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LOW IMPACT DEVELOPMENT FOR INDUSTRIAL AREAS

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14. ABSTRACT
Low impact development (LID) technology is an alternative method for maintaining pre-existing hydrology after a major renovation or for reducing stormwater pollutants that can degrade water quality and aquatic habitat in rivers, bays, and harbors.. The document provides guidance for selecting appropriate LID technologies that enable installations to comply with Navy LID policy and regulatory requirements. The objective of this project included conducting a literature review and developing a decision support system (DSS) for end users to select appropriate LID technology for pollutant treatment or for reducing the volume of stormwater runoff. This report describes the work involved in developing the DSS. Recommended follow-on work includes evaluating the performance and maintenance of a specific LID technology over time. Additionally, there is a data gap on the LID maintenance requirements and corresponding costs at Navy bases.

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Navy Environmental Sustainability Development to Integration Program

Low Impact Development for Industrial Areas

NESDI Project# 493

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NESDI FINAL REPORT

NESDI Program
Final Report

Low Impact Development for Industrial Areas
Project #493

July 2015

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EXECUTIVE SUMMARY

Stormwater program managers are faced with increasingly stringent stormwater discharge limits for heavy metals such as copper, zinc, nutrients, total suspended solids (TSS), oil and grease. These limits are required to reduce contaminant loading to a level that allows receiving waters to achieve acceptable water quality standards. Typically, the U.S. Environmental Protection Agency (U.S. EPA), state agencies, and local agencies set permit limits as part of the total mass daily loading regulatory framework.

Compliance can be a challenge due to the large number of stormwater outfalls, sheer volume of water, land area, and industrial processes at a typical military installation. Additionally, installations must comply with Energy Independence Security Act (EISA) Section 438 and the Navy Low Impact Development (LID) policy. Both require installations to implement LID technologies when new construction or major renovation exceeds 5,000 square feet or has a capital investment of at least $750,000.

EISA 438 requires any development or redevelopment project involving a federal facility with a footprint that exceeds 5,000 square feet to use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow.

The Navy LID policy builds upon EISA 438. The Department of the Navy has set the policy to comply with the precepts of LID for "no net increase in stormwater volume and sediment or nutrient loading from major renovation and construction projects". Major renovation projects are defined as "having a stormwater component and exceeding $5 million when initially approved by Deputy Assistant Secretary of the Navy". Major construction projects are those exceeding $750,000. The policy also applies for any project greater than 5,000 square feet (U.S. Army Corps of Engineers 2010).

LID can satisfy the regulatory pollutant compliance set by the EPA and the Navy LID policy. However, the Navy needs guidance on selecting the appropriate LID for implementation as well as coordinating the efforts among Capital Improvements, Environmental and Asset Management. The deliverable of this project, the Decision Support System (TR-NAVFAC-EXWC-EV-1507 *Stormwater Management Decision Support System for Using Low Impact Development Best Management Practices in Industrial Areas*), guides the end-user in selecting the most effective LID, placing it in the most effective location, and informs the end-user the maintenance required. The DSS and the literature review (TR-NAVFAC-EXWC-EV-1506 *Literature Review of Low Impact Development for Stormwater Control*) that was the foundation to the DSS can be found at the Defense Technical Information Center.

ACRONYMS AND ABBREVIATIONS

BMP	Best Management Practice
DSS	Decision Support System
EISA	Energy Independence Security Act
LID	Low Impact Development
NAVFAC EXWC	Naval Facilities Engineering and Expeditionary Warfare Center
NPDES	National Permit Discharge Elimination System
TSS	Total Suspended Solids
US EPA	United States Environmental Protection Agency

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1.0 INTRODUCTION

1.1 Background

Stormwater program managers are faced with increasingly stringent stormwater discharge limits for heavy metals such as copper, zinc, nutrients, total suspended solids (TSS), oil and grease. These limits are required to reduce contaminant loading to a level that allows receiving waters to achieve acceptable water quality standards. Typically, the U.S. Environmental Protection Agency (U.S. EPA), state agencies, and local agencies set permit limits as part of the total mass daily loading regulatory framework.

Copper, zinc, lead and other heavy metals are often found in stormwater runoff from industrial sites. These metals can originate from atmospheric deposition, run-on from adjacent sites, vehicle traffic, industrial operations, and erosion/oxidation of metal in building materials. Operations such as blasting, grinding and storage of metals at industrial sites are examples of activities contributing to metals in stormwater runoff. Galvanized roofing material and copper gutters can also be significant sources of metal pollutants. Other studies indicate that vehicle disc brake pads and car tires can be a significant source of copper, lead or zinc in runoff from paved areas.

Stormwater generated at Navy industrial sites (particularly during the “first flush”) can exceed the emerging metals, nutrient, oil and grease benchmark limits. Due to the large number of stormwater outfalls at each Navy installation and the sheer volume of water and surface area, the Navy is faced with a costly endeavor to comply with their National Pollutant Discharge Elimination System (NPDES) permit requirements across the country. Further complicating the matter at many Navy bases is the lack of available space for implementing a structural solution to capture and treat the runoff. Navy bases in Puget Sound, the Southwest and Hawaii have similar issues with metals and other contaminants in stormwater from their industrial areas, along with limited available space. Although each of the geographic locations varies in precipitation, they all need tools and solutions to comply with their NPDES permit requirements.

In addition to meeting the regulatory requirements in NPDES permits, installations must also comply with Energy Independence Security Act (EISA) Section 438 and the Navy Low Impact Development (LID) policy. Both regulations require installations to implement LID technologies when new projects exceed 5,000 square feet or $750,000.

1.2 Regulatory Drivers

The regulatory drivers for this project include stormwater NPDES permits, EISA Section 438 and the Navy LID policy. As mentioned above, the stormwater NPDES permits have pollutant limits that restrict the amount of pollutants being discharged in stormwater outfalls. Installations may comply with these limits by reducing the pollutants at the source or by capturing and treating the stormwater. LID technology can assist in capturing and treating certain pollutants for permit compliance. In addition, LID may be a better alternative to typical standard structural BMPs in terms of cost and performance.

EISA 438 requires installations to maintain or restore to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow. EISA 438 is triggered for any project that is greater than 5,000 square feet.

The Navy LID policy is similar to the EISA 438 policy. The Department of the Navy has set the goal for “no net increase in stormwater volume and sediment or nutrient loading from major renovation and construction projects”. Major renovation projects are defined as “having a stormwater component and exceeding $5 million when initially approved by Deputy Assistant Secretary of the Navy”. Major construction projects are those exceeding $750,000. The policy also applies for any project greater than 5,000 square feet (Penn 2007).

1.3 Objective of the Project

The objectives of this project were to first identify appropriate LID technologies that are suitable for Navy industrial areas such as waterfronts, airfields, and maintenance and repair facilities; and subsequently, to develop a decision support system (DSS) that allows facility and stormwater managers to choose a LID system(s) that is applicable to their requirements.

2.0 TECHNOLOGY DESCRIPTION

2.1 Technology Overview

Figure 1 Bioretention Cell at Washington Navy Yard

The low impact development approach works best by reducing runoff at the source via infiltration, evaporation, storage, and/or treatment. A LID system functions as a series of smaller units that can be summed up together as a larger stormwater treatment system. Capturing the rainfall at or near the source, reducing the overall energy of the runoff, and volumetric storage are some of the traits unique to this methodology. This project had used this concept to identify and evaluate LID technology. The systems can also be designed to mitigate a targeted range of pollutants. Figure 1 shows a retrofit using a bioretention cell at the Washington Navy Yard. Bioretention cells and vegetative filter strips are part of an integrated system designed to tackle the runoff from a site. LID technology is typically integrated into an existing infrastructure and designed to minimize stormwater runoff specifically for that site. However, LID system can also be implemented in new construction planning. The LID decision support system will be able to function under both retrofits to existing construction and for new construction efforts that need to reduce stormwater to be in compliance with the Navy LID policy or local stormwater requirements.

Attributes of applicable technology that could be used in industrial areas include:

1. Minimal surface footprint
2. Used in locations with high water tables
3. Unobtrusive to military operations
4. Reliable performance
5. Infrequent maintenance requirements
6. Performance on reducing targeted stormwater constituents
7. Ability to customize the treatment system through the use of advanced media and plants that uptake or volatilize the pollutants
8. Ability to service or replace the treatment media
9. Available spare parts and simple support requirements

The foundation of this system is the combination of the high rate of flow through the media and associated unit treatment processes that filter and uptake pollutants so that they are removed from the runoff. The media mix is selected depending on the target pollutants expected in the runoff flow. Sediment is removed via filtration and sedimentation. These processes can occur in the sorptive media, plants, and/or the media enclosure. Specialized media can be selected to remove phosphorus (iron and/or aluminum hydroxide material), heavy metals (organic/ inorganic mixtures, such as compost/steel slag), oils and other hydrocarbons (mulch and compost), and other pollutants of concern. After the useful treatment life, the media can be mechanically removed from a containment system such as a bioretention cell and be disposed of in an acceptable solid waste facility. If the media is contained in a mat, it can be rolled up and disposed of as a whole.

The literature review phase of this project was conducted prior to creating the decision support system. The literature review was crucial for the development of the decision support system because it provided information on LID technologies concerning performance and operation and maintenance. The literature review involved reviewing scientific journal articles, visiting installations with LID technologies implemented, and gathering information from the private industry.

2.2 Advantages and Limitations of the Technology

Advantages with using this technology include aesthetics, effective in capturing and treating metal pollutants and nutrients, and restoration of pre-project hydrology by reducing the surge of stormwater into the receiving body of water or river. LID may also be a better treatment alternative in terms of pricing. These types of controls can also be used in areas with limited space. For example,

However, the major disadvantage to using LID is the maintenance. Maintenance includes periodically replacing the plants, ensuring that any clogs in the system are removed, and repairing any damages to the system from heavy rain events. Because maintenance can be labor intensive, the user needs to know the full extent of the maintenance required before pursuing a specific LID technology.

3.0 PERFORMANCE OBJECTIVES

Table 1 lists the performance objectives created for this project. Only the qualitative performance objective is listed because the project was focused on the ease of using our product. The performance objective was met by having the end user involved in the development of the DSS. Personnel from NAVFAC HI Environmental, NAVFAC Mid-LANT Capital Improvement and Asset Management, and NAVFAC HQ provided feedback on improving the ease of use and use-ability of the DSS. They agreed that the final deliverable is use-able by the installation.

Table 1: Performance Objectives.

Performance Objective	Data Requirements	Success Criteria
Qualitative		
Ease of use	Feedback from operations, maintenance, and environmental monitoring and reporting personnel	Minimal training and operational reporting

4.0 TEST DESIGN

The development of the decision support matrix for LID systems in Navy industrial areas was the primary objective of this project. To perform this work, the team had to understand the constraints of the problem such as identifying the limitations at Navy sites for introducing LID systems. This step involved characterizing industrial sites and determining limiting factors for LID installation such as vehicle traffic flow, material storage, contaminant concentrations, and contaminant pathways. Once the constraints were identified, the project team looked at the available technology on the market, including innovative LID systems. The literature review was accomplished by identifying and consulting with vendors of the technology and reviewing existing literature. The team also looked at performance, cost, maintenance, limitations, and disposal issues related to each technology.

While conducting the literature review was straightforward, developing the DSS was more complicated. The following was the process used to create the DSS:

1. Conduct literature reviews and review of NPDES water quality monitoring at installations, and permit reports to characterize the soluble and particulate speciation of metals in the runoff.

2. Perform site characterization of Navy industrial areas to develop the performance criteria for LID systems that specifically targeted these areas. Areas targeted include scrap metal recycling facilities, motor pools, metal fabrication shops, and outdoor storage areas.

3. Investigate the unit processes and determine the available technologies and materials that can be used to mitigate the pollutants. These include filtration for removal of particulates and particulate-bound metals, and sorption technologies for dissolved metals. Sorption technologies will require specific media for metals removal.

4. Develop metrics and protocols for the selection of technologies. This includes, but is not limited to, predictability, reliability, and efficiency of performance, size, cost, construction, operations, and maintenance.

5. Report on the effectiveness of technologies and develop prototype designs, specifications, and monitoring protocols that are consistent with regulatory review procedures. A series of fact sheets are provided to the user with detailed information on the sizing, design, construction, effectiveness, and maintenance of the LID BMPs.

6. Develop the decision support system. The DSS presents generalized and “common sense” approaches for selection of practices that are cost-effective and will have positive results at reducing or eliminating heavy metals from stormwater. A series of templates have been developed to guide the user for the proper location, configuration, and design of the practices. The DSS

provides the following design templates:

- Sheet 1: Schematic of BMP Practices
- Sheet 2: Building Improvements
- Sheet 3: Downspout Disconnection
- Sheet 4: Filter Strip
- Sheet 5: Bioswale and Curb Cut
- Sheet 6: Tree Box Filter and Proprietary Devices
- Sheet 7: Metal Fence Treatment
- Sheet 8: Inlet Modification
- Sheet 9: Processing and Storage Area
- Sheet 10: Curb Cut

5.0 PERFORMANCE ASSESSMENT

Throughout the lifecycle of LID, various departments (capital improvement, asset management, public works and environmental) must coordinate efforts to select, construct and maintain the selected LID technology. Their coordination is essential to smoothly implement LID. Because the DSS involves the four departments, they provided continuous feedback on the DSS throughout the development of the DSS. Conference calls were conducted among the different departments as needed to ensure that the final product was applicable and easy to use. NAVFAC Atlantic Capital Improvement, NAVFAC Pacific Environmental, NAVFAC Headquarter Environmental and NAVFAC Southeast Public Works were part of the ongoing discussion in tailoring the DSS to a product that they can use. After the DSS was completed, the document was again sent to the various NAVFACs for their feedback. After continuous discussion and revisions to the DSS, the users have determined the DSS to be useable and applicable to Navy industrial areas. The DSS had successfully met the ease of use and adaptable to Navy industrial area qualitative criteria for this project.

6.0 COST ASSESSMENT

A return on investment or cost assessment cannot be calculated at this time, but can given knowledge of site and LID technology specific capital investment costs, Notice of Violations fees, and labor costs associated with the existing and proposed technology. These types of information varies because every installation has different environmental compliance requirements, and the costs of installing and maintaining LIDs and NOV fees (if any) will vary. Despite cost differences, the intangible benefits will be the same (Figure 2). Intangible benefits of this project include increased community relations, increased regulatory compliance and better understanding of the technology. This project provides more information on low impact development and its potential processes and uses. By understanding the technology better, the user may see more opportunities to utilize LID. Better community relations can be developed by demonstrating to the public that the Navy is proactive in maintaining compliance with its stormwater discharges. Lastly, increased regulatory compliance is achieved when LID controls are used to maintain pollutant concentrations within the permit limits.

Technology Integration Intangible Benefits

Select intangible benefit to add: Better Understanding of Technology | Add

Intangible Benefit	Additional Description	Edit	Delete
Community Relations	Demonstrate to the public that the Navy is proactive in the areas of stormwater control	Edit	Delete
Regulatory Compliance	Increase the knowlege of planners and designers on which LID technology is ideal for their design constraints. Help develop partnerships with regulatory boards to forward the adoption of LID systems.	Edit	Delete
Better Understanding of Technology	Deliverable will provide more technical knowledge on the capabilities of low impact development and how to select the most appropriate LID control at each installation	Edit	Delete

Figure 2: Intangible Benefits.

7.0 CONCLUSIONS AND RECOMMENDATIONS

This project successfully developed a document that stormwater managers and facility design and planning teams can use to implement LID to comply with their NPDES permits. The document is thorough and user friendly. The DSS will guide and require that environmental, capital improvements, asset management and public works personnel work together in selecting the appropriate LID, sizing it, selecting an appropriate location and maintaining it.

The framework of the DSS includes:

- Identification of Sources of Metals
- Determine Activities and Structures That Can Generate Metals Pollution
- Calculate Pollutant Loads
- Determine if Activity is a Minor Contribution to the Pollutant Load
- Determine if Non-Structural BMPs are Adequate
- Document and Maintain Improvements and Recommendations

Two key components of the DSS evaluation are the calculation of the runoff volume and the determination of the pollutant loads at the site under investigation. Runoff calculations are site specific and based on rainfall data. Pollutant load data can be derived based on site information about the specific pollutants or information on surface wash off. The later calculation is based on wash-off study information and can be used as an estimation tool where specific conditions exist.

Consideration of site pollutant loads and site constraints allow selection of the most applicable BMP. LID BMPs considered include Bioretention, Bioswale, Biofilter, Permeable Pavement, Media Filter, Permeable Friction Course, Compost Filter Mat, Vegetated Filter Strip, and Inlet Insert.

While the DSS is the main deliverable, it is complemented by the literature review report. The literature review contains comprehensive information on metals concentrations and characteristics in stormwater, along with various LID technologies and their performance in reducing metals concentrations and loads. This background information was used to build the DSS. Both the DSS and the literature review can be found on the Defense Technical Information Center. See the references below for the report number.

The recommended next steps would be to monitor the performance of LID on select bases. This monitoring would include quantitative evaluation of hydrologic and water quality performance as well as the evaluation of constructability, maintenance, and aesthetics. In addition, the DSS should be posted and be downloadable on the LID tab under e-Projects. That way, users can have easy access to the document and the DSS can be used to assist in implementing LID on installations.

REFERENCES

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