

Optimizing Site Development with On-Site Wastewater and Stormwater Systems

by

Gary S. MacConnell, P.E.

NCDEQ – Stormwater Program
2024 Webinar Series (May 15, 2024)



MacCONNELL
& Associates, P. C.

P. O. Box 129
Morrisville, North Carolina 27560
Tel: (919) 467-1239

I know we would all rather be fishing, but.....



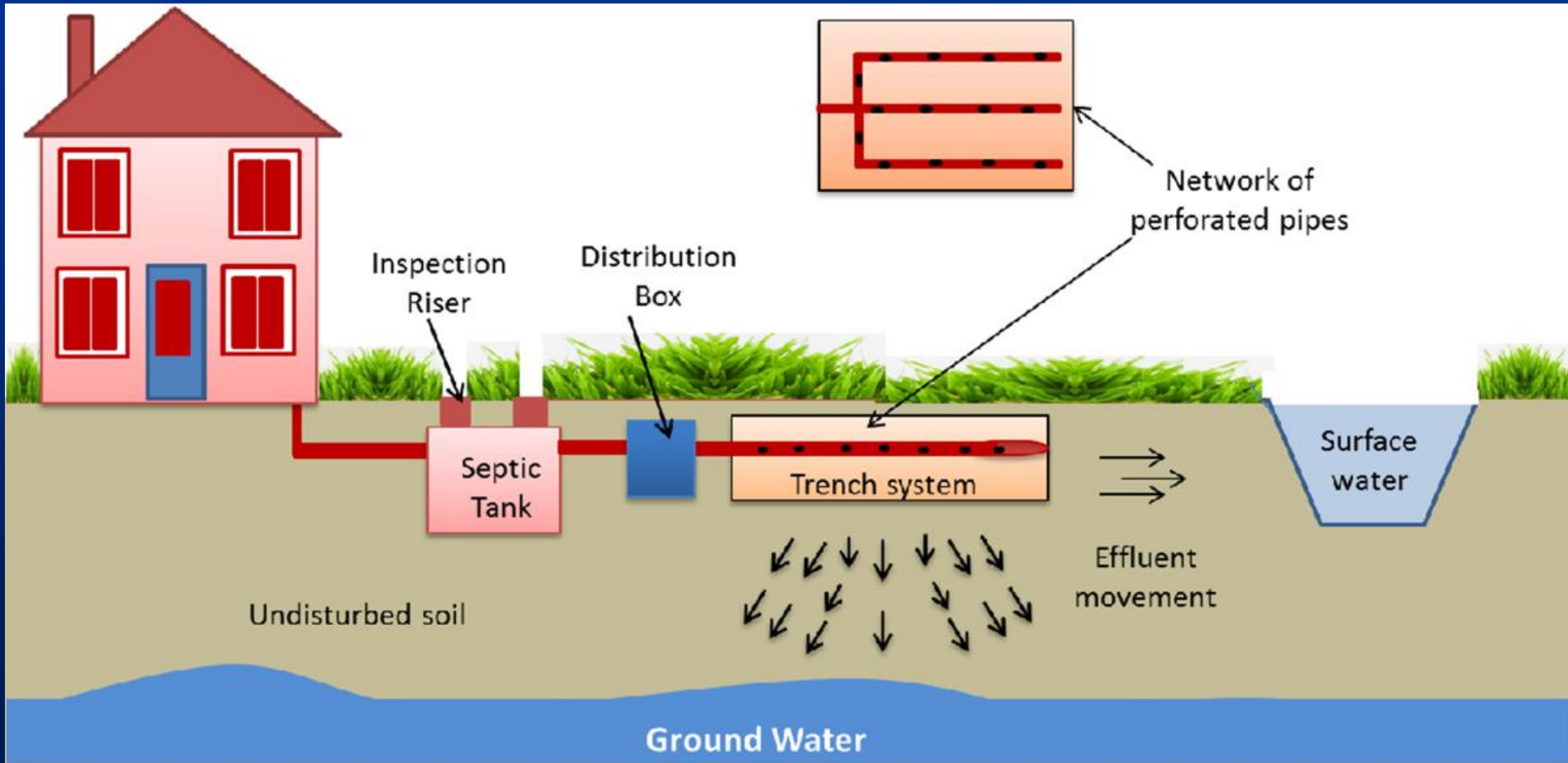
Presentation Overview

- Developments without Public Wastewater.
- Overview of Onsite Wastewater Options.
- Stormwater Minimum Design Criteria and Stormwater Control Measures Not Reviewed
- On-Site Wastewater – Stormwater Conflicts.
- Model/Methodology to Optimize Design (PPPPPP).
- Case Studies



MacCONNELL
& Associates, P. C.

Conventional Gravity System



Why On-Site Community System

- POTW is not available.
- Often preferred over individual on-site systems.
- Allows for concentrated development (cluster, conservation, etc.) .
- Maximizes open or natural areas.
- Environmentally friendly (groundwater recharge, irrigation of natural or landscaped areas, reuse, other).
- Operation and maintenance often provided by private utility or contractor.

Site Restrictions

- Soil Restrictions.
- Setbacks: Wells, Property Lines, Water Features, Land Features, Pool, Easements, etc.
- Challenging Topography.
- Contiguous Available Area.
- Client's Unrealistic Expectations.



MacCONNELL
& Associates, P. C.

Soil Restrictions

- Depth to Bedrock or Restrictive Layer.
- Depth to Seasonal High Water.
- Bad Soils.
- Disturbed Soils or Fill.
- Other.



MacCONNELL
& Associates, P. C.

Regulations

- NCDHHS – Subsurface
 - 15A NCAC 18E: WASTEWATER TREATMENT AND DISPERSAL SYSTEMS
- NCDEQ – Surface
 - 15A NCAC 02T: WASTE NOT DISCHARGED TO SURFACE WATERS
 - 15A NCAC 02U: RECLAIMED WATER



MacCONNELL
& Associates, P. C.

Benefits of Reuse, Advanced Pre-Treatment

- Increase Loading.
- Decrease Setbacks.
- Beneficial Reuse: Irrigation, Etc.
- Allows for Drip and Spray Irrigation.
- Fencing may not be Required.



MacCONNELL
& Associates, P. C.

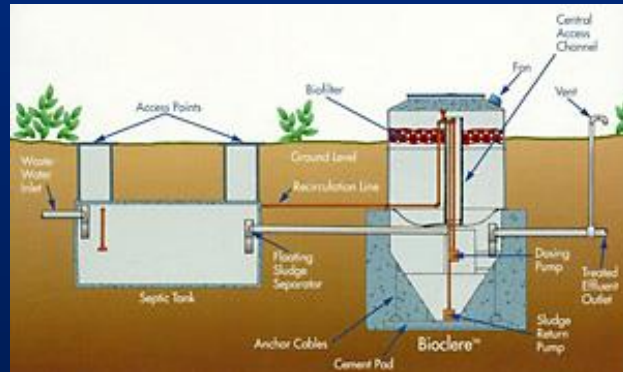
Reuse, Advanced Pre-Treatment

- Aerobic/Activated Sludge (Extended Aeration, Sequencing Batch Reactor, Etc.)
- Recirculating Media Filter.
- Membrane Bio-Reactor.
- Nutrient Removal.
- Disinfection: Chlorination or Ultra-Violet.



MacCONNELL
& Associates, P. C.

Aerobic Treatment



MacCONNELL
& Associates, P. C.

Recirculating Media Filter



MacCONNELL
& Associates, P. C.

Membrane Bio-Reactors



MacCONNELL
& Associates, P. C.

Methods Of Subsurface Dispersal

- **Subsurface:**
 - Conventional Gravity.
 - Pressure Manifold.
 - Low Pressure Pipe.
 - Chamber.
 - Panel Block.
 - Drip Irrigation.
 - Synthetic “Stone”.
 - Sand Lined Trench.
 - Other.



MacCONNELL
& Associates, P. C.

Conventional Gravity



MacCONNELL
& Associates, P. C.

Pressure Manifold



MacCONNELL
& Associates, P. C.

Low Pressure Pipe (LPP)



MacCONNELL
& Associates, P. C.

Chamber System



MacCONNELL
& Associates, P. C.

Panel System



MacCONNELL
& Associates, P. C.

Drip Irrigation



MacCONNELL
& Associates, P. C.

Synthetic Stone



MacCONNELL
& Associates, P. C.

Flow Equalization

- Reduce Treatment and/or Dispersal Requirements.
- Examples: Schools Churches, Camps, Etc.



MacCONNELL
& Associates, P. C.

Flow Reduction

- Regulations: NCDHHS & NCDEQ.
- Rules Based on Pre-Water Conservation Fixtures.
- Base on Fixtures and/or Historical Data.
- PE Documentation.
- Can Re-Rate System.



MacCONNELL
& Associates, P. C.

Conflicts with Stormwater and On-Site Wastewater

- Vertical and Horizontal Regulatory setbacks.
- Piping Conflicts and Separation.
- Use of better soils.
- Siting considerations.
- Can Re-Rate System.



MacCONNELL
& Associates, P. C.

Model to Optimize Design (PPPPPP)

(Prior Proper Planning Prevents Piss Poor Performance)

- Site Features (Easements, Wetlands, Structures, Etc.)
- Local UDO/Zoning & Meet with Officials.
- Preliminary Soils Evaluation.
- Preliminary Well Site Approval and Drilling.
- NCDEQ, NCDHHS – On-Site, & Local Rules.
- Concept Plan Based on Above.
- Preliminary Plat.
- Construction Plans and Permits.



MacCONNELL
& Associates, P. C.

Case Study – Background

- First Time Developer: no experience in development.
- Original Site Engineer: little understanding of community on-site systems.
- Community Farm Concept.
- Conservation Subdivision with +50% open space
- Relatively small lots with majority of development open space.
- In more rural area of county.

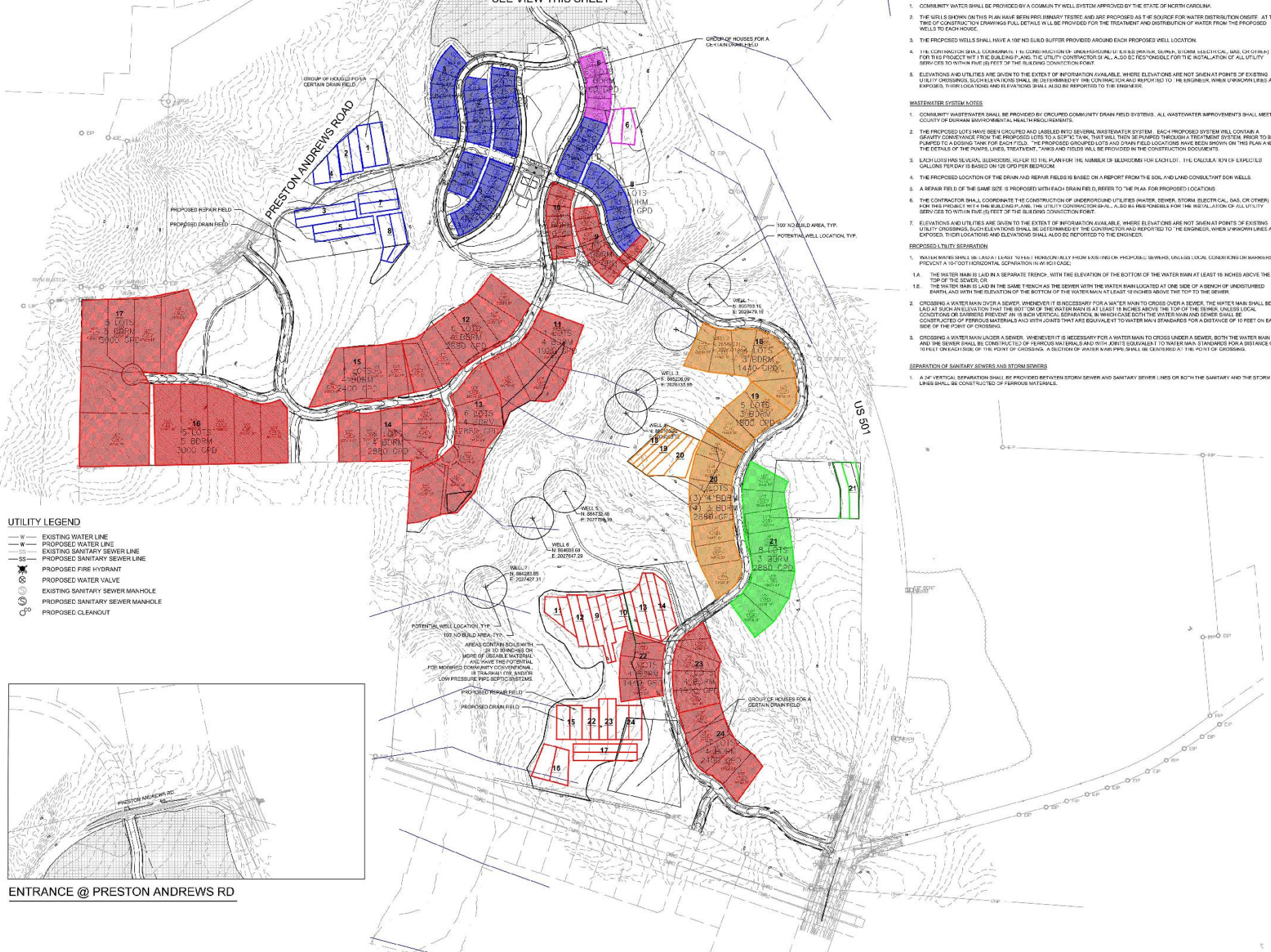
We Became Part of the Original Team Late in the Process

- We were brought to the Team at the request of the Soil Scientist who did not have confidence in Site Engineer with respect to on-site systems.
- Site Engineer had already developed and gotten approvals for site plan.
- No consideration for suitability of soils nor how much area would be required for drain fields.
- Soils work was not completed.
- Only responsible for water and wastewater systems.

Problems with Original Site Plan

- Houses/Roads/Farm Area Located in Better Soils.
- Areas designated for Drain Fields were arbitrary.
- Not enough Drainfield Area to Support development.
- Drip Lines running up gradient, not on contour.
- Subdivision laid out as if it was on municipal sewer.
- NCDOT roads with curb and gutter which were not in line with price point of homes.
- Wastewater Collection System had to be routed around Stormwater and Other Structures.

SEE VIEW THIS SHEET



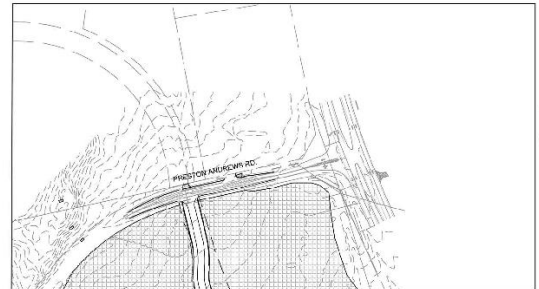
- WATER SYSTEM NOTES**
- COMMUNITY WATER SHALL BE PROVIDED BY A COMMUNITY WELL SYSTEM APPROVED BY THE STATE OF NORTH CAROLINA.
 - THE WELLS SHOWN ON THIS PLAN HAVE BEEN PRELIMINARILY TESTED AND ARE PROPOSED AS THE SOURCE FOR WATER DISTRIBUTION ON-SITE. AT THE TIME OF CONSTRUCTION DRAWINGS FULL DETAILS WILL BE PROVIDED FOR THE TREATMENT AND DISTRIBUTION OF WATER FROM THE PROPOSED WELLS TO EACH HOUSE.
 - THE PROPOSED WELLS SHALL HAVE A 10' NO BUILD BUFFER PROVIDED AROUND EACH PROPOSED WELL LOCATION.
 - THE CONTRACTOR SHALL COORDINATE ALL CONSTRUCTION OF UNDERGROUND UTILITIES WITH THE UTILITY CONTRACTOR. ALL CONSTRUCTION FOR THIS PROJECT WILL BE THE BUILDING PLANS. THE UTILITY CONTRACTOR SHALL ALSO BE RESPONSIBLE FOR THE INSTALLATION OF ALL UTILITY SERVICES TO WITHIN FIVE (5) FEET OF THE BUILDING CONNECTION POINT.
 - ELEVATIONS AND UTILITIES ARE GIVEN TO THE EXTENT OF INFORMATION AVAILABLE. WHERE ELEVATIONS ARE NOT GIVEN AT POINTS OF EXISTING UTILITY CROSSINGS, SUCH ELEVATIONS SHALL BE DETERMINED BY THE CONTRACTOR AND REPORTED TO THE ENGINEER. WHEN UNKNOWN LINES ARE EXPOSED, THEIR LOCATIONS AND ELEVATIONS SHALL ALSO BE REPORTED TO THE ENGINEER.

- WASTEWATER SYSTEM NOTES**
- COMMUNITY WASTEWATER SHALL BE PROVIDED BY GROUPED COMMUNITY DRAIN FIELD SYSTEMS. ALL WASTEWATER IMPROVEMENTS SHALL MEET COUNTY OF DURHAM ENVIRONMENTAL HEALTH REQUIREMENTS.
 - THE PROPOSED LOTS HAVE BEEN GROUPED AND LABELED INTO SEVERAL WASTEWATER SYSTEMS. EACH PROPOSED SYSTEM WILL CONTAIN A GRAVITY CONDUIT FROM THE PROPOSED LOTS TO A SEPTIC TANK, THAT WILL THEN BE PUMPED THROUGH A TREATMENT SYSTEM, PRIOR TO BE PUMPED TO A DOSING TANK FOR EACH FIELD. THE PROPOSED GROUPED LOTS AND DRAIN FIELD LOCATIONS HAVE BEEN SHOWN ON THIS PLAN AND THE DETAILS OF THE PUMPS, LINES, TREATMENT TANKS AND FIELDS WILL BE PROVIDED IN THE CONSTRUCTION DOCUMENTS.
 - EACH LOT HAS SEVERAL BEDROOMS. REFER TO THE PLAN FOR THE NUMBER OF BEDROOMS FOR EACH LOT. THE CALCULATION OF EXPECTED GALLONS PER DAY IS BASED ON 120 GPD PER BEDROOM.
 - THE PROPOSED LOCATION OF THE DRAIN AND REPAIR FIELDS IS BASED ON A REPORT FROM THE SOIL AND LAND CONSULTANT DON WELLS.
 - A REPAIR FIELD OF THE SAME SIZE IS PROPOSED WITH EACH DRAIN FIELD. REFER TO THE PLAN FOR PROPOSED LOCATIONS.
 - THE CONTRACTOR SHALL COORDINATE THE CONSTRUCTION OF UNDERGROUND UTILITIES WATER, SEWER, STORM, ELECTRICAL, GAS, OR OTHER FOR THIS PROJECT WITH THE BUILDING PLANS. THE UTILITY CONTRACTOR SHALL ALSO BE RESPONSIBLE FOR THE INSTALLATION OF ALL UTILITY SERVICES TO WITHIN FIVE (5) FEET OF THE BUILDING CONNECTION POINT.
 - ELEVATIONS AND UTILITIES ARE GIVEN TO THE EXTENT OF INFORMATION AVAILABLE. WHERE ELEVATIONS ARE NOT GIVEN AT POINTS OF EXISTING UTILITY CROSSINGS, SUCH ELEVATIONS SHALL BE DETERMINED BY THE CONTRACTOR AND REPORTED TO THE ENGINEER. WHEN UNKNOWN LINES ARE EXPOSED, THEIR LOCATIONS AND ELEVATIONS SHALL ALSO BE REPORTED TO THE ENGINEER.

- PROPOSED UTILITY SEPARATION**
- WATER MAINS SHALL BE LAD IN AT LEAST 18 FEET HORIZONTAL FROM EXISTING OR PROPOSED SEWERS, UNLESS LOCAL CODES OR ORDINANCES PREVENT A 18'-0" HORIZONTAL SEPARATION IN ANY CASE.
 - THE WATER MAIN IS LAD IN A SEPARATE TRENCH, WITH THE ELEVATION OF THE BOTTOM OF THE WATER MAIN AT LEAST 18 INCHES ABOVE THE TOP OF THE SEWER.
 - THE WATER MAIN IS LAD IN THE SAME TRENCH AS THE SEWER WITH THE WATER MAIN LOCATED AT ONE SIDE OF A BENCH OF UNDISTURBED EARTH, AND WITH THE ELEVATION OF THE BOTTOM OF THE WATER MAIN AT LEAST 18 INCHES ABOVE THE TOP OF THE SEWER.
 - CROSSING A WATER MAIN OVER A SEWER, WHENEVER IT IS NECESSARY FOR A WATER MAIN TO CROSS OVER A SEWER, THE WATER MAIN SHALL BE LAD AT SUCH AN ELEVATION THAT THE BOTTOM OF THE WATER MAIN IS AT LEAST 18 INCHES ABOVE THE TOP OF THE SEWER. UNLESS LOCAL CONDITIONS OR ORDINANCES PREVENT AN 18 INCH VERTICAL SEPARATION, IN WHICH CASE BOTH THE WATER MAIN AND SEWER SHALL BE CONSTRUCTED OF FERROUS MATERIALS AND JUNCTIONS THAT ARE EQUIVALENT TO WATER MAIN STANDARDS FOR A DISTANCE OF 10 FEET ON EACH SIDE OF THE POINT OF CROSSING.
 - CROSSING A WATER MAIN UNDER A SEWER, WHENEVER IT IS NECESSARY FOR A WATER MAIN TO CROSS UNDER A SEWER, BOTH THE WATER MAIN AND THE SEWER SHALL BE CONSTRUCTED OF FERROUS MATERIALS AND JUNCTIONS THAT ARE EQUIVALENT TO WATER MAIN STANDARDS FOR A DISTANCE OF 10 FEET ON EACH SIDE OF THE POINT OF CROSSING. A SECTION OF WATER MAIN SHALL BE CENTERED AT THE POINT OF CROSSING.

- SEPARATION OF SANITARY SEWERS AND STORM SEWERS**
- A 2'-0" VERTICAL SEPARATION SHALL BE PROVIDED BETWEEN STORM SEWER AND SANITARY SEWER LINES OR BOTH THE SANITARY AND THE STORM LINES SHALL BE CONSTRUCTED OF FERROUS MATERIALS.

- UTILITY LEGEND**
- W — EXISTING WATER LINE
 - W — PROPOSED WATER LINE
 - SS — EXISTING SANITARY SEWER LINE
 - SS — PROPOSED SANITARY SEWER LINE
 - ⊗ PROPOSED FIRE HYDRANT
 - ⊕ PROPOSED WATER VALVE
 - ⊙ EXISTING SANITARY SEWER MANHOLE
 - ⊙ PROPOSED SANITARY SEWER MANHOLE
 - ⊙ PROPOSED CLEANOUT

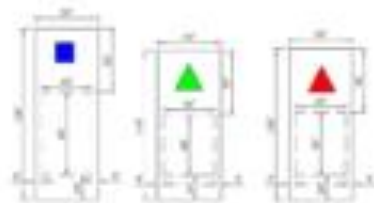


ENTRANCE @ PRESTON ANDREWS RD

Revised Project

- Development on one side of creek.
- Same number of homes.
- Use better soils for drain fields.
- Do away with “Community Farm Concept”.
- Keep Conservation Subdivision.
- Save as much infrastructure as possible.
- New portions use swales in lieu of curb and gutter.
- All drain fields on site.

PROPOSED LOT TYPES



TYPE 1: 20' x 100' = 2,000 sq ft
 TYPE 2: 15' x 100' = 1,500 sq ft
 TYPE 3: 10' x 100' = 1,000 sq ft

IMPERVIOUS AREA CALCULATIONS

Lot Type	Number of Lots	Subtotal Area	Area Impervious	Impervious %	Total Impervious Area	% Impervious Area of Total
Type 1 Lot	20	20,000	2,000	10%	2,000	1.0%
Type 2 Lot	15	15,000	1,500	10%	1,500	0.75%
Type 3 Lot	10	10,000	1,000	10%	1,000	0.5%
Building	50	50,000	50,000	100%	50,000	24.5%
TOTAL	65	95,000	54,500	57.4%	54,500	26.75%

PERMEABLE PAVEMENT: 0.10% (0.10%)



SITE DATA SUMMARY

PLANNED UNDER THE MAP
 ZONING: RESIDENTIAL MEDIUM DENSITY
 DISTRICT: R-2
 SUBDIVISION: 100-100-0000
 PROJECT: 100-100-0000
 MAP NO.: 100-100-0000
 MAP DATE: 10/10/2010
 MAP SCALE: 1" = 100'
 MAP PREPARED BY: [Name]
 MAP CHECKED BY: [Name]
 MAP APPROVED BY: [Name]

ITEM	DESCRIPTION	AREA (SQ FT)	PERCENTAGE (%)
TOTAL SITE AREA	1. TOTAL SITE AREA	95,000	100%
	2. IMPERVIOUS AREA	54,500	57.4%
	3. PERMEABLE PAVEMENT	5,450	5.74%
	4. TOTAL PERMEABLE AREA	40,050	42.1%
TOTAL IMPERVIOUS AREA	1. TOTAL IMPERVIOUS AREA	54,500	57.4%
	2. BUILDING FOOTPRINT	50,000	53.7%
	3. DRIVEWAYS	2,000	2.1%
	4. TOTAL DRIVEWAY AREA	2,000	2.1%
TOTAL PERMEABLE AREA	1. TOTAL PERMEABLE AREA	40,050	42.1%
	2. LAWN	10,000	10.5%
	3. DRIVEWAY	2,000	2.1%
	4. TOTAL DRIVEWAY AREA	2,000	2.1%

WATER SYSTEM NOTES

1. COMMUNITY WATER SHALL BE PROVIDED BY A COMMUNITY WELL SYSTEM APPROVED BY THE STATE OF NORTH CAROLINA.
2. THE WELLS SHOWN ON THIS PLAN HAVE BEEN PRELIMINARY TESTED AND ARE PROPOSED AS THE SOURCE FOR WATER DISTRIBUTION ON-SITE. AT THE TIME OF CONSTRUCTION DRAWINGS, FULL DETAILS WILL BE PROVIDED FOR THE TREATMENT AND DISTRIBUTION OF WATER FROM THE PROPOSED WELLS TO EACH HOUSE.
3. THE EXISTING WELLS SHALL HAVE A 10'-0" BUILD SETBACK PROVIDED AROUND EACH LOCATION.
4. THE CONTRACTOR SHALL COORDINATE THE CONSTRUCTION OF UNDERGROUND UTILITIES (WATER, SEWER, STORM, ELECTRICAL, GAS OR OTHER), THE UTILITY CONTRACTOR SHALL BE RESPONSIBLE FOR THE INSTALLATION OF ALL UTILITY SERVICES TO THE EDGE OF THE RIGHT-OF-WAY.
5. ELEVATIONS AND UTILITIES ARE GIVEN TO THE EXTENT OF INFORMATION AVAILABLE, WHERE ELEVATIONS ARE NOT GIVEN AT POINTS OF EXISTING UTILITY CROSSINGS, SUCH ELEVATIONS SHALL BE DETERMINED BY THE CONTRACTOR AND REPORTED TO THE ENGINEER. WHEN UNKNOWN LINES ARE EXPOSED, THEIR LOCATIONS AND ELEVATIONS SHALL ALSO BE REPORTED TO THE ENGINEER.
6. CONTRACTOR MAY REPURPOSE EXISTING METERS AND APERTANCES TO NEW LOCATION.

WASTEWATER SYSTEM NOTES

1. COMMUNITY WASTEWATER SHALL BE PROVIDED BY A COMMUNITY DRAINFIELD SYSTEM. ALL WASTEWATER IMPROVEMENTS SHALL MEET COUNTY OF DURHAM ENVIRONMENTAL HEALTH REQUIREMENTS.
2. THE PROPOSED LOTS HAVE BEEN GROUPED INTO SEVERAL COLLECTION SYSTEMS, EACH COLLECTION SYSTEM WILL CONTAIN A GRAVITY CONVERGENCE FROM THE PROPOSED LOT TO A SEPTIC PUMP TANK THAT WILL THEN PUMP THE WASTE TO A CENTRALIZED TREATMENT SYSTEM. THE TREATED EFFLUENT WILL THEN BE PUMPED TO VARIOUS DRAINFIELDS THROUGHOUT THE SITE. THE DETAILS OF THE PUMPS, LINES, TREATMENT, TANKS, AND FIELDS WILL BE PROVIDED IN THE CONSTRUCTION DOCUMENTS.
3. EACH LOT HAS 3-4 BEDROOMS, REFER TO THE PLAN FOR THE NUMBER OF BEDROOMS FOR EACH LOT. THE CALCULATION OF EXPECTED GALLONS PER DAY IS BASED ON 120 GPD PER BEDROOM. THE DRAINFIELD IS SIZED BASED ON 90 GPD PER BEDROOM (PER APPROVED 25% FLOW REDUCTION).
4. THE PROPOSED LOCATION OF INITIAL AND REPAIR DRAINFIELDS IS BASED ON REPORTS BY DON WELLS L.L.S. OF SKEC.
5. THE CONTRACTOR SHALL COORDINATE THE CONSTRUCTION OF UNDERGROUND UTILITIES (WATER, SEWER, STORM, ELECTRICAL, GAS OR OTHER), THE UTILITY CONTRACTOR SHALL ALSO BE RESPONSIBLE FOR THE INSTALLATION OF ALL UTILITY SERVICES TO THE EDGE OF THE RIGHT-OF-WAY.
6. ELEVATIONS AND UTILITIES ARE GIVEN TO THE EXTENT OF INFORMATION AVAILABLE, WHERE ELEVATIONS ARE NOT GIVEN AT POINTS OF EXISTING UTILITY CROSSINGS, SUCH ELEVATIONS SHALL BE DETERMINED BY THE CONTRACTOR AND REPORTED TO THE ENGINEER. WHEN UNKNOWN LINES ARE EXPOSED, THEIR LOCATIONS AND ELEVATIONS SHALL ALSO BE REPORTED TO THE ENGINEER.

PROPOSED UTILITY SEPARATION

1. WATER MAINS SHALL BE LAD AT LEAST 10 FEET HORIZONTALLY FROM EXISTING OR PROPOSED SEWERS, UNLESS LOCAL CONDITIONS OR BARRIERS PREVENT A 10-FOOT SEPARATION IN WHICH CASE:
 - 1.1. THE WATER MAIN IS LAD IN A SEPARATE TRENCH WITH THE ELEVATION OF THE BOTTOM OF THE WATER MAIN AT LEAST 18 INCHES ABOVE THE TOP OF THE SEWER, OR
 - 1.2. THE WATER MAIN IS LAD IN THE SAME TRENCH AS THE SEWER WITH THE WATER MAIN LOCATED AT ONE SIDE OF A BENCH OF UNDISTURBED EARTH AND WITH THE ELEVATION OF THE BOTTOM OF THE WATER MAIN AT LEAST 18 INCHES ABOVE THE TOP OF THE SEWER.
2. CROSSING A WATER MAIN OVER A SEWER: WHENEVER IT IS NECESSARY FOR A WATER MAIN TO CROSS OVER A SEWER, THE WATER MAIN SHALL BE LAD AT SUCH AN ELEVATION THAT THE BOTTOM OF THE WATER MAIN IS AT LEAST 18 INCHES ABOVE THE TOP OF THE SEWER. IF LOCAL CONDITIONS OR BARRIERS PREVENT AN 18 INCH VERTICAL SEPARATION, BOTH THE WATER MAIN AND SEWER SHALL BE CONSTRUCTED OF FERROUS MATERIALS WITH JOINTS THAT ARE EQUIVALENT TO WATER MAIN STANDARDS FOR A DISTANCE OF 10' ON EACH SIDE OF THE POINT OF CROSSING.
3. CROSSING A WATER MAIN UNDER A SEWER: WHENEVER IT IS NECESSARY FOR A WATER MAIN TO CROSS UNDER A SEWER, BOTH THE WATER MAIN AND SEWER SHALL BE CONSTRUCTED OF FERROUS MATERIAL AND WITH JOINTS EQUIVALENT TO WATER MAIN STANDARDS FOR A DISTANCE OF 10' FEET ON EACH SIDE OF THE POINT OF CROSSING. A SECTION OF WATER MAIN PIPE SHALL BE CENTERED AT THE POINT OF CROSSING.

SEPARATION OF SANITARY SEWERS AND STORM SEWERS

1. A 24" VERTICAL SEPARATION SHALL BE PROVIDED BETWEEN STORM SEWER AND SANITARY SEWER LINES OR BOTH THE SANITARY AND THE STORM LINES SHALL BE CONSTRUCTED OF FERROUS MATERIALS.
2. AN 8" HORIZONTAL SEPARATION SHALL BE PROVIDED BETWEEN STORM SEWER AND SANITARY SEWER LINES.



Wastewater System Design Components

- **Collection System:** Modified STEP System with multiple lots on one offsite STEP tank.
- **Wastewater Treatment System:** Recirculating Media Filter with UV-Disinfection, proprietary system.
- **Effluent Disposal:** Subsurface Drip Irrigation.

Collection System: Modified STEP System

- Private 6-inch collection sewer with cleanouts in lieu of manholes
- Allows for a couple of emergency generators to be cycled in an emergency.
- Ensures proper O&M through private utility.
- Works well with topography.
- No tanks on lots.
- Reduces O&M with respect to pumping and pump replacement.

Wastewater Treatment System: Recirculating Media Filter

- Technology based on recirculating sand filter.
- Uniform plastic media.
- Only moving parts are pumps.
- UV Disinfection.
- Simple to operate and maintain.
- Expandable, can be phased.
- Reuse quality with nutrient removal (Certified: NSF 40, 245, and 350), although not required for permit.

Wastewater System Design Criteria

Criteria	Influent	Permit Effluent	Design Effluent
3-4 Bedroom Homes	141		
ADF GPD	60,960		
Adjusted ADF (75%)	45,720		
BOD ₅ (mg/l)	250	30.0	15.0
TSS (mg/l)	250	30.0	15.0
Ammonia (mg/l)	25.0		1.00
Nitrate/Nitrite (mg/l)	0.00	13.0	12.3
Total N (mg/l)	40.0	14.0	13.3
Total P (mg/l)	11.0		8.9
Fecal Coliforms (G.M #/200ml)	10 ¹⁰	200	10



DO NOT TOP LOAD!
CONSEAL
CONCRETE SEALANTS

DO NOT TOP LOAD!
CONSEAL
CONCRETE SEALANTS





ADDITIONAL
PARTS INSIDE

Effluent Disposal: Subsurface Drip Irrigation

- Aesthetically pleasing, no visual impact.
- Fencing not required.
- Many zones with ability to modify dosing regimes.
- Dosing based on soils, lateral flow, and modeling.
- Forests and open fields.
- Alternate initial and repair fields.

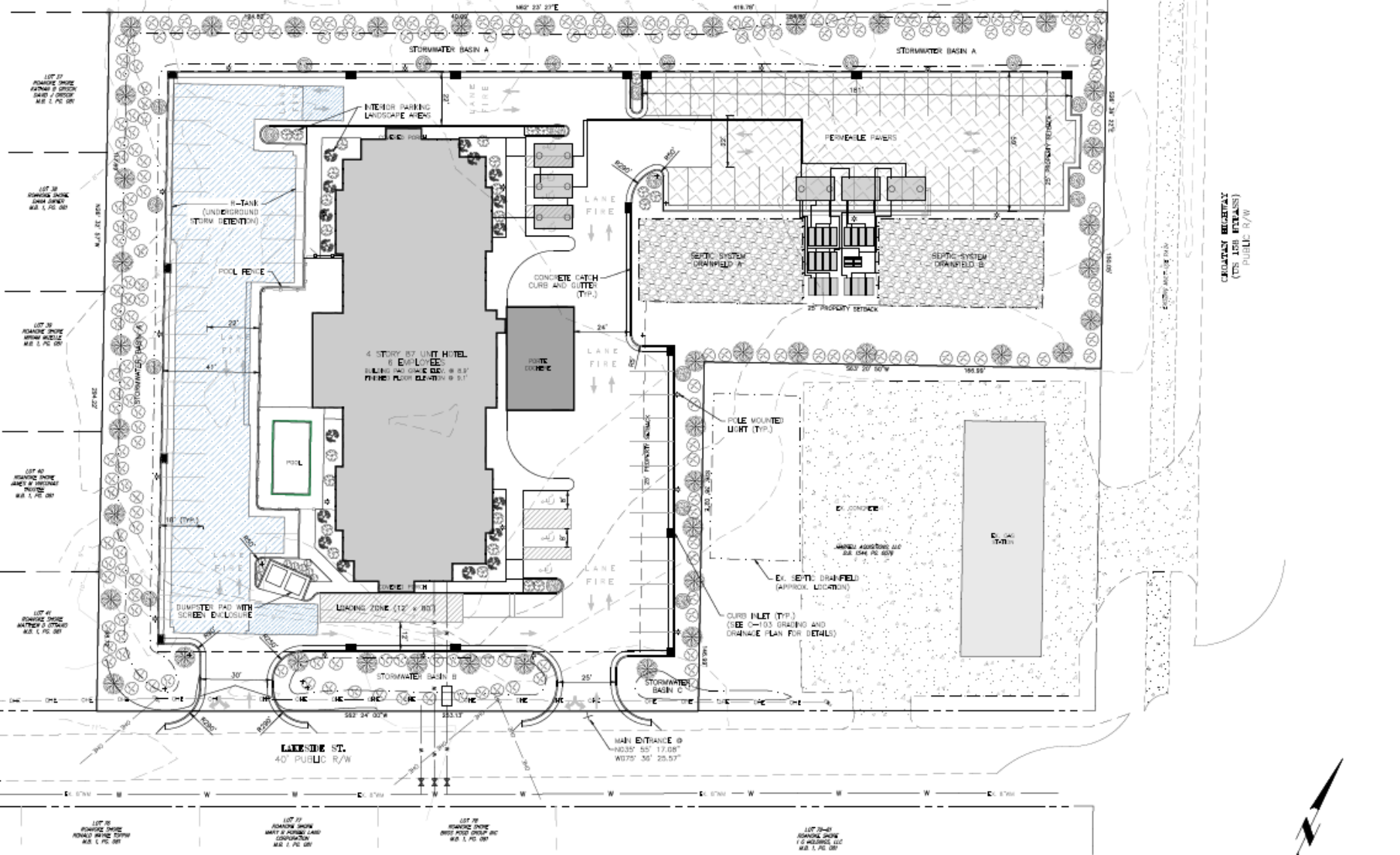
Lessons Learned

- Experience matters.
- With large community on-site systems soils dictate design.
- Modified STEP systems provide benefits and cost savings.
- Recirculating media filters with drip irrigation are a good option for community systems.
- Use PPPPP to optimize wastewater and stormwater design to be more cost effective.

Case Study – Motel at Coast

- Tight site.
- Setbacks from existing neighboring stormwater and on-site wastewater features.
- Potential conflicts with stormwater and on-site wastewater.

FOLLETT ST.
20' PUBLIC R/W
(ROANoke SOUND TO ATLANTIC OCEAN)



POST-CONSTRUCTION STORMWATER DRAINAGE INFORMATION

COUNTY:	DARE
CITY:	NAGS HEAD
PERMITTING:	STATE
TYPE:	COASTAL COUNTY OR COMMUNITY
BASE:	COASTAL STATE SW PERMITTING PROGRAM
NOTES:	NEAR SHELLEYPHOSPHORUS (SA) WATERS / COASTAL SW RULES APPLY
COMMIT:	DAW REGIONAL OFFICE
DES REGION:	WASHINGTON
CATEGORY:	COASTAL STATE SW PROGRAM
PHASE & INFO:	NOT A PHASE II STORMWATER AREA
RIVER BASIN:	PASQUOTANK
RECEIVING STREAM:	ROANOK SOUND (STREAM INDEX #30-21) (SA-HOW)

PROJECT AREA AND DENSITY INFORMATION

TOTAL PROPERTY AREA	99,233 SF (2.28 AC)
TOTAL SURFACE WATER AREA	0 SF
TOTAL COASTAL WETLAND AREA	0 SF
EXISTING BUILT-UPON AREA (BUA)	0 SF
PROPOSED BUILT-UPON AREA (BUA)	60,684 SF (1.39 AC)
PROJECT DENSITY	- BUA / TOTAL PROJECT AREA = 61.2%



FOR REVIEW ONLY
NOT RELEASED FOR
CONSTRUCTION

CRENSHAW HIGHWAY
(US 108 BYPASS)
PUBLIC R/W



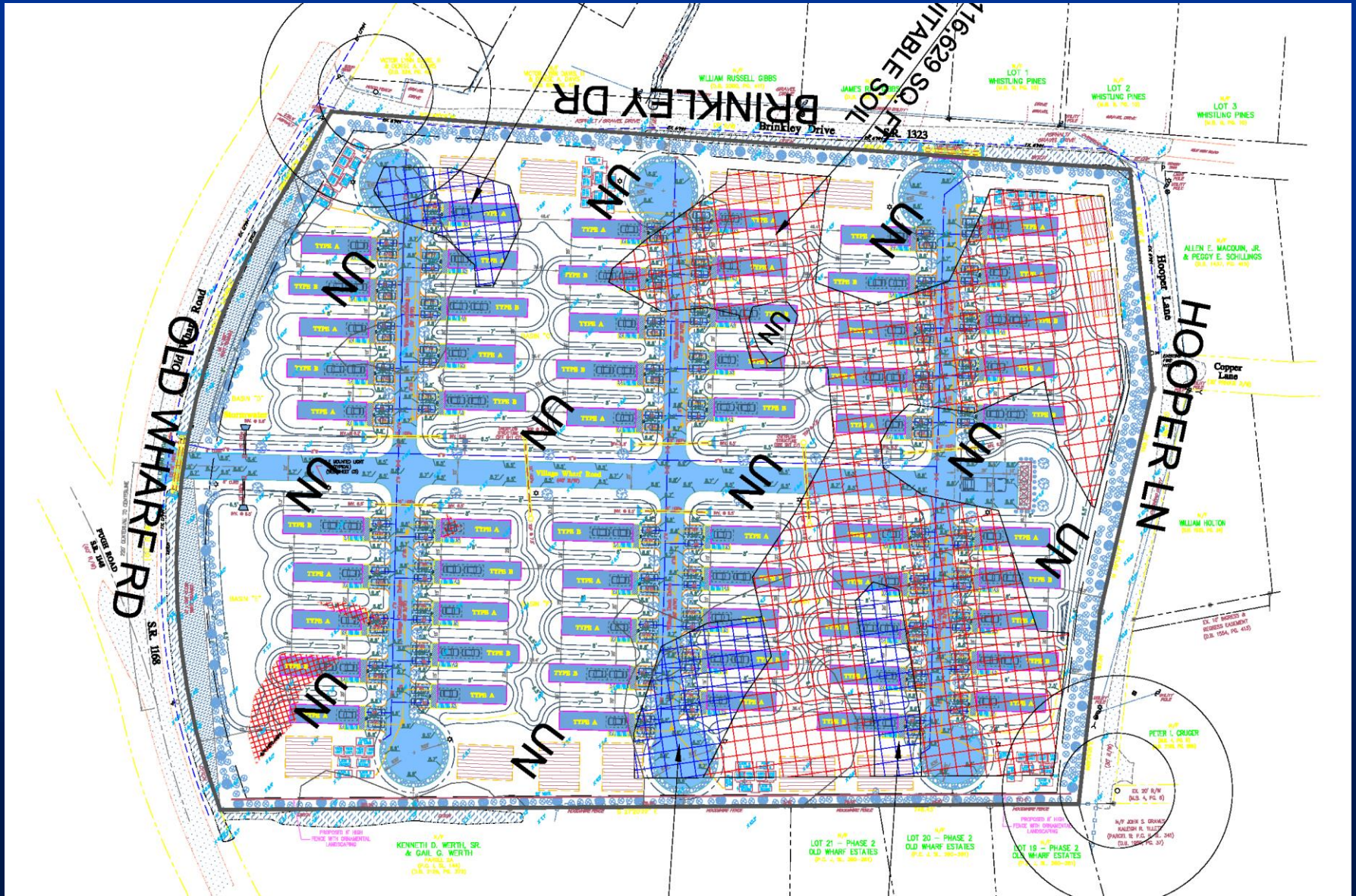
Case Study – Coastal Development

- Tight site.
- High seasonal groundwater.
- Poor soils.

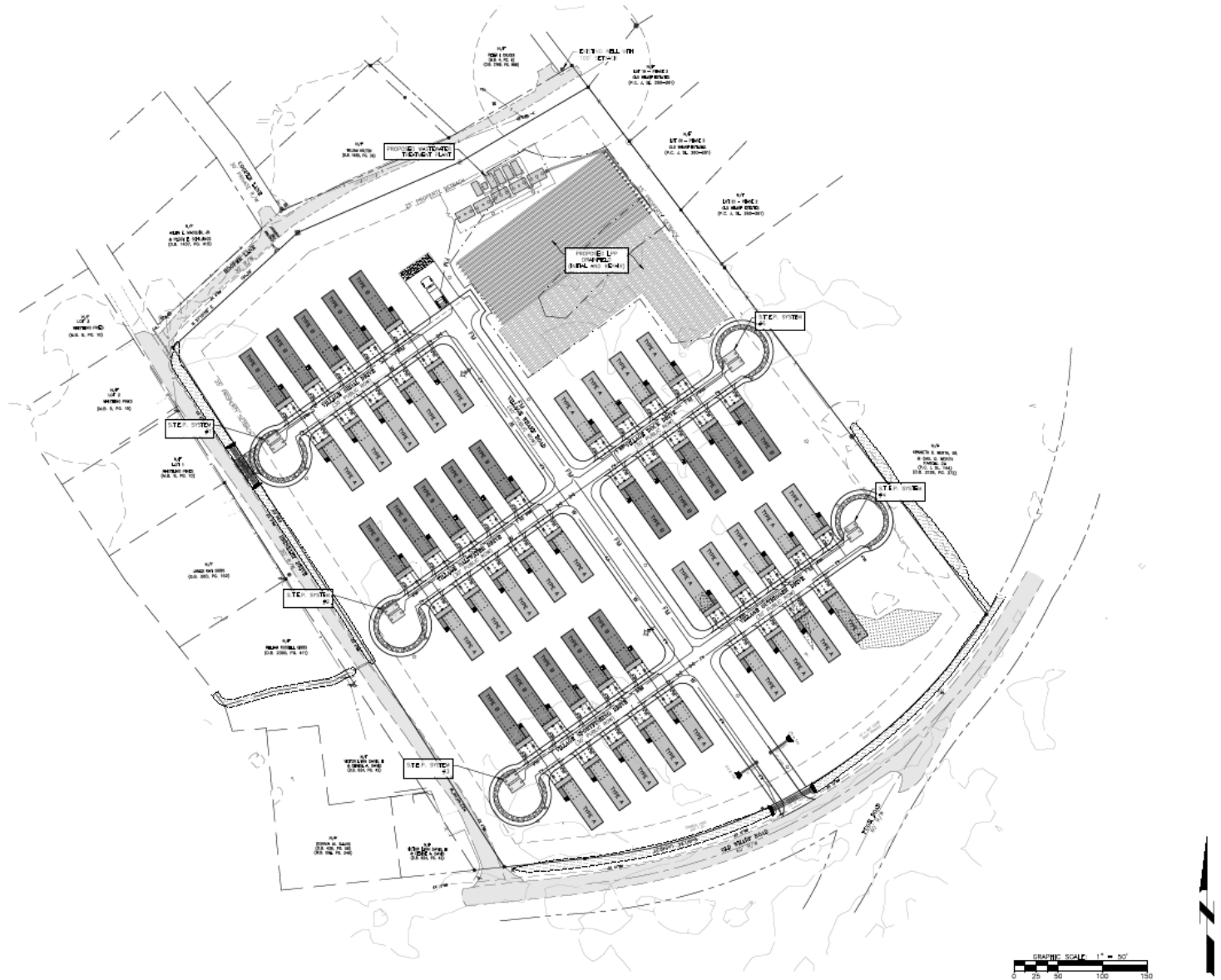
Design Considerations

- Stormwater:
 - Several infiltration basins.
 - Need fill to maintain seasonal groundwater separation.
 - Need to excavate poor soil and back fill with sand.
- On-site wastewater:
 - Engineer Flow Reduction.
 - Reduced loading rate (LTAR) with pre-treatment.

Site Plan with Soils



Wastewater System



Stormwater System



Contact Information:

Gary S. MacConnell, P.E.

919-467-1239

gary@macconnellandassoc.com



MacCONNELL
& Associates, P. C.

Questions?



MacCONNELL
& Associates, P. C.