TOWN OF KILL DEVIL HILLS

Land Where Flight Began

MEMORANDUM March 7, 2022

TO: Mayor and Board of Commissioners

FROM: Debora P. Diáz, Town Manager

REF: New Business

5. Limited Interim Stormwater Management Plan Update (Attached NB-5)

In response to identified drainage concerns and recent public comments, Town Engineer Pete Burkhimer has developed an update to the Town's Stormwater Management Plan. Planning Director Meredith Guns' accompanying memorandum details the recommended change, which is as follows:

> "It is the Town's policy to construct, maintain and rehabilitate its streets and roads so that their storm drainage systems (roadside ditches/swales, culverts, enclosed pipe systems, outfalls, etc.) accomplish the following objectives:
>
> i. Keep the street drained so that it is safely passable to vehicular and pedestrian traffic.
> ii. To the maximum extent practicable, avoid stormwater from the street draining onto private property, except through an easement.
> iii. Receive the surface flow of stormwater from adjacent single-family residential properties.
>
> In addition, in those areas where the Town determines that groundwater management measures are feasible, such a system may be installed and may provide some benefit to adjacent residential properties whose land and/are structures are lower than the elevation of the street. In so doing, the Town is applying a technique which has been shown to promote the three foregoing objectives. The Town welcomes any secondary benefits that such groundwater systems may provide in alleviating a private property owner's adverse drainage conditions due to being lower than the street, but affirmatively declares that it is under no duty to do so and accepts no liability should any such mitigation be ineffective or not totally effective in any given rainfall event."

This recommended update outlines the primary objectives and goals of the Town's capital projects, noting that drainage and stormwater projects are primarily designed to protect the Town's infrastructure and safety; adjacent private properties may receive some secondary benefits from these projects. Included with this update is a KDH Watershed Map prepared by Assistant Planning Director Derek Dail to highlight progress addressing areas of concern.

At its February 22, 2022, meeting the Street Improvement and Special Projects Committee reviewed this item and voted to recommend the BOC accept the policy statement as an adopted policy to be used while considering capital street and drainage projects.

A motion would be in order.

Director of
Planning and Inspections
MEREDITH GUNS

Building Inspector
MARTY SHAW
CHARLES THUMAN

Code Enforcement Officer
JORDAN BLYTHE

THE TOWN OF KILL DEVIL HILLS
NORTH CAROLINA

PLANNING DEPARTMENT

Assistant Director of
Planning and Inspections
CAMERON RAY

Senior Planner
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Zoning Administrator
DONNA ELLIOTT

March 7, 2022

Memorandum

To: Debbie Diaz, Town Manager

From: Meredith Guns, Planning Director MBG

Subject: Limited Interim Stormwater Management Plan Update

Attached to this memorandum is a Limited Interim Stormwater Management Plan Update. The update was developed by Pete Burkhimer, P.E. with American Engineering who serves as our Town Engineer, to address several recent public comments and other identified drainage concerns. The update is intended to identify sources of flooding and how/if they can be addressed as well as future stormwater project the Town may want to consider. Also attached to the plan update is a copy of a previous KDH Watershed Map, marked to show progress made on resolving areas of concern and marked aerial maps, prepared by Derek Dail, Assistant Public Services Director. The illustrations show conceptual scope of potential stormwater projects based on his Post Dorian drainage report.

Town Staff and the Town Engineers' recommendations starts on page 8 of the report. One of the key recommendations is for the Board of Commissioners to consider adopting the policy under #4(d) which states:

> It is the Town's policy to construct, maintain and rehabilitate its streets and roads so that their storm drainage systems (roadside ditches/swales, culverts, enclosed pipe systems, outfalls, etc.) accomplish the following objectives:
>
> i. Keep the street drained so that it is safely passable to vehicular and pedestrian traffic.
> ii. To the maximum extent practicable, avoid stormwater from the street draining onto private property, except through an easement.
> iii. Receive the surface flow of stormwater from adjacent single-family residential properties.
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> In addition, in those areas where the Town determines that groundwater management measures are feasible, such a system may be installed and may provide some benefit to adjacent residential properties whose land and/are structures are lower than the elevation of the street. In so doing, the Town is applying a technique which has been shown to promote the three foregoing objectives. The Town welcomes any secondary benefits that such groundwater systems may provide in alleviating a private property owner's adverse drainage conditions due to being lower than the street, but affirmatively declares that it is under no duty to do so and accepts no liability should any such mitigation be ineffective or not totally effective in any given rainfall event.

This policy outlines a clear statement as to primary objectives and goals of the Towns capital projects and includes drainage/stormwater work designed to protect the Town infrastructure and safety. The Town's goal to manage stormwater, however, it is important to understand drainage and stormwater projects are designed primarily to protect Town rights-of-ways while providing some secondary benefits (to varying degrees) to adjacent private properties.

On February 22, 2022 the Street Improvement/Special Project Subcommittee reviewed the report and the policy statement. The SISPC forwarded the report to the Board of Commissioners and recommended the Board accept the policy statement as an adopted policy to be used while considering capital street and drainage projects.

Limited, Interim Update to the
Kill Devil Hills, NC

Master Stormwater Plan

January 28, 2022

AMERICAN Engineering

American Engineering Associates
830 Greenbrier Circle, Suite 110
Chesapeake, VA 23320

PURPOSE. This Update document is prepared for the Kill Devil Hills (KDH) Town staff, Street Improvement and Special Projects Committee (SISPC) and Board of Commissioners (BOC) to consider the **historical** and **town-wide context** of potential future Stormwater Projects, or broader projects including Stormwater elements, being recommended by Town Engineer at SISPC's February 22, 2022 meeting.

This Update gives a broad overview of past "Master Stormwater" plans and studies, provides a status of some projects and efforts proposed under those past studies, and points out some policy and strategy matters that should be considered. It IS NOT a new edition of the Kill Devil Hills Master Stormwater Plan, as no such effort has been commissioned by the Town. It may be appropriate to do so, since the last full Master Stormwater Plan was prepared almost exactly 12 years ago.

1. BACKGROUND. Consideration of Town-wide storm drainage and stormwater infrastructure has been ongoing in Kill Devil Hills at least as far back as the catastrophic Ash Wednesday flooding event of March, 1962.

    a. Prior to that time, storm drainage infrastructure, especially outside of Department of Transportation road rights of way, was generally grossly inadequate or lacking altogether.

    b. Although the Ash Wednesday flooding was primarily tidal, as opposed to stormwater-driven, it pointed out the need to establish effective outfalls. Notable among these are the NCDOT Canal which passes through the Wright Brothers Memorial and what we now know as First Flight Village.

    c. In the 1980's, McDowell & Associate prepared an early master drainage study and plan, with a subsequent effort by Overman & Associates. Funding for some of these early efforts came from Coastal Area Management Act (CAMA) grants. Among other things, these early efforts identified "Adverse Drainage" areas and recommended some capital improvements .

    d. Albemarle & Associates, LLC, serving as Town Engineer, updated those earlier efforts in 2004 (the 2004 Plan). In 2005, Engineering Services of Virginia, Inc. (ESVI), acquired in 2014 by American Engineering Associates, became Town Engineer. Environmental Professionals, Inc (EPI) teamed with ESVI to prepare the latest "Town of Kill Devil Hills Stormwater Management Plan, 2010." (the 2010 Plan)

    e. A marked copy of a map from the 2004 Plan (provided with this Update) shows that many of the Adverse Drainage areas have been resolved or at least mitigated in the subsequent 18 years. Also provided is a copy of mapping prepared by KDH Public Services staff, showing currently-identified drainage projects areas after the occurrence of Tropical Storm Dorian in 2019.

2. WHAT CAUSES "FLOODING" IN KDH? There are two primary types of flooding, Tidal and Stormwater. The following brief notes apply to Tidal Flooding, as it is not the primary topic of this Update. Tidal Flooding can occur dynamically, when large ocean waves breach the dune structure and overwash onto public roads and private property or when large waves on the sound overwash similarly. Or, Tidal

Flooding can occur statically, when the relatively still waters of the sound and/or ocean rise and back up via ditches, canals, culverts/pipe systems or overland and affect public roads and private property. Most of the stormwater management/storm drainage measures discussed in this Update and previous Plans offer no mitigation of Tidal Flooding. There is little that can feasibly be done to defend against it in a lower-density context such as KDH. It is also noteworthy that above-normal tide events can provide an abnormal back pressure or "tailwater" effect on outfall pipes, ditches and canals causing the flooding effects of a Stormwater Flooding event to be worse than they would otherwise be during a normal tide.

The remainder of this paragraph 2 will focus on the causes of Stormwater Flooding.

a. **Abnormal Rainfall RATE**. Rainfall Rate is, broadly, how "hard" it is raining. It is measured in inches of rain volume per hour (in/hr). A higher Rainfall Rate (in/hr) in a given location will result in a higher rate of Stormwater Runoff in cubic feet per second (cfs), all other factors being equal. Of particular interest is Instantaneous Rainfall Rate. For example, if 4 inches of rain fall at a constant rate over a 4-hour period, that's a 1 in/hr Average Rain Rate, and the Instantaneous Rain Rate is also 1 in/hr throughout that storm. Actually, the Instantaneous Rain Rate varies throughout the storm; during the worst 10 minute of that storm, 2 inches of rain may fall, or 12 in/hr, with lighter rain ranging from zero to 1-2 inches per hour during the less severe parts of the storm.

   A 10-acre watershed in a KDH residential area might respond to an Instantaneous Rain Rate of 5 inches per hour might generate 5-10 cfs of Stormwater Runoff, depending on things like what percentage of the watershed is covered with rooftops, driveways and roads and whether or not previous rainfalls have caused the groundwater to rise up close to the surface.

   The US National Oceanic and Atmospheric Administration (NOAA) maintains, for all points in the country, a statistically-derived database (see their online Precipitation Frequency Data Server, or PFDS) that tells us how probable it is that we will have a rain of a certain intensity, lasting for a certain duration. This is called an Intensity-Frequency-Duration table. For the middle of KDH, say, at the Dare Center, for example, the 10-year, 15-minute rainfall intensity is 5.64 inches per hour, or 1.41 inches of rain in that ¼ hour. That means that over 200 years, if you cataloged all the 15-minute periods of rain, you'd have about 20 events (200 ÷ 10) whose "worst" 15 minutes had 5.64 in/hr or harder rain.

   One of the problems in using the PFDS for planning Stormwater Management infrastructure is that the data is slowly changing. 50 years ago, the 50-year, 24-hour total rain volume was about 6-7 inches; now in KDH it's 8.92 inches. This is probably related to climate change. Without the precision of the PFDS, most of us know that we are getting larger rain events more frequently; Hurricane Matthew sent KDH 13.7 inches in a 24-hour period spanning October 8-9, 2016, and 13 of those inches fell in the worst 6 hours of Matthew. Although it requires extrapolating from the PFDS (it only goes up to a 1,000-year interval), that works out to about the 2,000-year, 6-hour rainfall!

   It is intuitive that whatever standard we design to (such as a 50-year, 24-hour rain or a 10-year, 2 hour rain), Nature can always send us something worse—sometimes much worse. But we can't spend boundless amounts of money on infrastructure that's used at capacity once every 100 years, either. As a compromise, we select a "Design Storm" for stormwater improvements. Generally, the larger and/or more critical the area served, the higher (more intense) the Design Storm is set.

But, to summarize, an **excessively hard rain can generate stormwater runoff at a rate higher than the capacity of the existing ditch or pipe which is trying to carry it away**. This is the most direct, most common cause of Stormwater Flooding.

b. **Elevation is too LOW**. The road, property or structure floods because it is built at too low an elevation. (This, of course, is also a very common cause of Tidal Flooding.) Even if there is a ditch, culvert, pipe or canal system to carry the Stormwater Runoff caused by the Design Storm, if the adjacent road, lawn or house floor is lower than the elevation of the surface of the water flowing in the system, it obviously will flood.

As noted in paragraph 1.a above, in the early years of development on the NC Outer Banks, little thought was typically paid to storm drainage, and little stormwater infrastructure was built. In many cases, homes and some businesses were built on lower-elevation properties, with slab-on-grade construction. Perhaps the original owner/builder used floor coverings which could tolerate flooding once or twice a decade and didn't think it was worth the effort for a couple of extra courses of block and loads of fill sand. Subsequent owners, perhaps without investigation or deep thought on the subject, began to install more valuable floor coverings, furnishings, etc., lulled by a multi-year break since the last problematic flooding.

An all-too-common version of this problem in KDH is the cottage whose main living floor is 9-10' above the ground, far above the reach of Tidal or Stormwater flooding. But there is a concrete parking area underneath, and a small "utility room," perhaps for some light storage and maybe a washer/dryer set up on a platform. This works well for a generation, but someone decides to expand the utility room, often without permits, enclosing more of the low area and making living space out of it. In KDH there limitless variations on this story. In the best case, the lowest floor elevation is high enough relative to the street, the drainage system and surrounding property that no flooding occurs. At the other extreme is the cottage whose lower slab elevation is "in a hole," 4' lower than the street and 2' lower than the lowest point in any nearby drainage system.

When these types of situations are done without permit, or originally represented as "storage or utility space" and later converted to occupancy, a serious public policy question unfolds: These are "self-inflicted wounds," caused by unwise and often illegal actions by property owners who may or may not be the current owners. To what extent, if any, should the Town spend limited public funds to figuratively and literally "bail out" such situations? Is it fair to the majority of owners who have followed the rules and used sound design principles to see some of their tax money used for such? More discussion on this point follows a little later in this update.

A variation on the "too low" situation just discussed is somewhat more poignant. 60 years ago, an owner builds his cottage on a relatively low lot in a relatively low subdivision, and he/she is one of the first on the block to do so. This owner is somewhat sensitive to the potential for flooding, so he/she sets the lowest slab elevation 6" higher than the average surrounding ground, and 3" higher than the edge of pavement of the fronting Town street. The street, developed in the 1960's, has no drainage. But, for the first 15 years, there are only 3-4 heavy rains that cause ponded stormwater to rise up within 1" to 2" of that lower slab elevation. Then, there's a building boom. Surrounding lots are bought up and built upon. But new standards for keeping septic drainfields above the water table, and a heightened concern about flooding, cause the new, nearby owners to raise their lots up 1' to 2'. Plus, now it seems those heavier rains are coming a little more frequently. Now that original owner is getting 1" to 3" of water on his lower slab 2-3 times per decade, in part because the water can't spread out equally

over all the lots. Some are higher than the older ones, and the flooding is worse on the lower lot. This is not quite the "self-inflicted wound" mentioned in the previous paragraph.

From a public policy standpoint, it is also worth noting that a Town street can be built "too low," relative to its own drainage system, or to the elevation of the sound or ocean. While there is some fair debate about the extent to which the public body should help out where a house is unwisely built too low, there is no debate about whether the Town or the State should build and operate their roads and streets so that they are not flooded and remain passable in all but very extreme rain events.

In summary, when a house, or store, or street is **built too low** (relative to the ground or to the serving drainage system, if any), **it will flood** unless and until it is either raised or the drainage system is lowered (if that is even possible).

c. **Abnormal Long-Term Rain VOLUME.** This cause of Stormwater Flooding is a cousin of Abnormal Rain RATE, discussed in 1.a above. But in this case, there is no single, extremely hard or intense rain event generating an excessive rate of Stormwater Runoff which exceeds the capacity of the receiving drainage system. Instead, this problem develops over a period of several weeks or even a couple of months. For example, over an 4 week period, there may be 15 different rain events, none worse than 3 inches in a day in volume nor any greater than 1 in/hr in rate, but the total rain during that period is 19"—nearly half of a normal year's rain. None of these events cause a significant problem, but they cause a steady rise in the elevation of the groundwater, until at the end of the 4 weeks, it's lurking just below the surface. Then, a 3-4" rain event occurs during a thunderstorm, but the sandy soil is full of groundwater and none of the rain can soak in. It ALL runs off, as if the whole watershed were hard-surface, like a shopping center parking lot. A prime example of this is the flooding, notably in the Ocean Acres and Whispering Pines subdivisions, during and after the Veterans Day storm of 2009, nicknamed "Nor'Ida" as it resulted from the merger of Tropical Storm Ida with a nor'easter storm. In November and December, 2009, over 17" of rain fell. Flooding aggravated by the resulting high water table persisted well into the winter of 2010, giving rise to an emergency storm drainage/stormwater management project, which will be discussed further.

In summary, a different kind of drainage problem occurs when a **long-term pattern of moderate-intensity rains steadily raises the groundwater** essentially to the surface, then little of the next storm's runoff can infiltrate into the soil.

3. WHAT ARE THE SOLUTIONS TO STORMWATER FLOODING?

a. For many decades up until about 40-50 years ago, in traditional urban and suburban settings, preventing stormwater-caused flooding was called "Storm Drainage." The basic philosophy, called "Direct Runoff," was this:

- Pick a Design Storm for the area you're serving...the bigger the area, the heavier the storm. For example, one nearby City used to use the 5-year 20-minute rain rate for designing pipe systems serving up to 75 acres.

- Calculate the size of a pipe system big enough to carry the Design Flow generated by the Design Storm. For a 75 acre subdivision of average size lots, this might result in a flow rate exiting the project of 120 cfs. That might result in a 60" diameter concrete pipe laid at 0.21% slope; or, if a ditch could work at the same slope, it might have a 6' wide bottom, 2:1 side slopes and flow 33" deep.

- In other words, gather up the large QUANTITY of stormwater as fast as it arrives and push it to the river or ocean as quickly as you can. This is very expensive, and turns out to be somewhat environmentally insensitive.

- The size of the ditch or pipe increases as the available slope decreases. In other words, Direct Runoff systems are especially expensive in areas too flat to get a decent slope. Unsurprisingly, the Outer Banks, including KDH, fits this description.

b. Roughly coinciding with the federal Clean Water Act of 1972, an emphasis on improving water QUALITY began, in addition to processing the large QUANTITY of Direct Runoff. The term "Stormwater Management" came into favor, to describe both slowing down the peak discharge rate and applying some measure(s) to remove from the runoff pollutants such as sediment, chemical contaminants, hydrocarbons, etc. The more effective of such measures began to be refined and standardized as "Best Management Practices," or BMP's.

- Stormwater retention or detention was one of the first and most effective BMP's to be identified. In "Wet Detention," stormwater flows into a lake or pond at a high rate, causes the pond elevation to rise, then flows out the other side of the pond at a dramatically reduced rate, which is not as erosive or damaging to the downstream receiving waters. As a bonus, pollutants settle out of the flow stream, cleaning the outflow waters. The pond behind the movie theater in KDH is an example of a Wet Pond.

- In "Dry Detention," the functionality is similar, except stormwater is stored or detained on top of a grass or sandy bottom instead of on top of the water normally in the Wet Pond. Most of the commercial sites built in KDH over the last 25 years employ one or more Dry Ponds to meet their detention requirements under the Town Code. As a bonus, where the bottom of a Dry Pond is above the groundwater, Infiltration can occur, which is one of the most efficient, effective and highly rated Water Quality BMP's, as discussed below.

- There are numerous forms and variants on Infiltration Systems. In common, they all try to direct at least the potentially pollutant-laden "first flush" of runoff from a site into a setting where it can soak into, or infiltrate, into the soil. Just as wastewater from a septic system is treated and cleaned up by filtering through the soil, and by the action of microbes and plant systems in the soil, an infiltrative BMP cleans up the stormwater system. As a bonus, even when the arrival rate of stormwater, in cfs, is too great for ALL to be infiltrated, there is at least SOME reduction in discharge rate. In KDH, sites are required to "manage"—usually by infiltration—the runoff from a 4.3" rain, roughly a 10-year, 2-hour Design Storm.

- It is important to note that infiltration works best when the media—usually meaning the soil into which infiltration is occurring—is highly permeable. Less permeable soils work less well and require larger areas; when the soil permeability drops below a certain threshold, it just can't be used at all as an infiltrative BMP. So, in KDH we finally have some good news to offset the "bad news" that our flat terrain makes Direct Runoff very expensive: Our sandy soils are incredibly well suited and effective for infiltration. This is why almost all new commercial sites in KDH infiltrate their stormwater runoff into the sand beside, or sometimes underneath, their parking lots.

c. So, which of these three solutions noted above are the best for us to use in solving, or at least mitigating, KDH's stormwater challenges?

- As noted above, infiltration via small dry ponds works best for most of our commercial sites. Occasionally, where a very high percentage of site coverage is used, special arch-shaped underground chambers can be used to direct the runoff into the sand soils underneath the parking lots. Generally speaking, KDH does not have a problem with these recently developed commercial sites and their infiltration systems.

- There are relatively few areas in KDH which are being developed into new subdivisions of single family lots. Two recent examples are the Water Oak subdivision off West First Street and the extensions of Eden Street and Palmetto Street westward to Bay Drive. Both of these employed infiltration, using roadside swales somewhat as "linear dry ponds" to allow stormwater runoff to build up as it infiltrates into the soil below.

- So the primary remaining challenge is existing older residential subdivisions, with nonexistent or ineffective drainage systems, and/or systems whose infrastructure is at the end of its useful life. Drilling down, what can we do that meets all these requirements?

    - Cost-effective in the use of the Town's limited funding for capital projects.

    - Environmentally responsible, providing Water Quality benefits.

    - Able to keep our streets passable in all but the most extreme rain events.

    - Protective of our street pavement surface and base, prolonging their life.

    - Compact in size, so as to better coexist in our crowded street rights of way with the road pavement, sometimes sidewalks, our own water mains, and communications and electric utility lines.

    - And finally, able to solve, or at least mitigate, flooding damage to private properties adjacent to our streets, to the extent that the BOC determines that it is sound public policy to do so.

- The primary solution we have developed for stormwater management in existing residential settings is to **manage the groundwater, keeping it drawn down by relatively small-diameter perforated pipe encased in a drainage filter fabric "sock."** "Sock drains," as these pipes are called, operate in several ways:

    - They are installed as deep as practical, to achieve the maximum groundwater-lowering effect. As the groundwater rises, it gets above the level of the holes in the "sock drain" and flows in, rather than continuing to rise. Over a few days time, the groundwater lowering effect of a sock drain can reach out laterally up to 200' or more. This can allow "sock drain" in one street to provide some degree of groundwater management in the next block over. Our broad goal is to keep the groundwater at least 2.5', or 30", below the surface.

    - Oversimplified, if the groundwater is 30" below the surface in a flat area, and the sand is 33% porous, even the entire volume of a 10" rain can be infiltrated into the ground. This is much more effective, cost-effective and environmentally friendly than trying to rush untreated stormwater to the sound.

- Now if some of that 10" rain arrived very quickly, say, at a rate of 1-2 in/hr, it may not infiltrate into the ground as quickly as it falls, resulting in localized, short -term ponding. We provide for that by gently sloping roadside swales, where stormwater can accumulate until the soil can absorb it into the groundwater.

- During the height of the 10" rain event, stormwater is also being conveyed by the pipe toward the sound. But, by keeping the diameter of the pipe small and its longitudinal slope relatively flat, the velocities are slow. Early in the storm, some of the water in the sock drain will actually exfiltrate out through its perforations and into the drier soil. As the rain ends, the pipe "gets busy" drawing down the groundwater table to re-establish the "bank" of available dry storage in the pores of the soil and getting ready for the next rain event.

- "Sock drain" is relatively cheap. Until the recent inflation/supply chain problems, we were getting 12" – 15" diameter "sock drain" furnished and installed for about $40-$45 per linear foot. This is about half the cost of the larger pipe it would take to accomplish a similar level of service with Direct Runoff.

- Small-diameter "sock drain" is light and relatively easy to install, even in our roadside situations where the ground is full of main lines and service drops for water, electric power, CATV and telephone.

- Keeping the groundwater managed down is good for the subgrade, base and surface of our roadway pavements. It helps prevent freeze-thaw damage such as that which destroyed over a block of E Martin Street about 4 years ago.

- While the primary mission of "sock drain" is to drain and protect the roadway, when it manages the groundwater down to, say, 30" below the ground surface, it can bring huge relief to the adjacent property owner whose lower slab elevation is a foot or so too low to surface-drain out to the street. **Obviously, for the owner in a deep "hole," "sock drain" may reduce the severity and/or duration of the flooding problem, but it cannot prevent the problem altogether.**

- "Sock Drain" has a track record of success in KDH. We began using it to a modest degree in 2006-2010. It was absolutely the key to fixing the long-standing flooding in Ocean Acres (2010 and 2012) and Whispering Pines (2018). As may be seen from our project-tracking spreadsheet, all of our "street projects" from 2010 forward have included sock drain work. It is working.

- It must also be noted that there is a role in the overall KDH storm drainage system for larger "trunk lines." The existing NCDOT Canal through First Flight Village is a major trunk. As an extension of it, in 2015, we replaced undersized and structurally failing drive culverts under Asheville Drive, Prospect Avenue and Lowell Avenue, then along Woodmere Avenue and many blocks of N Memorial Boulevard. This route is now a trunk line of 48" smooth-wall pipe. Ultimately, the Memorial system will be projected southward all the way to Carolyn Drive, gradually reducing from 48" diameter to 42", then 36" and finally 30". This will finish relieving the long-standing, long-duration flooding in the Memorial and Wrightsville areas, which have already seen notable improvement due to the 2015 project. Another example of a relatively large "trunk" system is the Raymond Avenue/Bickett Street ditch/culvert system in the northern portion of KDH.

- An exciting prospect to enhance greatly the Memorial Boulevard trunk, discussed in the previous bullet, is the subject of the Town's pending application for a "Building Resilient Infrastructure and Communities" (BRIC) Grant from the Federal Emergency Management Agency (FEMA). If approved, KDH's BRIC Grant will fund the southern (Wrightsville Boulevard) extent of the Memorial Boulevard trunk, then develop a major additional outfall route westward along Goddard Avenue, under US 158, between the Dare County water and recreation facilities, through the school complex along Veterans Drive, then offsetting to the property line between Bermuda Bay and the school property and discharging to the sound. Consistent with the "R" (Resilience) in "BRIC," this adds a new, strong westerly outfall to Memorial trunk, taking some of the burden now shared by the northern outfall to the NCDOT canal and the temperamental 3 ocean outfalls. The resulting overall system would be more robust and reliable than anything KDH could achieve for many years with the limits of local funding.

4. <u>WHAT DO KDH STAFF & TOWN ENGINEER RECOMMEND TO SISPC & BOC, REGARDING STORMWATER</u>?

   a. Continue funding capital improvement projects as we have been recommending for the last 12 years. We are unsure whether street, drainage, water and sidewalk costs will ever recover to pre-2021 levels, or what the rate of cost inflation will be, but expect a vigorous program, holistic and integrated with all 4 infrastructure areas, to continue costing around $2 million annually, averaging about half from the Water Fund.

   b. All infrastructure areas are important. Certainly, let us not fall behind on rebuilding our "Poor"-rated streets. The next rating will be later this year, and some Fair2 and Fair3 streets will undoubtedly be found to have dropped to Poor. Drainage/Stormwater are important, but they must not come at the expense of street work. If a street is allowed to deteriorate too far, a $300,000 per mile overlay can become a $1,000,000 per mile reconstruction.

   c. Let's continue to seek out alternate/supplemental funding. The FEMA BRIC Grant application is a good example. We leave it to the BOC's wisdom as to whether the current state of stormwater needs is urgent enough to warrant an accelerated program funded by borrowed money or we continue to "pay as we go."

   d. KDH probably should make a clear policy statement as to our objectives when we do capital improvement projects that include drainage/stormwater management work, as it relates to solving problems on private property. The following could be a starting point for such a policy statement:

      It is the Town's policy to construct, maintain and rehabilitate its streets and roads so that their storm drainage systems (roadside ditches/swales, culverts, enclosed pipe systems, outfalls, etc.) accomplish the following objectives:

      i. Keep the street drained so that it is safely passable to vehicular and pedestrian traffic.

      ii. To the maximum extent practicable, avoid stormwater from the street draining onto private property, except through an easement.

      iii. Receive the surface flow of stormwater from adjacent single-family residential properties.

      In addition, in those areas where the Town determines that groundwater management measures are feasible, such a system may be installed and may provide some benefit to adjacent residential properties whose land and/are structures are lower than the elevation of the street. In so doing, the Town is applying a technique which has been shown to promote the

three foregoing objectives. The Town welcomes any secondary benefits that such groundwater systems may provide in alleviating a private property owner's adverse drainage conditions due to being lower than the street, but affirmatively declares that it is under no duty to do so and accepts no liability should any such mitigation be ineffective or not totally effective in any given rainfall event.

e. It is probably time for a full Stormwater Master Plan update; the last was done in 2010. Such an update should, at a minimum, result in an updated Townwide map showing all but the smallest components of the drainage system. Other potential elements could include:

   i. Condition rating of all components.

   ii. Capacity rating.

   iii. A more precisely-determined list of capital improvement projects.

   iv. Incorporation of the mapping rating elements of the plan into a Town-wide GIS system, which could also include water distribution, streets and other infrastructure.

W. SPORTSMAN DR.
ENTIRE STREET
ESTIMATE = $500,000
W. AVALON DR.
ENTIRE STREET
ESTIMATE = $500,000
W. DURHAM ST.
PHOEBUS ST. TO HAMPTON ST.
ESTIMATE = $52,000
W. DURHAM ST.
US158 TO NEWPORT NEWS ST.
ESTIMATE = $90,000
W. DURHAM ST.
HAMPTON ST. TO BAY DR.
ESTIMATE = $89,000
W Bickett St
E Bickett St
158
Edenton St
Portsmouth St
Hampton St
Phoebus St
Highview St
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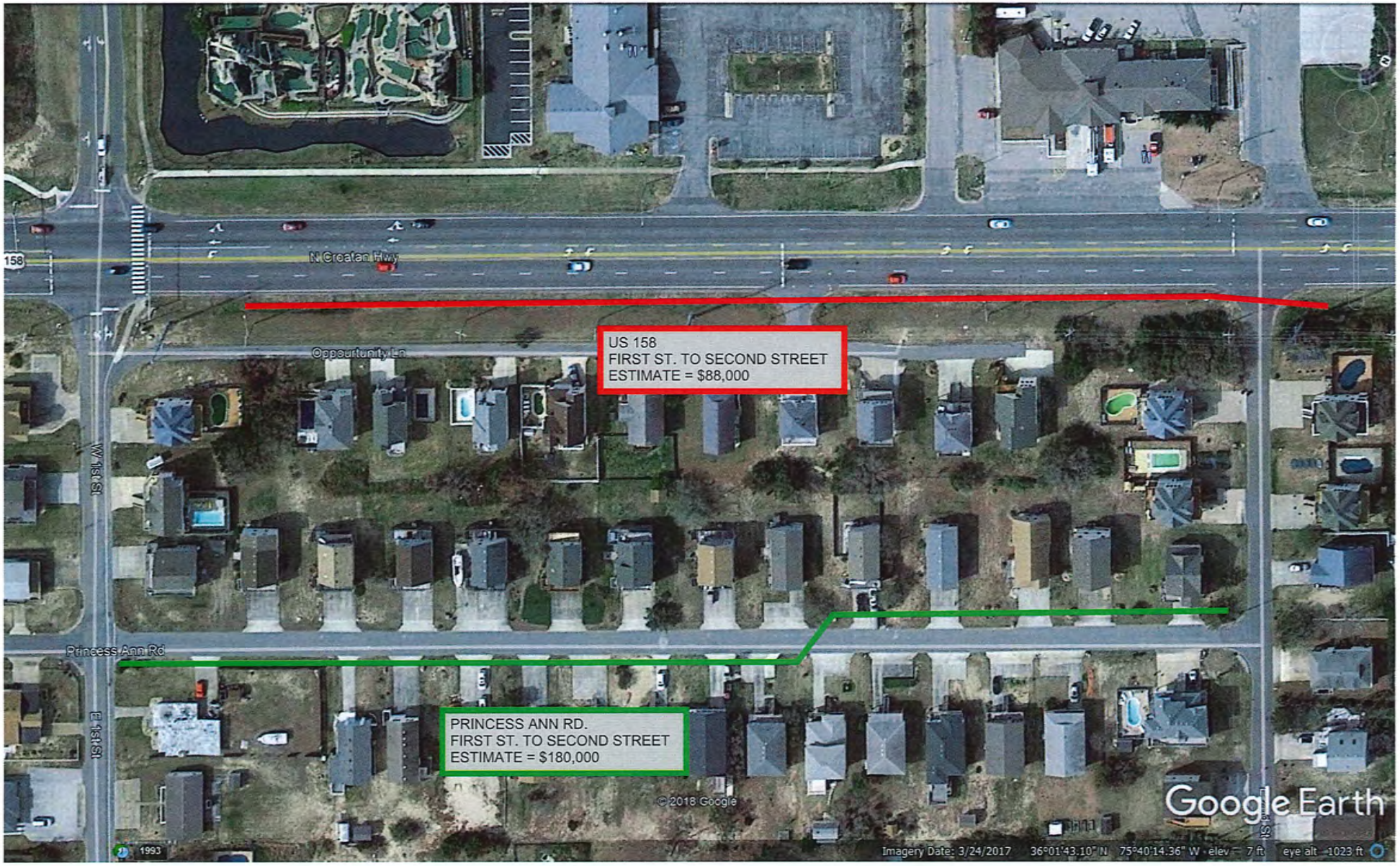
Google Earth
Imagery Date: 3/24/2017 36°02'15.76" N 75°41'04.08" W elev 6 ft eye alt 3172 ft


158
N Croatan Hwy
Opportunity Ln
W 1st St
E 1st St
Princess Ann Rd
US 158
FIRST ST. TO SECOND STREET
ESTIMATE = $88,000
PRINCESS ANN RD.
FIRST ST. TO SECOND STREET
ESTIMATE = $180,000
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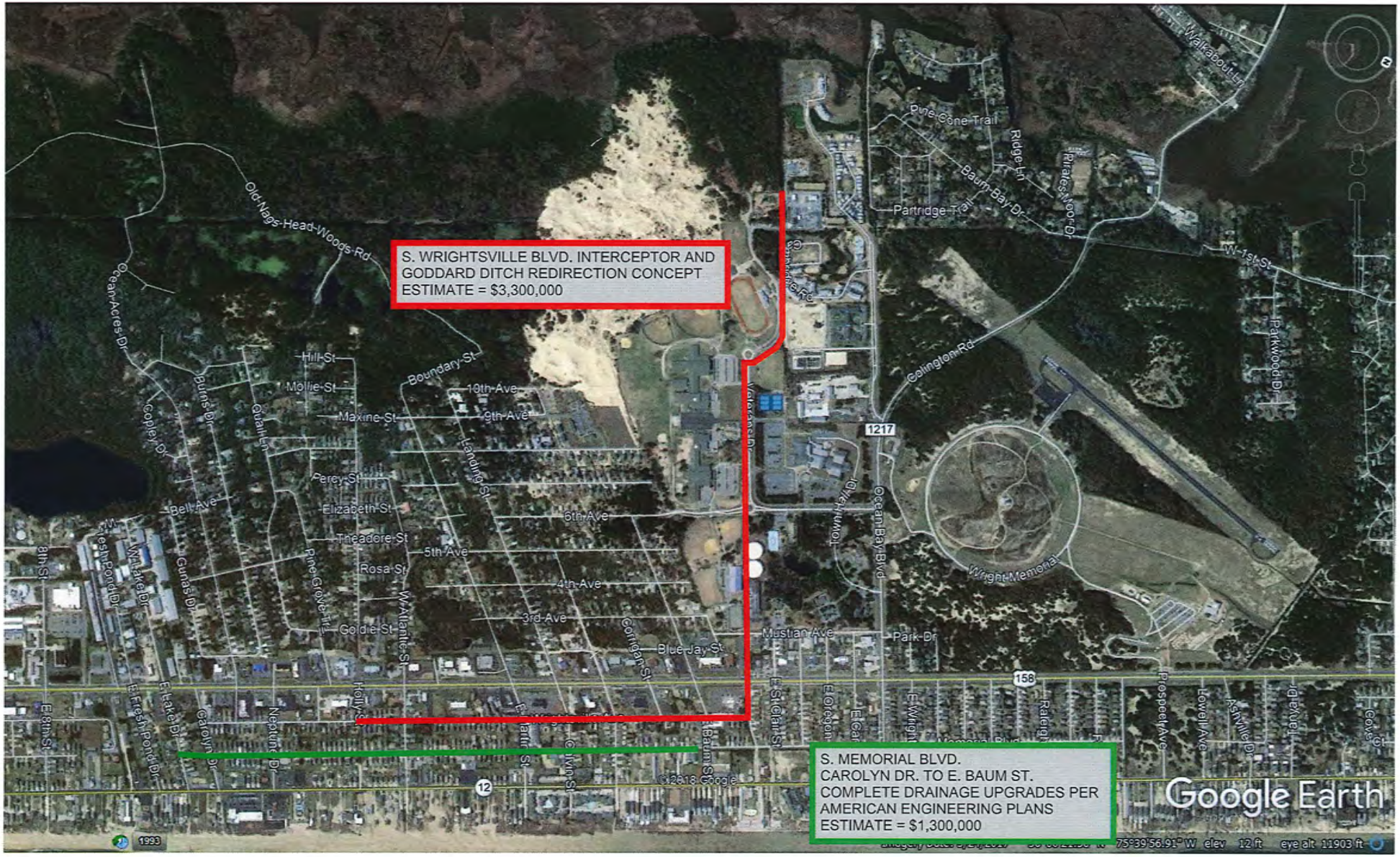
Google Earth
1993
Imagery Date: 3/24/2017 36°01'43.10" N 75°40'14.36" W elev -7 ft eye alt 1023 ft

W. 4th St
4th St
158 ST
Daily St
Wyandotte St
Bay Dr
Sea Sweep St
Apache St
Canal Dr
Great St
Seminole St
Aztec St
W. THIRD ST., CLAMSHELL DR, INDINA DRIVE AND CONNECTING STREETS ESTIMATE = $3,300,000
© 2018 Google
Google Earth
1993
Imagery Date: 3/24/2017 36°01'52.36" N 75°40'55.18" W elev 8 ft eye alt 3192 ft

Seminole St
Peter Ln
Newport News St
Aztec St
Polly St
Clam Shell Dr
Fir Ln
David Ln
W. DURHAM ST.
US158 TO NEWPORT NEWS ST.
ESTIMATE = $90,000
W 3rd St
N Croatan Hwy
158
1463
E 3rd St
E 5th St
US 158
W. THIRD STREET TO W. DURHAM ST.
OPTION 1: CONTINUOUS PIPE W. THIRD TO W. FOURTH, PIPE UNDER 5TH
ESTIMATE = $340,000
OPTION 2: PIPE ONLY UNDER DRIVEWAYS AND STREET
ESTIMATE = $150,000
Google Earth
Imagery Date: 3/24/2017 36°02'01.67" N 75°40'31.71" W elev 19 ft eye alt 2023 ft

VIRGINIA DARE SHORES
LEE AVENUE AND SURROUND STREETS
WITH DRAINAGE REPORTS
ESTIMATE = $430,000
COLUMBIA AVENUE ALTERNATIVE FOR
DEEP DRAINAGE OUTLET
Palmetto St
Walker St
Hayman Blvd
Sothern St
Lee Ave
Sportsman Dr
Bicket St
Columbia Ave
Ocean Park
Google Earth


S. WRIGHTSVILLE BLVD. INTERCEPTOR AND GODDARD DITCH REDIRECTION CONCEPT ESTIMATE = $3,300,000
S. MEMORIAL BLVD. CAROLYN DR. TO E. BAUM ST. COMPLETE DRAINAGE UPGRADES PER AMERICAN ENGINEERING PLANS ESTIMATE = $1,300,000
Old Nags Head Woods Rd
Ocean Acres Dr
Hill St
Mollie St
Maxine St
Boundary St
10th Ave
9th Ave
Percy St
Elizabeth St
Theadore St
Rosa St
6th Ave
5th Ave
4th Ave
3rd Ave
Goldie St
Blue Jay St
Landing St
Gordan St
Bell Ave
Burns Dr
Guain Ln
Copley Dr
Pine Grove Trl
W Atlantic St
Gunas Dr
W Lake Dr
Fresh Pond Dr
8th St
E 8th St
E Lake Dr
E Fresh Pond Dr
Carolyn Dr
Neptune Dr
Holly St
E Baum St
Mustian Ave
Park Dr
E Wright Memorial Blvd
Ocean Bay Blvd
Wright Memorial
Colington Rd
Parkwood Dr
W 1st St
Partridge Trail
Baum Bay Dr
Pine Cone Trail
Ridge Ln
Pirates Moor Dr
Walkabout Ln
Sharpe Rd
1217
158
12
Google Earth
1993
75°39'56.91" W elev 12 ft eye alt 11903 ft