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1. Introduction and Plan Purpose

The Municipality of Anchorage (MOA) is moving forward to implement a Green Infrastructure (GI) program to the maximum extent practical. The GI program will require and promote the use of Low Impact Development (LID) and GI techniques on new development and redevelopment projects. The purpose of this Implementation Plan is to provide a guidance document that identifies existing challenges to implementing GI and LID within the Municipality of Anchorage (MOA) and provide a proposed method for addressing and overcoming those challenges.

1.1. APDES Permit Requirements

Incorporating LID and GI in development and redevelopment projects in the MOA is currently a requirement of the joint MOA and Alaska Department of Transportation (ADOT) stormwater discharge permit under the Alaska Pollution Discharge Elimination System (APDES) program. This permit is issued by the Department of Environmental Conservation (ADEC). The current APDES permit, issued in 2010, requires onsite retention of stormwater runoff generated from the 90th percentile rainfall event through the use of LID techniques. The 90th percentile event is described in the permit as 0.52 inches of rainfall in a 24-hour period following 48 hours of no precipitation.

The APDES permit also requires the MOA to provide a mitigation plan for development of sites in which on-site retention is not technically feasible based on limiting site characteristics described in the permit. The MOA researched mitigation programs offered by other cities across the country to begin to formulate a mitigation program that would work for Anchorage. The research showed that most jurisdictions that have mitigation programs also operate some type of stormwater utility. Mitigation is typically achieved through the collection of various types of fees or user costs. The collected money is then managed by the stormwater utility and used to achieve various types of utility-planned projects. In Anchorage, creation of a stormwater utility and collection of stormwater fees is not supported by local law. Given this constraint, the MOA needed an alternate type of mitigation program. Through extensive conversations with personnel at EPA Region 10, ADEC, and national stormwater experts, it became clear that in cases where on-site retention is not feasible, other types of on-site stormwater management may be feasible and would benefit stormwater quality by providing on-site filtration and detention. With this in mind, the MOA began developing an on-site mitigation program that would allow the use of non-retention LID and GI techniques for on-site treatment of stormwater in locations where retention is not feasible.

The retention requirement was intended to be fully implemented by February of 2015, when the current permit expires. As the MOA began working toward implementing this requirement and the associated mitigation plan, the design and development community presented several technical problems and unanswered questions associated with incorporating retention and related LID and GI techniques. Many of these issues are centered on Anchorage's cold climate and associated infrastructure maintenance practices. Rather than attempt full implementation without addressing these issues, ADEC granted the MOA the opportunity to prepare and execute this Implementation Plan to provide a pathway for addressing the community's concerns over a planned time frame. The planned time frame for milestones of this plan is provided in Table 1 below. The Milestones in the table are discussed further in Section 2 of this plan.

Table 1: Implementation Plan Milestone Schedule

Milestone	Target Completion Date
New criteria manual to the public	Spring 2015
Feasibility and ROW width relationship	Summer 2015
GIS Map of Existing Projects	Spring 2015
Private project monitoring plan	Fall 2015
Implement private project monitoring program	Summer 2016
Construction Sequencing Plan requirements	Summer 2015
LID construction considerations course	Spring 2016
MOA LID special inspector certification	Summer 2016
LID Pilot Projects	2016 through 2020

1.2. Looking Forward

Through research of onsite retention and treatment techniques, the MOA found that on a national scale additional information was becoming available regarding the benefits of GI on water quality, and the national outlook on stormwater regulation and began to change. As the MOA began discovering local barriers to onsite stormwater retention, the EPA, on a parallel path, learned that it is not practical to require full retention of runoff generated from a 90^{th} percentile storm event for all cases. They concluded that promotion of broader and more flexible GI techniques is preferred. Led by the EPA, the national outlook on stormwater quality management has shifted from onsite retention to stormwater management through GI. The MOA is expecting this change to be reflected in our next APDES permit, anticipated in 2015. The MOA is expecting the next five years to be focused on implementing GI techniques for water quality management. As this shift was relatively in-line with the MOA's on-site mitigation program, only small changes in program planning and design criteria are needed to reflect this shift.

2. What is LID and GI?

Development and urbanization affect both the quantity and quality of stormwater runoff. Development increases peak flows and runoff volumes while concurrently increasing both the concentration and types of pollutants carried by runoff. Urban development within a watershed has a number of direct impacts on downstream waters and waterways including changes to stream flow, changes to stream geometry, and degradation of aquatic habitat.

LID and Green Infrastructure are terms given to a way of development that seeks to minimize disruption of an area's natural hydrology. LID works with nature to manage stormwater runoff as close to its source as possible, instead of collecting and disposing of stormwater as quickly as possible. LID employs principles such as preserving and recreating natural landscape features, minimizing effective impervious surfaces, and allowing vegetation and soil to provide natural cleaning and filtration. The LID approach seeks to create functional and appealing site drainage that treats stormwater as a resource rather than a waste product. There are many practices that have

been used to achieve to these principles such as bioretention facilities, infiltration facilities, vegetated filter strips, vegetated rooftops, rain barrels, and permeable pavements.

3. Addressing the Issues

As mentioned in Section 1 of this plan, the Anchorage design and development community has presented several technical concerns with incorporating LID and GI. These include:

1. Local Site Constraints
2. LID Causing Damage to Roadways
3. Lack of Performance Record
4. Conflicting MOA Policies
5. Lack of Public Knowledge
6. New Development vs. Re-Development
7. Phasing in Existing Projects
8. Maintenance Concerns

Each of these items are discussed in detail below.

3.1. Local Site Constraints

Problem. Development and re-development in Anchorage present many physical site constraints that can be seen as a barrier to implementing LID. These constraints include poorly infiltrating soils, shallow bedrock, high groundwater tables, extreme space constraints, utility conflicts, and heavy sediment accumulation from wintertime sanding activities. These types of challenges are present on many or most development and re-development projects in Anchorage.

Proposed Solution. To address these concerns, the MOA is currently developing adaptive design criteria that include various stormwater management controls intended to work successfully in many of these types of conditions. For example, for poorly infiltrating soils, facilities like rain gardens can be designed with perforated underdrains to collect excess water and carry it away instead of allowing water to pond or cause localized flood. The MOA's new stormwater management design criteria manual is anticipated to become publically available in 2015.

The MOA also recognizes that in some cases, LID implementation will not be feasible or practical. For cases with multiple constraining elements, such as extreme space constraints *and* a high groundwater table, LID techniques may not be the best way to provide water quality protection. For cases where LID is not feasible, the MOA has included an allowance for more traditional forms of water quality treatment.

Over the course of the next APDES permit, the MOA and ADOT will complete at least five LID pilot projects to demonstrate successful application of LID in Anchorage. WMS is looking for project opportunities that will address on-site constraints and demonstrate successful ways to overcome them. These pilot projects will then be monitored so that design criteria and practices can be adapted to best suit various site constraints. These projects and the resulting performance monitoring will also be publicized as much as possible to maximize the benefit of lessons learned. Public education and outreach is discussed further in section 3.5.

3.2. LID Causing Damage to Roadways

Problem: Roadway designers both within the MOA and in the public design community have expressed concern regarding the feasibility of LID and GI within public roadway and with managing stormwater within or near roadway structural sections. There is concern that infiltrated water can cause damage to the structural section, particularly because of Anchorage's freeze-and-thaw cycles, which tend to cause roadway heaving and cracking even under normal development scenarios. Current responsible engineering practice emphasizes that stormwater runoff should be directed away from roadways as quickly as possible. The concept of slowing runoff and managing it near a roadway has caused alarm for many designers.

Roadway designers are also concerned with conflicting demands for space within right-of-way areas that are fairly narrow. It is becoming more difficult to accommodate increasing traffic volumes, federal and local safety requirements, and the demand for multi-use corridors. In many locations in Anchorage, widening a narrow right-of-way would be detrimental to surrounding businesses and residential homes. In many cases, surface space is not available for LID and GI facilities, and subsurface facilities are either infeasible based on constraints such as groundwater depth, or the designers are concerned with structural integrity of the roadway as discussed above.

Proposed Solutions. The MOA is working a three-part solution to the concerns with LID and GI in roadways.

1. Many other jurisdictions across the US have experienced success with LID and roadways, but few of these applications experience Anchorage's frost depths (approximately 10 feet on average for a cleared roadway) or the repeating freeze-thaw cycle that Anchorage commonly experiences in the spring and the fall. Examples from other cold climate states such as Minnesota and New Jersey indicate that LID in roadways can be successful if it is applied appropriately. The MOA needs to demonstrate this through successful completion of roadway pilot project(s). Roadway LID pilot project(s) will help determine which applications are best-suited for roadway use, and provide a local example for concerned designers. The MOA continues to actively seek opportunities for LID pilot projects on municipal road projects and to continuing educating roadway designers on the appropriate applications of various LID techniques. The WMS section of the MOA is working with project managers in Public Works to find a municipal road project that can be used as an LID pilot project.

2. The MOA is developing an incentive for roadways to incorporate LID. For cases where LID is feasible along most of a roadway length, but not the entire length, the incentive allows the roadway treatment to focus on treatment for the feasible areas without being penalized for the rest. This essentially eliminates the need for duplicate stormwater treatment systems (both LID and traditional treatment), making LID more feasible and decreasing the overall treatment cost.

3. The MOA is working toward examining the relationship between right-of-way width and feasibility of LID/GI in roadways. There is initial evidence that LID and GI can be quite successful in cases where adequate space is available in the right-of-way. The MOA would like to quantify this relationship and focus LID and GI implementation in cases where it is most likely to be successful while providing an alternate pathway for cases that are technically infeasible. For roadway projects that have a ROW width greater than 60 feet, the MOA is developing a program that will analyze GI feasibility on a case-by-case basis. Feasibility determination will be based on specific site conditions so that conclusions can be drawn

regarding applicability of various types of GI techniques under a wide range of local roadway development conditions.

3.3. Lack of Performance Record

Problem: Designers and project owners throughout the Anchorage community have presented the concern that LID techniques are new in Anchorage and that project longevity and performance record is not known. Without data to demonstrate LID techniques can meet the project's proposed design life, engineers, project managers, and developers hesitate to include LID in their designs and budgets. This is especially true for capital projects that are publically funded. There is a common perception that using public funds for LID is not responsible.

Proposed Solutions. Despite public perception, many projects that have used LID techniques have been completed in Anchorage over the past 20 years. Most of these projects are private-sector projects, and they are not well-known. The MOA has formed a committee called the Green Infrastructure Working Group (GIWG). The GIWG is made up of community professionals in disciplines such as engineering, landscape architecture, arboriculture, and planning. This committee is compiling a list and creating an associated map of existing LID projects in Anchorage. They are providing as much information as possible about the performance and design of the existing projects. Once this project is completed, it will be provided to the public as a resource for LID performance record. The MOA is also considering utilizing the GIWG to develop an LID educational video for engineers and project managers.

The GIWG has also been asked to provide monitoring data (visual or other) for LID projects that they are currently working on or have previously completed. Many designers casually monitor their own projects, and this provides a way organize and track that performance information.

As discussed in section 3.1, the MOA is expecting the new stormwater design criteria manual to be made public in 2015. As LID and GI become required for projects, the number of sites in Anchorage that could offer valuable performance data will increase. The MOA will develop a program to track as many of these sites as possible for "pilot project monitoring." This way, even if the MOA was not involved in the design or construction, the performance of various LID techniques at sites with a number of different site constraints will be collected and documented. This is also anticipated to help answer questions regarding infiltration in various soils types, ideal design factors of safety for infiltration rates, and how to match particular techniques to given site conditions. The program will include a mechanism to regularly update the criteria manual based on findings. This proposed program is discussed further in Section 3.4.

3.4. Conflicting MOA Policies

Problem. Many private-sector designers have expressed concern that LID requirements conflict with other MOA development requirements. For example, if stormwater is directed into a bioretention facility, the bioretention facility will require vegetation that can withstand alternating wet and dry conditions and can provide appropriate pollutant uptake. In many cases, these types of plants are not included as MOA-approved landscaping vegetation. If the plants do not meet landscaping requirements, the bioretention facility does not "count" as landscaping and the designer lacks adequate space to include additional landscaped areas.

Proposed Solution. For these types of situations, the MOA has developed alternative-compliance allowances in local code. If a project encounters MOA regulations that are conflicting with LID application, WMS will provide a pathway for project approval through alternative compliance. The alternative compliance program will also alert WMS to new LID projects that are candidates for performance monitoring, as discussed in Section 3.3 above. This program will be developed and implemented in 2015, along with the release of the new criteria manual.

3.5. Lack of Public Knowledge

Problem. Anchorage's design and development community remains largely unaware of the purpose, need, design, and construction considerations related to LID. Successful implementation of LID requires careful consideration of site details and construction methods and sequencing. For example, if heavy construction equipment is driven over areas that are intended to be used for infiltration, the soil will compact, and its infiltrative capacity will decrease. Poor construction practices also skew project performance monitoring because measured conditions are not reflective of design assumptions. During construction of the MOA's current pilot projects, it became evident that additional education and outreach is needed for engineers, contractors, developers, and other stormwater professionals.

Proposed Solution. The MOA is proposing three components to a solution for this problem.

1. *Construction Sequencing Plan.* The upcoming stormwater criteria manual will include a requirement for designers to provide contractors with a Construction Sequencing Plan (CSP) for LID facilities. The CSP will identify and discuss specific construction activities, considerations, and proposed order for any proposed LID facilities that are included in the design. To aid designers in developing this plan, the new criteria manual includes a discussion of common construction sequencing considerations for each LID tool presented in the manual. This list will then be tailored and expanded to reflect the actual site conditions for each project.
2. *LID Construction Considerations Course for Contractor*s. The MOA will develop and host a training course for contractors that discusses basic construction considerations related to LID construction. This course will discuss the lessons learned from other projects and encourage discussion of additional considerations based on the participants' field experience.
3. *MOA LID Special Inspector Certification*. The MOA currently maintains a special inspector certification program. This program requires that certified inspectors be onsite to observe and approve certain types of construction. For example, a special inspector certified in concrete inspection is required for certain types concrete work and a special inspector certified in soils is required for fill and grade work. The MOA would like to develop a special inspector training and certification course for inspecting LID facility construction. This would allow a knowledgeable inspector to be present for all or portions of LID construction to ensure that the overall design intent is maintained.

In addition to these measures, the MOA completed two LID trainings for design professionals in 2013 and will continue to provide public education through the very successful annual stormwater meetings.

3.6. New Development vs. Redevelopment

Problem. Several designers have expressed a concern that LID is only feasible for new development projects and is not feasible for redevelopment. The new stormwater criteria manual will require LID to be implemented for both cases.

Proposed Solution. This concern is similar to the concern regarding lack of performance record for LID projects, which is discussed in Section 3.3. The MOA is planning to diffuse this concern through selecting redevelopment for LID pilot projects and/or highlighting private sector redevelopment projects that use LID techniques successfully.

3.7. Phasing in Existing Projects

Problem. The design and development community has expressed concern over how existing or phased projects would come into compliance with the new regulations. For example, if a project was started in 2014 under the old criteria, and is not completed until 2015 when the new criteria are released, it would be problematic for the project to comply with the new requirements.

Proposed Solution. The MOA is currently developing alternatives for how this can be handled. One option is to allow an introductory period of time where project designers can choose which criteria to follow, the old or the new. This is similar to the way the MOA introduced the new municipal code, Title 21.

3.8. Maintenance Concerns

Problem. Local maintenance personnel and designers have expressed concern regarding the frequency and type of maintenance that will be needed for LID facilities. Because most people are not familiar with these types of facilities, there is concern that the work will exceed maintenance capabilities and budgets for both private and public facilities. Additionally, just as Anchorage does not have a long-term LID performance record, we also do not have a long-term maintenance record for LID facilities. The relationship between facility life expectancy and maintenance frequency is also a concern.

Proposed Solution. The MOA recognizes that maintenance is a critical component of a successful LID program in Anchorage. To help facilitate appropriate and reasonable maintenance requirements, WMS has involved the MOA street maintenance personnel in the development of the new criteria manual as much as possible. The new criteria manual is also being developed with the intent to minimize maintenance needs. A “recommended maintenance” discussion has been added to the criteria for each stormwater control. This section is based on research from other communities and on feedback from local stormwater professionals. It includes both recommended activity and the frequency it should generally occur.

The MOA would like to incorporate maintenance tracking into the performance record monitoring discussed in Section 3.3. This would begin to provide a data-based record of what types of maintenance activities are required for various types of LID techniques and specific site conditions.

The MOA is considering a future education program for maintenance personnel and is looking for opportunities to improve communication between maintenance personnel and designers.

4. Summary

Through working with design and development professionals in Anchorage, the MOA has identified several obstacles to successful LID implementation. These obstacles can be overcome through implementation of the measures identified in this plan. A brief summary of the challenges and proposed solutions is provided in Table 2 below.

Table 2: Summary of Issues and Resolutions

Item No.	Description of Issue	Proposed Resolution
1	Local Site Constraints	Adaptive design criteria, flexibility for specific cases, and additional pilot projects
2	LID Causing Damage to Roadways	Pilot projects and design incentives
3	Lack of Performance Record	Compilation of existing projects and a new tracking program for future private sector projects
4	Conflicting MOA policies	Alternative compliance options
5	Lack of Engineering and Construction Knowledge	Construction sequencing plan, LID course for contractors, and LID special inspector certification
6	New Development vs. Re-Development	Additional pilot projects and performance record tracking
7	Phasing in Existing Projects	Flexibility for a specified period of time
8	Maintenance Concerns	Address maintenance in new criteria manual, incorporate maintenance into performance tracking program, and facility better communication with maintenance personnel