

Impacts and Mitigation Measures

A. Impact Identification Matrix (Water Supply Systems)

Problems and damages	Heavy winds	Heavy rains	Landslides	Earthquakes	Volcanic eruptions Lava and ash	Tsunamis and floods	Manmade
1. Watersheds	Siltation; soil erosion	Uprooting of trees; soil erosion; loss of retention capacity	Uprooting of trees; loss of vegetation; loss of retention capacity	Landslides	Mud flows; fines, ash deposits; destruction of waterbed; pollution of water resources; siltation	Saline intrusion and destruction of coastal zone waterbeds	Deforestation; siltation; fires; pollution
2. Sources (general)	Power outages; blocked access	Power outages; blocked access	Power outages; blocked access	Power outages; blocked access	Power outages; blocked access	Power outages; blocked access	Power outages; blocked access; contamination
2.1 Springs	Physical damage from windblown debris and falling trees; blockage of screens	Physical damage from floating debris; erosion; blockage of screens	Burying of spring; physical damage to weirs, walls, pipelines	Change of aquifer; loss of source; disappearance of physical structure; cracked retaining box, wall or weir; dislocated pipes; blockage of filters by silt, debris	Change of aquifer; loss of source; physical damage by lava flow	Undermining of structure; physical damage to weir and pipes by floating debris; blockage of filters by silt, debris, etc.	
2.2 River intakes	Physical damage from windblown debris and falling/uprooted trees; blockage of screens	Physical damage from floating debris; blockage of screens; siltation and filling of reservoir	Redirection of river bed; flow alterations; burying of intake; physical damage to walls, weirs, screens, pipes	Structural damage to weir, filter box; side- under cutting by water flow; dislocated or broken outlet pipe(s); valve controls dislocated or misaligned	Physical damage from lava flow and falling rocks, filling with rocks and ashes	Undermining of structure; physical damage to weir and pipes by floating debris; side scouring of banks; siltation	
2.3 Dams and impoundments	Physical damage from windblown debris and falling/uprooted trees; blockage of screens; wave damage to embankment	Physical damage from windblown and floating debris; blockage of screens; siltation and filling of reservoir; overtopping	Loss of impoundment volume; burying of intake; physical damage to walls, weirs, screens, pipes	Structural damage to weir, filter box, side- under cutting by water flow; dislocated or broken outlet pipe(s); valve controls dislocated or misaligned	Physical damage by lava flow and falling rocks; filling with rocks and ashes	Undermining of structure; physical damage to weir and pipes by floating debris; scouring of beds; overtopping by flood wave; siltation	
2.4 Groundwater well	Physical damage to above-ground structures and equipment from windblown debris and falling trees	Flooding of above- ground pump, motors and electrical equipment	Burying of well; physical damage to pumps	Shearing of the casing; collapse of casing wall; loss of well	Physical damage by lava flow and falling rocks; collapse of cover by ash load	Flooding of above- ground pump, motors and electrical equipment	

A. Impact Identification Matrix (Water Supply Systems) (continued)

Problems and damages	Heavy winds	Heavy rains	Landslides	Earthquakes	Volcanic eruptions Lava and ash	Tsunamis and floods	Manmade
2.5 Infiltration gallery	Little impact	Little impact	Burying of gallery; physical damage	Physical damage to host/ remaining structure; dislocation of outlet pipes	Physical damage by lava flow and falling rocks	Undermining of structure; physical damage by floating debris to roughing filter and screens; side- scouring of banks; alluvion	
3. Trunk (raw and treated)	Breakage of under- ground trunks by uprooting trees; breakage of exposed pipes by falling trees	Breakage and washing away of mainline at river crossings and along river beds	Breaks and loss of mainline; filling of mainline with silt and soil	Breaks of mainline	Break and loss of mainline	Break and loss of mainline	Puncture of mainline; stealing of water; vandalism; damage during road excavations
4. Treatment plant	Collapse of structure; roof damage; blockage by debris; power outages	Under-scouring of foundations; collapse of structures; flooding of buildings; short- circuits in electrical systems; fire; power outage	Collapse and/or removal of structure; blockage by debris and mud; power outage	Structural damage; collapse of structures; short-circuiting; fires; water main breaks; water damage; power outage	Structural damage; collapse of structures; short-circuiting; fires; water main breaks; water damage; blockage by lava; power outage	Structural damage; collapse of structures; short-circuiting; fires; water main breaks; water damage; power outage	Explosions; chlorine gas leaks; power outage
5. Pumping/booster station	Collapse of structure; roof damage; blockage by debris; power outage	Under-scouring of foundations; collapse of structures; flooding of buildings; short- circuits in electrical systems; fire; power outage	Collapse and/or removal of structure; blockage by debris and mud; power outage	Structural damage; collapse of structures; short-circuiting; fires; water main breaks; water damage; power outage	Structural damage; collapse of structures; short-circuiting; fires; water main breaks; water damage; power blockage; power outage	Structural damage; collapse of structures; short-circuiting; fires; water main breaks; water damage; power outage	Power outages; explosions; chlorine gas leaks
6. Storage	Collapse of structure; roof damage; breakage of mainline from debris	Under-scouring of foundations; collapse of structures; breakage of mainline from debris	Cracking; collapse and/or removal of structure	Structural damage; cracking and/or collapse of structures; breakage of mainline	Structural damage; contamination of stored water	Structural damage; removal of structure; breakage of mainline	Pollution
7. Distribution	Breakage of pipes by uprooting trees and falling utility poles	Breakage and washing away of pipes	Washing away of pipes	Breakage of pipes	Breakage of pipes	Pollution	Vandalism; accidental damages; pollution

B. Mitigation Identification Matrix (Water Supply Systems)

Problems and damages	Heavy winds	Heavy rains	Landslides	Earthquakes	Volcanic eruptions Lava and ash	Tsunamis and floods	Manmade
1. Watersheds	Prevent deforestation; carry out reforestation	Prevent deforestation; carry out reforestation; contour plowing	Prevent deforestation; carry out reforestation	Prevent deforestation; carry out reforestation	Careful selection of resource watershed	Careful selection of resource watershed regarding flood zones	Prevent deforestation; carry out reforestation; install measures to control fires and pollution
2. Sources (general)	Steady generator; provide all-weather access roads (including for heavy equipment)	Steady generator; provide all-weather access roads (including for heavy equipment)	Careful siting; prevention of deforestation; steady generator; all-weather access roads (including for heavy equipment)	Careful siting; steady generators	Careful siting	Careful siting; provide all-weather access roads (including for heavy equipment)	Careful siting; increased security
2.1 Springs	Keep site clear of loose debris; cover collection box and channels with protective slabs	Deeper foundations		Construct earthquake proof structures; use flexible joints	Decontaminate sources	Deeper foundations	
2.2 River intakes	Install stop-log upstream; install intake and sediment tank several feet upstream of weir and beside the main channel	Sheet piling under foundation; provide stop-log; rock-fill river banks; construct rubble masonry wall		Construct earthquake proof structures; use sheet piling; extend wing walls; use flexible joints	Decontaminate sources	Sheet piling under foundation; provide stop-log; rock-fill river banks; construct rubble masonry wall	
2.3 Dams and impoundments	Remove trees from embankment; construct wave- protected embankments	Install stop-log (boom); install silt cleaner behind screen; provide perpet wall	Careful siting; prevention of deforestation	Construct earthquake proof structures; use sheet piling; extend wing walls; use flexible joints; develop slipping banks below and above water line; provide perpet wall	Decontaminate sources	Construct grout curtain; earth-fill cofferdam; provide stop-log; rock- fill river banks; construct rubble masonry wall	
2.4 Groundwater well		Raise the pump house; install exterior flood wall or dike		Increase strength of causing by adding liner, if possible	Decontaminate sources; know location of alternative well sites	Raise the pump house; install exterior flood wall or dike	

B. Mitigation Identification Matrix (Water Supply Systems) (continued)

Problems and damages	Heavy winds	Heavy rains	Landslides	Earthquakes	Volcanic eruptions Lava and ash	Typhoons and floods	Manmade
2.5 Infiltration gallery		Install wood sheeting or Gabion baskets along the bank, creating a sedimentation area		Construct earthquake proof structures; use flexible pipe joints	Decentralize sources	Construct deeper foundations and wider dams	
3. Trunk (new and treated)	Lay mains away from trees and utility poles	Bury mains; reduce number of river crossings; affix main at downstream side of bridges; encourage vegetation for slope stabilization	Select main route away from landslide-prone areas; select pipe material suitable for soil conditions; promote vegetation for slope stabilization	Use flexible joints and appropriate pipe material	Use flexible joints and appropriate pipe material	Use flexible joints and appropriate pipe material	Bury mains; indicate location of mains
4. Treatment plant	Design and construct to withstand high wind speeds; install standby generators	Ensure adequate drainage; install standby generators	Select site away from slide-prone areas	Design and construct to withstand earthquakes; install standby generators; careful siting; use flexible joints and wall crossings	Careful siting; use flexible pipe joints at wall crossings; install standby generators	Careful siting of plant; adequate drainage; install standby generators	Careful siting; implement adequate safety procedures; install standby generators; increase security and security training of staff
5. Pumping/booster station	Design and construct to withstand high wind speeds; install standby generators	Ensure adequate drainage; install standby generators or use gravity systems	Select site away from slide-prone areas; follow topography	Design and construct to withstand earthquakes; install standby generators; careful siting; use flexible joints and wall crossings	Careful siting; use flexible pipe joints and wall crossings; install standby generators	Careful siting of station; install standby generators	Careful siting; implement adequate safety procedures; install standby generators; increase security
6. Storage reservoirs	Ensure reservoirs are filled during storms and close valves (to be installed if necessary)	Ensure adequate drainage	Select site away from slide-prone areas	Design and construct to withstand earthquakes; careful siting; use flexible joints and wall crossings	Careful siting; use flexible pipe joints and wall crossings; design and construct to carry safe loads	Careful siting of reservoir	Careful siting; increase security; implement adequate safety procedures
7. Distribution	Lay pipes away from trees and utility poles	Bury lines	Careful routing of pipes	Select adequate pipe material; use flexible joints and wall crossings	Select adequate pipe material; use flexible joints and wall crossings	Bury pipes and lay pipes away from trees and utility poles	Bury pipes; indicate location; proper mapping

