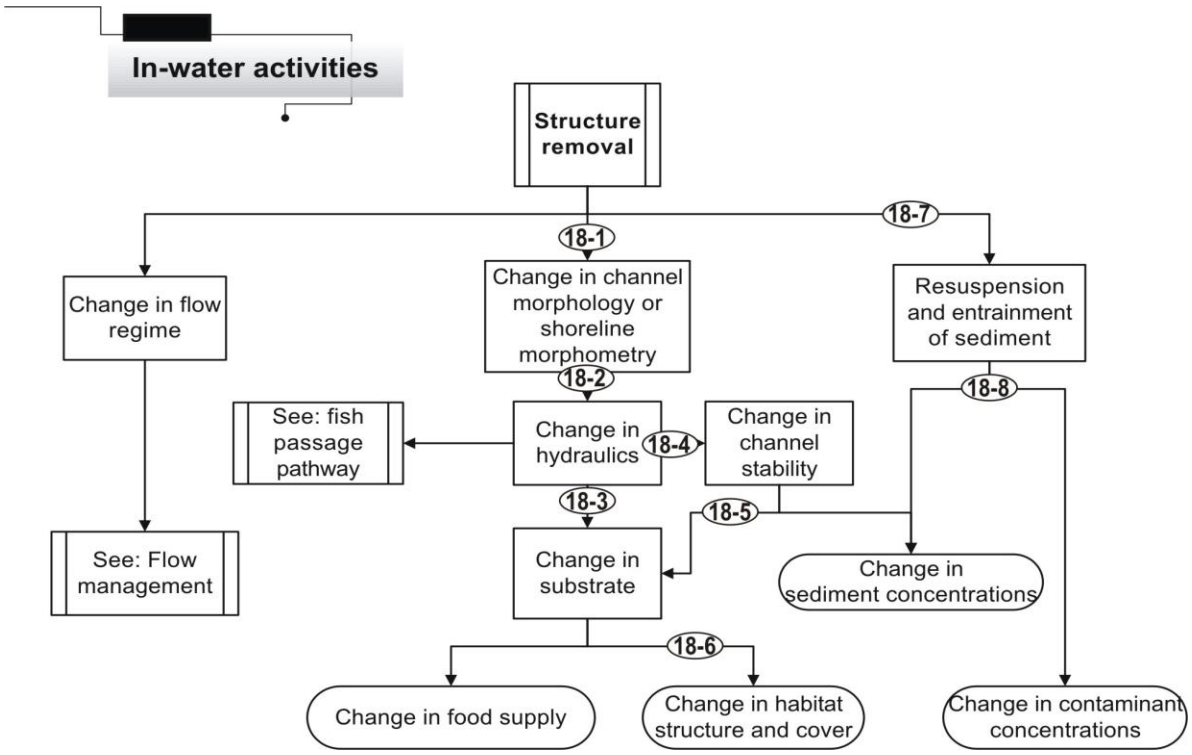


Figure 20. PoE Diagram 18 - Structure removal.

Table 19. Mitigation measures based on PoE Diagram 18 - Structure removal.

Link	Mitigation
18-1	Riparian vegetation plantings. Design and implement vegetation rehabilitation plan following construction/disturbance to re-plant riparian vegetation to pre-construction or better condition (e.g., trees for shade to cool water and provide overhead cover). • usually includes re-instatement of native soils or replacement with topsoil/suitable planting medium. • may include soil/seedbank salvage, vegetation transplant or bio-engineering (e.g., live stakes, cuttings) techniques. • typically only native species compatible with site conditions are used.
	Prohibit or limit access to banks or areas adjacent to waterbodies, to the extent required to protect the structural integrity of banks or shorelines.
	Rehabilitation of stream morphology and substrate to pre-disturbance condition or better.
	Stabilize/reinforce stream banks using tree and shrub plantings, root wads, boulders, vortex weirs, etc.
	Containment plan to keep dust, particulate scrubbings, blast sand, air-borne contaminants, and other potentially deleterious substances from entering the waterbody. This is used to avoid the necessity of dewatering.
18-2	Adjust channel morphology to maintain appropriate hydraulics (e.g., addition of riffles to slow upstream velocities; modification of width and/or depth to adjust velocities).
18-3	Rehabilitation of stream morphology and substrate to pre-disturbance condition or better.
18-4	Stabilize/reinforce stream banks using tree and shrub plantings, root wads, boulders, vortex weirs, etc.
18-5	Rehabilitation of stream morphology and substrate to pre-disturbance condition or better.
18-6	Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.
18-7	Design and implement isolation/containment plan to isolate temporary in-water work zones to maintain clean flow downstream/around the work zone at all times. The design should: • use only clean materials free of suspendable matter for temporary coffer dams. • situate or otherwise manage flow withdrawal and discharge (e.g., see dewatering discharge) so as to prevent erosion and sediment release to the waterbody. • ensure the work zone is stabilized to the extent practical against the impacts of high flow events during the work period. • remove fish from isolated in-water work zones if necessary.
	Treatment of dewatering (or other) discharge water by sediment settling ponds, filter bags, etc.
	Energy dissipation measures.
	Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).
	Seasonal timing to minimize impacts.
18-8	In-water silt curtains to contain suspended sediments.

Appendix A: Mitigation measures to break the paths in the Pathways of Effects (PoE) diagrams.

Mitigation Measures [1]	**Stressor Locations (pathway)**
O-BI Operational constraint for blasting. - Implement requirements and limitations for the use of confined explosives, in or near, fisheries waters.	4-1
M-Veg Minimize riparian vegetation removals. If removal is necessary use proper clearing techniques and protect retained vegetation.	1-1, 2-2, 3-9
M-Chem Use only specified amounts and types of fertilizer in areas draining to waterbodies. Avoid use of chemical dust suppressants, pesticides and herbicides in areas draining to waterbodies.	1-2, 1-9, 7-4
R-Veg Riparian vegetation plantings. Design and implement vegetation rehabilitation plan following construction/disturbance to re-plant riparian vegetation to pre-construction or better condition (e.g., trees for shade to cool water and provide overhead cover). • usually includes re-instatement of native soils or replacement with topsoil/suitable planting medium. • may include soil/seedbank salvage, vegetation transplant or bio-engineering (e.g., live stakes, cuttings) techniques. • typically only native species compatible with site conditions are used.	1-3, 1-9, 3-2, 3-10, 5-3, 8-2, 13-5, 13-6, 15-1, 16-3, 18-1
O-Acc Prohibit or limit access to banks or areas adjacent to waterbodies, to the extent required to protect the structural integrity of banks or shorelines.	1-1, 1-6, 2-1, 5-1, 8-1, 13-1, 13-4, 18-1
M-ExM Dispose or temporarily store all materials used or generated (e.g., organics, soils, woody debris, temporary stockpiles, construction debris) during site preparation, construction and clean-up in a manner that prevents their entry to waterbody.	1-4, 2-2, 3-12
D-SWM Stormwater management.	14-1, 16-2, 17-5, 17-6, 17-7
D-Dr Avoid or minimize diversion of surface and groundwater drainage to or from a waterbody (do not divert across watershed boundaries).	2-6, 3-1, 3-7, 14-1, 16-2, 17-7, 17-13
R-IsC Add/establish appropriate instream structure and cover for habitat, in such a way as to not destabilize the channel through negative impacts to hydraulics. Match structure/substrate type with previous or adjacent types where possible. This may entail the salvage and reinstatement of existing instream structure such as large wood debris, boulders, or instream aquatic vegetation.	1-5, 2-3, 8-3, 10-4, 10-5, 10-6, 11-6, 11-8, 13-3, 13-5, 13-6, 15-1, 15-2, 16-5, 18-6

(cont'd)

Appendix A (cont'd): Mitigation measures to break the paths in the Pathways of Effects (PoE) diagrams.

Mitigation Measures [1]	**Stressor Locations (pathway)**
R-BdSb Rehabilitation of stream morphology and substrate to pre-disturbance condition or better.	10-2, 10-4, 11-1, 11-3, 11-5, 13-2, 16-5, 18-1, 18-3, 18-5
D-C, D-Br Reduce or eliminate constriction of flow through structure design. Design and site piers and abutments to avoid or otherwise minimize encroachment into waterbody, and avoid sensitive habitats. Design bridge or culvert to not affect existing or natural flow regimes. Design and install culverts to prevent creation of barriers to fish movement, and maintain bankfull channel functions and habitat functions to the extent possible, includes: • embedment. • re-instatement of low flow channel and native substrates. • proper sizing, maintaining channel slope.	10-1, 16-2, 17-1
Adjust channel morphology to maintain appropriate hydraulics (e.g., addition of riffles to slow upstream velocities; modification of width and/or depth to adjust velocities).	10-2, 10-3, 11-2, 16-3, 16-4, 16-5, 18-2
R-ExS Stabilize exposed soils (targeted planting of specialized vegetation treatments, add structure to steep slopes, use of commercial seed mats, perforated soil cloth, etc.).	2-5, 3-3, 3-8, 5-3, 7-3, 8-4, 13-7
R-NCD Natural channel design principles used for new watercourse sections.	16-2, 16-3, 16-4, 17-12
R-Bk Stabilize/reinforce stream banks using tree and shrub plantings, root wads, boulders, vortex weirs, etc.	1-6, 2-4, 3-3, 4-5, 5-3, 7-3, 8-4, 11-1, 11-4, 13-7, 16-3, 18-1, 18-4
Create additional or replacement critical or limiting habitats.	17-11
Selective or phased vegetation removal or species management to maintain or reduce shade on stream and provide specialized riparian communities or habitats. This may be desirable for the management of certain species, such as Redside Dace, salmonids, or warmwater species at risk.	1-8, 7-5, 7-6
M-TF Design and implement isolation/containment plan to isolate temporary in-water work zones to maintain clean flow downstream/around the work zone at all times. The design should: • use only clean materials free of suspendable matter for temporary coffer dams. • situate or otherwise manage flow withdrawal and discharge (e.g., see dewatering discharge) so as to prevent erosion and sediment release to the waterbody. • ensure the work zone is stabilized to the extent practical against the impacts of high flow events during the work period. • remove fish from isolated in-water work zones if necessary. See fish transfer (**MFTr**) and fish screens (**MFSc**) for managing fishes.	5-6, 11-7, 12-1, 15-3, 17-12, 18-7

(cont'd)

Appendix A (cont'd): Mitigation measures to break the paths in the Pathways of Effects (PoE) diagrams.

Mitigation Measures [1]	**Stressor Locations (pathway)**
M-DwD Treatment of dewatering (or other) discharge water by sediment settling ponds, filter bags, etc.	1-7, 3-6, 6-4, 6-5, 12-1, 14-1, 18-7
M-DwD Energy dissipation measures.	3-5, 12-1, 14-1, 16-3, 16-4, 18-7
M-FSc Screens to prevent entrainment of fishes into water intakes.	12-1, 12-2, 17-3
M-ESC Sediment and erosion controls to prevent erosion of exposed soils to adjacent waterbody (e.g., erosion control fencing, fabrics, straw, straw bales, settling ponds).	1-6, 1-9, 2-1, 2-7, 3-2, 3-4, 3-11, 4-2, 4-4, 4-6, 5-4, 6-4, 6-5, 7-2, 13-3, 13-6, 18-7
In-water silt curtains to contain suspended sediments.	1-7, 3-4, 4-2, 4-4, 5-5, 15-4, 18-8
O-TW Seasonal timing to minimize impacts.	1-1, 1-2, 4-3, 5-2, 6-1, 7-1, 9-1, 9-2, 9-3, 12-1, 13-1, 13-4, 14-9, 15-1, 16-1, 17-2, 17-4, 17-8, 17-9, 17-10, 18-7
M-FTr Avoid impacts to fishes by excluding, moving, or frightening fishes away. Must be undertaken using proper handling techniques and strategies that will avoid or minimize stress.	4-3, 5-2, 9-1, 9-2
M-Eqp Vehicle and equipment re-fuelling and maintenance shall be conducted away from the water. Any part of equipment entering the water shall be free of fluid leaks and externally cleaned/degreased to prevent any deleterious substance from entering the water.	5-7, 5-8
M-Spl Spill containment plan.	5-9, 6-2
M-WSCon Containment plan to keep dust, particulate scrubbings, blast sand, air-borne contaminants, and other potentially deleterious substances from entering the waterbody. This is used to avoid the necessity of dewatering.	6-1, 6-3, 18-1
Wastewater cooling strategies (e.g., cooling towers, ponds, sprinklers, underground piping).	14-2
Wastewater nutrient removal strategies (e.g., wastewater treatment facilities, constructed wetlands, soil leaching systems).	14-3
Wastewater contaminant removal strategies (e.g., wastewater treatment facilities, constructed wetlands, soil leaching systems).	14-4
Wastewater sterilization techniques (e.g., chemical, UV).	14-5
Increase dilution or dilution rate of effluent (e.g., discharge location, effluent diffuser).	14-6, 14-7, 14-8
Dam design or operation to allow passage and minimize risk for fish passing upstream or downstream of a dam (e.g., downstream migration diversion methods, turbines that exhibit low fish mortality, spillways designed to pass fish safely, upstream migration via fish ladders, bypass channels).	16-1, 17-2, 17-4

(cont'd)

Appendix A (cont'd): Mitigation measures to break the paths in the Pathways of Effects (PoE) diagrams.

Mitigation Measures [1]	**Stressor Locations (pathway)**
Dam design, operation or mitigation (e.g., destratification systems) to reduce or eliminate effects upon downstream water chemistry, water temperature, total gas pressure, or flow regime.	16-1, 17-5, 17-6
Flow management (e.g., minimum flows, seasonal flow augmentation, flushing flows) for specific aquatic habitat management goals or to mitigate other effects of flow management.	16-1, 16-2, 16-5, 17-2, 17-4, 17-10

[1]Bolded code at the beginning of each Mitigation Measure is the MTO code for the corresponding MTO Mitigation Action. These are included to facilitate comparisons by reviewers.