

Appendix F

Conceptual Stormwater Servicing Alternatives

TABLE F-1: DESCRIPTION OF ALTERNATIVE STORMWATER SERVICING CONCEPTS

Alternative SWM Servicing Concept No. ¹	KNL Development Phase ²	Description of Proposed Drainage and Stormwater System		
		Minor System Drainage ³ (Storm Sewer System)	Major System Drainage ⁴ (Overland Flow)	Stormwater Management ⁵
1 ⁶	7	<ul style="list-style-type: none"> Existing area draining to Kizell Drain / Watt's Creek directed via proposed storm sewer outlet(s) into Kizell Cell. Existing area draining to Shirley's Brook diverted to Kizell Drain / Watt's Creek via proposed storm sewer outlet(s) into Kizell Cell. 	<ul style="list-style-type: none"> Area draining to Kizell Drain / Watt's Creek maintained as per existing conditions. Area draining to Shirley's Brook diverted to Kizell Drain / Watt's Creek via proposed storm sewer and overland outlet(s) into Kizell Cell. 	<ul style="list-style-type: none"> Water quality / quantity control provided in modified SWM pond constructed within Kizell Cell (minor system + major system).
	8	<ul style="list-style-type: none"> Existing area draining to Shirley's Brook diverted to Kizell Drain / Watt's Creek via proposed storm sewer outlet(s) into Kizell Cell. 	<ul style="list-style-type: none"> Portion of major system (ROW storage) diverted from Shirley's Brook to Kizell Drain / Watt's Creek via proposed storm sewer outlet(s) into Kizell Cell. Portion of major system (in excess of ROW storage) to drain to Shirley's Brook via overland outlet(s) as per existing conditions. 	<ul style="list-style-type: none"> Water quality / quantity control provided in modified SWM pond constructed within Kizell Cell (minor system + portion of major system). Portion of major system (in excess of ROW storage) to outlet to Shirley's Brook as per existing conditions (future development to provide quantity control as required).
	9	<ul style="list-style-type: none"> Existing area draining to Kizell Drain / Watt's Creek directed via proposed storm sewer outlet(s) into Beaver Pond. Existing area currently draining to Shirley's Brook diverted to Kizell Drain / Watt's Creek via proposed storm sewer outlet(s) into Beaver Pond. 	<ul style="list-style-type: none"> Area draining to Kizell Drain / Watt's Creek maintained to Beaver Pond as per existing conditions. Area south of CN rail draining to Shirley's Brook maintained as per existing conditions. Area north of CN rail directed to Shirley's Brook & Kizell Drain / Watt's Creek as per existing conditions. 	<ul style="list-style-type: none"> Existing Beaver Pond modified to provide quality / quantity control (minor system + major system). Major system drainage north of CN rail (in excess of ROW storage) to outlet to Shirley's Brook and Kizell Drain / Watt's Creek as per existing conditions (future development to provide quantity control as required).
2	7	<ul style="list-style-type: none"> Existing area draining to Kizell Drain / Watt's Creek directed via proposed storm sewer outlet(s) into Beaver Pond. Existing area draining to Shirley's Brook diverted to Kizell Drain / Watt's Creek via proposed storm sewer outlet(s) into Beaver Pond. 	<ul style="list-style-type: none"> Area draining to Kizell Drain / Watt's Creek maintained as per existing conditions. Area draining to Shirley's Brook diverted to Kizell Drain / Watt's Creek via new overland outlet(s) into Kizell Cell. 	<ul style="list-style-type: none"> Modified SWM pond in Kizell Cell to provide quantity control for major system drainage (in excess of ROW storage). Existing Beaver Pond modified to provide water quality and quantity control (minor system + portion of major system).
	8	<ul style="list-style-type: none"> Existing area draining to Shirley's Brook diverted to Kizell Drain / Watt's Creek via proposed storm sewer outlet(s) into Beaver Pond. 	<ul style="list-style-type: none"> Portion of major system (ROW storage) diverted from Shirley's Brook to Kizell Drain / Watt's Creek via proposed storm sewer outlet(s) into Beaver Pond. Portion of major system (in excess of ROW storage) directed to Shirley's Brook via overland outlet(s) as per existing conditions. 	<ul style="list-style-type: none"> Existing Beaver Pond modified to provide water quality and quantity control (minor system + portion of major system). Portion of major system (in excess of ROW storage) to outlet to Shirley's Brook as per existing conditions (future development to provide quantity control as required).
	9	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Area draining to Kizell Drain / Watt's Creek maintained to Beaver Pond as per existing conditions. Area south of CN rail draining to Shirley's Brook maintained as per existing conditions. Area north of CN rail directed to Shirley's Brook & Kizell Drain / Watt's Creek as per existing conditions. 	<ul style="list-style-type: none"> Existing Beaver Pond modified to provide quality / quantity control (minor system + major system). Major system drainage south of CN rail (in excess of ROW storage) to outlet to Shirley's Brook as per existing conditions (future development to provide quantity control as required). Major system drainage north of CN rail (in excess of ROW storage) to outlet to Shirley's Brook and Kizell Drain / Watt's Creek as per existing conditions (future development to provide quantity control as required).
3	7	<ul style="list-style-type: none"> Same as Alternative 2. 	<ul style="list-style-type: none"> Area draining to Kizell Drain / Watt's Creek maintained as per existing conditions. Area draining to Shirley's Brook maintained as per existing conditions. 	<ul style="list-style-type: none"> Major system drainage to Kizell Cell (in excess of ROW storage) to outlet to Kizell Cell as per existing conditions. Existing Beaver Pond modified to provide water quality and quantity control (minor system + portion of major system).
	8	<ul style="list-style-type: none"> Same as Alternative 2. 	<ul style="list-style-type: none"> Same as Alternative 2. 	<ul style="list-style-type: none"> Same as Alternative 2.
	9	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 2. 	<ul style="list-style-type: none"> Same as Alternative 2.
4	7	<ul style="list-style-type: none"> Existing area draining to Kizell Drain / Watt's Creek diverted via proposed storm sewer outlet(s) into Shirley's Brook. Existing area draining to Shirley's Brook directed via proposed storm sewer outlet(s) into Shirley's Brook. 	<ul style="list-style-type: none"> Same as Alternative 3. 	<ul style="list-style-type: none"> Existing major system drainage to Kizell Cell (in excess of ROW storage) to outlet to Kizell Cell as per existing conditions. New SWM pond(s) constructed to provide quality and quantity control outletting to Shirley's Brook.
	8	<ul style="list-style-type: none"> Existing area draining to Shirley's Brook directed via proposed storm sewer outlet(s) into Shirley's Brook. 	<ul style="list-style-type: none"> Area draining to Shirley's Creek maintained as per existing conditions. 	<ul style="list-style-type: none"> New SWM pond(s) constructed to provide quality and quantity control outletting to Shirley's Brook.
	9	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 2. 	<ul style="list-style-type: none"> Same as Alternative 2.

Notes:
1. Refer to Figures F-1 to F-4 for alternative SWM servicing concepts.
2. Proposed Kanata North Lands (KNL) phasing information provided by the City of Ottawa.
3. Minor system drainage includes runoff generated from storms up to and including a 5-year return period and is accommodated by a storm sewer system.
4. Major system drainage includes runoff generated from storms above a 5-year return period up to and including a 100-year return period and is accommodated overland within Rights-of-Way (ROW's).
5. The number, location and function of SWM components (i.e., outlets and ponds) are conceptual and intended only for the purposes of this exercise. Additional detailed analyses will be required to confirm appropriate siting and sizing of SWM requirements.
6. SWM servicing concept consistent with Kanata Lakes North Serviceability Study (IBI, 2006).

TABLE F-2: POTENTIAL EFFECTS – SURFACE WATER (Water Quality and Flood Control)

Alternative SWM Servicing Concept No. ¹	Sub-Watershed	Water Quality Considerations	Water Quantity Considerations	Additional Studies / Analyses ^{2,3}
1	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> Increase in water temperature within Kizell Cell, Beaver Pond and Kizell Drain / Watt's Creek resulting from additional impervious surfaces and extended detention times. Increase in Total Suspended Solids (TSS), nutrients, metals etc., from urban storm runoff discharging to Kizell Cell, Beaver Pond and Kizell Drain / Watt's Creek. Increase in Biochemical Oxygen Demand (BOD) and associated decrease in Dissolved Oxygen (DO) within Kizell Cell, Beaver Pond and Kizell Drain / Watt's Creek resulting from additional nutrients discharged in urban runoff. 	<ul style="list-style-type: none"> Increase in frequency and duration of frequent flows and annual runoff volume discharging to Kizell Drain / Watt's Creek may result in increased erosion threats to property and infrastructure downstream. Potential increase in peak flood flows discharging from Beaver Pond to Kizell Drain may have adverse impacts on downstream properties including identified flood vulnerable structures (i.e., March Road, Legget Drive). Increase in Beaver Pond 100-year water level could result in surcharging of adjacent foundations drains or reduction in design Hydraulic Grade Line (HGL) freeboard now provided to existing basement elevations. 	<ul style="list-style-type: none"> Confirm required storage volume in Kizell Cell and Beaver Pond to meet prescribed water quality criterion - "Enhanced" Protection (MOE, March 2003). Undertake erosion analyses for Kizell Drain / Watt's Creek to establish target release rates and erosion storage volumes for Kizell Cell and Beaver Pond. Confirm required flood control storage volumes to avoid increases in downstream flood risk. Assess impact of extended draw-down time on level of protection provided by the Beaver Pond (i.e., impacts associated with storm inter-event times) Confirm whether additional downstream stream rehabilitation/erosion protection works are required in conjunction with SWM controls to prevent additional stream erosion / threats to property and infrastructure. Confirm whether infrastructure improvements would be required / feasible at identified FVS locations if peak discharge from Beaver Pond is increased.
	Shirley's Brook	<ul style="list-style-type: none"> No increase in TSS, nutrients, metals etc., anticipated under frequent flow events as minor system diverted to Kizell Drain / Watt's Creek. Minor increase in TSS, nutrients, metals etc., under infrequent events from major system runoff. Increase in stream temperature resulting from reduction in base flow contributions associated with diversion of minor system to Kizell Drain / Watt's Creek. 	<ul style="list-style-type: none"> Decrease in baseflow contributions resulting from diversion of minor system flows. Decrease in frequency and duration of frequent flows discharged to Shirley's Brook. Potential decrease in flood flows may reduce 100-year flood level along critical reach between Terry Fox and Shirley's Brook Drive. Potential decrease in flood flows may reduce frequency of overtopping and extent of flooding at sensitive downstream hydraulic structures (i.e., Goulbourn Forced Road, March Valley Road, Shirley's Brook Drive and DND lands). 	<ul style="list-style-type: none"> Undertake water balance assessment to confirm how infiltration/recharge contributions and thermal regime in Shirley's Brook will be maintained under post-development conditions. Carry out a detailed hydrologic assessment to confirm whether quantity control will be required for major system flows discharging to Shirley's Brook. (Updated modeling will be used to assess reductions (if any) in flooding at downstream sensitive hydraulic structures, i.e., Goulbourn Forced Road, March Valley Road, Shirley's Brook Drive and DND lands).
2	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> Same as Alternative 1 (but much reduced impact to Kizell Cell). 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1 except: Confirm required storage volume in Beaver Pond to meet prescribed water quality criteria - "Enhanced" Protection (MOE, March 2003), i.e., no water quality storage provided in Kizell Cell.
	Shirley's Brook	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1.
3	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> Same as Alternative 1 (but much reduced impact to Kizell Cell). 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 2.
	Shirley's Brook	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1 (but reduced potential for decrease in flood risk at sensitive downstream hydraulic structures (i.e., Goulbourn Forced Road, March Valley Road, Shirley's Brook Drive and DND lands). 	<ul style="list-style-type: none"> Same as Alternative 1.
4	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> Minor decrease in water quality within Beaver Pond and Kizell Drain / Watt's Creek resulting from KNL Phase 9 urban runoff. 	<ul style="list-style-type: none"> Minor increase in frequency and duration of frequent flows resulting from KNL Phase 9 urban runoff. 	<ul style="list-style-type: none"> Same as Alternative 2.
	Shirley's Brook	<ul style="list-style-type: none"> Increase in water temperature in Shirley's Brook resulting from additional impervious surfaces and extended detention times. Increase in Total Suspended Solids (TSS), nutrients, metals, etc., from urban storm runoff discharging to Shirley's Brook. Increase in Biochemical Oxygen Demand (BOD) and associated decrease in Dissolved Oxygen (DO) within Shirley's Brook resulting from additional nutrients discharged in urban runoff. 	<ul style="list-style-type: none"> Increase in frequency and duration of frequent flows and annual runoff volume discharging to Shirley's Brook may result in additional downstream erosion, threats to property and infrastructure. Potential increase in peak flood flows discharging to Shirley's Brook may have adverse impacts on sensitive downstream hydraulic structures (i.e., March Valley Road, DND lands, etc.) and 100-year freeboard between Terry Fox and Shirley's Brook Drive. 	<ul style="list-style-type: none"> Undertake erosion analyses for Shirley's Brook to establish target release rates and storage volumes for new SWM ponds. Confirm whether additional downstream stream rehabilitation/erosion protection works are required in conjunction with SWM controls to prevent additional stream erosion and threats to property and infrastructure. Carry out detailed hydrologic analyses to confirm target peak outflow and storage volumes required for new SWM ponds to demonstrate no increase in downstream flood levels. Alternatively, assess benefits (if any) to SWM pond sizing from improvements to downstream sensitive hydraulic structures.

Notes:
1. Refer to Figures F-1 to F-4 for alternative SWM servicing concepts.
2. Additional studies / analyses do not comprise a full list of technical supporting documentation required as part of the development approvals process.
3. All alternatives require that the lack of compliance of the Beaver Pond with its existing Certificate of Approval be addressed.

TABLE F-3: POTENTIAL EFFECTS – FLUVIAL GEOMORPHOLOGY

Alternative SWM Servicing Concept No. ¹	Sub-Watershed	Erosion	Deposition	Additional Studies / Analyses
1	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> Sediment mobilization/redistribution of silt deposits which are currently stable under minor system flow volumes may deepen channel, resulting in bank erosion. This is of particular concern downstream of the Beaver Pond to the upstream side of March Road. Areas of considerable bank erosion in downstream reaches may be exacerbated by increased flow frequency and duration of channel-forming flows (minor system flows < 5-year return period). There are extensive erosion sites along the upper Kizell Drain (upstream of March Road and downstream of Herzberg Road) which may undergo an increase in rates of erosion as major flows (i.e., flows greater than the 5-year return period) are added. Addition of diverted major system from Shirley's Brook could erode deposited sediment which was mobilized by minor flows but not moved efficiently through the system. Some mobilization of finer sediments could occur between Kizell Cell and Beaver Pond. 	<ul style="list-style-type: none"> Mobilization of channel-stored sediment from upper reaches may result in deposition downstream when additional energy from minor system flows (i.e., less than the 5-year return period) is dampened by existing flow regime. Deposition will require additional time for watercourse to equilibrate, resulting in an altered sediment budget. Some deposition is expected within the Beaver Pond (i.e., permanent pool) from upstream entrained sediment. 	<ul style="list-style-type: none"> Analyses will be required to assess the impacts related to increase in frequent flow volume and duration on channel performance (i.e., erosion / deposition) in downstream reaches. Analyses to determine how far downstream from the Beaver Pond the geomorphic impact of the diversion (particularly deposition of remobilized sediment) will have an effect. If existing deposition rates are exacerbated then integration with aquatic biology component will be required to determine extent of impact. Based on these analyses downstream stream rehabilitation/erosion protection works may be required to mitigate potential loss of land, threats to infrastructure, etc. Magnitude of impact will need to be determined using continuous simulation modelling.
	Shirley's Brook	<ul style="list-style-type: none"> Disrupted sediment transport processes may alter creek configuration which could then be impacted when major system flows (i.e., flows greater than the 5-year return period) pass through. This could result in creek realignment and may affect downstream crossings. 	<ul style="list-style-type: none"> Loss of minor system flow volumes (i.e., less than the 5-year return period) could exacerbate sedimentation problems upstream of trail crossing (Site SBDR-5) and through channel block upstream of Hines Road. Deposition will require additional time for watercourse to equilibrate, resulting in an altered sediment budget. Mobilization of sediment deposited by minor system flow loss and re-entrained during major system flows may create sedimentation within on-line ponds (i.e., at Shirley's Brook Drive). 	<ul style="list-style-type: none"> Analyses will be required to assess the impacts related to loss of base flow volume on channel performance (i.e., erosion / deposition) in downstream reaches. Understanding of distance downstream along Shirley's Brook that the geomorphic impact will have an effect is required (i.e., particular attention is to be paid to areas upstream of Hines Road and upstream of March Valley Road. Magnitude of impact will need to be determined using continuous simulation modelling.
2	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1.
	Shirley's Brook	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1.
3	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1.
	Shirley's Brook	<ul style="list-style-type: none"> Same as Alternative 1 (with additional major system flows from Phase 7). 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1.
4	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> No anticipated change in existing rates of erosion provided erosion thresholds are met for stormwater discharge. 	<ul style="list-style-type: none"> No anticipated change in existing rates and location of deposition sites. 	<ul style="list-style-type: none"> Magnitude of impact (i.e., erosion) will need to be determined using continuous simulation modelling.
	Shirley's Brook	<ul style="list-style-type: none"> No anticipated change in existing rates of erosion provided erosion thresholds are met for stormwater discharge. If adequate mitigation of erosion impacts cannot be achieved by stormwater management, additional watercourse improvements (rehabilitation/realignment) may be required downstream (e.g., identified erosion site upstream of March Valley Road). 	<ul style="list-style-type: none"> No anticipated change in existing rates and location of deposition sites. 	<ul style="list-style-type: none"> Magnitude of impact (i.e., erosion) will need to be determined using continuous simulation modelling.

Notes:
1. Refer to Figures F-1 to F-4 for alternative SWM servicing concepts.

TABLE F-4: POTENTIAL EFFECTS – NATURAL ENVIRONMENT

Alternative SWM Servicing Concept No. ¹	Sub-Watershed	Wetland Habitat ²	Terrestrial Habitat ²	Aquatic Habitat	Additional Studies / Analyses
1	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> Removal of vegetation required to construct storm sewer outlet(s), SWM pond outlet at GFR, sediment forebay(s) and berming at west end of Kizell Cell. Impairment of existing hydrologic connection to red maple swamp via berm construction at west end of Kizell wetland. Removal of vegetation required to increase Beaver Pond permanent pool and active storage volumes. Reduction in water quality (i.e., increased in TSS, nutrients, metals, BOD, temperature, decrease in DO, etc.) in Kizell Cell and PSW portion of Beaver Pond. Increase in permanent pool depth and open water area in Kizell Cell and PSW portion of Beaver Pond. Increase in duration and fluctuation of storm event water levels in Kizell Cell and PSW portion of Beaver Pond. Increased deposition of fine sediment within wetland vegetation. Secondary changes to vegetation communities and natural habitats resulting from hydrological changes and water quality changes. Secondary loss of diversity and resilience in the food web resulting from impacts of hydrological changes and water quality changes on biota (especially benthic macroinvertebrates). Direct and indirect impacts on endangered and threatened wetland species and their habitats (e.g. Blanding's turtle and Least Bittern). 	<ul style="list-style-type: none"> Removal of vegetation required to construct storm sewer inlet(s), SWM pond outlet structure at GFR, berming at west end and major system outlet(s) into Kizell Cell. Removal of vegetation required to construct storm sewer outlet(s), additional permanent pool and active storage volume and major system outlet(s) into Beaver Pond. Removal of vegetation required to construct temporary sediment drying and / or disposal area adjacent to Kizell Cell. Direct and indirect impacts on endangered and threatened species and their habitats. 	<ul style="list-style-type: none"> Increase in stream temperature may negatively affect thermal regime within Kizell Drain and Watt's Creek and change fish community composition (e.g., decrease species richness, reduce occurrence of coolwater species). Increased erosion may result in changes in streamside cover and alteration of food sources. Reduction in water quality (i.e., increased nutrients, metals, BOD and reduced DO) may negatively impact benthic and fish community composition (i.e., benthic). 	<ul style="list-style-type: none"> Evaluation of mitigation measures to address potential thermal impacts. Identification of fish habitat restoration opportunities in event of potentially required habitat compensation. Evaluation of proposed wetland alterations against the characteristics and ecological functions for which the Kizell Wetland was identified by the MNR as provincially significant: <i>i.e.</i> biological, hydrological, socio-economic and special features Continuous hydrologic modeling to quantify changes in storm event water level and duration in the PSW.
	Shirley's Brook	<ul style="list-style-type: none"> Reduction or changes in the wetland habitat adjacent to Shirley's Brook in Trillium Woods, due to changing hydrology. 	<ul style="list-style-type: none"> Removal of vegetation required to construct major system outlet(s) to Shirley's Brook. Direct and indirect impacts on endangered and threatened species and their habitats. 	<ul style="list-style-type: none"> Decrease in contributions from base flow / frequent flows may reduce channel area (i.e., depth, width) and result in increased periods of intermittent or no flow. Decrease in groundwater recharge and base flow contributions may negatively impact thermal regime and change fish community composition (e.g., decrease species richness, reduce occurrence of coolwater species). Reduction in low flows may create new fish barriers or exacerbate existing low flow barriers. Reduction in bankfull flow may increase in-stream deposition (inability to move material) resulting in a loss of habitat and spawning areas. Reduction in moderate flood flows and disconnection from flood plain overbank areas (i.e., 2-year) in immediate downstream reaches may impact access to additional habitat areas and reduce food sources. 	<ul style="list-style-type: none"> In-stream barrier assessments to identify low-flow barriers as a result of changes in baseflow. Assessment of potential impacts to fish habitat form and function. Demonstration that ecological requirements to sustain Shirley's Brook fishery are maintained in post-development scenario. Identification of fish habitat restoration opportunities in event of potentially required habitat compensation.

TABLE F-4: POTENTIAL EFFECTS – NATURAL ENVIRONMENT

Alternative SWM Servicing Concept No. ¹	Sub-Watershed	Wetland Habitat ²	Terrestrial Habitat ²	Aquatic Habitat	Additional Studies / Analyses
2	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> Removal of vegetation required to construct storm sewer outlet(s), additional water quality storage requirements and sediment forebay(s) into Beaver Pond. Removal of vegetation required to construct pond outlet structure at GFR and berming at west end of Kizell Cell (major system). Reduction in water quality (i.e., increased in TSS, P, nutrients, metals, BOD, temp, decrease in DO, etc.) in Kizell Cell and Beaver Pond. Increase in permanent pool depth and open water area in Beaver Pond (dredging of PSW area anticipated). Increase in duration and fluctuation of frequent storm event water levels in Beaver Pond. Increased deposition of fine sediment within wetland vegetation in Beaver Pond. Secondary changes to vegetation communities and natural habitats resulting from hydrological changes and water quality changes. Secondary loss of diversity and resilience in the food web resulting from impacts of hydrological changes and water quality changes on biota (especially benthic macroinvertebrates). Direct and indirect impacts on endangered and threatened wetland species and their habitats (e.g. Blanding's turtle and Least Bittern). 	<ul style="list-style-type: none"> Removal of vegetation required to construct storm sewer outlet(s), additional water quality storage requirements, sediment forebay(s) and major system outlet(s) into Beaver Pond. Removal of vegetation required to construct SWM pond outlet structure at GFR, berming at west end of Kizell Cell and major system outlet(s) into Kizell Cell. Removal of vegetation required to construct temporary sediment drying and / or disposal area adjacent to Beaver Pond. Direct and indirect impacts on endangered and threatened species and their habitats. 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1.
	Shirley's Brook	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1.
3	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> Removal of vegetation required to construct storm sewer outlet(s), additional water quality storage requirements and sediment forebay(s) into Beaver Pond. Removal of vegetation required to construct pond outlet structure at GFR. Reduction in water quality (i.e., increased in TSS, nutrients, metals, BOD, temperature, decrease in DO, etc.) in Kizell Cell (minimal) and Beaver Pond. Increase in permanent pool depth and open water area in Beaver Pond (dredging of PSW area anticipated). Increase in duration and fluctuation of storm event water levels in Beaver Pond. Increased deposition of fine sediment within wetland vegetation in Beaver Pond (PSW portion). Secondary changes to vegetation communities and natural habitats resulting from hydrological changes and water quality changes. Secondary loss of diversity and resilience in the food web resulting from impacts of hydrological changes and water quality changes on biota (especially benthic macroinvertebrates). Direct and indirect impacts on endangered and threatened wetland species and their habitats (e.g. Blanding's turtle and Least Bittern). 	<ul style="list-style-type: none"> Removal of vegetation required to construct storm sewer outlet(s), additional water quality storage requirements, sediment forebay(s) and major system outlet(s) into Beaver Pond. Removal of vegetation required to construct SWM pond outlet structure at GFR and major system outlet(s) into Kizell Cell. Removal of vegetation required to construct temporary sediment drying and / or disposal area adjacent to Beaver Pond. Direct and indirect impacts on endangered and threatened species and their habitats. 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1.
	Shirley's Brook	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1.

TABLE F-4: POTENTIAL EFFECTS – NATURAL ENVIRONMENT

Alternative SWM Servicing Concept No. ¹	Sub-Watershed	Wetland Habitat ²	Terrestrial Habitat ²	Aquatic Habitat	Additional Studies / Analyses
4	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> Reduction in water quality (i.e., increased in TSS, nutrients, metals, BOD, temperature, decrease in DO, etc.) in Kizell Cell and Beaver Pond from urban runoff (very minimal). Secondary changes to vegetation communities and natural habitats resulting from water quality changes. Secondary loss of diversity and resilience in the food web resulting from impacts of hydrological changes and water quality changes on biota (especially benthic macroinvertebrates). Direct and indirect impacts on endangered and threatened wetland species and their habitats (e.g. Blanding's turtle and Least Bittern). 	<ul style="list-style-type: none"> Removal of vegetation required to construct storm sewer outlet(s) to Beaver Pond. Removal of vegetation required to construct major system outlet(s) to Kizell Cell and Beaver Pond. Direct and indirect impacts on endangered and threatened species and their habitats. 	<ul style="list-style-type: none"> Potential changes in flow characteristics, stream temperature and water quality as a result of increased urbanized runoff. 	<ul style="list-style-type: none"> Evaluation of proposed fish habitat alterations as a result of land use change, identification of potential impacts and mitigation/compensation measures.
	Shirley's Brook	<ul style="list-style-type: none"> Not applicable. 	<ul style="list-style-type: none"> Removal of vegetation required to construct major system outlet(s) and new SWM pond(s) to Shirley's Brook. Direct and indirect impacts on endangered and threatened species and their habitats. 	<ul style="list-style-type: none"> Potential changes in flow characteristics, stream temperature and water quality as a result of increased urbanized runoff. 	<ul style="list-style-type: none"> Evaluation of proposed fish habitat alterations as a result of land use change, identification of potential impacts and mitigation/compensation measures.

Notes:
 1. Refer to Figures F-1 to F-4 for alternative SWM servicing concepts.
 2. Input provided by the City of Ottawa.

TABLE F-5: POTENTIAL EFFECTS – ENGINEERING & COSTS

Alternative SWM Servicing Concept No. ¹	Sub-Watershed	Engineering Considerations	Cost Considerations	Additional Studies / Analyses
1	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> Standard construction techniques anticipated to modify Kizell Cell using berming (no dredging). Standard construction techniques anticipated to construct sediment forebay(s) and major system outlets into Kizell Cell and Beaver Pond. Grading / dredging of Beaver Pond to accommodate additional flood control storage volume may be difficult due to existing vegetation. Future removal of accumulated sediment in Kizell Cell and Beaver Pond will be difficult and could result in additional environmental impacts. Location required for temporary sediment drying and / or disposal area adjacent to Kizell Cell and Beaver Pond may result in additional environmental impacts. 	<ul style="list-style-type: none"> Moderate capital cost required to construct SWM pond outlet, berming, storm sewer inlet(s) and sediment forebay(s) and major system inlet(s) into Kizell Cell. Low to moderate capital cost required to construct storm sewer inlet(s) and sediment forebay(s), major system inlet(s), grading/dredging and modifications to the existing Beaver Pond outlet structure (if required). Moderate to high O&M costs expected in order to maintain Kizell Cell and Beaver Pond and remove accumulated sediments over long term. No additional cost associated with land requirements in order to construct SWM facilities. Moderate to high capital cost of implementing downstream erosion and flood mitigation works (i.e., Proponent will be required to demonstrate no increase in downstream flood risk. However, there may be opportunities to mitigate existing flood risks that could contribute to the ultimate SWM solution e.g., replacement of under-sized culverts). 	<ul style="list-style-type: none"> Detailed grading plans and supporting calculations for Kizell Cell and Beaver Pond in order to meet required water quality and flood control storage volumes. Preparation of detailed ESC and construction phasing plans to minimize impacts to the Kizell Cell and Beaver Pond during construction. Detailed O&M manual for Kizell Cell and Beaver Pond (updated) to include proposed methods, protection measures and contingencies during sediment clean out.
	Shirley's Brook	<ul style="list-style-type: none"> No significant SWM construction anticipated in Shirley's Brook. 	<ul style="list-style-type: none"> Low capital and O&M costs expected for Shirley's Brook. 	<ul style="list-style-type: none"> No additional studies or analyses required.
2	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> Standard construction techniques anticipated to modify SWM pond (major system storage) within Kizell Cell including berming and major system outlet(s) (no dredging). Standard construction techniques anticipated to construct storm sewer outlet(s), sediment forebay(s) and major system outlets into Beaver Pond. Excavation / dredging of Beaver Pond to accommodate additional permanent pool and flood control storage volume may be difficult if bedrock at shallow depth. Future removal of accumulated sediment in Beaver Pond will be difficult and could result in additional environmental impacts. Location required for temporary sediment drying and / or disposal area adjacent to Beaver Pond may result in additional environmental impacts. 	<ul style="list-style-type: none"> Low to moderate capital cost required to construct SWM pond outlet, berming, and major system inlet(s) into Kizell Cell. High capital cost to construct required to construct storm sewer inlet(s) and sediment forebay(s), major system inlet(s), excavation / dredging for additional storage volume and modifications to the existing Beaver Pond outlet structure (if required). Moderate to high O&M costs expected in order to maintain Kizell and Beaver Pond and remove accumulated sediments over long term. No additional cost associated with land requirements in order to construct SWM components. Moderate to high capital cost of implementing downstream erosion and flood protection works if required. 	<ul style="list-style-type: none"> Same as Alternative 1.
	Shirley's Brook	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1.
3	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> Same as Alternative 2 except: No significant SWM construction anticipated within Kizell Cell. 	<ul style="list-style-type: none"> Same as Alternative 2 except: Low capital cost required to construct major system inlet(s) into Kizell Cell. Moderate to high O&M costs expected in order to maintain Beaver Pond and remove accumulated sediments over long term. 	<ul style="list-style-type: none"> Same as Alternative 1.
	Shirley's Brook	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1. 	<ul style="list-style-type: none"> Same as Alternative 1.
4	Kizell Drain / Watt's Creek	<ul style="list-style-type: none"> No significant SWM construction anticipated within Kizell Cell. Standard construction techniques anticipated to construct sediment forebay(s) and major system outlets into Beaver Pond. Future removal of accumulated sediment in Beaver Pond will be difficult and could result in additional environmental impacts. Location required for temporary sediment drying and / or disposal area adjacent to Beaver Pond may result in additional environmental impacts. 	<ul style="list-style-type: none"> Same as Alternative 3 except: Low to moderate capital cost to construct required to construct storm sewer inlet(s), and sediment forebay(s), major system outlet(s) and modifications to the existing Beaver Pond outlet structure (if required). Moderate to high O&M costs expected in order to maintain Beaver Pond and remove accumulated sediments over long term. 	<ul style="list-style-type: none"> Same as Alternative 1.
	Shirley's Brook	<ul style="list-style-type: none"> Standard construction techniques anticipated to construct proposed SWM ponds required to service proposed development discharging to Shirley's Brook. 	<ul style="list-style-type: none"> High capital cost expected to construct new SWM pond(s) within Shirley's Brook. Moderate O&M costs expected in order to maintain new SWM pond(s) and remove accumulated sediments over long term. High capital cost associated with land requirements in order to construct SWM pond(s) as no SWM blocks are identified on Draft Plan of Subdivision. Moderate to high capital cost of implementing downstream erosion and flood protection works if required. 	<ul style="list-style-type: none"> Standard SWM pond design briefs, O&M requirements and ESC plans for construction will be required.

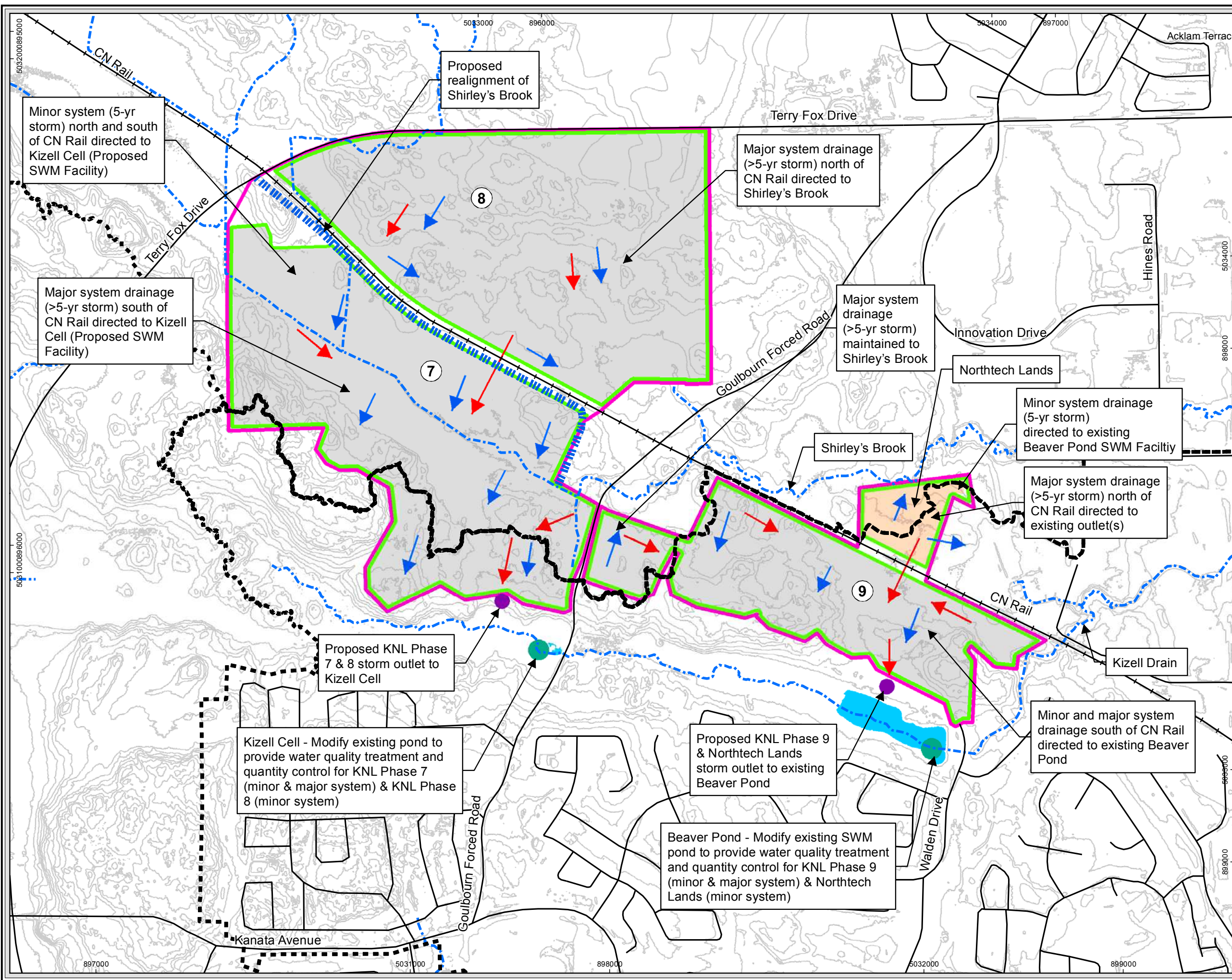
Notes:
1. Refer to Figures F-1 to F-4 for alternative SWM servicing concepts.

TABLE F-6: ENVIRONMENTAL APPROVALS & PERMITTING

Alternative SWM Servicing Concept No. ¹	Approval and Permitting Considerations
1	<ul style="list-style-type: none"> • MOE amendment to Certificate of Approval (C of A or ECA) to reflect proposed modifications to Kizell Cell and Beaver Pond • MOE Permit to Take Water per O. Reg. 387/04 for diversion of drainage area from Shirley's Brook into Kizell Drain • DFO Federal Fisheries Act (FFA) approval for impacts associated with construction of SWM pond within Kizell Cell (to be confirmed whether the Kizell Cell is fish habitat per the FFA) • DFO Federal Fisheries Act (FFA) approval for impacts associated with realignment of Shirley's Brook from Terry Fox Drive to GFR • City of Ottawa planning approvals for work within PSW • MNR permit approval under Section 17 2) c) of Endangered Species Act (ESA) for construction of SWM pond in Kizell Cell (Blanding's Turtle - SAR) and Beaver Pond (Least Bittern – SAR) • MVCA permit approval under O. Reg. 153/06 for grading and alteration within Kizell Cell and Beaver Pond (PSW) • MVCA permit approval under O. Reg. 153/06 for realignment of Shirley's Brook from Terry Fox Drive to GFR • <i>Drainage Act</i> process required to divert Shirley's Brook drainage area into the Kizell Drain and implement erosion protection works downstream (if required) • MNR to confirm whether or not proposed berming within Kizell cell and/or modifications to existing Beaver Pond outlet require approval (as dams) under the <i>Lakes and Rivers Improvement Act</i>
2	<ul style="list-style-type: none"> • Same as Alternative 1
3	<ul style="list-style-type: none"> • MOE amendment to Certificate of Approval (C of A or ECA) to reflect proposed modifications to Kizell Cell and Beaver Pond • MOE Permit to Take Water per O. Reg. 387/04 for diversion of drainage area from Shirley's Brook into Kizell Drain • DFO Federal Fisheries Act (FFA) approval for impacts associated with realignment of Shirley's Brook from Terry Fox Drive to GFR • City of Ottawa planning approvals for work within PSW (in Beaver Pond cell) • MNR permit approval under Section 17 2) c) of Endangered Species Act (ESA) for modifications to Beaver Pond (Least Bittern – SAR) • MVCA permit approval under O. Reg. 153/06 for grading and alteration within Beaver Pond (PSW) • MVCA permit approval under O. Reg. 153/06 for realignment of Shirley's Brook from Terry Fox Drive to GFR • <i>Drainage Act</i> process required to divert Shirley's Brook drainage area into the Kizell Drain and implement erosion protection works downstream (if required) • MNR to confirm whether or not modifications to existing Beaver Pond outlet require approval (as a dam) under the <i>Lakes and Rivers Improvement Act</i>
4	<ul style="list-style-type: none"> • MOE amendment to Certificate of Approval (C of A or ECA) to reflect proposed modifications to Kizell cell and Beaver Pond • City of Ottawa planning approvals for work within PSW (in Beaver Pond) • MVCA permit approval under O. Reg. 153/06 for grading and alteration within Beaver Pond (PSW) • MVCA permit approval under O. Reg. 153/06 for realignment of Shirley's Brook from Terry Fox Drive to GFR • MNR to confirm whether or not modifications to existing Beaver Pond outlet require approval (as dams) under the <i>Lakes and Rivers Improvement Act</i> • DFO Federal Fisheries Act (FFA) approval for impacts associated with realignment of Shirley's Brook from Terry Fox Drive to GFR • MOE ECA for new SWM ponds draining to Shirley's Brook • MNR permit approval under Section 17 2) c) of Endangered Species Act (ESA) for modifications to Beaver Pond (Least Bittern – SAR) – if required for Phase 9

Notes:
 1. Refer to Figures F-1 to F-4 for alternative SWM servicing concepts.

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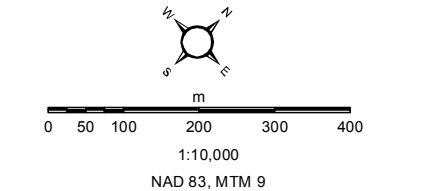


Legend

- Subwatershed Boundary
- Remaining KNL Development Phases 7, 8 & 9
- Northtech Lands
- Proposed Major System (Overland Flow) Catchment Area
- Proposed Minor System (Storm Sewer) Catchment Area
- Proposed Direction of Minor System Drainage
- Proposed Direction of Major System Drainage
- Proposed Storm Sewer Outfall
- Existing SWM Facility (no change)
- Modifications to Existing SWM Facility
- New SWM Facility
- Proposed Shirley's Brook Realignment
- Existing Watercourse
- Pond



Basemapping and orthophotography provided by the City of Ottawa.



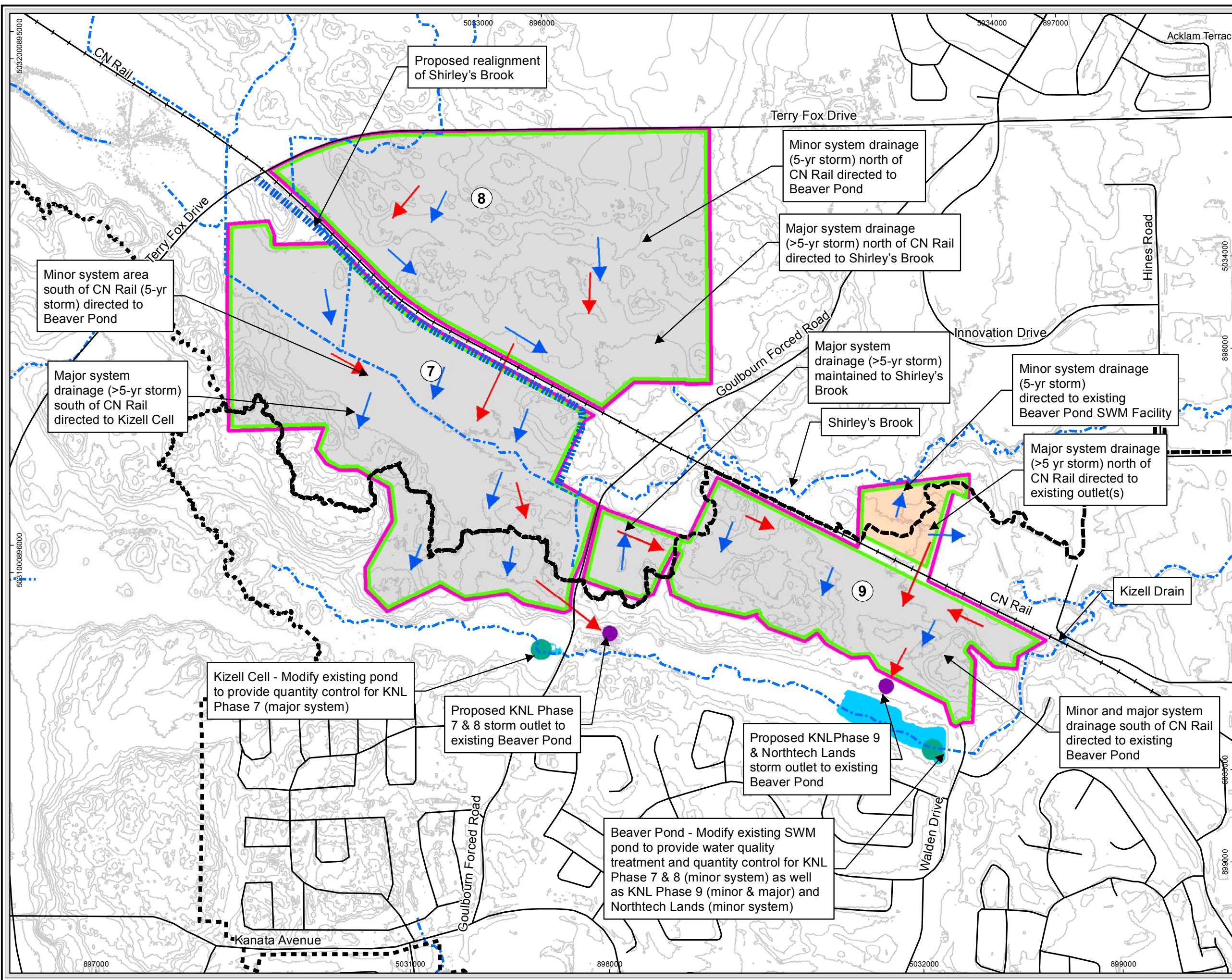
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**SWM Servicing Alternative 1
 Shirley's Brook & Watt's Creek
 Phase 2 SWM Study**

Diversion of Minor System Drainage for Phases 7 & 8 to Kizell Cell
 Diversion of Portion of Major System Drainage for Phase 7 to Kizell Cell.

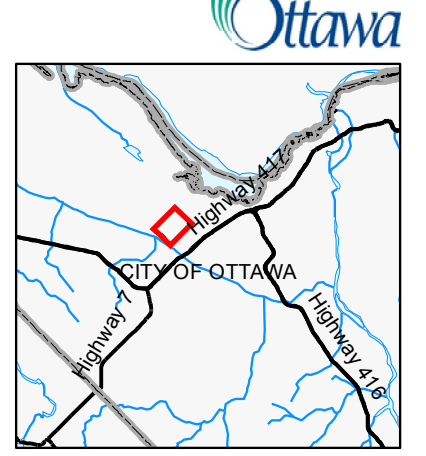
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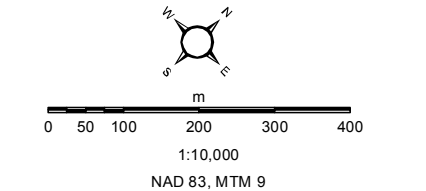


Legend

- Subwatershed Boundary
- Remaining KNL Development Phases 7, 8 & 9
- Northtech Lands
- Proposed Major System (Overland Flow) Catchment Area
- Proposed Minor System (Storm Sewer) Catchment Area
- Proposed Direction of Minor System Drainage
- Proposed Direction of Major System Drainage
- Proposed Storm Sewer Outfall
- Existing SWM Facility (no change)
- Modifications to Existing SWM Facility
- New SWM Facility
- Proposed Shirley's Brook Realignment
- Existing Watercourse
- Pond



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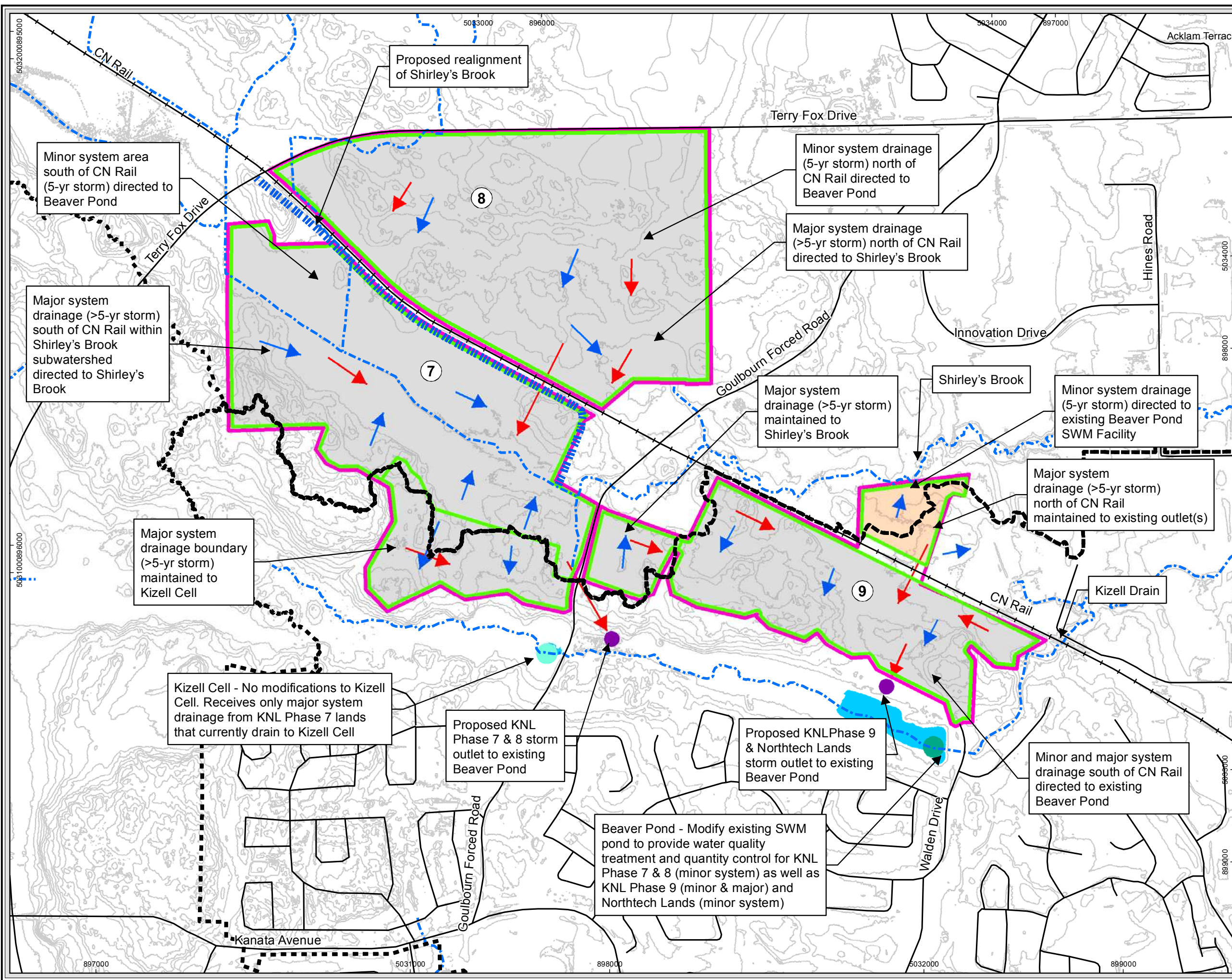
SWM Servicing Alternative 2 Shirley's Brook & Watt's Creek Phase 2 SWM Study

Division of Minor System Drainage for Phase 7 & 8 to Beaver Pond.
 Division of Portion of Major System Drainage for Phase 7 to Kizell Cell.

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Figure F-2

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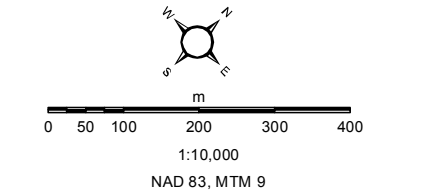


Legend

- Subwatershed Boundary
- Remaining KNL Development Phases 7, 8 & 9
- Northtech Lands
- Proposed Major System (Overland Flow) Catchment Area
- Proposed Minor System (Storm Sewer) Catchment Area
- Proposed Direction of Minor System Drainage
- Proposed Direction of Major System Drainage
- Proposed Storm Sewer Outfall
- Existing SWM Facility (no change)
- Modifications to Existing SWM Facility
- New SWM Facility
- Proposed Shirley's Brook Realignment
- Existing Watercourse
- Pond



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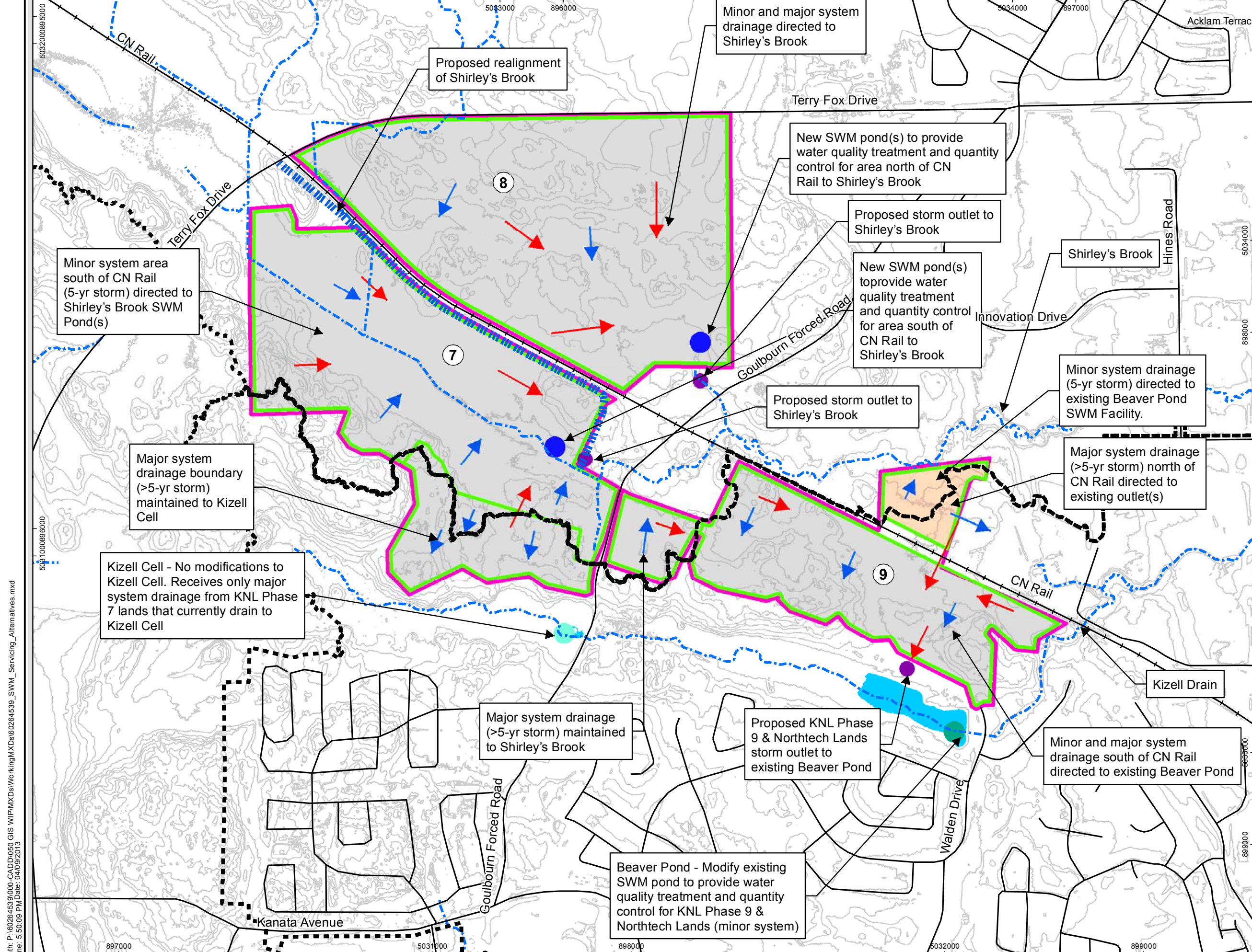


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**SWM Servicing Alternative 3
 Shirley's Brook & Watt's Creek
 Phase 2 SWM Study**

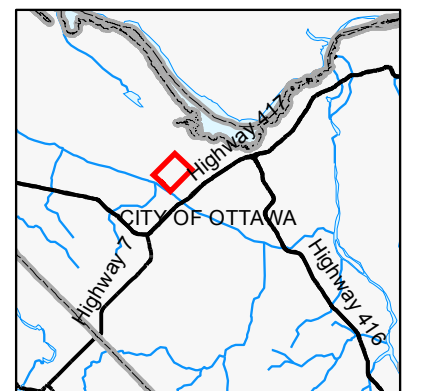
Diversion of Minor System Drainage for Phases 7 & 8 to Beaver Pond.
 Maintain existing Major System Drainage Boundaries

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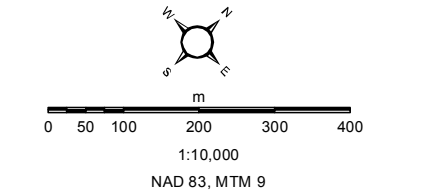


Legend

- Subwatershed Boundary
- Remaining KNL Development Phases 7, 8 & 9
- Northtech Lands
- Proposed Major System (Overland Flow) Catchment Area
- Proposed Minor System (Storm Sewer) Catchment Area
- Proposed Direction of Minor System Drainage
- Proposed Direction of Major System Drainage
- Proposed Storm Sewer Outfall
- Existing SWM Facility (no change)
- Modifications to Existing SWM Facility
- New SWM Facility
- Proposed Shirley's Brook Realignment
- Existing Watercourse
- Pond



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**SWM Servicing Alternative 4
Shirley's Brook & Watt's Creek
Phase 2 SWM Study**

Maintain Minor and Major Drainage
System Boundaries (No Diversion)

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Figure F-4