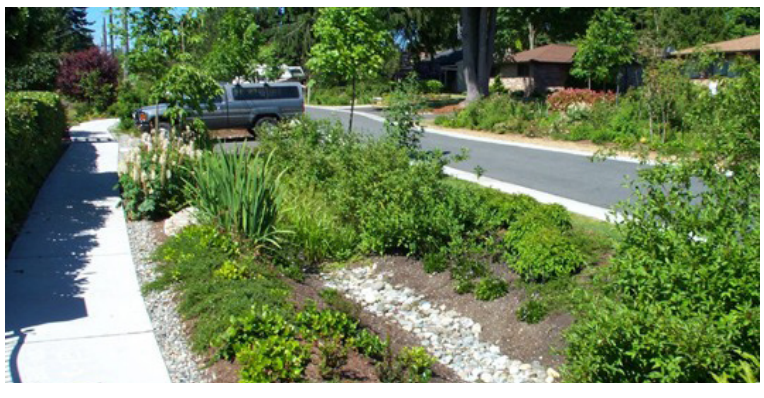
Low Impact Development (LID) Feasibility Study

Analysis of opportunities and constraints to incorporate LID elements into Capital Improvement Program (CIP) projects in Kirkland, Washington



Prepared for the City of Kirkland
by SvR Design Company
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CITY OF KIRKLAND
WASHINGTON

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Kirkland Low Impact Development (LID) Feasibility Study Report

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Project Summary

City of Kirkland staff and SvR Design Company reviewed the upcoming Transportation Projects in the Capital Improvement Program (CIP) for opportunities to incorporate Low Impact Development elements into each project. For example, if a project description included street widening or installation of a sidewalk, SvR evaluated the opportunity to include porous pavements or bioretention swales within the right-of-way. The review of the projects not only considered the transportation elements listed in the CIP transporation project descriptions but also the stormwater benefit, pedestrian and other non-motorized users, and the information and demonstration potential of the recommended elements.

City of Kirkland staff selected the following CIP transportation projects for review:

- 116th Avenue NE sidewalk, bicycle lanes, and equestrian trail (CIP Project #: NM 0001 000)
- NE 100th Street at Spinney Homestead Park sidewalk (CIP Project #: NM 0034 000)
- 116th Avenue NE (Highlands)sidewalk: (CIP Project #: NM 0044 000)
- 13th Avenue sidewalk (CIP Project #: NM 0054 000)
- 122nd Avenue NE sidewalk (CIP Project#: NM 0055 000)
- 6th Street sidewalk (CIP Project #: NM 0059 000)
- 99th Place NE/100th Avenue NE sidewalk (CIP Project #: NM 0060 000)
- Park Lane pedestrian corridor enhancements (CIP Project #: NM 0064 000)
- Central Way pedestrian enhancements (CIP Project #: NM 0065 000)
- 120th Avenue NE roadway improvements (CIP Project #: ST 0063 000)

What is Low Impact Development?

Low Impact Development (LID) is an approach to stormwater management that integrates conservation of natural site features with small scale engineered landscape elements. These elements are designed to emulate natural hydrological and ecological processes to reduce water flows and improve water quality. Small LID elements can be distributed over residential, commercial, and/or industrial sites in order to further reduce peak water flows and provide water quality treatment (Puget Sound Action Team [PSAT], Washington State University [WSU], 2005).

Through incorporation of low impact development strategies, we attempt to mimic the natural ecosystem in the City of Kirkland by promoting natural vegetative processes including evaporation, transpiration, and infiltration of stormwater. By treating these elements *in situ,* the City of Kirkland has the potential to recreate the functional storage of and treatment that is supplied by native vegetation or historic forested conditions, while promoting a vibrant economy, creating healthy and aesthetically pleasing spaces for its residents, and protecting the ecology of the Lake Washington basin.

Bioretention system during large storm event at High Point Redevelopment, Seattle

Why is LID important?

Over the last 25 years, Western Washington has seen rapid development within urban areas. As more trees and native vegetation areas are replaced with roadways, shopping centers, and housing developments to support the growth, new impervious surfaces increase the stormwater runoff and pollutants into nearby water bodies. For example, during a storm event in a developed area, water levels may rise rapidly due to a reduced amount of pervious surfaces, changes to soil structure and lack of vegetation which results in a surge of stormwater conveyed via conventional pipe systems to discharge points in streams and lakes. In such storms, pollutants such as phosphorous, nitrogen, bacteria, heavy metals, hydrocarbons (i.e. oil and grease) are transported to aquatic ecosystems and can have impacts on plant, animal, and human health and activities (PSAT, WSU, 2005).

The LID approach emphasizes a distributed, "top-of-the-pipe" strategy to stormwater management by reducing water flow and providing treatment closer to the source of stormwater runoff. Conventional stormwater management tools utilize hard-surfaced, often subterranean structures to collect and rapidly convey stormwater from residential and commercial development to central control ponds for treatment and detention and/or direct discharge points in streams and lakes, often resulting in severe erosion and the transfer of pollutants to these discharge locations (PSAT, WSU, 2005).

Introduction

Why incorporate LID in Capital Improvement Program (CIP) projects?

An LID approach to capital improvement programs works to control the volume of stormwater by integrating site planning and stormwater management from the beginning of the design process of a project to preserve a more hydrologically functional landscape (PSAT, WSU, 2005). Through an understanding of the fundamental functions of low impact development, a variety of strategies can be deployed at a small scale and often with modest project costs. For municipal CIP projects, this approach to building and infrastructure development will rely on solutions that protect and restore native soil and vegetation, which creates an overall cityscape that is more beautiful, environmentally sustainable, and healthy than using other conventional approaches. The City of Kirkland Natural Resource Management Plan and the Kirkland City Council Philosophy of Environmental Stewardship support LID in City of Kirkland projects.

The City of Kirkland is not alone in its work to investigate the potential to include LID in its CIP projects. For example, the Department of Planning and Development in the City of Seattle is currently working on a "Sustainable Infrastructure Initiative" that supports cross-departmental collaboration to incorporate a number of strategies to promote sustainability in its CIP projects, ranging from the inclusion of LID within public right-of-ways to water "swapping" to the reduction of carbon emissions in its ports (Presentation, Steve Moddemeyer, 7/12/2007). Seattle's Sustainable Infrastructure Initiative builds on the prior enactment of the "Green Factor" point-based system in which developers can choose a variety of options to meet City of Seattle landscaping requirements. Bonus points are provided for landscape proposals that include rain water harvesting, low-water use plants, larger trees, tree preservation, green roofs and green walls (City of Seattle, 2007). Prior to the "Green Factor" ordinance, SvR Design Company provided consultation to the City of Seattle in publishing a "Client Assistance Memo" regarding Green Parking Lot design that utilizes permeable pavement and natural drainage systems (City of Seattle, 2005).


Department of Planning and Development
CAM 515
Seattle Permits
Green Parking Lots
WHO SHOULD CONSIDER GREEN PARKING LOTS?
WHAT ARE GREEN PARKING LOTS?
Natural Drainage Landscapes
Permeable Paving
HOW DO GREEN PARKING LOTS MEET REQUIREMENTS?
City of Seattle
Department of Planning & Development

Case Studies of street projects in Seattle that included LID systems versus conventional systems suggest that an LID approach to stormwater management can not only provide reductions in stormwater volumes as well as improvements in water quality, but also decrease project costs. Table 1 provides a cost comparison of street projects with LID and conventional systems.

Table 1 Cost comparisons for LID natural drainage systems (NDS, i.e. a series of LID elements) and conventional drainage designs

Street Type	Local Street with Bioretention Swales (SEA Project) (LID)	Local Street (conventional)	Collector Street with a series of stair-stepping Bioretention Swales (Cascade Project) (LID)	Collector Street (conventional)	Broadview Green Grid (incorporates SEA & Cascade type designs) (LID)
Objectives & Measures					
Transportation & aesthetics	• 1 sidewalk per block • New street paving • Traffic calming • Enhanced landscaping	• 2 sidewalks per block • New street paving • No traffic calming • Conventional landscaping	• No street improvement • Enhanced landscaping	• No street Improvement • Conventional landscaping	• 1 sidewalk per block • New paving • Enhanced landscaping
Stormwater management	• Higher protection for aquatic biota • More closely mimics natural hydrology • Bio-remediate pollutants	• Flood protection focus • Water quality treatment	• Improved water quality treatment • Some flood protection	• Flood protection focus • Water quality treatment	• Higher water quality and aquatic biota protection • Some flood protection
% impervious cover	35%	35%	35%	35%	35%
Cost per block (330 linear feet)	$325,000	$425,000	$285,000	$520,400	$280,000

Based on case studies of the Seattle Public Utilities' Street Edge Alternatives (SEA) Street project on 2nd Ave. NW and 110th Cacade Project in Seattle, Washington.
*2000-2003 dollars
Source: Adapted from Cost Analysis of Natural vs. Traditional Drainage Systems Meeting NDS Stormwater Goals (2004) in (PSAT, WSU, 2005, p.89).

Washington's neighbors to the south are also finding ways to pair LID with CIP projects. The San Francisco Public Utilities Commission (SFPUC) expects to craft an evaluation process to review capital improvement projects for flood mitigation to determine the feasibility of LID approaches as part of its 5-year CIP program (SFPUC, 2007). Portland, Oregon has taken an even more comprehensive approach to LID by adopting a "Green Streets Policy" in April, 2007 that " directs City Bureaus and agencies to cooperatively plan and implement Green Streets as an integral part of the City's maintenance, installation, and improvement programs for its infrastructure located in the public right of way, and to integrate the Green Street Policy into the City's Comprehensive Plan, Transportation System Plan, and Citywide Systems Plan" (City of Portland, Auditor's Office, 2007) In passing this resolution, the Portland City Council recognized that "60 to 70 % of Portland stormwater is attributable to paved streets and runoff directed from private property and concentrated in the public right of way" and streets with LID elements are "an effective way to help manage stormwater volume and water quality". Portland's Green Streets Policy emphasizes the need for "identifying and evaluating opportunities to partner" to coordinate land use planning and capital improvement projects as well as to encourage cross-bureau collaboration in planning (City of Portland, Auditor's Office, 2007).

In addition to the inclusion of LID in CIP projects, a number of cities in Washington, including Kirkland, have adopted ordinances and/or revised their comprehensive plans to promote and/or require LID in private development (City of Kirkland, 2007, see Appendix A) (PSAT, 2000). For example, the City of Issaquah revised its municipal code to allow "deviations from stormwater design standards to achieve 'low impervious surface development.'" Issaquah's municipal code also provides up to a 50 percent reduction in stormwater utility fees for a project that infiltrates 100 percent of its stormwater. Employing more of an encouragement approach, the cities of Lacey and Tumwater have adopted ordinances which promote voluntary preservation of 60-65 percent of natural habitat or forested areas in developments. In order to achieve goals of "zero effect drainage," the City of Lacey will "grant administrative variances from traditional standards to achieve the ordinance's goal," including "constructing narrower roads without curb and gutter" and "using pervious paving systems." Island County adopted a stormwater ordinance that permits developers to include LID in their projects using design standards based on *Low Impact Development Design Strategies—An Integrated Design Approach,* Prince Georges County, Maryland, 2000. While the City of Issaquah offers incentives for LID and Lacey and Tumwater encourage the voluntary inclusion of LID in projects, the City of Olympia *requires* LID in projects within a specific drainage basin. Some of Olympia's LID regulations include tree protection and replacement requirements, impervious surface limits, minimum tree density requirements, allowances for increased sidewalk planter widths (up to 25'), and matching post-development stormwater discharge rates to pre-development discharge rates (PSAT, 2000).

The examples of LID incorporated both in CIP and in private development projects suggest that this approach to stormwater management is gaining greater acceptance and implementation. The next section provides more detail about a number of specific elements that comprise LID.

LID in commercial areas

Vine Street, Seattle (before)

Vine Street, Seattle • Cistern Steps (after)

Vine Street, Seattle • Cistern Steps (after)

LID in residential areas

Highpoint, Seattle (before)

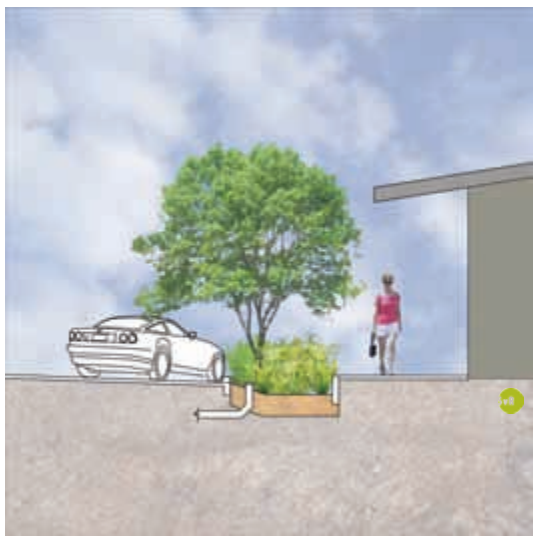
Highpoint Redevelopment (Bioretention swales & porous pavement) (after)

Highpoint Redevelopment (Bioretention swales) (after)

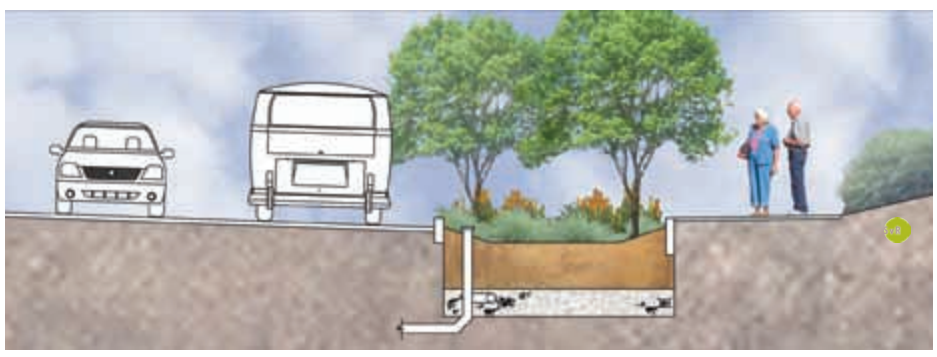
Bioretention and Bioinfiltration Facilities

Bioretention and bioinfiltration facilities commonly include swales, rain gardens, and planters. These facilities are vegetated conveyance or retention depressions that use soils and plants to improve water quality, reduce the runoff volume, and attenuate the peak runoff rate.

Bioretention and bioinfiltration swales perform similar functions as traditional grassed swales by serving as a conveyance structure and filtering and infiltrating runoff. However, the use of amended soils with bioretention media increases infiltration, water retention, nutrient and pollutant removal. (LID Center, Inc. 2005) In places within the Puget Sound basin where compacted, non-infiltrative native soils are often a problem, permeable materials such as gravel can be used to increase the retention capacity of the channel. Bioinfiltration swales work because they encourage infiltration into the existing landscape while also allowing the physical and chemical properties of the plants and soils to remove pollutants from the water that flows slowly, through them.



Bioretention Swale



Rain garden

Rain gardens are depressions with amended soils and plants to soak up and retain water, and they typically have overflow control. Rain gardens provide water quality treatment and attenuate flows by filtering stormwater through both soil and vegetation and then allowing that water to infiltrate into the underlying subsoil. Properly constructed rain gardens attempt to replicate the ecosystem of an upland forest floor through the use of specific shrubs, trees, groundcover, mulch, and soils. By intercepting, detaining, and infiltrating runoff, rain gardens reduce the energy of stormwater flows and reduce on-site erosion (Low Impact Development Center [LID], Inc. 2005).

Stormwater planter boxes are similar to rain gardens but usually are contained by small concrete walls along their perimeter with an open or closed bottom. Planter boxes have a more defined shape than rain gardens and are suitable for more confined urban settings. In general, planter boxes have minimal side slope, but function and are designed in a similar way to rain gardens. Planters typically have about one foot of ponding depth over three to five feet of amended soils, drought tolerant plants, and mulch. Stormwater planters can also be designed to overflow into the conveyance system. Stormwater planter boxes can be designed to meet regulatory requirements water quality treatment. Depending on the infiltration characteristics of native soils, stormwater planter boxes can also attenuate peak stormwater flows.

Stormwater Planter Box

A tree box filter is similar to a stormwater planter box, but includes a street tree or shrub. Tree box filters are primarily designed to provide water quality treatment. Tree box filters function via a curb inlet that allows stormwater to enter, filter through amended soils, and then exits through an underdrain into the storm drain or infiltrates into the subsurface soils (LID Center, Inc., 2005).

Tree Box/Tree Pit Filter

Sizes for tree box filter range from four-foot-by-six-foot to ten-foot-by-twelve-foot and are sized to capture 91-percent total annual volume of rainfall. Tree box filters are designed to capture and filter stormwater from micro drainage areas, but many tree box filters can be distributed across a large drainage basin to effectively treat large volumes of stormwater. Detention or infiltration can be added below the tree box filters to meet flow control requirements.

Stormwater Flow Control and Attenuation

Bioretention swales, raingardens, and stormwater planters can reduce stormwater peak flows and volumes that enter a conventional conveyance system via subsurface storage in soil and gravel layers, absorption of stormwater by surrounding soils and/or the infiltration into subsoil (the layer below the topsoil). The possible reduction of stormwater volume is dependent on the available detention storage in the gravel layer and ponding area, the maximum flow rate into the subsoil, and the flow rate into the facility (related to storm intensity and drainage area) (LID Center, Inc., 2005). The cross-section of a bioretention swale can be sized to provide conveyance for any given storm, as required, though the more flat area there is at the bottom of a swale, the more pollutants are removed.

Water Quality Treatment

Studies suggest that LID strategies that include bioretention systems, which use plants to remove pollutants, can provide significant pollutant reductions for phosphorous, nitrogen, heavy metals, and hydrocarbons (i.e. oil and grease) as well as reduce stormwater volumes as outlined (PSAT, WSU, 2005, pps.85-88). Bioretention systems are effective in pollutant removal and flow reduction through processes of:

- Sedimentation—slowing water to allow settling of non-soluble particulates
- Filtration—straining of non-soluble particulates
- Adsorption—the binding of nutrients, metal, and organics to filter media particles
- Infiltration—downward movement of surface water to interstitial soil water which initiates adsorption
- Phytoremediation—extraction and absorption of metals, petroleum hydrocarbons, pesticides, chlorinated solvents, and surfactants (studies illustrate that vegetated soils are more effective at pollutant removal than non-vegetated soils).
- Plant resistance—plant materials reduce flow velocities
- Thermal attenuation—reduces water temperatures as storm flows move through subsurface soil layers, which is important for salmonid habitat

  (PSAT, WSU, 2005, excerpts from pps. 85-86)

Table 2 provides a comparison of pollutant removal efficiency in conventional stormwater management systems versus LID approaches.

Table 2 Comparative pollutant removal capability of stormwater treatment practices (in percentages).

Stormwater Management System	Dry Extended Detention Pond (Conventional)	Wetlands (LID)	Water Quality Swales (LID)	Ditches (Conventional)
Pollutant				
TN (mg/L)	31	30	84	-9
NO3 (mg/L)	No data available (ND)	ND	ND	ND
P (mg/L)	20	49	34	-16
Cu (µg/L)	26	40	51	14
Pb (µg/L)	54	68	67	17
Zn (µg/L)	26	44	71	0

Source: Adapted from CWP, 2000b (removal percentages are for total metals) in (PSAT, WSU, 2005, p.87)
Note: The negative numbers for Total Nitrogen (TN) and Phosphorous (P) in the Ditches column of Table 2 are possibly due to biological processes occurring in the ditch. These processes may actually be contributing to a net increase of TN and P rather than the decrease seen in the other LID elements described in the table.

Bioretention swales, raingardens, and stormwater planters that capture a stormwater volume equal to 0.5" of runoff from an impervious area (or the water quality volume) have a 50 percent phosphorous removal efficiency. This phosphorous removal efficiency increases to 65 percent for bioretention and biofiltration facilities that capture a stormwater volume equal to 1.0" of runoff from an impervious area, providing significant reductions in phosporous loading (LID Center, Inc., 2005).

Bioretention swales, raingardens, stormwater planters, and tree box filters can be used in commercial, residential, and industrial areas, but should not be located in areas of high sediment loads or where the site is not entirely stabilized (LID Center, Inc., 2005). They can be used in conjunction with other LID elements that filter or capture sediment.

Maintenance Needs & Costs

To ensure hydraulic efficiency of the bioretention and bioinfiltration facilities, the health and effectiveness of soil and plants, periodic inspection and maintenance to remove trash, debris, and collected sediment is required. In the event of an extreme drought, trees and shrubs may need to be watered in a similar manner as other landscaping.

Porous or Permeable Pavement

Porous/permeable pavement provides a hard surface for walking and driving, but also allows for water to flow through the pavement section due to the incorporation of void spaces within the paving system. One method is to use an open graded asphalt or concrete with reduced fines and a special binder that allows for the rapid flow of water. Water is able to pass through the pavement by flowing through voids between the aggregate. Another way to construct a permeable paving surface is to use paver blocks. The paver blocks themselves are not permeable, but are installed with gaps between the pavers to allow stormwater to percolate into the subsurface.

Porous Pavement (left) & Standard Pavement (right)

Porous paving must be thought of as a system of horizontal layers to effectively control and detain stormwater. Beneath the porous paving material, a sub-base composed of a layer of fine aggregate above a layer of larger aggregate both reduces runoff volume and peak discharge as well as provides water quality benefits. Stormwater, which passes through the sub-base filters out the suspended solids. Some studies suggest that total phosphorous and nitrogen removal for porous pavements is estimated at 62% and 88% respectively (LID Center, Inc., 2005).

Porous Pavement Sidewalk

Location

Permeable pavements are suitable for a variety of locations with light traffic loading such as residential streets, parking lots, driveways, and walkways. Permeable pavement is not appropriate for roadways with high and heavy traffic loading, except potentially on shoulders.

Pavers (with permeable gaps)

Maintenance Needs & Costs

In order to prevent clogging by fine sediment particles, it may be necessary to vacuum the pavement up to four times per year depending on localized sediment loads. Porous and permeable pavements and pavers should not be pressure-washed as this may force particles deeper into the pavement material (LID Center, Inc., 2005).

Porous Pavement Bike Lanes
Olympia, Washington

Kirkland LID Feasibility Study for CIP Projects Matrix

As part of the evaluation process, a matrix comparing LID benefits and opportunities was created to summarize each project. This matrix is meant to be used as a tool for Kirkland to compare the various projects considering not only the stormwater benefits but additional benefits associated that can result from incorporating LID elements into the right-of-way. The following matrix is broken into six sections:

- CIP Info – This section lists the general CIP project information including what the drainage basin where the project is located.

- LID Approach – This column lists the proposed LID elements.

- Low Impact Development (LID) Criteria – Stormwater function, demonstration potential, capital cost, and baseline maintenance efforts were scored high (value of 3), moderate (value of 2), or low (value of 1). This rating system was used to quantify the incorporation of LID. The range for the cumulative scoring in the last column is as follows: High 12-11, Moderate 10-8, and Low 7-4.

- Other Benefits from Proposed LID Elements – Additional benefits of LID elements include ecological function, habitat and human health, and ecological connectivity. In addition, the projects were evaluated for how they aligned with the Kirkland Comprehensive Plan Framework Goals and encourage interagency collaboration. Finally, the proposed elements were evaluated for the promotion of carbon neutral patterns including increase of pedestrian and bicycle facilities as opposed to increased street width for vehicular traffic. These benefits were also scored as either high (value of 3), moderate (value of 2), or low (value of 1). The range for the cumulative scoring in the last column is as follows: High 21-18, Moderate 17-14, and Low 13-7.

- Cumulative Priority Valuation – This column totals the cumulative valuation score for the Cumulative LID Valuation Score and the Cumulative Benefit Valuation Score. The range for the scoring is as follows: High 33-28, Moderate 27-21, and Low 20-11

- Collaboration Opportunities – These columns indicate the potential for Kirkland to engage the community, other agencies, and organizations through the design and even the maintenance of the proposed LID elements.

The results of the evaluation matrix should be used in conjunction with the following conceptual cross sections and images of how LID elements could be incorporated within the right-of-way. In addition, a map indicating the geographical context of the project and where it is in relation to nearby waterbodies, schools, and parks.

Kirkland Low Impact Development Feasibility Study for Capital Improvement Program Transportation Projects - Matrix

LID Feasibility City of Kirkland CIP Projects
Prepared By SvR Design Company
12/11/2007

LEGEND for Matrix Score: High / Moderate / Low

CIP Info				LID Approach	Low Impact Development (LID) Criteria					Other Benefits from Proposed LID Elements								Cumulative Priority Valuation	Collaboration Opportunities	
CIP Location (CIP Project Number)	% Funded	CIP w/ ROW acquisition	Stormwater Basin Information	Proposed LID Elements	LID Stormwater Function Flow Control or Treatment Compared to CIP (High = 3, Low =1)	LID demonstration potential (High = 3, Low =1)	LID Element Capital Cost - Compared to "Conventional" Stormwater Management (Low Cost = 3, High Cost =1)	Baseline LID Maintenance needs/costs (Low Cost =3, High Cost = 1)	Cumulative LID Valuation Score High = 12-11 Moderate = 10-8 Low = 7-4	Ecological: stream, wetland, and/or tree canopy (High = 3, Low =1)	Habitat and Human health (High = 3, Low =1)	Ecological Connectivity (High = 3, Low =1)	Other benefits (High = 3, Low =1)	Comprehensive Plan Framework Goal (FG) Alignments High = 3 Low =1 (See Appendix B)	Encourages Inter-agency Collaboration (High = 3, Low =1)	Promotes System wide Carbon-neutral Patterns (High = 3, Low =1)	Cumulative Benefit Valuation Score High = 21-18 Moderate = 17-14 Low = 13-7	Total LID and Benefits Valuation Score High = 33-28 Moderate = 27-21 Low = 20-11	Possibility of pairing with future redevelopment of adjacent site's)	Possible Public and Private Maintenance Partnerships
116th Ave. - NE 40th St to NE 60th St. (0001000)	83%	No	Yarrow Creek (Preliminary report for stormwater management requirements being prepared by Perteet)	Swales, Porous Pavement for Multi-use trail, Reduction of Current Lane Widths	High (3) Reduction of impervious surface versus original CIP strategy, Improved water quality treatment, within Sensitive Areas	High (3) LID adjacent to Sensitive areas: Yarrow Creek; Function of LID along a Multi-modal use corridor; Visible to other adjacent property owners: City of Bellevue, State Parks, WSDOT	Low Cost (3) A reduction of new impervious surfaces could reduce or eliminate detention and/or treatment structures	Moderate (2) Increased in some areas due to proximity of Yarrow Creek	11	High (3) Reduces pollutants and peak flows to Yarrow Creek	High (3) Improve downstream surface water quality	High (3) Stream restoration/ invasive plant removal; improve access to Bridle Trails State Park for equestrians and other users	High (3) Traffic calming via road diet and delineated separation for users	High (3) FG-1, FG-2, FG-5, FG-7, FG-9, FG-10, FG-11, FG-13	Moderate (2) Project may engage Kirkland Planning + Public Works. Possibly Kirkland + WSDOT or WA State Parks	Moderate (2) This project encourages alternative transportation, while using local resources to manage stormwater.	19	30	No	Bridle Trails State Park, Local Equestrian Association, and WSDOT
NE 100th St. (0034000)	100%	No	100th - Moss Bay 116th Ave NE - Forbes Creek (Stream Protection Flow Control)	Rain gardens, Swales, Porous Sidewalks, Reduction of Impervious Surface	Moderate (2) Reduction of impervious surfaces	Moderate (2) Function of porous pavements	Low Cost (3) Difference in cost of concrete vs. porous concrete is not significant.	Low Cost (3)	10	Low (1) This is an opportunity for a demonstration project	High (3) Improve downstream surface water quality	Low (1)	Moderate (2) LID feature is visible to cyclists and pedestrians crossing over 405 completing a bicycle connection	High (3) FG-1, FG-2, FG-3, FG-5, FG-7, FG-9, FG-10, FG-11, FG-13	Moderate (2) Project may engage Kirkland Planning + Public Works	Moderate (2) This project encourages alternative transportation, while using local resources to manage stormwater.	12	22	No	Adjacent homeowners and surrounding community
116th Ave. NE - NE 94th St. to NE 100th St. (0044000)	100%	No	100th - Moss Bay 116th Ave NE - Forbes Creek (Stream Protection Flow Control) Soils may have a high infiltration rate	Swale at NE 95th St, Rain gardens, Tree pits, Porous Sidewalks, Reduction of Pervious Surface	High (3) Water quality treatment	Moderate (2) Function of bioretention swale and rain gardens along a roadway	Low Cost (3) Existing ditch will have to be regraded and enhanced with amended soils and vegetation	Low Cost (3)	11	High (3) Removal of pollutants from street runoff into storm drainage system	High (3) Improve downstream surface water quality	Moderate (2) maintaining existing vegetated ditch network	Moderate (2) LID feature is visible to cyclists and pedestrians crossing over 405 completing a bicycle connection	High (3) FG-1, FG-2, FG-3, FG-5, FG-7, FG-9, FG-10, FG-11, FG-13	Moderate (2) Project may engage Kirkland Planning + Public Works	Moderate (2) This project encourages alternative transportation, while using local resources to manage stormwater.	17	28	No	Adjacent homeowners and surrounding community
13th Ave. (0054000)	100%	No	Moss Bay	Porous Sidewalk through Van Aalst Park	High (3) Reduction of impervious surface	Moderate (2) Function of porous pavements	Low Cost (3) Difference in cost of concrete vs. porous concrete is not significant. No curb will have to be replaced	Low Cost (3)	11	Moderate (2) nearby wetlands; stream on southern edge of park	Low (1)	Moderate (2)	High (3) Opportunity to educate park visitors	High (3) FG-1, FG-2, FG-3, FG-5, FG-7, FG-9, FG-10, FG-11, FG-13	High (3) Project may engage Kirkland Planning, Public Works and Parks	Moderate (2) This project encourages alternative transportation, while using local resources to manage stormwater.	16	27	No	Parks & Recreation Department; Local community
122nd Ave. NE (0055000)	100%	No	70th to 73rd - Moss Bay 73rd to 80th - Forbes Creek	Swales, Rain gardens, Porous Sidewalk	High (3) Improve function of existing swales and porous pavements while maintaining pedestrian safety	High (3) Function of LID in front of school and homes	Low Cost (3) Difference in cost of concrete vs. porous concrete is not significant. Swales may have to be regraded and enhanced with amended soils and vegetation	Low Cost (3)	12	High (3) Reduce drainage to Forbes Creek	High (3) Improve downstream surface water quality	Moderate (2) maintaining existing vegetated ditch network	High (3) Opportunity to combine function with education at the high school. Use public art to bridge between the school, neighborhood and LID project	High (3) FG-1, FG-2, FG-3, FG-5, FG-7, FG-9, FG-10, FG-11, FG-13	Moderate (2) Project may engage Kirkland Planning + Public Works, possibly include cooperation between Kirkland and Lake Washington High School	Moderate (2) This project encourages alternative transportation, while using local resources to manage stormwater.	18	30	Yes: Washington High School is planning to re-build on-site in near future	Iraq Veterans group, Earth Corps, & Lake Washington High School

Kirkland Low Impact Development Feasibility Study for Capital Improvement Program Transportation Projects - Matrix

LEGEND for Matrix Score
- High
- Moderate
- Low

CIP Info				LID Approach	Low Impact Development (LID) Criteria					Other Benefits from Proposed LID Elements								Cumulative Priority Valuation	Collaboration Opportunities	
CIP Location (CIP Project Number)	% Funded	CIP w/ ROW acquisition	Stormwater Basin Information	Proposed LID Elements	LID Stormwater Function Flow Control or Treatment Compared to CIP (High = 3, Low =1)	LID demonstration potential (High = 3, Low =1)	LID Element Capital Cost - Compared to "Conventional" Stormwater Management (Low Cost = 3, High Cost =1)	Baseline LID Maintenance needs/costs (Low Cost =3, High Cost = 1)	Cumulative LID Valuation Score High = 12-11 Moderate = 10-8 Low = 7-4	Ecological: stream, wetland, and/or tree canopy (High = 3, Low =1)	Habitat and Human health (High = 3, Low =1)	Ecological Connectivity (High = 3, Low =1)	Other benefits (High = 3, Low =1)	Comprehensive Plan Framework Goal (FG) Alignments High = 3 Low =1 (See Appendix B)	Encourages Inter-agency Collaboration (High = 3, Low =1)	Promotes System wide Carbon-neutral Patterns (High = 3, Low =1)	Cumulative Benefit Valuation Score High = 21-18 Moderate = 17-14 Low = 13-7	Total LID and Benefits Valuation Score High = 33-28 Moderate = 27-21 Low = 20-11	Possibility of pairing with future redevelopment of adjacent site's)	Possible Public and Private Maintenance Partnerships
6th St. (0059000)	100%	No	Moss Bay	Porous Sidewalk and Rain garden in Pocket Park, Reduction of Impervious Surface	Moderate (2)	Moderate (2) Function of porous pavements and small rain garden	Low Cost (3) Difference in cost of concrete vs. porous concrete is not significant and park is vegetated	Low Cost (3)	10	High (3) Nearby stream & wetlands area	Low (1)	High (3) Using a currently non-programmed green space for LID demonstration	High (3) Opportunity to use right of way bulb-outs to increase pedestrian safety	High (3) FG 1, FG-2, FG-3, FG-5, FG-7, FG-9, FG-10, FG-11, FG-13	High (3) Project may engage Kirkland Planning + Public Works + Parks	High (3) This project reduces automotive lane width and promotes alternative transportation, while using local resources to manage stormwater.	19	29	Yes: New residential redevelopment along 6th Ave. just north of proposed CIP project	Adjacent homeowners and surrounding community
99th Pl. NE & 100th Ave. (0060000)	100%	No	South Slope Juanita Direct Discharge to Lake Washington	Swales, Stormwater Planters and/or Rain gardens, Porous Pavements, Reduction of Impervious Surface	High (3) Water quality treatment	High (3) Function of small pocket stormwater planters/ rain gardens	Moderate (2) Removal of pavement and installation of amended soils and vegetation	Moderate (2)	10	High (3) Reduces pollutants and peak flows to Lake Washington	High (3) Improve downstream surface water quality	High (3) Due to the stream that flows under the project area and it's proximity to Lake Washington .	High (3) Opportunity to use right of way bulb-outs to increase pedestrian safety along wide ROW	High (3) FG-1, FG-2, FG-3, FG-5, FG-7, FG-8, FG-9, FG-10, FG-11, FG-13	Moderate (2) Project may engage Kirkland Planning + Public Works	High (3) This project reduces automotive lane width and promotes alternative transportation, while using local resources to manage stormwater.	20	30	Yes: Condos are being built on Shumway property; other indications of future redevelopment	Adjacent homeowners and surrounding community
Central Way (0065000)	100%	No	Moss Bay - Direct Discharge to Lake Washington	Stormwater planters within "Bump-outs", Porous Pavements, Reduction of Impervious Surface	Low (1) Not enough space for water quality treatment of roadway runoff	High (3) Function of stormwater planter/ rain garden	Moderate (2) Removal of pavement and installation of amended soils and vegetation	High (1) due to visibility of the site; some maintenance may be conducted by adjacent business owners	7	Low (1) this is more of a demonstration project	High (3) Improve downstream surface water quality	Low (1) High-profile demonstration project could lay the ground for more projects	High (3) Opportunity to use right of way bulb-outs to increase pedestrian safety	High (3) FG-1, FG-2, FG-3, FG-4. FG-5, FG-7, FG-8, FG-9, FG-10, FG-11, FG-13	High (3) Project may engage Kirkland Planning, Public Works and Parks	High (3) This project reduces automotive lane width and promotes alternative transportation, while using local resources to manage stormwater.	17	24	Yes: Lake Shore Plaza Mall may be redeveloped	Kirkland Downtown Association
120th Ave. NE (0063000)	100%	Yes ($5,483,400 in budget)	Juanita Creek Basin	Swales within area that drains directly to Juanita Creek (132nd to Creek)	Moderate (2) Flow Control and water quality treatment prior to direct discharge into Juanita Creek	High (3) Importance of localized treatment prior to discharging into a water body	High (1) Land acquisition may be required for LID near Juanita Creek	High (1) Due to proximity of Juanita Creek	7	High (3) Reduces pollutants and peak flows to Juanita Creek	High (3) Improve downstream surface water quality	High (3) Yes, adjacent connections to Juanita Creek and Hourglass Pond	Low (1)	Moderate (2) FG-1, FG-2, FG-4. FG-5, FG-7, FG-13	Moderate (2) Project may engage Kirkland Planning + Public Works, Kirkland + WA Dept of Fish and Wildlife	Low (1) Despite the application of LID elements, this project prioritizes increasing automobile capacity	15	22	Yes: New transit center at NE 78th; Planned "urban center" for area; zoning changing to Office/Multi-family	Evergreen Hospital Medical Center and adjacent businesses
Park Lane (0064000)	5%	No	Moss Bay - Direct Discharge to Lake Washington	Stormwater Planters and/or Rain gardens with Porous Pavements, Reduction of Impervious Surface	Moderate (2) Reduction of impervious surfaces	High (3) Function of stormwater planter/ rain garden and porous pavements	High (1) Realigning the street to create a living street with porous pavements and LID elements delineating the drive aisle and parking areas	High (1) Due to visibility of the site; some maintenance may be conducted by adjacent business owners	7	High (3) A LID approach could potentially save much of the existing canopy cover by providing more water access to tree roots will improve tree health	Low (1)	Moderate (2) Connections to Peter Kirk Park can be accentuated, but this "green street" could eventually connect to the water	High (3) From an urban design perspective, investments in Park Lane can create a "living street" that connects downtown to Peter Kirk Park and Lake Street	High (3) FG-1, FG-2, FG-3, FG-4. FG-5, FG-7, FG-8, FG-9, FG-10, FG-11, FG-13	High (3) Project may engage Kirkland Planning, Public Works and Parks	High (3) This project reduces automotive lane width and promotes alternative transportation, while using local resources to manage stormwater.	18	25	Yes: New transit center will be located on 3rd St. & Park Lane, Antique Mall site in next five years, and remote possibility of corner Lake St. & Central Way in distant future	Kirkland Downtown Association

116th Ave. NE (NE 60th St. - Kirkland City Limits) (CIP Project #: NM 0001 000)

CIP Project Description

Install Bike & Pedestrian facilities on the 116th Ave. NE corridor between NE 60th Street and Bellevue city limits.

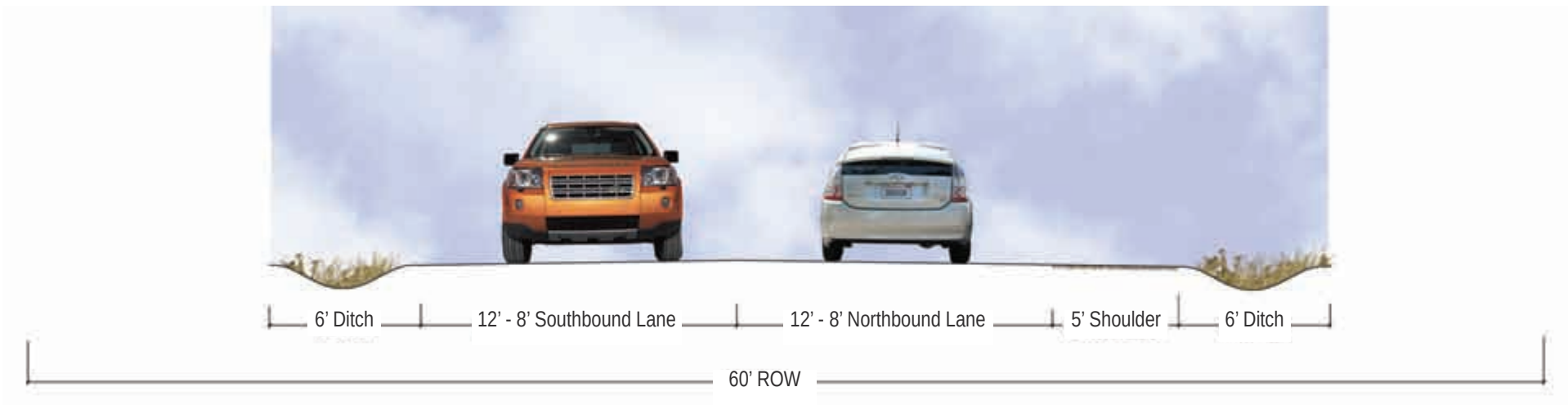
LID Opportunities and Benefits

- Biroretention swales can treat runoff from roadway prior to directly discharging to Yarrow Creek.
- Porous pavements for the bike lane on the west side and the sidewalk on the east side will reduce new impervious surfaces.
- Narrow the width of the proposed equestrian trail will reduce new impervious surfaces.

Bioretention swales can provide flow control and water quality treatment of roadway runoff required for Yarrow Creek and the associated wetlands. While the planned bike lane on the west side of the street will improve bicyclist safety, the use of porous pavement for the bike lane will provide some water quality treatment and attenuation of runoff from the roadway. Working with the equestrian community, Kirkland may be able to install a permeable trail surface that is safe for horses and better for Yarrow Creek. If one is not available, a narrow trail with areas for the horses to pass each other will reduce the imperivous surface required within the right-of-way. Using the existing paving in a more efficient way, Kirkland can achieve all of the city's goals on this complex project.

General existing conditions & considerations

- Active equestrian community that wants safe access for horses and riders to Bridle Trails State Park.
- Existing bicycle network from Bellevue ends at city limits.
- Travel lanes are wider (12.5') along corridor than Kirkland's standard (lane widths begin at 11' and increase depending on conditions and traffic demand).
- Impervious surfaces impact adjacent Yarrow Creek and wetlands.



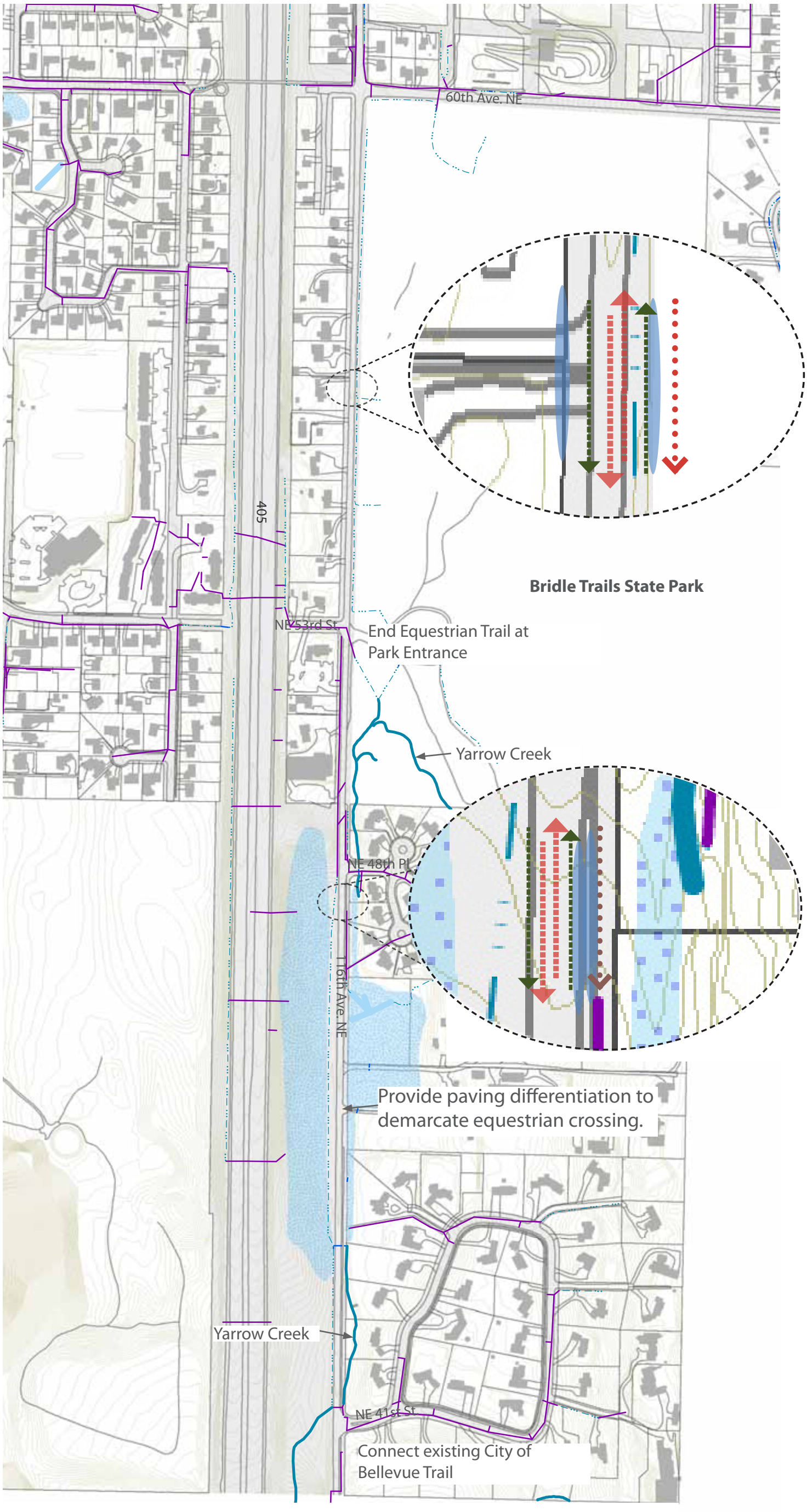
116th Avenue NE looking north at NE 41st Street - existing

Proposed concept

- Bioretention swales on both east and west sides
- Reduction of existing travel lanes width to 10' or 11' on each side
- Create a 5' climbing bike lane from existing paved shoulder on east side
- Create a 5' bike lane with porous pavement on west side
- Equestrian trail ranging from 3' to 8' in width on east side from city limits to Bridle Trails State Park entrance.

116th Avenue NE looking north at NE 41st St. - proposed

116th Ave. NE (NE 60th St. – Kirkland City Limits) (CIP Project #: NM 0001 000)



NE 100th St. (CIP Project #: NM 0034 000)

CIP Project Description

Install ~620 ft. of sidewalk along the north side of 100th St. between 116th Ave. NE and 120 ft. west of 114th Ave. NE. Project will consist of concrete curb, gutter, and planter strip with street trees

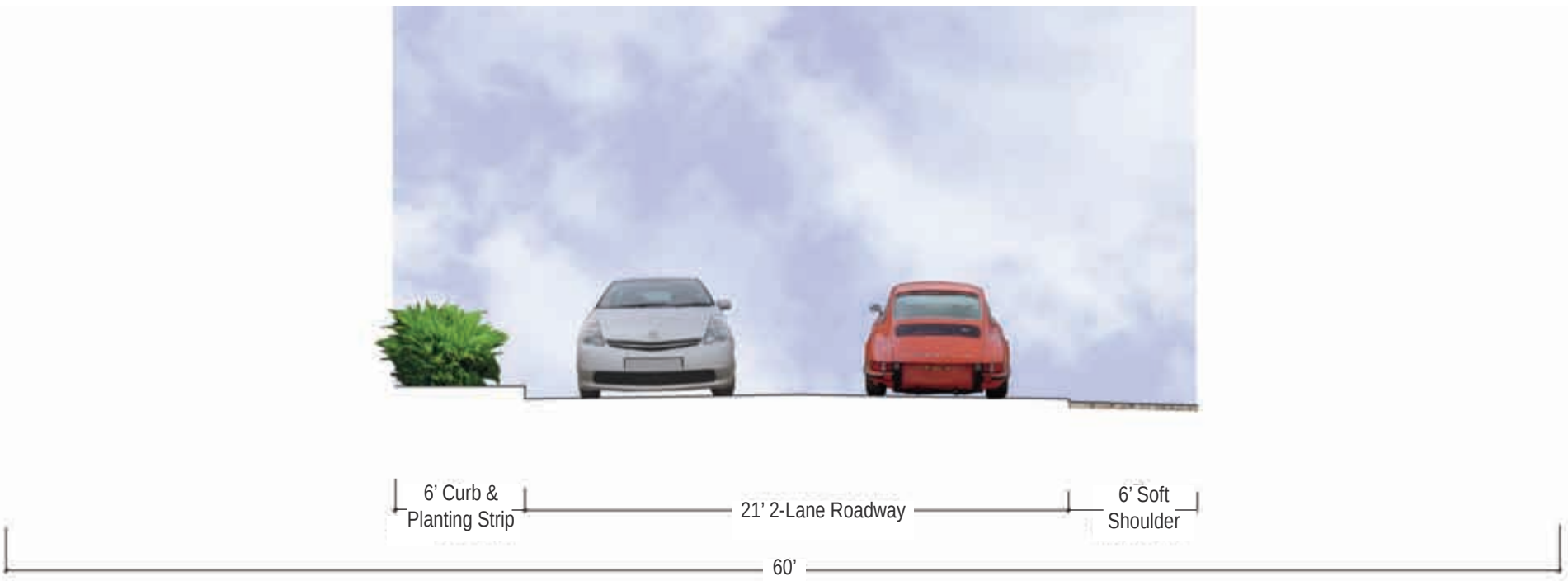
LID Opportunities and Benefits

- Installing porous pavement sidewalks will reduce the runoff from the shoulders.
- Rain gardens and bioretention swales can provide stormwater treatment from the north side the roadway.

Installing porous sidewalks and bioretention swales or raingardens will reduce the existing impervious areas of the shoulder. In addition to the bioretention swales and rain gardens between the sidewalk and the roadway providing water quality treatment and some flow attenuation, there will be a vegetated horizontal buffer between the pedestrians and the roadway. As a high point with territorial views, the site is extremely photogenic and as such, could compellingly extend Kirkland's "brand" as a green city. The site is often used by pedestrians and bicyclists and would benefit from a complete street approach that accommodates all of these user groups.

General existing conditions & considerations

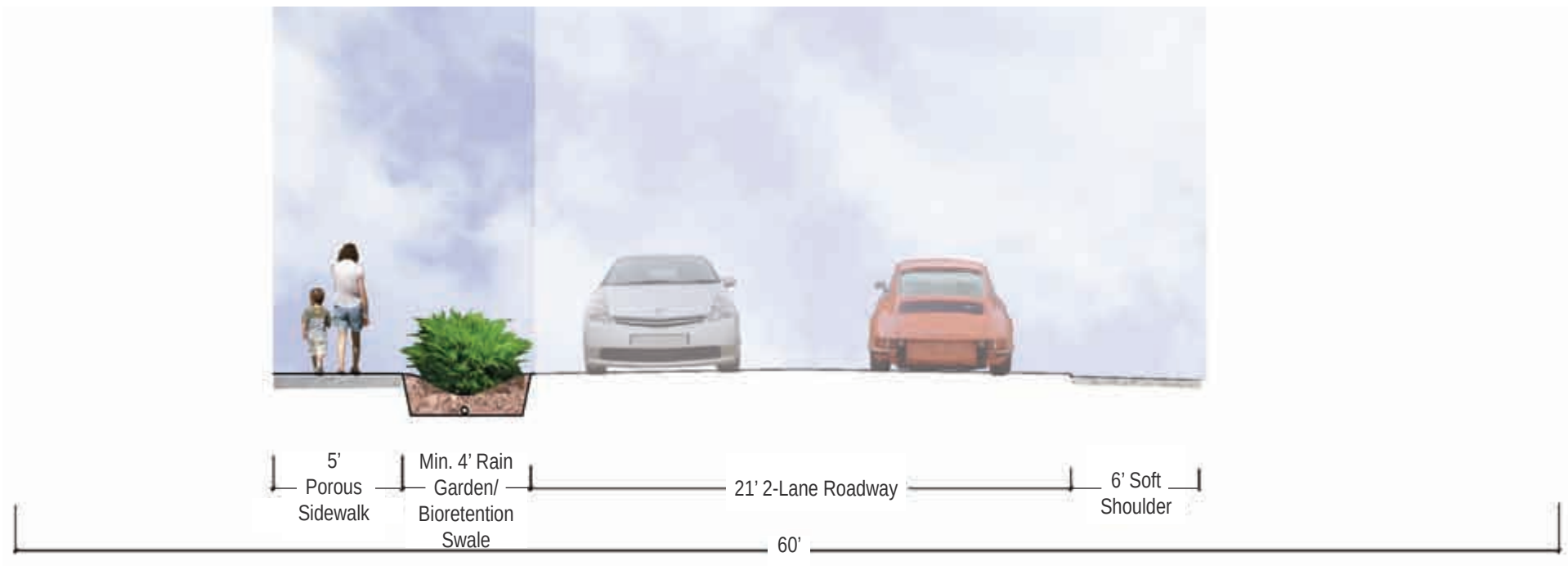
- No sidewalk on either north or south side of street
- In some locations the slope will be a LID design driver, e.g. slope 4.6% just east of 114th St. NE
- There is currently encroachment in the ROW (residential landscaping and fences)



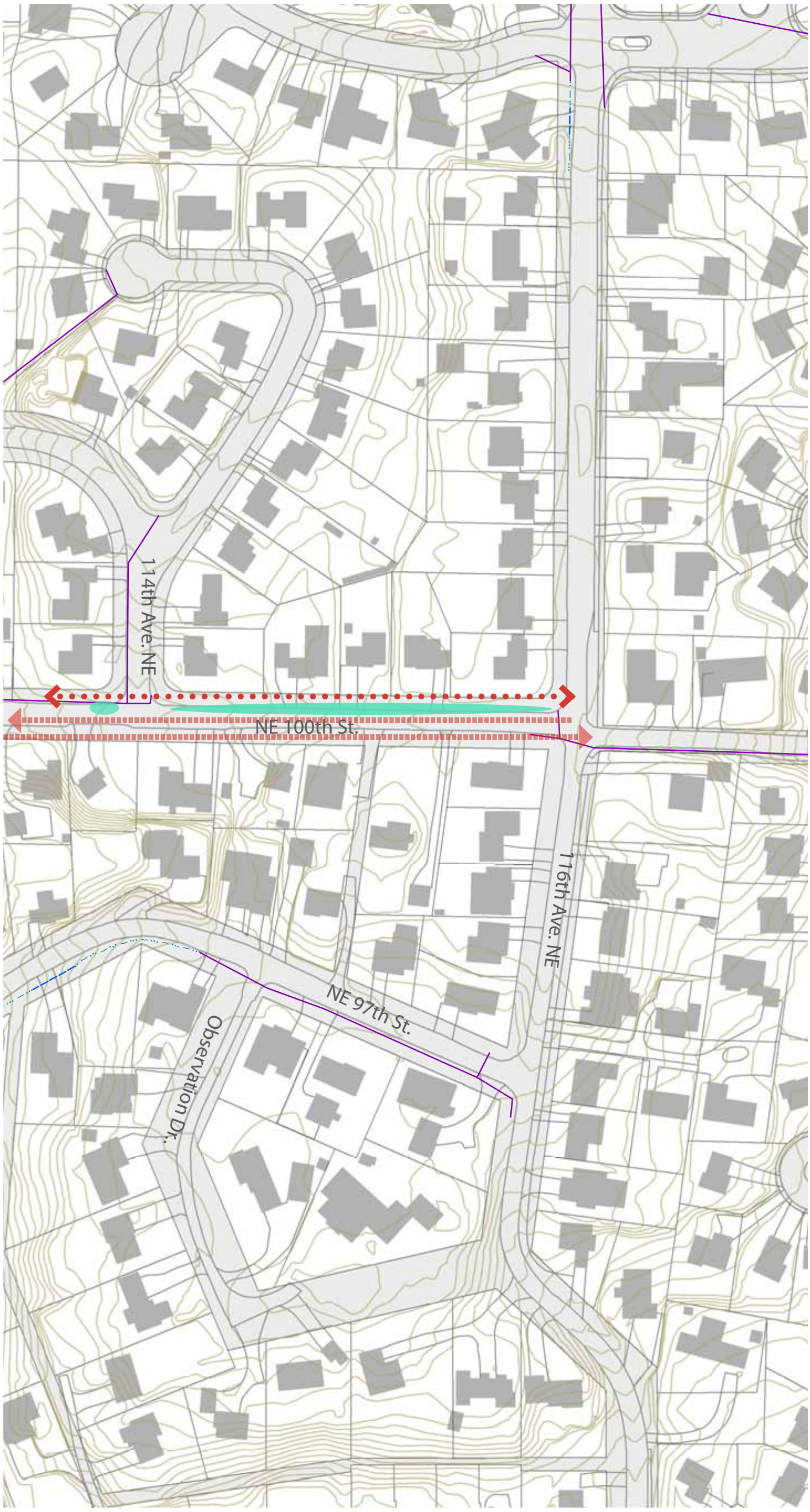
100th St. NE looking east at NE 114th Ave.

Proposed concept

- Porous pavement sidewalks on north side of NE 100th St.
- Rain garden/bioretention swales within planting strip



100th St. NE looking east NE 114th Ave.



Legend

- Pedestrian Circulation
- Vehicular Travel Lanes
- Right-of-Way
- Pavement Edges
- Contour Lines (2')
- Stream
- Pipe
- Culvert
- Ditch
- Wetland
- Bioretention swales/Rain gardens

116th Ave. NE (NE 100th St. - NE 94th Pl.) (CIP Project #: NM 0044 000)

CIP Project Description

Install ~1,900 ft. of concrete curb, gutter, sidewalk, and street trees along east side of 116th Ave. NE from the existing sidewalk north of NE 100th St. to NE 94th St.

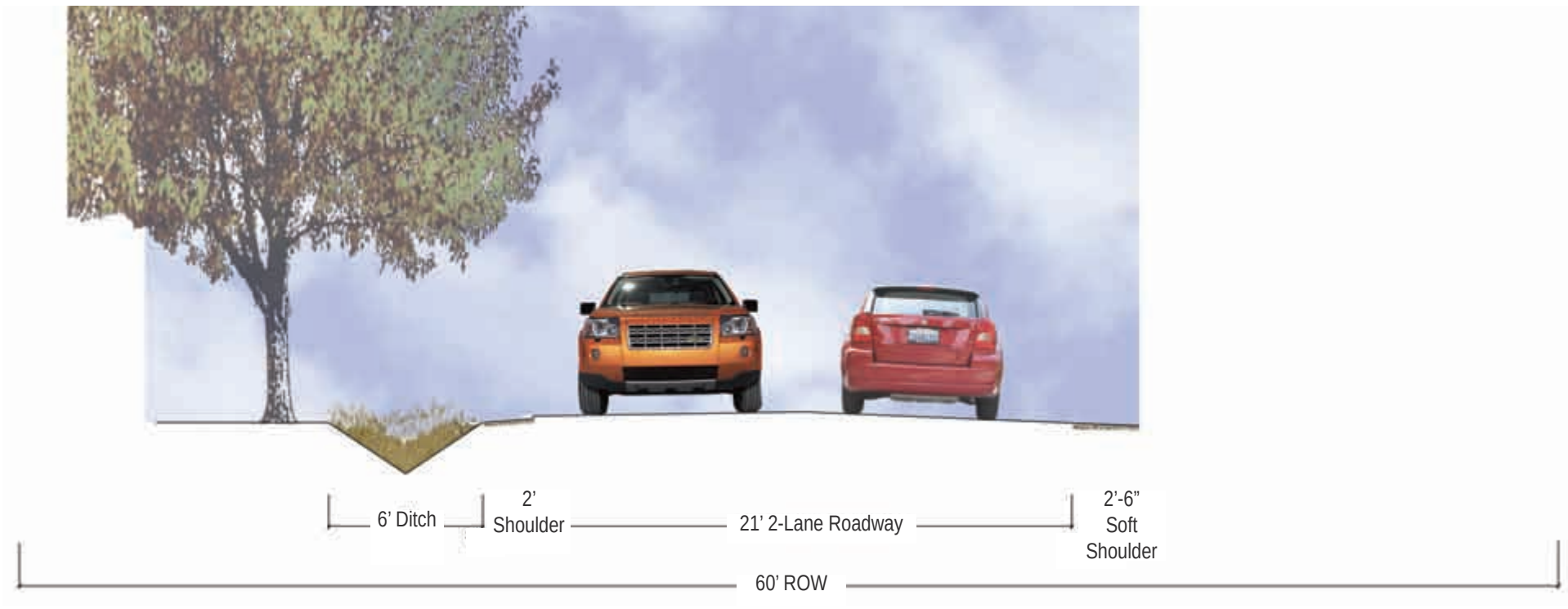
LID Opportunities and Benefits

- Installing porous pavement sidewalks will reduce the runoff from the shoulders.
- Rain gardens and bioretention swales can provide flow attenuation and stormwater treatment of roadway runoff.

Soil and plant treatments in bioretention swales and rain gardens can provide flow attenuation and water quality treatment to meet Forbes Creek Basin requirements for Stream Protection Flow Control. Porous pavement sidewalks will improve pedestrian safety and provide information about stormwater management particularly for children en route to Peter Kirk Elementary School.

General existing conditions & considerations

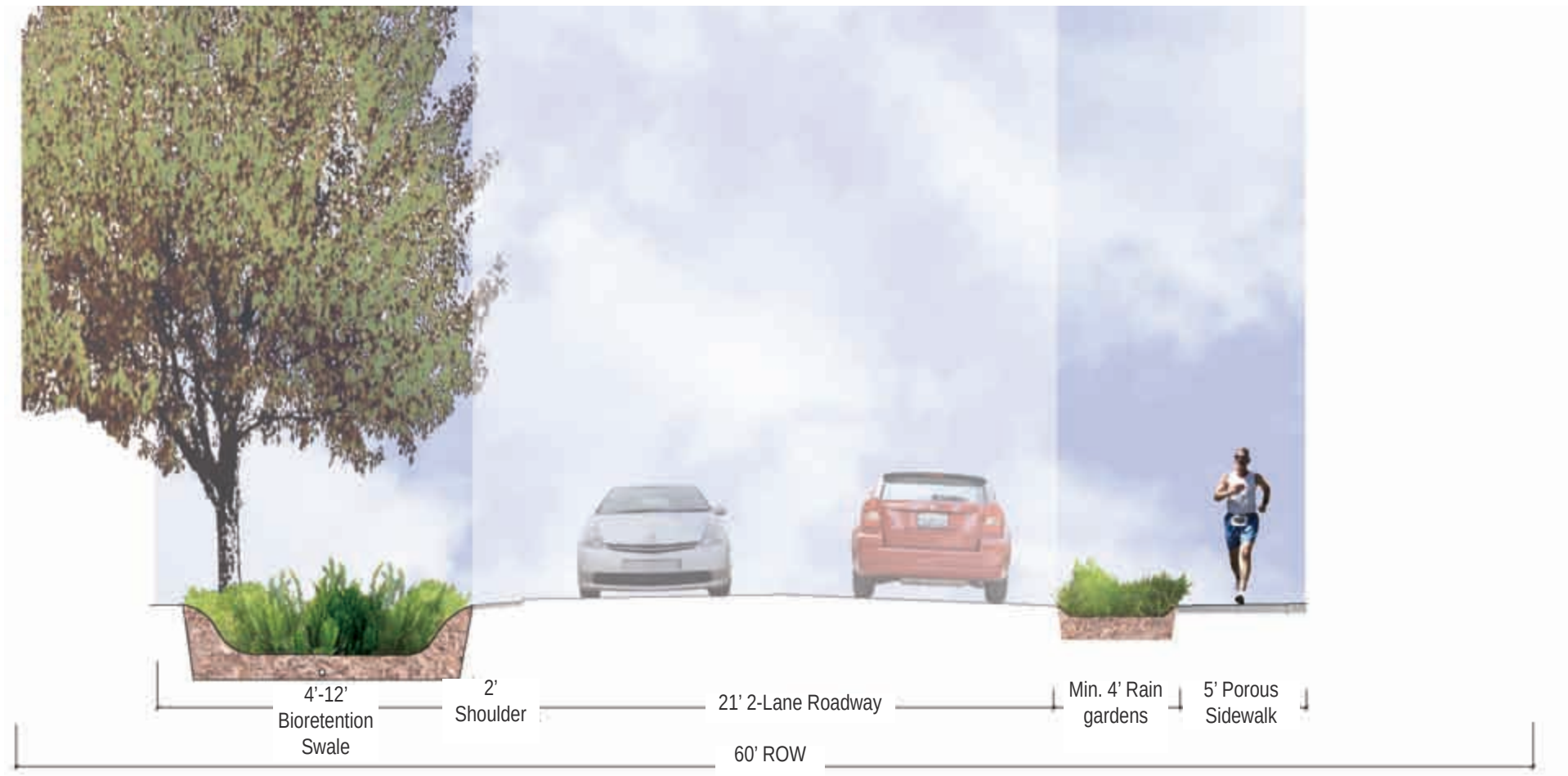
- No sidewalk on either east or west side of street
- Designated walk route to Peter Kirk Elementary School
- Steep slopes between NE 97th Lane and NE 95th St
- Ditch at 116th Ave. NE and NE 95th St.



116th Ave. NE looking north at NE 95th St. - existing

Proposed concept

- Porous pavement sidewalks on east side
- Rain gardens on some parts of east side (overflow to bioswale below)
- Bioretention swale on west side beginning at NE 95th St. and extending to the north ~150-250'



116th Ave. NE looking north at NE 95th St. - proposed

116th Ave. NE (NE 100th St. – NE 94th Pl.) (

Legend

- Pedestrian Circulation
- Vehicular Travel Lanes
- Right-of-Way
- Pavement Edges
- Contour Lines (2')
- Stream
- Pipe
- Culvert
- Ditch
- Wetland
- Bioretention swale
- Rain garden or Stormwater Planter

13th Ave. (CIP Project #: NM 0054 000)

CIP Project Description

Install ~815 ft. of concrete sidewalk on the south side of 13th Ave. between 3rd St. and 4th St. (Van Aalst Park). Project will also include concrete curb and gutter.

LID Opportunities and Benefits

- Installing porous pavements will reduce the amount of new impervious surface.

While the planned sidewalks will improve pedestrian safety, particularly for children en route to Van Aalst Park, using porous pavement will reduce runoff from the right-of-way.

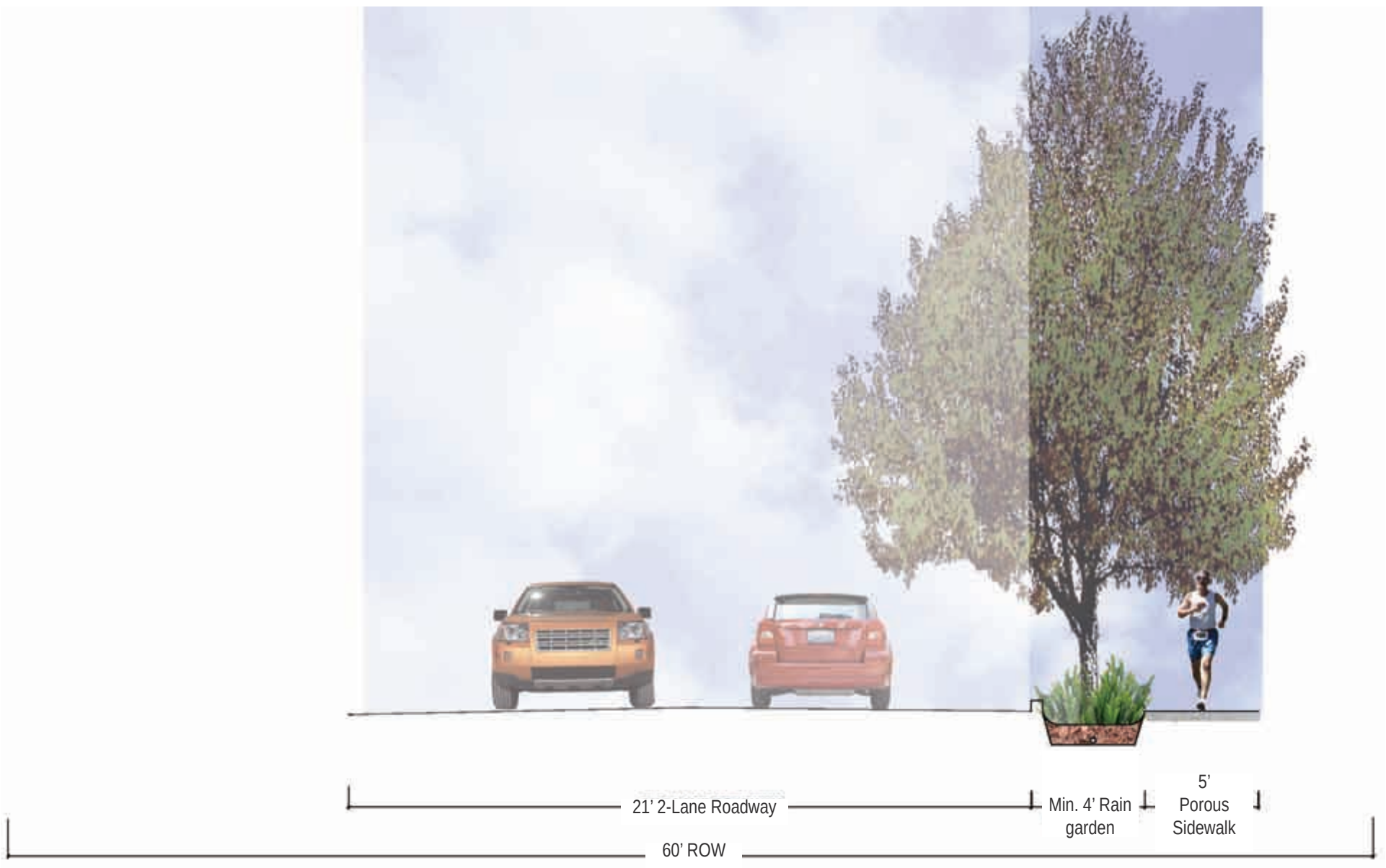
General existing conditions & considerations

- Adjacent to Van Aalst Park
- Walking route to park
- Nearby wetlands on southern edge of park
- 13.8% slope just east of 3rd St.

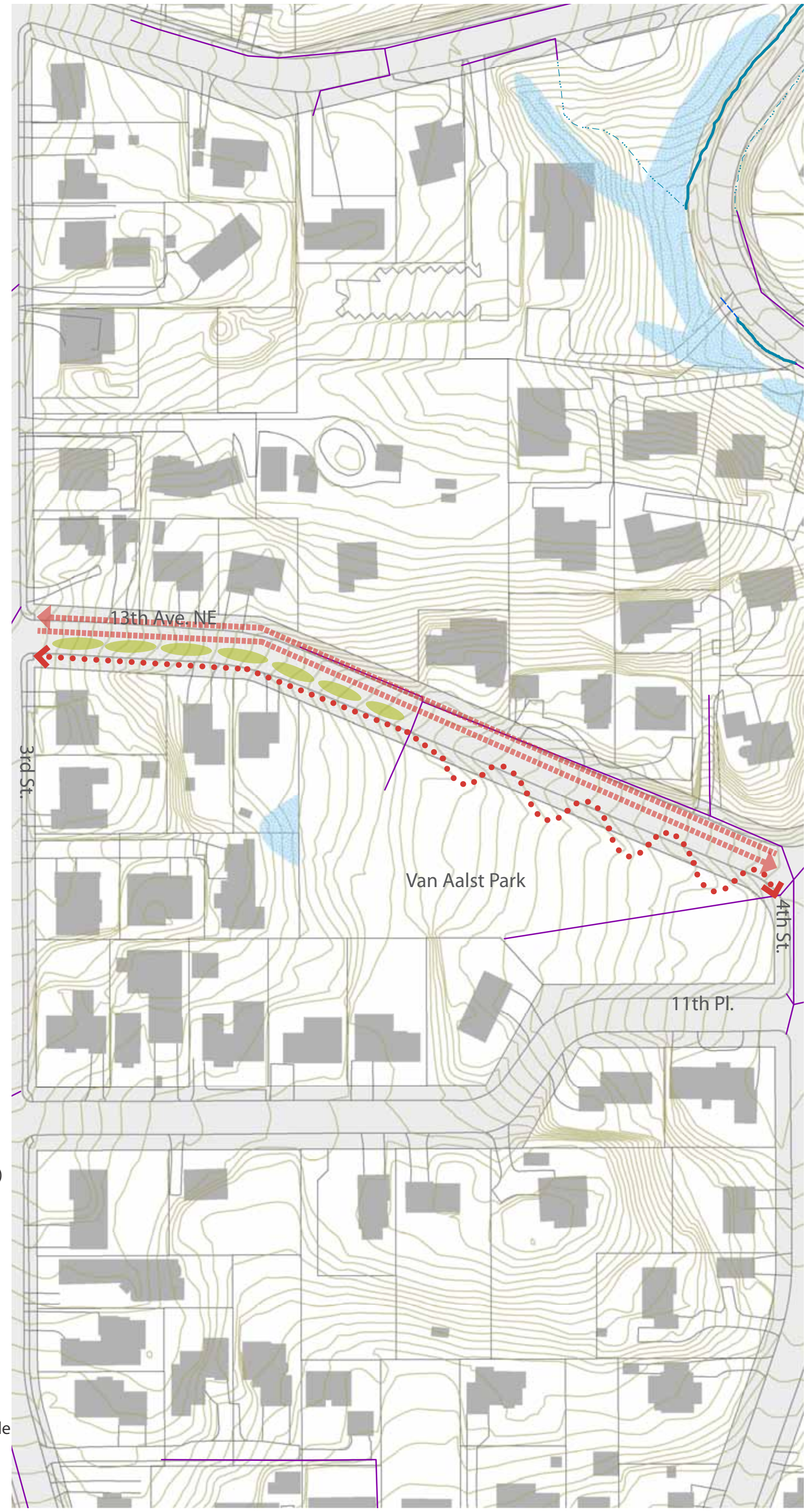
13th Ave. looking east - existing

Proposed concept

- Porous pavement sidewalk on south side of 13th Ave
- Within Van Aalst Park the sidewalk will meander through existing street trees, thus precluding the need to plant new trees



13th Ave. looking east - proposed


13th Ave. NE
3rd St.
Van Aalst Park
4th St.
11th Pl.
Legend
Pedestrian Circulation
Vehicular Travel Lanes
Right-of-Way
Pavement Edges
Contour Lines (2')
Stream
Pipe
Culvert
Ditch
Wetland
Bioretention swale
Rain garden or Stormwater Planter
0
100
200
300
Feet

122nd Ave. (CIP Project #: NM 0055 000)

CIP Project Description

Install ~2,100 ft. of five-feet concrete sidewalk along the east side of 122nd Ave. between NE 70th St. and NE 75th St. a five-foot concrete sidewalk along west side of 122nd Ave. NE between NE 75th St. and NE 80th St. Project will evaluate the use of Low Impact Development standards.

LID Opportunities and Benefits

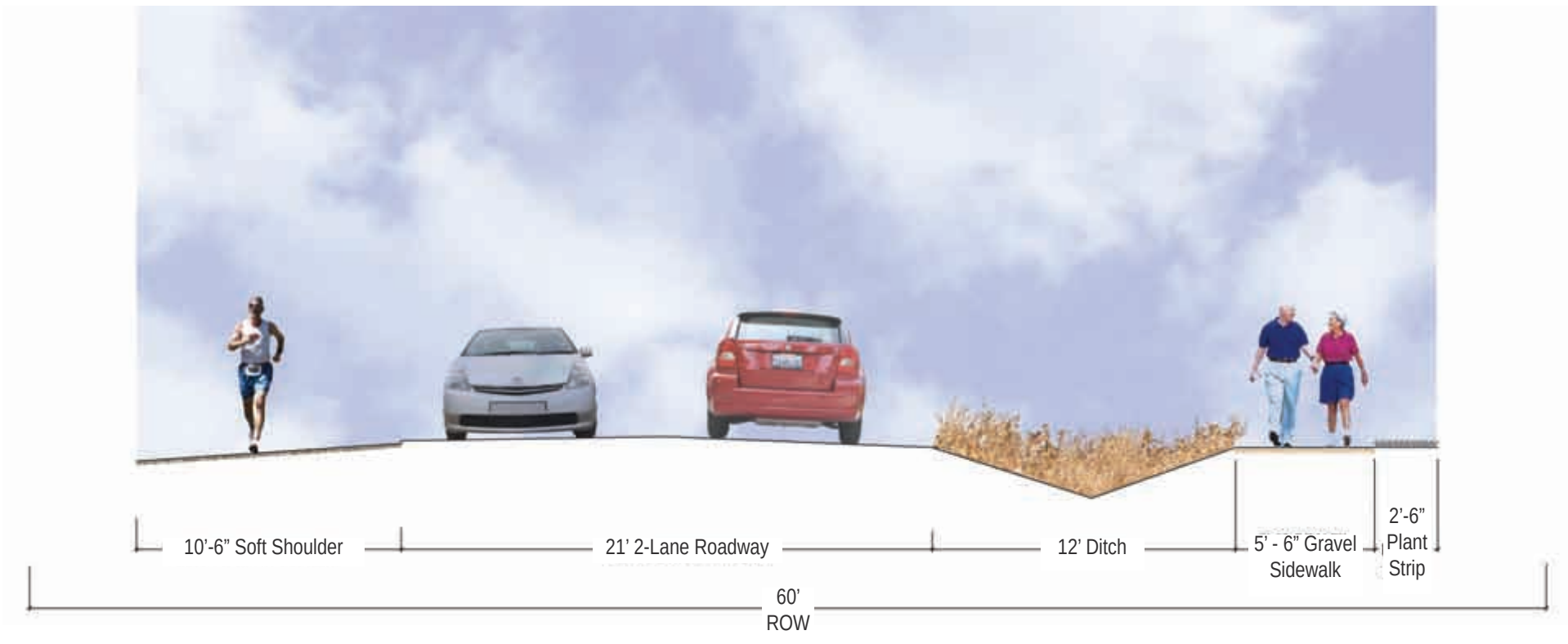
- Enhancing the existing ditch network to include bioretention swales and rain gardens can provide flow attenuation and stormwater treatment for the existing roadway runoff.
- Installing porous pavements will reduce the amount of impervious surface.

Amending the soils and plant treatments in bioretention swale will improve the function of existing ditches by increasing flow attenuation and water quality treatment. In addition to maintaining pedestrian safety by installing bioretention swales between the roadway and the sidewalk, there is an educational opportunity for the students en route to Lake Washington High School. If there are high infiltration rates, LID elements could decrease discharge into the Forbes Creek Basin.

Zone 1 (between NE 80th St. & NE 75th St.)

General existing conditions & considerations

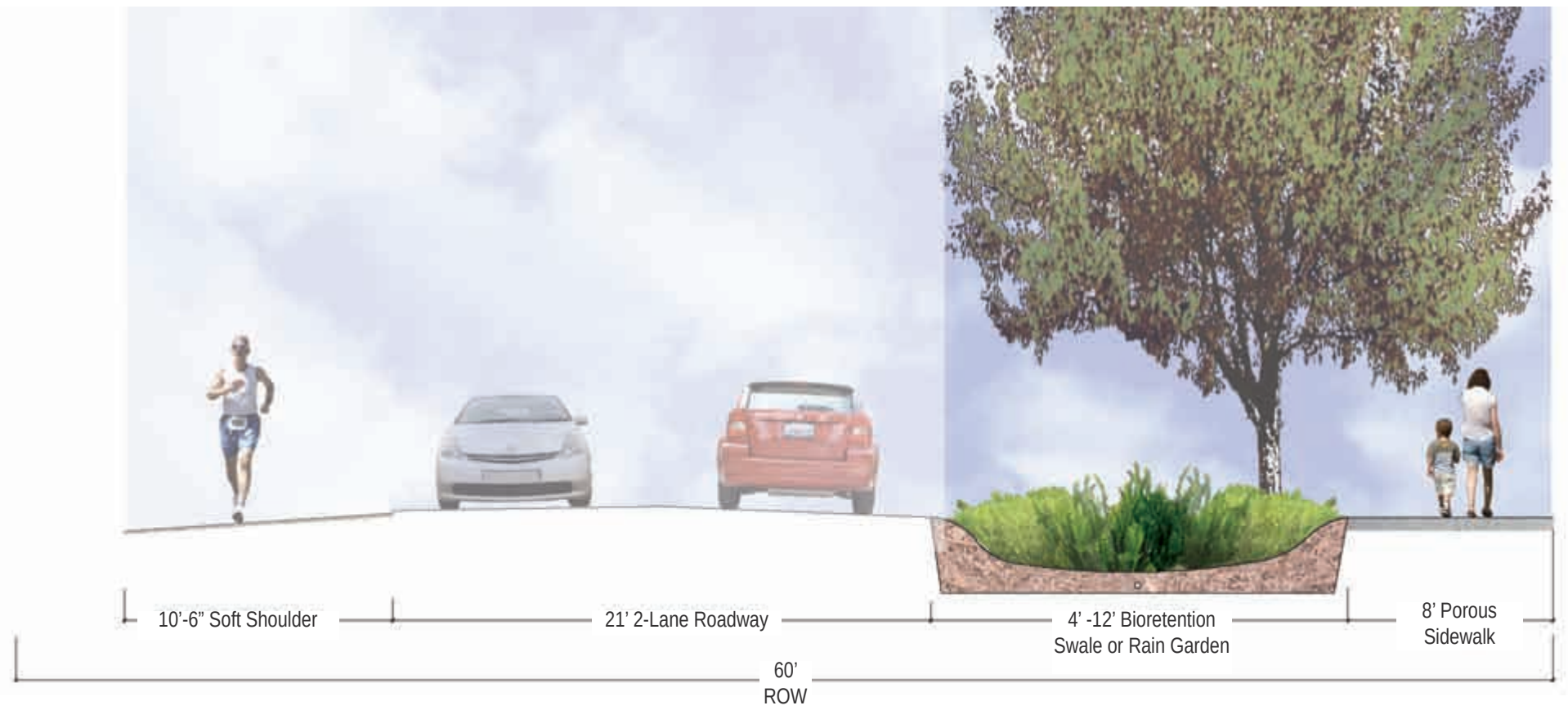
- Ditches on west side and along east side near NE 78th St.
- Gravel sidewalk along west side
- Adjacent to Lake Washington High School



122nd Avenue NE looking south at NE 80th St. - existing

Proposed concept

- Bioretention swales or rain gardens on west side
- Porous pavement sidewalk along west side
- Educational/interpretive signage

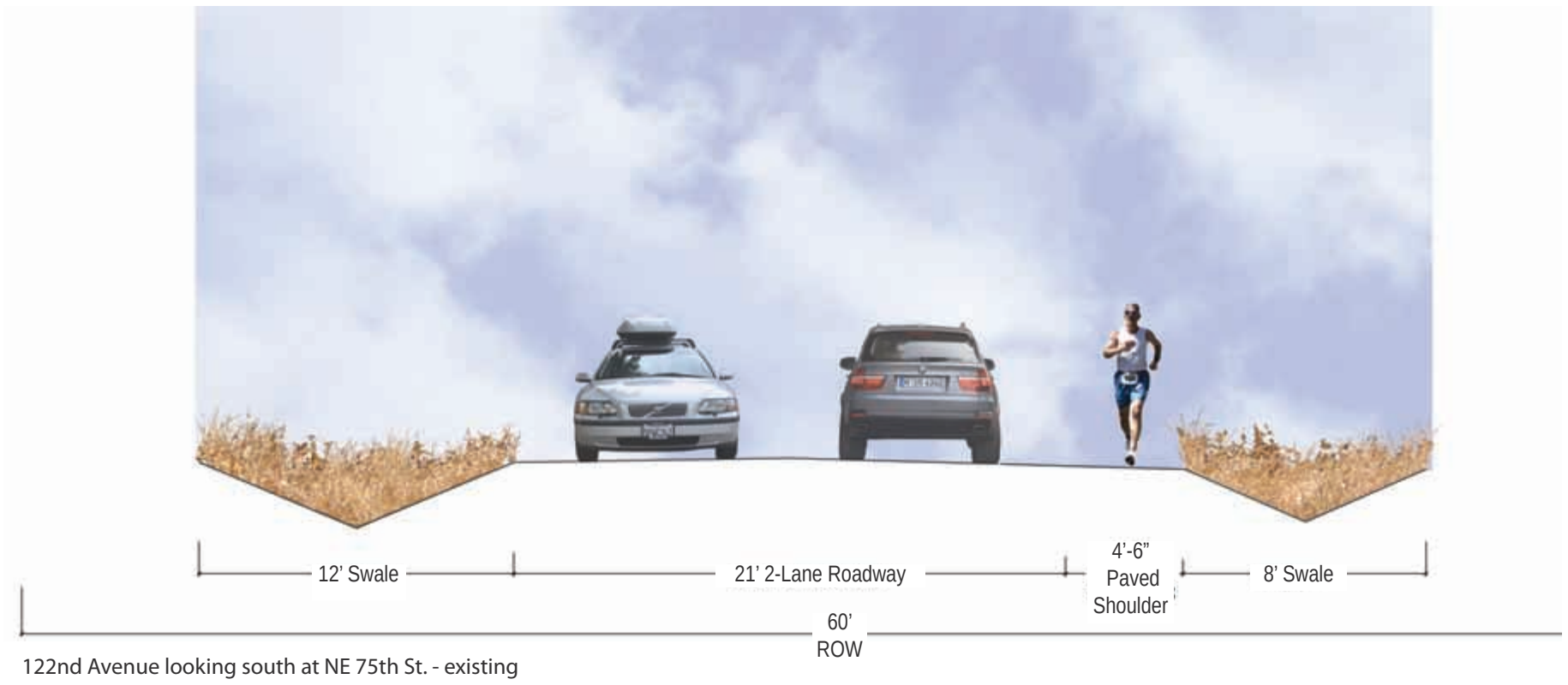


122nd Avenue NE looking south at NE 80th St. - proposed

Zone 2 (between NE 75th ST. & NE 73rd St.)

General existing conditions & considerations

- No sidewalks
- Ditches on both east and west sides



122nd Avenue looking south at NE 75th St. - existing

Proposed concept

- Porous pavement sidewalk along west side
- Bioretention swale on west side (enhance ditch on east side for bioretention)

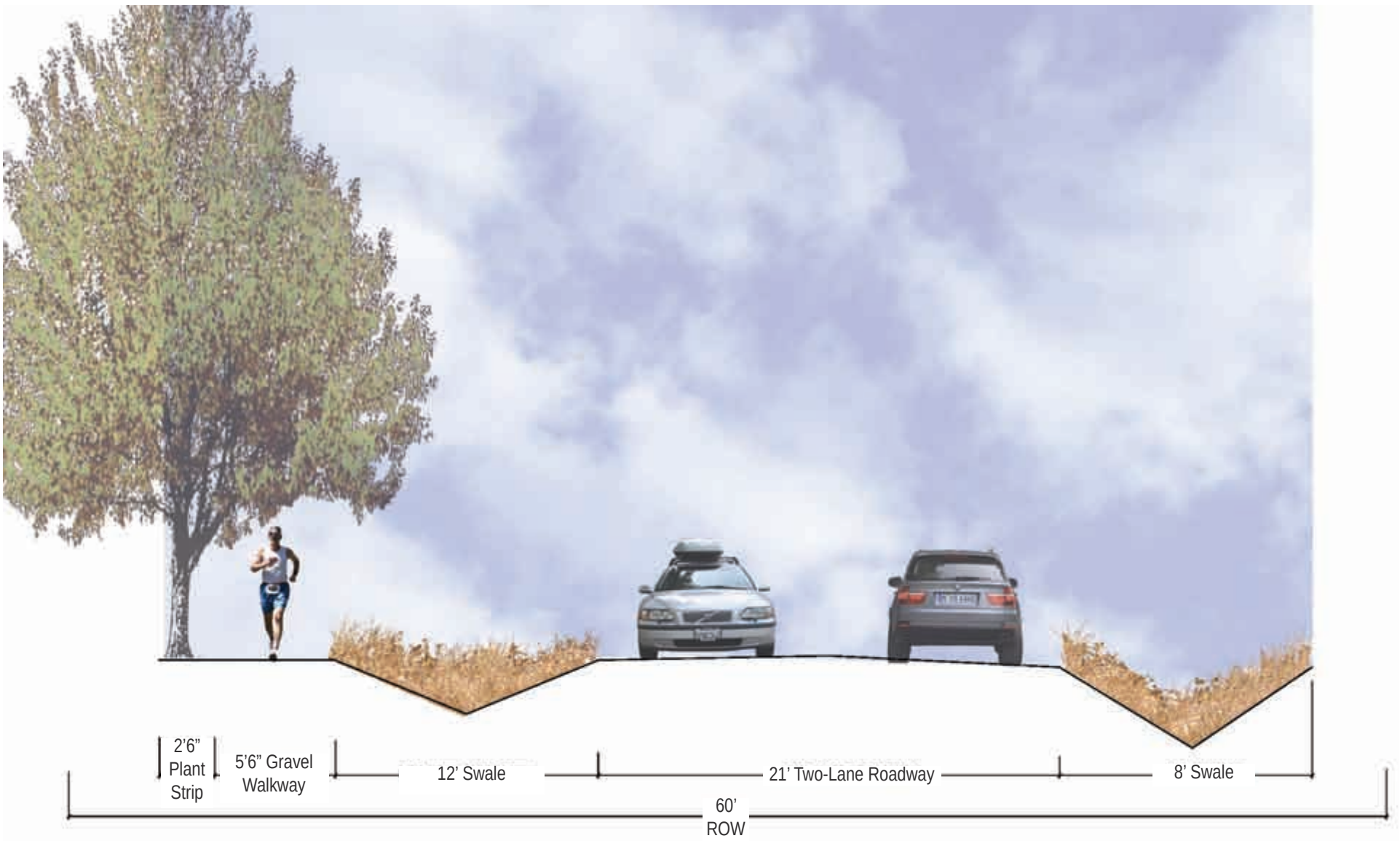
122nd Avenue looking south at NE 75th St. - proposed

122nd Ave. (CIP Project #: NM 0055 000)

Zone 3 (between NE 73rd St. and NE 70th St.)

General existing conditions & considerations

- Ditches on west side
- Paved shoulder on west side
- Sidewalk on east side

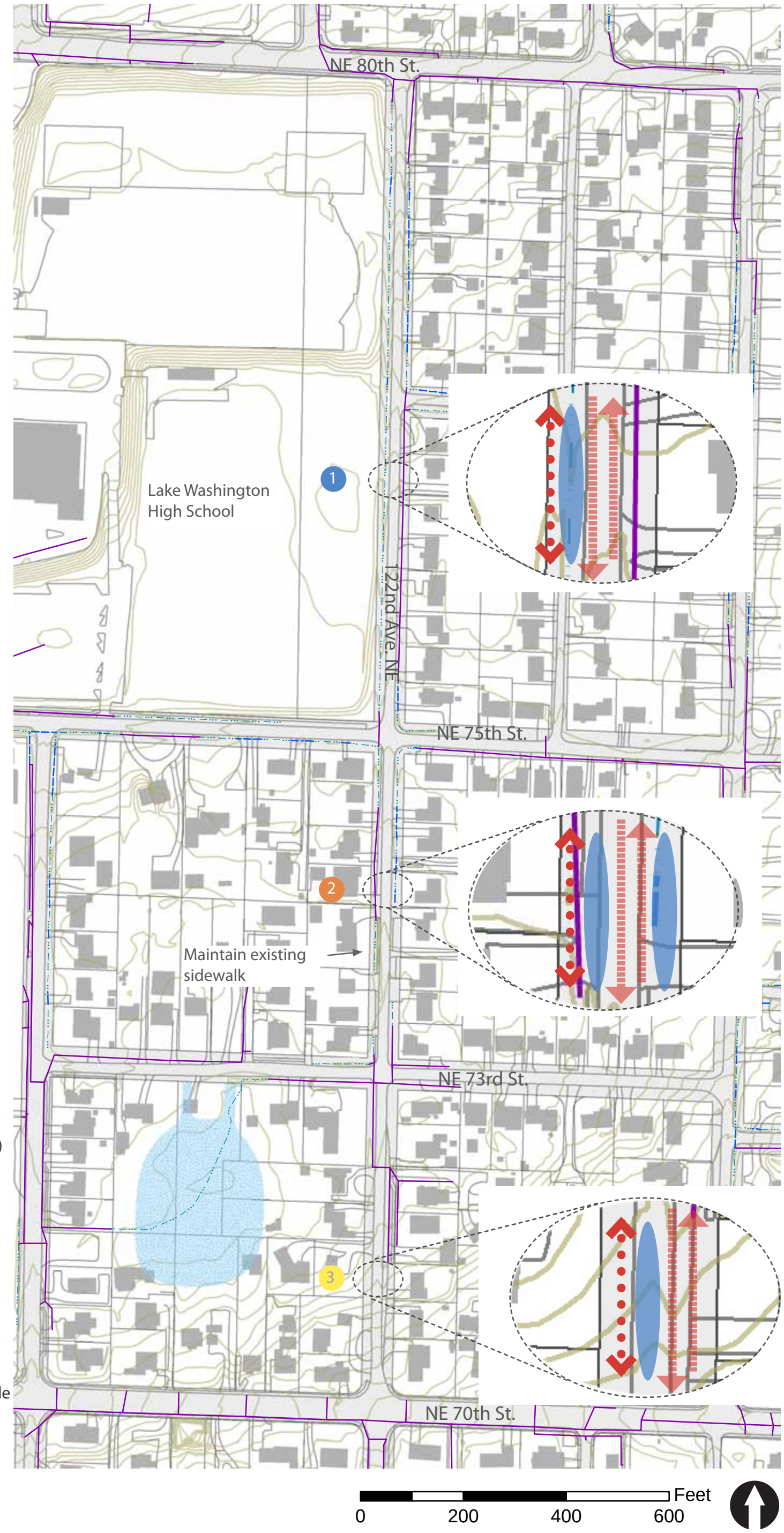


122nd Ave. NE looking north at 78th Pl. - existing

Proposed concept

- Bioswale/rain gardens on both sides of street
- Maintain existing concrete sidewalk on east side

122nd Ave. NE looking north at 78th Pl. - proposed



Legend

- Pedestrian Circulation
- Vehicular Travel Lanes
- Right-of-Way
- Pavement Edges
- Contour Lines (2')
- Stream
- Pipe
- Culvert
- Ditch
- Wetland
- Bioretention swale
- Rain garden or Stormwater Planter

6th St. Sidewalk (CIP Project#: NM 0059 000)

CIP Project Description

Install ~ 500 linear ft. of five-foot cement concrete sidewalk and crossing improvements at Kirkland Ave. In locations where applicable a planter strip will be installed.

LID Opportunities and Benefits

- Installing porous pavement sidewalks will reduce the runoff from the shoulders.
- Rain gardens and bioretention swales can provide flow attenuation and stormwater treatment of roadway runoff.

Porous sidewalks will reduce the amount of new impervious surfaces. In addition to installing porouse sidewalks along 6th St, creating areas for stormwater collection and treatment in an underutilized pocket park, there is an opportunity to provide demonstration of stormwater management to pedestrians. Rain gardens and bioretention swales will provide flow attenuation and water quality treatment for runoff collected from the roadway.

General existing conditions & considerations

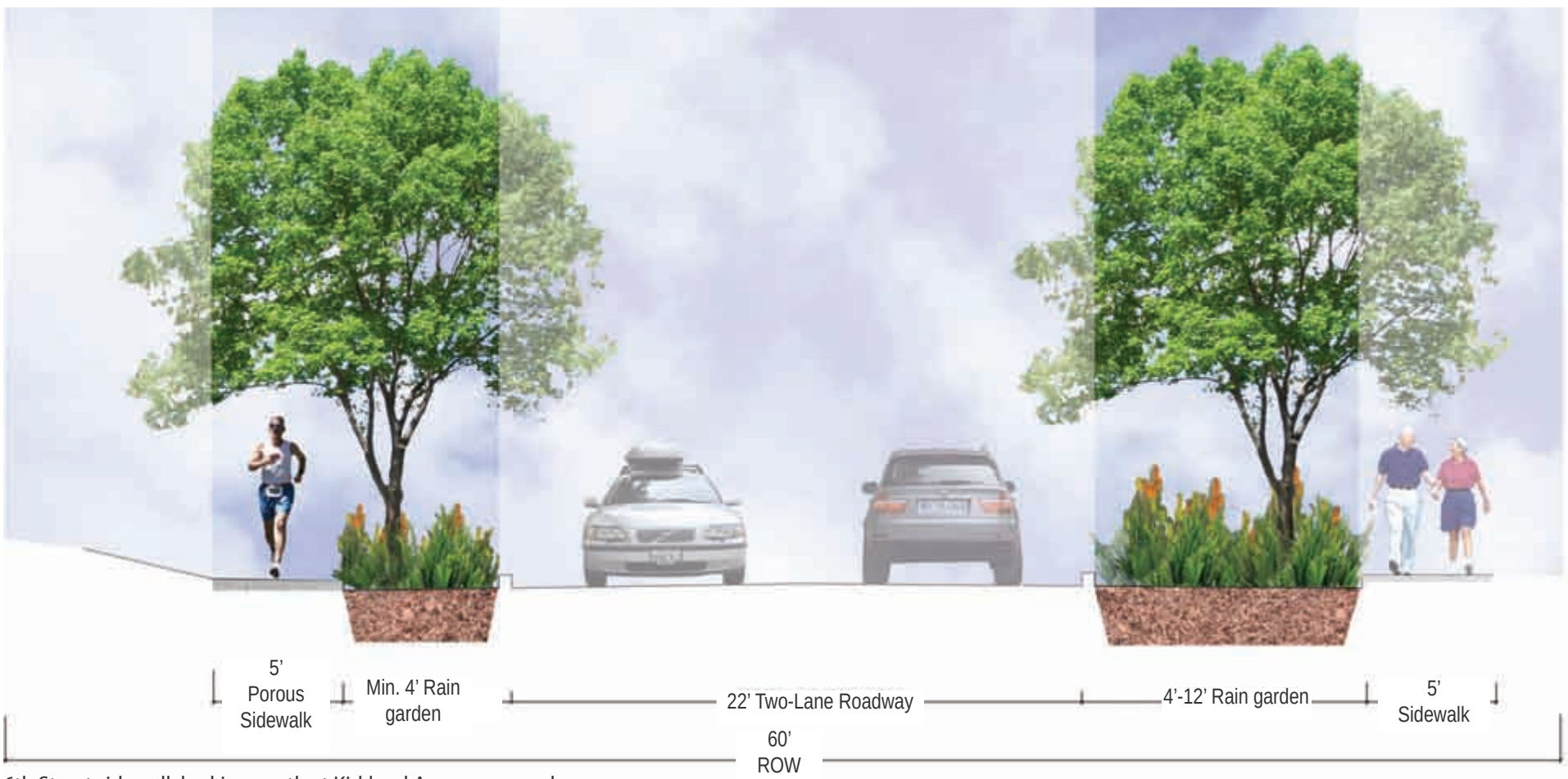
- No sidewalk on 6th St. from Kirkland Ave. to 1st Ave. S.
- Pedestrian crossing at corner of 6th St. S. & Kirkland Ave.
- Road cross section crowns east of center; only 8' of roadway drains to east side of the street
- Small triangular pocket park at corner of 6th St. S. and north side of Kirkland Ave.

Pocket Park at 6th St. S. and Kirkland Avenue looking north - existing (see on diagram)

Pocket Park with rain garden at 6th St. S. and Kirkland Avenue looking north - proposed

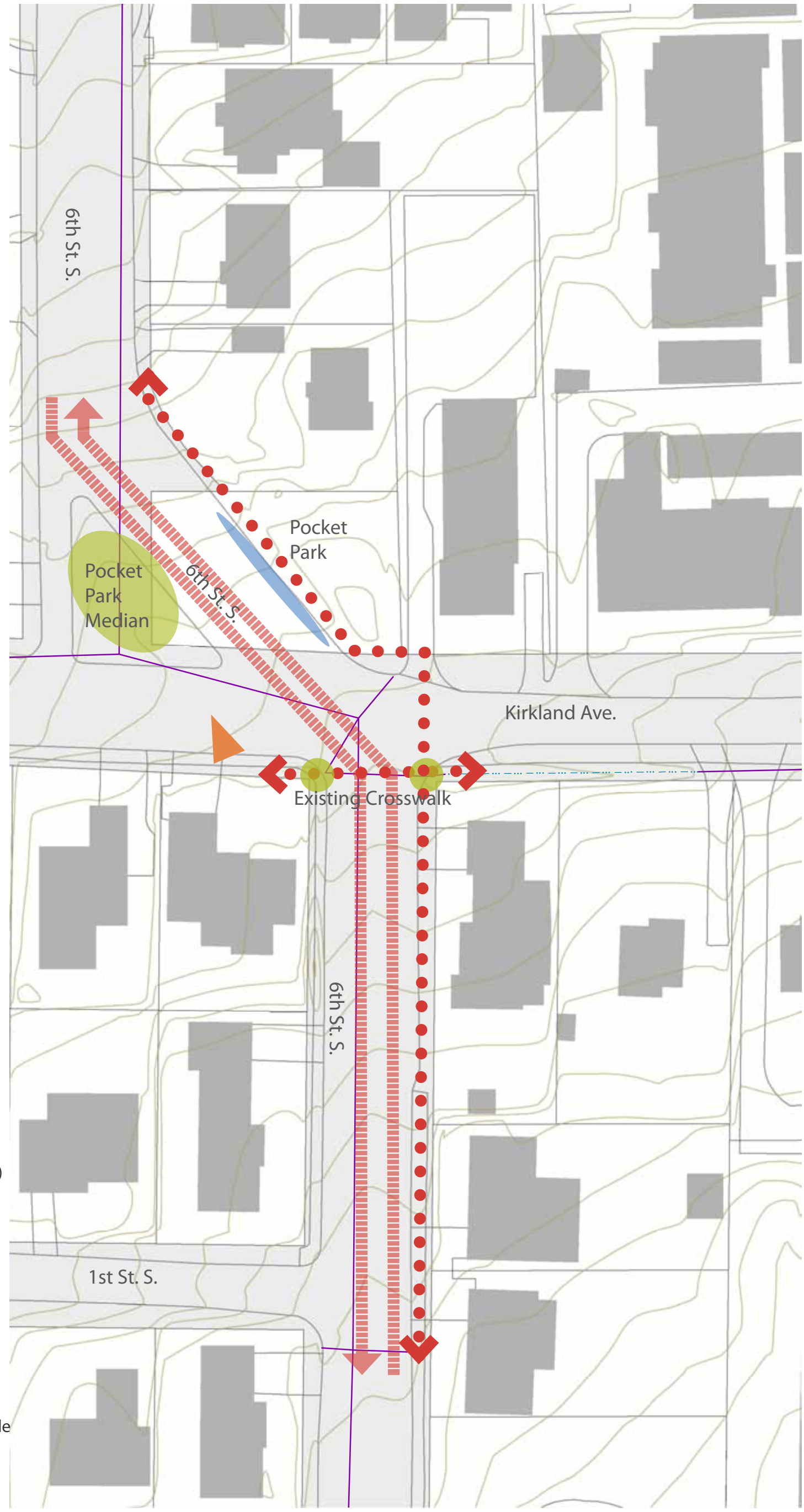
Proposed concept

- Porous pavement sidewalk on east side of 6th St. S.
- Rain garden in pocket park
- Possible rain garden along sidewalk and bulb-out extensions at crosswalk



6th Street sidewalk looking south at Kirkland Ave. - proposed

6th St. Sidewalk (CIP Project#: NM 0059 000)



99th Pl. NE/100th Ave. NE (CIP Project#: NM 0060 000)

CIP Project Description

Install ~1350 linear ft. of curb, gutter, and sidewalk and five-foot planter strip in some areas. Available right-of-way and steep slopes may preclude the planter strip in some areas. ADA compliant wheelchair ramps will also be required at cross-walk locations.

LID Opportunities and Benefits

- Installing porous pavement sidewalks will reduce the runoff from the shoulders.
- Rain gardens can provide flow attenuation and stormwater treatment of roadway runoff.

Creating singular or a series of rain gardens near the existing catch basins will attenuate peak flows and treat the stormwater before discharging to Lake Washington and the adjacent wetlands. Based on the location of the property lines and the edge of the travel lanes, there is available right-of-way to install these LID elements to benefit stormwater and pedestrian safety.

General existing conditions & considerations

- Road undulates along longitudinal axis creating drainage pockets (see profile to right)
- Road cross slope consistently slopes to west
- Some structures along the west side of the road are lower than the roadway
- Sub-basins may drive up project costs

Profile view of 99th Pl./100th Ave. NE

99th Pl. NE /100th Ave. NE existing conditions (looking south)

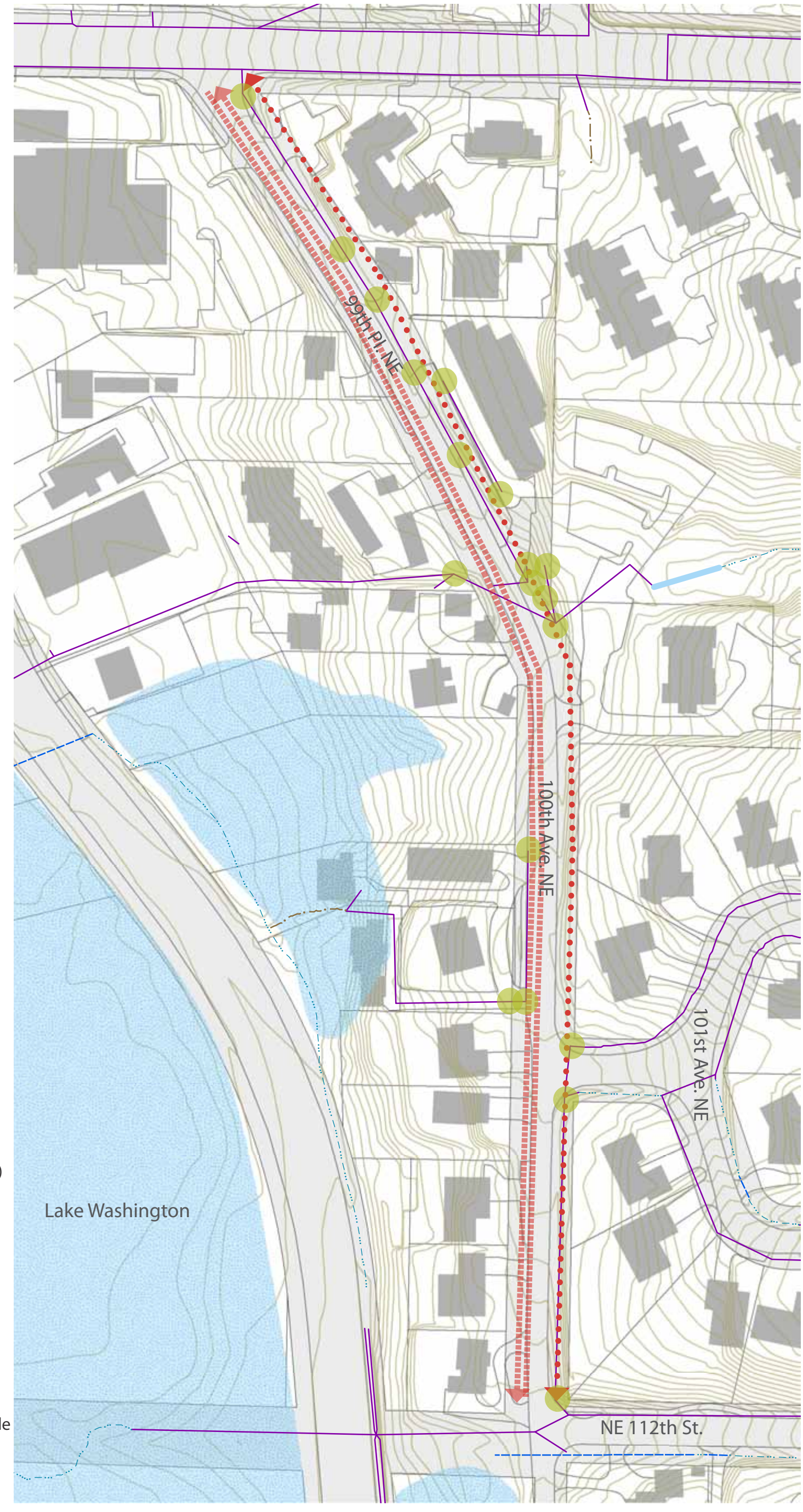
99th Pl. NE /100th Ave. NE existing conditions (looking north)

Proposed concept

- Connect existing sidewalk segments on east side with porous pavement
- Rain gardens at existing catch basin locations, possibility of stepped or cascading stormwater planter or rain garden design depending on size of catchment area

99th Pl. NE /100th Ave. NE cascading rain gardens - proposed

99th Pl. NE/100th Ave. (CIP Project#: NM 0060 000)



Legend

- Pedestrian Circulation
- Vehicular Travel Lanes
- Right-of-Way
- Pavement Edges
- Contour Lines (2')
- Stream
- Pipe
- Culvert
- Ditch
- Wetland
- Bioretention swale
- Rain garden or Stormwater Planter

Central Way (CIP Project #: NM 0065 000)

CIP Project Description

Central Way at Lake St. design and construction of pedestrian "bump-outs" at key crosswalks along Central Way

LID Opportunities and Benefits

- Stormwater planters near existing catch basin can attenuate flow and treat some of the runoff from the roadway.
- Stormwater planters and porous pavements will reduce existing impervious areas and reduce runoff from the right-of-way.

Due to the large amount of impervious cover in adjacent areas versus the amount of space available for LID elements, stormwater planters can provide nominal flow attenuation and water quality treatment, but their high visibility will provide enormous public awareness and demonstration benefits of what LID elements look like and how they can be incorporated into the existing right-of-way. In addition, to providing some stormwater benefit, the stormwater planters will provide some safety for pedestrians crossing Central Way.

Zones 1 & 3

General existing conditions & considerations

Crosswalks with no bulb-out

Proposed concept

- Add bulb-out to create a refuge for pedestrians crossing street and promote traffic calming
- Incorporate stormwater planters within bulb-out to serve as a LID demonstration feature as well as to provide nominal water quality improvements

Zone 2

General existing conditions & considerations

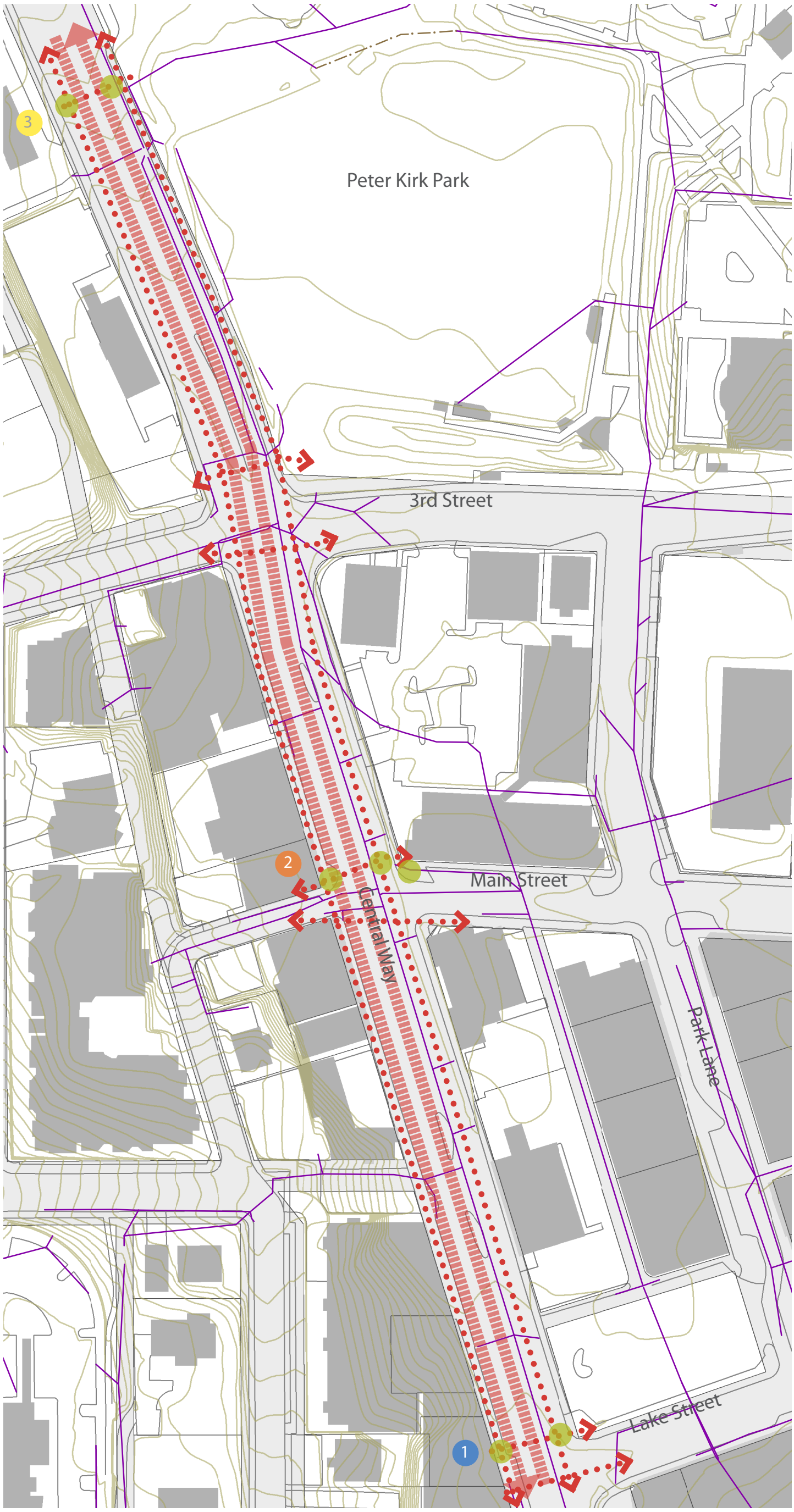
- Crosswalk with no bulb-out
- Striped (unused) parking space surrounding catch basin

Proposed concept

- Add bulb-out to create a refuge for pedestrians crossing street and promote traffic calming
- Incorporate stormwater planters within bulb-out to serve as a LID demonstration feature as well as to provide nominal water quality improvements [same as proposed in zone #1]

In addition:
Utilize striped area and parking spot for stormwater planter to treat runoff from adjacent impervious surfaces

Stormwater planters in bulb-out at Central Way & Main Street - proposed



Legend

- Pedestrian Circulation
- Vehicular Travel Lanes
- Right-of-Way
- Pavement Edges
- Contour Lines (2')
- Stream
- Pipe
- Culvert
- Ditch
- Wetland
- Bioretention swale
- Rain garden or Stormwater Planter

0 100 200 300 Feet

120th Ave. NE (CIP Project #: ST 0063 000)

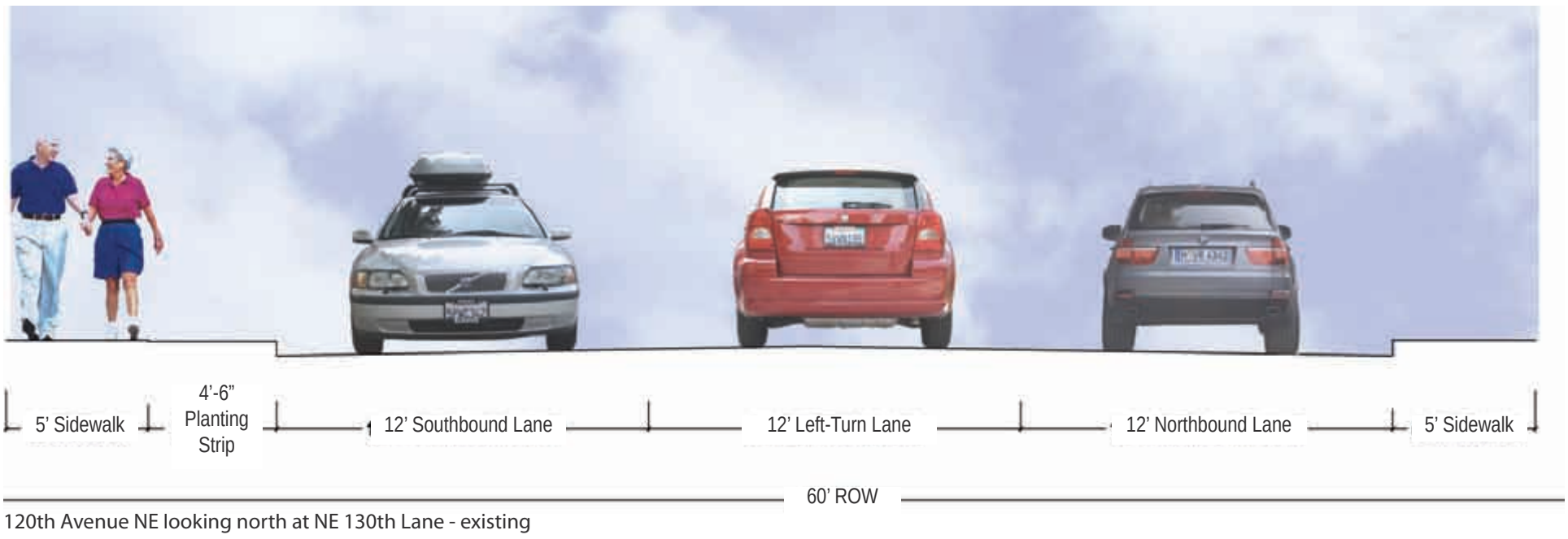
CIP Project Description

Widen 120th Ave. to a five-lane cross section between north of Totem Lake Mall at approximately NE 128th St. NE and NE 132nd St. Final alignment includes two travel lanes in each direction and a two-way left-turn lane along with landscaped median islands, curb, gutter, sidewalk and bicycle lanes. Three signalized intersections will be reconstructed. Project length: ~1,650 ft.
LID opportunities include use of bioswales.

LID Opportunities and Benefits

- North of the Juanita Creek culvert, bioretention swales and rain gardens can treat stormwater runoff from the roadway.
- Additional vegetation and porous pavements will reduce impervious surfaces.
- South of the Juanita Creek crossing, porous pavement sidewalks can provide flow attenuation prior to discharge into the conventional system.

Bioretention swales will provide flow attenuation and water quality treatment for the increased impervious roadway surface prior to direct discharge into Juanita Creek. South of Juanita Creek crossing, porous sidewalks can be used to decrease the amount of new impervious surface that needs to be collected and treated in the conventional system. Demonstrating the importance of localized retention and treatment prior to directly discharging into Juanita Creek is beneficial in this location where commercial transitions to a residential neighborhood within a highly used corridor.



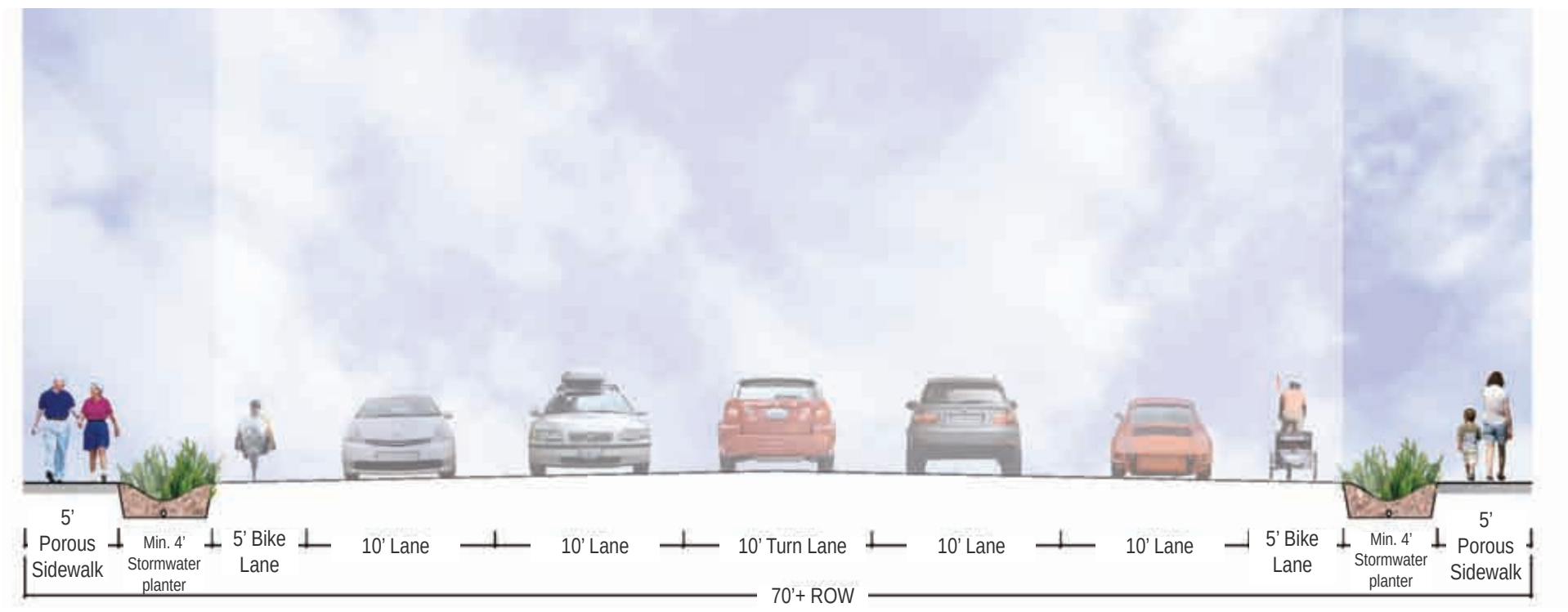
120th Avenue NE looking north at NE 130th Lane - existing

General existing conditions & considerations

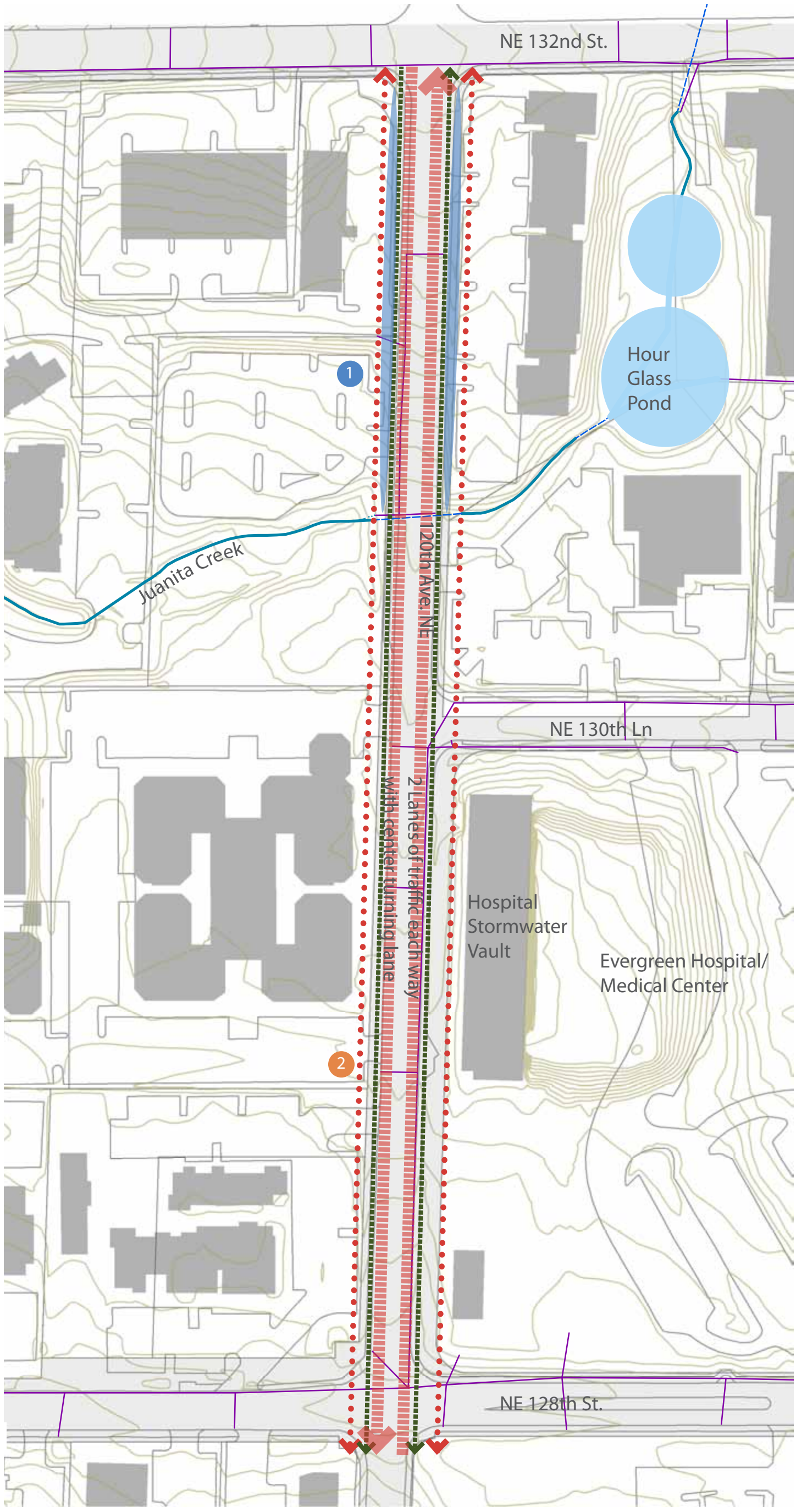
- Stream piped underneath 120th Ave. NE & adjacent parking lots
- ~4% slope between 128th St. & 130th Ln.; ~9% slope between 130th Ln. & NE 132nd St.
- Evergreen Hospital emergency entrance at NE 130th Ln
- Underground stormwater vault for hospital located on east side of 120th Ave. NE south of NE 130th Ln (~200')

Proposed concept

- Stormwater planters on both east and west sides of 120th Ave. NE within area that drains directly to Juanita Creek (north of creek to 132nd)
- Porous sidewalks on both east and west sides of 120th Ave. NE



120th Avenue NE looking north at NE 130th Lane - proposed



Legend

- Bicycle Circulation
- Pedestrian Circulation
- Vehicular Travel Lanes
- Right-of-Way
- Pavement Edges
- Contour Lines (2')
- Stream
- Pipe
- Culvert
- Ditch
- Wetland
- Stormwater Planter
- Rain garden

Park Lane Pedestrian Corridor Enhancements (CIP Project #: NM 0064 000)

CIP Project Description

Aged and failing sidewalks along this corridor due to tree roots that have impacted sidewalk panels between Lake Street and Main Street are a continued maintenance issue. This study will look for opportunities for pedestrian connections to transit and design standards along this corridor. Additionally the valued existing tree canopy will be evaluated and possible solutions for urban trees will be developed.

LID Opportunities and Benefits

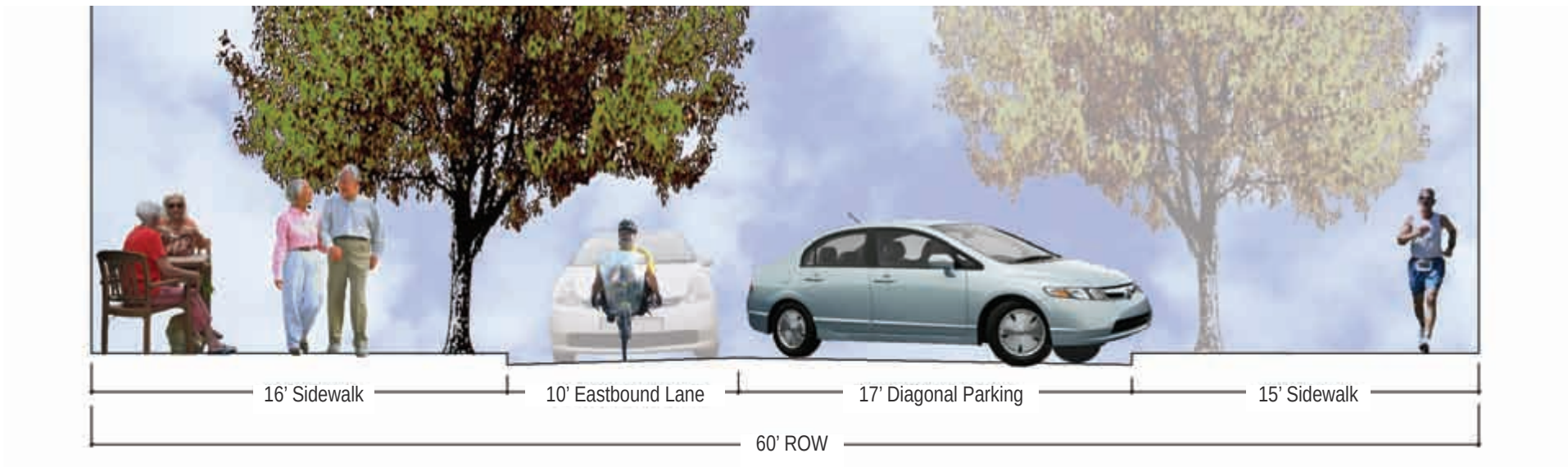
- Porous pavements can provide flow attenuation prior to discharge into the conventional system.
- Bioretention swales and rain gardens can treat stormwater runoff from parking areas.
- Additional vegetation and porous pavements will reduce impervious surfaces.

Both LID elements can be designed to treat runoff for Park Lane to meet water quality requirements. Some stormwater attenuation will be provided, but is not required since Park Lane directly discharges to Lake Washington. Use of porous pavements and raingardens can provide more water to existing trees. LID elements can incorporate "eco-revelatory" design features to showcase water as intrinsic to Kirkland's identity with the inclusion of rain gardens, conservation of existing tree canopy, artistic downspouts and other water features from existing buildings, and porous pavement. These features will help to preserve the natural feel or Park Lane as a connection from the waterfront business area to Peter Kirk Park. In addition, this location will be a "green gateway" from the proposed Downtown Kirkland Transit Center on 3rd Street.

Zone 1 (Park Lane West)

General existing conditions & considerations

- Established tree canopy, but issues with tree root impacts on existing sidewalks
- One-lane, east-bound traffic
- Pull-in diagonal parking
- Sidewalk bulb-outs at cross-walks
- Thriving commercial district
- Popular pedestrian destination



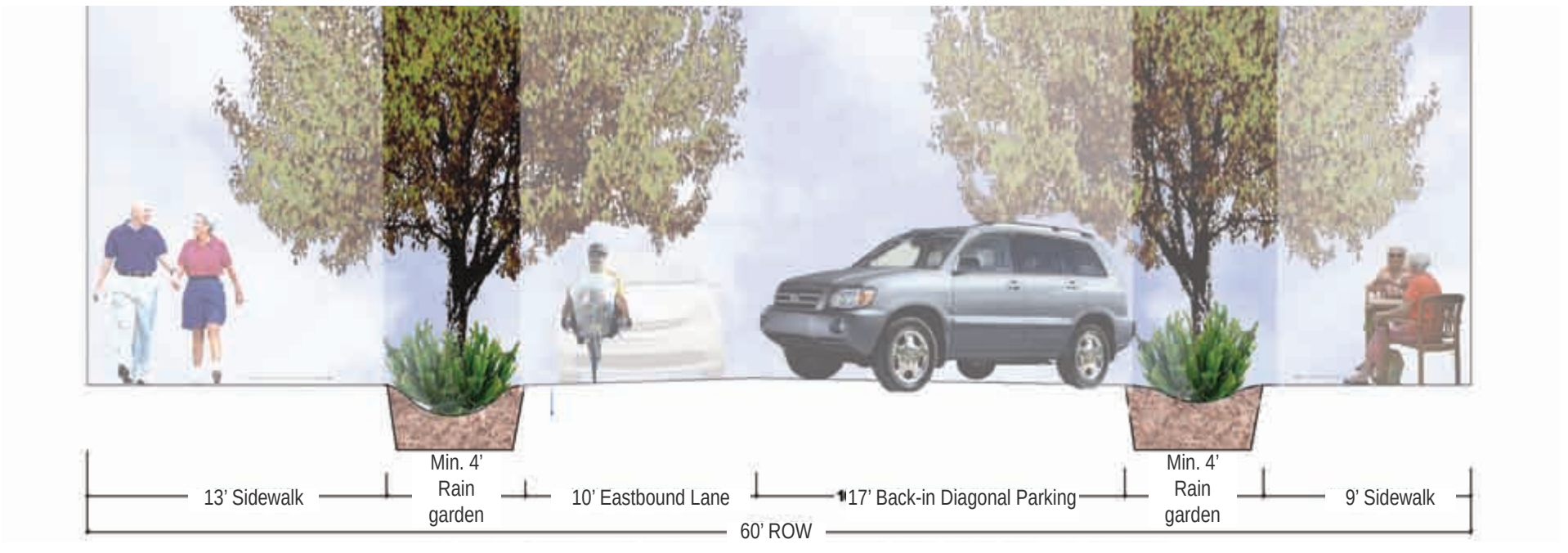
Park Lane looking west between Lake Street and Main Street - existing

Proposed concept

- Conserve existing tree canopy & improve sidewalks by using porous pavement, increasing tree pit size, and/or trimming roots
- Align bulb-outs with larger trees, plant new trees
- Incorporate rain gardens at bulb-outs
- Reveal existence of stormwater with artistic downspout features and/or other water features
- Porous or permeable pavement treatments (can connect to existing storm drainage)

Other considerations:

- Diagonal back-in parking to improve pedestrian and bicyclist safety
- Add plantings to create a buffer between car exhaust and sidewalk users

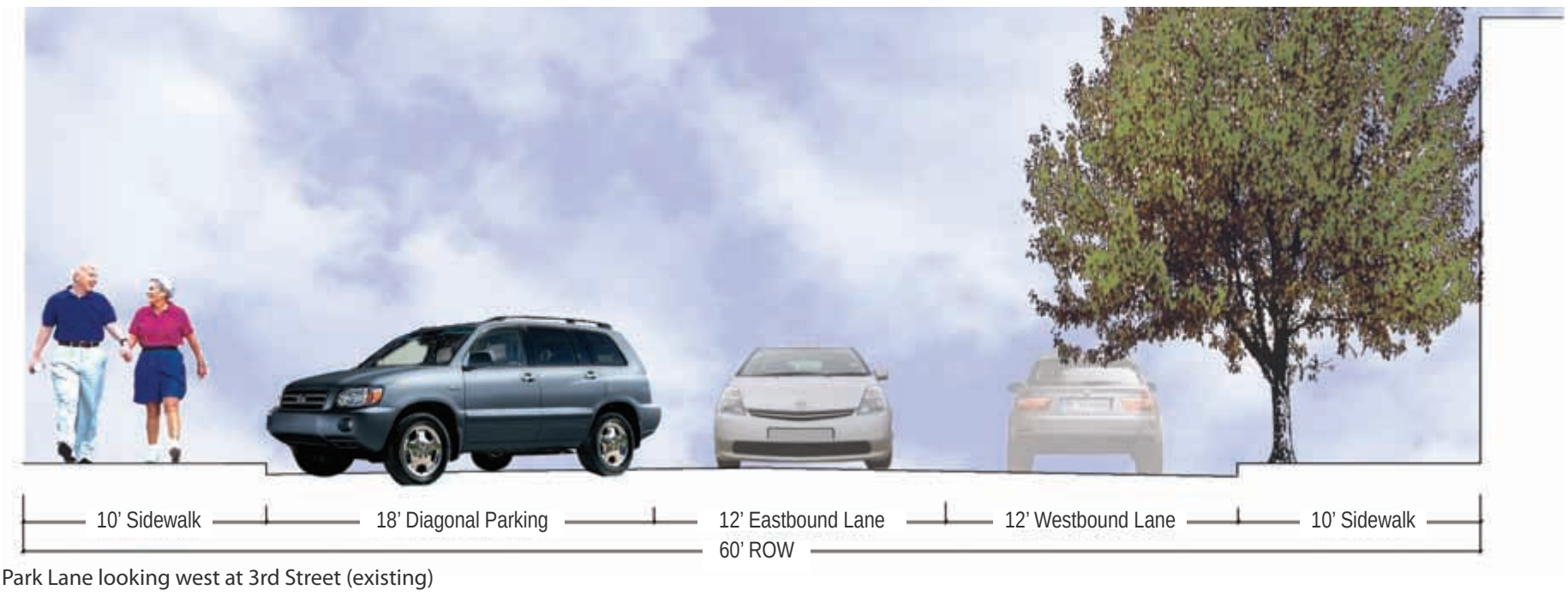


Park Lane looking west between Lake Street and Main Street - proposed

Zone 2 (Park Lane East)

General existing conditions & considerations

- Fewer established street trees than Park Lane west.
- Two-way traffic
- Pull-in diagonal parking
- Farmer's Market location (Wednesday afternoons, May-October)
- Lacks sense of enclosure--no distinct edge on southern side, smaller trees, wide street, and blank walls/rear orientation of businesses on the north side of Park Lane



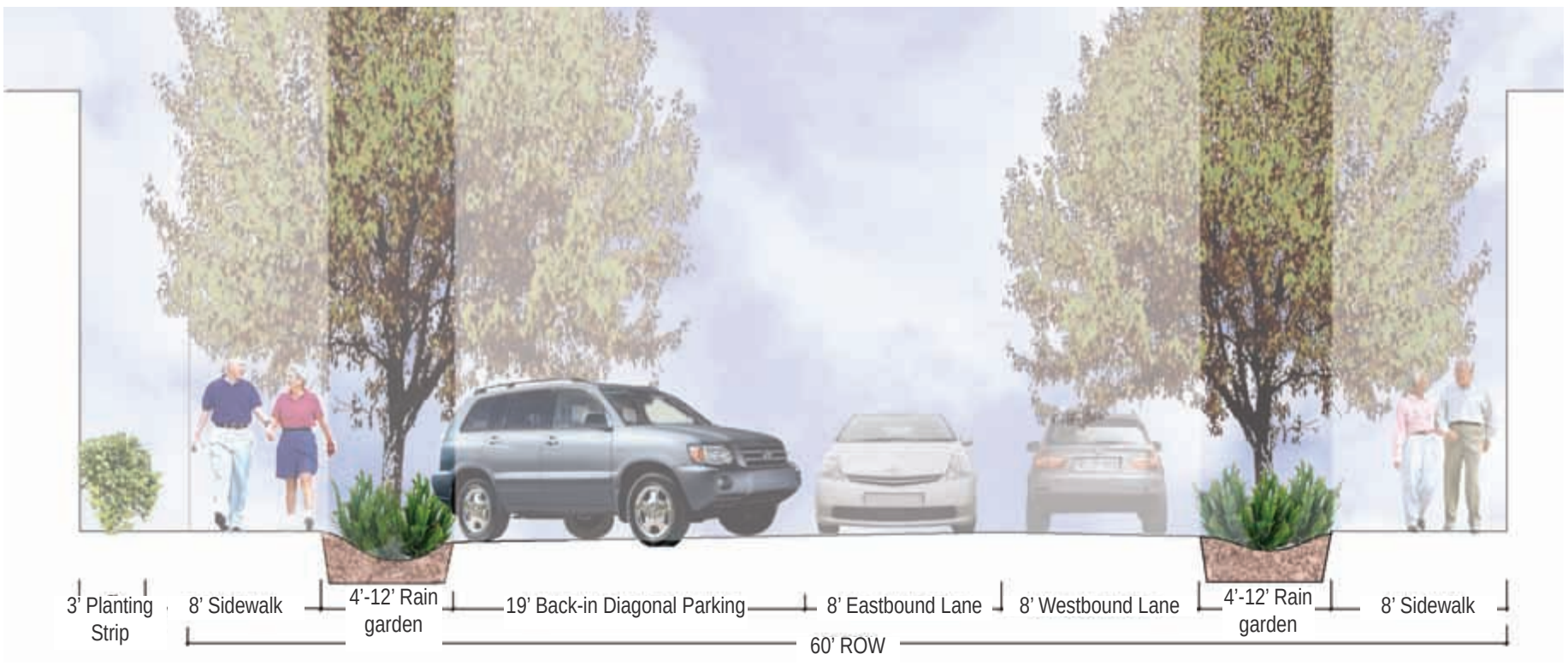
Park Lane looking west at 3rd Street (existing)

Proposed concept

- Plant new trees
- Incorporate rainwater gardens at pedestrian crossing bulb-outs
- Reveal existence of stormwater with artistic downspout features and/or other water features
- Porous pavement treatments can connect to existing storm drainage

Other considerations:

- Diagonal back-in parking to improve pedestrian and bicyclist safety
- Add plantings to create a buffer between car exhaust and sidewalk users
- Include design features to enhance farmer's market aesthetics and meet vendor needs
- Create/revise design guidelines to ensure that future development and businesses will be oriented towards Park Lane



Park Lane looking west at 3rd Street- proposed

Zone 3

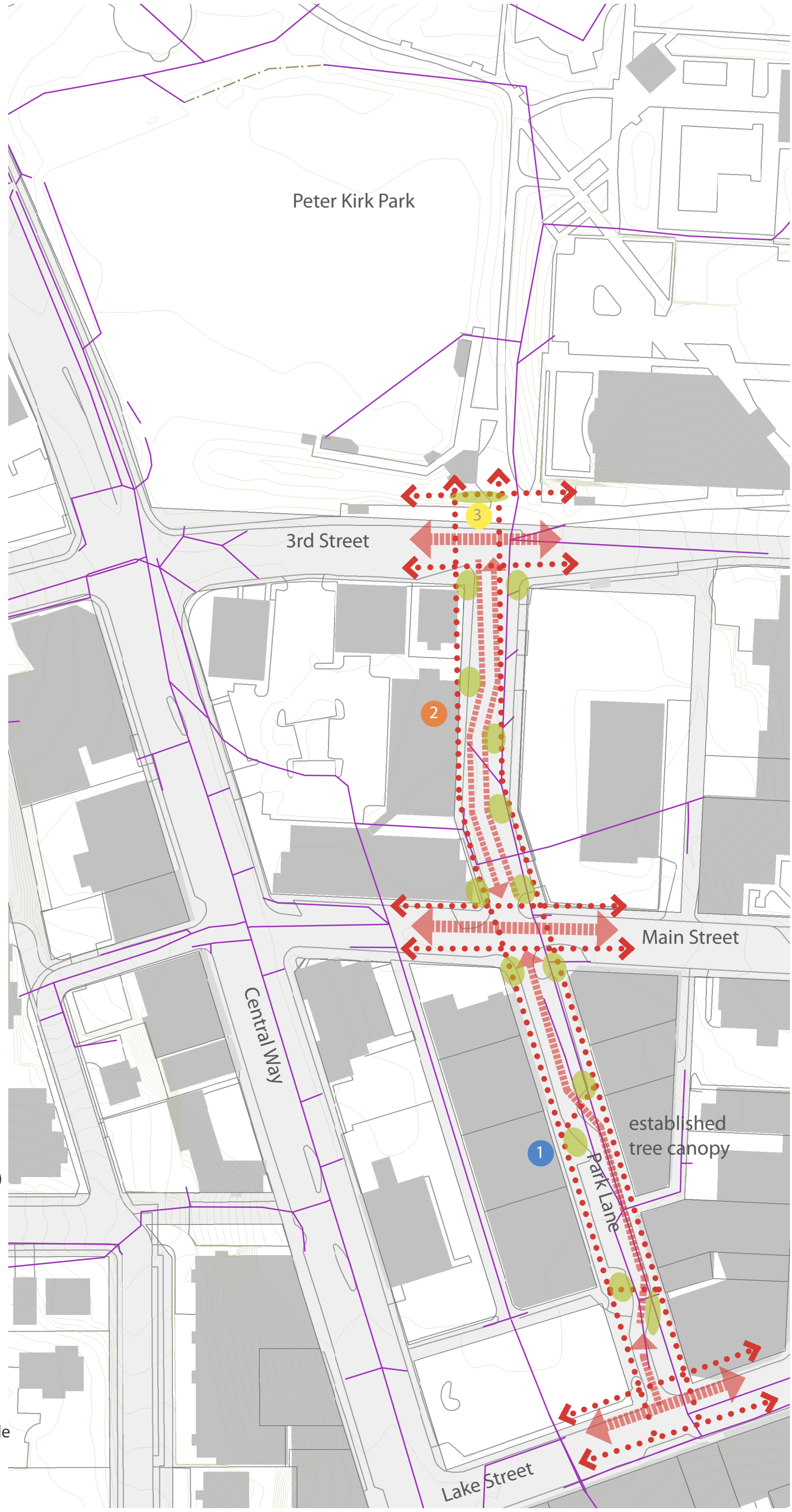
General existing conditions & considerations

Site of future Downtown Transit Center and entrance to Peter Kirk Park

Proposed concept

- Incorporate rainwater gardens at bulb-outs at pedestrian crossings to Transit Center
- Good location for an interpretive display regarding LID features (due to the large number of people who will be waiting in the area)
- Enhance connections between travel modes; provide amenities for pedestrians and transit clients such as benches and shelters

Park Lane Pedestrian Corridor Enhancements (CIP Project #: NM 0064 000)



The following estimate of probable cost for each project includes a unit price for each of the LID elements recommended for the various CIP projects. The unit prices were provided so that as the design of the CIP projects progresses Kirkland staff will have a general idea of the costs for these elements. These unit prices are based on 2007 construction costs and will need to be adjusted for the year that the project is constructed.

The quantities listed for the LID elements was estimated based on the length of the transportation improvements listed in the CIP description. These quantities may increase or decrease based on project revisions and budget. The costs are also not meant to replace all stormwater improvement costs associated with the project. As the designs progress, conventional stormwater management facilities or conveyance pipes may also need to be included.

Estimate of Probable Cost for Installation of Low Impact Development Elements

LID Feasibility City of Kirkland CIP Projects
Prepared By SvR Design Company
1/4/2008

CIP Location (CIP Project Number)		116th Ave. - NE 40th St to NE 60th St. (0001000)		NE 100th St. (0034000)		116th Ave. NE - NE 94th St. to NE 100th St. (0044000)		13th Ave. (0054000)		122nd Ave. NE (0055000)		6th St. (0059000)		99th Pl. NE & 100th Ave. (0060000)		Central Way+ (0065000)		120th Ave. NE++ (0063000)		Park Lane (0064000)	
LID Element	LID Element Unit Cost	Quantity (sq. yards)	Cost	Quantity (sq. yards)	Cost	Quantity (sq. yards)	Cost	Quantity (sq. yards)	Cost	Quantity (sq. yards)	Cost	Quantity (sq. yards)	Cost	Quantity (sq. yards)	Cost	Quantity (sq. yards)	Cost	Quantity (sq. yards)	Cost	Quantity (sq. yards)	Cost
Bioretention / Bioinfiltration Rain garden*	$120	0	$0	0	$0	500	$60,000	10	$1,200	0	$0	100	$12,000	500	$60,000	0	$0	170	$20,400	0	$0
Bioretention / Bioinfiltration Swale**	$120	2,800	$336,000	550	$66,000	1,000	$120,000	0	$0	700	$84,000	300	$36,000	0	$0	0	$0	0	$0	0	$0
Bioretention / Bioinfiltration Stormwater Planter***	$200	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	170	$34,000	0	$0	100	$20,000
Porous Sidewalk - Concrete****	$45	5,889	$265,000	333	$15,000	889	$40,000	444	$20,000	1,167	$52,500	306	$13,750	750	$33,750	0	$0	1,833	$82,500	333	$15,000
Total Estimated Cost for LID in CIP Projects (2007 Costs including installation)		**$601,000**		**$81,000**		**$220,000**		**$21,200**		**$136,500**		**$61,750**		**$93,750**		**$34,000**		**$102,900**		**$35,000**	

Cost Estimate Assumptions:
*Cost for Rain gardens include 1 cubic yard of amended soil, 9 square feet of plantings, 1 cubic yard of excavation, and 3 feet of underdrain, and one overflow or curb cut.
**Cost for Swales include 1 cubic yard of amended soil, 9 square feet of plantings, 1 cubic yard of excavation, and 3 feet of underdrain, and one overflow or curb cut.
***Cost for Stormwater Planter include include cast-in-place wall 2 foot deep along curb line, 1 cubic yard of amended soil, 9 square feet of plantings, 1 cubic yard of excavation, and 3 feet of underdrain, and one overflow or curb cut.
****Cost for Porous concrete include 4 inch thick sidewalk and 6 inch gravel subbase.
+Costs assume ten 10 square yard stormwater planters along Central Way
++Costs do not account for additional right-of-way that may need to be purchased to accommodate LID elements, specifically for 120th Ave NE

Appendix A: Comprehensive Plan Framework Goals

According to the February 2007 City of Kirkland Comprehensive Plan, there are 17 Vision/Framework Goals that "express the fundamental planning principles for guiding growth and development in Kirkland over the 20-year horizon of the Comprehensive Plan." These goals are reiterated here for your reference.

FG-1 Maintain and enhance Kirkland's unique character

FG-2 Support a strong sense of community

FG-3 Maintain vibrant and stable residential neighborhoods and mixed-use development, with housing for diverse income groups, age groups, and lifestyles.

FG-4 Promote a strong and diverse economy

FG-5 Protect and preserve environmentally sensitive areas, and a healthy environment.

FG-6 Identify, protect and preserve the City's historic resources, and enhance the identity of those areas and neighborhoods in which they exist.

FG-7 Encourage low impact development and sustainable building practices.

FG-8 Maintain and enhance Kirkland's strong physical, visual, and perceptual linkages to Lake Washington.

FG-9 Provide safety and accessibility for those who use alternative modes of transportation within and between neighborhoods, public spaces, and business districts and to regional facilities.

FG-10 Create a transportation system which allows the mobility of people and goods by providing a variety of transportation options.

FG-11 Maintain existing park facilities, while seeking opportunities to expand and enhance the current range of facilities and recreational programs.

FG-12 Ensure public safety.

FG-13 Maintain existing adopted levels of service.

FG-14 Plan for a fair share of regional growth, consistent with State and regional goals to minimize low-density sprawl and direct growth to urban areas.

FG-15 Solve regional problems that affect Kirkland through regional coordination and partnerships.

FG-16 Promote active citizen involvement and outreach education in development decisions and planning for Kirkland's future.

FG-17 Establish development regulations that are fair and predictable.

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