Doan Brook-Frontal Lake Erie (04110003 05 04)
Nonpoint Source Pollution Implementation Strategy (NPS-IS)

Version 1.0

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Developed by:

DOAN BROOK
Watershed Partnership

Bluestone Heights

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Chapter 1: Introduction

1.1 Report Background

Nonpoint Source Implementation Strategy (NPS-IS) is planning to meet U.S. Environmental Protection Agency (USEPA) nine minimum elements for impaired waters. NPS-IS is the new foundation upon which state and federal nonpoint source project funding is accessed. This NPS-IS is the new administrative base for Doan Brook-Frontal Lake Erie HUC-12 (041100030503), herein known as 'the HUC-12'. The current plan sets goals for improving local watershed health during the first half of the twenty-first century. It will guide HUC-12 stakeholders to address non-point source pollution issues and aquatic life use impairment using the best available science.

This NPS-IS expands upon the Doan Brook Watershed Action Plan (DB WAP 2013) which was endorsed by the State of Ohio Department of Natural Resources (ODNR) and Ohio EPA's (OEPA) watershed plan program in May of 2013. The DB WAP provided a starting point for initial project implementation to improve and protect the waters of Doan Brook and its Lake Erie shoreline, but did not account for the entire HUC-12. DBWP, Bluestone, and their collaborators including watershed communities, local agencies, and other conservation organizations recognize the importance of strategic project implementation as they seek to address the impairments within this HUC-12. Additional updates to this document will continue to address impairments threatening water quality and the ecological integrity of these watersheds, through efforts such as streambank and wetland restoration, green infrastructure, and stormwater management projects.

This HUC-12 has a rich history of advocacy. In 1974, the Joint Committee on Doan Brook Watershed was formed by the cities of Cleveland Heights, Shaker Heights, and Cleveland and with individual citizen advocates. In 2000, after NEORSD completed a significant Doan Brook Watershed Study, a Partnership Transition Committee was created to investigate possible organizational structures for a new organization to implement restoration within the Doan Brook Watershed. In 2002, DBWP was registered as an Ohio nonprofit organization. DBWP supports awareness, leads planning and restoration projects within the watershed, and serves as a collective voice for Doan Brook and its constituencies.

DBWP is led by a working board of trustees with permanent seats for representatives of the cities of Cleveland, Cleveland Heights and Shaker Heights, as well as from the Northeast Ohio Regional Sewer District, Cleveland Museum of Natural History, Cuyahoga River Restoration, Cleveland Botanical Garden, University Circle Inc. and the Nature Center at Shaker Lakes. The board also includes resident representatives for the upper and lower reaches of Doan Brook.

Bluestone was founded in 2009 to advocate for small watersheds and landforms in the Cleveland area. Bluestone brings long-term geo-science perspectives and a sense of place to urban environmental issues. Bluestone began with on-site environmental education and stewardship advocacy. Ecological research and environmental assessments have since been added. Bluestone Heights works to illuminate buried natural features and regenerate local ecological functions.

HUC-12 Profile

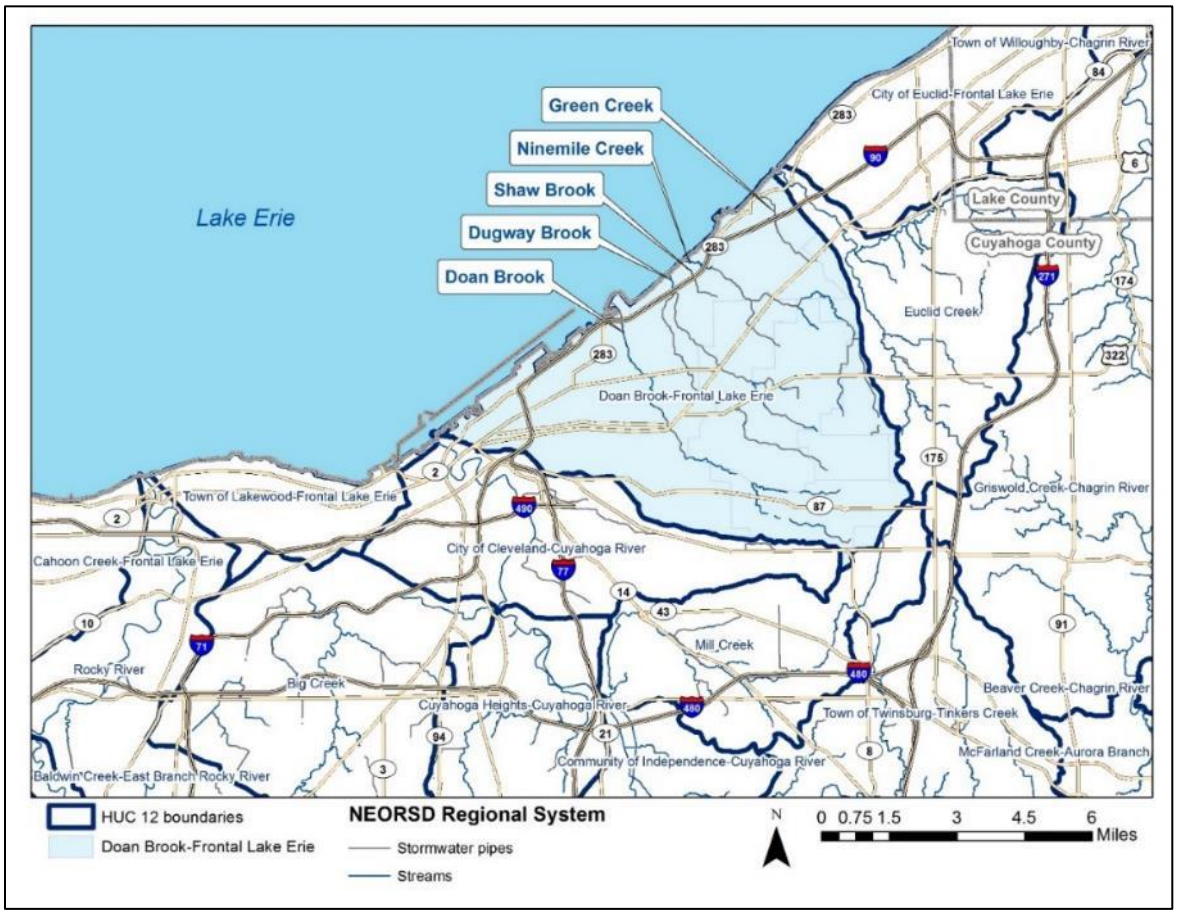

Figure 1: Location of HUC-12 in NE Ohio

The Doan Brook-Frontal Lake Erie Watershed HUC-12 (041100030503) covers 44 square miles between two adjacent HUC-12 units: City of Cleveland-Cuyahoga River (west) and Euclid Creek (east). The HUC-12 lies fully within Cuyahoga County, including all or parts of 11 Cleveland East Side municipalities (Figure 1 and Figure 2).

The HUC-12 includes six streams, west to east:

Giddings Brook (7.2 sq. mi) now comprises upper and lower sewersheds, each completely buried and directly culverted into Doan Brook, although historically, Giddings Brook was a direct tributary to Lake Erie. This diversion into Doan Brook expands the Doan Brook's watershed area and contributes to increased runoff volume. **Doan Brook** (11.3 sq. mi) is the largest stream in the HUC-12 and retains a mostly open, if channelized, main stem course along with several buried tributaries. East of Doan, the remaining five streams have only isolated stream segments remaining open. **Dugway Brook** consists of co-equal west and east branches (8.7 sq. mi). **Shaw Brook** (1.1 sq. mi) is mostly buried in the urban fabric. **Nine Mile Creek** (7.8 sq. mi) is open in only isolated ravine segments. **Green Creek** (5 sq. mi) shows moderate urban encroachment and a fully urban lower course. All six streams probably converged when Lake Erie's level was significantly lower, several thousand years ago (p.11)

Doan, Dugway and Nine Mile emerge on the uppermost regions of the HUC-12 boundary within relatively broad ravines. This area of the HUC-12 attracted some of the earliest agricultural enterprise in the North Union Shaker settlement (1822-1885). The Shaker presence kept much of this area free of development into the early twentieth century. Since then, the uppermost boundary of the HUC-12 has generally witnessed suburban development.

Characteristic ravines (p.11) are incised within the middle section of the HUC-12. With the least buildable landscapes due to topography and underlying geology, this "ravine belt" within the HUC-12 contains the greatest number of open stream segments. As a result of the open stream segments, this area of the HUC-12 has benefited from several watershed remediation projects and will continue to in the future. The fish spawning grounds and nurseries of the Doan, Dugway, Shaw, and Nine Mile estuaries make these locations desirable for future watershed remediation as well.

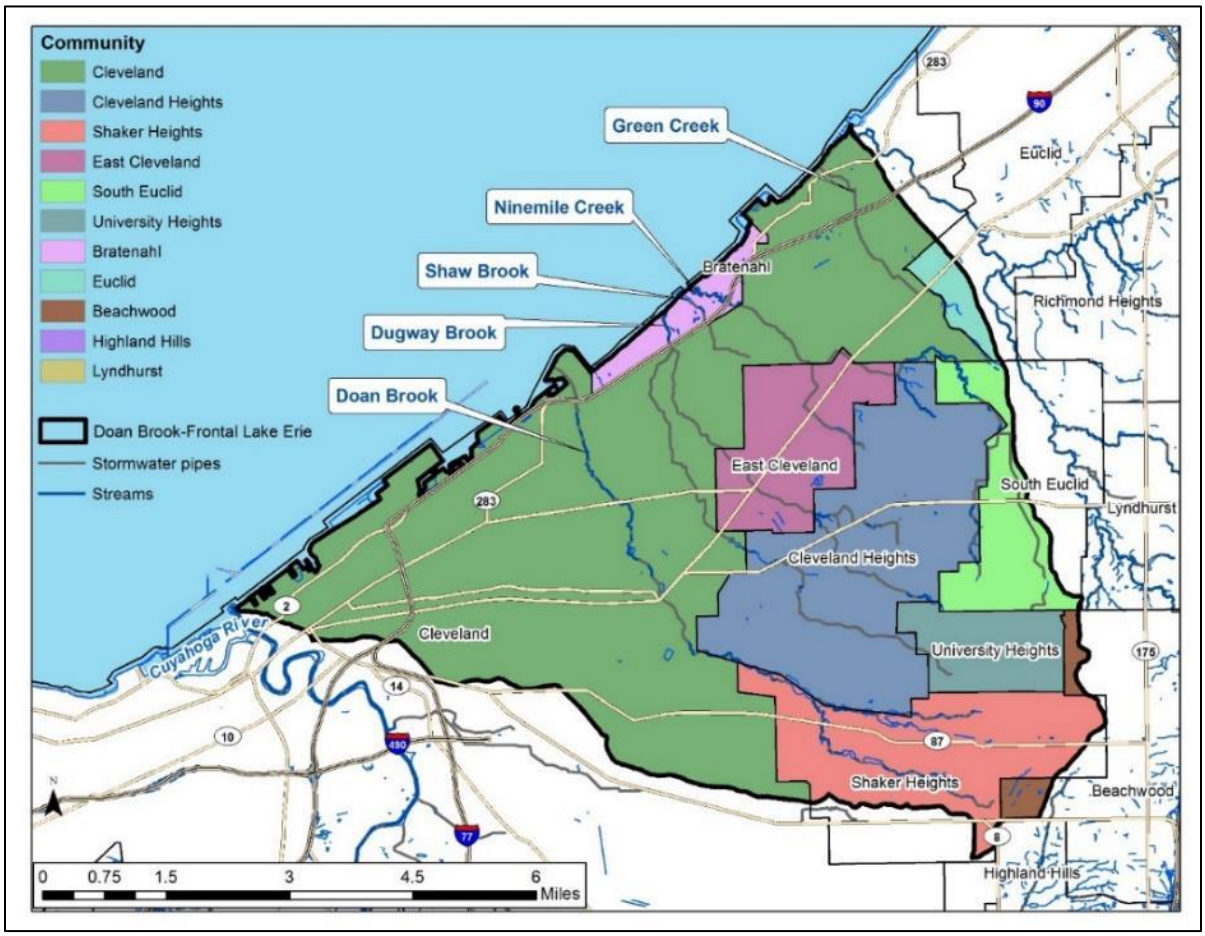

Figure 2: Municipalities in the HUC-12

History

The HUC-12 holds Greater Cleveland's earliest Euro-American settlements, dating to the early years of the Connecticut Western Reserve (1796 to about 1840). The HUC-12 boundaries straddle the historic Buffalo Rd (current Euclid Ave), the route by which most early settlers arrived to Cleveland and one of the country's earliest National Roads (US-20, Boston to Seattle). More recently, I-90 has transformed hydrology in northern section of the HUC-12 and replaces US-20 as the primary east-west thoroughfare. The HUC-12's transportation evolution mirrors the communities' urbanization trends and provides a useful framework for history, as defined in six distinct historical periods.

1) **Walking and Riding** (1796-1850). During the earliest years, Euro-Americans appropriated prehistoric trails along natural stream channels. Most Cleveland-bound settlers arrived along Euclid Ave, the main trail from New England and New York State. East of Cleveland, the avenue followed the base of the Portage Escarpment and so traversed all HUC-12 streams. Small settlements grew where the road crossed Giddings (East End), Doan (Doans Corners), Dugway (Ruples Corners), and Nine Mile (Nine Mile Creek). These old fords continue to anchor the more densely occupied areas of the HUC-12. During the 1820s and 1830s, small quarries and mills appeared throughout the middle section of the HUC-12 along Doan, Dugway, and Nine Mile. The North Union Shakers built large millponds on the Doan, forming what is now known as Horseshoe Lake and Lower Shaker Lake.

2) **Steam Railroads** (1850-1900): In 1852, a transcontinental railroad (CSX) opened across the lowermost, coastal region of the HUC-12 giving rise to a century of industrial growth. After the Civil War, local industrialists built country estates and attendant amenities on the Doan and Dugway. Their vision would preserve picturesque ravines and their wealth allowed for early land preservation within the HUC 12. Exemplary are Lake View Cemetery (1869) and Forest Hill Sanitarium (1871) in the Dugway gorges, and the Rockefeller Park and Ambler Park carriage runs (1880s) in the Doan ravines. In 1881, a second transcontinental rail line (NKP) opened and soon included a short line laid up the Green Creek gorge to serve Nine Mile Creek quarries (Euclid RR). The NKP accelerated the development of this area and began the era of stream burial. By the 1900, Doan remained the only stream that had not been culverted in the northern portion of the HUC-12.

3) **Electric Railroads** (1895-1925) Electrification accelerated economic activity during the 1890s and 1900s. Electric power came to transportation, workplace, and home. A period icon is Nela Park, General Electric's Lighting Division headquarters, established in 1911 on 92 acres of the Nine Mile Creek gorge. Rapid settlement came during the late 1890s as three electric interurban railroads opened across the HUC-12. The Cleveland Painesville and Eastern put rails along the shoreline (Lake Shore Blvd) and Euclid Ave. The Cleveland and Eastern climbed Cedar Glen and Euclid Heights to run along Mayfield Rd. Settlement was intensive along these routes. Electrification brought a second wave of industrialist estates to the middle and upper regions of Dugway and Nine Mile. As settlement proceeded, small-scale agriculture diminished.

4) **Early Automobiles** (1910-1960): By the 1910s, many Clevelanders were self-propelled and exploring HUC-12 uplands. A growing road network between the interurban thoroughfares encouraged settlement on formerly open land. In 1918, the Cleveland Metropolitan Park District was formed to preserve fast-disappearing open spaces on Cleveland's periphery, but the initiative did not reach inward into the HUC-12. Instead, early industrialists gifted parkland within the HUC-12 in this era. Doan's terrace ravine lands became Shaker Lakes, Rockefeller, and Ambler Parks. Wade, Rockefeller, and Gordon Parks were established along the lower section of the Doan in Cleveland. On the lower reaches of Dugway East, the Rockefeller holdings became Forest Hill Parkway (now Pattison and Rockefeller Parks). On a smaller scale, Cain Park, Cumberland Park, and Forest Hill Park were created within the Dugway East terrace ravines. By 1960, the HUC-12 achieved its current land use pattern, detailed in section 2.1.2.

5) **Interstate Highways** (1960-2010): By the 1960s, the regional manufacturing economy was in decline. Within the HUC-12, the Interstate Highway System initially disguised the trend by redistributing wealth in new places and ways. The new highways (I-90, I-271 and I-480) effectively leapfrogged local commerce beyond the HUC-12 to points east and south as the exurbs grew. In this context, the HUC-12 became a crucial exception to regional Interstate System development. In 1964, thwarted plans for the Clark Freeway (I-290) which would have traversed eastward to I-271 along the Doan through its upper and middle watershed. The Lee Freeway was slated to connect the Clark Freeway to I-90 across the Dugway terrace ravines, but was also blocked by grassroots opposition movements. A significant impact to the coastal zone of the HUC-12, however, resulted when the streams were culverted under the I-90 freeway. This adverse impact on the estuaries of Doan, Dugway and Nine Mile persists. Between I-90 and the former dredge disposal facility, Dike 14, the Doan estuary was buried entirely.

6) **Walking and Riding Redux** (2000-present). The twenty-first century brings renewed interest in human-powered transportation (walking and biking) and in new forms of mass transit. In this vein, Cuyahoga Greenways is a joint effort between Cuyahoga County Planning, Cleveland Metroparks, and NOACA. The long-term goal is a county-wide network of greenways and trails to link neighborhoods, parks, and public transportation. The immediate goal is to connect existing trails,

parks, and other points of interest. Within the HUC-12, the Doan Brook Lake to Lakes Trail is a model for linking isolated stream riparian areas into a greenway format. Other linkable HUC-12 greenspaces lie in Dugway Brook East between John Carroll University and the Bratenahl Nature Preserve (Dugway estuary), and in Nine Mile Creek between John Carroll and Euclid Ave. Renewed interest in human-powered transit mirrors interest in restoring health to local watersheds.

1.3 Public Participation and Involvement

The DB WAP received input from a variety of organizations, professional peers, and the public. Most of the information collected during the creation of the DB WAP remains relevant to the identification of NPS-IS critical areas and projects.

The projects proposed in Chapter 4 within the Doan Brook Watershed Critical Area were presented to the public throughout 2016. Project identification and development was informed by Technical Advisory Committee meetings, consultant meetings, site visits, and through partner and stakeholder review and input. With potential projects identified, DBWP focused outreach to the public through a quarterly newsletter (Spring/Summer 2016), information posted on the DBWP website, and the DBWP's Annual Meeting where potential projects were presented and citizens could weigh in. More than 65 concerned citizens attended to comment on project selection, ultimately guiding prioritization of these projects

In addition to the feedback collected during the 2016 process, the DBWP Board of Trustees is a working board, meaning its members are chosen strategically to contribute to DBWP's mission. These organizations include: The Northeast Ohio Regional Sewer District, the three watershed municipalities (Cleveland Heights, Shaker Heights, and Cleveland), the Cleveland Museum of Natural History, Cuyahoga River Restoration, the Cleveland Botanical Gardens, University Circle Inc., the Nature Center at Shaker Lakes, as well as citizen representatives from upstream and downstream communities. Many of these representatives have been working together since DBWP's inception in 2002 and have well-established relationships with many citizens, businesses, governmental agencies, and other non-profit groups working on watershed restoration in Northeast Ohio. The DBWP Board is able to contribute valuable input and feedback to the NPS-IS process via their extended community networks.

Additionally, since 2013, Bluestone has hosted a variety of workshops and experiential education hikes (including bicycle tours in 2017) throughout the HUC-12. These guided activities are designed to bring awareness to streams above and below ground by showcasing completed and potential water quality and green infrastructure projects.
Each of these events typically draws between 30-50 participants with multiple (3-4) events each year.

In 2017, Bluestone hosted two Ravine Workshops, complementing the suite of existing educational offerings in the HUC-12. Using a format from the Alliance for the Great Lakes, these workshops collected feedback from the 28 participants identifying assets, acknowledging issues, and brainstorming ideas for ways to protect and enhance their neighborhood ravines.

DBWP and Bluestone Heights will continue to update and refine this document as further information is gathered from stakeholders and milestones are reached in the implementation of this Plan.

Chapter 2: HUC-12 Watershed Characterization and Assessment Summary

2.1 Summary of HUC-12 Watershed Characterization

2.1.1 Physical and Natural Features

Streams and Watersheds

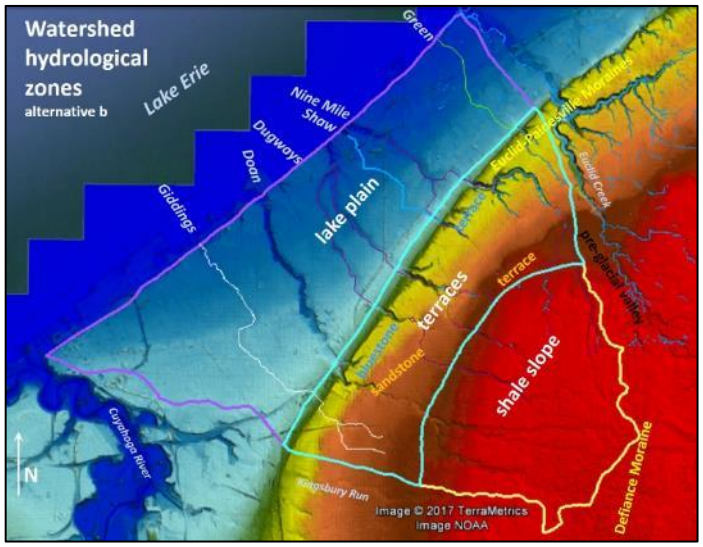

Figure 3: HUC-12 hydrological zones and rivers

As it descends the Portage Escarpment, the HUC-12 has three subaerial hydrological zones (Figure 3): *shale slope*, *sandstone terraces* and *lake plain*. Each zone has one or two characteristic types of ravine landforms.

shale slope: Beginning at the HUC-12's southeast apex, the escarpment slopes gently northwest on a highly erodible shale substrate. The shale slope holds most HUC-12 stream headwaters which incise relatively broad ravines with significant floodplains (*shale slope ravines*).

sandstone terraces: An escarpment dominates the middle section of the HUC 12. Two sandstone units (Berea and Euclid) form distinct, level terraces with a northwest-facing outcrop or cliff face (Figure 6). On each terrace, HUC-12 streams have cut a deep ravine, with narrow or nonexistent floodplains. Within the Berea unit, streams cut small, ragged, and steep ravines, often with rock shelter overhangs to form a sandstone gulch. Conversely, the bluestone gorges are characterized by ravine exposures within the Euclid unit that show low cliff faces but no overhangs.

lake plain: At the bottom of the escarpment, former Lake Erie wave action cut a relatively flat landscape, known as the lake plain, that lies upon a shale substrate. The HUC-12 streams have incised ravines northward across the plain. *Lake plain ravines* resemble those of the shale slope in that they are broad in relation to depth and have significant floodplains. As prehistorically rising lake levels inundated ('drowned') the mouths of lake plain ravines, freshwater estuaries or lacustuaries have emerged.

The HUC-12 is located within Ohio's Level III ecoregion Erie-Ontario Lake Plains (EOLP). Lake plain stream courses fall mostly within the Level IV ecoregion Erie Lake Plain (#61a). The HUC-12's highland areas extend into the Level IV ecoregion Low Lime Drift Plain (#61c). Biological criteria applicable to rivers and streams in the Erie-Ontario Lake Plains (EOLP) are given below in Table 4 (p.24).

From west to east, the HUC-12 holds six streams. Each descends the escarpment to incise ravines typical of the hydrological zones. In result, the HUC-12 exhibits recurring zone-specific subaerial features. The six streams are, essentially, variations on a common pattern of zone-based geo-hydrology. The **streams** are as follows:

Giddings Brook (length: 6.5 mi, area: 7.2 sq. mi) is now completely buried. Giddings' culverted shale slope and sandstone terrace stormwater system has been rerouted to join the Doan Brook sewershed. Much of the lake plain portion of the Giddings watershed is now an independent, self-contained sewershed with a Lake Erie outfall at E 55th St. This outfall has elements of estuarine structure. One or more very small lake-direct tributaries used to lie west of Giddings. No information survives.

Doan Brook (length: 11.3 mi, area: 11.9 sq. mi) begins far up onto the shale slope. Its three headwater tributaries are historically unique in retaining open courses within relatively broad ravines. Slope ravines hold the four man-made Shaker Lakes which maintain some wetland function. Lower Shaker Lake has a constructed wetland (5 a) at the Nature Center at Shaker Lakes. At the mouth of the gorge, Doan enters a ~1 mi culvert (in two sections) under Cleveland's University Circle district. With the piped upper Giddings sewershed now entering the University Circle culvert, the Doan storm sewer catchment is increased by 20%. Upon exiting the culvert at RM 3.0, Doan is channelized for its lake plain run to a drowned valley estuary at RM 0.75. The estuary is entirely culverted under a large I-90 cloverleaf interchange.

Dugway Brook comprises west and east branches of near-equal lengths (~7.2 mi) and a collective watershed of 8.7 sq. mi. Both branches drain from the shale slope with culverted headwaters. Open channel segments carry each branch through the sandstone terraces. Both branches are fully culverted across the lake plain. The culverts merge at RM 0.6. At RM 0.5, a drowned valley channel takes the stream to the lake. The estuary has lost its natural meanders but retains good channel width. Of the four HUC-12 estuaries, Dugway retains the greatest ecological diversity.

Shaw Brook (length: 4.3 mi, area: 1.1 sq. mi) has short open segments through its sandstone gulch, bluestone gorge and drowned valley. Much of Shaw's natural flow has been incorporated into the local storm sewer grid. The Shaw estuary, beginning at RM 0.2 has been greatly enlarged to serve as a pleasure craft marina. Dredging and margin armoring have reduced natural habitat features.

Nine Mile Creek (length: 8 mi, area: 7.8 sq. mi) has culverted west and east shale slope headwaters. An east branch shale slope tributary holds the Langerdale Marsh constructed wetland (10 a). The west branch holds the Oakwood Green constructed wetland (5.5 a). The shale slope culverts merge at slope base (Bluestone Rd). The mainstem runs free through a sandstone gulch. It is culverted again for 0.2 mi and opens at the head of a bluestone gorge. Toward the bottom of the gorge, the mainstem picks up Quilliams Creek tributary as it exits a sizeable bluestone gorge. Nine Mile is culverted across the lake plain to RM 1.1. At RM 0.6, Nine Mile enters an estuary subject to historical landscaping and recent residential development. The feature retains its nineteenth-century meanders but the stream channel has been significantly narrowed and its margins are now hardened.

Green Creek (length: 5 mi, area 5 sq. mi) has open segments across its bluestone terrace and escarpment ravine. Gorge hydrology is complicated by the presence of the abandoned Euclid Railroad right of way. From 1883 to 1968, this railroad served quarrying operations at the gulch and upper gorge areas of Nine Mile Creek and Euclid Creek just to the east. Since abandonment, the railbed terrace is slumping into the base of the ravine carrying with it a range of stone and slag ballast, wooden ties and abutments, and steel rails and other hardware. Green Creek is entirely buried across the lake plain with a culverted Lake Erie outfall.

Prehistoric Stream Channels:

For the six known streams in the HUC-12 nearly 90 miles of prehistoric stream channels can be identified, conservatively speaking. Also as a conservative estimate, approximately 60 miles of open channels have been lost to culverting and abandonment (Figure 4 and Table 1). Several small, unnamed streams cannot be accounted for in this analysis. Could they be included, the watershed would show more than 100 miles of prehistoric stream courses and more than 70 miles of lost open channels.

Culverting on the lake plain began during the 1880s to create commercial and industrial real estate. During the early twentieth century, suburban land development accelerated. On the lake plain, all mainstem channels were culverted except for that of Doan Brook. On the escarpment, many mainstem channel segments were culverted, again with the exception of Doan. On the headwater areas of the Heights, the early twentieth century residential street storm sewer grid was engineered to capture many natural flows. Between culverting and abandonment, fully two-thirds of the prehistoric channel mileage has been eliminated.

Doan Brook has lost much less open water than the other streams. Wealthy benefactors have been the primary factor. On the lower escarpment and lake plain, major late nineteenth century landowners (Ambler, Gordon, Rockefeller and Wade) maintained open if highly engineered channels on landscaped floodplains. Most of these areas later became public parks. Higher on the escarpment, upscale residential development came to Doan's north, middle and south branches. In these areas, open channels were maintained for their picturesque value

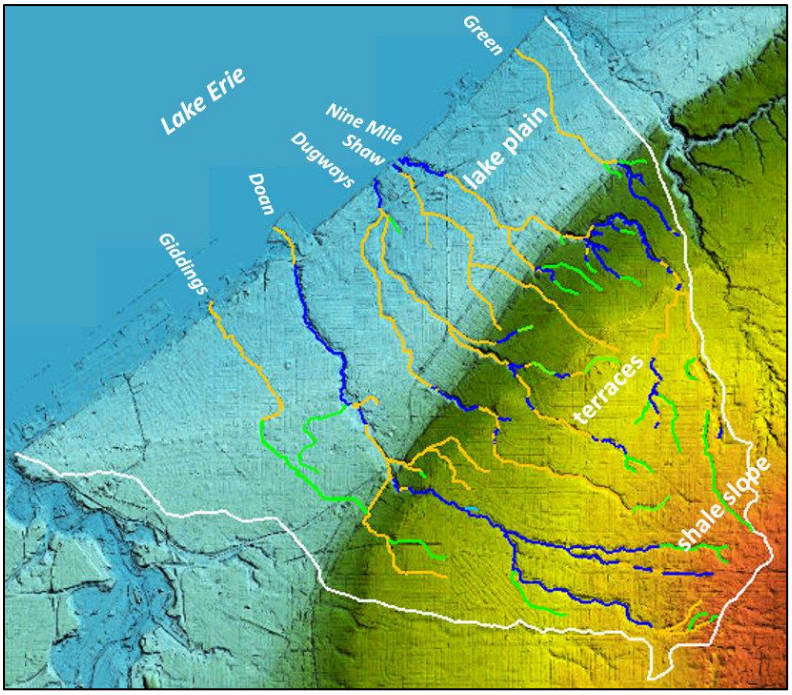

Figure 4: HUC-12 stream channel history[1]

Stream	Open	Culvert	Abandoned	Total
Giddings	0 mi	4.33 mi	3.58 mi	**7.91 mi**
Doan	11.45 mi	14.41 mi	4.86 mi	**30.7 mi**
Dugway	3.31 mi	11.54 mi	2.76 mi	**17.6 mi**
Shaw	0.15 mi	5.41 mi	0 mi	**5.56 mi**
Nine Mile	6.39 mi	8.46 mi	5.81 mi	**20.7 mi**
Green	1.84 mi	2.34 mi	0.72 mi	**4.9 mi**
Total	**23.14 mi**	**46.49 mi**	**17.73 mi**	**87.4 mi**
Lost Channel Length		46.49 mi	17.73 mi	**64.2 mi**

Table 1: HUC-12 channel lengths by stream and type[2]

[1] Blue=open (~23 mi); brown=culverted (~46 mi); green=abandoned (~18 mi)

[2] For headwaters, the relationship between culverted and abandoned segments is approximate.

Geology

The HUC-12 lies upon the Portage Escarpment, the northwest slope that joins North America's Central Lowland and Appalachian Highland (Brockman 1998). Within the HUC-12, the exposed bedrock sequence is ~500 ft. thick with alternating shale and sandstone units (Figure 5). Near the middle of the exposure, two adjacent Devonian sandstone units, the Euclid bluestone (Bedford Fm informal unit) and the Berea Sandstone, give structure to the HUC-12's hydrological zones (p.11). The sandstones are resistant to subaerial erosion whereas the overlying and underlying shale units erode quickly when exposed to the elements. The hydrological role of the sandstones can be seen in the way the sequence erodes to form the local Portage Escarpment segment (Figure 5).During the Pleistocene, repeated glacial advances exposed and scoured the resistant frontal and upper surfaces of each sandstone unit. In result, each has a northwest-facing cliff-like frontal exposure and a flat terrace-like upper exposure. They appear as two steps or terraces on the escarpment front. Together, the *sandstone terraces* define the steepest part of the escarpment face and the hinge point for hydrological zones above and below.

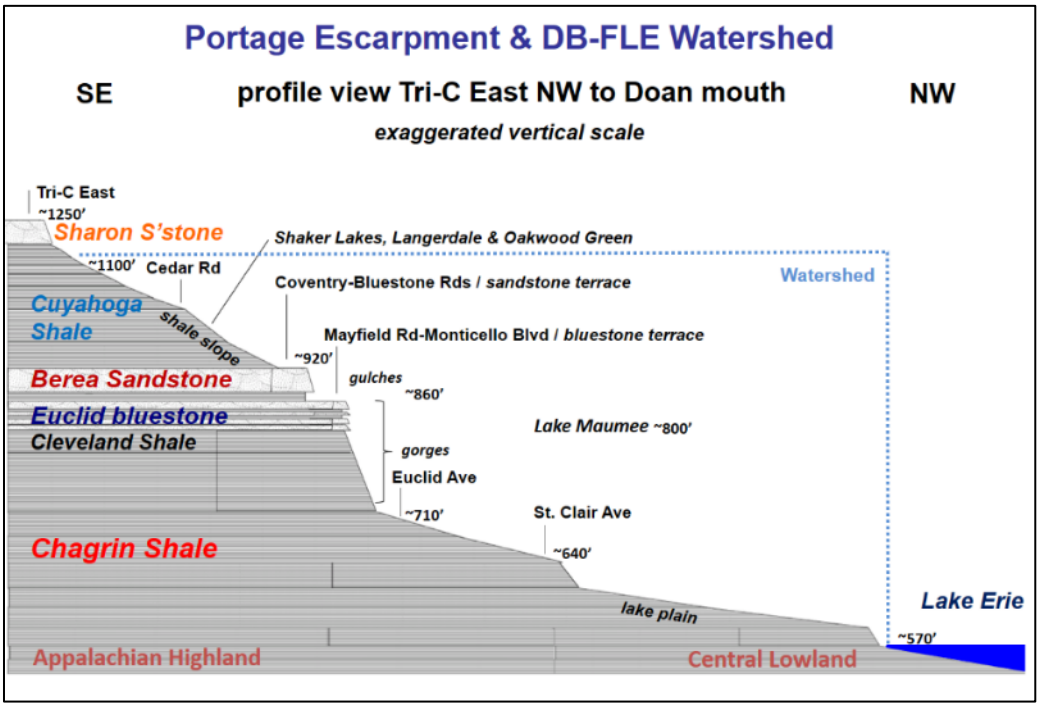

Figure 5: Bedrock Sequence on the East Side Portage Escarpment

Above the Berea terrace, the overlying shale unit (Carboniferous Cuyahoga Fm) is much less resistant. Glacial advances created a shallow incline or slope rising to the south. Onto this shale slope, post-glacial streams have incised relatively broad ravines. Just below Berea, the Euclid bluestone terrace forms a protective caprock atop a set of soft shale units (Cleveland and Chagrin members of the Ohio Shale). Caprock prevented glaciers from bulldozing the underlying shale exposures into a shallow slope. Thus, the steepest part of the escarpment face is formed by the bluestone-capped shale front. Similarly, the caprock has fostered the erosion of deep, narrow *bluestone gorges* into the Cleveland and Chagrin units.

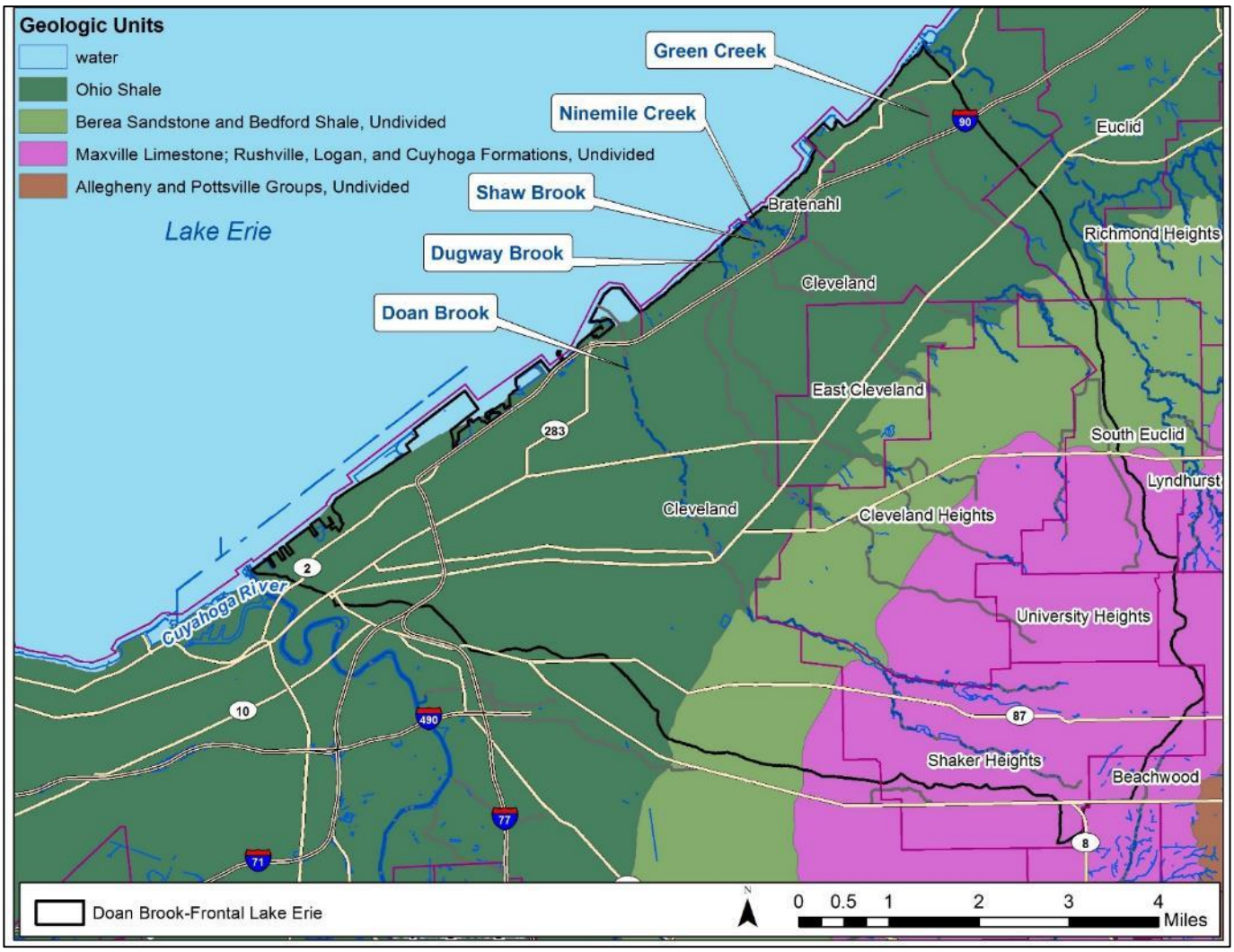

Figure 6: HUC-12 Geologic Units

Soils

As the last glacier retreated, a mantle of fine glacial till accumulated upon previously scoured bedrock. Clay dominates the mantle which ranges from one to several meters in thickness. Derived soils are moist and relatively impermeable. The mantle thickens in areas of retreat moraines, which mark deposition that occurred at pauses in the glacial retreat.

With the emergence of a post-glacial hydrology, soils differentiated by hydrological zone (Figure 7). Mahoning Complex soils developed upon the Cuyahoga Shale substrate of the shale slope. The Loudenville and Mitiwanga Complexes emerged on the sandstone terraces. Elnora Complex soils formed as the lake plain accumulated lake bottom clay sediment; they are the HUC-12's heaviest and least permeable. The lake plain does however have islands of well-drained sandy and peaty soils as remnants of fossil beaches and lagoons. The Bratenahl estuaries are in a sandy Oshtemo area and have isolated areas of hydric soils. As the Doan Brook retains more floodplains than any other stream, it has the greatest amount of floodplain (Tioga) soils (Figure 7). Urbanization has diminished the distribution of the natural soil types. Almost 20% of the soils are urban land, which is defined as land where over 80% of the surface is covered by asphalt, concrete, buildings, or other man-made surfaces (Soil Survey of Cuyahoga County, p. 46) (Table 2).

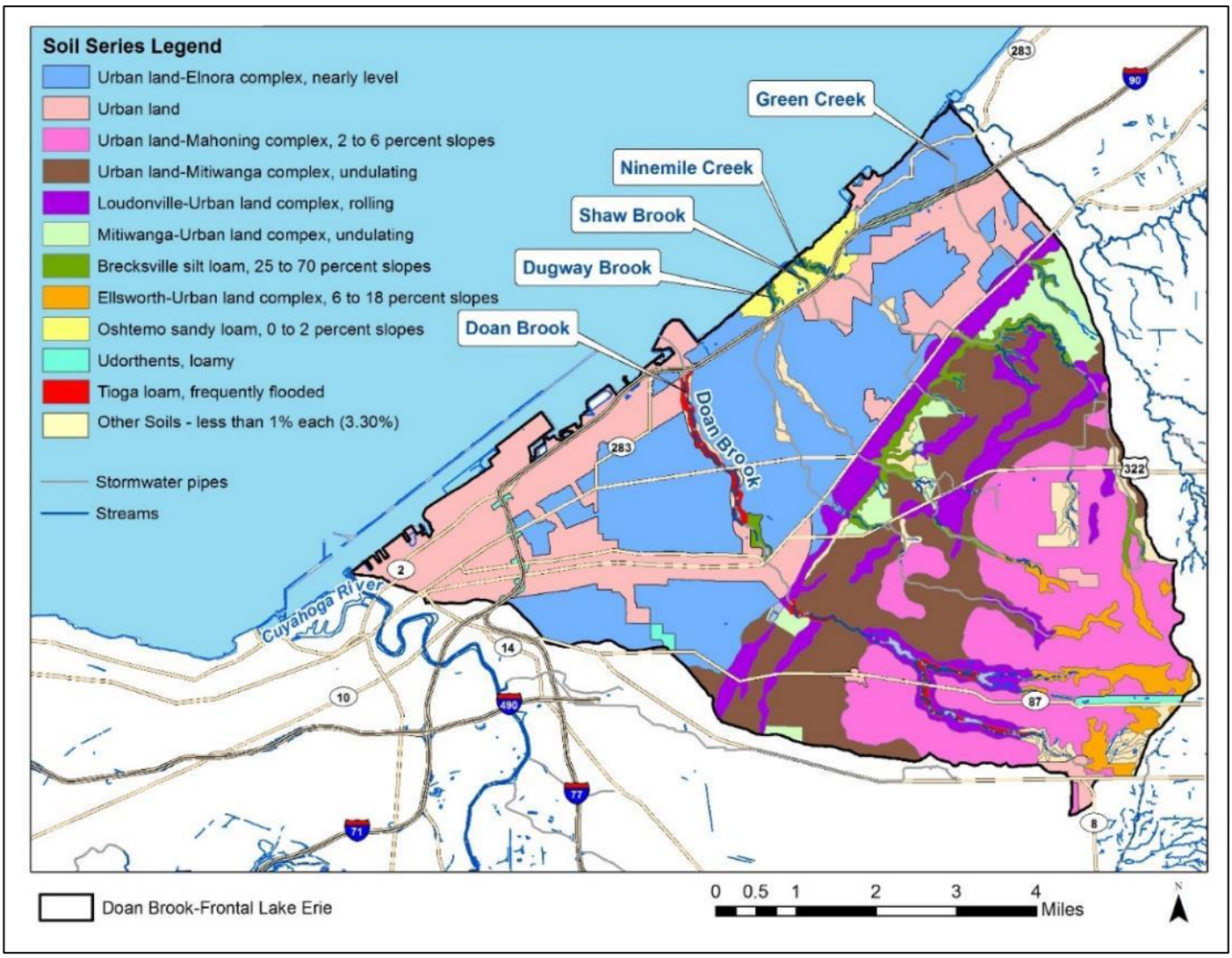

Figure 7: HUC-12 Soils

Soil Type	Rating	Acres in HUC-12	Percent of HUC-12
Urban land-Elnora complex, nearly level		7,911.50	26.60%
Urban land		5,477.80	18.40%
Urban land-Mahoning complex, 2 to 6 percent slopes		5,222.90	17.60%
Urban land-Mitiwanga complex, undulating		4,185.70	14.10%
Loudonville-Urban land complex, rolling	C	2,502.40	8.40%
Mitiwanga-Urban land complex, undulating		890.3	3.00%
Brecksville silt loam, 25 to 70 percent slopes	D	721.4	2.40%
Ellsworth-Urban land complex, 6 to 18 percent slopes	D	667.3	2.20%
Udorthents, loamy		348.1	1.20%
Oshtemo sandy loam, 0 to 2 percent slopes	A	353.2	1.20%
Tioga loam, frequently flooded	A	284.4	1.00%
Allis-Urban land complex	D	126.1	0.40%
Mahoning silt loam, 0 to 2 percent slopes	D	126.1	0.40%
Ellsworth silt loam, 6 to 12 percent slopes	D	81.1	0.30%
Dekalb-Loudonville complex, 25 to 70 percent slopes	C	84	0.30%
Hornell-Urban land complex, rolling	D	90.2	0.30%
Oshtemo-Urban land complex, undulating		93	0.30%
Urban land-Oshtemo complex, undulating		49.8	0.20%
Water		60.8	0.20%
Mahoning silt loam, 2 to 6 percent slopes	D	62	0.20%
Mahoning-Urban land complex, 2 to 6 percent slopes	D	65.8	0.20%
Ellsworth silt loam, 12 to 18 percent slopes	D	66.9	0.20%
Ellsworth silt loam, 2 to 6 percent slopes	D	17.6	0.10%
Orrville silt loam, frequently flooded	B/D	33.9	0.10%
Oshtemo sandy loam, 25 to 55 percent slopes	A	36.8	0.10%
Ellsworth silt loam, 25 to 70 percent slopes	D	7.1	0.00%
Mitiwanga silt loam, 0 to 2 percent slopes	C/D	11.4	0.00%
Totals for HUC-12		**29,742.80**	**100.00%**

Table 2: Soil Type Acreage/Percentage

Wetlands

HUC-12 wetlands vary by hydrological zone. Shale slope features generally lie in dam-created inline basins. Doan Brook's four historical Shaker Lakes are prime examples. They serve as freshwater ponds with dense macrophyte communities. Some have small patches of emergent and forested/shrub wetlands (DBWAP 2013, Chapter 3, Section 3). Nine Mile Creek has two young wetlands constructed as stormwater retention basins: Langerdale Marsh and Oakwood Greens. On the sandstone terraces, Green Creek has one soft-buffered inline pond in South Euclid. In the coastal zone, Dugway Brook and Nine Mile Creek hold significant estuarine wetlands. The engineered mouths of Giddings and Doan Brooks could be enhanced to function as wetlands.

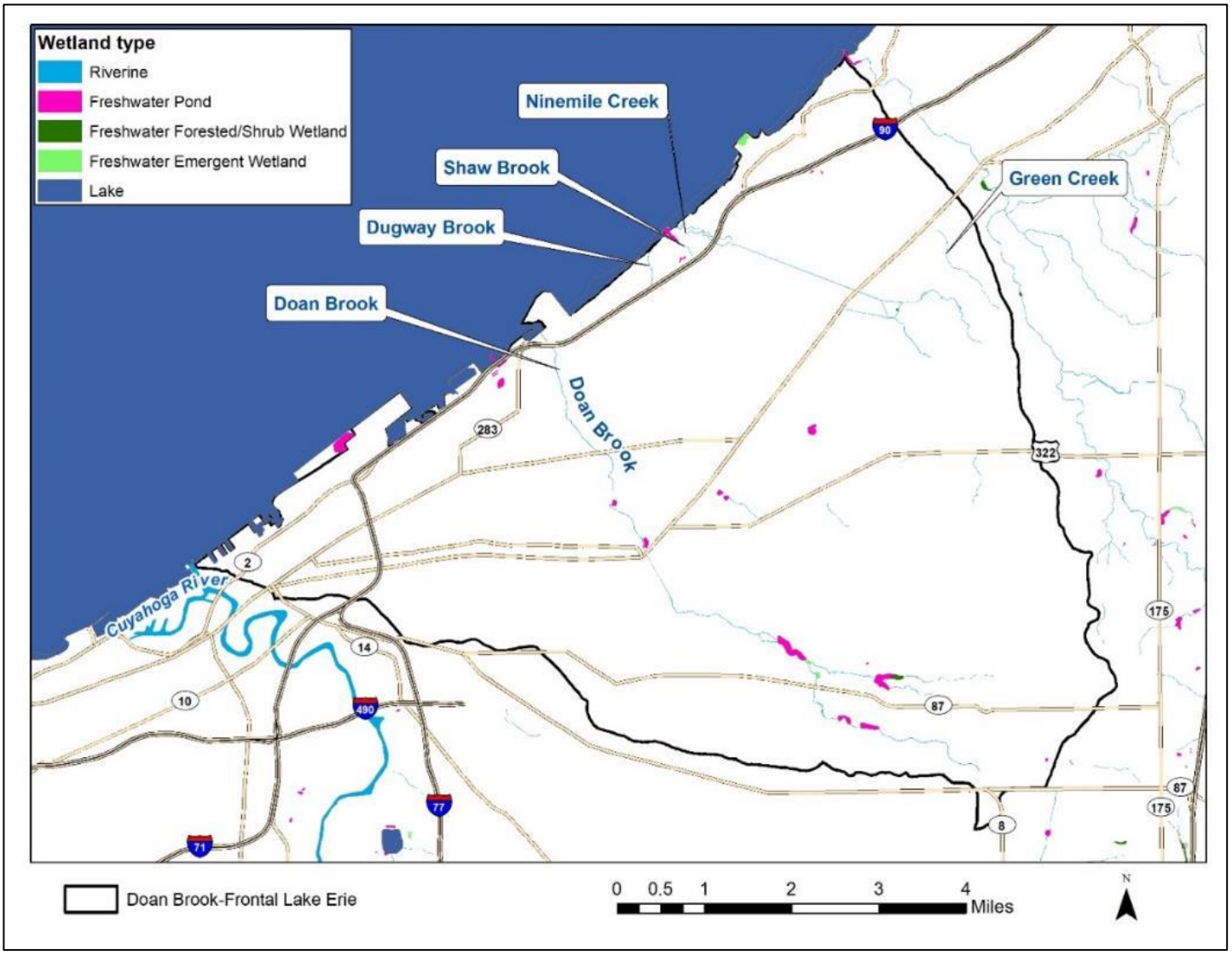

Figure 8: HUC-12 Wetlands

Fisheries and Wildlife

Fish and wildlife densities and diversities largely correlate with the distribution and size of wetlands. The greatest presence lies in the coastal zone, especially in the Dugway and Nine Mile estuaries (Figure 9). The Doan Brook riparian corridor and associated park lands represent a significant means for coastal wildlife, especially birds and fish, to penetrate inland. For a list of mammal, reptile, and amphibian species that have been observed in the Doan Brook riparian corridor, refer to the Doan Brook WAP (DBWAP 2013, Chapter 3, Section 2). Over 200 species of birds have been observed along the Doan Brook since 1980, with many migratory birds relying on the riparian corridor, which is considered an Audubon Important Bird Area, as a stopover in the spring and fall. A 1998 survey by the Ohio EPA and NEORSD of the Doan Brook found 10 species of fish and one hybrid, with more than 90% of the fish collected being either green sunfish or creek chub, which are both pollution tolerant species. In 2010, a "Bio-Blitz" of the marsh at the confluence of Doan Brook's North and South Branches found five species of fish: goldfish (*Carassius auratus*), green sunfish (*Lepomis cyanellus*), blacknose dace (*Rhinichthys atratulus*), creek chub (*Semotilus atromaculatus*), and stoneroller minnow (*Campostoma anomalum*).

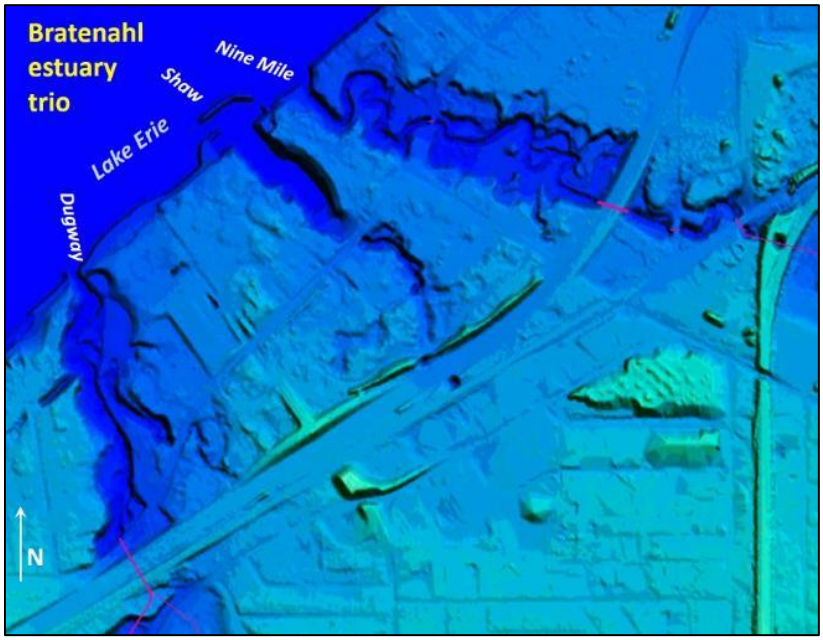

Figure 9: Dugway, Shaw, and Nine Mile Drowned Valley Estuaries

Rare, Threatened, and Endangered Species

In 2001, The Ohio Department of Natural Resources Division of Natural Areas and Preserves Assessment Report for the Doan Brook Watershed Study reported the presences of Richardson's pondweed (*Potamogeton richardsonii*) (state potentially threatened), Canada hawkweed (*Hieracium canadense*) (state threatened), Emmons' sedge (*Carex albicans var. emmonsii*) (state threatened), and butternuts (*Jugulans cinerea*) (state potentially threatened) in or near the Doan Brook watershed. Furthermore, the US Fish and Wildlife Service identified three federally listed species whose range covers all or portions of the Doan Brook watershed: the peregrine falcon (*Falcon peregrinus*), the piping plover (*Charadius melodus*) and the Indiana Bat (*Myotis sodalis*). There are no known records of these species breeding in the watershed, although they are seasonally present as migrants.

Invasive Nuisance Species

Only the Doan Brook riparian corridor has an inventory of invasive species. Flora includes non-native plants considered invasive or aggressive species that can decimate native plants and biodiverse plant communities. The Shaker Lakes are

dominated by exotic macrophytes and in some onshore areas non-native herbaceous species such as garlic mustard, Japanese knotweed, purple loosestrife and bishop's weed have been identified. An exhaustive list of other invasive flora can be found in the Doan Brook WAP (DBWAP 2013, Chapter 3, Section 2). The most common invasive fish species in collections from both the Ohio EPA and Northeast Ohio Regional Sewer District is the goldfish (*Carassius auratus*). Other potentially harmful invasive aquatic animal species most likely in the watershed include zebra mussels and the rusty crayfish (*Orconectes rusticus*).

As part of the Cleveland-Cuyahoga County Port Authority's ongoing commitment to providing the public with improved lakefront access and supporting environmental initiatives, a multi-phased plan has been developed to manage invasive species populations and enhance native habitats at the Cleveland Lakefront Nature Preserve. Invasive species identified at the park include Common Reed (*Phragmites australis*), Poison Hemlock (*Conium maculatum*), Mugwort (*Artemisia vulgaris*), and Porcelain berry (*Ampelopsis brevipedunculata).* Invasive species will be removed in small sections of the preserve each year over multiple years. Areas treated for invasive species have been planted with native trees, shrubs, grasses, and wildlife.

2.1.2 Land Use and Protection

The majority of land in the HUC-12 is highly developed and urbanized, as is evidenced by only 10% of the total acreage being used for parks or open space (Figure 11 and Table 3). The primary land use in the HUC-12 is residential development, both in the form of single family and multi-family dwellings (57.4%). Commercial and industrial land use both account for around 10% of total land use respectively, and are concentrated near downtown Cleveland and along major east-west thoroughfares (I-90, Euclid Avenue, Cedar Avenue, etc.). The HUC-12 hosts a number of world-renowned institutions that are centered in Cleveland's University Circle neighborhood. This neighborhood hosts three medical campuses – the Cleveland Clinic Main Campus, University Hospitals Medical Center, and the Cleveland Veteran's Administration Hospitals – as well as a number of premier cultural and educational institutions including Case Western Reserve University, Cleveland Museum of Art, Cleveland Botanical Garden, Cleveland Museum of Natural History, the Cleveland Orchestra, the Cleveland Institute of Art, the Cleveland Institute of Music, and Western Reserve Historical Society. Outside of the University Circle neighborhood, the HUC-12 is also home to Cleveland State University and John Carroll University. Many of these institutions serve as important partners in watershed activities and outreach in the HUC-12.

The HUC-12 also hosts major entities designated as utilities in terms of land use. This includes the Burke Lakefront Airport near downtown Cleveland on the shores of Lake Erie, the Baldwin Water Treatment Plant near University Circle, and NEORSD's Easterly Water Treatment Plant.

Parks and open spaces are located along the Doan Brook riparian corridor and in the coastal and upland areas of the Dugway, Shaw, Green, and Nine Mile streams. The Doan Brook riparian corridor includes the Cleveland Lakefront Nature Preserve, Gordon Park, Rockefeller Park, Wade Park, Ambler Park, the Shaker Parklands, Shaker Heights Country Club, and Canterbury Golf Club. It also contains four man-made lakes – Green, Marshall, Horseshoe, and Lower Shaker Lake – on Doan Brook and two man-made lagoons. Where Dugway flows through the shale slope and sandstone terraces there is the historic Lake View Cemetery and Forest Hills Park, as well as Cain Park, Cumberland Park, and green space around Park Synagogue. Glenview Park and Bratenahl Nature Preserve are located near the mouth of the Dugway. The area encompassed by the Nine Mile watershed in the shale slope and sandstone terraces includes two reconstructed wetlands – Langerdale Marsh and Oakwood Green – Dennison Park, Quarry Park, and undeveloped ravine areas along Quilliams Creek and near General Electric's Nela Park campus. Shoreby Shaw Marina and Weller Nine Mile Preserve are located near the mouths of Shaw and Nine Mile.

The prevalence of park space along the Doan Brook provides ample opportunity for restoration projects and improved land management practices to provide beneficial impacts on stream and riparian quality. The existence of undeveloped and protected land in both the coastal areas and in the upland ravines and stream segments of Dugway, Shaw, Green, and Nine Mile present similar opportunities for possible restoration and improved land management.

Figure 10: Doan Brook Gorge (May 20, 2018. Photo credit: Alicia Beattie)

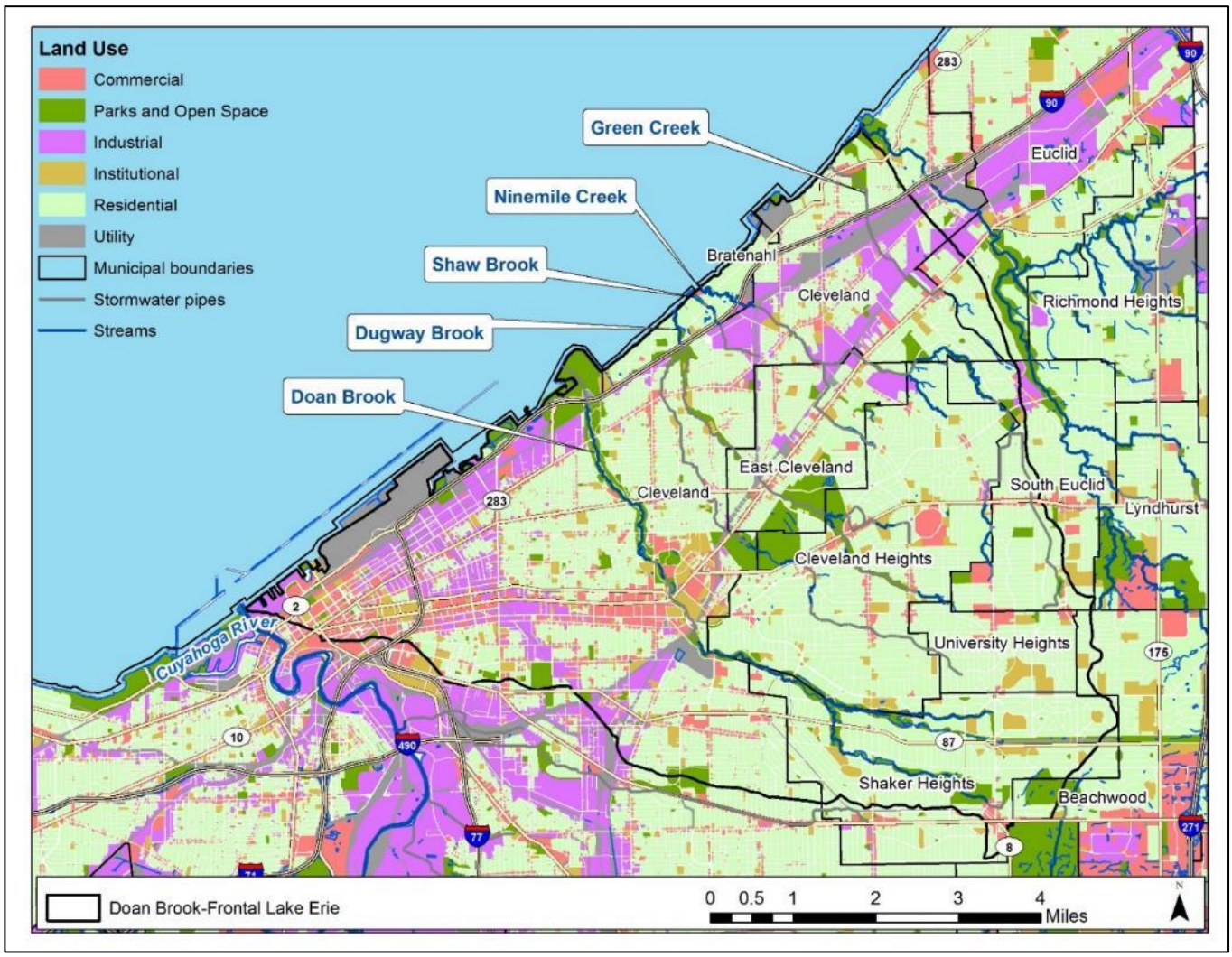

Figure 11: Land Use in HUC-12

HUC-12 Land Use Group	Acres	Percentage
Commercial	2291.03	9.43
Parks and Open Space	2399.39	9.87
Industrial	2314.29	9.52
Institutional	1619.15	6.66
Residential	13953.64	57.40
Utility	1730.22	7.12

Table 3: Land Use as Percentage of Total Area

Reflecting the patterns in land use, the HUC-12 is dominated by impervious surface area due to high levels of development (Figure 12). Parks and open spaces represent the primary areas of pervious cover in the HUC-12. This exemplifies the value of these spaces to the urban neighborhoods surrounding them. It also represents opportunities for green infrastructure projects that reduce impervious surface cover and associated storm water runoff to have a significant impact on stream quality in the HUC-12.

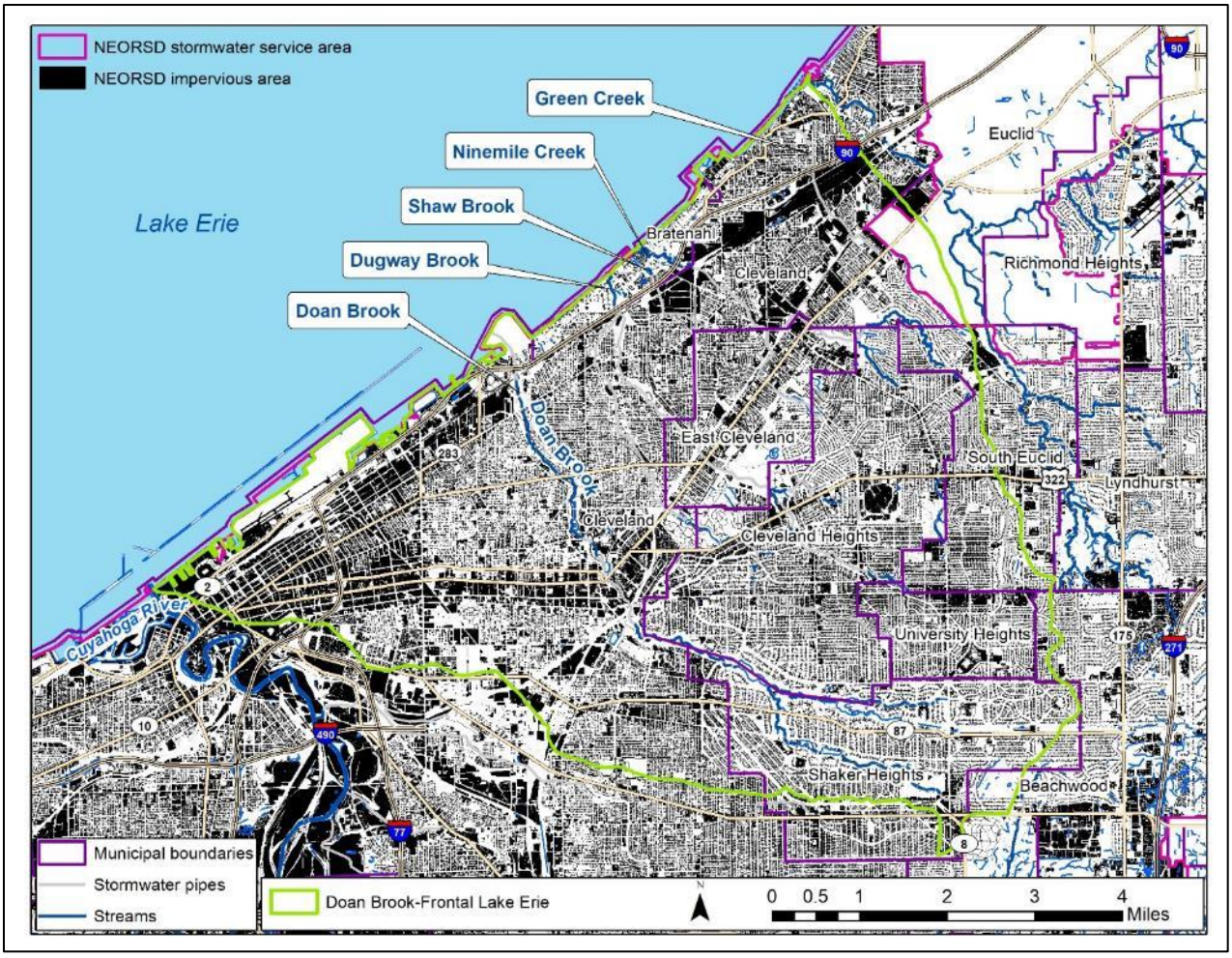

Figure 12: Impervious Cover in HUC-12 (NEORSD)

2.2 Summary of HUC-12 Biological Trends

The Ohio EPA adopted biological criteria into the Ohio Water Quality Standards in 1990. An aquatic life use (ALU) designation is assigned to a stream or river based on the potential aquatic biological community that can realistically be sustained given the biological, physical, and chemical attributes of the waterway. Specifically, two fish and one macroinvertebrate indices are used to determine if a specific stream segment is reaching aquatic life use designation (IBI, ICI, QHEI). Table 4 lists the biological criteria for applicable aquatic life use (ALU) designations in the Erie-Ontario Lake Plains ecoregion.

Biological Index	Assessment Method	Biological Criteria for the Applicable Aquatic Life Use Designations		
		WWH	EWH	MWH
IBI	Headwater	40	50	24
	Wading	38	50	24
	Boat	40	48	24 / 30
MIwb	Wading	7.9	9.4	6.2
	Boat	8.7	9.6	5.8 / 6.6
ICI	All	34	46	22

Table 4: Biological criteria applicable to rivers and streams in the Erie-Ontario Lake Plains (EOLP)

The HUC-12 was last sampled at 13 sites (Figure 13) from 2011-2016 by OEPA and NEORSD. There is no TMDL (Total Maximum Daily Load) for the HUC-12; OEPA will complete an assessment in 2019. Additionally, NEORSD is updating its Stormwater Masterplan for its service area in 2018 which will identify and inventory HUC-12 issues. None of the HUC-12 sampling sites attain the Ohio EPA biological criteria for the designated ALU for warmwater habitat (WWH) (Table 5).

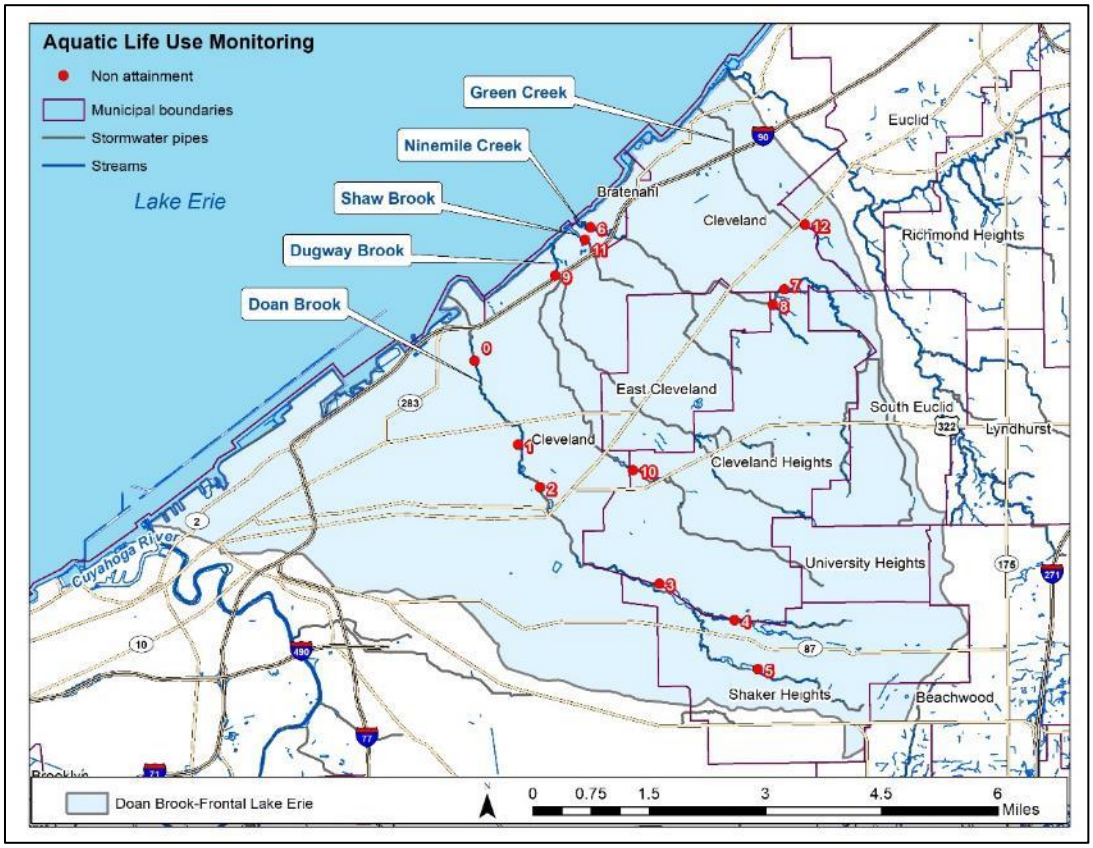

Figure 13: Aquatic Life Use Monitoring in HUC-12 (Ohio EPA)

ID	Sample Station Name	River Mile (DA)	Fish Year	IBI Score	IBI Narrative	MIWB Score[3]	Invert Year	ICI Score	ICI Narrative	Invert Narrative	QHEI Score	Attainment
0	DOAN BROOK AT CLEVELAND @ ST. CLAIR AVE.	0.75 (9.1)	2016	32	Fair	NA	2016	16	Fair		51	Non
1	DOAN BROOK ADJ. MLK DR	2.27 (8.1)	2016	24	Poor		2015	0		Poor	60.1	Non
2	DOAN BROOK AT CLEVELAND @ WADE PARK	3.1 (7.7)	2016	24	Poor	NA	2016	18	Fair		78.5	Non
3	DOAN BROOK AT SHAKER HEIGHTS @ COVENTRY RD.	5.5 (4.4)	2015	22	Poor	NA	2015	0		Very Poor	58	Non
4	DOAN BROOK AT SHAKER HEIGHTS, DST. LEE RD.	6.64 (1.3)	2016	24	Poor		2016	4	Poor		65.5	Non
5	S. BR. DOAN BROOK AT SHAKER HEIGHTS @ ATTLEBORO RD.	1.31 (3.4)		0		NA	2014	2	Very Poor		61.5	Non
6	NINEMILE CREEK AT CLEVELAND @ LAKE SHORE BLVD.	0.34 (11.8)	2015	12	Very Poor		2015	0		Poor	66	Non
7	NINEMILE CREEK ADJ. BELVOIR BLVD, UPST. NELA PARK TRIB.	3.34 (0.7)	2011	20	Poor	NA	2011	0		Low Fair	61.3	Non
8	NINEMILE CREEK (NELA PARK BRANCH) UPST BELVOIR BLVD. CULVERT	0.01 (3.2)	2011	12	Very Poor	NA	2011	0		Poor	55	Non
9	DUGWAY BROOK AT BRATENAHL @ LAKE SHORE BLVD.	0.45 (6.2)	2014	24	Poor	NA	2014	16	Low Fair		71	Non
10	DUGWAY BROOK (W. BR.) AT EAST CLEVELAND @ LAKEVIEW CEMETERY	2.4 (2.6)		0		NA	2014	24	Fair		51	Non
11	SHAW BROOK NEAR BRATENAHL @ LAKE SHORE BLVD.	0.4 (1.5)	2013	12	Very Poor	NA	2013	14	Low Fair		53.5	Non
12	GREEN CREEK NEAR EUCLID, UPST. EUCLID AVE.	2.1 (0.6)	2013	20	Poor	NA	2013	0		Low Fair	47.5	Non

Table 5: HUC-12 Aquatic Life Use Monitoring for WWH (Ohio EPA)

[3] Mlwb was not utilized for headwater streams (<20 square miles drainage area)

2.3 Summary of HUC-12 Pollution Causes and Associated Sources

Table 6 lists the causes and sources of HUC-12 water quality impairment as identified in the Ohio EPA's 2016 Integrated Water Quality Monitoring and Assessment Report. The highly urban and suburban environments that exist across the HUC-12 are associated with all impairments listed below. Organic enrichment is largely caused from fertilizer runoff from urban lawns and golf courses, as well as sanitary sewage from cross-connected or leaking sanitary sewers and combined sewer overflows. The high percentage of impervious surfaces (Figure 12) has led to a greater variation of high and low flow regimes. The amount of impervious surface also increases sediment loads and substrate embeddedness, resulting from erosion-caused sediment deposition. Limited floodplain access and a lack of riparian vegetation cause streambed down-cutting and bank destabilization in many open watercourses. The OEPA projects a TMDL in 2019 which will further identify specific sources leading to the HUC-12's non-attainment status.

Causes of impairment	Sources of impairment
Flow Regime Modification	Sediment Resuspension (contaminated sediment)
Habitat Alterations	Combined Sewer Overflows
Pollutants in Urban Stormwater	Channelization
	Municipal (urbanized high density area)
	Urban runoff/Storm sewers

Table 6: Causes and Sources of Impairment in HUC-12

2.4 Additional Information for Determining Critical Areas and Developing Implementation Strategies

Doan Brook

Following the adoption of the DB WAP in 2013, the DBWP was awarded a Great Lakes Restoration Initiative grant from OEPA in 2015 to identify, design, and prioritize possible habitat restoration projects in the Doan riparian corridor. From 2015-2016, Environmental Design Group worked with DBWP to produce project plans and designs for four sites requiring restoration. Additional, potential project sites for future restoration were also identified. Four projects were ultimately outlined: Rockefeller Park stream restoration and channel improvements; Sowinski Park oxbow wetland restoration and channel improvements; Doan estuary restoration; and Canterbury Golf Club stream restoration. This process and the resulting design documents will inform the creation of NPS-IS projects for Doan Brook.

Chapter 3: Critical Area Conditions & Restoration Strategies

3.1 Overview of Critical Areas

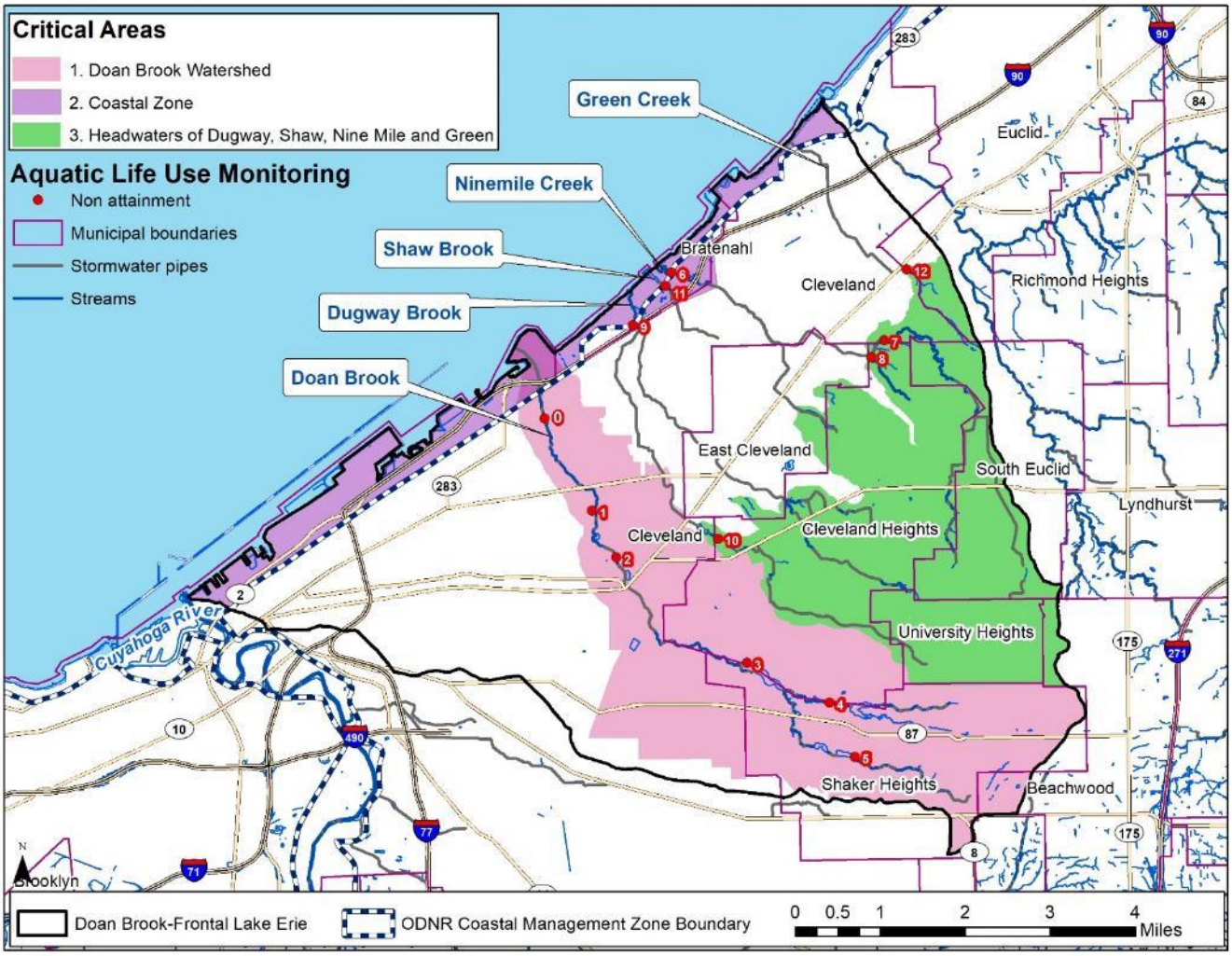

Figure 14: HUC-12 Critical Areas

3.2 Critical Area 1 (Doan Brook): Conditions, Goals & Objectives

3.2.1 Detailed Characterization

Critical Area 1 (Doan Brook) covers both the footprint of the Doan Brook's natural watershed and the area that comprises the Doan's current sewershed so as to provide ample opportunity for both restoration projects oriented towards the natural watershed and green infrastructure projects outside this natural boundary but within the constructed sewershed boundaries.

Doan Brook stretches 11.3 miles from the shale slope to the shoreline of Lake Erie and drains an area of 11.9 square miles in three municipalities: Cleveland, Cleveland Heights, and Shaker Heights. The Doan is the largest stream in the HUC-12 and is the only stream in the HUC-12 that is primarily open throughout the course of the main stem.

The stream begins as three separate headwater branches (North, Middle, and South) in the shale slope that eventually converge into a main stem at Lower Shaker Lake, the largest of four man-made lakes that punctuate the Doan and serve as freshwater ponds that also host small patches of emergent and forested/shrub wetlands in their immediate proximity.

The North and Middle branches flow in from the east to form Horseshoe Lake, which was created as a mill pond by the Shakers. The North branch begins south of Shelburne Road near Green Road and travels along Shelburne Road. The Middle branch travels along South Park Boulevard after surfacing at the intersection of South Park and Warrensville Center Road. Downstream from Horseshoe Lake, the North and Middle branches converge and flow through a wooded corridor that has been designated as a wildlife preserve. Just upstream from the Lower Shaker Lake at the Nature Center at Shaker Lakes marsh, the main stem is joined by the stream's South branch.

The South branch first surfaces from storm-sewer pipes on the Canterbury Golf Club property east of the intersection of South Woodland Road and Belvoir Boulevard. It flows southwest along the west edge of the golf course and then enters into a culvert at Shaker's Van Aken District. The South branch resurfaces at the Shaker Country Club and stays above ground as it enters Green Lake southeast of the intersection of South Woodland and Lee Roads. From Green Lake, the South branch continues west into Marshall Lake, then turns north between South Park and West Park Boulevards through Southerly Park and the forest at the Nature Center at Shaker Lakes.

Downstream from Lower Shaker Lake, the Doan descends the sandstone terrace towards the lake plain through a narrow gorge segment located between Fairhill Road and North Park Boulevard that is characterized by steep valley walls. This gorge segment is presently undeveloped but historically hosted a mill and small quarries. Upon exiting the gorge, the stream enters a culvert that runs beneath Cleveland's University Circle district. In this culverted section, the Doan joins with Giddings Brook, which was historically a direct lake tributary to the West of the Doan but is now completely culverted and rerouted. The Doan emerges from the closed culvert near the Cleveland Museum of Art and enters into an engineered open channel in Cleveland's historic Rockefeller Park and Cultural Gardens. The stream travels through this channel alongside Martin Luther King Jr. Boulevard towards its mouth at Lake Erie where it is culverted again beneath I-90 and the Cleveland Lakefront Nature Preserve. The Cleveland Lakefront Nature Preserve (formerly known as Dike 14) is an 88-acre man-made peninsula that has become a haven for migratory birds and butterflies. It is a designated Important Bird Area (IBA). About 280 species of birds have been recorded to date (Ohiodnr.gov). The Preserve's land mass began taking shape in the late 1970s as the U.S. Army Corps of Engineers disposed of sediment dredged from the Cuyahoga River in a walled-off area along the Lake Erie shoreline. It was operated as a Confined Disposal Facility (CDF) from 1979 to 1999 by the U.S. Army Corps of Engineers, under contract with the Cuyahoga County Port Authority and the City of Cleveland. The Cleveland-Cuyahoga County Port Authority now manages this area as a greenspace and opened it to the public in 2012.

Figure 15: Cleveland Lakefront Nature Preserve signage (Photo taken September 6, 2018 by Alicia Beattie).

Figure 16: Monarch habitat at Cleveland Lakefront Nature Preserve (Photo taken September 6, 2018 by Alicia Beattie)

As a result of culverting and abandonment, Doan Brook has lost nearly 20 mi of open stream courses (Figure 18). This number includes four Doan tributaries which no longer have any surface flow. The streams (and their lost channel mileage) are Blue Rock Brook (3.13 mi), Spring Pond Brook (1.75 mi) and Wade Spring (0.41 mi) (Figure x). Farther upstream the 'Onaway' branch (1.11 mi) is also without any open course.

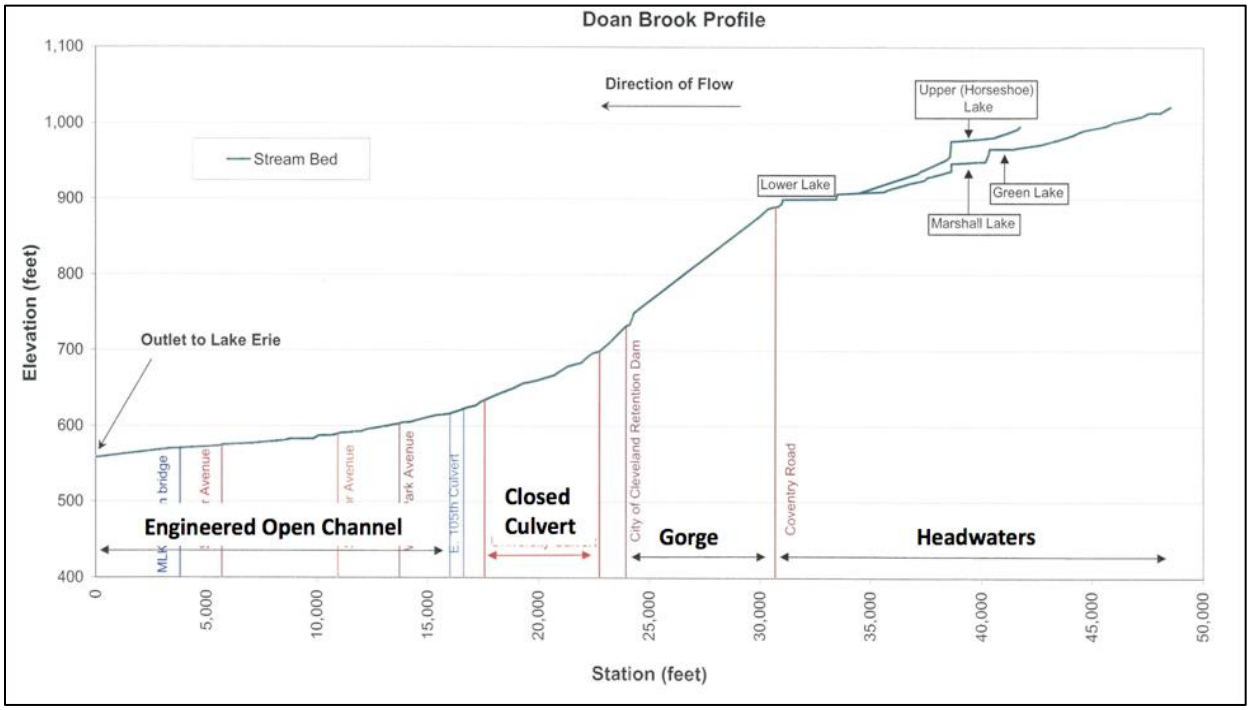

Figure 17: Doan Brook Profile

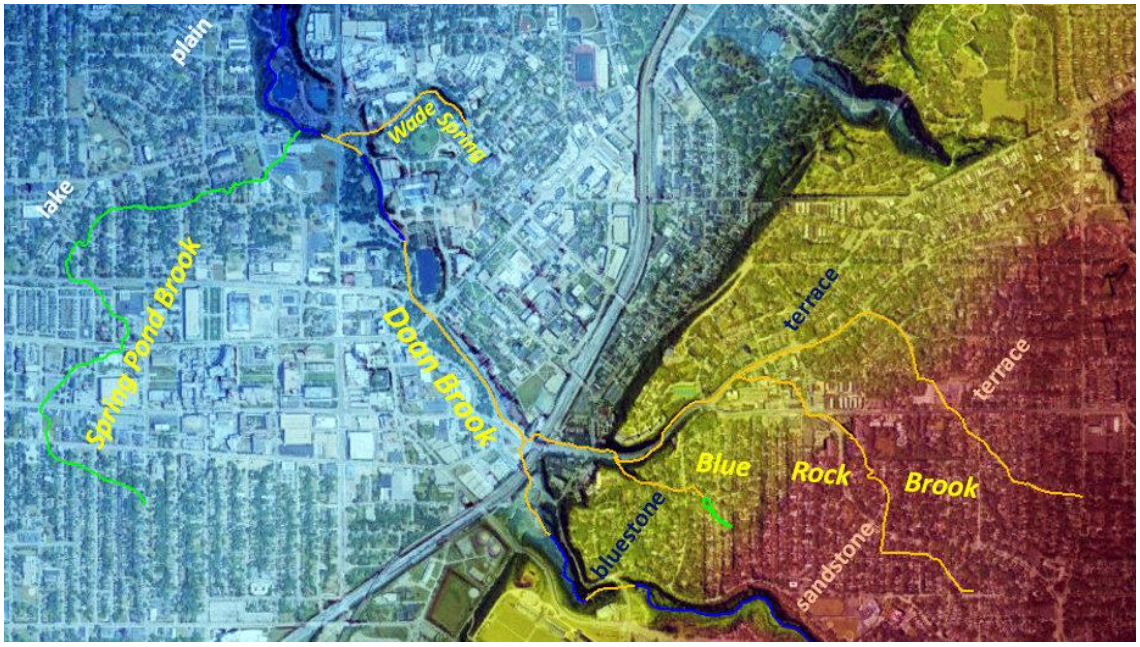

Figure 18: Doan Book lost tributary channels[4]

[4] Blue=open; brown=culverted; green=abandoned

Land use in the Critical Area is representative of the land use patterns in the HUC-12 overall with the majority of land dedicated to residential use and clusters of urban and industrial land use along major thoroughfares (primarily in the lake plain). A large percentage of the institutional land use present in the HUC-12 falls within Critical Area #1 as it contains Cleveland's University Circle neighborhood, home to Cleveland Clinic, Case Western Reserve University, and many of Cleveland's cultural institutions. The Baldwin Water Treatment Plant is a major utility in the Critical Area. The Baldwin Water Treatment Plant is one of the oldest and largest such plants in the United States. Built originally in 1925 to assist with a growing population during Cleveland's early expansion, the plant continues to provide water treatment for a large population in Cleveland.

The Doan Brook riparian corridor includes numerous parks and open spaces that amount to a continuous expanse of green space through the Critical Area. It has the most intact riparian corridor in the HUC-12, and therefore serves as an important passageway and oasis for wildlife in the heavily urbanized environment. Furthermore, the Doan Brook riparian corridor and associated park lands represent a significant amount of pervious surface area in the Critical Area.

3.2.2 Detailed Biological Conditions

ID	Sample Station Name	River Mile (DA)	Fish Year	IBI Score	IBI Desc.	MIWB Score[5]	Invert year	ICI Score	ICI Desc.	Invert Desc.	QHEI Score	Attainment
0	DOAN BROOK AT CLEVELAND @ ST. CLAIR AVE.	0.75 (9.1)	2016	32	Fair	NA	2016	16	Fair		51	Non
1	DOAN BROOK ADJ. MLK DR	2.27 (8.1)	2016	24	Poor		2015	0		Poor	60.1	Non
2	DOAN BROOK AT CLEVELAND @ WADE PARK	3.1 (7.7)	2016	24	Poor	NA	2016	18	Fair		78.5	Non
3	DOAN BROOK AT SHAKER HEIGHTS @ COVENTRY RD.	5.5 (4.4)	2015	22	Poor	NA	2015	0		Very Poor	58	Non
4	DOAN BROOK AT SHAKER HEIGHTS, DST. LEE RD.	6.64 (1.3)	2016	24	Poor		2016	4	Poor		65.5	Non
5	S. BR. DOAN BROOK AT SHAKER HEIGHTS @ ATTLEBORO RD.	1.31 (3.4)		N/A		NA	2014	2	Very Poor		61.5	Non

Table 7: Doan Brook Aquatic Life Use Monitoring for WWH

Doan Brook was last sampled at 6 sites (Figure 13) from 2011-2016 by OEPA and NEORSD. There is no TMDL (Total Maximum Daily Load) for the HUC-12; OEPA will complete an assessment in 2019. Additionally, NEORSD is creating a Stormwater Masterplan for this HUC 12 beginning in 2018 which will identify and inventory problem areas, such as erosion and flooding hotspots. Presently, none of the Doan Brook sampling sites attain the OEPA biological criteria for the designated ALU for warmwater habitat (WWH)

Index of Biotic Integrity (IBI)

As indicated in the Fisheries and Wildlife section (p.19), fish diversity in the Doan Brook is low, and a few pollution tolerant species are dominant. Only a single sample station at RM 0.75, near the culverted mouth of the Doan, had a "Fair" IBI score. The other sample stations in the headwaters received "Poor" scores or were not scored at all. These scores reflect the habitat impacts of surrounding urbanization such as increased sediment load and substrate embeddedness, which have consequences for biological diversity. Similarly, negative impacts on biological communities are associated with extreme flow fluctuations caused by channelized and culverted stream courses and impervious cover.

[5] Mlwb was not utilized for headwater streams (<20 square miles drainage area)

Invertebrate Community Index (ICI)

The ICI standard for WWH is 34. None of the sample sites in the Doan Brook achieve that standard. The sampling sites at RM 0.75 and RM 3.1 have the highest ICI scores ("Fair") of the Doan Brook sites, with none of the sampling sites in the headwaters receiving better than a "Poor" score.

Qualitative Habitat Evaluation Index (QHEI)

Five of the six sampling sites on the Doan exceed the target score of 55, with the RM 3.1 site in Rockefeller Park receiving the highest score. These scores only reflect the potential of these stream segments to support healthier biological communities and must be contrasted at present with the low ICI and IBI scores at these sites. However, these scores highlight the fact that the Doan Brook has the potential to host more diverse fish and macroinvertebrate populations throughout its riparian corridor.

3.2.3 Detailed Causes and Associated Sources

Table 6 lists the causes and sources of HUC-12 water quality impairment as identified in the Ohio EPA's 2016 Integrated Water Quality Monitoring and Assessment Report. All of the identified causes and sources of impairment are associated with the heavy urban and suburban development throughout the HUC-12. Development patterns in Critical Area 1 (Doan Brook) are consistent with the rest of the HUC-12. From the headwaters to the mouth at Lake Erie, the Doan Brook flows through dense, urban and suburban areas with high levels of impervious surface area and aging storm water/sewer infrastructure. Urban runoff from the roadways, parking lots, buildings, and lawns of Cleveland, Cleveland Heights, and Shaker Heights are a major concern for Doan Brook as they contribute to flashiness and transport harmful chemicals and nutrients into the stream ecosystem. Similarly, CSO outfalls are major contributors to the contamination of the stream. In Cleveland, the Doan Brook is almost entirely disconnected from its floodplain as it either flows through culverts or is channelized in historic retaining walls. This negatively impacts stream habitat and flow regimes.

Figure 19: Doan Brook downstream of Wade Park Ave w. failing retaining walls (Photo taken June 4, 2018 by Alicia Beattie).

Figure 20: Doan Brook downstream of Saint Casimir Way at Sowinski Park (Photo taken June 4, 2018 by Alicia Beattie).

3.2.4 Outline Goals and Objectives for the Critical Area

Goals

The overall nonpoint source restoration goal of this NPS-IS is to improve IBI, MIwb, ICI, and QHEI scores such that the entire HUC-12 is brought into full attainment of the designated ALU. Non-attainment in Critical Area 1 (Doan Brook) is due to poor ICI and IBI scores at all six Doan Brook sampling sites. Macroinvertebrate community health has not been assessed but should be in the future. The goals for Critical Area 1 (Doan Brook) are to improve IBI and ICI scores at sampling sites 0, 1, 2, 3, 4, and 5 and improve QHEI scores at site 0 on the Doan Brook so that the stream will improve from non-attainment to full attainment of the designated ALU. The goals are as follows:

GOAL 1. Achieve an IBI score of 40 at sample site 0 (RM 0.75)
Not Achieved: Current score is 32

GOAL 2. Achieve an ICI score of 34 at sample site 0 (RM 0.75)
Not Achieved: Current score is 16

GOAL 3. Achieve an QHEI score of at least 55 at sample site 0 (RM 0.75)
Not Achieved: Current score is 51

GOAL 4. Achieve an IBI score of 40 at sample site 1 (RM 2.27)
Not Achieved: Current score is 24

GOAL 5. Achieve an ICI score of 34 at sample site 1 (RM 2.27)
Not Achieved: Current score is 0

GOAL 6. Maintain a QHEI score of at least 55 at sample site 1 (RM 2.27)
Achieved: Current score is 60.1

GOAL 7. Achieve an IBI score of 40 at sample site 2 (RM 3.1)
Not Achieved: Current score is 24

GOAL 8. Achieve an ICI score of 34 at sample site 2 (RM 3.1)
Not Achieved: Current score is 18

GOAL 9. Maintain a QHEI score of at least 55 at sample site 2 (RM 3.1)
Achieved: Current score is 78.5

GOAL 10. Achieve an IBI score of 40 at sample site 3 (RM 5.5)
Not Achieved: Current score is 22

GOAL 11. Achieve an ICI score of 34 at sample site 3 (RM 5.5)
Not Achieved: Current score is 0

GOAL 12. Maintain an QHEI score of at least 55 at sample site 3 (RM 5.5)
Achieved: Current score is 58

GOAL 13. Achieve an IBI score of 40 at sample site 4 (RM 6.64)
Not Achieved: Current score is 24

GOAL 14. Achieve an ICI score of 34 at sample site 4 (RM 6.64)
Not Achieved: Current score is 4

GOAL 15. Maintain a QHEI score of at least 55 at sample site 4 (RM 6.64)
Achieved: Current score is 65.5

GOAL 16. Achieve an IBI score of 40 at sample site 5 (RM 1.31)
Not Achieved: Current score is NA

GOAL 17. Achieve an ICI score of 34 at sample site 5 (RM 1.31)
Not Achieved: Current score is 2

GOAL 18. Maintain an QHEI score of at least 55 at sample site 5 (RM 1.31)
Achieved: Current score is 61.5

Objectives

OBJECTIVE 1: Complete 2,000 feet of stream enhancement through Rockefeller Park between E. 105th St. and Wade Park Ave, including bank stabilization of 1,000 feet.

OBJECTIVE 2: Reconstruct a stable stream channel in Rockefeller Park with the proper dimension, pattern, and profile that reduces erosion, provides habitat, and will reconnect stream to floodplains when possible and within the Historic Preservation Act guidelines.

OBJECTIVE 3: Reconstruct a stable stream channel through the Upper Watershed (North, Middle, South Branches) with the proper dimension, pattern, and profile that reduces erosion, provides habitat, and will reconnect stream to floodplains when possible.

OBJECTIVE 4: Perform streambank stabilization/restoration and facilitate fish passage in area of severe erosion near trash rack dam on Doan Brook at MLK Blvd.

OBJECTIVE 5: Implement projects that will direct 20 acres of impervious surface to stormwater control measures that provide water quality benefit.

OBJECTIVE 6: Plant native plants, shrubs and trees along 2000 feet of stream bank through Rockefeller Park.

OBJECTIVE 7: Plant native plants, shrubs and trees along 800 feet of stream bank along the South Branch at Woodbury School.

OBJECTIVE 8: Remove or modify check dams along 600 linear feet of the stream in Rockefeller Park.

OBJECTIVE 9: Evaluate the feasibility of various day-lighting alternatives at Cleveland Lakefront Nature Preserve and implement recommendations.

OBJECTIVE 10: Restore in-stream and riparian habitat in 16 acres of the watershed.

As these objectives are implemented, water quality monitoring (both project related and regularly scheduled monitoring) will be conducted to determine progress toward meeting the identified goals (i.e., water quality standards). These objectives will

be reevaluated and modified if determined to be necessary. For instance; many agricultural BMPs can be “stacked” (a systems approach) that will also incrementally improve the quality and quantity of runoff and drainage waters and in-stream water quality. When reevaluating, the committee will reference the Ohio EPA Nonpoint Source Management Plan Update (Ohio EPA, 2013), which has a complete listing of all eligible NPS management strategies to consider including:

- Urban Sediment and Nutrient Reduction Strategies;
- Altered Stream and Habitat Restoration Strategies;
- Nonpoint Source Reduction Strategies; and
- High Quality Waters Protection Strategies

3.3 Critical Area 2 (Coastal Zone): Conditions, Goals & Objectives

3.3.1 Detailed Characterization

Critical Area 2 (Coastal Zone) forms the northern limit for most of the Doan Brook-Frontal Lake Erie HUC-12. With its northern margin as the fully armored Lake Erie shoreline, Critical Area 2 (Coastal Zone) constitutes a narrow band of terrestrial lowland directly south of the shoreline (Figure 21). The southern boundary follows that set by the Ohio Department of Natural Resources Lake Erie Coastal Zone (following approximately the CSX railroad/Interstate 90/Lakeshore Boulevard) but has been expanded to include additional areas draining to the mouths of Dugway Brook, Shaw Brook and Nine Mile Creek. Critical Area 2 (Coastal Zone) does not include coastal areas draining to Doan Brook (including Gordon Park and Dike 14), as these areas are included in Critical Area 1 (Doan Brook).

Within Critical Area 2 (Coastal Zone), the mouths of Dugway Brook, Shaw Brook and Nine Mile Creek retain features of drowned valley estuaries typical of all but the smallest Lake Erie tributaries. Several thousand years ago, the lake's surface level lay significantly lower than at present. With increased gradient, tributary streams incised into the current coastal zone. More recently, the lake has risen in elevation (with the isostatic rebound of the Niagara sill) with the result that lake water now inundates the ravines. Backwater reaches inland in a range of several hundred to more than 2,000 linear feet, depending upon ravine depth. As inundation has slowed lakeward flows, the lower courses have been subject to increased meandering within the silting drowned ravines. Historical development has either served to entrench nineteenth-century meanders into their floodplains or eliminate them altogether by culverting.

Like all of Lake Erie's drowned valleys, those of Critical Area 2 (Coastal Zone) exhibit estuarine habitat. However, all such features show the degradations of anthropogenic development; estuarine floodplains are valuable real estate. As mentioned above, development has filled in meanders, raised floodplains and hardened streambanks. Hydrological and ecological processes have therefore been compromised in all Coastal Zone habitats.

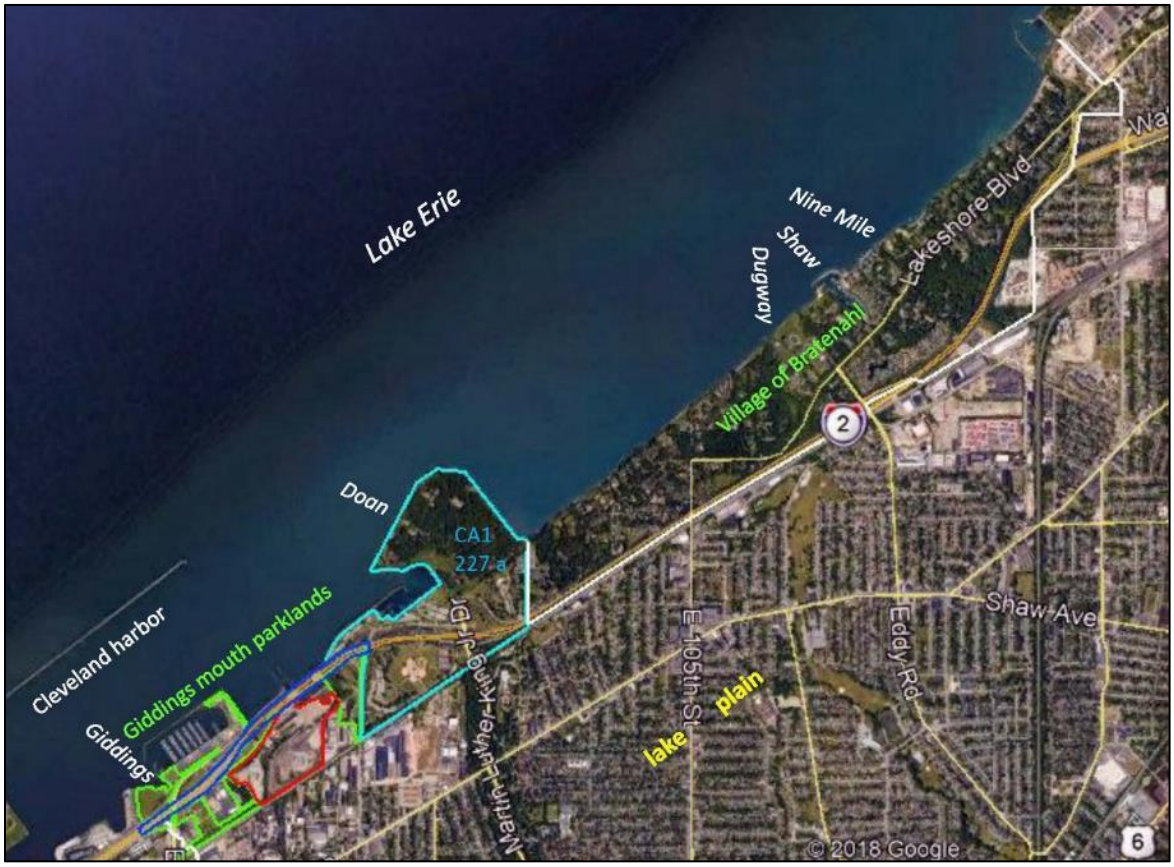

Figure 21: Coastal Zone critical area (East 55th Street to Village of Bratenahl)

Dugway Brook

Dugway Brook is fully open within the coastal zone but is greatly transformed. While historical maps show several meanders covering the entire floodplain, the channel is now confined to the west side of the ravine (Figure 22). Three areas of infill have eliminated at least two meanders and two small west-flowing ravines. Only the final eastward meander remains and even it has been shortened (Figure 22).

North of Lakeshore Boulevard, the mainstem of Dugway Brook flows openly for approximately 2,000 linear feet. For 1,000 feet north of Lakeshore Boulevard, significant amounts of fill material have raised the floodplain by 15 feet to approximately 595 feet above sea level. North of this reach to Lake Erie, the floodplain has not received as much fill, but the stream channel has been confined within a stone retaining wall, steel bulkheading and coarse hard fill. The northernmost 500 ft. of channel is entirely armored with hard structures.

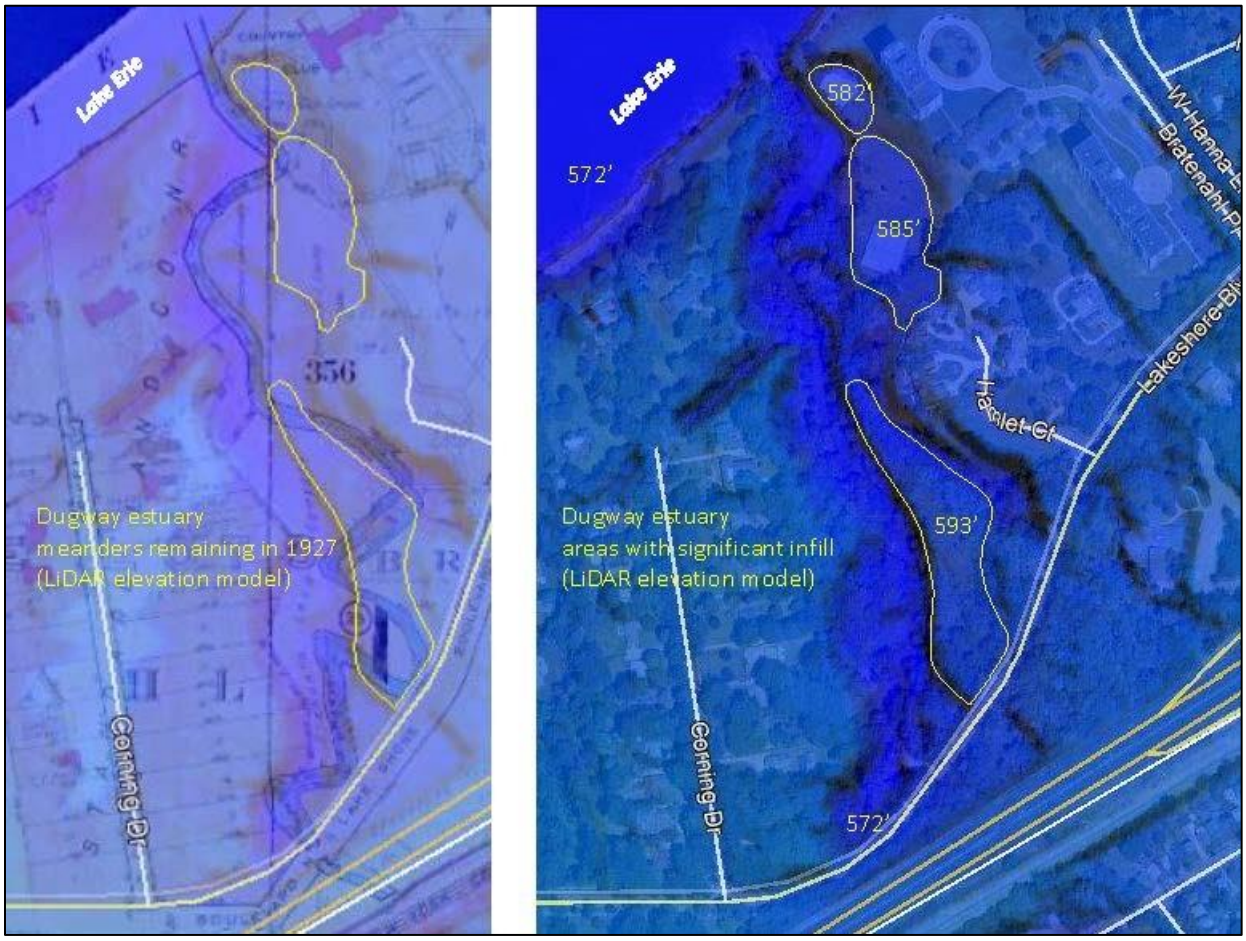

Figure 22: Dugway Brook estuary conditions in 1927 (left). Current conditions resulting from fill placed in floodplain (right)

Shaw Brook

In the early 1900s, the major Shaw Brook headwater stream was diverted eastward into the Nine Mile Creek sewershed. Downstream of this point, Shaw Brook has been culverted for nearly its entire course. The Coastal Zone includes Shaw Brook's only open reach: a small remnant flowing within a highly infilled floodplain between Interstate 90 and Lakeshore Boulevard.

It is not clear from historical records whether Shaw Brook had a significant prehistoric drowned valley at its mouth along Lake Erie; however, since early historic times (1850s), the stream mouth has been enlarged occasionally to shelter small pleasure boats. In the 1990s, the harbor was greatly enlarged to receive large pleasure craft. The current channel is 800 feet long and averages 200 feet in width with a dredged depth of 12 feet. The streambanks are entirely hardened with steel bulkheading.

Nine Mile Creek

South of Interstate 90, the mainstem of Nine Mile Creek is free of culverting for 1.5 river miles to Lake Erie (Figure 23). Currently, the estuarine area begins at RM 0.3, approximately at the Lakeshore Boulevard crossing. Downstream of Lakeshore Boulevard, the historic meanders have been hardened as landscape features. Upstream of Lakeshore Boulevard (south of Interstate 90), Nine Mile Creek exhibits meanders and its floodplain has been preserved in a more-or-less natural state.

Between Interstate 90 and Lakeshore Boulevard, Nine Mile Creek's riparian zone has been largely preserved. Approximately 40 acres have been owned by one family since the 1880s and is known as Southside. Never subject to infill, the Southside ravine retains a well-developed terrace perched midway (elevation of approximately 590 feet) between the current floodplain (elevation of approximately 580 feet) and the lake plain rim (elevation approximately 600 feet) (Figure 23). Wetlands are found in meander scars on the terrace and floodplain. Logged just once, the Southside property contains the only sizeable beech-oak forest on the lake plain in Cuyahoga County. In 2011, the family placed 28 acres under a conservation easement held by Western Reserve Land Conservancy. As part of the conservation plan, NEORSD, EnviroScience, Inc., and the landowner share responsibilities for wetland enhancement and invasive species control on the property.

Impervious cover in the Nine Mile Creek drainage area is approximately 39.4 percent (USGS StreamStats; NLCD 2011 impervious dataset). Within the Village of Bratenahl, significant impervious surfaces include transportation corridors such as: Interstate 90 and State Route 2 (2.64 miles); Lakeshore Boulevard, Eddy Road, and East 105th Street (3.02 miles); and side streets (5.15 miles).

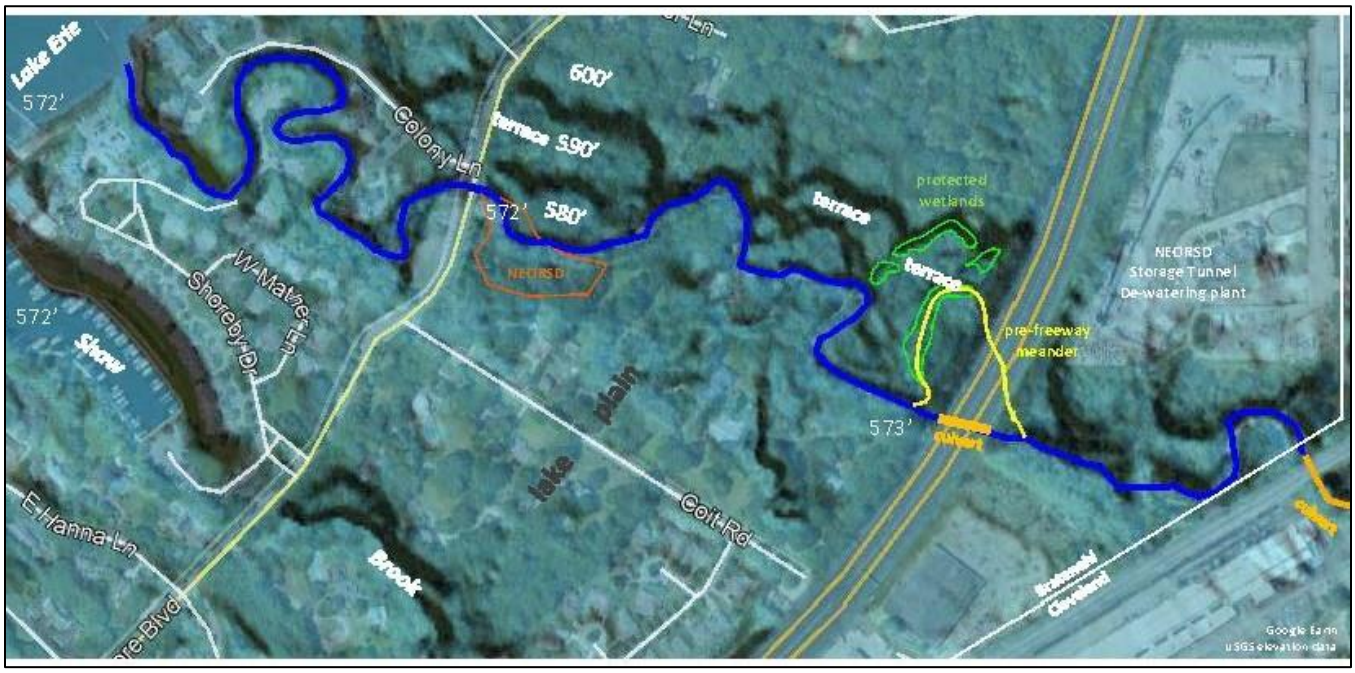

Figure 23: Nine Mile Creek Southside vicinity (between Lakeshore Boulevard and Interstate 90)

Giddings Brook

Early in the twentieth century, the historical upper Giddings Brook culvert (draining a sewershed of 1.8 square miles) was rerouted to become part of Doan Brook (Critical Area 1). North of the diversion point, all of Giddings Brook's natural flow has been taken into the lake plain storm sewer grid. Under East 55th Street, one major storm sewer lies along much of the lower reaches of Giddings Brook's natural alignment. This sewer empties into Lake Erie within Critical Area 2 (Coastal Zone), just west of the East 55th Street Marina and within the Cleveland Harbor (Figure 24).

There is no historical record of a drowned valley estuary at the Giddings Brook mouth. By 1850, the area had been taken over by a large railroad maintenance facility, which obliterated the stream's natural features. The current sewer outfall delivers to an artificial lake-level plunge pool about 100 feet in diameter (Figure 24). Within the pool, NEORSD has a floatable controls unit tethered to the sewer outfall. Boats are prevented from entering by a floating barrier at the mouth of the pool. The pool opens onto a larger embayment which extends approximately 400 feet lakeward and then opens fully to the harbor at a

yacht club breakwater. The width of the embayment at the breakwater is about 210 feet. The embayment covers about 1.5 acres; its coast is slightly hardened with rubble.

The Giddings Brook outfall is surrounded by 57 acres of sparsely wooded parkland, Interstate 90 marginal areas, and various abandoned (unmown) private properties (Figure 25). Cleveland Metroparks manages the non-road parklands as part of the East 55th Street Marina. The East Shoreway (Interstate 90 and State Route 2) contributes significant impervious cover draining to this outfall (approximately 1.1 miles and 24 acres of paved surface). An associated interchange, marginal roadways and a few side streets contribute approximately an additional 2 miles of pavement and bring the local impervious surface area to greater than 30 acres.

An adjacent 54 acres includes the site of the demolished (in 2017) FirstEnergy lakefront power plant. FirstEnergy remains the landowner and is evaluating future plans for this property. One plan, entitled Public A (prepared by CallisonRTKL), features nearly 20 acres of proposed urban woodland (Figure 26).

Figure 24: Mouth of Giddings Brook vicinity

Figure 25: Parklands near mouth of Giddings Brook

Figure 26: CallisonRTKL Public A scenario for FirstEnergy demolition site (facing southwest)

3.3.2 Detailed Biological Conditions

The Coastal Zone covers less than 10% of the area of the HUC-12 watershed. The individual stream segments within the zone represent less than 10% of their full lengths. The chemical and biological conditions of these streams are therefore determined upstream of the Coastal Zone. The primary upstream source of habitat impairment is flash flood flows generated on impervious surfaces. All three open stream segments (Dugway Brook, Shaw Brook and Nine Mile Creek) have major NEORSD CSO outfalls just upstream of the Coastal Zone boundary, contributing a primary source of chemical and biological impairment. Within the Coastal Zone, primary water quality and habitat impairments include stream bed scouring and entrenchment, streambank erosion and downstream sedimentation, and poor water quality.

NEORSD and OEPA monitor habitat and water quality for Dugway Brook, Shaw Brook and Nine Mile Creek in the Coastal Zone. The Dugway Brook and Nine Mile Creek monitoring locations are downstream of the final culvert outfalls and within the estuarine channels. The Shaw Brook monitoring location is located upstream of Lakeshore Boulevard in the stream's lake plain remnant. To meet WWH aquatic life use targets, streams in the Coastal Zone need to achieve an IBI fish diversity score of 40, ICI invertebrate diversity score of 34, and a QHEI score of 55. Recent monitoring results are as follows.

ID	Sample Station Name	Attain-ment	ALU Design-ation	Drain-age Area (mi^2)	Year	IBI Score	IBI Narrative	ICI Score	ICI Narrative	QHEI Score	QHEI Narrative
6	NINEMILE CREEK AT CLEVELAND @ LAKE SHORE BLVD. (OEPA); RM 0.40 (NEORSD)	Non	WWH	11.8	2015 (OEPA); 2013 (NEORSD)	12* (OEPA); 20* (NEORSD)	Very poor (OEPA); Poor (NEORSD)	8* (NEORSD)	Poor (OEPA); Poor (NEORSD)	66 (OEPA); 76.5 (NEORSD)	Excellent (OEPA); Excellent (NEORSD)
9	DUGWAY BROOK AT BRATENAHL @ LAKE SHORE BLVD. (OEPA); RM 0.37 (NEORSD)	Non	WWH	6.2	2014 (OEPA); 2014 (NEORSD)	24* (OEPA); 24* (NEORSD)	Poor (OEPA); Poor (NEORSD)	16* (OEPA); 16 (NEORSD)	Low/Fair (OEPA); Fair (NEORSD)	71 (OEPA); 70 (NEORSD)	Excellent (OEPA); Excellent (NEORSD)
11	SHAW BROOK NEAR BRATENAHL @ LAKE SHORE BLVD. (OEPA); RM 0.40 (NEORSD)	Non	WWH	1.5	2013 (OEPA); 2013 (NEORSD)	12* (OEPA); 12* (NEORSD)	Very poor (OEPA); Very poor (NEORSD)	14* (OEPA); 14* (NEORSD)	Low Fair (OEPA); Fair (NEORSD)	53.5* (OEPA); 53.5* (NEORSD)	Fair (OEPA); Fair (NEORSD)

Table 8: Coastal Zone Aquatic Life Use Monitoring of WWH.[6]

Index of Biotic Integrity (IBI)

Fish diversity in the coastal zone stream segments is poor, and a few pollution tolerant species are dominant. IBI scores range 12 to 24 (Poor). Streams in this critical area need to increase IBI fish diversity scores to 40 in order to meet WWH aquatic life use targets for wading streams.

Invertebrate Community Index (ICI)

Macroinvertebrate diversity in the coastal zone stream segments is poor to fair, and pollution tolerant species are dominant. ICI scores range from 8 to 14. Streams in this critical area need to increase ICI invertebrate diversity scores to 34 in order to meet WWH aquatic life use targets for wading streams.

Qualitative Habitat Evaluation Index (QHEI)

Streams in this critical area should achieve QHEI scores of 55 to meet WWH aquatic life use targets. QHEI scores in the coastal zone stream segments ranged from 53.5 (Fair) to 76.5 (Excellent), reflecting the potential of these stream segments to support more diverse biological communities. The general level of the QHEI scores can be contrasted at present with the low ICI and IBI scores at these sites.

In sum, all three open stream reaches fall below the ALU attainment threshold for IBI and ICI. Alternatively, Dugway Brook and Nine Mile Creek have excellent QHEI scores and the highly transformed Shaw Brook reach has a fair QHEI score. Based on

[6] Significant departures from biocriteria are indicated with an asterisk.

NEORSD chemical water quality monitoring in 2013 and 2014, all three reaches have water quality exceedances for *E. coli* and Dugway Brook and Nine Mile Creek have exceedances for mercury. Shaw Brook has extremely low levels of dissolved oxygen. In addition to water quality impairments, instability of stream bed substrate due to urban stormwater also contributes to lack of attainment at these sites.

Ongoing improvements in upstream stormwater infrastructure should improve biological conditions on the lower reaches of Dugway Brook, Shaw Brook and Nine Mile Creek. In 2011, NEORSD completed the Dugway Brook East Interceptor Relief Sewer Alignment (DEIRS) to reduce the number of sanitary sewer overflows per year in Dugway Brook East Branch. A similar project on the Dugway Brook West Branch was completed in 2016. Scheduled for completion in 2019, the East 140th Street Consolidation and Relief Sewer Project will install bioretention cells on upper reaches of Shaw Brook and Nine Mile Creek. The Euclid Creek storage tunnel was completed in 2018 and will become fully operational in 2019. The Dugway Storage Tunnel is scheduled to go online in 2019. These facilities should eliminate 98% of CSO events and slightly reduce flashiness in Dugway Brook and Nine Mile Creek. Preliminary data from Mill Creek (south of Doan Brook) indicate that the Mill Creek Storage Tunnel (opened in 2017) has improved the biotic environment of that stream.

3.3.3 Detailed Causes and Associated Sources

Causes of impairment at these sites include habitat alterations, flow regime modifications, and pollutants in urban stormwater. Sources of impairment at these sites include municipal (urbanized high-density area), sediment resuspension (contaminated sediment), combined sewer overflows, channelization, and urban runoff/storm sewers. Most OEPA monitoring locations yield data indicating good or excellent/fair or good habitat quality. Yet the scores for fish and macroinvertebrate diversity are poor. These results suggest that exceedances in biological and chemical contaminants are the likely causes of impairment for these streams. Detailed information about causes and associated sources for Dugway Brook, Shaw Brook, and Nine Mile Creek is provided below.

Dugway Brook

In the highly constrained estuary, streambank erosion, sediment deposition, and streambed instability occur from Lakeshore Boulevard to the mouth of Dugway Brook (Biohabitats, Inc., 2011). The following CSO outfalls are sources of impairment to these reaches of Dugway Brook:

- NEORSD CSO-230 Dugway Brook outfall (approximately 600 feet upstream of Lakeshore Boulevard)
- NEORSD CSO-231 Dugway Brook outfall (approximately 600 feet upstream of Lakeshore Boulevard)

Shaw Brook

With the harbor enlargement, hydrological and ecological function at the mouth of Shaw Brook is greatly reduced. The following CSO outfalls are sources of impairment to this reach of Shaw Brook:

- NEORSD CSO-232 Shaw Brook outfall (south of Interstate 90, east of Eddy Road)

Nine Mile Creek

In the Southside area, between Interstate 90 and Lakeshore Boulevard, Nine Mile Creek is free to meander more-or-less the full width of its floodplain. Due to flashy and high volume stormwater flows, streambank erosion and sedimentation is occurring within this reach. At one location, erosion is occurring around failing storm sewer infrastructure within the stream channel. The following CSO outfall is a source of impairment to this reach of Nine Mile Creek:

- NEORSD CSO-211 Nine Mile Creek outfall (east of Coit Road, between the railroad tracks)

Giddings Brook

The following CSO outfall is a source of impairment to this reach of Giddings Brook:

- NEORSD CSO-202 Giddings Brook outfall (East 55th Street at Lake Erie)

3.3.4 Outline Goals and Objectives for the Critical Area

The overall nonpoint source restoration goals of this NPS-IS are to improve or maintain IBI, ICI, and QHEI scores so that non-attaining sites can achieve full attainment of WWH. Non-attainment in Critical Area 2 (Coastal Zone) is due to poor ICI and IBI scores at three OEPA monitoring locations. The goals for Critical Area 2 (Coastal Zone) are to improve IBI and ICI scores and maintain currently attaining QHEI scores at OEPA monitoring locations so that these streams will improve from non-attainment to full attainment of the designated ALU.

Goals

Specific goals referencing the non-attaining sites are provided below:

GOAL 1. Achieve an IBI score of 40 at Dugway Brook's mouth (at Lakeshore Boulevard)

Not Achieved: Current score is 24 (OEPA and NEORSD)

GOAL 2. Achieve an ICI score of 34 at Dugway Brook's mouth (at Lakeshore Boulevard)

Not Achieved: Current score is 16 (OEPA and NEORSD)

GOAL 3. Maintain a QHEI score of at least 55 at Dugway Brook's mouth (at Lakeshore Boulevard)

Achieved: Current score is 71 (OEPA)

GOAL 4. Achieve an IBI score of 40 at Shaw Brook's mouth (at Lakeshore Boulevard)

Not Achieved: Current score is 12 (OEPA and NEORSD)

GOAL 5. Achieve an ICI score of 34 at Shaw Brook's mouth (at Lakeshore Boulevard)

Not Achieved: Current score is 14 (OEPA and NEORSD)

GOAL 6. Achieve QHEI score of at least 55 at Shaw Brook's mouth (at Lakeshore Boulevard)

Not Achieved: Current score is 53.5 (OEPA and NEORSD)

GOAL 7. Achieve an IBI score of 40 at Nine Mile Creek's mouth (at Lakeshore Boulevard)

Not Achieved: Current scores are 12 (OEPA) and 20 (NEORSD)

GOAL 8. Achieve an ICI score of 34 at Nine Mile Creek's mouth (at Lakeshore Boulevard)

Not Achieved: Current score is 8 (NEORSD)

GOAL 9. Maintain a QHEI score of at least 55 at Nine Mile Creek's mouth (at Lakeshore Boulevard)

Achieved: Current score is 76.5 (NEORSD)

GOAL 10. Reduce total annual phosphorus load to Lake Erie by 40 percent (based on the *U.S. Action Plan for Lake Erie*, February 2018).

Not achieved.

Objectives

To achieve these goals for Critical Area 2 (Coastal Zone), the following objectives need to be achieved:

OBJECTIVE 1: Reforest 187 acres of riparian and coastal areas with native vegetation.*

**This objective is based on planned revegetation areas and Cuyahoga County Planning Commission's GreenPrint tool for tree canopy data.*

OBJECTIVE 2: Restore 3,500 linear feet of in-stream and lacustrine estuarine habitat using bioengineering techniques.*

**This objective is based on planned in-stream and lacustrine estuarine habitat restoration areas.*

OBJECTIVE 3: Restore 4,500 linear feet of Lake Erie coast line using bioengineering techniques.

OBJECTIVE 4: Install green infrastructure and stormwater retrofits in areas draining to escarpment ravines and open streams.*

- Install green infrastructure and stormwater retrofits (e.g. rain gardens, rain barrels, depaving) on residential streets and at 80 residential parcels to reduce pollutant loads, stormwater volumes, and flashiness.

**This objective is based on an assumed 10% participation rate by residential landowners within the critical area.*

As these objectives are implemented, water quality monitoring (both project related and regularly scheduled monitoring) will be conducted to determine progress toward meeting the identified goals (i.e., water quality standards). These objectives will be reevaluated and modified if determined to be necessary. For instance; many agricultural BMPs can be "stacked" (a systems approach) that will also incrementally improve the quality and quantity of runoff and drainage waters and in-stream water quality. When reevaluating, the committee will reference the Ohio EPA Nonpoint Source Management Plan Update (Ohio EPA, 2013), which has a complete listing of all eligible NPS management strategies to consider including:

- Urban Sediment and Nutrient Reduction Strategies;
- Altered Stream and Habitat Restoration Strategies;
- Nonpoint Source Reduction Strategies; and
- High Quality Waters Protection Strategies

3.4 Critical Area 3 (Escarpment Ravines): Conditions, Goals & Objectives

3.4.1 Detailed Characterization

Critical Area 3 (Escarpment Ravines) addresses non-point source pollution issues in the highly incised headwaters of five streams located east of Doan Brook within the Doan Brook-Frontal Lake Erie HUC-12. The escarpment ravines forming these headwater streams lie where the drainages traverse the Portage Escarpment shale slope and sandstone terraces. These ravines have been spared from development within a densely urban area due to their steep topography. The critical area comprises 30 ravine segments holding open watercourses (

Table 9). There are 6 segments on Dugway Brook west, 6 on Dugway Brook east, 2 on Shaw Brook, 13 on Nine Mile Creek and 3 on Green Creek. Together, the ravine segments hold 9.57 miles of open watercourses.

Stream	Open Segment	Segment Substrate	Land Use	Segment Length (LF)	QHEI Score	HHEI Score
Dugway Brook West	E Overlook-Edgehill	Berea Terrace	Residential	594		84
	Euclid Heights Blvd.	Berea Terrace	Residential	765		79
	Lake View quarries	Euclid Terrace	Institutional	894		
	Lake View up dam	Euclid Terrace	Institutional	996		
	Lake View down dam	Euclid Terrace	Institutional	1,260		
	Kent & Cedar-Dem	Berea Terrace	Residential	126		78
	Deming house	Berea Terrace	Residential	275		63
	Ambler	Euclid Terrace	Residential	380		75
Dugway Brook East	Staunton-Thayen	Shale Slope	Residential	1,410		87
	Thayen-Superior	Shale Slope	Residential	660		
	Cumberland Park	Berea Terrace	Parkland	1,011		73
	Compton Creek	Berea Terrace	Institutional	888		
	Forest Hill – DS reach	Berea Terrace	Parkland	1,055*	72	
	Forest Hill – mid reach	Berea Terrace	Parkland	1,055*	52.5	
	Forest Hill – US reach	Berea Terrace	Parkland	1,055*	74	
	E Br Forest Hill	Euclid Terrace	Parkland	1,155		
	Compton Forest Hill	Euclid Terrace	Parkland	1,209		
	Rockefeller upper	Euclid Terrace	Parkland	353		77
	Rockefeller lower	Euclid Terrace	Parkland	353		87
Shaw Brook	Glen Allen	Berea Terrace	Residential	435		24
	Orchard Road	Euclid Terrace	Residential	2,982	N/A	N/A
Nine Mile Creek	Langerdale Marsh	Shale Slope	Residential	804		
	Oakwood Green	Shale Slope	Parkland	1,620		
	Oakwood Country Club	Shale Slope	Parkland	1,695		
	Oakwood-Mayfield	Shale Slope	Residential	1,530		80
	Bluestone-Quarry	Berea Terrace	Parkland	546		85
	Belvoir-Quarry	Berea Terrace	Commercial	522		
	Princeton-Belvoir	Euclid Terrace	Residential	9,321		
	Westburn-Rockwood	Euclid Terrace	Residential	528		
	Bridgeview-Runnymede	Euclid Terrace	Residential	1,080		
	Runnymede-Brinkmore	Euclid Terrace	Residential	1,188		
	Stoneleigh-Langton	Euclid Terrace	Residential	1,551		
	Quilliams	Euclid Terrace	Residential	4,194		
	Dresden-Hanover	Euclid Terrace	Residential	853	N/A	N/A
	Caledonia ravine downstream	Euclid Terrace	Institutional	1,364*		86
	Caledonia ravine upstream	Euclid Terrace	Institutional	1,364*		83
	Mainstem - US of culvert	Euclid Terrace	Residential	8,870*	64	
	Mainstem - DS of Princeton Blvd	Euclid Terrace	Residential	8,870*	56.5	
	Mainstem - US of CSO 212	Euclid Terrace	Residential	8,870*	61	
	Mainstem - South of Euclid/Cle. line	Euclid Terrace	Residential	8,870*	55.5	
	Mainstem - Above cataract	Euclid Terrace	Residential	8,870*	64.5	
Green Creek	Terrace	Euclid Terrace	Residential	4,569		
	Gorge	Euclid Terrace	Residential	3,030		67
	Gorge East	Euclid Terrace	Residential	1,527		68

Table 9: Ravine segments with open watercourses in Critical Area 3.

Urban stream flashiness subjects the ravine segments to entrenchment and bank erosion. The ravines also receive storm runoff laden with yard waste, pet wastes, fertilizers and pesticides. Residential property owners introduce an abundance of yard waste and solid refuse. The ravines and their watercourses thus provide opportunity for restoration projects oriented toward erosion control and public outreach to diminish deliberate and inadvertent dumping. A primary obstacle to restoration planning in any given ravine is the abundance of individually-owned thalwag-bordered parcels.

Ohio EPA monitoring indicates non-attainment of WWH for Dugway Brook at Lake View Cemetery and Lakeshore Boulevard, Shaw Brook at Lakeshore Boulevard, the west branch of Nine Mile Creek upstream of Belvoir Boulevard, the east branch of Nine Mile Creek upstream of Belvoir Boulevard, Nine Mile Creek at Lakeshore Boulevard, and Green Creek upstream of Euclid Avenue.

Critical Area 3 (Escarpment Ravines) includes areas draining to the escarpment ravines of Dugway Brook, Shaw Brook, Nine Mile Creek, and Green Creek.

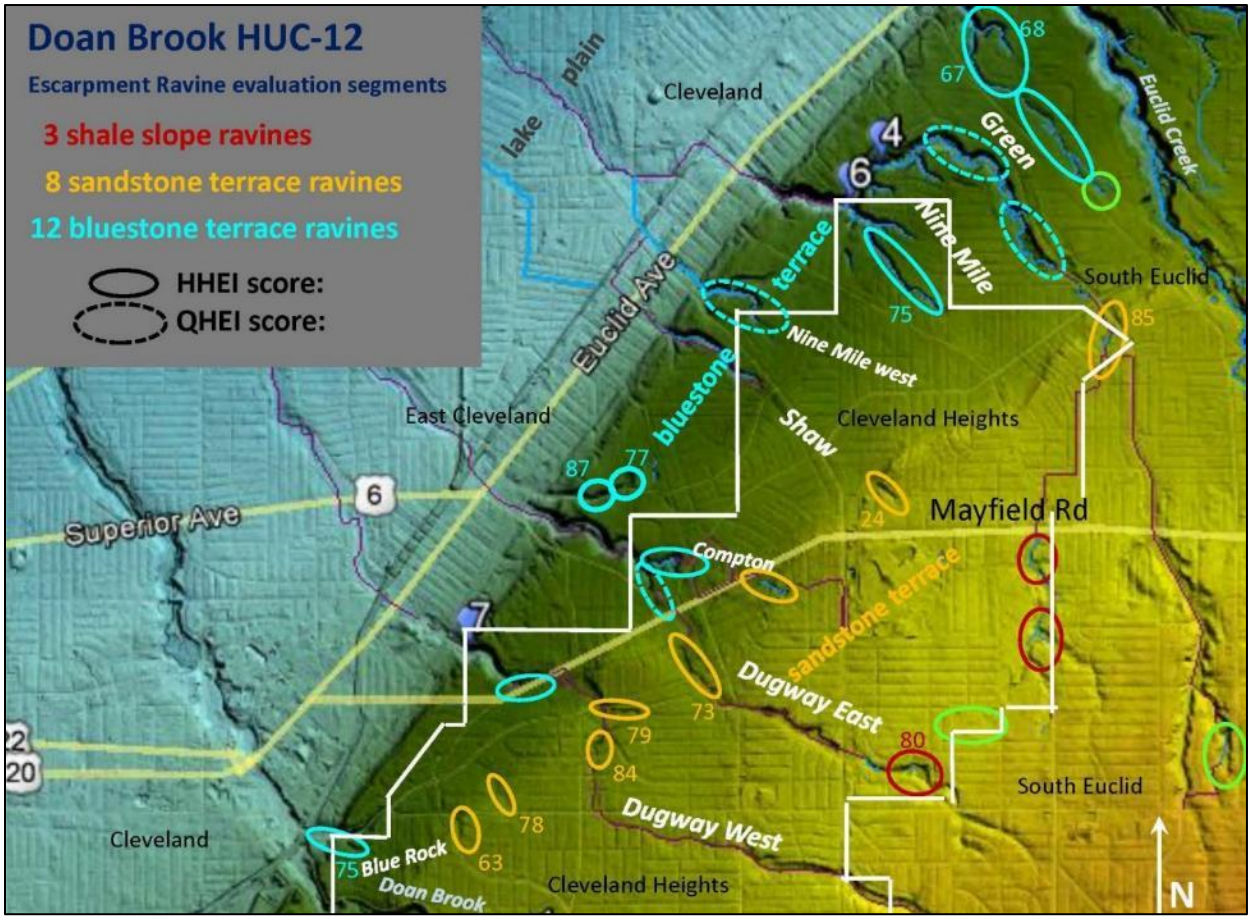

Figure 27: Critical Area 3 (Escarpment Ravines) and habitat assessment scores

Detailed Characterization of Critical Area 3 (Escarpment Ravines)

Dugway Brook's east branch and Nine Mile Creek have headwater ravine segments on the shale slope. Dugway Brook's west branch and Shaw Brook have their highest open segments on the Berea terrace. Green Creek's high segment cuts through the Euclid terrace. At the base of the Euclid terrace, all open courses terminate at culverts taking stream flow under Euclid Ave and the lake plain. The escarpment ravines hold three wetlands: Upper Green Creek/Nine Mile Creek, Langerdale Marsh and Oakwood Green. Sizable hard-buffered artificial ponds lie on Dugway Brook's west branch (two in Lake View Cemetery) and on Dugway east (Severance Condos and Forest Hill Park).

Deeply entrenched and north-facing, the sandstone terrace ravines harbor slightly cooler microclimates. Their second growth, mixed mesophytic forests are dominated by pin oak, tulip and sugar maple. These ravines do not have the hemlock-white pine forest typical of deep ravines on the Glaciated Allegheny Plateau; they may lie too low on the Portage Escarpment and too close to temperature-ameliorating Lake Erie. More likely, clear-cutting has encouraged the more common mesophytic sylvan species to gain foothold. Deer over-browsing keeps the understory clear in all ravines. Escaped ground covers, such as English ivy, myrtle and pachysandra are the most common invasive plants. The shale slope ravines are shallower and therefore more prone to development; they have less forest cover. *Phragmites austrailis* is beginning to invade the shale slope wetlands.

The sandstone terrace ravines lie in northern Cleveland Heights and north-adjacent areas of Cleveland, East Cleveland, Euclid and South Euclid. Quarrying was a significant early settler activity. During the early nineteenth century, small-scale quarrying in Berea ravines minimally modified their hydrological structures. During the late nineteenth century, industrial-scale works came to the Berea and Euclid terraces at Nine Mile Creek. A great volume of rock was removed. As quarrying ceased during the early twentieth century, the large landscape voids were subject to municipal landfilling. In consequence, the Nine Mile Creek sandstone ravines were greatly diminished in size and hydrological complexity.

With sides too steep for traditional building methods, the escarpment ravines are mostly free of roads and structures. Seventeen ravines are surrounded by small residential lots typical of post-WWII inner ring suburban development. Three Dugway (east and west) Berea segments have larger, pre-war period house lots. In total, virtually all (hundreds of) residential lots have a stream-side parcel boundary extending downslope to the ravine thalweg. Four segments are located within parklands; Forest Hill Park includes two ravines. The Cumberland and Bluestone-Quarry Berea ravine segments have parkland on one side and residential on the opposite bank. Major institutional landowners include Lake View Cemetery (Dugway west bluestone ravines), Park Synagogue (Compton Creek Berea ravine), and Nela Park (Nine Mile Creek bluestone ravine).

Most open water segment hydrology has remained stable for many decades. Two exceptions have had positive effects upon non-point source pollution issues within the critical area. Both involve the construction of shale slope wetlands in Nine Mile Creek. In 1910, the Oakwood Country Club was formed around 145 acres along a mile-long stretch of Nine Mile Creek west branch. Much of this segment spent a century under golf course landscaping. In 2009, the acreage was bought for commercial development. Thirty-seven acres were converted to big box retail and associated impervious surfaces. At this time, the developer (First Interstate Properties) also set aside 21 acres for wetland development and allocated $400,000 to complete the project. The result, Oakwood Green, has a bioretention area of 18 acres. In 2017, 130 new trees were planted at Oakwood Green, including Ohio buckeye, tulip and bald cypress.

In the early 1960s, the City of South Euclid built a 10.4-acre dry pond stormwater detention basin on a southeastern tributary ravine of Nine Mile Creek. The City used eminent domain to procure the stream-bordering portions of numerous residential parcels so that the Langerdale Urban Marsh project could be built within the residential ravine. In 2012, the City retrofitted the dry pond with small vegetated wetlands, enlarged storm water storage areas, a naturalized channel and other wetland habitat enhancements. Partners in the Langerdale Urban Marsh project included Cuyahoga SWCD, City of South Euclid, Biohabitats, Inc., Stephen Hovancsek and Associates, Inc., and Mark Haynes Construction, Inc.

On the critical area's eastern flank, the Nine Mile Creek bluestone ravine accounts for a significant amount of the area's total pervious surface. Considering this area at larger scale, the bluestone ravines of Nine Mile Creek and Euclid Creek lie within a few hundred yards of each other. This pair of deep channels integrates numerous parks and other green spaces. It serves as a migration route and wildlife refuge complementary with that of the Doan Brook riparian corridor on the critical area's western flank.

3.4.2 Detailed Biological Conditions

Four sampling sites are relevant to comprehending the critical area's biotic integrity (below). OEPA investigated these sites from 2011 to 2015. None of the sites are in attainment of their ALU designation (WWH). Additionally, NEORSD conducted monitoring for the Nine Mile Creek monitoring locations in 2013.

ID	Sample Station Name	River Mile (DA)	Fish Year	IBI Score	IBI Desc.	MIWB Score[7]	Invert year	ICI Score	ICI Desc.	Invert Desc.	QHEI Score	Attainment
7	NINEMILE CREEK ADJ. BELVOIR BLVD, UPST. NELA PARK TRIB.	3.34 (0.7)	2011	20*	Poor	NA	2011	-		Low Fair	61.3 (58.5)	Non
8	NINEMILE CREEK (NELA PARK BRANCH) UPST BELVOIR BLVD. CULVERT	0.01 (3.2)	2011	12*	Very Poor	NA	2011	-		Poor	55 (52.5)	Non
10	DUGWAY BROOK (W. BR.) AT EAST CLEVELAND @ LAKEVIEW CEMETERY	2.4 (2.6)	2014	-		NA	2014	24*	Fair		51*	Non
12	GREEN CREEK NEAR EUCLID, UPST. EUCLID AVE.	2.1 (0.6)	2013	20*	Poor	NA	2013	-		Low Fair	47.5	Non

Table 10: Headwater Ravines Aquatic Life Use Monitoring.[8]

Index of Biotic Integrity (IBI)

Fish diversity in the escarpment ravine stream segments is low, and a few pollution tolerant species are dominant (p. 16). IBI scores range 12 to 20 (Poor). These scores reflect the habitat impacts of surrounding urbanization such as increased sediment load and substrate embeddedness. Similarly, negative impacts on biological communities are associated with extreme flow fluctuations caused by channelized and culverted stream courses and impervious cover.

Streams in this critical area need to increase IBI fish diversity scores to 40 in order to meet WWH aquatic life use targets for headwater streams.

Invertebrate Community Index (ICI)

Dugway Brook's west branch is the only site to receive an ICI score (24, Fair). Streams in this critical area need to increase ICI invertebrate diversity scores to 34 in order to meet WWH aquatic life use targets for headwater streams.

Qualitative Habitat Evaluation Index (QHEI)

QHEI scores reflect the potential of these stream segments to support healthier biological communities. QHEI scores at OEPA monitoring locations within the escarpment ravines ranged from 47.5 (Fair) to 61.3 (Good). Additional QHEI assessments performed by Bluestone Heights in 2017 and 2018 indicated Fair, Good, or Excellent habitat quality within additional escarpment ravines draining to Dugway Brook and Nine Mile Creek. The general level of the QHEI scores can be contrasted at present with the low ICI and IBI scores at these sites. The habitat scores suggest that the escarpment ravines have the potential to host more diverse fish and macroinvertebrate populations.

[7] Mlwb was not utilized for headwater streams (<20 square miles drainage area)

[8] Significant departures from biocriteria are indicated with an asterisk. QHEI scores collected by NEORSD in 2013 are indicated with parentheses.

3.4.3 Detailed Causes and Associated Sources

Causes of impairment at these sites include habitat alterations, flow regime modifications, and pollutants in urban stormwater. Sources of impairment at these sites include municipal (urbanized high-density area), sediment resuspension (contaminated sediment), combined sewer overflows, channelization, and urban runoff/storm sewers. Most OEPA monitoring locations yield data indicating good or excellent/fair or good habitat quality. Yet the scores for fish and macroinvertebrate diversity are poor. These results suggest that exceedances in biological and chemical contaminants are the likely causes of impairment for these streams. Detailed information about causes and associated sources for some streams are provided below.

Dugway Brook

Few open stream segments remain in the Dugway Brook watershed; 3 percent of Dugway Brook is open channel, 31 percent is combined sewers, and 66 percent in separate sewers (NEORSD RIDE Study, 2004). Two interceptor tunnels constructed by NEORSD will mitigate combined sewer overflows to Dugway Brook. In Dugway Brook's east branch and associated ravines at Forest Hill Park, lack of fish and macroinvertebrate habitat due to scouring to bedrock and lack of instream cover may be contributing to low biological diversity.

Shaw Brook

Field observations (2018) indicate that no segments of Shaw Brook's escarpment ravines have sufficient flow to provide aquatic habitat due to upstream diversion of flow into culverts.

Nine Mile Creek

Nine Mile Creek between Princeton and Belvoir Boulevards is surrounded by 39 acres of forested floodplain; however, the stream does not have access to its floodplain in all areas due to incision. This reach is characterized by alternating sections of scoured bedrock and gravel/cobble depositional bars, likely a result of flashy stormwater flows and lack of floodplain access through this open segment.

Figure 28: Nine Mile Creek escarpment ravine

Green Creek

In 1883, the Euclid Railroad short line was built to bring products from the Nine Mile and Euclid Creeks sandstone quarries to the Nickel Plate Road on the lake plain. The Green Creek escarpment ravine provided a relatively gentle traverse through the steep lower escarpment face. The railroad was abandoned in 1967 and the facility quickly deteriorated. The railbed terrace within the area of steepest stream gradient is now slumping into the stream course. As flashy stormwater flows undercut the streambanks, this slumping and erosion contribute fine materials (silt, clay, gravel, and coke slag) into the streambed which inhibit stream flow and impair aquatic habitat.

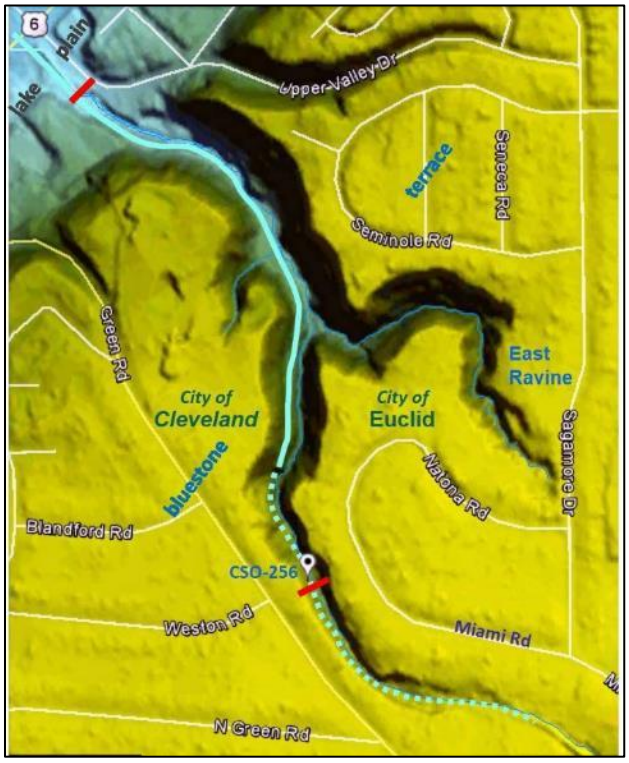

Figure 29: Green Creek escarpment ravine

3.4.4 Outline Goals and Objectives for the Critical Area

The overall nonpoint source restoration goals of this NPS-IS are to improve or maintain IBI, ICI, and QHEI scores so that non-attaining sites can achieve full attainment of the WWH designated ALU. Non-attainment in Critical Area 3 (Escarpment Ravines) is due to poor ICI and IBI scores at four OEPA monitoring locations. Macroinvertebrate community health should be addressed in 2019. The goals for Critical Area 3 (Escarpment Ravines) are to improve IBI and ICI scores and maintain currently attaining QHEI scores at OEPA monitoring locations so that these streams will improve from non-attainment to full attainment of the designated ALU.

Goals

Specific goals referencing the non-attaining sites are provided below:

GOAL 1. Achieve an IBI score of 40 at Dugway Brook's west branch at Lake View Cemetery (O07)

Not Achieved: Current score is unassessed (OEPA)

GOAL 2. Achieve an ICI score of 34 at Dugway Brook's west branch at Lake View Cemetery (O07)

Not Achieved: Current score is 24 (OEPA)

GOAL 3. Achieve a QHEI score of 55 at Dugway Brook's west branch at Lake View Cemetery (O07)

Not Achieved: Current score is 51 (OEPA)

GOAL 4. Achieve an IBI score of 40 at Nine Mile Creek at Belvoir Blvd culvert (O04/N10)

Not Achieved: Current score is 20 (OEPA and NEORSD)

GOAL 5. Achieve an ICI score of 34 at Nine Mile Creek at Belvoir Blvd culvert (O04/N10)

Not Achieved: Current score is unassessed (OEPA and NEORSD)

GOAL 6. Maintain a QHEI score of 55 at Nine Mile Creek at Belvoir Blvd culvert (O04/N10)

Achieved: Current score is 55 (OEPA)

GOAL 7. Achieve an IBI score of 40 at Nine Mile Creek at Quilliams Creek mouth (O06/N09)

Not Achieved: Current scores are 20 (OEPA) and 12 (NEORSD)

GOAL 8. Achieve an ICI score of 34 at Nine Mile Creek at Quilliams Creek mouth (O06/N09)

Not Achieved: Current score is unassessed (OEPA and NEORSD)

GOAL 9. Maintain a QHEI score of 61.3 at Nine Mile Creek at Quilliams Creek mouth (O06/N09)

Achieved: Current score is 61.3 (OEPA)

GOAL 10. Achieve an IBI score of 40 at Green Creek ravine mouth (O10)

Not Achieved: Current score is 20 (OEPA)

GOAL 11. Achieve an ICI score of 34 at Green Creek ravine mouth (O10)

Not Achieved: Current score is unassessed (OEPA)

GOAL 12. Achieve a QHEI score of 55 at Green Creek ravine mouth (O10)

Not Achieved: Current score is 47.5 (OEPA)

GOAL 13. Achieve HHEI score indicating Class III primary headwater habitat for the Green Creek escarpment ravine.

Not achieved: Current score indicates Class II primary headwater habitat (Bluestone Heights)

Objectives

To achieve these goals for Critical Area 3 (Escarpment Ravines), the following objectives need to be achieved:

OBJECTIVE 1: Reforest 370 acres of riparian and upland areas with native vegetation.*

**This objective is based on Cuyahoga County Planning Commission's GreenPrint tool for tree canopy data.*

OBJECTIVE 2: Restore 12,642 linear feet of in-stream habitat using natural channel design features and principles (e.g. restoration of floodplain access, streambank stabilization using bioengineering techniques).*

**This objective is based on estimated proportion of open stream segments requiring restoration.*

OBJECTIVE 3: Permanently protect 31 acres of riparian areas along escarpment ravines.

- Permanently protect riparian areas through fee-simple acquisition or conservation easements.
- Riparian setback adoption for cities of Shaker Heights, University Heights, Cleveland Heights, and East Cleveland.
- Riparian setback enforcement for the cities of Cleveland and South Euclid and the Village of Bratenahl.

OBJECTIVE 4: Install green infrastructure and stormwater retrofits in areas draining to escarpment ravines and open streams.*

- Install green infrastructure and stormwater retrofits (e.g. rain gardens, rain barrels, depaving) on residential streets and at 2,590 residential parcels to reduce pollutant loads, stormwater volumes, and flashiness.
- Install green infrastructure and stormwater retrofits (e.g. downspout disconnection, bioretention, permeable pavement, depaving) at 250 institutional parcels to reduce pollutant loads, stormwater volumes, and flashiness.

**This objective is based on an assumed 10% participation rate by residential landowners and 30% participation rate by institutional landowners within the critical area.*

As these objectives are implemented, water quality monitoring (both project related and regularly scheduled monitoring) will be conducted to determine progress toward meeting the identified goals (i.e., water quality standards). These objectives will be reevaluated and modified if determined to be necessary. For instance; many agricultural BMPs can be "stacked" (a systems approach) that will also incrementally improve the quality and quantity of runoff and drainage waters and in-stream water quality. When reevaluating, the committee will reference the Ohio EPA Nonpoint Source Management Plan Update (Ohio EPA, 2013), which has a complete listing of all eligible NPS management strategies to consider including:

- Urban Sediment and Nutrient Reduction Strategies;
- Altered Stream and Habitat Restoration Strategies;
- Nonpoint Source Reduction Strategies; and
- High Quality Waters Protection Strategies

Chapter 4: Projects and Implementation Strategy

This section outlines projects and evaluations that are believed to be necessary to remove the impairments to the Doan Brook-Frontal Lake Erie HUC-12 as a result of the identified cause and associated sources of nonpoint source pollution. Because attainment status is based on biological conditions, it will be necessary to periodically re-evaluate the status of the critical area to determine if the implemented projects are sufficient to achieve restoration. Time is an important factor to consider when measuring project success and overall status. Biological systems in some cases can show response fairly quickly (i.e., one season); others system may take longer (i.e., several seasons, years) to show recovery. There may also be reasons other than nonpoint source pollution for the impairment. Those issues will need to addressed under different initiatives, authorities, or programs which may or may not be accomplished by the same implementers addressing the nonpoint source pollution issues.

The Doan Brook-Frontal Lake Erie HUC-12 was delineated into three critical areas to address causes and sources of impairment. Overview Tables of projects in each critical area will be presented in the following subsections (4.1.1, 4.2.1, 4.3.1). The projects described in the Overview Tables have been prioritized using the following three step prioritization method:

Priority 1: Projects that specifically address one or more of the listed Objectives for the Critical Area.

Priority 2: Projects where there is land-owner willingness to engage in projects that are designed to address the cause(s) and source(s) of impairment or where there is an expectation that such potential projects will improve water quality in one of the HUC-12's waterways

Priority 3: Input from the public on water quality issues and/or project ideas gathered from key stakeholders will be evaluated for potential project development and implementation.

Project Summary Sheets (PSS) are in subsections 4.1.2, 4.2.2, and 4.3.2. These PSS provide the essential nine elements for short-term and/or next step projects that are in development and/or in need of funding. As projects are implemented and new projects developed these sheets will be updated. Any new PPS created will be submitted to the state of Ohio for funding eligibility verification (i.e., all nine elements are included).

4.1 Critical Area 1 (Doan Brook): Overview Table and Project Sheets

The information included in Table 11 is a condensed overview of all identified projects needed for nonpoint source restoration of Critical Area 1 (Doan Brook). Project Summary Sheets are included for short term projects or any project that is considering seeking funding in the near future. Only those projects with complete Project Summary Sheets will be considered for state and federal NPS program funding.

4.1.1 Critical Area 1 (Doan Brook): Projects and Implementation Strategy Overview Table

Critical Area 1 (Doan Brook) is based on Non-Attainment status of aquatic life use designation at all of the sampling sites in the Doan Brook. The Critical Area 1 Overview Table provides a quick summary of what needs to be done, where, and what problem (cause/source) will be addressed and includes projects at all levels of development (i.e. concept, need funding, in progress). This Overview Table is intended to show a prioritized path toward the restoration of the Doan Brook Critical Area.

For *Doan Brook-Frontal Lake Erie HUC-12* (041100030503) —Critical Area 1 (Doan Brook)								
Applicable Critical Area	**Goal**	**Objective**	**Project #**	**Project Title** *(EPA Criteria g)*	**Lead Organization** *(criteria d)*	**Time Frame** *(EPA Criteria f)*	**Estimated Cost** *(EPA Criteria d)*	**Potential/Actual Funding Source** *(EPA Criteria d)*
Urban Sediment and Nutrient Reduction Strategies								
Altered Stream and Habitat Restoration Strategies								
1	1,2	2,6,10	1	Sowinski Park Oxbow Wetland Restoration	DBWP	Short	$397,260.00	Ohio EPA Section 319 Grant Program; Great Lakes Restoration Initiative; Sustain Our Great Lakes program; Northeast Ohio Regional Sewer District; private foundations
1	4,5	2,6,8,10	2	Rockefeller Park Stream Restoration	DBWP	Short	$429,596.00	Ohio EPA Section 319 Grant Program; Great Lakes Restoration Initiative; Sustain Our Great Lakes program; Northeast Ohio Regional Sewer District; private foundations
Agricultural Nonpoint Source Reduction Strategies								
High Quality Waters Protection Strategies								
Other NPS Causes and Associated Sources of Impairment								

Table 11: Critical Area 1 (Doan Brook) Project Overview Table

4.1.2 Critical Area 1 (Doan Brook): Project Summary Sheets

Nine Element Criteria	Information needed	Explanation
n/a	**Title**	Sowinski Park Oxbow Wetland Restoration
criteria d	**Project Lead Organization & Partners**	Doan Brook Watershed Partnership; Northeast Ohio Regional Sewer District; City of Cleveland.
criteria c	**HUC-12 and Critical Area**	Doan Brook-Frontal Lake Erie HUC-12 (041100030503) – Critical Area 1
criteria c	**Location of Project**	Doan Brook in Sowinski Park; directly south of Ukrainian Cultural Garden and adjacent to the Latvian Garden Upstream coordinates: 41.525759, -81.626492
n/a	**Which strategy is being addressed by this project?**	*Restore Streams Using Natural Channel Design Methods.*
criteria f	**Time Frame**	Short term (1-3 yrs.)
criteria g	**Short Description**	This project in Sowinski Park would retain historic stream walls that can remain with in-stream modifications to improve habitat, replace failing wall segments with natural streambank armoring, and create an oxbow wetland to reduce turbidity and sediment loads.
criteria g	**Project Narrative**	This project will target a 600-foot linear stretch of the Doan Brook that flows through Sowinksi Park, which is situated within the historic Rockefeller Park and Cultural Gardens. Throughout Rockefeller Park, the Brook is channelized within historically significant sandstone walls. The property is owned by the City of Cleveland. In Rockefeller Park, the Doan Brook is impaired by the presence of Martin Luther King Jr. Boulevard and historic culverts and channel walls which inhibit habitat and floodplain functions. Past restoration efforts that have been proposed for Brook segments in Rockefeller Park have been stymied by costs and the public's desire to preserve the historic walls and culverts that are characteristic of the park. With these obstacles in mind, this proposed project retains historic stream walls that can remain with in-stream modifications to improve habitat, replaces failing wall segments with natural streambank armoring, and creates an oxbow wetland to reduce turbidity and sediment loads. QHEI data collected in 2018 by Doan Brook Watershed Partnership and Chagrin River Watershed Partners indicated a QHEI score of 59.25 for the stretch of the Doan in Sowinski Park, which exceeds the target score of 55. Improvements to failing wall segments, in-stream habitat, and the addition of an oxbow wetland in the park would only serve to bolster this score.

criteria d	**Estimated Total cost**	Total Estimated: $397,260.00 (Environmental Design Group 2016) *Costs may need to be updated at time of grant application.
criteria d	**Possible Funding Source**	Ohio EPA Section 319 Grant Program; Ohio EPA Water Resource Restoration Sponsorship Program; Great Lakes Restoration Initiative; Clean Ohio Conservation Fund; Sustain Our Great Lakes program; Northeast Ohio Regional Sewer District; private foundations
criteria a	**Identified Causes and Sources**	Causes of impairment for Doan Brook include: • Habitat alterations • Flow regime modification • Pollutants in urban stormwater Sources of impairment for Doan Brook include: • Municipal (urbanized high density area) • Sediment resuspension (contaminated sediment) • Combined sewer overflows • Channelization • Urban runoff/storm sewers
criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	Significant improvement required: current IBI score is 32 and current ICI score is 16 at RM 0.75. The IBI needs to be increased to 40 and the ICI needs to be increased to 34.
	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	By replacing failing channel walls segments with natural streambank and creating an oxbow wetland habitat this project will make progress towards achieving Objective 2. It will achieve approximately 25% of Objective 10 depending on the final acreage of the oxbow wetland. Through native plantings on restored stream banks it will make progress towards Objective 6.
	Part 3: Load Reduced?	103.7 Tons sediment/yr., 103.7 P/yr., and 207.4 N/yr.
criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	IBI, ICI, and QHEI scores will be assessed before and after project implementation. If the project is funded through the Ohio EPA Section 319 Grant program, staff from the OEPA-DSW Ecological Assessment Unit will perform both pre-and post-project monitoring. NEORSD could also perform monitoring.
criteria e	**Information and Education**	DBWP will publicize project on its website and in its annual newsletter. Educational signage will be developed for the site.

Table 12: Sowinski Park Oxbow Wetland Restoration

Nine Element Criteria	Information needed	Explanation
n/a	**Title**	Rockefeller Park Stream Restoration
criteria d	**Project Lead Organization & Partners**	Doan Brook Watershed Partnership; Northeast Ohio Regional Sewer District; City of Cleveland.
criteria c	**HUC-12 and Critical Area**	Doan Brook-Frontal Lake Erie HUC-12 (041100030503) – Critical Area 1
criteria c	**Location of Project**	Doan Brook from Wade Park Avenue to 1365 LF downstream Upstream coordinates: 41.515904, -81.618043
n/a	**Which strategy is being addressed by this project?**	*Restore Streams Using Natural Channel Design Methods.*
criteria f	**Time Frame**	Short term (1-3 yrs.)
criteria g	**Short Description**	This project will restore a segment of Doan Brook in historic Rockefeller Park with failing wall segments and check dams that impede fish passage. The project would repair failing walls to reduce erosion into the brook, modify the check dams to promote fish passage, create and improve in-stream habitat, and reduce sediment and nutrient input into the brook by providing floodplain connectivity. Through improvements in both fish and macroinvertebrate assemblages due to improved aquatic habitat, this project will have a positive impact on water quality as assessed by IBI and ICI metric scores
criteria g	**Project Narrative**	This project will target a stretch of the Doan Brook in historic Rockefeller Park in which fish passage is limited by a series of check dams. Throughout Rockefeller Park the Brook is channelized within historically significant sandstone walls. The property is owned by the City of Cleveland. In Rockefeller Park the Doan Brook is impaired by the presence of Martin Luther King Jr. Boulevard and historic culverts and channel walls which inhibit habitat and floodplain functions. Past restoration efforts that have been proposed for Brook segments in Rockefeller Park have been stymied by costs and the public's desire to preserve the historic walls and culverts that are characteristic of the park. This project would aim to disturb the existing aesthetic as little as possible while modifying the area to improve stream habitat and connectivity. It calls for modifying the check dams to allow for fish passage, repairing failing wall segments of the existing channel with natural streambank stabilization techniques, creating secondary channels and floodplain storage, and adding in-stream habitat structures to create a two-stage channel. The two-stage channel design will decrease stream velocities and sediment transport, without compromising the channel's ability to convey larger wet-weather flows. The creation of a planted wetland area with secondary channel will provide floodplain connectivity, thereby reducing sediment and nutrient input into the Brook. In-stream features including rock baffles and wooden crib habitat will provide sinuosity and habitat for fish. These baffles should be placed below the normal water elevation to reduce trash and debris collection during combined sewer flows. The proposed improvements would retain a majority of

		the mature tree canopy and historic walls facing the trail and Martin Luther King Jr. Blvd. QHEI data collected in 2018 by Doan Brook Watershed Partnership and Chagrin River Watershed Partners indicated a QHEI score of 63.25 for this stretch of the Doan, which exceeds the target QHEI score of 55 (Ohio EPA data from 2016 showed a QHEI score of 60.1 at this site). By repairing or replacing failing wall segments and improving in-stream habitat this project would maintain and ideally increase this score.
criteria d	**Estimated Total cost**	Total Estimated: $429,596.00 (Environmental Design Group 2016) *Costs may need to be updated at time of grant application.
criteria d	**Possible Funding Source**	Ohio EPA Section 319 Grant Program; Ohio EPA Water Resource Restoration Sponsorship Program; Great Lakes Restoration Initiative; Clean Ohio Conservation Fund; Sustain Our Great Lakes program; Northeast Ohio Regional Sewer District; private foundations
criteria a	**Identified Causes and Sources**	Causes of impairment for Doan Brook include: • Habitat alterations • Flow regime modification • Pollutants in urban stormwater Sources of impairment for Doan Brook include: • Municipal (urbanized high-density area) • Sediment resuspension (contaminated sediment) • Combined sewer overflows • Channelization • Urban runoff/storm sewers
criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	Significant improvement required: current IBI score is 24 and ICI score is 0 at RM 2.27. The IBI needs to be increased to 40 and the ICI needs to be increased to 34. QHEI score is already at or above target score of 55 but additional improvements would help maintain this status.
	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	This project would fulfill Objective 8 and will make a significant impact on Objective 2 by replacing failing channel wall segments with natural streambanks and creating secondary channels and floodplain storage. It will achieve roughly 25% of Objective 6 depending on the number/size of secondary channels and floodplain storage habitats are created and planted with native flora. This project will also address Objective 10 by enhancing and creating in-stream habitat.
	Part 3: Load Reduced?	275.2 Tons sediment/yr., 275.2 P/yr., and 550.4 N/yr.
criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	IBI, ICI, and QHEI scores will be assessed before and after project implementation. If the project is funded through the Ohio EPA 319 program, staff from the OEPA-DSW Ecological Assessment Unit will perform both pre-and post-project monitoring. NEORSD could also perform monitoring.
criteria e	**Information and Education**	DBWP will publicize the project on its website and in its annual newsletter. Signage will be installed at the site that highlights the project and educates visitors about floodplain connectivity and in-stream habitats.

Table 13: Rockefeller Park Stream Restoration

4.2 Critical Area 2 (Coastal Zone): Overview Table and Project Sheets

The information included in Table 14 is a condensed overview of all identified projects needed for nonpoint source restoration of Critical Area 2 (Coastal Zone). Project Summary Sheets are included for short term projects or any project that is considering seeking funding in the near future. Only those projects with complete Project Summary Sheets will be considered for state and federal NPS program funding.

4.2.1 Critical Area 2 (Coastal Zone): Projects and Implementation Strategy Overview Table

Critical Area 2 (Coastal Zone) is based on Non-Attainment status of aquatic life use designation at the OEPA sampling sites at the mouths of Dugway Brook, Shaw Brook, and Nine Mile Creek. The Critical Area 2 Overview Table provides a quick summary of what needs to be done, where, and what problem (cause/source) will be addressed and includes projects at all levels of development (i.e. concept, need funding, in progress). This Overview Table is intended to show a prioritized path towards the restoration of the Lake Erie Coastal Zone Critical Area.

For *Doan Brook-Frontal Lake Erie HUC-12* (041100030503) —Critical Area 2 (Coastal Zone)								
Applicable Critical Area	**Goal**	**Objective**	**Project #**	**Project Title** *(EPA Criteria g)*	**Lead Organization** *(criteria d)*	**Time Frame** *(EPA Criteria f)*	**Estimated Cost** *(EPA Criteria d)*	**Potential/Actual Funding Source** *(EPA Criteria d)*
Urban Sediment and Nutrient Reduction Strategies								
Altered Stream and Habitat Restoration Strategies								
2	7, 8 ,9	2	1	Nine Mile Creek Restoration (RM 0.3 – 0.7)	Bluestone Heights	Short	$500,000	Ohio EPA Section 319 Grant Program; Great Lakes Restoration Initiative; Sustain Our Great Lakes program; Northeast Ohio Regional Sewer District; private foundations
2	1, 2, 3	2	2	Dugway Brook Stream and Lacustrine Estuary Habitat Restoration	Bluestone Heights	Short	$1,967,900	Ohio EPA Section 319 Grant Program; Great Lakes Restoration Initiative; Sustain Our Great Lakes program; U.S. Army Corps of Engineers; Northeast Ohio Regional Sewer District; private foundations
2	10	2	3	Giddings Brook Stream and Lacustrine Estuary Habitat Restoration	Bluestone Heights	Short	$500,000	Ohio EPA Section 319 Grant Program; Great Lakes Restoration Initiative; Sustain Our Great Lakes program; Northeast Ohio Regional Sewer District; private foundations
Agricultural Nonpoint Source Reduction Strategies								
High Quality Waters Protection Strategies								
Other NPS Causes and Associated Sources of Impairment								

Table 14: Critical Area 2 (Coastal Zone) Project Overview Table

4.2.2 Critical Area 2 (Coastal Zone): Project Summary Sheets

Nine Element Criteria	Information needed	Explanation
n/a	**Title**	Nine Mile Creek Restoration (RM 0.3 – 0.7)
criteria d	**Project Lead Organization & Partners**	Village of Bratenahl; Bluestone Heights; Northeast Ohio Regional Sewer District; Western Reserve Land Conservancy; private landowner.
criteria c	**HUC-12 and Critical Area**	Doan Brook-Frontal Lake Erie (HUC-12: 041100030503), Critical Area 2 (Coastal Zone)
criteria c	**Location of Project**	Coordinates: 41.556878, -81.596722 (vicinity) The project site is located near the intersection of Lakeshore Boulevard and Coit Road (immediately west of Interstate 90) within the Village of Bratenahl. The restoration will be located on property owned by a private landowner and with portions of the property under a conservation easement held by Western Reserve Land Conservancy.
n/a	**Which strategy is being addressed by this project?**	*Restore Streams Using Natural Channel Design Methods.*
criteria f	**Time Frame**	Short-Term (Priority) (1-3 yr)
criteria g	**Short Description**	The project partners propose to restore approximately 1,500 linear feet of Nine Mile Creek by stabilizing streambanks, enhancing the stream's access to its floodplain, managing invasive plant species, and enhancing native vegetation in the riparian zone.
criteria g	**Project Narrative**	The project partners propose to restore approximately 750 linear feet of Nine Mile Creek. Currently, severe erosion at this site is contributing to water quality concerns for Nine Mile Creek and Lake Erie. Erosion is exacerbated by high velocity flow from a culvert under Interstate 90 and the presence of a failing headwall associated with a storm sewer outfall within the stream channel. Restoration objectives will be accomplished through natural channel design methods and a bio-engineered streambank stabilization approach. Restoration strategies may include debris removal, stabilizing streambanks, enhancing the stream's access to its floodplain, managing invasive plant species in the riparian corridor, and enhancing native vegetation in the riparian corridor. The project site is located along Nine Mile Creek from river mile (RM) 0.3 to 0.7. The upstream end of project is a culvert outflow under Interstate 90 and the downstream end of the project is Lakeshore Boulevard. The project site is located within the Village of Bratenahl on privately owned parcels totaling 39 acres. Northeast Ohio Regional Sewer District (NEORSD) has completed environmental mitigation on these parcels, including wetland preservation, creation, and enhancement, invasive species management (through an existing contract with EnviroScience, Inc.), and placement of a permanent conservation easement for 26.4 acres. Western Reserve Land Conservancy (WRLC) holds this conservation easement, which includes uplands, wetlands, and riparian areas along Nine Mile Creek. Deer fencing has been placed along the perimeter of the property and excludes Nine Mile Creek. Immediately downstream of Interstate 90, there is an oxbow meander that has formed wetland habitats. Steelhead trout have been observed migrating to this reach of Nine Mile Creek from Lake Erie.

		Bluestone Heights has met with the private landowner and held discussions with NEORSD and WRLC regarding their support of the project. Nine Mile Creek is a direct tributary to Lake Erie. Nine Mile Creek is in nonattainment of its warmwater habitat (WWH) aquatic life use designation (ALU) near its mouth (at Lakeshore Boulevard and at the downstream end of the project reach). This project will provide a load reduction of 478.1 pounds/year of nitrogen, 239.1 pounds/year of phosphorus, and 239.1 tons/year of sediment to Nine Mile Creek and Lake Erie. This project will also reestablish ecological function to this reach of Nine Mile Creek by improving in-stream habitat and creating long-term stream channel stability.
criteria d	**Estimated Total cost**	Total estimated project cost: $500,000 *Costs may need to be updated at time of grant application.*
criteria d	**Possible Funding Source**	Ohio EPA Section 319 Grant Program; Great Lakes Restoration Initiative; Sustain Our Great Lakes program; Northeast Ohio Regional Sewer District; private foundations.
criteria a	**Identified Causes and Sources**	Causes of impairment for Nine Mile Creek include: • Habitat alterations • Flow regime modification • Pollutants in urban stormwater Sources of impairment for Nine Mile Creek include: • Municipal (urbanized high density area) • Sediment resuspension (contaminated sediment) • Combined sewer overflows • Channelization • Urban runoff/storm sewers
criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	One objective to reach the goals of Critical Area 2 (Coastal Zone) is to restore 3,500 linear feet of in-stream and lacustrine estuarine habitat using bioengineering techniques (Objective 2).
	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	This project will meet 21 percent of the in-stream habitat restoration target (Objective 2) for Critical Area 2.
	Part 3: Load Reduced?	Total estimated load reductions for this project: Sediment: 239.1 tons/year Phosphorus: 239.1 pounds/year Nitrogen: 478.1 pounds/year
criteria i	**How will the effectiveness of this project in addressing the**	The success of this project will be evaluated by project partners in the following ways: 1) Floodwaters accessing floodplain in stream restoration area.

	NPS impairment be measured?	2) Proper establishment and effective streambank stabilization function of riparian and wetland vegetation. 3) Feedback from collaborators regarding attainment of project goals and objectives. 4) Post-construction QHEI assessment to determine improvements in stream habitat as a result of this project. Success will also be measured by contributing to achievement of full attainment of warmwater habitat for Nine Mile Creek at Lakeshore Boulevard. This sampling will be conducted by Ohio EPA.
criteria e	**Information and Education**	This restoration project will include the following information and education deliverables: 1) The Village, with assistance from Bluestone Heights, will coordinate and conduct one tour for elected officials and interested community members to review the restoration upon completion. 2) The project will be highlighted through Bluestone Heights and Village websites and social media outlets. 3) The Village, with assistance from Bluestone Heights, will create a news release highlighting the restoration project for publishing in local newspapers.

Table 15: Nine Mile Creek Restoration

Nine Element Criteria	Information needed	Explanation
n/a	**Title**	Dugway Brook Stream and Lacustrine Estuary Habitat Restoration
criteria d	**Project Lead Organization & Partners**	Village of Bratenahl; Bluestone Heights; Northeast Ohio Regional Sewer District; U.S. Army Corps of Engineers.
criteria c	**HUC-12 and Critical Area**	Doan Brook-Frontal Lake Erie (HUC-12: 041100030503), Critical Area 2 (Coastal Zone)
criteria c	**Location of Project**	Coordinates: 41.552760, -81.609729 (vicinity) The project site is located north of Lakeshore Boulevard and east of Corning Drive within the Village of Bratenahl, Cuyahoga County, Ohio. This project includes stream and lacustrine estuary restoration on Dugway Brook near its confluence with Lake Erie. The project is located on property owned by the Village, in areas owned by the adjacent Bratenahl Place Condo Association, and on private properties.
n/a	**Which strategy is being addressed by this project?**	*Restore Streams Using Natural Channel Design Methods.*
criteria f	**Time Frame**	Short-Term (Priority) (1-3 yr)
criteria g	**Short Description**	The partners propose to restore 2,000 linear feet of Dugway Brook from Lakeshore Boulevard to the mouth of Lake Erie, in addition to restoring estuary marsh habitat at the mouth of Dugway Brook. This project will improve the hydrological function and biological habitat of Dugway Brook and provide water quality benefits to Dugway Brook in addition to marsh habitat at the mouth of Dugway Brook and Lake Erie.
criteria g	**Project Narrative**	Dugway Brook is a direct tributary to Lake Erie. The two Dugway Brook branches are culverted across the lake plain before they meet just south of Lakeshore Boulevard. North of Lakeshore Boulevard, the mainstem of Dugway Brook flows openly for approximately 2,000 linear feet to Lake Erie in the Village of Bratenahl. This open reach of Dugway Brook is backwatered by Lake Erie in a lacustrine estuary. This lacustrine estuary provides habitat for migrating birds and spawning fish species. Dugway Brook is in nonattainment of its warmwater habitat (WWH) aquatic life use designation (ALU) near its mouth (at Lakeshore Boulevard, RM 0.4). Within the estuary, Dugway Brook is channelized with retaining walls, sheet piling and hardened shoreline near its mouth. Historically, the floodplain has received a large but undetermined amount of coarse fill. Several meanders have been eliminated and the floodplain has been raised beyond normal access by the stream. Streambank erosion, sediment deposition, and streambed instability is occurring from Lakeshore Boulevard to the mouth of Dugway Brook (Biohabitats, Inc., 2011). In 2011, Biohabitats, Inc. developed a *Determination of Federal Interest (DFI) Fact Sheet* for the U.S. Army Corps of Engineers to assist with determining the Corps' interest in pursuing restoration at this site. Based on recommendations included in the DFI, the project partners propose to restore approximately 2,000 linear feet of Dugway Brook from Lakeshore Boulevard to Lake Erie for the express purpose of re-establishing estuary marsh habitat. Restoration strategies may include bioengineering techniques such as removal of artificial structures, reshaping the

		channel including reestablishing meanders and regrading banks to a more gentle slope. This will help stabilize eroding streambanks and reconnect floodplains in limited areas. Additionally, invasive plant species will be removed and the restoration area will be revegetated with native riparian and marsh plant species. This project will reestablish ecological function to this reach of Dugway Brook by creating long-term stream channel stability and restoring in-stream and lacustrine estuary habitats for migrating birds and spawning fish species. This project will also provide a load reduction of 680 pounds/year of nitrogen, 340 pounds/year of phosphorus, and 340 tons/year of sediment to Dugway Brook and Lake Erie.
criteria d	**Estimated Total cost**	Biohabitats, Inc. provided preliminary cost estimates for restoration alternatives within the DFI. These cost estimates were used to inform the total cost estimates below. <u>Total estimated project cost:</u> $1,967,900 <u>Expense breakdown:</u> Final site assessment, design, and permitting: $200,000 Stream/estuary restoration, riparian/marsh revegetation: $1,742,900 Restoration project oversight: $15,000 Grant management and educational outreach: $10,000
criteria d	**Possible Funding Source**	Ohio EPA Section 319 Grant Program; Great Lakes Restoration Initiative; Sustain Our Great Lakes program; U.S. Army Corps of Engineers; Northeast Ohio Regional Sewer District; private foundations
criteria a	**Identified Causes and Sources**	Causes of impairment for Dugway Brook include: • Habitat alterations • Flow regime modification • Pollutants in urban stormwater Sources of impairment for Dugway Brook include: • Municipal (urbanized high density area) • Sediment resuspension (contaminated sediment) • Combined sewer overflows • Channelization • Urban runoff/storm sewers
criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	One objective to reach the goals of Critical Area 2 (Coastal Zone) is to restore 3,500 linear feet of in-stream and lacustrine estuarine habitat using bioengineering techniques (Objective 2).
	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	This project will meet 57 percent of the in-stream habitat restoration target (Objective 2) for Critical Area 2 (Coastal Zone).
	Part 3: Load Reduced?	Total estimated load reductions for this project: Sediment: 340 tons/year Phosphorus: 340 pounds/year Nitrogen: 680 pounds/year

criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	The success of this project will be evaluated by project partners in the following ways: 1) Proper establishment and effective streambank stabilization function of riparian and wetland vegetation. 2) Feedback from collaborators regarding attainment of project goals and objectives. 3) Post-construction QHEI assessment to determine improvements in stream habitat as a result of this project. Success will also be measured by contributing to achievement of full attainment of warmwater habitat for Dugway Brook at Lakeshore Boulevard. This sampling will be conducted by Ohio EPA.
criteria e	**Information and Education**	This restoration project will include the following information and education deliverables: 1) One project sign detailing the stream restoration project and benefits to Dugway Brook and Lake Erie. 2) The Village, with assistance from Bluestone Heights, will coordinate and conduct one tour for elected officials and interested community members to review the restoration upon completion. 3) The project will be highlighted through Bluestone Heights and Village websites and social media outlets. 4) The Village, with assistance from Bluestone Heights, will create a news release highlighting the restoration project for publishing in local newspapers.

Table 16: Dugway Brook Stream and Lacustrine Estuary Habitat Restoration

Nine Element Criteria	Information needed	Explanation
n/a	**Title**	Giddings Brook Stream and Lacustrine Estuary Habitat Restoration
criteria d	**Project Lead Organization & Partners**	City of Cleveland; Northeast Ohio Regional Sewer District; Cleveland Metroparks; Bluestone Heights
criteria c	**HUC-12 and Critical Area**	Doan Brook-Frontal Lake Erie (HUC-12: 041100030503), Critical Area 2 (Coastal Zone)
criteria c	**Location of Project**	Coordinates: 41.531196, -81.653006 (vicinity) The project site is located near the intersection of East 55th Street and North Marginal Road within the City of Cleveland in Cuyahoga County, Ohio. The project is located on property owned by the City of Cleveland and managed by Cleveland Metroparks as the East 55th Street Marina.
n/a	**Which strategy is being addressed by this project?**	*Restore Streams Using Natural Channel Design Methods.*
criteria f	**Time Frame**	Short-Term (Priority) (1-3 yr)
criteria g	**Short Description**	The partners propose to restore 1.6 acres of Lake Erie estuarine marsh habitat at the mouth of Giddings Brook. This project will improve water quality at this lacustrine estuary marsh by improving aquatic habitat through the removal of artificial structures and fill material and via native marsh plantings. These efforts will translate into improvements in both fish foraging and spawning and overall aquatic and ecological health of the lacustrine estuary and Lake Erie.
criteria g	**Project Narrative**	Giddings Brook is a direct tributary to Lake Erie. The mouth of Giddings Brook is a lacustrine estuary. There are no Ohio EPA monitoring locations on Giddings Brook. The partners propose to restore 1.6 acres of Lake Erie estuarine marsh habitat at the mouth of Giddings Brook. This lacustrine estuary will be restored to provide habitat for migrating birds and spawning fish species. Restoration strategies may include bioengineering techniques such as removal of artificial structures and fill material, regrading coastline to a more gradual slope, removal of invasive plant species, revegetation with native marsh plant species and native stabilizing shoreline plants, and installation of near shore structures for fish foraging and spawning habitat. Factors that need to be considered during final design of this project include the presence of a floatables control unit within the current Giddings Brook outlet plunge pool and the future installation of a storage tunnel by the Northeast Ohio Regional Sewer District that will reduce combined sewer overflows to Giddings Brook and Lake Erie. Future restoration would be protected from erosive wave action and ice scour due to the presence of the Cleveland Harbor breakwater.
criteria d	**Estimated Total cost**	Total estimated project cost: $500,000 *Costs may need to be updated at time of grant application.*
criteria d	**Possible Funding Source**	Ohio EPA Section 319 Grant Program; Great Lakes Restoration Initiative; Sustain Our Great Lakes program; Northeast Ohio Regional Sewer District; private foundations

criteria a	**Identified Causes and Sources**	Causes of impairment for Giddings Brook include: • Habitat alterations • Flow regime modification • Pollutants in urban stormwater Sources of impairment for Giddings Brook include: • Municipal (urbanized high density area) • Sediment resuspension (contaminated sediment) • Combined sewer overflows • Channelization • Urban runoff/storm sewers
criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	One objective to reach the goals of Critical Area 2 (Coastal Zone) is to restore 3,500 linear feet of in-stream and lacustrine estuarine habitat using bioengineering techniques (Objective 2).
	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	This project will meet 6 percent of the in-stream habitat restoration target (Objective 2) for Critical Area 2 (Coastal Zone).
	Part 3: Load Reduced?	Total estimated load reductions for this project: Sediment: 1,323 tons/year Phosphorus: 2,858 pounds/year Nitrogen: 17,653 pounds/year
criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	The success of this project will be evaluated by project partners in the following ways: 1) Proper establishment and effective streambank stabilization function of riparian and wetland vegetation. 2) Feedback from collaborators regarding attainment of project goals and objectives. 3) Post-construction QHEI assessment to determine improvements in stream habitat as a result of this project.
criteria e	**Information and Education**	This restoration project will include the following information and education deliverables: 1) One project sign detailing the stream restoration project and benefits to the mouth of Giddings Brook and Lake Erie. 2) The City of Cleveland, with assistance from Bluestone Heights, will coordinate and conduct one tour for elected officials and interested community members to review the restoration upon completion. 3) The project will be highlighted through Bluestone Heights and city websites and social media outlets. 4) The City of Cleveland, with assistance from Bluestone Heights, will create a news release highlighting the restoration project for publishing in local newspapers.

Table 17: Giddings Brook Stream and Lacustrine Estuary Habitat Restoration

4.3 Critical Area 3 (Escarpment Ravines): Overview Table and Project Sheets

The information included in Table 18 is a condensed overview of all identified projects needed for nonpoint source restoration of Critical Area 3 (Escarpment Ravines). Project Summary Sheets are included for short term projects or any project that is considering seeking funding in the near future. Only those projects with complete Project Summary Sheets will be considered for state and federal NPS program funding.

4.3.1 Critical Area 3 (Escarpment Ravines): Projects and Implementation Strategy Overview Table

Critical Area 3 (Escarpment Ravines) is based on Non-Attainment status of aquatic life use designation at all of the sampling sites in the headwaters of Dugway, Shaw, Nine Mile, and Green waterways. The Critical Area 3 Overview Table provides a quick summary of what needs to be done, where, and what problem (cause/source) will be addressed and includes projects at all levels of development (i.e. concept, need funding, in progress). This Overview Table is intended to show a prioritized path toward the restoration of the escarpment ravines of these streams.

For *Doan Brook-Frontal Lake Erie HUC-12* (041100030503) —Critical Area 3 (Escarpment Ravines)								
Applicable Critical Area	**Goal**	**Objective**	**Project #**	**Project Title** *(EPA Criteria g)*	**Lead Organization** *(criteria d)*	**Time Frame** *(EPA Criteria f)*	**Estimated Cost** *(EPA Criteria d)*	**Potential/Actual Funding Source** *(EPA Criteria d)*
Urban Sediment and Nutrient Reduction Strategies								
Altered Stream and Habitat Restoration Strategies								
3	4, 5, 6	2	1	Nine Mile Creek Escarpment Ravine Restoration and Preservation	Bluestone Heights	Short	$1,250,000	Ohio EPA Section 319 Grant Program; Great Lakes Restoration Initiative; Sustain Our Great Lakes program; Northeast Ohio Regional Sewer District; private foundations
3	10, 11, 12	2	2	Green Creek Escarpment Ravine Restoration	Bluestone Heights	Short	$500,000	Ohio EPA Section 319 Grant Program; Great Lakes Restoration Initiative; Sustain Our Great Lakes program; Northeast Ohio Regional Sewer District; private foundations
Agricultural Nonpoint Source Reduction Strategies								
High Quality Waters Protection Strategies								
Other NPS Causes and Associated Sources of Impairment								

Table 18: Critical Area 3 (Escarpment Ravines) Project Overview Table

4.3.2 Critical Area 3 (Escarpment Ravines): Project Summary Sheets

Nine Element Criteria	Information needed	Explanation
n/a	**Title**	Nine Mile Creek Escarpment Ravine Restoration and Preservation
criteria d	**Project Lead Organization & Partners**	City of South Euclid; City of Cleveland; City of Cleveland Heights; Bluestone Heights; Northeast Ohio Regional Sewer District
criteria c	**HUC-12 and Critical Area**	Doan Brook-Frontal Lake Erie (HUC-12: 041100030503), Critical Area 3 (Escarpment Ravines)
criteria c	**Location of Project**	Coordinates: 41.545405, -81.541639 (vicinity) The project site is located north of the intersection of Princeton and Belvoir Boulevards and south of the Belvoir Boulevard culvert within the cities of South Euclid, Cleveland Heights and Cleveland in Cuyahoga County, Ohio. The project is located on properties owned by the cities of South Euclid, Cleveland Heights, and Cleveland.
n/a	**Which strategy is being addressed by this project?**	*Restore Streams Using Natural Channel Design Methods.*
criteria f	**Time Frame**	Short-Term (Priority) (1-3 yr)
criteria g	**Short Description**	The partners propose to restore 7,550 linear feet (1.43 miles) of Nine Mile Creek by restoring floodplain access, stabilizing streambanks, restoring aquatic habitat, enhancing riparian vegetation, and permanently preserving the stream corridor.
criteria g	**Project Narrative**	The Nine Mile Creek escarpment ravine is a forested, undeveloped stream in a densely-populated urban environment within the cities of South Euclid, Cleveland Heights, and Cleveland. This ravine includes approximately 39 acres of undeveloped floodplain. Nine Mile Creek is culverted under Princeton Boulevard at the upstream end of the project site and at Belvoir Boulevard at the downstream end of the project site. Downstream of Belvoir Boulevard, the stream flows underground through a culvert until Aspinwall Avenue in the City of Cleveland. South/west of Belvoir Boulevard, the culverted ravine exists on an approximately 26-acre property owned by General Electric Co. in the City of East Cleveland. Nine Mile Creek is in nonattainment of its warmwater habitat (WWH) aquatic life use designation (ALU) at the Belvoir Boulevard culvert. Within Nine Mile Creek's open channel between Princeton and Belvoir Boulevards, this project will restore access to approximately 39 acres of floodplain for 7,550 linear feet (1.43 miles) of stream. This project will also stabilize eroding streambanks, restore aquatic habitat, enhance riparian vegetation, and reduce stormwater flows to downstream reaches and Lake Erie. This project will provide a load reduction of 1,275 pounds/year of nitrogen, 637.5 pounds/year of phosphorus, and 637.5 tons/year of sediment to Nine Mile Creek and Lake Erie. This project will also reestablish ecological function to this reach of Nine Mile Creek by improving in-stream habitat and creating long-term stream channel stability. Post-restoration Qualitative Habitat Evaluation Index (QHEI) scores will be maintained or improved

		to a target score of 55 within the restoration reach. Finally, this project will permanently preserve this uniquely natural greenspace within a dense urban area through a conservation easement or fee simple acquisition. Successful completion of this project may lead to additional restoration opportunities along Nine Mile Creek, including possible daylighting and permanent preservation of Nine Mile Creek from Belvoir Boulevard to Euclid Avenue in the City of East Cleveland.
criteria d	**Estimated Total cost**	Total estimated project cost: $1,250,000 *Costs may need to be updated at time of grant application.*
criteria d	**Possible Funding Source**	Ohio EPA Section 319 Grant Program; Great Lakes Restoration Initiative; Sustain Our Great Lakes program; Northeast Ohio Regional Sewer District; private foundations
criteria a	**Identified Causes and Sources**	Causes of impairment for Nine Mile Creek include: • Habitat alterations • Flow regime modification • Pollutants in urban stormwater Sources of impairment for Nine Mile Creek include: • Municipal (urbanized high density area) • Sediment resuspension (contaminated sediment) • Combined sewer overflows • Channelization • Urban runoff/storm sewers
criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	One objective to reach the goals of Critical Area 3 (Escarpment Ravines) is to restore 12,642 linear feet of in-stream habitat using natural channel design features and principles (Objective 2).
	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	This project will meet 59.7 percent of the in-stream habitat restoration target (Objective 2) for Critical Area 3 (Escarpment Ravines).
	Part 3: Load Reduced?	Total estimated load reductions for this project: Sediment: 637.5 tons/year Phosphorus: 637.5 pounds/year Nitrogen: 1,275 pounds/year
criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	The success of this project will be evaluated by project partners in the following ways: 1) Floodwaters accessing floodplain in stream restoration area. 2) Proper establishment and effective streambank stabilization function of riparian and wetland vegetation. 3) Feedback from collaborators regarding attainment of project goals and objectives.

		4) Post-construction QHEI assessment to determine improvements in stream habitat as a result of this project. Success will also be measured by contributing to achievement of full attainment of warmwater habitat for Nine Mile Creek adjacent to Belvoir Boulevard. This sampling will be conducted by Ohio EPA.
criteria e	**Information and Education**	This restoration project will include the following information and education deliverables: 1) One project sign detailing the stream restoration project and benefits to Nine Mile Creek and Lake Erie. 2) The cities of South Euclid and Cleveland, with assistance from Bluestone Heights, will coordinate and conduct one tour for elected officials and interested community members to review the restoration upon completion. 3) The project will be highlighted through Bluestone Heights and city websites and social media outlets. 4) The cities of South Euclid and Cleveland, with assistance from Bluestone Heights, will create a news release highlighting the restoration project for publishing in local newspapers.

Table 19: Nine Mile Creek Escarpment Ravine Restoration and Preservation

Nine Element Criteria	Information needed	Explanation
n/a	**Title**	Green Creek Escarpment Ravine Restoration
criteria d	**Project Lead Organization & Partners**	City of Euclid; City of Cleveland; Bluestone Heights; Northeast Ohio Regional Sewer District; Indian Hills Homeowners' Association
criteria c	**HUC-12 and Critical Area**	Doan Brook-Frontal Lake Erie (HUC-12: 041100030503), Critical Area 3 (Escarpment Ravines)
criteria c	**Location of Project**	Coordinates: 41.555843, -81.544378 (vicinity) The project site is located east of Green Road and south of Euclid Avenue along the border of the cities of Euclid and Cleveland in Cuyahoga County, Ohio. The restoration will be located on property owned by the City of Euclid (not on private properties).
n/a	**Which strategy is being addressed by this project?**	*Restore Streams Using Natural Channel Design Methods.*
criteria f	**Time Frame**	Short-Term (Priority) (1-3 yr)
criteria g	**Short Description**	The partners propose to restore 2,300 linear feet of Green Creek by removing railroad fill material, stabilizing streambanks, restoring the ravine to a natural channel, and restoring headwater stream aquatic habitat.
criteria g	**Project Narrative**	The Green Creek escarpment ravine is a forested, undeveloped stream in a densely-populated urban environment within the cities of Euclid and Cleveland. In the 1880s, a short line railroad was constructed on the west side of the Green Creek ravine. A 15-foot wide terrace was excavated to hold the railbed. For 80 years, ballast materials (primarily coke slag) were added to the terrace to control erosion. Currently, ballast materials associated with the railroad comprise a significant component of the west side of the ravine. Groundwater flow trapped behind the abandoned railroad bed saturates the ravine slope and contributes to terrace slumping into the streambed. This slumping and erosion contribute fine materials (silt, clay, gravel, and coke slag) into the streambed which inhibit stream flow and impair aquatic habitat. This project will restore 2,300 linear feet of Green Creek by removing railroad fill material, stabilizing streambanks, restoring the ravine to a natural channel, and restoring headwater stream aquatic habitat. Headwater Habitat Evaluation Index (HHEI) assessment scores for three reaches within this ravine reveal lower habitat quality than analogous escarpment ravines within the HUC-12. This project will improve a post-construction HHEI score to the range of Class III primary headwater streams. The downstream boundary of the proposed restoration is where Green Creek is culverted immediately south of Euclid Avenue. The upstream boundary of the proposed restoration is where Green Creek forms a natural nickpoint through the bedrock, north of Glenridge Road. Green Creek is a direct tributary to Lake Erie. Green Creek is in nonattainment of its warmwater habitat (WWH) aquatic life use designation (ALU) upstream of Euclid Avenue. This project will provide a load reduction of 234.6 pounds/year of nitrogen, 117.3 pounds/year of phosphorus, and 117.3 tons/year of sediment to Green Creek and Lake Erie. This project will also enhance ecological function to this reach of Green Creek by improving in-stream habitat.

criteria d	**Estimated Total cost**	Total estimated project cost: $500,000 *Costs may need to be updated at time of grant application.*
criteria d	**Possible Funding Source**	Ohio EPA Section 319 Grant Program; Great Lakes Restoration Initiative; Sustain Our Great Lakes program; Northeast Ohio Regional Sewer District; private foundations
criteria a	**Identified Causes and Sources**	Causes of impairment for Green Creek include: • Pollutants in urban stormwater • Habitat alterations • Flow regime modification **Field observations have also identified sedimentation due to erosion of anthropogenic fill within the ravine as a cause of impairment.* Sources of impairment for Green Creek include: • Municipal (urbanized high density area) • Sediment resuspension (contaminated sediment) • Combined sewer overflows • Channelization • Urban runoff/storm sewers **Field observations have also identified erosion of railbed terrace as a source of impairment.*
criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	One objective to reach the goals of Critical Area 3 (Escarpment Ravines) is to restore 12,642 linear feet of in-stream habitat using natural channel design features and principles (Objective 2).
	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	This project will meet 18.2 percent of the in-stream habitat restoration target (Objective 2) for Critical Area 3 (Escarpment Ravines).
	Part 3: Load Reduced?	Total estimated load reductions for this project: Sediment: 117.3 tons/year Phosphorus: 117.3 pounds/year Nitrogen: 234.6 pounds/year
criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	The success of this project will be evaluated by project partners in the following ways: 1) Decrease in erosion and proper establishment and effective streambank stabilization function of riparian vegetation. 2) Feedback from collaborators regarding attainment of project goals and objectives. 3) Post-construction HHEI assessment to determine improvements in stream habitat as a result of this project.

		Success will also be measured by contributing to achievement of full attainment of warmwater habitat ALU designation at Green Creek (upstream of Euclid Avenue). This sampling will be conducted by Ohio EPA.
criteria e	**Information and Education**	This restoration project will include the following information and education deliverables: 1) In advance of and throughout restoration, Bluestone Heights will present the project at meetings of the Indian Hills Homeowners' Association (although the project will take place entirely on public land, the restoration will abut private properties whose owners belong to the HOA). 2) One project sign detailing the stream restoration project and benefits to Green Creek and Lake Erie. 3) The City of Euclid, with assistance from Bluestone Heights, will coordinate and conduct one tour for elected officials and interested community members to review the restoration upon completion. 4) The project will be highlighted through Bluestone Heights and City websites and social media outlets. 5) The City of Euclid, with assistance from Bluestone Heights, will create a news release highlighting the restoration project for publishing in local newspapers.

Table 20: Green Creek Escarpment Ravine Restoration

References

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