# Kennedy Road EA Study - Evaluation of Low Impact Development Options

| Criteria for Evaluating Alternatives | Indicators | Option 1: Box Trench Design | Option 2: Vegetated / Bio Swale Design | Option 3: Bioretention and Rain Garden Design<br>- provides partial infiltration | Option 4: Infiltration trenches and soak-aways | Option 5: Underground storage tanks |
|---|---|---|---|---|---|---|
| **A Natural Environment** | | | | | | |
| **1 Ecological benefit** | - provision of pollinator food resource and habitat.<br>- adaptation to variable temperature and moisture conditions.<br>- ability to reduce local air temperature.<br>- ability to improve local air quality.<br>- enhance urban biodiversity. | - planted with salt, water and pollution tolerant native flowering species.<br>- vegetation has ability to reduce local air temperature and improve local air quality in vicinity of LID.<br>- urban biodiversity is enhanced by species planted in LID. | - planted with salt, water and pollution tolerant native flowering species.<br>- vegetation has ability to reduce local air temperature and improve local air quality in vicinity of LID.<br>- urban biodiversity is enhanced by species planted in LID. | - planted with salt, water and pollution tolerant native flowering species.<br>- vegetation has ability to reduce local air temperature and improve local air quality in vicinity of LID.<br>- urban biodiversity is enhanced by species planted in LID. | - no planting opportunities.<br>- no reduction of local air temperatures and air quality.<br>- no enhancements to urban biodiversity. | - no planting opportunities.<br>- no reduction of local air temperatures and air quality.<br>- no enhancements to urban biodiversity. |
| ***Rating*** | | Most Preferred | Most Preferred | Most Preferred | Least Preferred | Least Preferred |
| **2 Soil Permeability** | - compatibility (partial or complete) with existing soil permeability conditions. | - reliant on insitu sub-soil condition for infiltration. | - reliant on insitu sub-soil condition for infiltration. | - reliant on insitu sub-soil condition for infiltration. | - reliant on insitu sub-soil condition for infiltration. | - no reliance on insitu sub-soil condition for infiltration. |
| ***Rating*** | | Somewhat Preferred | Somewhat Preferred | Somewhat Preferred | Somewhat Preferred | Most Preferred |

| Criteria for Evaluating Alternatives | Indicators | Option 1: Box Trench Design | Option 2: Vegetated / Bio Swale Design | Option 3: Bioretention and Rain Garden Design<br>- provides partial infiltration | Option 4: Infiltration trenches and soak-aways | Option 5: Underground storage tanks |
|---|---|---|---|---|---|---|
| **3 Impacts to groundwater** | - provides sufficient separation between infiltration surface (absorption media) and groundwater level.<br>- compatibility (partial or complete) with existing groundwater levels.<br>- ability to remove pollutants (e.g. salt, oil) from water runoff. | - feature extends from surface to below-ground resulting in moderate separation from groundwater level.<br>- vegetation plantings can provide nutrient uptake and filtering of pollutants from runoff.<br>- capacity to reduce volume of events up to the 25 mm storm, which cumulatively are responsible for majority of annual pollutant load.<br>- this LID can be used in combination with an adjacent Silva Cell system (for tree planting separate from the LID) to increase contaminant reduction through filtering particulate, biotic activity, and tree uptake. | - feature extends from surface to below-ground resulting in moderate separation from groundwater level.<br>- vegetation plantings can provide nutrient uptake and filtering of pollutants from runoff.<br>- capacity to reduce volume of events up to the 25 mm storm, which cumulatively are responsible for majority of annual pollutant load.<br>- this LID can be used in combination with an adjacent Silva Cell system (for tree planting separate from the LID) to increase contaminant reduction through filtering particulate, biotic activity, and tree uptake.<br>- media is thinner than in Option 1 and Option 3 and as such has less potential to capture contaminants. | - feature extends from surface to below-ground resulting in moderate separation from groundwater level.<br>- vegetation plantings can provide nutrient uptake and filtering of pollutants from runoff.<br>- capacity to reduce volume of events up to the 25 mm storm, which cumulatively are responsible for majority of annual pollutant load.<br>- this LID can be used in combination with an adjacent Silva Cell system (for tree planting separate from the LID) to increase contaminant reduction through filtering particulate, biotic activity, and tree uptake. | - top of features is below the surface, and extends further below-ground resulting in less separation from groundwater level.<br>- no planting opportunities to provide nutrient uptake and filtering of pollutants from runoff.<br>- this LID can be used in combination with an adjacent Silva Cell system (for tree planting separate from the LID) to increase contaminant reduction through filtering particulate, biotic activity, and tree uptake. | - deepest feature resulting in least separation from groundwater level.<br>- no planting opportunities, however quality control isolator row can be incorporated into the storage design to remove pollutants.<br>- capacity to reduce volume of events up to the 25 mm storm, which cumulatively are responsible for majority of annual pollutant load.<br>- this LID can be used in combination with an adjacent Silva Cell system (for tree planting separate from the LID) to increase contaminant reduction through filtering particulate, biotic activity, and tree uptake. |
| ***Rating*** | | Most Preferred | More Preferred | Most Preferred | Less Preferred | Somewhat Preferred |
| **Summary Natural Environment** | | **More Preferred** | **More Preferred** | **More Preferred** | **Less Preferred** | **Somewhat Preferred** |

| Criteria for Evaluating Alternatives | Indicators | Option 1: Box Trench Design | Option 2: Vegetated / Bio Swale Design | Option 3: Bioretention and Rain Garden Design<br>- provides partial infiltration | Option 4: Infiltration trenches and soak-aways | Option 5: Underground storage tanks |
|---|---|---|---|---|---|---|
| **B Socio-Cultural Environment** | | | | | | |
| **1 Aesthetics** | - potential to enhance aesthetics of road corridor.<br>- provision of year-round seasonal interest. | - a well defined space with flowering plants to enhance the streetscape aesthetics with a mix of perennial and woody species.<br>- provides three-season plantings that enhance seasonal interest in area. | - a less defined space with flowering plants to enhance the streetscape aesthetics with perennial species.<br>- provides three-season plantings that enhance seasonal interest in area. | - a less defined space with flowering plants to enhance the streetscape aesthetics with perennial and woody species.<br>- provides three-season plantings that enhance seasonal interest in area. | - Minimal opportunity to enhance aesthetics of road corridor as LID is only marginally visible and has no planting opportunities.<br>- does not provide seasonal interest. | - No opportunity to enhance aesthetics of the road corridor as LID is not visible.<br>- does not provide seasonal interest. |
| ***Rating*** | | Most Preferred | More Preferred | More Preferred | Less Preferred | Least Preferred |
| **2 Education Opportunities** | - potential to educate public about stormwater management. | - good opportunities to educate public on function and benefits of LID to support stormwater management as LID is very visible and there is adequate space for educational information boards onsite. | - good opportunities to educate public on function and benefits of LID to support stormwater management as LID is very visible; although space for educational information boards onsite is more limited than other options. | - good opportunities to educate public on function and benefits of LID to support stormwater management as LID is very visible and there is adequate space for educational information boards onsite. | - -marginal visibility of LID limits educational opportunities. | - no educational opportunities. |
| ***Rating*** | | Most Preferred | More Preferred | Most Preferred | Less Preferred | Least Preferred |
| **Summary Socio-Cultural Environment** | | **Most Preferred** | **More Preferred** | **Most Preferred** | **Less Preferred** | **Least Preferred** |

| Criteria for Evaluating Alternatives | Indicators | Option 1: Box Trench Design | Option 2: Vegetated / Bio Swale Design | Option 3: Bioretention and Rain Garden Design<br>- provides partial infiltration | Option 4: Infiltration trenches and soak-aways | Option 5: Underground storage tanks |
|---|---|---|---|---|---|---|
| **C Technical Factors** | | | | | | |
| **1 Quality control** | - ability to meet quality control criteria.<br>- ability to contribute to quality control along with other treatment train options. | - planted vegetation media offers pretreatment filtration of undissolved solids. Primary filtration by engineered soil and absorption media.<br>- runoff enters via street storm sewer, which could easily allow for upstream treatment features such as oil/grit separators, catch basin inserts, etc. | - planted vegetation media offers pretreatment filtration of undissolved solids. Primary filtration by engineered soil and absorption media.<br>- runoff enters via overland flow/curb cuts, which does not easily allow for upstream treatment features. | - planted vegetation media offers pretreatment filtration of undissolved solids. Primary filtration by engineered soil and absorption media.<br>- runoff enters via overland flow/curb cuts, which does not easily allow for upstream treatment features. | - grass/sod surface offers pretreatment filtration before infiltrating engineered trenches and soak-aways.<br>- runoff can enter or discharge via street storm sewer, which could easily allow for upstream or downstream treatment features such as oil/grit separators, catch basin inserts, etc. | - quality control can be incorporated into the storage design, less effective than filtration.<br>- runoff can enter or discharge via street storm sewer, which could easily allow for upstream or downstream treatment features such as oil/grit separators, catch basin inserts, etc. |
| ***Rating*** | | Most Preferred | More Preferred | More Preferred | More Preferred | Somewhat Preferred |
| **2 Quantity control** | - ability to control peak flows. | - gravel storage layer provides some storage volume.<br>- discharges only through infiltration, not suitable for control of higher peak flows. | - gravel storage layer provides some storage volume.<br>- discharges only through infiltration, not suitable for control of higher peak flows. | - gravel storage layer provides some storage volume.<br>- discharges only through infiltration, not suitable for control of higher peak flows. | - stone void area provides moderate storage volume.<br>- can discharge to street storm sewer, suitable for control of higher peak flows. | - large void space provides most storage volume.<br>- can discharge to street storm sewer, suitable for control of higher peak flows. |
| ***Rating*** | | Somewhat Preferred | Somewhat Preferred | Somewhat Preferred | More Preferred | Most Preferred |
| **3 Erosion control** | - volumetric retention capacity. | - gravel storage layer provides some storage volume. | - gravel storage layer provides some storage volume. | - gravel storage layer provides some storage volume. | - stone void area provides moderate storage volume. | - large void space provides most storage volume. |
| ***Rating*** | | Somewhat Preferred | Somewhat Preferred | Somewhat Preferred | More Preferred | Most Preferred |
| **4 Maintenance requirements** | - ease and frequency of maintenance. | - a well defined footprint will improve lifecycle and performance maintenance. Vegetation and filter media add to maintenance frequency and duration. | - less defined footprint and may hinder maintenance of adjacent grass and/or planting. Vegetation and filter media add to maintenance frequency and duration. | - less defined footprint and may hinder maintenance of adjacent grass and/or planting. Vegetation and filter media add to maintenance frequency and duration. | - less defined footprint and may hinder maintenance of adjacent grass and/or planting. Lack of vegetation and filter media reduce maintenance frequency and duration. | - a well defined footprint to facilitate lifecycle and performance maintenance; however, excavations for extensive repair may impact adjacent spaces. |
| ***Rating*** | | More Preferred | Somewhat Preferred | Somewhat Preferred | Somewhat Preferred | Less Preferred |

| Criteria for Evaluating Alternatives | Indicators | Option 1: Box Trench Design | Option 2: Vegetated / Bio Swale Design | Option 3: Bioretention and Rain Garden Design<br>- provides partial infiltration | Option 4: Infiltration trenches and soak-aways | Option 5: Underground storage tanks |
|---|---|---|---|---|---|---|
| **5 Surface footprint** | - size of surface footprint.<br>- ability to accommodate surface footprint. | - surface footprint is lower relative to Option 2 and 3 due to well defined box trench.<br>- linear, narrow footprint can be easily accommodated in boulevard. | - requires highest surface area relative to other options.<br>- linear, but wider footprint not easily accommodated in boulevard. | - surface footprint is lower relative to Option 2, but somewhat higher than Option 1 since overall footprint of LID is less defined than Option 1.<br>- linear footprint, wider than Option 1, narrower than Option 2. Footprint can be accommodated in boulevard. | - minimal surface footprint required compared to other options.<br>- linear, narrow footprint can be easily accommodated in boulevard. | - minimal surface footprint impacts. |
| ***Rating*** | | More Preferred | Less Preferred | Somewhat Preferred | Most Preferred | Most Preferred |
| **Summary Technical Factors** | | **More Preferred** | **Somewhat Preferred** | **Somewhat Preferred** | **More Preferred** | **More Preferred** |

| Criteria for Evaluating Alternatives | Indicators | Option 1: Box Trench Design | Option 2: Vegetated / Bio Swale Design | Option 3: Bioretention and Rain Garden Design<br>- provides partial infiltration | Option 4: Infiltration trenches and soak-aways | Option 5: Underground storage tanks |
|---|---|---|---|---|---|---|
| **D Financial Factors** | | | | | | |
| **1 Estimated capital costs** | - Relative cost of the materials for LID construction. | $ 25,000.00 per 100m.sq. Drainage Area | $ 11,000.00 per 100m.sq. Drainage Area | $ 23,000.00 per 100m.sq. Drainage Area | $ 24,000.00 per 100m.sq. Drainage Area | $ 14,000.00 per 100m.sq. Drainage Area |
| ***Rating*** | | Somewhat Preferred | Most Preferred | Somewhat Preferred | Somewhat Preferred | More Preferred |
| **2 Estimated maintenance costs** | - Relative costs associated with typical maintenance of the LIDs (includes monitoring, inspection, material and parts replacement). | Average Annual Maintenance Cost:<br>50 Years Evaluation Period:<br>$140.00 per 100m.sq. Drainage Area | Average Annual Maintenance Cost:<br>50 Years Evaluation Period:<br>$90.00 per 100m.sq. Drainage Area | Average Annual Maintenance Cost:<br>50 Years Evaluation Period:<br>$140.00 per 100m.sq. Drainage Area | Average Annual Maintenance Cost:<br>50 Years Evaluation Period:<br>$1,600.00 per 100m.sq. Drainage Area | Average Annual Maintenance Cost:<br>50 Years Evaluation Period:<br>$33.00 per 100m.sq. Drainage Area |
| ***Rating*** | | Somewhat Preferred | More Preferred | Somewhat Preferred | Less Preferred | Most Preferred |
| **3 Life-cycle costs and savings** | - Relative comparison of life-cycle costs and savings of each option. | Present Value Life Cycle Cost for<br>50 Years Evaluation Period:<br>$27,000.00 per 100m.sq. Drainage Area | Present Value Life Cycle Cost for<br>50 Years Evaluation Period:<br>$14,000.00 per 100m.sq. Drainage Area | Present Value Life Cycle Cost for<br>50 Years Evaluation Period:<br>$27,000.00 per 100m.sq. Drainage Area | Present Value Life Cycle Cost for<br>50 Years Evaluation Period:<br>$75,000.00 per 100m.sq. Drainage Area | Present Value Life Cycle Cost for<br>50 Years Evaluation Period:<br>$14,000.00 per 100m.sq. Drainage Area |
| ***Rating*** | | More Preferred | Most Preferred | More Preferred | Less Preferred | Most Preferred |
| **Summary Financial Factors** | | **Somewhat Preferred** | **Most Preferred** | **Somewhat Preferred** | **Less Preferred** | **Most Preferred** |

| Criteria for Evaluating Alternatives | Option 1: Box Trench Design | Option 2: Vegetated / Bio Swale Design | Option 3: Bioretention and Rain Garden Design | Option 4: Infiltration trenches and soak-aways | Option 5: Underground storage tanks |
| --- | --- | --- | --- | --- | --- |
| **Overall Summary** | **Most Preferred** | **Most Preferred** | **More Preferred** | **Least Preferred** | **Somewhat Preferred** |
| **RECOMMENDATION** | **Option 1: Box Trench Design will be carried forward as the preferred LID concept for Warden Avenue.** Although ranked the same as Option 2 overall, Option 1 is preferred over Option 2 as it can achieve a greater degree of pollutant removal, which will reduce impacts to groundwater. In areas with higher groundwater table, Option 2 will be considered as a viable preferred LID concept to Option 1. | Although ranked the same as Option 1 overall, Option 2 cannot achieve the same degree of pollutant removal as Option 1. However, since Option 2 does not require the same design depth as Option 1. **Option 2 will be considered as a viable preferred LID concept for areas with higher groundwater table**. | | | |