TOWN OF CHAPEL HILL

Town Hall
405 Martin Luther King Jr. Boulevard
Chapel Hill, NC 27514

Item Overview

Item #: 17., **File #:** [23-0459], **Version:** 1 **Meeting Date:** 5/24/2023

Close the Legislative Hearing and Consider a Conditional Zoning Application for UNC Health Eastowne.

Staff:
Britany Waddell, Director
Judy Johnson, Assistant Director
Tas Lagoo, Senior Planner

Department:
Planning

See Summary Report on the next page.

The Agenda will reflect the text below and/or the motion text will be used during the meeting.

PRESENTER: Tas Lagoo, Senior Planner

a. Without objection, the revised report and any other materials submitted at the hearing for consideration by the Council will be entered into the record
b. Introduction and revised recommendation
c. Presentation by the applicant
d. Comments from the public
e. Comments and questions from the Mayor and Town Council
f. Motion to close the Legislative Hearing
g. Motion to adopt the Resolution of Consistency and Reasonableness
h. Motion to enact an Ordinance to rezone the property

RECOMMENDATION: That the Council adopt Resolution A and enact Revised Ordinance A, approving the Conditional Zoning Application.

CLOSE THE LEGISLATIVE HEARING AND CONSIDER A CONDITIONAL ZONING APPLICATION FOR UNC HEALTH EASTOWNE (PROJECT #CZD-22-7)

SUMMARY REPORT

TOWN OF CHAPEL HILL PLANNING DEPARTMENT
Britany Waddell, Director
Judy Johnson, Assistant Director
Tas Lagoo, Senior Planner

PROPERTY ADDRESSES	MEETING DATE	APPLICANT
100, 200, 300, 500, 600, 700, 800, 901 and 998 Eastowne Drive	May 24, 2023	McAdams on behalf of Health System Properties LLC (Property Owner)

TOWN MANAGER'S RECOMMENDATION

That the Council 1) close the legislative hearing, 2) adopt the Resolution of Consistency and Reasonableness, and 3) enact the Ordinance approving the Conditional Zoning application.

UPDATES SINCES THE APRIL 19, 2023, LEGISLATIVE HEARING

- **Development on the Northern 20:** Construction of a parking structure on the Northern 20 shall only be authorized by the Town Manager upon demonstration of parking demand. If the deck is needed, efforts will be made to minimize impacts and to shift the construction site close to the US 15-501 and Eastowne Drive intersection.
- **Community Benefits:** Includes a $5 million contribution to support the creation of a loan fund supporting acquisition, preservation, and creation of affordable housing for a twenty (20) year term. Further refinement of this condition is anticipated prior to the Council meeting.
- **Green Building Standards:** The property owner proposes all buildings designed to meet the more stringent of either (1) the North Carolina adopted energy code or (2) 20 percent better than the 2016 published version of ASHRAE 90.1.
- **EV Parking**: The property owner shall provide a minimum of two percent of the parking spaces with EV charging stations and a minimum of 25 percent of the spaces to be "EV-capable."
- **Project Phasing:** The property owner will be required to apply for the first Zoning Compliance Permit (ZCP) within 5 years of the approval of this Conditional Zoning District.
- **15-501 Pedestrian Crossing:** Subject to NCDOT approval, the property owner will enhance pedestrian crossings at the southern Eastowne Drive/US 15-501 intersection.
- **Urban Design Review:** The Town's Urban Designer has provided some comments on the proposed Eastowne streetscape summarized in the Technical Report.

ZONING

Existing: Office/Institutional-3 (OI-3); Office/Institutional-2 (OI-2); Mixed Use–Office/Institutional-1 (MU-OI-1)

Proposed: Office/Institutional-3-Conditional Zoning District (OI-3-CZD)

DECISION POINTS

Modifications to Regulations: The property owner requests modifications to regulations related to the following:

- RCD buffers and dimensional regulations
- Steep slopes
- Parking maximums and bicycle minimums
- Floor Area Ratio
- Buffer along Eastowne Drive
- Maximum size of signs
- Requirements for the "district-specific plan"
- Staff authorization of minor modifications

PROCESS

Conditional Zoning is a legislative process that allows Town Council to review the rezoning application for consistency with the Land Use Plan in the Comprehensive Plan and establish standards that address impacts on surrounding properties.

PROJECT OVERVIEW

UNC Health proposes to construct multiple healthcare-related buildings (totaling approximately 1.1 million square feet) and several parking decks to create a new medical campus along Eastowne Drive.

Construction of a new medical office building ("MOB 2") adjacent to the recently completed MOB 1 is slated to begin as soon as possible. Development of the remainder of the site is expected to proceed at a tempo

PROJECT LOCATION

of roughly 1 new building every 3-5 years, with full buildout over at least 25 years.

The project site includes two parts. The approximately 30-acre "Inner Loop" is bounded by Eastowne Drive and US 15-501 and will host the majority of development on the site. The approximately 20-acre "Northern 20" lies between Eastowne Drive and Interstate 40. Approximately half of the Northern 20 will be placed in a permanent conservation easement and the remainder may be used to construct a parking garage during the final phase of development in the Inner Loop.

Transportation Impact Analyses were completed to determine the short-term impacts of MOB 2 and to understand potential impacts of the full development. Subsequent TIAs will be completed with each phase of development.

Prior to completion of MOB 2, UNC Health will make several improvements to and along Eastowne Drive between US 15-501 and Old Sterling Drive.

ATTACHMENTS

1. Technical Report and Project Fact Sheet
2. Draft Staff Presentation
3. Resolution A, Resolution of Consistency and Reasonableness
4. Ordinance A, Approving the Application
5. Resolution B, Denying the Application
6. Draft Applicant Presentation
7. Applicant Materials
8. Traffic Impact Analysis and Sensitivity Analysis
9. Plan Sheets

TECHNICAL REPORT

UPDATES SINCES THE APRIL 19, 2023, LEGISLATIVE HEARING

1. ***Development on the Northern 20*:** Concern was raised over the proposed construction of a parking garage on the Northern 20 acres. As shown, the property owner is proposing preservation of approximately 10 acres, or 50 percent, of the Northern 20. Some Councilmembers noted that a parking garage should only be allowed as a last resort.

   The property owner and Town staff have explored other options to consider. The following conditions have been included in Revised Ordinance A and included in Revised Ordinance A:

   Parking Spaces: A total ratio of 4.5 vehicular parking spaces per 1,000 sf of building area are authorized for construction within the Inner Loop (approximately 4,000 spaces). A maximum 1,200-space parking structure, to be located on the Northern 20, shall be subsequently authorized by the Town Manager upon demonstration that the need for additional parking exists.

   If peak hour utilization of the vehicular parking spaces exceeds 80 percent of the capacity, a parking structure to provide the additional parking necessary to meet the overall demonstrated need for the Eastowne development shall be approved by the Town Manager on the Northern 20.

   Parking Structure on Northern 20: The property owner shall investigate the option of moving the proposed parking structure closer to US 15-501 on the Northern 20. This location will require impacts to the Jordan Buffer, Resource Conservation District and intermittent stream. Access to the deck off from Eastowne Drive will be reviewed and approved by NCDOT and the Town. Current permitting requirements, at a minimum, include approvals from the Town of Chapel Hill (Jordan Buffer & RCD), US Army Corp of Engineers (wetlands), NCDENR-DWR (stream) and NCDOT (access). Any RCD encroachment reasonably associated with relocating the parking structure is permitted as part of this Conditional Zoning. If the permits can be obtained, the property owner will construct the parking deck as close as reasonably possible to US 15-501 and Eastowne Drive.

   Town staff and the property owner explored several alternatives including:

   - Increasing the height and capacity of parking garages within the Inner Loop. The property owner has indicated each proposed parking garage would be increased 2-3 stories.

   - Providing diagonal parking along Eastowne Drive. Staff estimates this could provide 200-300 spaces and may impact the Level of Service, safety, and multimodal travel on the street.

- Executing a land swap with the Town if the Town could acquire property to support a parking deck near Eastowne.

- Providing for an off-site park-and-ride and shuttle for employees. This could be operated from Eubanks Road or the Friday Center.

2. ***By-Right Development on the Northern 20:*** Councilmembers have asked staff to outline the level of by-right development that could occur on the Northern 20. Staff note the following:

   Based on the current zoning for the Northern 20 (MU-OI-1), approximately 250,000 sq. ft. of floor area is permitted by-right. Although development larger than 20,000 sq. ft. of floor area or 40,000 sq. ft. of land disturbance would require a Special Use Permit or Conditional Zoning District, the requirement could be avoided by subdividing the Northern 20 and executing multiple projects that each fall below the floor area and land disturbance thresholds.

   Off-street parking is only allowed as an accessory use in MU-OI-1 districts. As a result, a standalone parking garage could not be built by-right as the primary or only use on the Northern 20.

   It is also important to note that because the Northern 20 is essentially state-owned property, N.C. General Statute 160D-913 limits the Town's zoning authority to the regulation of *buildings* on the site. Activities such as tree-clearing or the construction of surface parking lots are outside the scope of the Town's zoning authority over the Northern 20.

3. ***Community Benefits*:** Councilmembers were largely supportive of UNC Health's proposal to offer $5 million of seed funding for an affordable housing revolving loan fund and staff has been working to finalize details of loan fund. The following condition has been included in Revised Ordinance A:

   Community Benefits: The Property owner or its successors or assigns (Owner) will contribute five (5) million dollars to support a revolving loan fund product for acquisition, preservation, and creation of affordable housing in the town limits of Chapel Hill (the "Loan"). The Town intends to use the Loan funds as top-tier seed funding for a larger Affordable Housing Loan Fund (the Fund) created at the direction of the Town and administered by a third party selected by the Town. A final funding Agreement ("Agreement") will be executed by Owner and the Town prior to issuance of the first Zoning Compliance Permit or establishment of the Fund, whichever occurs sooner. The following terms shall apply to the Loan:

   - The Loan will be for a period of 20 years from its transfer to the Fund, extendable at the discretion of the Owner but otherwise repayable at the end of that period.
   - As top-tier funding to the Fund, the Loan would be made at 0% interest to the Town or fund administrator and without recourse to the Town or fund administrator.
   - The Loan funds will serve in a subordinate loss position to the Town in the case of losses being incurred by the Fund.
   - The Loan proceeds would be made available to the Fund within 45 days of Agreement execution.

   In the event that, through no fault of Owner, the Town should decline or fail to create the Fund or similar affordable housing finance product, or should the Fund not

continue in operation for the period of the Loan, this conditional zoning approval shall remain valid and enforceable and not be adversely affected thereby.

4. ***Green Building Standards:*** Based on continued discussions with Town Staff, the following condition has been included in Revised Ordinance A:

   Energy Efficiency: All buildings shall either be designed to be 20 percent better than the 2016 version of ASHRAE 90.1 or in accordance with the current NC energy code, whichever is more stringent. For each building, the property owner will submit an energy model with the building permit plans to demonstrate that the building is designed to perform to the aforementioned standard.

   For purposes of ASHRAE 90.1-2016 energy modeling and calculations, the following applies:

   a. Loads associated with specialty medical equipment shall be excluded from the energy models (baseline and proposed/design). Specialty equipment such as but not limited to linear accelerators, imaging equipment (CT scanners, MRI, etc), specialty pharmacy equipment, etc.

   b. Town staff shall allow a lower proposed/design improvement over baseline if applicant demonstrates that there is no commercially practical method to achieve a 20% reduction. Factors could consist of but not limited to equipment technology availability, material shortages, laws/regulations prohibiting manufacturing of certain materials, new codes, etc.

   LEED building standard shall be reviewed for approach to energy conservation, indoor air quality, sustainability and building commissioning. The following LEED design goals shall be followed where practical in a facility designed for patient care:

   a. Third party building commissioning to ensure performance of energy conservation measures at completion of project.
   b. Strive to provide the highest indoor air quality design and eliminate or limit use of any materials that off gas to the indoor environment.
   c. Meet Energy efficiency measures as outlined in either ASHRAE 90.1 -2016 or NC energy code, whichever is more stringent.
   d. Where practical, specify materials made from sustainable and renewable resources.
   e. Provide on-site renewable energy production (i.e. photovoltaics)

   UNC Health agrees to review with Staff the current standards and adjust criteria if mutually agreeable. The spirit of the projects is to build the most energy efficient buildings that are practical considering the mission of UNCH which is to provide the best possible medical care to its patients.

5. ***EV Parking***: The property owner will provide at least 2 percent of the parking spaces in each parking structure with an EV charging station. Additionally, at least 25 percent of the spaces shall be "EV-capable". The following conditions have been included in Revised Ordinance A:

   Electric Vehicle Parking: All new parking structures in the development shall adhere to the following standards:

a. Prior to each Zoning Final Inspection for each parking structure, two percent (2%) of parking spaces, or more if demonstrated by ongoing monitoring of the use, in each parking structure shall be served by electric vehicle ("EV") charging stations. Charging stations shall be "Level 2" or higher as defined by the Society of Automotive Engineers and sites must:
    i. Provide a Level 2 charging capacity (208/240V) or greater
    ii. Comply with relevant regional or local standard for electrical connectors, such as SAE Surface Vehicle Recommended Practice J1772, SAE Electric Vehicle.
    iii. Conductive Charge Coupler so that they are compatible with all types of chargers.
    iv. When possible, EVSE-installed spaces should be identified and shared with the Town of Chapel Hill during the Zoning Compliance Permit review process.
b. Twenty-five percent (25%) of parking spaces in each parking structure shall be "EV Designed," meaning the structure will be designed with accommodations to be installed to infrastructure at a later date. More specifically, this means that that the final plans (and any amendments) show the full installation of up to 25 percent of the total spaces for Level 2 charging (or equivalent vehicle charging capacity by DCFC), including:
    i. the locations for future charging stations, pavement markings and signage
    ii. the locations for future pavement markings and signage related to ADA access that complies with the U.S. Access Board's latest version of the *Design Recommendations for Accessible Electric Vehicle Charging Stations* (or comparable ADA guidance agreed to by Town staff)
    iii. the location of future conduit and raceways
    iv. the location for future, upsized transformers
    v. the location and durable marking of future electrical panels with dedicated circuits for EV charging*
    vi. the location for borings between parking deck levels and/or walls for future conduit and raceways*

*Completed borings between parking levels and/or walls, and the durable marking of locations to reserve space for future electrical equipment (panels, transformers), will be made during the time of construction, and observed by zoning inspections staff at the time of final review.

Electric Vehicle Utilization: An analysis of the utilization of existing EV parking spaces will be provided by the Property owner with each Zoning Compliance Permit submittal and, if the staff finds there to be reasonable justification, the required number of EV spaces can be adjusted accordingly. An increase or reduction in the required number of EV spaces will be considered a minor modification.

Electric Bicycle Charging: All parking structures shall include at least three (3) 110-volt receptacles within five (5) feet of bicycle racks that meet Town standards.

6. ***Project Phasing*:** The property owner will be required to submit an application for the first Zoning Compliance Permit (ZCP) within 5five (5) years of the approval of this Conditional Zoning District

7. ***15-501 Pedestrian Crossing*:** Subject to NCDOT approval, the property owner will enhance pedestrian crossings at the southern Eastowne Drive/US 15-501 intersection. The following condition has been included in Revised Ordinance A:

US 15-501 and Southern Eastowne Drive Pedestrian Improvements: That enhanced pedestrian refuge islands should be provided on both pedestrian crosswalks of US 15-501 in coordination with NCDOT and the Town.

8. ***Urban Designer Review***: The Town's Urban Designer has provided the following comments: "the Eastowne Drive frontages along the UNC Health Eastowne development, from what is understood, are to be a similar configuration to that which currently exists along the parking structure that was built as part of MOB 1. This consists of an approximately 3-foot wide grass strip along the curb, and a ten-foot-wide multiuse path. Beyond the path are trees spaced approximately 40 feet apart. Consider exploring if the trees could be spaced a little closer together, if suitable for the health of the growing trees.

   The Eastowne Revised Concept Site Plan dated 03-30-23, indicates a "Tree Canopy" zone and 15-foot buffer beyond the right-of-way. Ample additional shade trees and other vegetation should be provided in this zone, to create a "soft" edge to the campus along Eastowne Drive. Illustrative renderings of the project previously presented, while not featuring a specific design layout, have been generally indicative of this character."

   Revised Ordinance A has a condition requiring major streets to be landscaped with, at a minimum, canopy trees planted at increments of thirty (30) feet on center with groupings or limited breaks in accordance with emergency services requirements.

PROPOSED ZONING

The property owner proposes an Office/Institutional-3-Conditional Zoning District (OI-3-CZD) zoning district for the site.

The intent of the Office/Institutional-3 (OI-3) is "to provide for major educational, research, public service, and office uses, and their necessary support functions, while minimizing conflicts with adjacent land uses." (LUMO Section 3.3.5)

The property owner has submitted a Conditional Zoning application, which allows review of a development proposal in conjunction with a rezoning, and which allows site-specific standards to be applied as conditions through a legislative process. Conditions are typically used to:

- Address conformance of the development with Town regulations and adopted plans.
- Modify use, intensity, and development standards to be more restrictive when addressing impacts reasonably expected to be generated by development.
- Modify intensity and development standards to be less restrictive when accommodating the property owner's proposed site plan (Modifications to Regulations).

A –CZD suffix would be added to the zoning district designation to indicate the site-specific nature of the rezoning.

SITE CONTEXT

Staff has identified the following physical and regulatory characteristics of the land which are relevant to consideration of a Zoning Atlas Amendment:

- The site consists of approximately 50 acres.
- The site fronts on US 15-501, a NCDOT-maintained arterial road that serves as one of Chapel Hill's primary travel corridors. The site is adjacent to Interstate-40, which provides vehicular access to the broader region.
- The "Northern 20" is recognized as a "Moderate Natural Area" under the North Carolina Natural Heritage Program[1].
- The "Inner Loop" has been heavily developed and includes the recently completed Eastowne Medical Office Building 1 (MOB 1), a multilevel parking deck, and several one- and two-story office buildings that were constructed during the 1970's and 1980's.
- The site contains the following hydrological features:
    - A manmade pond and perennial stream located in the "Inner Loop" subject to a Resource Conservation District (RCD).
    - Intermittent streams on the "Northern 20" and portions of the "Inner Loop" are also subject to RCDs.
- The site is adjacent to the following uses and zoning districts:
    - The Pine Gate Apartments to the west are zoned Residential-4 (R-4).
    - The Eastowne Office Park to the north is zoned Office/Institutional-2 (OI-2).
    - The Parkline office building to the south is zoned Office/Institutional-2 (OI-2). Several other vacant parcels to the south are zoned Residential-1 (R-1).
- The site includes multiple steeps slopes of at least 25 percent grade. A large share of steep slopes within the "Inner Loop" are manmade. The majority of naturally occurring steep slopes are found in the "Northern 20".

PROPOSED MODIFICATIONS TO REGULATIONS

1) **Section 3.6.3 Resource Conservation District (RCD) Buffer:** The property owner proposes to modify the RCD Buffer standards as shown:
    a) RCD buffers for the restored stream shall only consist of the 50-foot streamside zone. There shall be no buffers associated with the managed use zone or the upland zone.
    b) RCD impacts shall be allowed for the pond draining and stream restoration project from US 15-501 to Eastowne Drive.
    c) RCD impacts shall be allowed for the construction of the site access opposite the intersection of Old Sterling Drive with Eastowne Drive and the extension of the multi-use path along Eastowne Drive.
    d) RCD impacts shall be allowed for the construction of an above ground stormwater control (SCM) measure for the small RCD area on the north side of the project inside the "Inner Loop".
    e) RCD impacts shall be allowed for the two (2) stream vehicular crossings shown on the current Conditional Zoning plan. A total of three (3) vehicular stream crossings may be permitted if deemed necessary to provide adequate emergency access to the Parcel Identifier Number 9890-91-1209. Pedestrian and bicycle crossings are permitted with the approval of the Town Manager.

[1] https://ncnhde.natureserve.org/content/map

Staff Comment: RCD regulations are intended to be applied to the areas within and along watercourses within the town's planning jurisdiction in order to preserve the water quality of the town's water supply, to minimize danger to lives and properties from flooding in and near the watercourses, to preserve the water-carrying capacity of the watercourses, and to protect them from erosion and sedimentation, to retain open spaces and greenways and to protect their environmentally-sensitive character, to preserve urban wildlife and plant life habitats from the intrusions of urbanization, to provide air and noise buffers to ameliorate the effects of development, and to preserve and maintain the aesthetic qualities and appearance of the town.

A manmade pond and a severely impaired stream are responsible for a majority of RCD buffers in the "Inner Loop". The property owner is proposing to drain the pond and invest in a stream restoration project that will return the stream to a natural form that supports a diverse riparian ecosystem. This work is entirely in keeping with the intent of the Town's RCD regulations. Other work in the RCD will be limited to features that are necessary to allow for adequate pedestrian and vehicular access to the site and sufficient stormwater management. Impacts on the RCD will be minimized through the use of low-impact features such as boardwalks and bottomless culverts.

2) **Section 3.6.3 Dimensional Regulations in the Resource Conservation District (RCD):** The property owner proposes to modify the Dimensional regulations of the RCD as shown below in order to allow for the proposed stream crossings, construction of a stormwater control measures, and stream restoration:

Zone	Square Footage
Resource Conservation District Total Land Disturbance	180,000 sq. ft.
Resource Conservation District Streamside Zone Land Disturbance	172,000 sq. ft.
Resource Conservation District Streamside Zone Impervious Surface Area	25,000 sq. ft.

Staff Comment: Land disturbance and impervious surface within the RCD are proposed in to order to implement a stream restoration project, build stormwater management features, and provide adequate vehicular and pedestrian access on the site. Each of these activities represent commitments made by the property owner that exceed Town standards, enhance the project, and help the project achieve the goals of the Comprehensive Plan.

3) **Table 3.8.1 Dimensional Matrix:** The property owner proposes to remove the maximum Floor Area Ratio (FAR) for this development. The FAR for Office/Institutional-3 zoning is 0.566.

Staff Comment: Floor Area Ratio (FAR) is used to regulate the total floor area that can be built on a site based on its gross land area. A FAR is not necessary in this case because total floor area is capped by the terms and conditions of the Conditional Zoning District.

4) **Section 4.4.7(g)-(h) Procedures – All Other Conditional Zoning Districts:** The definitions of major and minor modifications to this conditional zoning ordinance and associated district-specific plan will be modified to allow administrative approval of the following:
    a. relocation of public amenity spaces
    b. reconfiguration of pedestrian, bicycle, or vehicular circulation

c. an increase of building height up to 15 percent of the approved height
d. improvements related to construction of future Bus Rapid Transit stop on US 15-501
e. an increase of less than 20 percent of the approved floor area
f. an increase of less than 10 percent of the approved number of parking spaces
g. relocation of vehicular access points to public rights-of-way by less than 50 feet from their approved location
h. relocation of building envelopes by less than 100 feet from their approved location

Staff Comment: Administrative approval of minor modifications can provide property owners with greater flexibility to adjust to changing circumstances or unforeseen constraints as development progresses. Staff would only be permitted to approve a minor modification request if it is compliant with all applicable regulations.

5) **Section 5.3.2 Steep Slopes:** The property owner proposes to increase the total allowable percentage of disturbance of *naturally occurring* steep slopes from 25 percent to 35 percent and to exempt manmade steep slopes associated with prior development of the site.

Staff Comment: Steep slope regulations are intended to protect streams, lakes, and wetlands from the effects of erosion on water quality and water body integrity; to protect the plant and animal habitat of steep slopes from the effects of land disturbance; and to preserve the natural beauty and economic value of the town's wooded hillsides.

The majority of disturbed steep slopes on the property are manmade slopes associated with previous development activity. The current steep slopes regulations exempt only manmade slopes associated with roads, driveways, and parking areas.

6) **Section 5.6.2: Landscape Buffers:** The property owner proposes modifications to the required width and type of buffer, as detailed in the table below.

Buffer Location	Required Buffer	Proposed Buffer
Eastowne Drive	15 ft. Type B	No buffer required. Street trees to be planted at intervals of approximately 30 feet
US 15-501	20-ft, Type C	20-ft, modified buffer to be consistent with existing plantings along US 15-501.

Staff Comment: Landscape buffers are intended to separate proposed development from different adjacent land uses or zoning designations to minimize potential nuisances, reduce the visual impact of unsightly aspects of adjacent development, provide separation of spaces, and establish a sense of privacy.

The property owner proposes reduced buffers along Eastowne Drive in order to facilitate an activated street frontage along Eastowne Drive, which is consistent with the Comprehensive Plan.

7) **Section 5.9.7 Minimum and Maximum Off-Street Vehicular and Bicycle Parking Requirements:** The property owner proposes to set the maximum total parking space limit at 4.5 spaces per 1,000 square feet of floor area. Minimum bicycle parking spaces shall be 2.5 percent of total vehicular parking.

Staff Comment: The proposed parking maximum is consistent with the various LUMO-mandated maximums for uses that are anticipated on the site. A harmonized parking maximum is proposed because the exact use-mix is not known at this time. The property owner proposes to provide a parking demand analysis with each application for a new building.

8) Section 5.12.1.a.4 Utilities – Water Main and Hydrant Installation: The requirement for installation of water mains and fire hydrants will be amended as follows:

"No work shall commence ~~building permits shall be issued~~ with combustible materials until all required ~~water mains and~~ operational fire hydrants necessary for fire protection are installed and operational. For purposes of this subsection, "operational" means that the water mains and fire hydrants are capable of delivering sufficient water to meet domestic and fire fighting needs."

Staff Comment: The proposed modification is consistent with building codes and has been vetted by Town staff responsible for enforcing said codes.

9) Section 5.14 Signs: The property owner proposes to increase the maximum size of signs visible from the public right of way. Signs not visible from the public right of way will be exempt from the Town's sign ordinance.

a. Four (4) new UNC Health Eastowne Business Park and/or medical office site type commercial center signs up to 240 square feet each on Eastowne Drive shall be allowed for the proposed development on the Inner Loop. Sign dimensions shall be restricted to the following:
   i. Maximum Height: 12 feet
   ii. Maximum Width: 20 feet
   iii. Maximum Thickness: 18 inches
   iv. Minimum Letter Height on Panels: 12 inches
b. External wall signage (to include building address and/or name) shall be permitted on each building and parking structure at a location that allow for optimal visibility and wayfinding.
c. Internal site wayfinding signage shall be permitted at each intersection for vehicular and pedestrian traffic.
d. Internal building signage not facing the public right-of-way for identification and wayfinding is not subject to review by the Town.
e. The northern parcel will be allowed up to two (2) ground mounted signs if the parking structure is constructed.

Staff Comments: Sign regulations are intended to ensure that signs are compatible with their surroundings; appropriate to the identity of individual properties and the community; and appropriate to traffic safety.

Larger signs than those typically allowed under the sign ordinance would be appropriate given the scale of the proposed development and its potential to serve as a gateway feature to Chapel Hill.

10) Appendix A "District-Specific Plan": The property owner proposes to amend the definition of the "district-specific plan" accompanying this ordinance as follows:

> "A plan, to scale, showing the approximate location of uses and structures proposed for a parcel of land as required by the applicable application and regulations, including but not limited to lot lines, streets,

building ~~sites~~ envelopes, reserved open space, ~~buildings~~, major landscape features - both natural and manmade - and, depending on requirements, the location of proposed utility lines."

Staff Comment: A "District-Specific Plan" is the site plan that accompanies an approved Conditional Zoning District. The proposed definition of a "District-Specific Plan" differs from the standard definition by removing the requirement to demonstrate the exact location of proposed buildings. Instead, the proposed definition allows the property owner to indicate "building envelopes" that define which areas of the site will be built upon. This modification is intended to balance the property owner's need for greater flexibility (given the prolonged build-out period for the project) and the Town's need to ensure that the rezoning is consistent with community interests.

Council Findings and Public Purpose: The Council has the ability to modify the regulations according to Section 4.4.7 of the Land Use Management Ordinance. Staff believes that the Council could modify the regulations if it makes a finding in this particular case that public purposes are satisfied to an equivalent or greater degree. If the Council chooses to deny a request for modifications to regulations, the property owner's alternative is to revise the proposal to comply with the regulations.

AFFORDABLE HOUSING

The property owner proposes to support affordable housing by providing $5 million in seed funding to the Town to establish an affordable housing revolving loan fund. The fund could support the acquisition of existing affordable housing under threat of redevelopment and creation of new affordable housing. Once initial funding is committed, staff anticipate that a fund administrator could quadruple the fund size by attracting additional private funding. With $5 million in seed funding, the revolving loan fund could preserve or create around 500 affordable housing units or around 1,000 units for a fund with $10 million in seed funding over 20 years.

This community benefit proposal aligns with the Town's affordable housing goals, the Council-approved Preservation Strategy Framework[2], and best practices in the field of affordable housing development and preservation.

CONSISTENCY WITH THE COMPREHENSIVE PLAN AND OTHER DOCUMENTS

North Carolina General Statute 160D-605 requires the Town Council to consider a statement of Plan consistency when reviewing any Zoning Atlas Amendment. Town staff has reviewed this application for compliance with the themes from the 2020 Comprehensive Plan[3], the standards of the Land Use Management Ordinance[4], and the Town of Chapel Hill, NC : Design Manual and Standard Details[5] and provides the following evaluation of consistency for the UNC Health Eastowne proposal:

	Description of Plan Element	Staff Evaluation

[2] https://www.townofchapelhill.org/government/departments-services/affordable-housing-and-community-connections/affordable-housing/strategies-and-plans/preservation-strategy
[3] http://www.townofchapelhill.org/home/showdocument?id=15001
[4] https://www.municode.com/library/#!/nc/chapel_hill/codes/code_of_ordinances?nodeId=CO_APXALAUSMA
[5] http://www.townofchapelhill.org/town-hall/departments-services/public-works/engineering/design-manual-and-standard-details

Land Use Category	**Future Land Use Map:** The site is located in Sub-Area A of the North 15-501 Corridor Focus Area. Commercial/Office uses are identified as primary uses in the Sub-Area while Institutional/University/Civic uses are identified as secondary uses. The FLUM notes that this Focus Area "should include employment centers, whether single user or in a mixed office setting, within proximity to future transit stops" and housing of various price points. The FLUM also notes that "redevelopment and development should enhance how people are connected to and experience the area's natural resources. **Chapel Hill 2020:** The site is located in the North 15-501 Focus Area (Area 5) as identified by the Chapel Hill 2020 Comprehensive Plan. The plan calls for "efforts, in partnership with property owners in the area, to identify sections to rezone and to provide enhanced connectivity for bicycles, transit, pedestrians, and vehicles using the complete streets approach."	The FLUM and Chapel Hill 2020 envision the North 15-501 Corridor as a vibrant gateway into Chapel Hill that is well served by multimodal transportation options. The proposed rezoning is consistent with the character envisioned by the FLUM and Chapel Hill 2020 because the proposed zoning district will allow for the creation of a major employment center in close proximity to existing and future transit stops as well as a broad range of existing and proposed residential developments. The property owner has proposed to enhance pedestrian and bicycle connectivity in the area by providing: • buffered bicycle lanes and updated sidewalks along Eastowne Drive; • a multiuse path along US 15-501; • easements to support potential connections to the Dry Creek Trail and New Hope Commons; and • a multiuse trail connecting Old Sterling Drive to US 15-501. The property owner will support transit service in the area by providing up to two additional bus stops along Eastowne Drive and by providing the land necessary to construct a Bus Rapid Transit Station along US 15-501.
Building Height	The FLUM states that typical building heights in Sub-Area A should be 4-6 stories with 6 stories along activated street frontages.	The property owner proposes to construct several 6-story medical buildings throughout the project site.

Mobility And Connectivity	The Mobility and Connectivity Plan recommends multi-use paths along major roadways in the 15-501 corridor, bike lanes along Eastowne Drive, a bicycle/pedestrian overpass or underpass at the intersection of US 15-501 and Eastowne Drive, and significant transit-oriented improvements such as dedicated transit lanes in the center median of US 15-501. The plan also calls for an extension of the Dry Creek Trail through the site.	The property owner proposes to construct a new multi-use path along the US 15-501 frontage, bike lanes and improved sidewalks along Eastowne Drive, and a multiuse trail through the "Inner Loop". The property owner will dedicate an easement through the "Northern 20" to allow for a connection to the Dry Creek Trail. The property owner will provide land necessary for a Bus Rapid Transit station along US 15-501.
Greenway Master Plan	The existing Dry Creek Trail is proposed to extend to the site.	The property owner will dedicate an easement through the "Northern 20" that will allow the Dry Creek Trail to connect to Eastowne Drive.
Climate Action and Response	The Climate Action and Response Plan identifies Sustainable Development as a top strategy to reduce our community carbon footprint and build resiliency. The Transportation and Land Use chapter calls for creating walkable, bikeable, transit-served neighborhoods through strategies such as supportive zoning and integrated land use – transportation planning.	As discussed above, the property owner proposes improvements that will support pedestrian, bicycle, and transit infrastructure in the area. By developing a major employment center near existing and proposed housing, the proposal can reduce car-dependence in the US 15-501 corridor. Because the property owner proposes a medical campus that is expected to draw patients from across the region and divert patients away from existing medical uses at the UNC main campus, its proximity to major roadways (US 15-501 and I-40) has the potential to relieve congestion and reduce vehicle-miles-traveled closer to the Town's core. The property owner has committed to installing solar photovoltaic panels on all new buildings and electric vehicle charging stations in all new parking decks.
Chapel Hill 2020 Goals	Opportunities for this application to support goals of Chapel Hill 2020 include: • The property owner proposes a medical campus with open spaces and trails that should provide a welcoming experience for a wide variety of people. *(A Place for Everyone. 1)*	

	• Structured parking is oriented in a manner that will provide visitors direct access to medical office buildings with limited conflict points with vehicular traffic. *(A Place for Everyone. 1)* • The proposed medical campus is expected to be a major employment center that will also help to support local restaurants, retail, and other businesses. *(Community Prosperity and Engagement. 2)* • The multi-use paths, trail connections, and proposed internal street connectivity promote a safe, vibrant, and connected community. (*Community Prosperity and Engagement.3)* • The proposed medical campus is within walking distance to public transit routes along Eastowne Drive. Multiple bicycle and pedestrian improvements will increase opportunities for active transportation for patients, employees, and nearby residents. (*Getting Around.1*) • Committed support for a future Bus Rapid Transit station will help connect the site to a regional transportation system. *(Getting Around. 3)* • Proposed sidewalks, multi-use path, trails, and access to bus routes along US 15-501 and Eastowne Drive offer multimodal access to the site. Alternative modes of transportation promote air quality, sustainability, and energy conservation. These strategies align with the theme of *Getting Around*. • The proposed medical campus will contribute to a diversity of neighborhoods in the North 15-501 Corridor. *(Good Places, New Spaces. 5)* • The proposed medical campus will bring significant density and economic activity to underutilized properties and ensure the permanent conservation of environmentally sensitive lands. *(Good Places, New Spaces. 8)* • The proposed medical campus will include the draining of a manmade pond, stream restoration, and permanent conservation of a state-designated Natural Heritage Area. Stormwater control measures will be designed to accommodate the 50-year storm event. *(Nurturing Our Community. 2)* • The proposed medical campus will include several upgrades to existing sidewalks, add a multiuse path along 15-501, and provide easements that will enable pedestrian connections to the Dry Creek Trail and New Hope Commons. *(Nurturing Our Community. 4)*

REASONABLENESS OF THE ZONING ATLAS AMENDMENT

Reasonableness is determined by comparing the scale of permissible development under the proposed zoning district to the scale permitted under existing zoning, and by considering characteristics of the site and its surroundings. North Carolina General Statute 160D-605 requires the Town Council to consider a statement of reasonableness when reviewing any Zoning Atlas Amendment.

The analysis below considers the property owner's proposed zoning district and overall proposed use program. Specific characteristics of the development proposal, compliance with regulations, and appropriate conditions to address potential impacts of the development are evaluated elsewhere.

SUMMARY OF ANALYSIS FOR REASONABLENESS
Supporting Factors • The proposed zoning of OI-3 is appropriate as it facilitates a range of neighborhoods in the North 15-501 Corridor, as proposed by Chapel Hill 2020 and the FLUM. • The rezoning facilitates the construction of a medical campus that will strengthen Chapel Hill's employment base and relieve development pressure on UNC Hospital. • The development of a medical campus in this location aligns with multiple themes of Chapel Hill 2020. • The proposed Conditional Zoning district would bring significant density to an underutilized portion of Chapel Hill. • Conditions provide an opportunity to limit intensity and to establish standards that address any impacts on surrounding properties.
Other Considerations • Further analysis and/or zoning conditions may be needed to determine whether adequate pedestrian connectivity, vehicular access, and transit service are in place to support the proposed zoning. • Existing regulations include measures for protecting environmental features such as steep slopes and the stream corridor. Zoning conditions may be useful for enhanced protection, if warranted by further environmental analysis.

FINDINGS OF FACT

Staff provides the following evaluation of the application under the three Findings of Fact identified in LUMO Section 4.4. LUMO states that the Zoning Atlas shall not be amended unless at least one of the Findings are made.

FINDING #1: The proposed zoning amendment is necessary to correct a manifest error.	
Arguments	To date, no arguments in support or in opposition have been submitted or identified by staff.
Staff Evaluation	There appears to be no manifest error in the Town's Zoning Atlas.

FINDING #2: The proposed zoning amendment is necessary because of changed or changing conditions in a particular area or in the jurisdiction generally.	
Arguments	As Chapel Hill continues to densify and as UNC Health continues to grow as a regional healthcare provider, the development of a medical campus in close proximity to both US 15-501 and Interstate 40 is beneficial to both the Town and UNC Health. The location of the proposed medical campus has the potential to relieve the Town's urban core from a significant amount of traffic and place a major employment center in close proximity to housing. To date, no arguments in opposition have been submitted or identified by staff.
Staff Evaluation	The Council could make the finding that the proposed zoning amendment is necessary because of changing conditions in Chapel Hill.

FINDING #3: The proposed zoning amendment is necessary to achieve the purposes of the comprehensive plan.	
Arguments	Staff notes that the Conditional Zoning application could contribute to the purposes of the Comprehensive Plan through the following: • Facilitating development that implements the Character Type designated on the Future Land Use Map. • Supporting goals of Chapel Hill 2020 including *A Place for Everyone*, *Community Prosperity and Engagement, Getting Around*, *Good Places-New Spaces,* and *Nurturing Our Community*. To date, no arguments in opposition have been submitted or identified by staff.
Staff Evaluation	The Council could make the finding that the proposed zoning amendment is necessary to achieve the purposes of the Comprehensive Plan.

PROJECT FACT SHEET

Overview

Site Description	
Project Name	UNC Health Eastowne
Address	100, 200, 300, 400, 500, 600, 700, 800, 901 and 998 Eastowne Drive
Gross Land Area	2,423,112 sq. ft. (55.6 acres)
Orange County Parcel Identifier Numbers	9890-80-0195, 9890-80-7564, 9890-80-0643, 9890-80-2764, 9890-80-3947 and 9890-91-1209
Existing Zoning	Office/Institutional-3 (OI-3); Office/Institutional-2 (OI-2); Mixed Use – Office/Institutional-1 (MU-OI-1)
Proposed Zoning	Office/Institutional-3-Conditional Zoning District (OI-3-CZD)

Site Development Standards

Topic	Comment	Status
Development Intensity		
Use (Sec. 3.7)	*Proposed Uses:* Business, office-type; Business, convenience; Hospital; Research activities; Medical clinic	✓
Inclusionary Zoning Ordinance (Sec. 3.10)	NA	NA
Density (Sec. 3.8)	NA	NA
Dimensional Standards (Sec. 3.8)	*Setback (secondary) and Core (primary) height*: No maximums per LUMO. 120 ft. maximum building height established as a voluntary condition *Setbacks:* no minimum setbacks	✓
Floor area (Sec. 3.8)	*Maximum allowed:* 1,100,000 sq. ft. (in addition to existing Medical Office Building 1)	✓
Landscape		
Buffers (Sec. 5.6.2)	<u>Required</u> / <u>Proposed</u> **US 15-501:** 20 ft, Type C / 20 ft, modified street trees (modification requested) **Eastowne Drive:** 15 ft, Type B **I-40:** 30 ft, Type D / 100 ft, Type D **Interior:** 15 ft, Type B / 15 ft, Type B	**M**

Tree Canopy (Sec. 5.7)	*Minimum required:* 16.7 acres (30% of GLA) *Proposed:* 19.5 acres (35% of GLA)	
Landscape Standards (Sec. 5.9.6)	Final Plans application must comply	**FP**
Environment		
Resource Conservation District (RCD) Uses (Sec. 3.6.3)	A greenway and sidewalks are proposed within the RCD and are permitted uses. A maximum of three stream crossing are permitted in order to vehicular and pedestrian connection within the "Inner Loop" and the "Northern 20". These are permitted where there is a practical necessity to their location.	
RCD Dimensional Standards (Sec. 3.6.3)	*Proposed Impervious surfaces:* 25,000 sq. ft. *Proposed Land disturbance:* 180,000 sq. ft.	**M**
Erosion Control (Sec. 5.3.1)	Orange County Erosion Control permit required	
Steep Slopes Land Disturbance (Sec. 5.3.2)	*Maximum Disturbance allowed:* 25% of areas with existing 4:1 slopes or greater *Proposed:* Disturb up to 35% of naturally occurring steep slope areas (modification requested)	**M**
Stormwater Management (Sec. 5.4)	Meet or exceed LUMO standards Property owner proposes to design stormwater control measures to accommodate the 50-year, 24-hour duration storm event.	
Land Disturbance	Will comply at final plans.	**FP**
Impervious Surface	*Maximum allowed:* 1,696,178 sq. ft. (70% of GLA) *Will comply at final plans*	**FP**
Solid Waste & Recycling	Application must comply	**FP**
Jordan Riparian Buffer (Sec. 5.18)	*Minimum buffer required:* 50 ft. *Proposed:* 50 ft.; land disturbance as noted for RCD	
Access & Circulation		
Traffic Impact Analysis (Sec. 5.9)	TIA completed	
Road Improvements (Sec. 5.8)	Road Improvements Required for MOB 2: a. Southern Eastowne Drive/US 15-501 Intersection: The existing left-turn lane on Eastowne Drive shall be extended to provide a minimum of 375 feet of vehicle storage. b. Eastowne Drive: The section of Eastowne Drive between the existing Medical Office Building Parking Deck Access Driveway and Old Sterling Drive shall have on-street parking eliminated. Buffered bicycle lanes and a three-	**C**

	lane vehicular cross-section shall be implemented, including street widening where necessary. Left-turn lanes with 100 feet of storage shall be delineated in this vicinity for the relocated Parking Deck Access Driveway and Old Sterling Drive. c. Parking Deck Access Driveway: The access driveway for the existing parking deck shall include a southbound right-turn auxiliary egress lane with at least 75 feet of storage at the Eastowne Drive intersection. d. Signal Timing: The property owner shall provide a payment of $15,000 to the Town to support optimization of signal timing. Signal timings at the following intersections shall be reoptimized to account for site-related traffic: i. Northern Eastowne Drive/US 15-501 ii. Southern Eastowne Drive/US 15-501 iii. Sage Road/US 15-501 e. Dobbins Drive: Dobbins Drive shall be restricted to a right-in/right-out intersection. A median of sufficient length shall be installed to effectuate this restriction. f. US 15-501 and Southern Eastowne Drive Pedestrian Improvements: That enhanced pedestrian refuge islands should be provided on both pedestrian crosswalks of US 15-501 in coordination with NCDOT and the Town. Roadway improvements for all development after MOB 2 shall be determined by subsequent TIAs that will be conducted prior to each development phase.	
Vehicular Access (Sec. 5.8)	Five driveways spread across the Eastowne Drive frontage	
Bicycle Improvements (Sec. 5.8)	Buffered bike lanes along Eastowne Drive	
Pedestrian Improvements (Sec. 5.8)	• Greenway along stream restoration project • Multiuse path along US 15-501 • Multiuse path along Eastowne Drive	
Transit Improvements (Sec. 5.8)	Property owner to provide up to two additional bus shelters on Eastowne Drive and dedicate land necessary for a Bus Rapid Transit station on US 15-501.	
Vehicular Parking (Sec. 5.9)	*Maximum Parking:* 4.5 spaces per 1,000 sq. ft. of floor area	**M**
Bicycle Parking (Sec. 5.9)	*Minimum required:* 2.5 percent of vehicular spaces	**M**
Electric Vehicle Parking	EV chargers located at 2% of parking spaces and 25% of parking spaces to be EV-ready.	
Parking Design Standards (Sec. 5.9)	Application must comply	**FP**

Loading (Sec 5.9)	Application must comply	**FP**
Technical		
Fire	Built to Town Standards	✓
Recreation Area (Sec. 5.5)	NA	**NA**
Lighting Plan (Sec. 5.11)	Built to Town Standards; not to exceed 0.3 footcandles at property line	**FP**
Signage (Sec. 5.14)	Modification requested for maximum size.	**M**
Schools Adequate Public Facilities (Sec. 5.16)	NA	**NA**
Homeowners Association (Sec. 4.6)	NA	**NA**

Project Summary Legend

Symbol	Meaning
✓	Meets Requirements
M	Seeking Modification
C	Requires Council Endorsement
FP	Required at Final Plans
NA	Not Applicable

May 24, 2023

Town Council

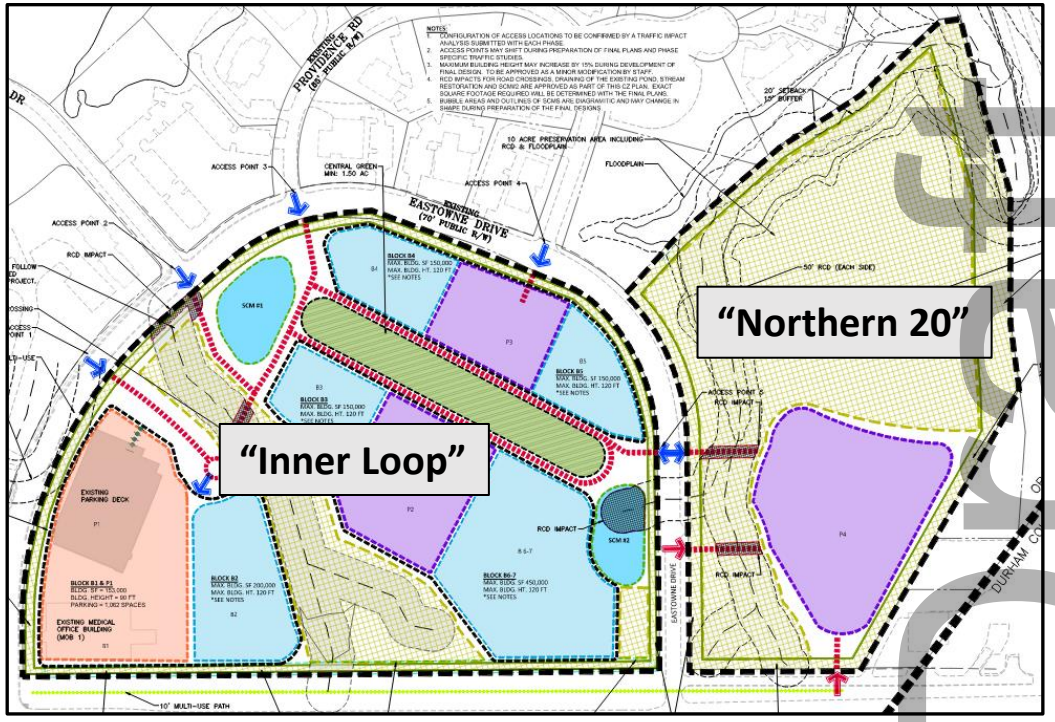
Conditional Zoning – UNC Health Eastowne

RECOMMENDATION

Close the Legislative Hearing

Adopt Resolution A

Enact Ordinance A



TIMELINE

STAFF REVIEW

COUNCIL WORK SESSION
MAR 15, 2023

PLANNING COMMISSION
APRIL 18, 2023

OPEN PUBLIC HEARING
APRIL 26, 2023

COUNCIL ACTION
MAY 24, 2023

Updates Since April 26

Development on the Northern 20:

- Parking structure to be authorized by Town Manager *only if* UNC-Health demonstrates 80% utilization of existing parking.

- Additional RCD encroachment to be authorized if parking structure can be moved further south.

Updates Since April 26

By-Right Development on the Northern 20:

- Approx. 250,000 sq. ft. of floor area is permitted by-right, subject to the 20/40 rule.
- Off-street parking is only allowed as an accessory use.
- Town zoning authority extends only to buildings.

Updates Since April 26

Community Benefits:

- UNC-Health making $5 Million contribution to establish an Affordable Housing Loan Fund
- 20-year term at 0% interest, non-resource
- Anticipated impact: 500-1,000 units of affordable housing over 20 years

Updates Since April 26

Sustainability:

- UNC Health will provide 2% EV parking spaces and 25% EV-ready spaces.

- Buildings will be designed to meet the more stringent of (1) NC energy codes or (2) 20% better than the 2016 version of ASHRAE 90.1

Updates Since April 26

Project Phasing:

- First ZCP must be applied for within 5 years of approval of this conditional zoning.

Pedestrian Crossings:

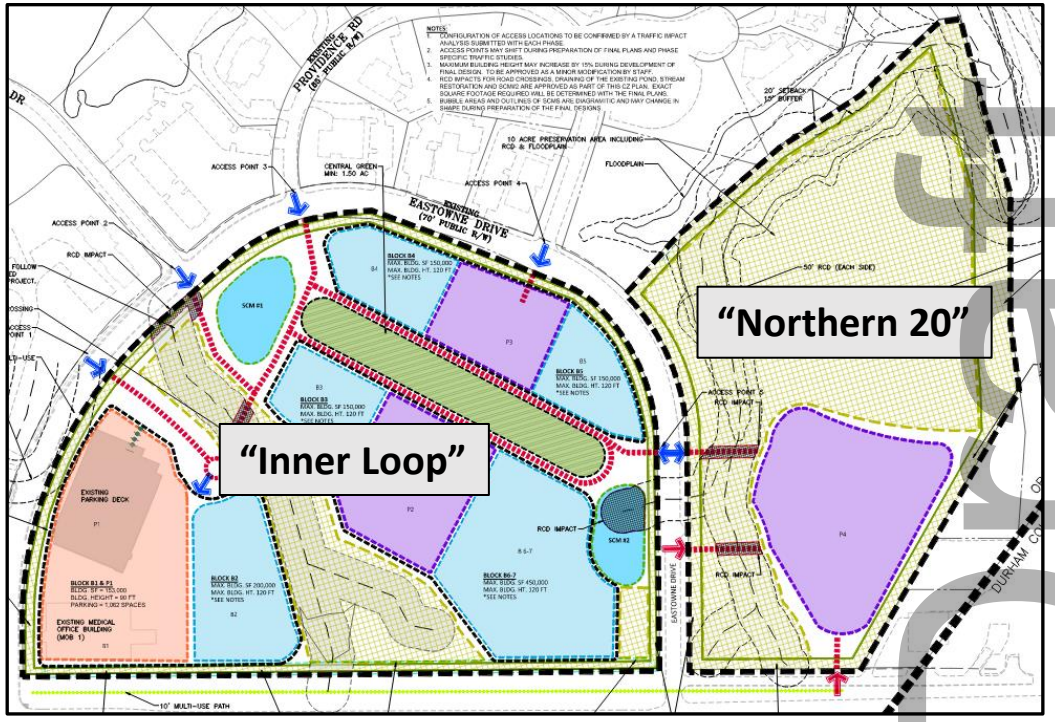
- Subject to NCDOT approval, UNC Health will enhance US 15-501 pedestrian crossings

RECOMMENDATION

Close the Legislative Hearing

Adopt Resolution A

Enact Ordinance A



RESOLUTION A
Resolution of Consistency and Reasonableness

A RESOLUTION REGARDING THE APPLICATION FOR A CONDITIONAL ZONING ATLAS AMENDMENT FOR THE PROPERTY LOCATED AT 100-998 EASTOWNE DRIVE TO OFFICE/INSTITUTIONAL-3-CONDITIONAL ZONING DISTRICT (OI-3-CZD) (PROJECT #CZD-22-7) REASONABLENESS AND CONSISTENCY WITH THE COMPREHENSIVE PLAN (2023-05-24/R-13)

WHEREAS, the Council of the Town of Chapel Hill has considered the application for Conditional Zoning submitted by McAdams, on behalf of owner Health System Properties, LLC, to rezone six parcels totaling approximately 50 acres located at 100, 200, 300, 400, 500, 600, 700, 800, 901 and 998 Eastowne Drive on property identified as Orange County Property Identifier Numbers 9890-80-0195, 9890-80-7564, 9890-80-0643, 9890-80-2764, 9890-80-3947 and 9890-91-1209, to allow a medical campus; and

WHEREAS, the Council finds that the amendment, if enacted, is consistent with the Town's Comprehensive Plan, as explained by, but not limited to, the following elements of the Comprehensive Plan:

- Family-friendly, accessible exterior and interior places throughout the town for a variety of active uses (*A Place for Everyone.1)*
- A welcoming and friendly community that provides all people with access to opportunities (*A Place for Everyone.4*)
- Foster success of local businesses (*Community Prosperity and Engagement.2)*
- Promote a safe, vibrant, and connected (physical and person) community *(Community Prosperity and Engagement.3)*
- A connected community that links neighborhoods, businesses, and schools through the provision of greenways, sidewalks, bike facilities, and public transportation (*Getting Around.2)*
- Connect to a comprehensive regional transportation system (*Getting Around.3)*
- Create a comprehensive transportation system that provides everybody safe and reasonable access to all the community offers (*Getting Around.5)*
- A community that has a parking system based on strategies that support the overall goals of a holistic transportation system (*Getting Around.8)*
- A range of neighborhood types that addresses residential, commercial, social, and cultural needs and uses while building and evolving Chapel Hill's character for residents, visitors, and students *(Good Places, New Space.5)*
- Open and accessible common spaces for community gathering, cultural uses, and community development (*Good Places, New Spaces.7)*
- Future land use, form, and density that strengthen the community, social equity, economic prosperity, and natural environment *(Good Places, New Space.8)*
- Maintain and improve air quality, and manage stormwater to heal local waterways and conserve biological eco systems within the town boundaries and the Extra Territorial Jurisdiction *(Nurturing Our Community.2)*
- Protect, acquire, and maintain natural/undeveloped open spaces and historic sites in order to protect wildlife corridors, provide recreation, and ensure safe pedestrian and bicycle connections. *(Nurturing our Community.3)*
- Support the Parks and Recreation Master Plan and the Greenways Master Plan to provide recreation opportunities and ensure safe pedestrian and bicycle connections *(Nurturing*

our Community.4)

- Protect neighborhoods from the impact of development such as stormwater runoff, light and noise pollution, and traffic *(Nurturing our Community.8)*
- The University, the UNC Health Care System, and the Town will coordinate closely to manage development in ways that respect history, traditions, and the environment while fostering revitalization and innovation *(Town and Gown Collaboration.5)*
- Promote access for all residents to health-care centers, public services, and active lifestyle opportunities *(Town and Gown Collaboration.6)*

WHEREAS, the Council finds that the amendment if enacted, is reasonable and in the public's interest, as explained by, but not limited to, the following considerations:

1) Conform with the applicable provisions of the Land Use Management Ordinance and Town Code with modifications shown below.
2) Conform with the Comprehensive Plan
3) Be compatible with adjoining uses
4) Mitigate impacts on surrounding properties and the Town as a whole
5) Be harmonious with existing and proposed built systems including utility infrastructure, transportation facilities, police and fire coverage, and other public services and facilities
6) Be harmonious with natural systems such as hydrology, topography, and other environmental constraints

NOW, THEREFORE, BE IT RESOLVED by the Council of the Town of Chapel Hill that the Council hereby finds the proposed Conditional Zoning Atlas Amendment to be reasonable and consistent with the Town Comprehensive Plan.

This the 24th day of May, 2023.

REVISED ORDINANCE A
(Approving the Conditional Zoning Application)

AN ORDINANCE AMENDING THE CHAPEL HILL ZONING ATLAS TO REZONE THE PROPERTY LOCATED AT 100-998 EASTOWNE DRIVE TO OFFICE/INSTITUTIONAL-3-CONDITIONAL ZONING DISTRICT (OI-3-CZD) (PROJECT #CZD-22-7) (2023-05-24/O-2)

WHEREAS, the Council of the Town of Chapel Hill has considered the application for Conditional Zoning submitted by McAdams, on behalf of owner Health System Properties, LLC, to rezone six parcels totaling approximately 50 acres located at 100, 200, 300, 400, 500, 600, 700, 800, 901 and 998 Eastowne Drive on property identified as Orange County Property Identifier Numbers 9890-80-0195, 9890-80-7564, 9890-80-0643, 9890-80-2764, 9890-80-3947 and 9890-91-1209, to allow a medical campus and finds that the amendment if enacted, is reasonable and in the public's interest and is warranted to support the purposes of the Comprehensive Plan; and

WHEREAS, the application, if rezoned to Office/Institutional-3–Conditional Zoning District (OI-3-CZD) according to the district-specific plan dated April 6, 2023 and the conditions listed below would:

1) Conform with the applicable provisions of the Land Use Management Ordinance and Town Code with modifications shown below.
2) Conform with the Comprehensive Plan
3) Be compatible with adjoining uses
4) Mitigate impacts on surrounding properties and the Town as a whole
5) Be harmonious with existing and proposed built systems including utility infrastructure, transportation facilities, police and fire coverage, and other public services and facilities
6) Be harmonious with natural systems such as hydrology, topography, and other environmental constraints

MODIFICATIONS TO REGULATIONS

WHEREAS, the Council of the Town of Chapel Hill finds, in this particular case, that the proposed development with the following requested modifications to regulations satisfies public purposes to an equivalent or greater degree:

1. **Section 3.6.3 Resource Conservation District (RCD) Buffer:** Modify the RCD Buffer standards as shown:
    a) RCD buffers for restored stream shall only consist of the 50-foot stream side zone. There shall be no buffers associated with the managed use zone or the upland zone.
    b) RCD impacts shall be allowed for the pond draining and stream restoration/enhancement project from US 15-501 to Eastowne Drive.
    c) RCD impacts shall be allowed for the construction of the site access opposite the intersection of Old Sterling Drive with Eastowne Drive and the extension of the multi-use path along Eastowne Drive.
    d) RCD impacts shall be allowed for the construction of an above ground stormwater control (SCM) measure for the small RCD area on the north side of the project inside the "Inner Loop".
    e) RCD impacts shall be allowed for the two (2) stream vehicular crossings shown

on the district-specific plan. A total of three (3) vehicular stream crossings may be permitted if deemed necessary to provide adequate emergency access to the Parcel Identifier Number 9890-91-1209. Pedestrian and bicycle crossings are permitted with the approval of the Town Manager.

This finding is based on a determination that the public purposes are satisfied to an equivalent or greater degree as the stream restoration and improvements proposed along with the need to provide vehicular access through the site are appropriate for the site for development providing employment and health care opportunities.

2. **Section 3.6.3 Dimensional Regulations in the Resource Conservation District (RCD):** Disturbance for proposed vehicular and pedestrian crossings of the RCD, construction of the access point opposite Old Sterling Road, construction of SCM#2, as shown on the plans, and restoration of the stream between US 15-501 and Eastowne Drive shall be permitted. Dimensional regulations for the RCD are modified to allow the following:

Zone	Square Footage
Maximum Resource Conservation District Land Disturbance	180,000 sq. ft.*
Maximum Resource Conservation District Stream side Zone Land Disturbance	172,000 sq. ft.*
Maximum Resource Conservation District Stream side Zone Impervious Surface Area	25,000 sq. ft.*

*Potential additional land disturbance and impervious surfaces may be authorized by the Town Manager in addition to the figures above. Such additional impacts must be associated with relocation of the parking structure to increase the preservation area of the Northern 20.

This finding is based on a determination that the public purposes are satisfied to an equivalent or greater degree because development in the RCD is necessary to ensure adequate circulation on the project site, to facilitate sufficient stormwater management, to allow for restoration of an impaired water body, and will be designed in a manner that minimizes impacts.

3. **Table 3.8-1 Dimensional Matrix:** The Dimensional Matrix Floor Area Ratio (FAR) for Office/Institutional-3 (OI-3) zoning district is a maximum of 0.566. The request is to eliminate the FAR as the maximum floor area permitted as part of the project is limited to 1,100,000 square feet.

This finding is based on a determination that the public purposes are satisfied to an equivalent or greater degree because total buildable floor area on the project site is effectively capped by the terms and conditions of this ordinance.

4. **Section 4.4.7(g)-(h) Procedures – All Other Conditional Zoning Districts:** LUMO Sections 4.4.7(g) and 4.4.7(h) notwithstanding, the definitions of major and minor modifications to this conditional zoning ordinance and associated district specific plan shall be as follows:

   a. Items i through v listed below shall constitute a minor modification and shall be approved by the Town Manager. All minor modifications must be consistent with the approved district specific plan and comply with all applicable requirements. Consistency means the changes would not significantly negatively alter the development's impervious coverage, demand on public facilities, stormwater

runoff, or other characteristic from that indicated by the approved district-specific plan. Where measurable and except where provided otherwise, a ten (10) percent change shall be considered significant whether such change is proposed through one (1) request or through multiple requests over an extended period of time. Notwithstanding, the following shall constitute a minor modification:

i. Relocation of public amenity spaces, provided that the total amount of public amenity space is not reduced and accessibility is not negatively impacted.
ii. Reconfiguration or relocation of internal streets, sidewalks, trails, or parking areas provided that no increase in encroachment or disturbance in the Resource Conservation District (RCD) is required (unless required for emergency services).
iii. Addition, or relocation, of bicycle or pedestrian access points to a preexisting public right-of-way.
iv. Clearing, grading or other improvements required for a future Bus Rapid Transit stop.
v. An increase of up to 15 percent of the approved height of each building.

b. The following shall constitute a major modification to district specific plan and will require the filing of an application for approval of a major modification. Any requests pursuant to these items will be deemed minor if below the thresholds stated below.

i. A change in the uses permitted or the density of overall development.
ii. An increase of ten (10) percent or more in the floor area approved by the Town Council.
iii. An increase or redistribution of ten (10) percent or more in the number of parking spaces approved by the Town Council, not exceeding a ratio of 4.5 per 1,000 square feet vehicular parking spaces.
iv. A change in the size, location, or orientation of an impervious feature that decreases the width of a landscape buffer below the minimum applicable buffer width requirements.
v. Elimination of an approved bicycle/pedestrian access point to a public right-of-way
vi. Relocation of vehicular access points to public right-of-way by more than fifty (50) feet from the approved location (to be measured from approved centerline to proposed centerline and, when appropriate, subject to approval by the North Carolina Department of Transportation (NDOT)); removal of bicycle/pedestrian or vehicular access points to public right-of-way (unless dictated by Town of Chapel Hill Transportation or NCDOT); addition of vehicular access points to preexisting public rights-of-way (unless dictated by Town of Chapel Hill Transportation, Town of Chapel Hill Emergency Services or NCDOT).
vii. Relocation of building envelopes to more than one hundred (100) feet from their approved location or to within fifty (50) feet of exterior property lines. For building envelopes that are approved within fifty (50) feet of an exterior property line, relocation to more than one hundred (100) feet from their approved location or to a location that is more than fifteen (15) percent closer to an exterior property line. Any relocation of building envelopes that results in additional encroachment into buffers associated with Resource Conservation Districts shall be considered a major modification.
viii. A change in a condition of Town Council approval.

This finding is based on a determination that the public purposes are satisfied to an equivalent or greater degree to provide flexibility for the future phases of the development.

5. **Section 5.3.2 Steep Slopes:** The total percentage of disturbed slopes with a grade of 25 percent or greater will not exceed 30 percent of steep slopes that are not manmade and resulting from the previous construction of roadways, parking lots, buildings, sidewalks, stockpiles, or the pond dam.

   This finding is based on a determination that the public purposes are satisfied to an equivalent or greater degree because a significant portion of the disturbed slopes were created during previous development of the property.

6. **Section 5.6.2: Landscape Buffers**

	Required	Proposed
Eastowne Drive	15-ft, Type B Buffer	No buffer; Street tree plantings 30 foot on-center average spacing to be consistent with existing plantings along Eastowne Drive.
US 15-501	20-ft, Type C Buffer	20-ft, modified buffer to be consistent with existing plantings along US 15-501.

   This finding is based on a determination that the public purposes are satisfied to an equivalent or greater degree because bufferyards along Eastowne Drive will hinder opportunities to develop a "complete street" as envisioned by the Chapel Hill 2020 Comprehensive Plan.

7. **Section 5.9.7 Minimum and Maximum Off-Street Vehicular and Bicycle Parking Requirements:** Maximum total vehicular parking spaces shall be 4.5 spaces per 1,000 square feet of floor area. Minimum bicycle parking spaces shall be 2.5 percent of total vehicular parking.

   This finding is based on a determination that the public purposes are satisfied to an equivalent or greater degree because the proposed maximum is consistent with existing LUMO standards.

8. **Section 5.12.1.a.4 Utilities – Water Main and Hydrant Installation:** The requirement for installation of water mains and fire hydrants will be amended as follows:

   No work shall commence with combustible materials until all required operational fire hydrants necessary for fire protection are installed and operational. For purposes of this subsection, "operational" means that the water mains and fire hydrants are capable of delivering sufficient water to meet domestic and fire fighting needs.

   This finding is based on a determination that the public purposes are satisfied to an equivalent or greater degree because the proposed modification is consistent with relevant requirements of applicable building codes.

9. **Section 5.14 Signage:** The requirements for signage shall be amended as follows:

a. Four (4) new Eastowne Business Park and/or medical office commercial center signs up to 240 square feet each on Eastowne Drive shall be allowed for the proposed development on the Inner Loop. Sign dimensions shall be restricted to the following:
    i. Maximum Height: 12 feet
    ii. Maximum Width: 20 feet
    iii. Maximum Thickness: 18 inches
    iv. Minimum Letter Height on Panels: 12 inches
b. External wall signage (to include building address and/or name) shall be permitted on each building and parking structure at a location that allow for optimal visibility and wayfinding.
c. Internal site wayfinding signage shall be permitted at each intersection for vehicular and pedestrian traffic.
d. Internal building signage not facing the public right-of-way for identification and wayfinding is not subject to review by the Town.
e. The northern parcel will be allowed up to two (2) ground signs if the parking structure is constructed.

This finding is based on a determination that the public purposes are satisfied to an equivalent or greater degree because the proposed signage will be appropriate in the context of a medical campus and will highlight a gateway feature to Chapel Hill.

10. **Appendix A "District-Specific Plan"**: The definition of a "district-specific plan" accompanying this ordinance shall be amended as follows:

> A plan, to scale, showing the approximate location of uses and structures proposed for a parcel of land as required by the applicable application and regulations, including but not limited to lot lines, streets, building ~~sites~~ envelopes, reserved open space, buildings, major landscape features - both natural and manmade-and, depending on requirements, the location of proposed utility lines.

This finding is based on a determination that the public purposes are satisfied to an equivalent or greater degree because the modified district-specific plan, in conjunction with the conditions of this ordinance, provide sufficient certainty and control over the nature of the proposed development.

CONDITIONAL ZONING DISTRICT

WHEREAS the Council of the Town of Chapel Hill finds, in this particular case, the proposed rezoning with the following uses, subject to the conditions below, satisfies the purposes of Office/Institutional-3–Conditional Zoning District (OI-3-CZD).

NOW, THEREFORE, BE IT ORDAINED by the Council of the Town of Chapel Hill that the Chapel Hill Zoning Atlas be amended as follows:

SECTION I

The following Orange County parcels identified by Parcel Identifier Number (PIN) 9890-80-0195, 9890-80-0643, 9890-80-2764, 9890-80-3947, 9890-80-7564, 9890-91-1209, described below, shall be rezoned to Office/Institutional-3-Conditional Zoning District (OI-3-CZD):

"Inner Loop" Tract

Being all of the land as shown on Plat Book 38, Page 25 in the Orange County Register of Deeds. Being more particularly described as:

Beginning at an existing concrete monument at the intersection of the northern right of way of U.S. Highway 15-501 and the eastern right of way line of Eastowne Drive, the point of beginning; thence with the right of way line of Eastowne Drive, North 29°06'48" West a distance of 119.95 feet to a concrete monument; thence with a curve to the right a radius of 937.70 feet, an arc length of 650.17 feet, a chord bearing of North 08°53'16" West, a chord length of 637.22 feet to an existing iron pipe; thence with a curve to the right a radius of 937.70 feet, an arc length of 156.48 feet, a chord bearing of North 15°45'23" East, a chord length of 156.30 feet to an existing iron pipe; thence North 20°12'27" East a distance of 140.69 feet to an existing iron pipe; thence North 19°58'31" East a distance of 51.64 feet to a point; thence with a curve to the right a radius of 445.03 feet, an arc length of 99.79 feet, a chord bearing of North 24°49'13" East, a chord length of 99.58 feet to a point; thence with a curve to the right a radius of 445.03 feet, an arc length of 139.07 feet, a chord bearing of North 40°11'45" East, a chord length of 138.50 feet to a point; thence with a curve to the right a radius of 443.57 feet, an arc length of 230.65 feet, a chord bearing of North 66°18'32" East, a chord length of 228.06 feet to a point; thence North 80°56'20" East a distance of 305.22 feet to a point; thence with a curve to the right a radius of 429.63 feet, an arc length of 165.79 feet, a chord bearing of South 88°01'34" East, a chord length of 164.76 feet to an existing iron pipe; thence with a curve to the right a radius of 429.63 feet, an arc length of 358.57 feet, a chord bearing of South 53°03'42" East, a chord length of 348.26 feet to a point; thence South 29°18'14" East a distance of 532.19 feet to an existing iron pipe on the northern right of way line of U.S. Highway 15-501; thence with the northern right of way line of U.S. Highway 15-501, South 60°45'37" West a distance of 755.12 feet to an existing iron pipe; thence South 61°02'01" West a distance of 279.53 feet to an existing iron pipe; thence South 60°59'56" West a distance of 235.02 feet to an existing iron pipe; thence South 61°01'00" West a distance of 214.68 feet to the point and place of beginning, containing an area of 1,304,919 square feet or 29.96 acres and including to a midpoint of the adjoining Eastowne Drive and US 15-501 rights-of-way.

"Northern 20" Tract

Being all of the land shown as "Tract 4" on Plat Book 73, Page 142 in the Orange County Register of Deeds. Being more particularly described as:

Beginning at an existing iron pipe on the northern right of way line of Eastowne Drive, being the southeast corner of lot 12 of Eastowne Hills Subdivision, as shown on Plat Book 33, Page 113, the point of beginning; thence with the common line of Eastowne Hills Subdivision, North 13°08'17" East a distance of 180.20 feet to an existing iron pipe; thence North 20°29'33" East a distance of 314.94 feet to an existing iron pipe; thence North 28°29'11" East a distance of 224.86 feet to an existing iron pipe; thence North 18°33'35" East a distance of 250.18 feet to an existing iron pipe being the southeast corner of lands now or formerly owned by the Town of Chapel Hill, as described in Deed Book 2148, Page 271; thence with said common line, North 52°33'44" East a distance of 50.72 feet to an existing iron pipe on the southern right of way line of Interstate 40; thence with the southern right of way line of Interstate 40, South 43°25'41" East a distance of 224.01 feet to a concrete monument; thence South 46°05'51" East a distance of 198.08 feet to a concrete monument; thence South 28°35'04" East a distance of 305.84 feet to a concrete monument; thence South 36°14'20" East a distance of 155.91 feet to an existing iron pipe, being the northwest corner of lands now or formerly owned by the Straw Valley Project,

LLC, as described in Deed Book 5889, Page 410; thence with the common line of Straw Valley Project and others, South 01°01'31" West a distance of 751.15 feet to a concrete monument on the northern right of way line of U.S. Highway 15-501; thence with the northern right of way line of U.S. Highway 15-501, South 61°02'59" West a distance of 397.02 feet to an existing iron pipe at the intersection of the northern right of way line of U.S. Highway 15-501 and the eastern right of way line of Eastowne Drive; thence with the right of way line of Eastowne Drive, North 29°15'19" West a distance of 535.87 feet to an existing iron pipe; thence with a curve to the left a radius of 499.63 feet, an arc length of 382.51 feet, a chord bearing of North 51°11'32" West, a chord length of 373.24 feet to the point and place of beginning, containing an area of 893,234 square feet or 20.51 acres including to a midpoint of the adjoining Eastowne Drive and US 15-501 rights-of-way.

SECTION II

BE IT FURTHER ORDAINED by the Council of the Town of Chapel Hill that the following conditions are hereby incorporated by reference:

1. Expiration of Conditional Zoning Atlas Amendment: An application for the first Zoning Compliance Permit must be filed by May 24, 2028 (5 years from the date of this approval). Consistent with the requirements of LUMO 4.4.7(f), the Town Manager may grant additional 12-month extensions. The time extension request shall have paramount considerations for health, general welfare, or public safety or will require Council re-approval as a major modification to this conditional zoning. [LUMO 4.4.7(f)]

2. Consent to Conditions: This approval is not effective until the property owner provides written consent to the approval. Written consent must be provided within ten (10) business days of enactment by the Town Council.

3. Land Use Intensity: This Conditional Zoning Atlas Amendment authorizes the following:

Permitted Uses: Business, office-type; Business, convenience, Hospital; Research activities; Medical Clinic	
Gross Land Area	2,423,112 sq. ft. (55.6 acres)
Floor Area (IN ADDITION to MOB-1)	1,100,000 sq. ft.
Maximum Parking Spaces	4.5 spaces per 1,000 sf of floor area
Minimum Bicycle Parking Spaces	2.5% of number of vehicular spaces
Total Impervious Surface	70% (per LUMO)
Maximum Land Disturbance	1,700,000 sq. ft.
Minimum Tree Canopy Coverage	35% of GLA
Resource Conservation District Maximum Total Land Disturbance	180,000 sq. ft.
Resource Conservation District Maximum Stream side Zone Land Disturbance	172,000 sq. ft.*
Resource Conservation District Maximum Stream side Zone Impervious Surface Area	25,000 sq. ft.

*Land Disturbance in the RCD Streamside Zones shall be limited to the following:

- Maximum of 13,000 square feet for construction of a stormwater control measure in the Inner Loop.
- Maximum of 40,000 square feet for pedestrian and vehicular crossings.

- Maximum of 119,000 square feet for pond draining and stream restoration.
- Maximum of 8,000 square feet for site entrance work at the intersection of Eastowne Drive and Old Sterling Road.

4. Building Height: Maximum height of all structures shall be 120 feet from the main entrance elevation to the top of the roof deck and shall exclude screening, mechanical penthouses, and other mechanical equipment.

5. Cumulative Tracking: Each Final Plan application shall include a cumulative tally of the existing and proposed:

    a. Floor Area
    b. Tree Canopy
    c. Impervious surface
    d. Green Stormwater Infrastructure
    e. Land disturbance
    f. Resource Conservation District (RCD) disturbance
    g. Bicycle parking
    h. Vehicular parking spaces (including Electric Vehicle parking spaces)

6. Illustrative Site Plans: The illustrative site plans that accompany the District Specific Plan for this development are not regulatory documents. The Illustrative site plans are intended only to provide examples of potential building configurations within the building envelopes defined in the District Specific Plan.

7. Notice of Minor Modifications: All requests for minor modifications to this ordinance or associated District Specific plan shall be publicly advertised.

8. Phasing Plan: Each Zoning Compliance Permit application shall include a phasing plan for the current and remaining phases of the Eastowne development. The phasing plan will include detailed information on the phase seeking a ZCP and updated tracking data for the future phases. Proposed revisions to the phasing plan can be submitted at any time for approval by the Town staff. Approval of a phasing plan shall be reviewed as a minor modification provided that it is consistent with the conditions of this ordinance. The phasing plan shall depict the path of achieving Ordinance standards for the overall project and how each phase contributes to the total. The phasing plan shall include:

    - anticipated number,
    - exact location and type of structures,
    - floor areas,
    - impervious area of the structures seeking a ZCP,
    - general location of the remaining structures,
    - estimated tree canopy coverage, and
    - timing for public amenities including vehicular and bicycle/pedestrian improvements and connectivity.

9. Lot Subdivision/Recombination - Recombination Plat: Prior to the start of any on-site construction activity, a recombination plat application combining the development site lots shall be approved by the Town and recorded at the County Register of Deeds.

10. Detailed Plan Review and Approval: Town staff will review the individual building proposals for compliance with the Conditional Zoning District, including the Land Use Management Ordinance and the property owner's Design Principles.

Plans, plats, and associated detailed requirements as set forth in this ordinance shall be reviewed and approved by the Town Manager, or their designee, as well as outside agencies, such as NC Department of Transportation (NC DOT), Orange Water and Sewer Authority (OWASA) and Duke Energy, where appropriate.

11. Demolition Plan: Prior to beginning any proposed demolition activity, the property owner must obtain demolition permits from both the Planning and Inspections departments. While the demolition component may be submitted to Planning in tandem with the Zoning Compliance Permit for new construction, a separate stand-alone demolition permit shall be issued prior to an Inspection's Demolition permit. Further, prior to the issuance of a demolition permit for all existing structures 500 square feet or larger, Orange County Solid Waste staff shall conduct a deconstruction assessment pursuant to the County's Regulated Recyclable Materials Ordinance (RRMO).

12. Accessibility Requirements: Prior to issuance of a Certificate of Occupancy, the property owner shall provide the minimum required handicapped infrastructure according to the Americans with Disabilities Act and associated codes and standards.

13. Community Benefits: The Property owner or its successors or assigns (Owner) will contribute five (5) million dollars to support a revolving loan fund product for acquisition, preservation, and creation of affordable housing in the town limits of Chapel Hill (the "Loan"). The Town intends to use the Loan funds as top-tier seed funding for a larger Affordable Housing Loan Fund (the Fund) created at the direction of the Town and administered by a third party selected by the Town. A final funding Agreement ("Agreement") will be executed by Owner and the Town prior to issuance of the first Zoning Compliance Permit or establishment of the Fund, whichever occurs sooner. The following terms shall apply to the Loan:
    - The Loan will be for a period of 20 years from its transfer to the Fund, extendable at the discretion of the Owner but otherwise repayable at the end of that period.
    - As top-tier funding to the Fund, the Loan would be made at 0% interest to the Town or fund administrator and without recourse to the Town or fund administrator.
    - The Loan funds will serve in a subordinate loss position to the Town in the case of losses being incurred by the Fund.
    - The Loan proceeds would be made available to the Fund within 45 days of Agreement execution.

    In the event that, through no fault of Owner, the Town should decline or fail to create the Fund or similar affordable housing finance product, or should the Fund not continue in operation for the period of the Loan, this conditional zoning approval shall remain valid and enforceable and not be adversely affected thereby.

14. Essential Services: The property owner continue to provide annual payments to the Town of Chapel Hill as indicated in the existing Memorandum of Understandings between the property owner and Orange County for provision of essential services (including fire and police protection).

Street Design and Ownership

15. Internal Streets: All streets, utilities, landscaping and other infrastructure within the development shall be constructed, owned, and maintained by the property owner.

16. Accessible Corridors: Prior to issuance of a Zoning Compliance Permit for each development phase the property owner shall identify and provide pedestrian corridors through and around that phase that are accessible to people with disabilities.

17. Construction of Internal Streets: Prior to the issuance of a Zoning Compliance Permit for any construction east of the stream mitigation project, the property owner shall provide a plan demonstrating that adequate vehicular circulation and emergency access will be provided at all phases of development. Approval by the Town Manager shall be required prior to issuance of a Zoning Compliance Permit.

18. Public Access Easements & Private Maintenance: Public access easements, providing public ingress and egress, to and connecting the development blocks must be recorded prior to issuance of a Zoning Final Inspection for the Block or the phase being developed.

19. Street Lighting – Eastowne and 15-501: Prior to issuance of a Zoning Final Inspection of proposed Medical Office Building – 4 (MOB-4), the property owner shall design and install street lighting along the site frontage on Eastowne Drive. Prior to issuance of a Zoning Final Inspection for the final phase within the Inner Loop the property owner shall design and install street lighting along the site frontage on US 15-501 pursuant to North Carolina Department of Transportation (NCDOT) approval. Design and construction details including at signalized and unsignalized intersections must be approved by the Town Manager and NCDOT prior to issuance of a Zoning Compliance Permit. An approved phasing plan may detail the installation sequence for the lighting installation.

20. Eastowne Drive Improvements: Prior to the Zoning Final Inspection of the proposed MOB-4, Eastowne Drive shall, at a minimum, be improved to include buffered bicycle lanes and include street widening where deemed necessary by a subsequent Traffic Impact Analysis for MOB-4.

Landscape and Buffers

21. Tree Canopy: The development shall maintain no less than thirty-five percent (35%) tree canopy coverage, including all conservation easement areas and buffers.

22. Street Trees: Major streets shall be landscaped with, at a minimum, canopy trees planted at increments of thirty (30) feet on center average with groupings or limited breaks in accordance with emergency services requirements.

23. Landscape Bufferyards:

Frontage	Type
US 15-501	20-foot Modified
Eastowne Drive	Street trees to be planted 30 feet on-center on average
I-40 Interstate	100-foot Type E
Internal	15-foot Type B

The buffer requirement noted in the schedule of required buffers may be reduced by one grade of intensity (e.g., C to a B) if the development is designed such that there is no parking between the buildings located on the site and the adjacent street.

24. Invasive Exotic Vegetation: Prior to issuance of a Zoning Compliance Permit, the property owner shall identify on the planting plan any known invasive exotic species of vegetation within that phase, as defined by the Southeast Exotic Pest Plant Council (SE-EPPC) and provide notes indicating removal of these species from the landscape buffer areas prior to planting. [Town Design Manual]

25. Alternate Buffer: Prior to issuance of a Zoning Compliance Permit, review shall be required from the Community Design Commission for any proposed alternate buffer. [LUMO 5.6.8]

26. Landscape Protection: Prior to issuance of a Zoning Compliance Permit, a detailed Landscape Protection Plan shall be approved. The plan shall include a complete and currently updated tree survey showing critical root zones of all rare and specimen trees and labeled according to size and species. The plan shall also indicate which trees will be removed and which will remain. The plan shall also include standard notes, tree protection fencing details, and location of tree protection fencing. [LUMO 5.7.3]

27. Tree Protection Fencing: Prior to issuance of a Zoning Compliance Permit, the property owner shall provide a detail of a tree protection fence and a note on the Final Plans indicating that tree protection fencing will be installed prior to land-disturbing activity on the site. The plans shall include continuous tree protection fencing around construction limits and indicated construction parking and materials staging/storage areas, and Town standard landscaping protection notes, subject to Town Manager approval. [LUMO 5.7.3]

28. Landscape Planting Plan: Prior to issuance of a Zoning Compliance Permit, the property owner shall provide a detailed Landscape Planting Plan with a detailed planting list, subject to Town Manager approval.

29. Site Retaining Wall Construction: If applicable, the final location and wall heights of all site retaining walls shall be shown on the Final Plans for each phase and approved by the Town Manager prior to issuance of a Zoning Compliance Permit.

Parking

30. Parking Deck Design: All parking decks shall utilize a horizontal deck design and shall be screened on all sides that are visible from the public right-of-way.

31. Structured Parking: At full build-out of the Inner Loop, at least eighty percent (80%) of parking spaces shall be located in structured parking facilities. Early phases of development may have a lower percentage of parking provided in structured parking facilities.

32. Parking Needs Assessment: The property owner shall provide to the Town an updated parking assessment addressing parking utilization and expected needs, to be submitted with each Zoning Compliance Permit for each Phase of development. Demonstration of parking needs may include surveys of existing parking lot utilization with documentation provided by the property owner of vehicular parking utilization at peak hours, number of staff on-site, number of patients, use of bicycle parking spaces and efforts to increase alternative modes of transportation use by employees. In addition, the Town shall be required to provide information on transit use at the Eastowne stop(s).

33. Parking Spaces: A total ratio of 4.5 vehicular parking spaces per 1,000 sf of building area are authorized for construction within the Inner Loop (approximately 4,000

spaces). A maximum 1,200-space parking structure, to be located on the Northern 20, shall be subsequently authorized by the Town Manager upon demonstration that the need for additional parking exists.

If peak hour utilization of the vehicular parking spaces exceeds 80 percent of the capacity, a parking structure to provide the additional parking necessary to meet the overall demonstrated need for the Eastowne development shall be approved by the Town Manager on the Northern 20.

34. Parking Structure on Northern 20: The property owner shall investigate the option of moving the proposed parking structure closer to US 15-501 on the Northern 20. This location will require impacts to the Jordan Buffer, Resource Conservation District and intermittent stream. Access to the deck off from Eastowne Drive will be reviewed and approved by NCDOT and the Town. Current permitting requirements, at a minimum, include approvals from the Town of Chapel Hill (Jordan Buffer & RCD), US Army Corp of Engineers (wetlands), NCDENR-DWR (stream) and NCDOT (access). Any RCD encroachment reasonably associated with relocating the parking structure is permitted as part of this Conditional Zoning. If the permits can be obtained, the property owner will construct the parking deck as close as reasonably possible to US 15-501 and Eastowne Drive.

35. Electric Vehicle Parking: All new parking structures in the development shall adhere to the following standards:
    a. Prior to each Zoning Final Inspection for each parking structure, two percent (2%) of parking spaces, or more if demonstrated by ongoing monitoring of the use, in each parking structure shall be served by electric vehicle ("EV") charging stations. Charging stations shall be "Level 2" or higher as defined by the Society of Automotive Engineers and sites must:
        i. Provide a Level 2 charging capacity (208/240V) or greater
        ii. Comply with relevant regional or local standard for electrical connectors, such as SAE Surface Vehicle Recommended Practice J1772, SAE Electric Vehicle.
        iii. Conductive Charge Coupler so that they are compatible with all types of chargers.
        iv. When possible, EVSE-installed spaces should be identified and shared with the Town of Chapel Hill during the Zoning Compliance Permit review process.
    b. Twenty-five percent (25%) of parking spaces in each parking structure shall be "EV Designed," meaning the structure will be designed with accommodations to be installed to infrastructure at a later date. More specifically, this means that that the final plans (and any amendments) show the full installation of up to 25 percent of the total spaces for Level 2 charging (or equivalent vehicle charging capacity by DCFC), including:
        i. the locations for future charging stations, pavement markings and signage
        ii. the locations for future pavement markings and signage related to ADA access that complies with the U.S. Access Board's latest version of the *Design Recommendations for Accessible Electric Vehicle Charging Stations* (or comparable ADA guidance agreed to by Town staff)
        iii. the location of future conduit and raceways
        iv. the location for future, upsized transformers
        v. the location and durable marking of future electrical panels with dedicated circuits for EV charging*

vi. the location for borings between parking deck levels and/or walls for future conduit and raceways*

*Completed borings between parking levels and/or walls, and the durable marking of locations to reserve space for future electrical equipment (panels, transformers), will be made during the time of construction, and observed by zoning inspections staff at the time of final review.

36. Electric Vehicle Utilization: An analysis of the utilization of existing EV parking spaces will be provided by the Property owner with each Zoning Compliance Permit submittal and, if the staff finds there to be reasonable justification, the required number of EV spaces can be adjusted accordingly. An increase or reduction in the required number of EV spaces will be considered a minor modification.

37. Electric Bicycle Charging: All parking structures shall include at least three (3) 110-volt receptacles within five (5) feet of bicycle racks that meet Town standards.

38. Gameday Parking: If requested by the Town, the property owner shall consider, and negotiate in good faith, to provide parking spaces to support weekend athletic events at the University of North Carolina at Chapel Hill.

Bicycle/Pedestrian Facilities

39. Old Sterling/US 15-501 Pathway: Prior to the Zoning Final Inspection for Medical Office Building Three (MOB-3), the property owner shall construct a 5-foot wide pathway that runs in the outer 20-feet of the stream side zone of the RCD adjacent to the stream mitigation project and connects Old Sterling Drive to the multi-use path along US 15-501. Permeable pavements will be explored and implemented where feasible.

40. US 15-501 Multi-use Path: Subject to the approval of the North Carolina Department of Transportation (NCDOT), the property owner shall construct a multi-use path within the US 15-501 right-of-way along the development's full US 15-501 frontage. The multiuse path shall be completed prior to the earlier of the following:
    a. The Zoning Final Inspection for the final phase of development in the Inner Loop
    b. The first Zoning Compliance Permit issued after NCDOT completes its planned widening of US 15-501

41. Eastowne Multi-use Path: Prior to the Zoning Final Inspection for MOB-5, the property owner shall complete the Eastowne Multi-use Path along the full frontage of Eastowne Drive.

42. Shower Facilities: The property owner shall provide at least four (4) showers and associated facilities in each new building.

43. Greenways/Multi-use Paths: The property owner shall grant public access easements for all greenways, multiuse paths, and sidewalks in the development except where doing so would compromise the security or privacy of employees, patients, or other visitors.

44. Easements for Bicycle/Pedestrian Connectivity: If requested by the Town of Chapel Hill, the property owner shall grant the necessary easements and/or dedicate the necessary right-of-way to allow for the construction of bicycle/pedestrian connections to New Hope Commons Drive, the Dry Creek Trail, or other publicly maintained trail systems.

Requested easements shall not reduce, or otherwise impact, the development area (Block P4) as shown in approved the district-specific plan.

45. Design of Bicycle and Pedestrian Facilities: All pedestrian, bicycle, and greenway facilities within and adjacent to the development shall be designed and constructed to meet Town standards unless otherwise approved by the Town Manager. For all sidewalk, bicycle and greenway facilities, easements shall be granted to the Town and the public for public use. All facilities along public rights-of-way shall have adequate lighting, to be reviewed and approved by the Town Manager.

46. Sidewalk Dimensions: Minimum sidewalk widths shall be five (5) feet. The multi-use path and greenway along US 15-501 shall be ten (10) feet wide. Internal sidewalks along the building frontages will be a minimum eight (8) feet wide.

47. Location of Bicycle and Pedestrian Facilities: The location of greenways and paths for pedestrians and cyclists in the development will be generally consistent with the District Specific Plan.

48. Bicycle Parking: Prior to issuance of a Zoning Compliance Permit, the property owner shall provide dimensioned details that comply with the Town parking standards for proposed bicycle parking spaces in accordance with this ordinance. Bicycle parking spaces may be placed near building entrances, or within parking structures. Spaces shall be located in well-lit and visible areas. The spaces must comply with the Spring 2010 Association of Pedestrian and Bicycle Professionals Guidelines and the Class I and Class II bicycle parking standards required by the Town Design Manual. [LUMO 5.9.7 and Town of Chapel Hill Design Manual]

49. Low Vision Design Features: Any proposed pedestrian facilities should incorporate low vision design features as feasible.

Transit

50. Eastowne Drive Bus Stops: Prior to the issuance of any Zoning Compliance Permit, the property owner shall coordinate with Chapel Hill Transit to determine the need, and timing of construction, for additional bus stops along Eastowne Drive. Prior to full build-out of the Inner Loop, the property owner shall provide up to two (2) additional bus stops in locations negotiated with Chapel Hill Transit.

51. Bus Rapid Transit Station: Upon request by the Town, the property owner shall dedicate sufficient land for the construction of a Bus Rapid Transit (BRT) station along US 15-501. After completion of the BRT station, no Zoning Compliance Permits shall be issued for new buildings within development until the property owner provides an adequate pedestrian connection to the station. Clearing, grading, buffer impacts or Resource Conservation District (RCD) impacts necessary to construct the connection to the BRT will be considered a minor modification.

Traffic/Transportation

52. Subsequent Transportation Impact Analysis (TIA) Updates: With the first Final Plan submittal of each development phase, the property owner will provide a TIA that is consistent with Town and NCDOT standards for the development phase. The TIA shall be conducted by a qualified party chosen by the Town and the cost of preparation of the

TIA shall be borne by the property owner. The property owner shall be responsible for all mitigation measures necessary for NCDOT and Town approval.

53. North Carolina Department of Transportation (NCDOT) Approvals: NCDOT approval shall be required prior to the issuance of a Zoning Compliance Permit for any new construction (of more than 5,000 square feet) in the development. Prior to issuance of a Zoning Compliance Permit, plans for any improvements to State-maintained roads or in associated rights-of-way shall be approved by NCDOT.

54. Medical Office Building Two ("MOB-2") Traffic Mitigation Measures: Prior to the issuance of a Zoning Final Inspection for MOB-2, the property owner shall provide the following, subject to NCDOT and Town approval:

    a. Southern Eastowne Drive/US 15-501 Intersection: The existing left-turn lane on Eastowne Drive shall be extended to provide a minimum of 375 feet of vehicle storage.

    b. Eastowne Drive: The section of Eastowne Drive between the existing Medical Office Building Parking Deck Access Driveway and Old Sterling Drive shall have on-street parking eliminated. Buffered bicycle lanes and a three-lane vehicular cross-section shall be implemented, including street widening where necessary. Left-turn lanes with 100 feet of storage shall be delineated in this vicinity for the relocated Parking Deck Access Driveway and Old Sterling Drive.

    c. Parking Deck Access Driveway: The access driveway for the existing parking deck shall include a southbound right-turn auxiliary egress lane with at least 75 feet of storage at the Eastowne Drive intersection.

    d. Signal Timing: The property owner shall provide a payment of $15,000 to the Town to support optimization of signal timing. Signal timings at the following intersections shall be reoptimized to account for site-related traffic:
        i. Northern Eastowne Drive/US 15-501
        ii. Southern Eastowne Drive/US 15-501
        iii. Sage Road/US 15-501

    e. Dobbins Drive: Dobbins Drive shall be restricted to a right-in/right-out intersection at Eastowne Drive. A concrete median of sufficient length shall be installed to effectuate this restriction.

    f. US 15-501 and Southern Eastowne Drive Pedestrian Improvements: That enhanced pedestrian refuge islands should be provided on both pedestrian crosswalks of US 15-501 in coordination with NCDOT and the Town.

55. Easements for Vehicular Connectivity: If requested by the Town of Chapel Hill, the property owner shall grant the necessary easements and/or dedicate the necessary right-of-way to allow for the construction of a vehicular connection to New Hope Commons Drive. The requested easements and right-of-way shall not reduce, or otherwise impact, the development area (Block P4) as shown in the approved district-specific plan.

56. Traffic Management Plan: Prior to the issuance of a Zoning Compliance Permit for each development phase, an updated Traffic Management Plan shall be submitted to the Town Manager. The Transportation Management Plan shall include monitoring of electric

vehicle parking spaces usage. Management and monitoring of employee parking shall be included. [LUMO 4.5.2]

57. Traffic Signs: The property owner shall be responsible for placement and maintenance of temporary regulatory signs before issuance of any Certificates of Occupancy.

Stormwater Management

58. Stormwater Management: All stormwater control measures shall be designed to accommodate the 50-year, 24-hour rainfall event (exceeding the Town's requirement for the 25-year storm event).

59. Treatment of Existing Impervious Surface: The development shall include adequate infrastructure to treat all new impervious surface and at least 50 percent of existing impervious surface as of the date of enactment of this ordinance.

60. Green Stormwater Infrastructure for Impervious Area: A minimum of 1 acre of impervious area shall be treated using green stormwater infrastructure (GSI) designed to the current NCDEQ Minimum Design Criteria to the maximum extent practicable.

Resource Conservation District and Jordan Buffer

61. Stream Crossings: The development shall be limited to two (2) vehicular stream crossings and two (2) pedestrian stream crossings. A total of three (3) vehicular stream crossings may be permitted if deemed necessary to provide adequate emergency access to the Parcel Identifier Number 9890-91-1209. All crossings shall be constructed in a manner that, to the maximum practicable extent, minimizes impacts on Resource Conservation District (RCD) and Jordan Buffers. Bottomless culverts or bridges shall be used for all stream crossings.

62. Stream Mitigation: Prior to any land disturbance within the stream and issuance of a Zoning Compliance Permit, plans and design standards for stream restoration should be designed to follow the guidelines set forth by Dave Rosgen's *(*as outlined in the Appendix of this ordinance and available at: *https://wildlandhydrology.com/resources/docs/River%20Restoration%20and%20Natural%20Channel%20Design/Rosgen_Geomorphic_Channel_Design.pdf*)
natural channel design methods. All restoration work shall be completed prior to issuance of a Zoning Final Inspection for Medical Office Building-3 (MOB-3). The designs will seek to establish physical, chemical, and biological functions within the stream systems that are self-regulating and emulate a natural stable form within the constraints imposed by the site's conditions. Not only will the channel be restored to a natural stable form, the floodplain and riparian areas will be graded and revegetated to ensure stability and re-establishment of natural riparian processes. Work will include assessing the existing reach and watershed; determining appropriate channel dimensions, pattern and profile; designing appropriate floodplain widths; incorporating channel and floodplain structures to maintain stability, hold grade, and provide habitat; and providing an appropriate planting plan for channel banks and floodplain to establish a diverse riparian ecosystem.

63. Development in the Resource Conservation District (RCD) and Jordan Buffer: Streets, bridges, and other similar transportation facilities as depicted in the District-Specific Plan are permitted in the RCD. Pedestrian access trails; greenways; bridges; driveway crossings; maintenance access on modified natural streams; playground equipment;

protection of existing structures, facilities, and stream bank; road crossings; road relocation; stormwater best management practice (BMP); utility, electric, aerial, crossings of streams; utility electric underground crossings; utility, non-electric crossings; wetland, stream and buffer restoration; and wildlife passage structures are allowed with or without mitigation (as per LUMO Section 5.18.7(b)) in the Jordan Buffer.

Parcel 9890-91-1209 ("Northern 20")

64. Development and Permitted Uses on the Parcel 9890-91-1209: No uses other than structured parking shall be permitted on the parcel identified as 9890-91-1209. No construction activities or clearing of land (other than those related to public infrastructure, bicycle/pedestrians/vehicular connectivity, or recreational facilities) shall begin on this parcel until the last phase of the development.

65. Preservation of the Parcel 9890-91-1209: Prior to issuance of a Zoning Compliance Permit for MOB-2, the property owner shall record an easement for the perpetual conservation of at least 10-acres of land located in the parcel. The easement shall be dedicated to an appropriate conservation organization subject to Town Manager approval.

Public Amenity Spaces

66. Public Amenity Spaces: All public amenity spaces shall be designed in accordance with the Design Principles for the Eastowne Campus.

67. Central Green: A central green shall be provided within the Eastowne Drive site and be completed prior to issuance of a Zoning Final Inspection for Medical Office Building #4 and shall include publicly accessible gathering spaces.

Green Building and Sustainable Infrastructure

68. Energy Efficiency: All buildings shall either be designed to be 20 percent better than the 2016 version of ASHRAE 90.1 or in accordance with the current NC energy code, whichever is more stringent. For each building, the property owner will submit an energy model with the building permit plans to demonstrate that the building is designed to perform to the aforementioned standard.
    For purposes of ASHRAE 90.1-2016 energy modeling and calculations, the following applies:

    a. Loads associated with specialty medical equipment shall be excluded from the energy models (baseline and proposed/design). Specialty equipment such as but not limited to linear accelerators, imaging equipment (CT scanners, MRI, etc), specialty pharmacy equipment, etc.

    b. Town staff shall allow a lower proposed/design improvement over baseline if applicant demonstrates that there is no commercially practical method to achieve a 20% reduction. Factors could consist of but not limited to equipment technology availability, material shortages, laws/regulations prohibiting manufacturing of certain materials, new codes, etc.

    LEED building standard shall be reviewed for approach to energy conservation, indoor air quality, sustainability and building commissioning. The following LEED design goals shall be followed where practical in a facility designed for patient care:

a. Third party building commissioning to ensure performance of energy conservation measures at completion of project.
b. Strive to provide the highest indoor air quality design and eliminate or limit use of any materials that off gas to the indoor environment.
c. Meet Energy efficiency measures as outlined in either ASHRAE 90.1 -2016 or NC energy code, whichever is more stringent.
d. Where practical, specify materials made from sustainable and renewable resources.
e. Provide on-site renewable energy production (i.e. photovoltaics)

UNC Health agrees to review with Staff the current standards and adjust criteria if mutually agreeable. The spirit of the projects is to build the most energy efficient buildings that are practical considering the mission of UNCH which is to provide the best possible medical care to its patients.

69. All-Electric Design: All buildings shall be designed to allow for all-electric operation or all-electric capable design, as possible and where it does not interfere with energy conservation standards stated in Energy Efficiency condition and where suitable for a medical use.

70. Sustainable Rooftops: Solar photovoltaic systems, green roofs, or a combination thereof shall be installed on fifty (50) percent of available rooftop space remaining after necessary roof access and mechanical equipment is designed. The remainder of available rooftop space shall be designed to allow for future installation of solar photovoltaic systems, green roofs, or a combination thereof.

71. Plantings and Water Conservation: The development shall be landscaped using drought-resistant plants wherever possible. Only native non-invasive species may be used. The property owner shall not install or operate any permanent irrigation systems.

72. Energy Management Plan: Prior to issuance of a Zoning Compliance Permit, the property owner shall submit an Energy Management Plan (EMP) for Town approval. The plan shall: a) consider utilizing sustainable energy, currently defined as solar, wind, geothermal, biofuels, hydroelectric power; b) consider purchase of carbon offset credits and green power production through coordination with the NC GreenPower program; and (c) if requested, provide for the property owner to report to the Town of Chapel Hill the actual energy performance of the plan, as implemented, during the period ending one year after occupancy. [Town Policy April 2007]

Design Principles

73. Design Principles for the Eastowne Campus: Prior to issuance of the first Zoning Compliance Permit, the property owner shall receive input from the Community Design Commission (CDC) and work with the Town's Urban Designer and other Town staff to review and evaluate design principles subject to approval by the Town Manager. The approved documents will be recorded and cross-referenced with this ordinance prior to issuance of the first Zoning Compliance Permit. Town and CDC review and approval of the design principles shall not exceed a total of 90 working days from the initial submission to the Town or within such further time consented to in writing by the property owner. No new vertical development may occur until the Town Manager approves the design principles unless such development otherwise complies with the dimensional requirements of the Land Use Management Ordinance. After initial approval of the design principles, minor modifications to the final, approved design principles may be approved by the Town. Should the Town Manager deny the design principles, unless

such development complies with the dimensional requirements of the Land Use Management Ordinance and complies with this ordinance and associated District-Specific plan, a Zoning Compliance Permit shall not be issued.

74. Design Principles Certification: Submission of each Final Plan shall include a signed and sealed certification that the proposed plan complies with the approved Design Principles for the UNC Heath Eastowne Campus.

Fire Safety

75. Fire Protection and Utility Plan: A fire flow report for hydrants within 500 feet of each building shall be provided and demonstrate the calculated gallons per minute with a residual pressure of 20 pounds per square inch. The calculations should be sealed by a professional engineer licensed in the State of North Carolina and accompanied by a water supply flow test conducted within one year of the submittal. Refer to the Town Design Manual for required gallons per minute.

76. Fire Access: Prior to issuance of a Certificate of Occupancy, fire access shall be reviewed and approved by the Town of Chapel Hill.

77. Fire Department Connections, Locations: FDCs shall be installed within 100 feet of a hydrant or unless otherwise approved by the fire code official and shall not be obstructed or hindered by parking or landscaping. FDCs shall be equipped with National Standard Thread (NST) and be a 2.5" siamese.

78. Fire Apparatus Access for Chapel Hill Fire Department: All fire department access determinations shall be based upon Chapel Hill Fire Department apparatus specifications (data specifications provided by Office of the Fire Marshal/Life Safety Division) and field verification. All proposed fire department access designs shall be reviewed and shall also pass field inspection.

Solid Waste Management and Recycling

79. Refuse Collection Service: Prior to the issuance of any Zoning Compliance Permit involving a land use that generates refuse or solid waste, the property owner shall verify that refuse collection service is to be contracted privately, unless the property owner demonstrates that all requirements for public refuse collection have been met in the design and construction of one or more sections of the project.

80. Deconstruction Assessment: For any existing structure 500 square feet or larger a deconstruction assessment shall be conducted by OCSW staff prior to the issuance of a demolition permit pursuant to the County's Regulated Recyclable Materials Ordinance (RRMO). Prior to any demolition or construction activity on the site, the property owner shall hold a pre-demolition/pre-construction conference with Solid Waste staff. This may be held at the same pre-construction meeting held with other development/enforcement officials.

State and Federal Approvals

81. State or Federal Approvals: Any required State or federal permits or encroachment agreements (e.g., 401 water quality certification, 404 permit) shall be approved and copies of the approved permits and agreements be submitted to the Town of Chapel Hill prior to the issuance of a Zoning Compliance Permit.

Miscellaneous

82. Certificates of Occupancy: No Certificates of Occupancy shall be issued until all required public improvements are complete or a bond is place with the Town for incomplete improvements. A note to this effect shall be placed on the final plats.

If the Town Manager approves a phasing plan, no Certificates of Occupancy shall be issued for a phase until all required public improvements for that phase are complete, and no Building Permits for any phase shall be issued until all public improvements required in previous phases are completed to a point adjacent to the new phase. A note to this effect shall be placed on the final plats.

83. New Street Names and Numbers: The name of the development and its streets and building numbers shall be approved by the Town Manager prior to issuance of a Zoning Compliance Permit.

84. Vested Right: This Conditional Zoning constitutes a site-specific vesting plan (and is defined as such in the Chapel Hill Land Use Management Ordinance) establishing a vested right as provided by N.C.G.S. Section 160D-108.1 and the Chapel Hill Land Use Management Ordinance. The Town makes no further representations regarding vested rights as they relate to this approval. During the period of vesting this permit may be subject to subsequent changes to Town regulations to the extent such regulations have been enacted under authority other than the Town's zoning authority.

85. Continued Validity: Continued validity and effectiveness of this approval shall be expressly conditioned on the continued compliance with the plans and conditions listed above.

86. Non-Severability: If any of the above conditions is held to be invalid, approval in its entirety shall be void.

BE IT FURTHER RESOLVED that the Council hereby approves the application for a Conditional Zoning for UNC Heath Eastowne at 100-998 Eastowne Drive.

This the 24th day of May, 2023.

United States
Department of
Agriculture

**Natural
Resources
Conservation
Service**

**Part 654 Stream Restoration Design
National Engineering Handbook**

Chapter 11 Rosgen Geomorphic Channel Design

Issued August 2007

Cover photo: Stream restoration project, South Fork of the Mitchell River, NC, three months after project completion. The Rosgen natural stream design process uses a detailed 40-step approach.

Advisory Note

Techniques and approaches contained in this handbook are not all-inclusive, nor universally applicable. Designing stream restorations requires appropriate training and experience, especially to identify conditions where various approaches, tools, and techniques are most applicable, as well as their limitations for design. Note also that product names are included only to show type and availability and do not constitute endorsement for their specific use.

Chapter 11 Rosgen Geomorphic Channel Design

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Chapter 11 Rosgen Geomorphic Channel Design

654.1100 Purpose

This chapter outlines a channel design technique based on the morphological and morphometric qualities of the Rosgen classification system. While this approach is written in a series of steps, it is not a cookbook. This approach is often referred to as the Rosgen design approach. The essence for this design approach is based on measured morphological relations associated with bankfull flow, geomorphic valley type, and geomorphic stream type. This channel design technique involves a combination of hydraulic geometry, analytical calculation, regionalized validated relationships, and analogy in a precise series of steps. While this technique may appear to be straightforward in its application, it actually requires a series of precise measurements and assessments. It is important for the reader to recognize that the successful application of this design approach requires extensive training and experience.

The contents of this chapter were submitted to the technical editors of this handbook as a manuscript titled Natural Channel Design Using a Geomorphic Approach, by Dave Rosgen, Wildland Hydrology, Fort Collins, Colorado. This material was edited to fit the style and format of this handbook. The approaches and techniques presented herein are not universally applicable, just as other approaches and techniques presented in this handbook are not necessarily appropriate in all circumstances. However, the Rosgen Geomorphic Approach for Natural Channel Design has been implemented in many locations and is cited as the methodology of choice for stream restoration by several state and local governments.

654.1101 Introduction

River restoration based on the principles of the Rosgen geomorphic channel design approach is most commonly accomplished by restoring the dimension, pattern, and profile of a disturbed river system by emulating the natural, stable river. Restoring rivers involves securing their physical stability and biological function, rather than the unlikely ability to return the river to a pristine state. Restoration, as used in this chapter, will be used synonymously with the term rehabilitation. Any river restoration design must first identify the multiple specific objectives, desires, and benefits of the proposed restoration. The causes and consequences of stream channel problems must then be assessed.

Natural channel design using the Rosgen geomorphic channel design approach incorporates a combination of analog, empirical, and analytical methods for assessment and design. Because all rivers within a wide range of valley types do not exhibit similar morphological, sedimentological, hydraulic, or biological characteristics, it is necessary to group rivers of similar characteristics into discreet stream types. Such characteristics are obtained from stable reference reach locations by discreet valley types, and then are converted to dimensionless ratios for extrapolation to disturbed stream reaches of various sizes.

The proper utilization of this approach requires fundamental training and experience using this geomorphic method. Not only is a strong background in geomorphology, hydrology, and engineering required, but the restoration specialist also must have the ability to implement the design in the field. The methodology is divided into eight major sequential phases:

I Define specific restoration objectives associated with physical, biological, and/or chemical process.

II Develop regional and localized specific information on geomorphologic characterization, hydrology, and hydraulics.

III Conduct a watershed/river assessment to determine river potential; current state; and the nature, magnitude, direction, duration, and consequences of change. Review land

use history and time trends of river change. Isolate the primary causes of instability and/or loss of physical and biological function. Collect and analyze field data including reference reach data to define sedimentological, hydraulic, and morphological parameters. Obtain concurrent biological data (limiting factor analysis) on a parallel track with the physical data.

IV Initially consider passive restoration recommendations based on land use change in lieu of mechanical restoration. If passive methods are reasonable to meet objectives, skip to the monitoring phase (VIII). If passive efforts and/or recovery potential do not meet stated multiple objectives, proceed with the following phases.

V Initiate natural channel design with subsequent analytical testing of hydraulic and sediment transport relations (competence and capacity).

VI Select and design stabilization/enhancement/vegetative establishment measures and materials to maintain dimension, pattern, and profile to meet stated objectives.

VII Implement the proposed design and stabilization measures involving layout, water quality control, and construction staging.

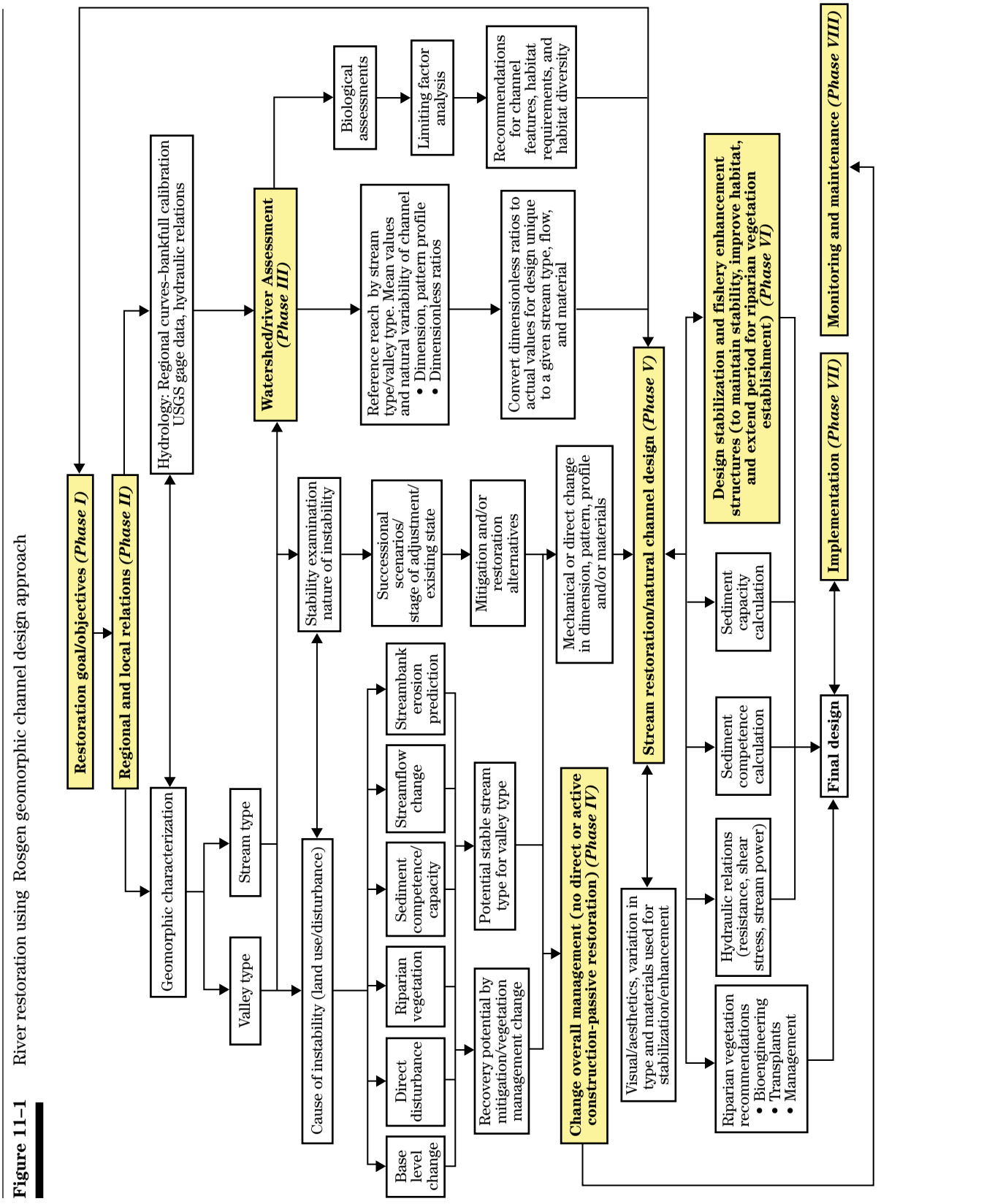
VIII Design a plan for effectiveness, validation, and implementation monitoring to ensure stated objectives are met, prediction methods are appropriate, and the construction is implemented as designed. Design and implement a maintenance plan.

The conceptual layout for the phases of the Rosgen geomorphic channel design approach is shown in figure 11–1. The various phases listed above are indicated on this generalized layout. The flowchart is indicative of the full extent and complexity associated with this method.

Because of the complexity and uncertainty of natural systems, it becomes imperative to monitor each restoration project. The following are three objectives of such monitoring:

- Ensure correct implementation of the design variables and construction details.
- Validate the analog, empirical, and analytical methods used for the assessment and design.
- Determine effectiveness of the restoration methods to the stated physical and biological restoration objectives.

Figure 11–1 River restoration using Rosgen geomorphic channel design approach



654.1102 Restoration phases

(a) Phase I—Restoration objectives

It is very important to obtain clear and concise statements of restoration objectives to appropriately design the solution(s). The potential of a certain stream to meet specific objectives must be assessed early on in the planning phases so that the initial restoration direction is appropriate. The common objectives are:

- flood level reduction
- streambank stability
- reduce sediment supply, land loss, and attached nutrients
- improve visual values
- improve fish habitat and biological diversity
- create a natural stable river
- withstand floods
- be self-maintaining
- be cost-effective
- improve water quality
- improve wetlands

It is essential to fully describe and understand the restoration objectives. The importance of formulating clear, achievable, and measurable objectives is described in detail in NEH654.02. Often the objectives can be competing or be in conflict with one another. Conflict resolution must be initiated and can often be offset by varying the design and/or the nature of stabilization methods or materials planned.

The assessment required must also reflect the restoration objectives to ensure various related processes are thoroughly evaluated. For example, if improved fishery abundance, size, and species are desired, a limiting factor analysis of habitat and fish populations must be linked with the morphological and sedimentological characteristics.

(b) Phase II—Developing local and regional relations in geomorphic characterization, hydrology, and hydraulics

Geomorphic characterization
The relations mapped at this phase are the geomorphic characterization and description levels for stream classification (Rosgen 1994, 1996). Valley types (table 11–1) are mapped prior to stream classification to ensure reference reach data are appropriately applied for the respective valley types being studied. Morphological relations associated with stream types are presented in figures 11–2 (Rosgen 1994) and 11–3 (Rosgen 1996) and summarized in table 11–2. In natural channel design using the Rosgen geomorphic channel design approach, it is often advantageous to have an undisturbed and/or stable river reach immediately upstream of the restoration reach. Reference reach data are obtained and converted to dimensionless ratio relations to extrapolate channel dimension, pattern, profile, and channel material data to rivers and valleys of the same type, but of different size. If an undisturbed/stable river reach is not upstream of the restoration reach, extrapolation of morphological and dimensionless ratio relations by valley and stream type is required for both assessment and design.

An example of the form used to organize reference reach data, including dimensionless ratios for a given stream type, is presented in table 11–3. Specific design variables use reference reach data for extrapolation purposes, assuming the same valley and stream type as represented. These relations are only representative of a similar stable stream type within a valley type of the disturbed stream.

Hydrology
The hydrology of the basin is often determined from regional curves constructed from long-term stream gage records. Relationships of flow-duration curves and flood-frequency data are used for computations in both the assessment and design phases. Stream Hydrology is also addressed in NEH654.05. Relations are converted to dimensionless formats using bankfull discharge as the normalization parameter. Bankfull discharge and dimensions associated with stream gages are plotted as a function of drainage area for extrapolation to ungaged sites in similar hydro-physiographic provinces. A key requirement in the development of

Table 11–1 Valley types used in geomorphic characterization

Valley types	Summary description of valley types
I	Steep, confined, V-notched canyons, rejuvenated side slopes
II	Moderately steep, gentle-sloping side slopes often in colluvial valleys
III	Alluvial fans and debris cones
IV	Gentle gradient canyons, gorges, and confined alluvial and bedrock-controlled valleys
V	Moderately steep, U-shaped glacial-trough valleys
VI	Moderately steep, fault, joint, or bedrock (structural) controlled valleys
VII	Steep, fluvial dissected, high-drainage density alluvial slopes
VIII	Wide, gentle valley slope with well-developed flood plain adjacent to river and/or glacial terraces
IX	Broad, moderate to gentle slopes, associated with glacial outwash and/or eolian sand dunes
X	Very broad and gentle valley slope, associated with glacio- and nonglacio-lacustrine deposits
XI	Deltas

Figure 11–2 Broad-level stream classification delineation showing longitudinal, cross-sectional, and plan views of major stream types

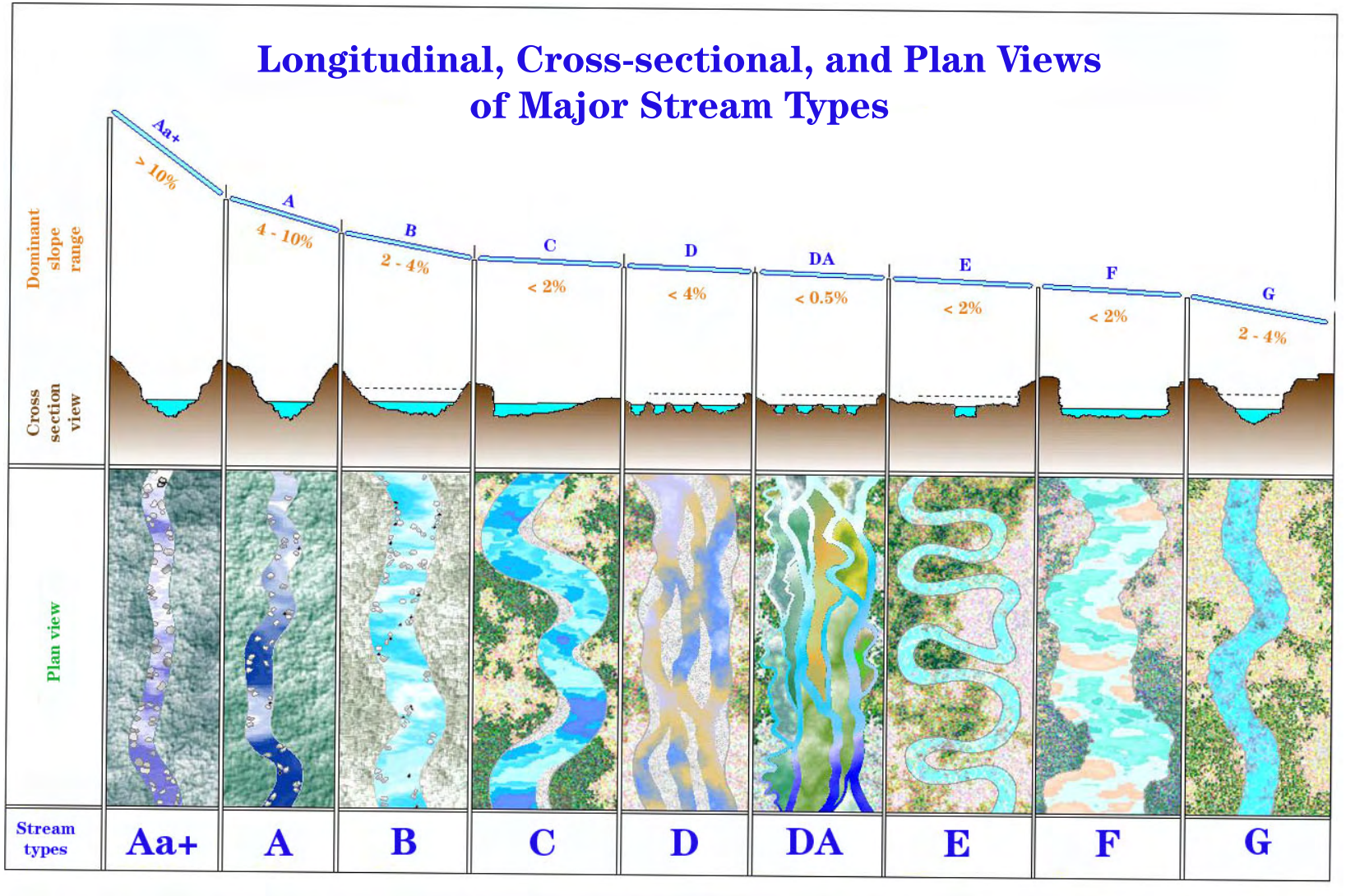
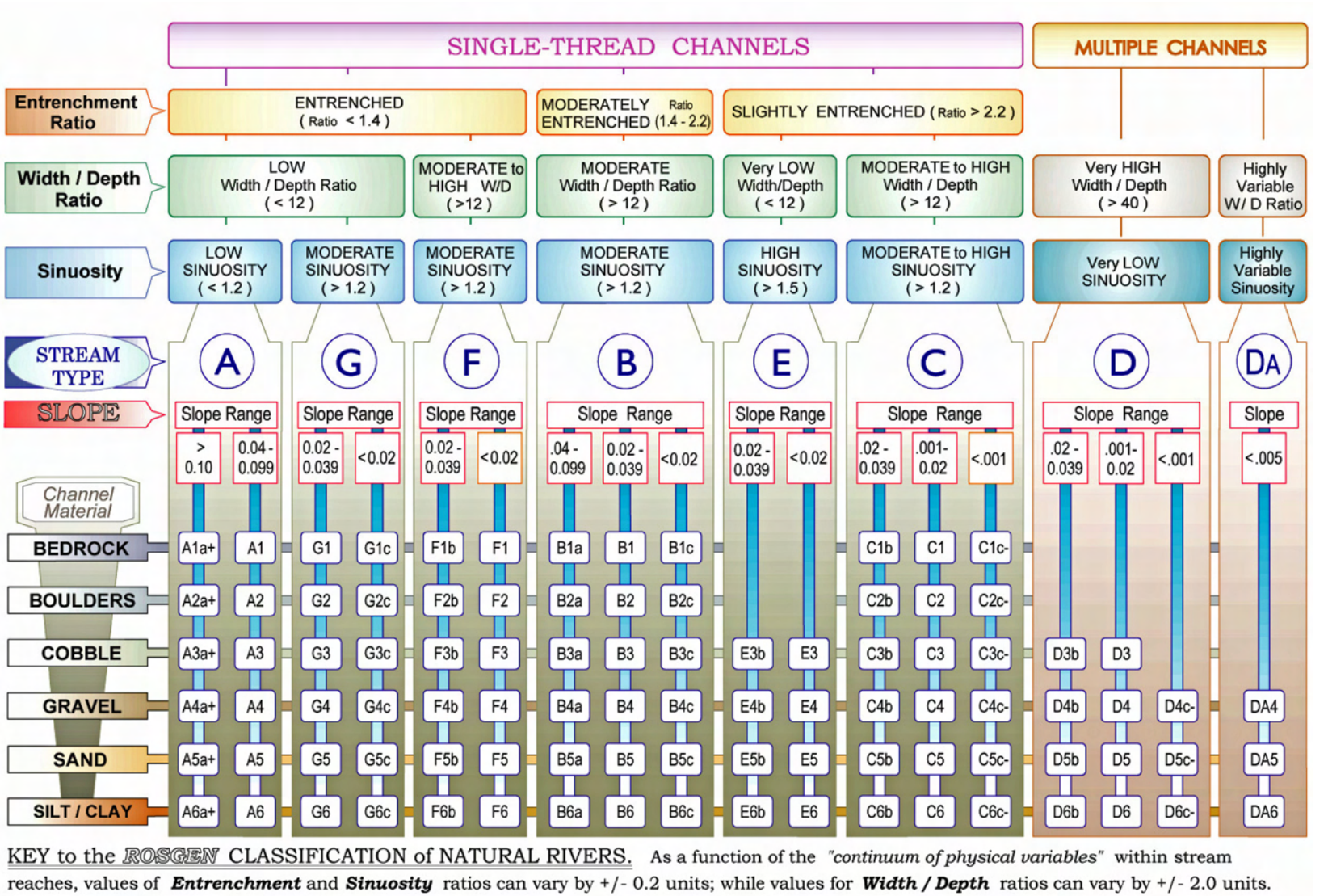


Figure 11–3 Classification key for natural rivers



KEY to the *ROSGEN* CLASSIFICATION of NATURAL RIVERS. As a function of the *"continuum of physical variables"* within stream reaches, values of ***Entrenchment*** and ***Sinuosity*** ratios can vary by +/- 0.2 units; while values for ***Width / Depth*** ratios can vary by +/- 2.0 units.

Table 11–2 General stream type descriptions and delineative criteria for broad-level classification (level 1)

Stream type	General description	Entrenchment ratio	W/d ratio	Sinuosity	Slope	Landform/ soils/features
Aa+	Very steep, deeply entrenched, debris transport, torrent streams	<1.4	<12	1.0 to 1.1	>.10	Very high relief. Erosional, bedrock, or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with deep scour pools; waterfalls
A	Steep, entrenched, cascading, step-pool streams. High energy/ debris transport associated with depositional soils. Very stable if bedrock or boulder-dominated channel	<1.4	<12	1.0 to 1.2	.04 to .10	High relief. Erosional or depositional and bedrock forms. Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in associated step-pool bed morphology
B	Moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools. Very stable plan and profile. Stable banks	1.4 to 2.2	>12	>1.2	.02 to .039	Moderate relief, colluvial deposition and/or structural. Moderate entrenchment and width-to-depth ratio. Narrow, gently sloping valleys. Rapids predominate with scour pools
C	Low gradient, meandering, point bar, riffle/pool, alluvial channels with broad, well-defined flood plains	>2.2	>12	>1.2	<.02	Broad valleys with terraces, in association with flood plains, alluvial soils. Slightly entrenched with well-defined meandering channels. Riffle/ pool bed morphology
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks	n/a	>40	n/a	<.04	Broad valleys with alluvium, steeper fans. Glacial debris and depositional features. Active lateral adjustment with abundance of sediment supply. Convergence/divergence bed features, aggradational processes, high bed load and bank erosion
DA	Anastomizing (multiple channels) narrow and deep with extensive, well-vegetated flood plains and associated wetlands. Very gentle relief with highly variable sinuosities and width-to-depth ratios. Very stable streambanks	>2.2	Highly variable	Highly variable	<.005	Broad, low-gradient valleys with fine alluvium and/or lacustrine soils. Anastomized (multiple channel) geologic control creating fine deposition with well-vegetated bars that are laterally stable with broad wetland flood plains. Very low bed-load, high wash load sediment
E	Low gradient, meandering riffle/pool stream with low width-to-depth ratio and little deposition. Very efficient and stable. High meander width ratio	>2.2	<12	>1.5	<.02	Broad valley/meadows. Alluvial materials with flood plains. Highly sinuous with stable, well-vegetated banks. Riffle/pool morphology with very low width-to-depth ratios
F	Entrenched meandering riffle/pool channel on low gradients with high width-to-depth ratio	<1.4	>12	>1.2	<.02	Entrenched in highly weathered material. Gentle gradients with a high width-to-depth ratio. Meandering, laterally unstable with high bank erosion rates. Riffle/pool morphology
G	Entrenched gully step-pool and low width-to-depth ratio on moderate gradients	<1.4	<12	>1.2	.02 to .039	Gullies, step-pool morphology with moderate slopes and low width-to-depth ratio. Narrow valleys, or deeply incised in alluvial or colluvial materials (fans or deltas). Unstable, with grade control problems and high bank erosion rates

Table 11–3 Reference reach summary data form

River Reach Summary Data

Channel dimension

Mean riffle depth (d_{bkf})		ft	Riffle width (W_{bkf})		ft	Riffle area (A_{bkf})		ft^2
Mean pool depth (d_{bkfp})		ft	Pool width (W_{bkfp})		ft	Pool area (A_{bkfp})		ft^2
Mean pool depth/mean riffle depth		$d_{bkfp}/(d_{bkf})$	Pool width/riffle width		W_{bkfp}/W_{bkf}	Pool area/riffle area		A_{bkfp}/A_{bkf}
Max riffle depth (d_{mbkf})		ft	Max pool depth (d_{mbkfp})		ft	Max riffle depth/mean riffle depth		
Max pool depth/mean riffle depth						Point bar slope		
Streamflow: estimated mean velocity at bankfull stage (u_{bkf})					ft/s	Estimation method		
Streamflow: estimated discharge at bankfull stage (Q_{bkf})					ft^3/s	Drainage area		mi^2

Channel pattern

Geometry	Mean	Min.	Max.		Dimensionless geometry ratios	Mean	Min.	Max.
Meander length (Lm)				ft	Meander length ratio (Lm/W_{bkf})			
Radius of curvature (Rc)				ft	Radius of curvature/riffle width (Rc/W_{bkf})			
Belt width (W_{blt})				ft	Meander width ratio (W_{blt}/W_{bkf})			
Individual pool length				ft	Pool length/riffle width			
Pool to pool spacing				ft	Pool to pool spacing/riffle width			

Channel profile

Valley slope (VS)		ft/ft	Average water surface slope (S)		ft/ft	Sinuosity (VS/S)		
Stream length (SL)		ft	Valley length (VL)		ft	Sinuosity (SL/VL)		
Low bank height (LBH)	start	ft	Max riffle depth	start	ft	Bank height ratio (LBH/max riffle depth)	start	
	end	ft		end	ft		end	

Facet slopes	Mean	Min.	Max.		Dimensionless geometry ratios	Mean	Min.	Max.
Riffle slope (S_{rif})				ft/ft	Riffle slope/average water surface slope (S_{rif}/S)			
Run slope (S_{run})				ft/ft	Run slope/average water surface slope (S_{run}/S)			
Pool slope (S_p)				ft/ft	Pool slope/average water surface slope (S_p/S)			
Glide slope (S_g)				ft/ft	Glide slope/average water surface slope (S_g/S)			

Feature midpoint[a/]	Mean	Min.	Max.		Dimensionless geometry ratios	Mean	Min.	Max.
Riffle depth (d_{rif})				ft	Riffle depth/mean riffle depth (d_{rif}/d_{bkf})			
Run depth (d_{run})				ft	Run depth/mean riffle depth (d_{run}/d_{bkf})			
Pool depth (d_p)				ft	Pool depth/mean riffle depth (d_p/d_{bkf})			
Glide depth (d_g)				ft	Glide depth/mean riffle depth (d_g/d_{bkf})			

Channel materials

Geometry		Reach[b/]	Riffle[c/]	Bar		Reach[b/]	Riffle[c/]	Bar	
% Silt/clay					D_{16}				mm
% Sand					D_{35}				mm
% Gravel					D_{50}				mm
% Cobble					D_{84}				mm
% Boulder					D_{95}				mm
% Bedrock					D_{100}				mm

a/ Minimum, maximum, mean depths are the average midpoint values except pools which are taken at deepest part of pool
b/ Composite sample of riffles and pools within the designated reach
c/ Active bed of a riffle

such relations is the necessity to field-calibrate the bankfull stage at each gage within a hydro-physiographic province (a drainage basin similar in precipitation/runoff relations due to precipitation/elevation, lithology and land uses).

Regional curves—The field-calibrated bankfull stage is used to obtain the return period associated with the bankfull discharge. Regional curves of bankfull discharge versus drainage area are developed (fig. 11–4) (adapted from Dunne and Leopold 1978)). To plot bankfull dimensions by drainage area, the U.S. Geological Survey (USGS) 9–207 data (summary of stream discharge measurements at the gage) are obtained to plot the at-a-station hydraulic geometry relations (fig. 11–5 (adapted from Rosgen 1996; Rosgen and Silvey 2005)). These data are then converted to dimensionless hydraulic geometry data by dividing each value by their respective bankfull value. These relations are used during assessment and design to indicate the shape of the various cross sections from low flow to high flow. In the development of the dimensionless hydraulic geometry data, current meter measurements must be stratified by stream type (Rosgen 1994, 1996) and for specific bed features such as riffles, glides, runs, or pools.

Figure 11–4 Regional curves from stream gaging stations showing bankfull discharge (ft^3/s) vs. drainage area (mi^2)

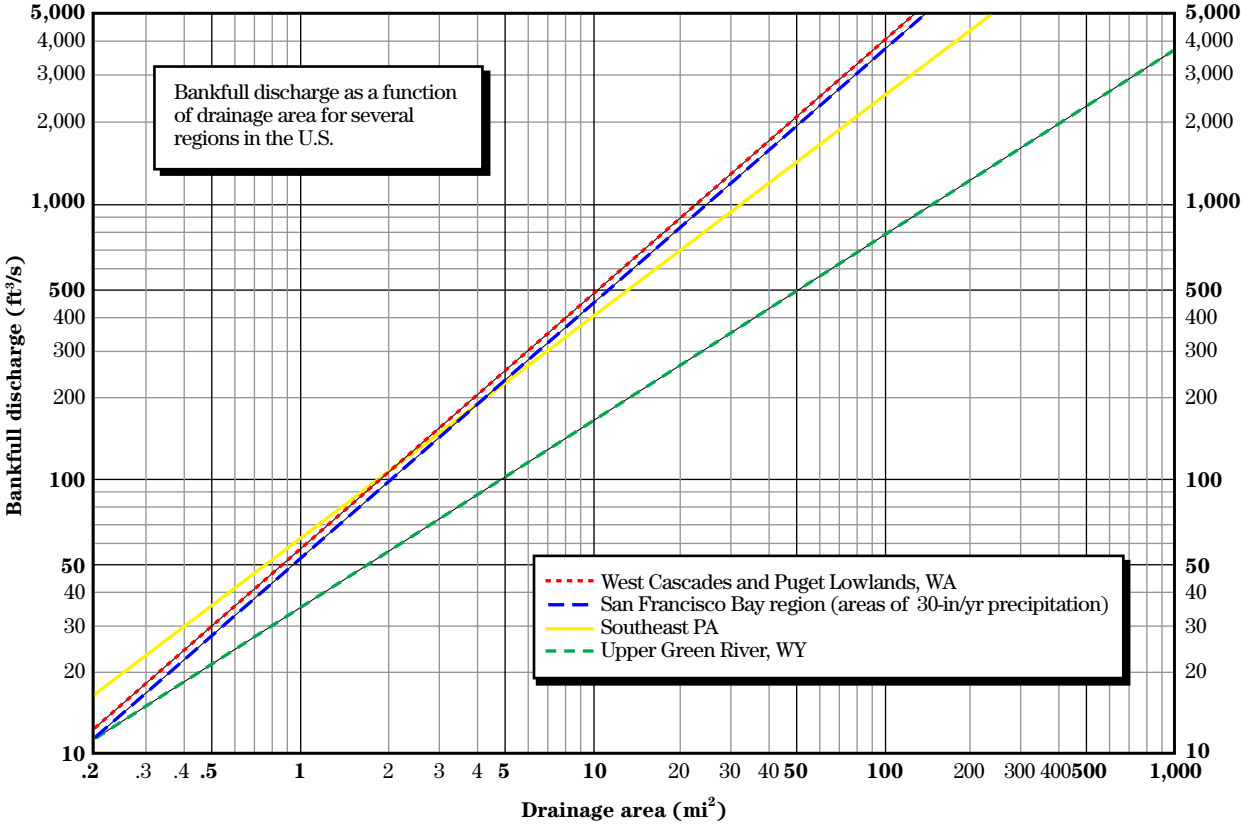
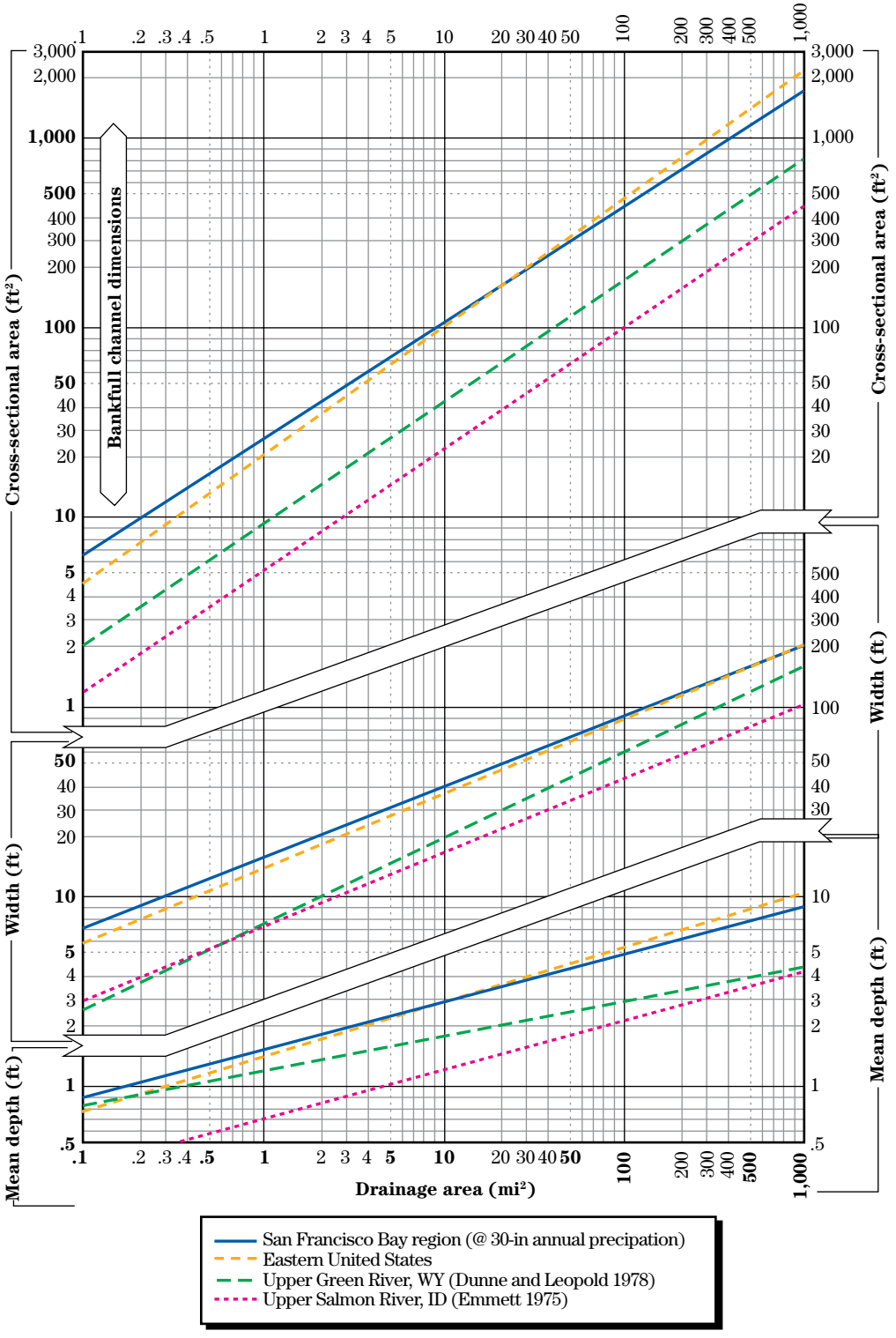


Figure 11–5 Regional curves from stream gage stations showing bankfull dimensions (width, depth, and cross-sectional area) vs. drainage area (mi²)



Hydraulic relations
Hydraulic relations are validated using resistance equations for velocity prediction at ungaged sites. (Stream Hydraulics is addressed in more detail in NEH654.06) Validation is accomplished by back calculating relative roughness (R/D_{84}) and a friction factor (u/u^*) from actual measured velocity for a range of streamflows including bankfull:

$$u = \left[2.83 + 5.66 \log\left(\frac{R}{D_{84}}\right)\right] u^* \qquad \text{(eq. 11–1)}$$

where:
u = mean velocity (ft/s)
R = hydraulic radius
D_{84} = diameter of bed material of the 84th percentile of riffles
u^* = shear velocity $(gRS)^{½}$
g = gravitational acceleration
S = slope

Measured velocity, slope, channel material, and hydraulic radius data from various Colorado rivers using this friction factor (u/u^*) and relative roughness (R/D_{84}) relation are shown in figure 11–6 (Rosgen, Leopold, and Silvey 1998; Rosgen and Silvey 2005).

Manning's *n* (roughness coefficient) can also be back-calculated from measured velocity, slope, and hydraulic radius. Another approach to predict velocity at ungaged sites is to predict Manning's *n* from a friction factor back-calculated from relative roughness shown in figure 11–7 (Rosgen, Leopold, and Silvey 1998; Rosgen and Silvey 2005). Manning's *n* can also be estimated at the bankfull stage by stream type as shown in the relationship from gaged, large streams in figure 11–8. Vegetative influence is also depicted in these data (Rosgen 1994).

Dimensionless flow-duration curves—Flow-duration curves (based on mean daily discharge) are also obtained from gage stations then converted to dimensionless form using bankfull discharge as the normalization parameter (fig. 11–9 (Emmett 1975)). The purpose of this form is to allow the user to extrapolate flow-duration curves to ungaged basins. This relationship is needed for the annual suspended and bed-load sediment yield calculation along with channel hydraulic variables.

(c) Phase III—Watershed and river assessment

Land use history is a critical part of watershed assessment to understand the nature and extent of potential impacts to the water resources. Past erosional/depositional processes related to changes in vegetative cover, direct disturbance, and flow and sediment regime changes provide insight into the direction and detail for assessment procedures required for restoration. Time series of aerial photos are of particular value to understand the nature, direction, magnitude, and rate of change. This is very helpful, as it assists in assessing both short-term, as well as long-term river problems.

Assessment of river stability and sediment supply
River stability (equilibrium or quasi-equilibrium) is defined as the ability of a river, over time, in the present climate to transport the flows and sediment produced by its watershed in such a manner that the stream maintains its dimension, pattern, and profile without either aggrading or degrading (Rosgen 1994, 1996, 2001d). A stream channel stability analysis is conducted along with riparian vegetation inventory, flow and sediment regime changes, limiting factor analysis compared to biological potential, sources/causes of instability, and adverse consequences to physical and biological function. Procedures for this assessment are described in detail by Rosgen (1996, 2001d) and in Watershed Assessment and River Stability for Sediment Supply (WARSSS) (Rosgen 1999, 2005).

It is important to realize the difference between the dynamic nature of streams and natural adjustment processes compared to an acceleration of such adjustments. For example, bank erosion is a natural channel process; however, accelerated streambank erosion must be understood when the rate increases and creates a disequilibrium condition. Many stable rivers naturally adjust laterally, such as the "wandering" river. While it may meet certain local objectives to stabilize high risk banks, it would be inadvisable to try to "control" or "fix in place" such a river.

In many instances, a braided river and/or anastomizing river type is the stable form. Designing all stream systems to be a single-thread meandering stream may not properly represent the natural stable form. Valley types are a key part of river assessment to understand

Figure 11–6 Relation of channel bed particle size to hydraulic resistance with river data from a variety of eastern and western streams

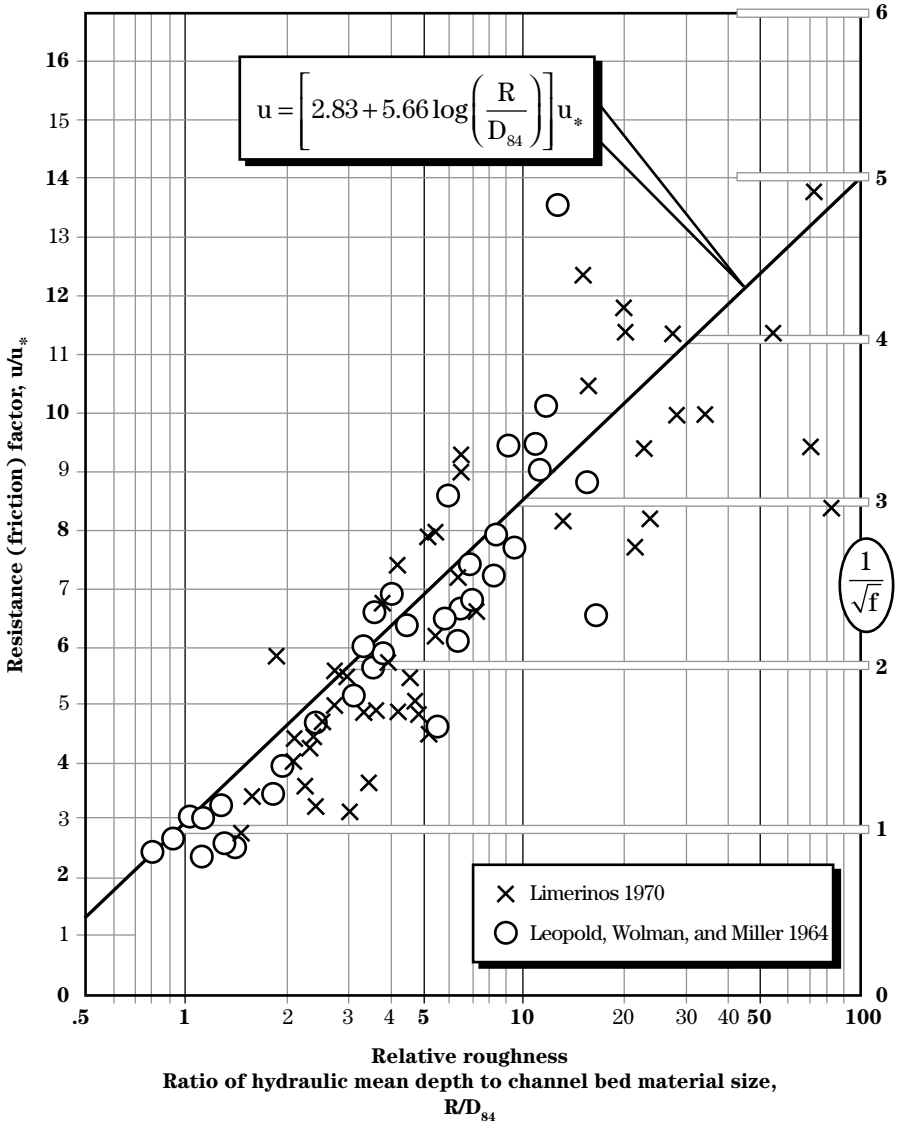


Figure 11–7 Prediction of Manning's n roughness coefficient

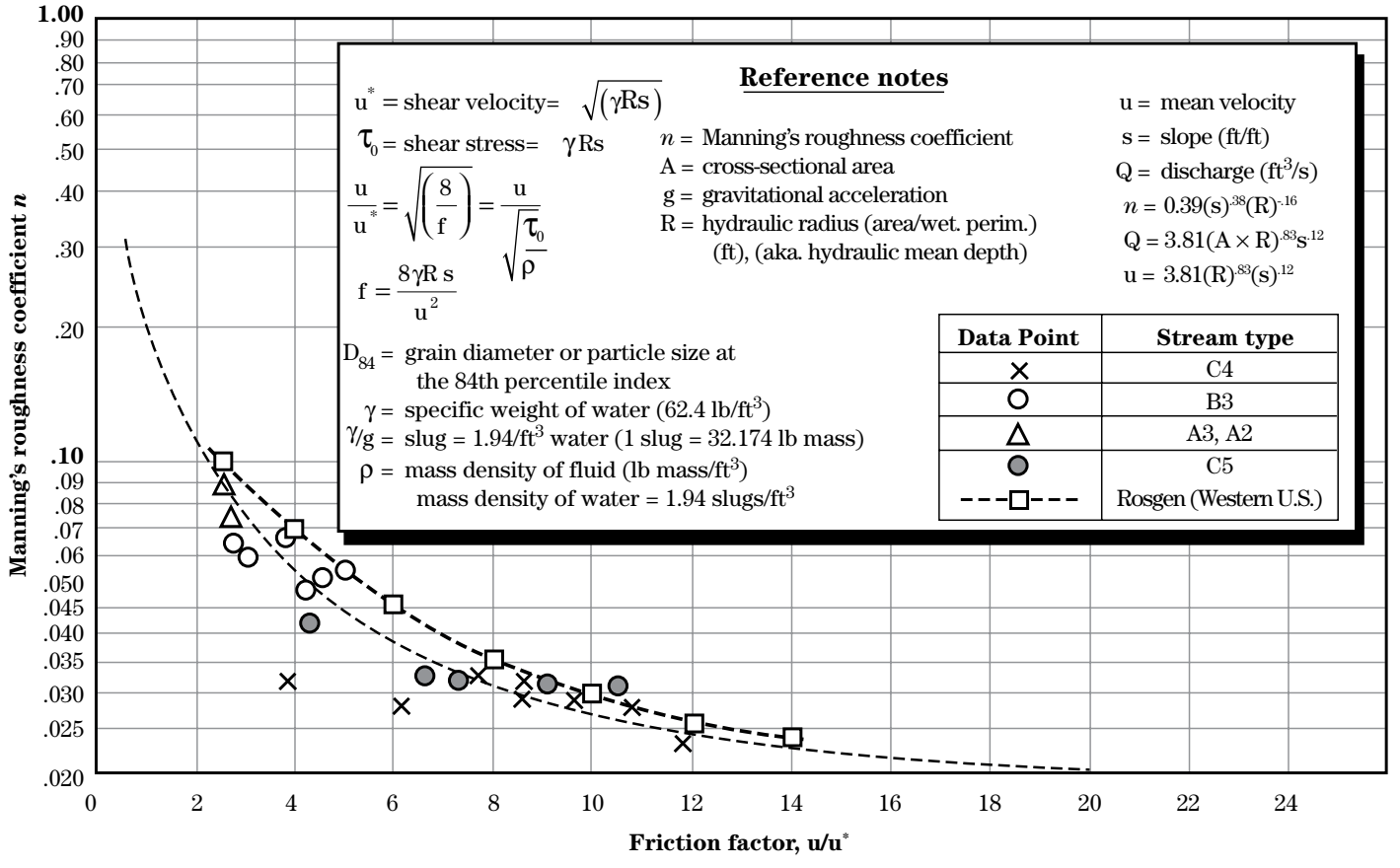
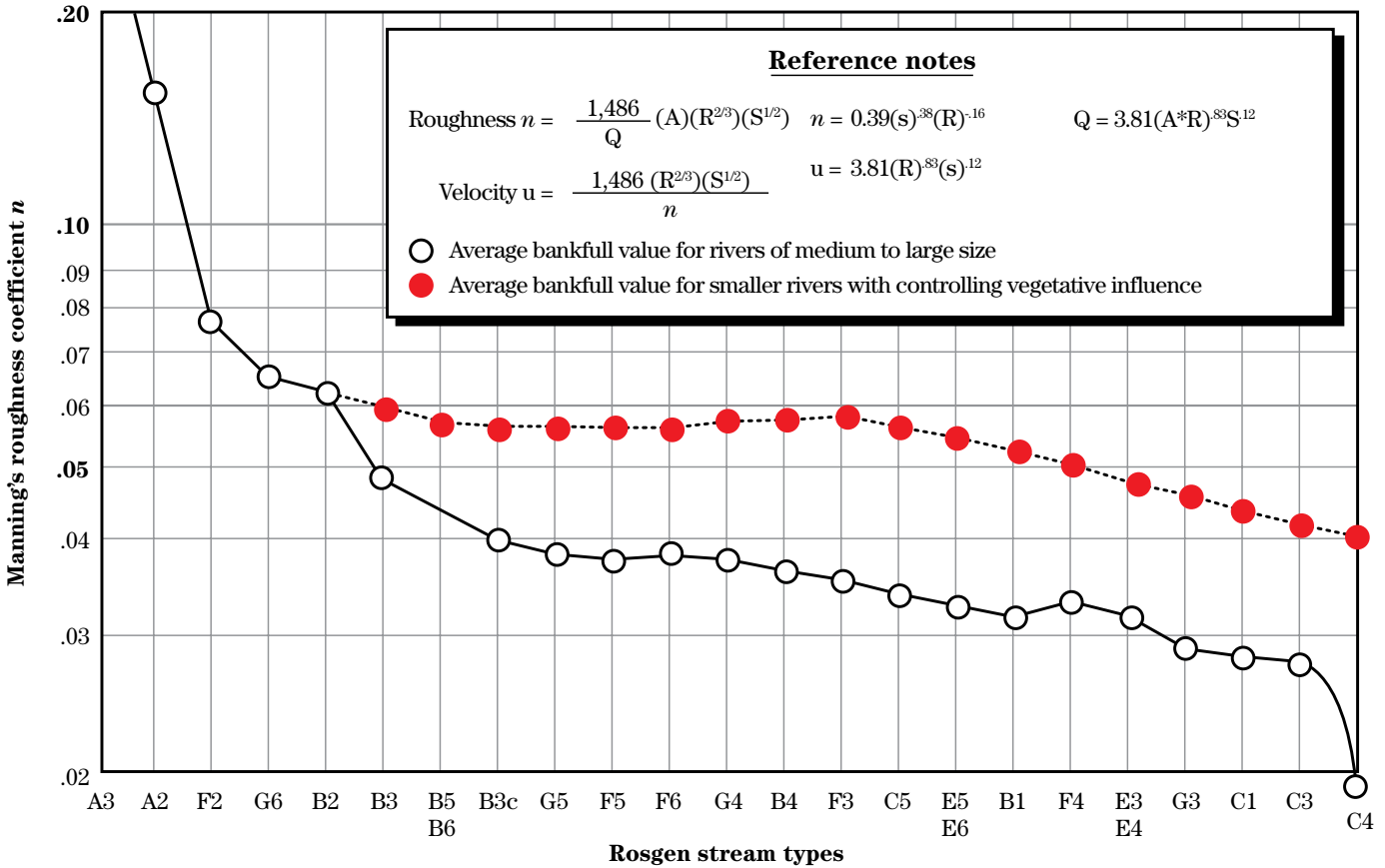


Figure 11–8 Bankfull stage roughness coefficients (n values) by stream type for 140 streams in the United States and New Zealand

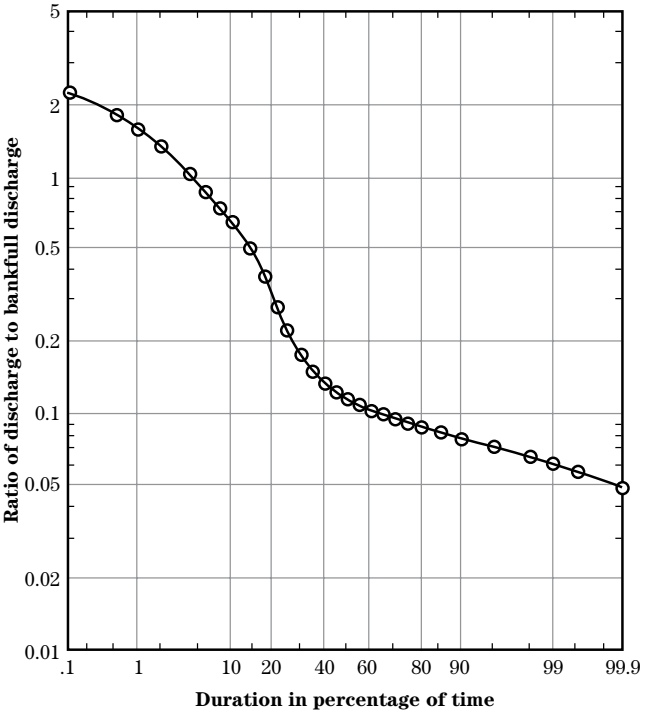


which stream types are stable within a variety of valley types in their geomorphic settings. Reference reaches that represent the stable form have to be measured and characterized only for use in similar valley types. This prevents applying good data to the *wrong* stream type.

Time-trend data using aerial photography is very valuable at documenting channel change. Field evidence using dendrochronology, stratigraphy, carbon dating, paleochannels, or evidence of avulsion and avulsion dates can help the field observer to understand rate, direction, and consequence of channel change.

The field inventory and the number of variables required to conduct a watershed and river stability assessment is substantial. The flowchart in figure 11–10 represents a general summary of the various elements used for assessing channel stability as used in this methodology. The assessment effort is one of the key procedural steps in a sound restoration plan, as it identifies the causes and consequences of the problems leading to loss of physical and biological river function. Some of the major variables are described to provide a *general* overview.

Figure 11–9 Dimensionless flow-duration curve for streamflow in the upper Salmon River area

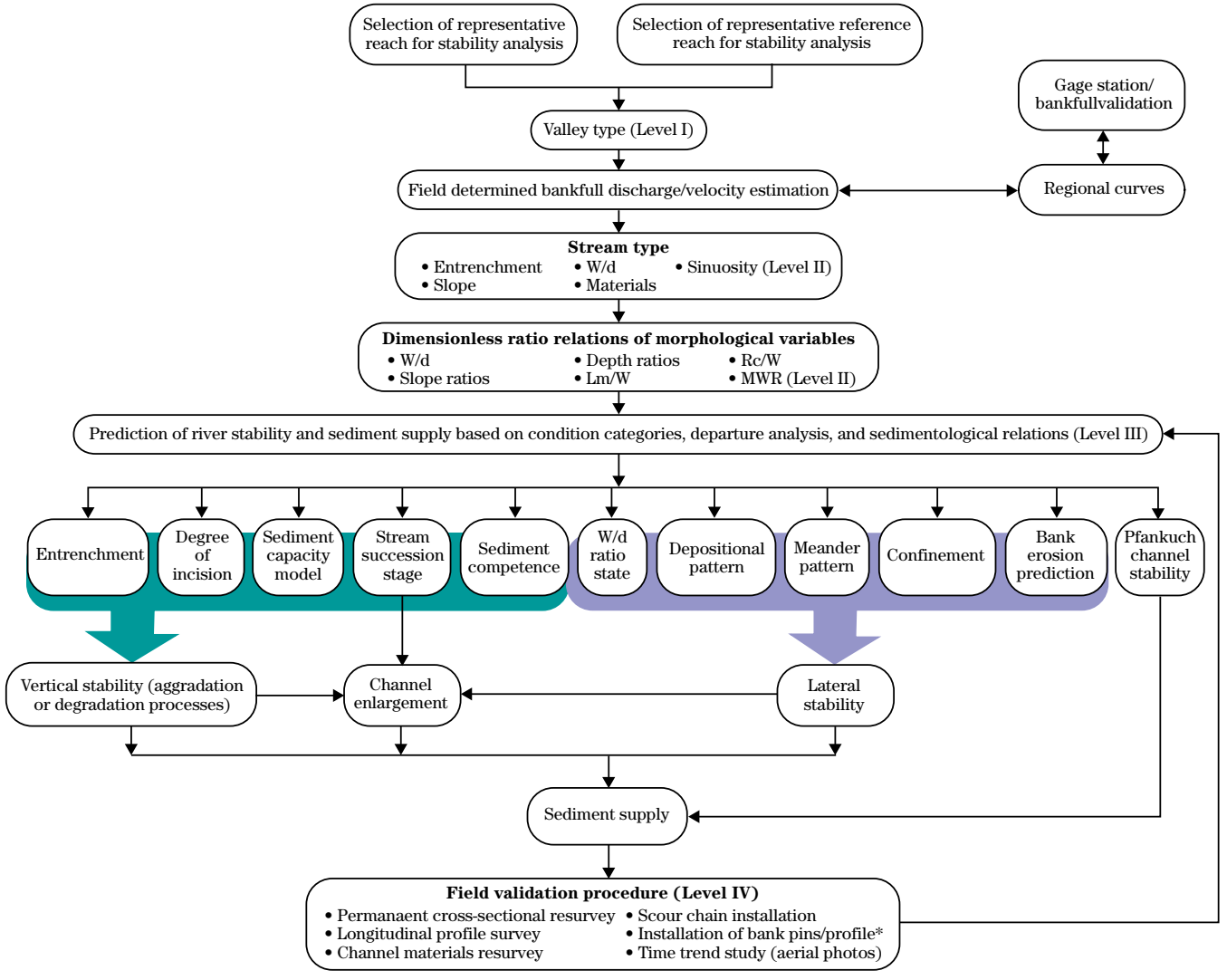


Streamflow change—Streamflow alteration (magnitude, duration, and timing) due to land use changes, such as percent impervious cover, must be determined at this phase. Streamflow models, such as the unit hydrograph approach, must be calibrated by back-calculating what precipitation probability generates bankfull discharge for various antecedent soil moisture and runoff curve numbers. It is critical to separate bankfull discharge from flood flows, as each flow category, including flood flow, has a separate dimension, pattern, and profile. This varies by stream type and the lateral and vertical constraints imposed within the valley (or urban "valley").

Flow-duration curves by similar hydro-physiographic provinces from gaged stations are converted to bankfull dimensionless flow duration for use in the annual sediment yield calculation. Snowmelt watershed flow prediction output (Troendle, Swanson, and Nankervis 2005) is generally shown in flow-duration changes, rather than an annual hydrograph. Similar model outputs using flow-duration changes are shown in Water Resources Evaluation of Nonpoint Silvicultural Sources (U.S. Environmental Protection Agency (EPA) 1980).

Sediment competence—Sedimentological data are obtained by a field measurement of the size of bar and bed material, bed-load sediment transport, suspended sediment transport, and bankfull discharge measurements at the bankfull stage. Sediment relations are established by collecting energy slope, hydraulic radius, bed material, bar material, and the largest particle produced by the drainage immediately upstream of the assessment reach. Critical dimensionless shear stress is calculated from field data to determine *sediment competence* (ability to move the largest particle made available to the channel). Procedures for this field inventory are presented in Andrews (1984) and Rosgen (2001a, 2001d, 2005). Potential aggradation, degradation, and channel enlargement are predicted for the disturbed reach, comparing the required depth and slope necessary to transport the largest size sediment available. These calculations can be accomplished by hand, spreadsheet, or by commercially available computer programs.

Figure 11–10 Generalized flowchart of application of various assessment levels of channel morphology, stability ratings, and sediment supply



*Optional: sediment measurements (largest size moved at bankfull, D_t)

Changes in channel dimension, pattern, and profile are reflected in changes of velocity, depth, and slope. These changes in the hydraulic variables are reflected in values of shear stress. Shear stress is defined as:

$$\tau = \gamma RS \qquad \text{(eq. 11–2)}$$

where:
τ = bankfull shear stress (lb/ft^2)
γ = specific weight of water = 62.4 lb/ft^3
R = hydraulic radius of riffle cross section (ft)
S = average water surface slope (ft/ft)

Use the calculated value of τ (lb/ft^2) and the Shields diagram as revised with the Colorado data (fig. 11–11 (Rosgen and Silvey 2005)) to predict the moveable particle size (mm) at bankfull shear stress.

Another relationship used in assessment and in design is the use of dimensionless shear stress (τ^*_{ci}) to determine particle entrainment. Dimensionless shear stress is defined as:

$$\tau^* = 0.0834\left(\frac{D_{50}}{\hat{D}_{50}}\right)^{-0.872} \qquad \text{(eq. 11–3)}$$

where:
τ^* = dimensionless shear stress
D_{50} = median diameter of the riffle bed (from 100 count in the riffle or pavement sample)
$\hat{D}_{50}$ = median diameter of the bar sample (or subpavement sample)

If the ratio $\frac{D_{50}}{\hat{D}_{50}}$ is between the values of 3.0 and 7.0, calculate the critical dimensionless shear stress using equation 11–3 (modifications adapted from Andrews 1983, 1984; Andrews and Erman 1986).

If the ratio $\frac{D_{50}}{\hat{D}_{50}}$ is **not** between the values of 3.0 and 7.0, calculate the ratio $\frac{D_{max}}{D_{50}}$

where:
D_{max} = largest particle from the bar sample (or the subpavement sample)
D_{50} = median diameter of the riffle bed (from 100 count in the riffle or the pavement sample)

If the ratio $\frac{D_{max}}{D_{50}}$ is between the value of 1.3 and 3.0, calculate the critical dimensionless shear stress:

$$\tau^* = 0.0384\left(\frac{D_{max}}{D_{50}}\right)^{-0.887} \qquad \text{(eq. 11–4)}$$

Once the dimensionless shear stress is determined, the bankfull mean depth required for entrainment of the largest particle in the bar sample (or subpavement sample) is calculated using equation 11–5:

$$d_{bkf} = 1.65\tau^* \frac{D_{max}}{S} \qquad \text{(eq. 11–5)}$$

where:
d_{bkf} = required bankfull mean depth (ft)
1.65 = submerged specific weight of sediment
τ^* = dimensionless shear stress
D_{max} = largest particle from bar sample (or subpavement sample) (ft)
S = bankfull water surface slope (ft/ft)

The bankfull water surface slope required for entrainment of the largest particle can be calculated using equation 11–6:

$$S = 1.65\tau^* \frac{D_{max}}{d_{bkf}} \qquad \text{(eq. 11–6)}$$

Equations 11–5 and 11–6 are derived from the basic Shields relation.

If the protrusion ratios are out of the usable range as stated, another option is to calculate sediment entrainment using dimensional bankfull shear stress (eq. 11–2 and fig. 11–11).

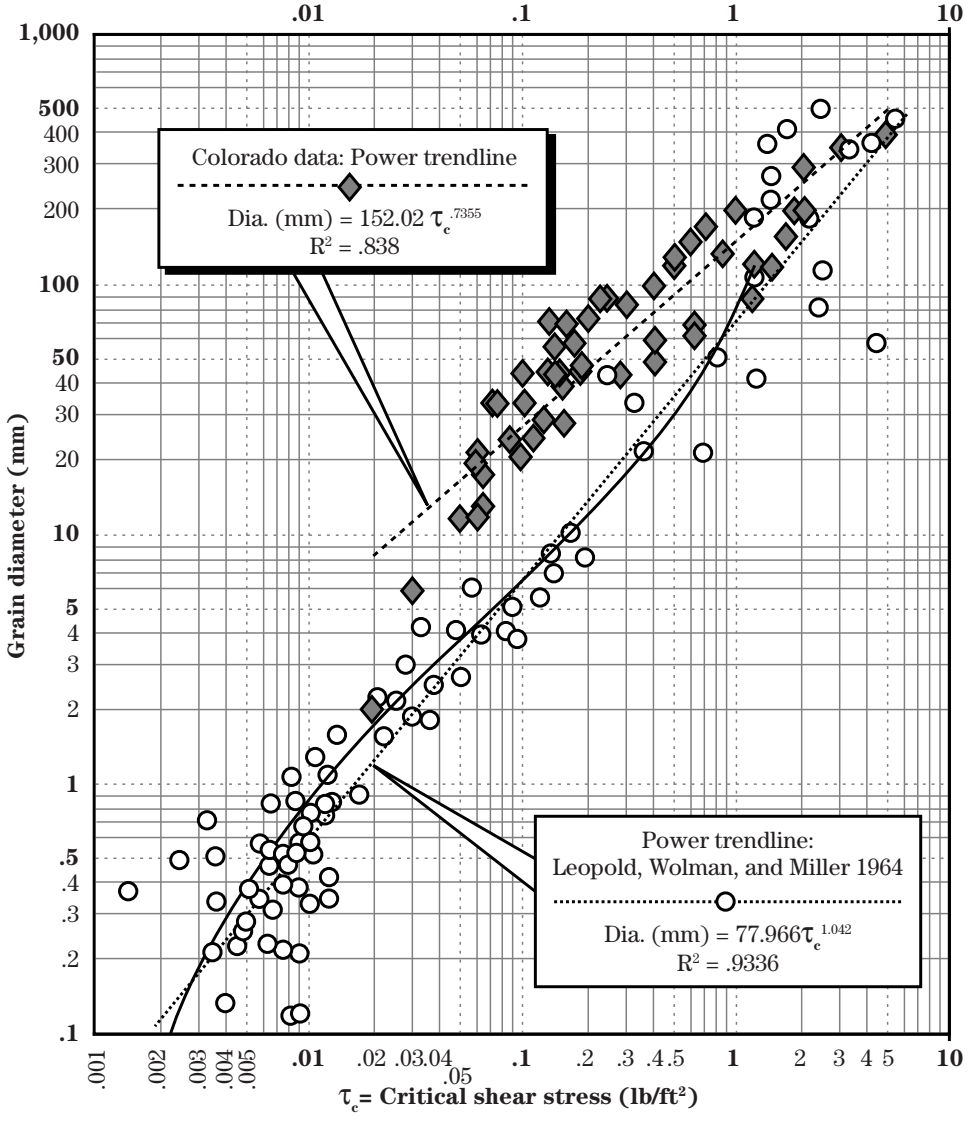
Sediment capacity—In addition to sediment competence, sediment capacity is important to predict river stability. Unit stream power is also utilized to determine the distribution of energy associated with changes in the dimension, pattern, profile, and materials of stream channels. Unit stream power is defined as shear stress times mean velocity:

$$\omega = \tau u \qquad \text{(eq. 11–7)}$$

where:
ω = unit stream power (lb/ft/s)
τ = shear stress (lb/ft^2)
u = mean velocity (ft/s)

Predicted sediment rating curves are converted to unit stream power for the same range of discharges by individual cells to demonstrate reduction or increase in coarse sediment transport.

Figure 11–11 Relation between grain diameter for entrainment and shear stress using Shields relations



Laboratory and field data on critical shear stress required to initiate movement of grains (Leopold, Wolman, and Miller 1964). The solid line is the Shields curve of *the threshold of motion;* transposed from the θ versus R_g form into the present form, in which critical shear is plotted as a function of grain diameter.

The use of reference dimensionless sediment rating curves by stream type and stability rating, (Troendle et al. 2001), as well as hydrology and hydraulic data, are all needed for the stability and design phases. Additional information will be presented in the respective sequential, analytical steps of each phase of the procedure. Local suspended sediment and bed-load data can be converted to regional sediment curves by plotting bankfull and suspended sediment data by drainage area. Examples of suspended sediment data plotted by 1.5-year recurrence interval discharge/drainage area for many regions of the United States as developed from USGS gage data by the U.S. Department of Agriculture (USDA), Agricultural Research Service (ARS) are presented in Simon, Dickerson, and Heins (2004). These relations can be used if a direct measurement of bankfull sediment cannot be obtained for subsequent analysis. Caution should be exercised in using an arbitrary bankfull value without field calibration of the bankfull discharge. The 1.5-year recurrence interval discharge is often greater than the actual bankfull value in wet climates and urban areas.

The disadvantage of using various suspended and bed load equations for the Rosgen geomorphic channel design methodology is the difficulty of determining sediment supply for sediment rating curves. It is common in the use of these models to have predicted values of many orders of magnitude different than observed values. The use of developed dimensionless ratio sediment rating curves for both suspended (less wash load) and bed load by stream type and stability is the improvement of predicted versus observed values. Results of an independent test of predicted versus observed values for a variety of USGS gage sites are shown in figures 11–12, 11–13, and 11–14. These figures show that predicted sediment rating curves match observed values for a wide range of flows. The model for bed-load transport reflects sediment transport based on changes in the channel hydraulics from a reference condition.

Validation of sediment competence or entrainment relations can also assist in the development and application of subsequent analysis. These data can be collected by installing scour chains and actual measurements of bed-load transport grain size for a given shear stress using Helley-Smith bed-load samplers. Plotting existing data collected by others in this manner can also help in developing a data base used in later analysis.

The use of reference dimensionless ratio sediment rating curves (bed load and suspended less wash load) requires field measured bankfull sediment and dis-

Figure 11–12 Comparison of predicted sediment rating curve to observed values from the Tanana River, AK, using the Pagosa Springs dimensionless ratio relation

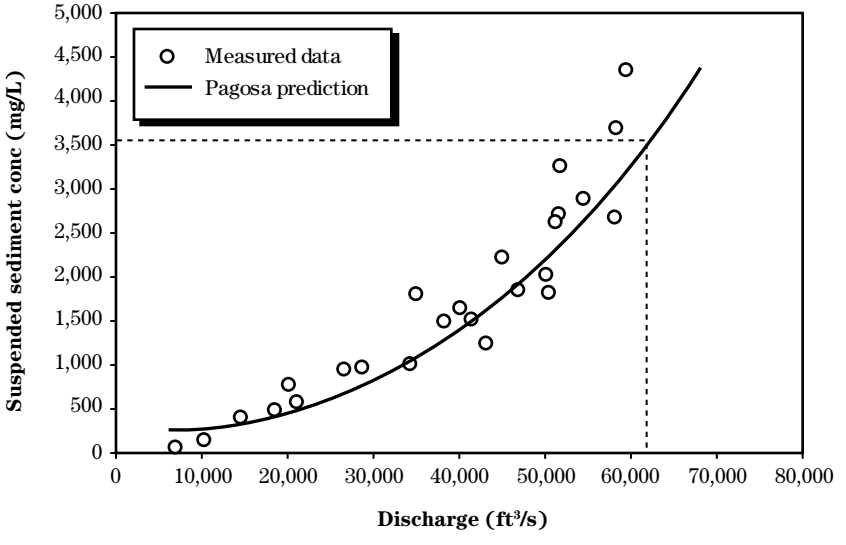
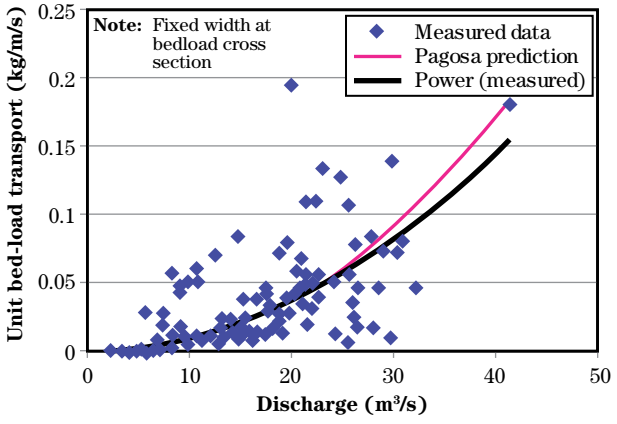
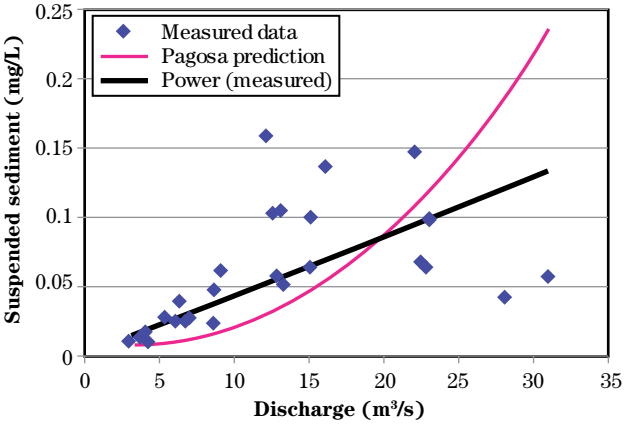


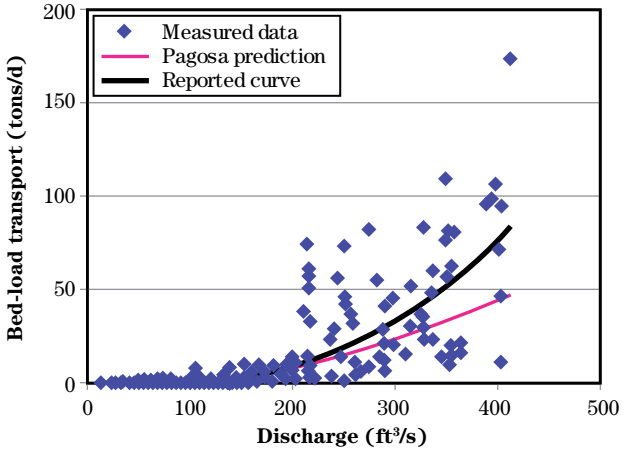
Figure 11–13 Predicted vs. measured sediment data using reference dimensionless rating curve (data from Leopold and Emmett 1997; Ryan and Emmett 2002)

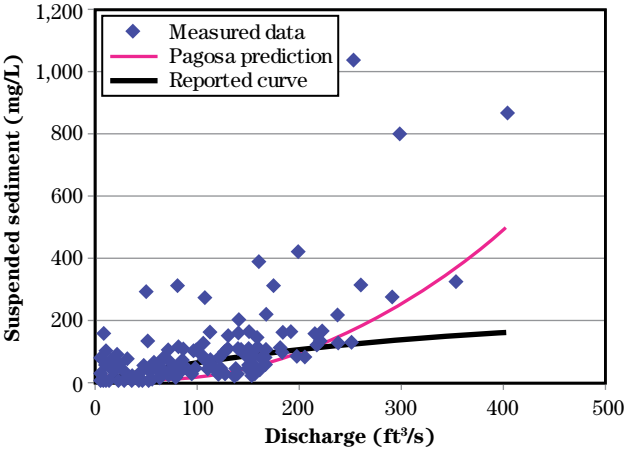
East Fork River near Big Sandy, WY (from Leopold and Emmett 1997)



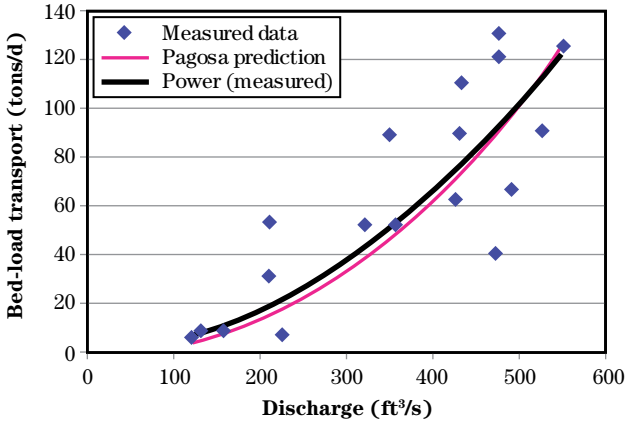


Little Granite Creek near Bondurant, WY (from Ryan and Emmett 2002)





Maggie Creek (F4)—NV



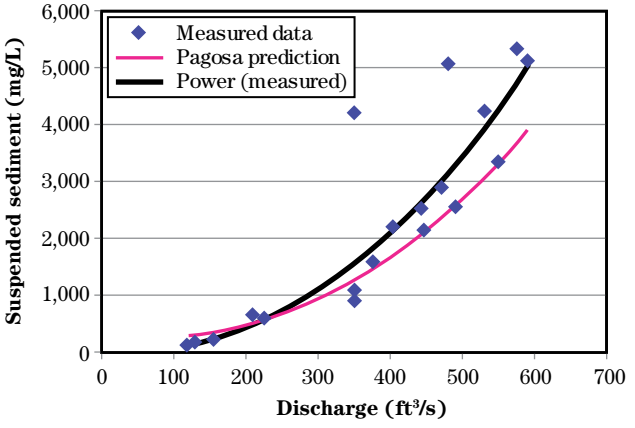
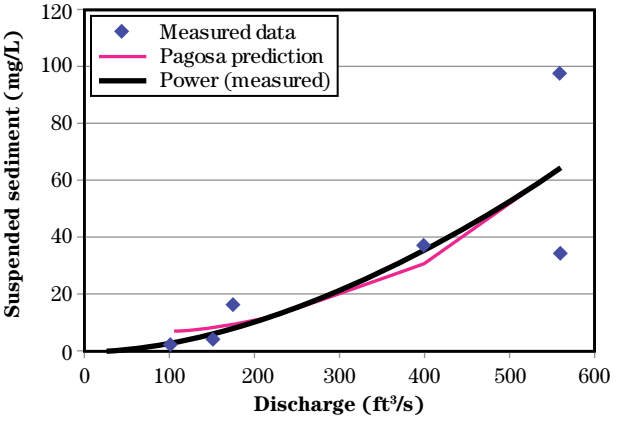
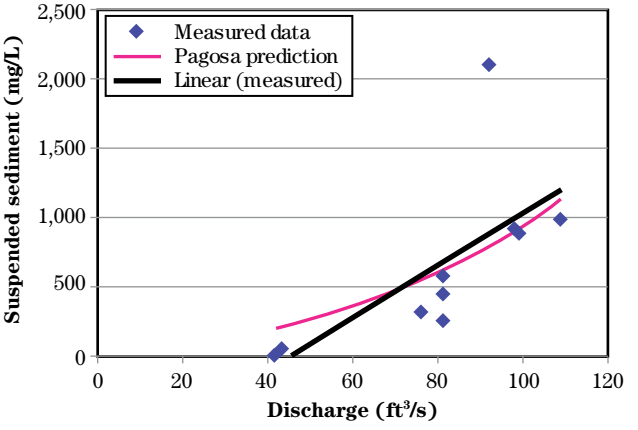


Figure 11–14 Predicted vs. measured suspended sediment data using dimensionless reference curve (data from Emmett 1975)

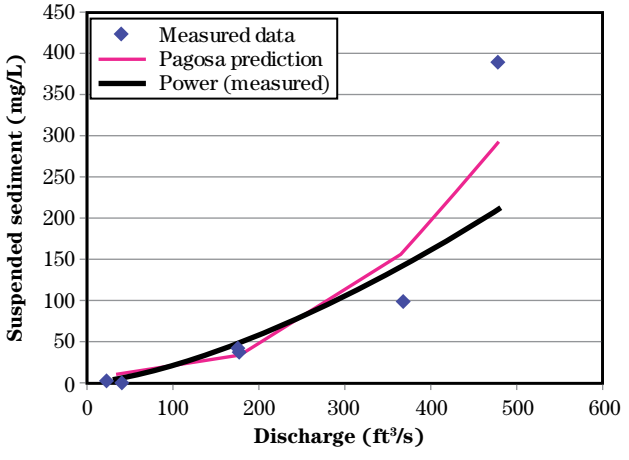
Warm Springs Creek near Clayton, ID 13297000



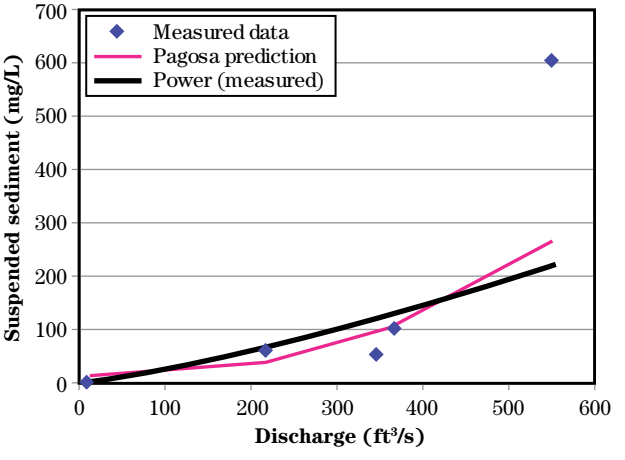
Upper Salmon Watershed 13297250



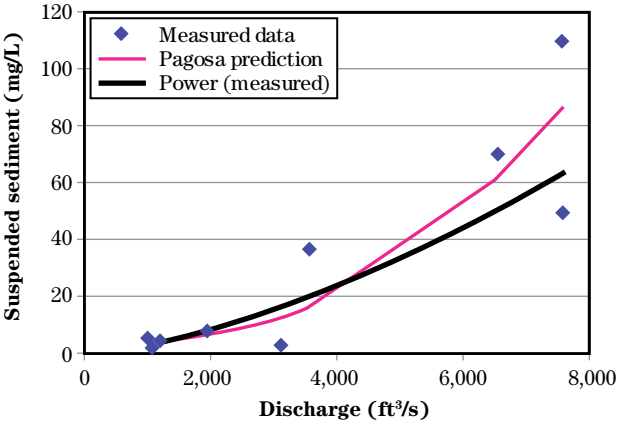
Upper Salmon Watershed 13297340



Upper Salmon Watershed 13297360



Upper Salmon Watershed 13297380



Upper Salmon Watershed 13297425

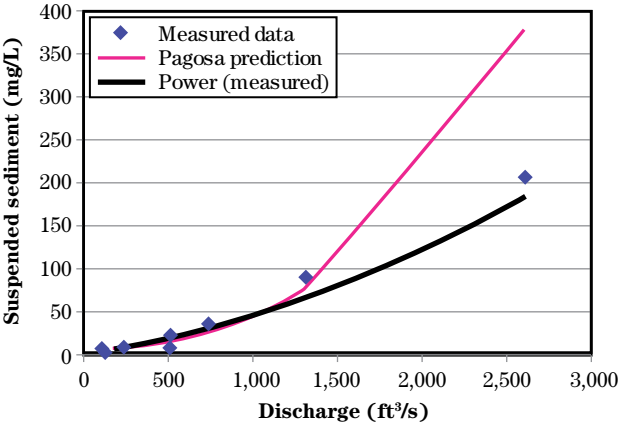
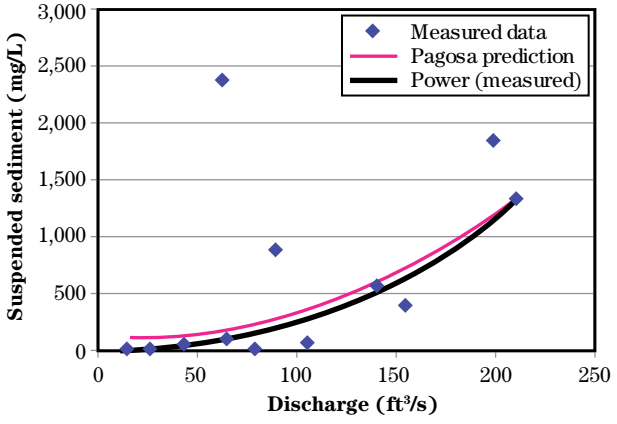
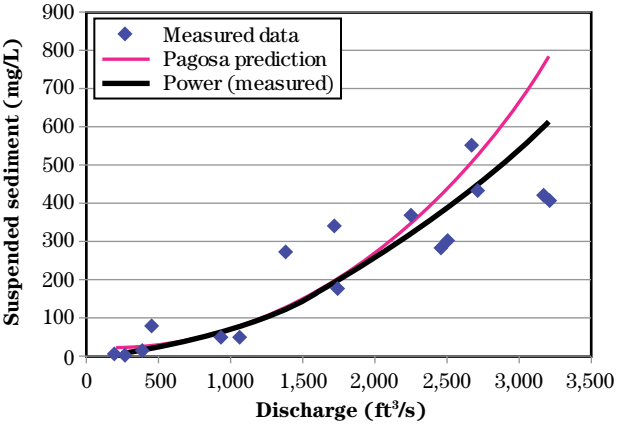


Figure 11–14 Examples of predicted vs. measured suspended sediment data using dimensionless reference curve (data from Emmett 1975)—Continued

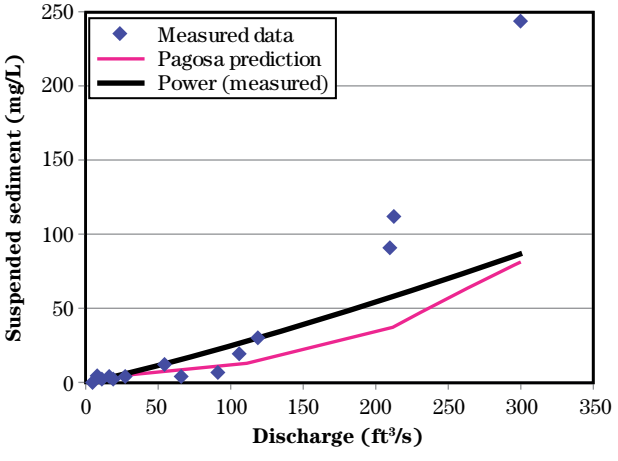
Big Boulder Creek near Clayton, ID 13297500



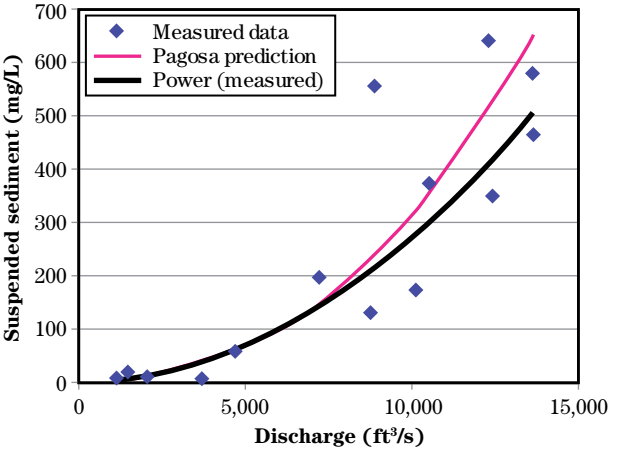
East Fork Salmon River near Clayton, ID 13298000



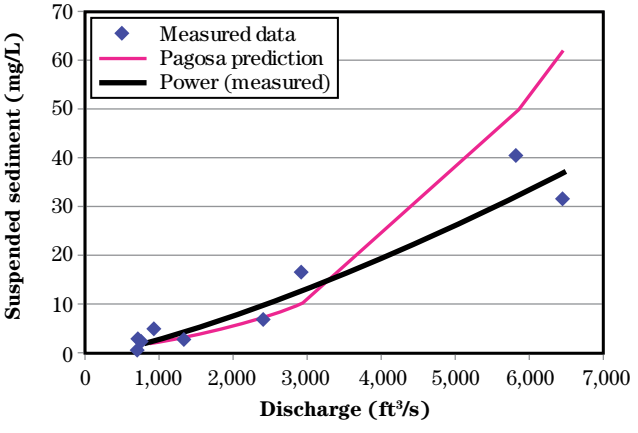
Little Boulder Creek near Clayton, ID 13297450



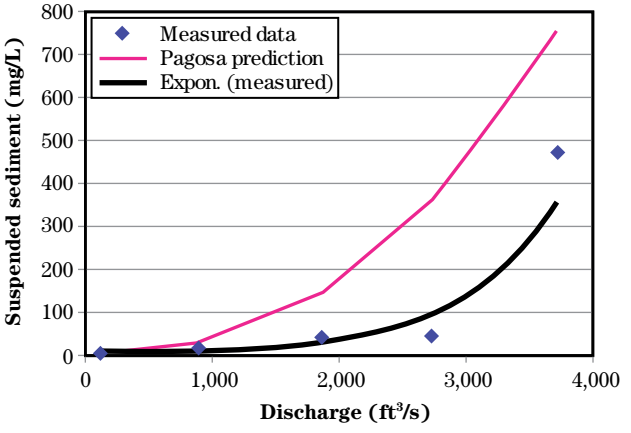
Salmon River near Challis, ID 13298500



Salmon River below Yankee Fork 13296500



Yankee Fork Salmon River near Clayton, ID 1329600



charge. Regional bankfull sediment relations versus drainage area may be substituted if actual bankfull measurements are impossible to obtain, but must be extrapolated from streams of similar lithology, stream type, and stability. Examples of such relations using 1.5-year recurrence interval discharge for suspended sediment are shown in Simon, Dickerson, and Heins (2004). Dimensionless flow-duration curves are also used to produce total annual sediment yield once dimensionless ratio sediment and flow-duration curves are converted to dimensional relations. The examples of predicted sediment rating curves to observed values using a dimensionless sediment rating curve were presented in figures 11–12 to 11–14. Changes in unit stream power (eq. 11–7) are calculated to determine changes in transport rate due to change in depth, slope, and/or velocity. Dimensionless flow-duration curves are used to generate total annual sediment yield from the generated sediment rating curves and bed-load transport by unit stream power.

Streambank erosion—Streambank erosion rate (lateral erosion rate and sediment, tons/yr) is predicted as part of the river stability assessment. The influence of vegetative change, direct disturbance, and other causes of bank instability is quantitatively assessed. One of the major consequences of stream channel instability is accelerated streambank erosion and associated land loss. Fish habitat is adversely affected not only due to increased sediment supply but also by changes in pool quality, substrate materials, imbrication, and other physical habitat loss. Water temperatures are also adversely affected due to increases in width-to-depth ratio due to lateral accretion. The prediction methodology is presented in Rosgen (1996) and in Rosgen (2001d) utilizing a Bank Erodibility Hazard Index (BEHI) and Near Bank Stress (NBS) calculations.

Successional stages of channel evolution—A useful tool at this phase is the determination of various stream type scenarios and stages of channel evolution as depicted in figure 11–15. It is imperative to identify the present stage of the stream and predict the direction and consequence of change. The various stages and scenarios depicted in figure 11–15 assist the observer in this assessment. River channels undergo morphological change due to various disturbance and/or recovery (Rosgen 1996, 2001d, 2005). The assessment phase must identify current states and scenarios. For each state within a scenario, there are specific morphological, sedimentological, hydraulic, and biological relations depicted. The associated interpretations of these relations assist in river assessments.

River stability analysis—Additional stability variables are required for assessment, including the influence of large woody material, flow regime, depositional features, meander patterns, riparian vegetation, and channel stability ratings by stream type, and are summarized in the form shown in table 11–4.

Figure 11–15 Various stream type succession scenarios

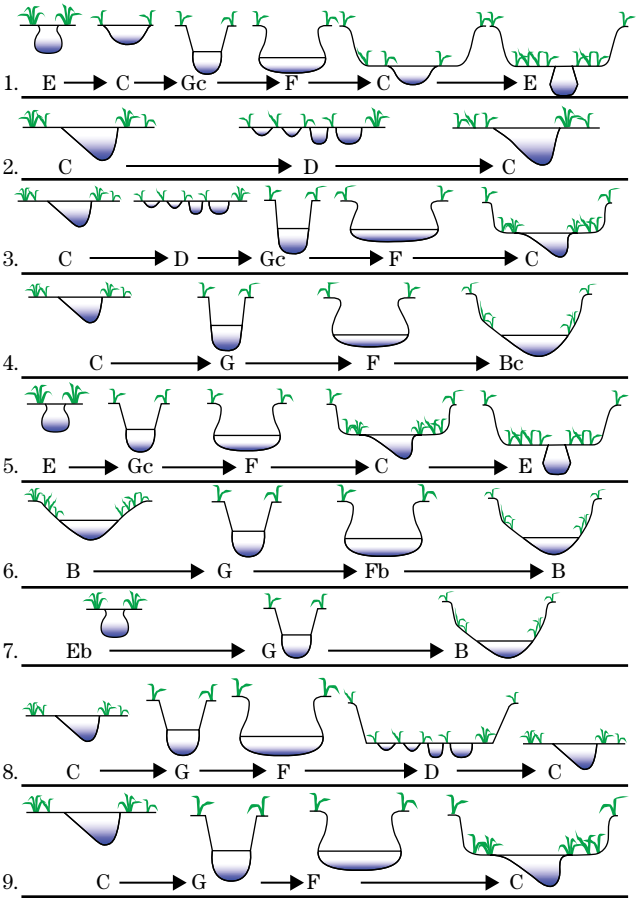


Table 11–4 Stream channel stability assessment summary form

Stream		**Stream**		**Date**		**Observers**								
Level III variables	Stream type		Flow regime		Stream size		Stream order		Meander pattern		Depositional pattern		Debris/channel blockage	
	Riparian vegetation	Current composition/density	Potential composition/density	Altered channel state (dimension, pattern, profile, materials)										
Channel dimension	Mean bankfull depth (ft)		Mean bankfull width (ft)		Cross section area (ft^2)		Remarks							
Channel dimension relationships	Width/depth ratio (W/D)		Reference condition width/depth ratio (W/D_{ref})		(W/D)/(W/D_{ref})		Circle	Stable	Moderately unstable	Unstable	Highly unstable			
Channel pattern	Mean (range)	MWR		Lm/W_{bkf}		Rc/W_{bkf}		Sinuosity						
River profile and bed features	Circle		Riffle/pool	Step/pool	Plane bed	Convergence/divergence	Dune/antidunes/smooth bed							
	Max bankfull depth (ft)	Riffle	Pool	Depth ratio (max/mean)	Riffle	Pool	Pool to pool spacing		Slope	Valley		Average bankfull		
Channel stability rating	Pfankuch rating		Pfankuch adjusted by stream type (use potential/reference reach)											
Bank erosion summary	Length of reach studied (ft)		Annual streambank erosion rate	(ton/yr)	ton/yr/ft	Curved used		Remarks						
Degree of confinement	Reference MWR		MWR/ Reference MWR		Unconfined (1.0–0.80)	Moderately confined (0.79–0.30)	Confined (0.29–0.1)	Severely confined (<0.1)						
Lateral stability	Circle		Stable		Moderately unstable		Unstable	Highly unstable (accelerated lateral erosion)						
Sediment capacity	Sufficient capacity		Insufficient capacity											
Stream channel scour/deposition	Largest particle-bar sample (mm)		τ_{ci}		Existing $depth_{bkf}$		Required $depth_{bkf}$		Existing $slope_{bkf}$		Required $slope_{bkf}$			
Degree of incision	Bank height ratio		Stable (no incision)	Slightly incised	Moderately incised	Deeply incised	Width of flood prone area (ft)		Entrenchment ratio					
Channel enlargement	Circle		Stable		Slight		Moderate		Extensive					
Stream successional stage		→		→		→		→		→		Existing stream state (type)		Potential stream state (type)
Vertical stability	Circle		Stable		Aggradation		Degradation							
Sediment supply (channel source)	Circle		Very high	High	Moderate	Low	Score		Remarks/causes					

Base-level change—A key part of channel stability analysis. Degree of channel incision (lowering of local base level) is determined by the ratio of the lowest bank height divided by maximum bankfull depth, called the bank height ratio. A stream may not be entrenched (vertically constrained), but may be partially incised, leading to entrenchment. A grade-control structure requirement is often associated with partially incised channels (Rosgen 1997a).

Direct disturbance and riparian vegetation—The direct disturbance of stream channels must be offset by correcting dimension, pattern, profile, and often channel materials. Levees adjacent to both banks should be set back allowing room for a flood plain. Riparian vegetation change is not only a major cause of instability and loss of function, but is a key solution in restoration and natural channel design. Riparian vegetation reestablishment should contain the correct overstory and understory species to be compatible for a self-sustaining, long-term solution.

Biological assessments—Biological assessments that describe fish species, food chains, diversity with broad categories of ecoregions, and stream types (habitat units) are currently collected with the assessment level for identifying biological potential. Limiting factor analysis provides information that identifies specific problems that may be corrected by changed management and/or restoration.

It is readily apparent that this procedure involves extensive field observations and an extensive data base followed by a thorough and detailed analysis. All of this must be completed prior to restoration planning, as it forms much of the foundation for what follows.

It is important to understand the various causes of instability responsible for loss of physical and biological function and corresponding loss of value. Recommendations that follow are critically linked to land uses, disturbance regime, and other problem sources. The flowchart (fig. 11–10) depicts the assessment criteria of channel stability.

(d) Phase IV—Passive recommendations for restoration

A first priority in restoration is to seek a natural recovery solution based on changes in the variables causing the instability and/or loss of physical and biological function. Changes in land use management can influence riparian vegetation composition, density and vigor, flow modifications (diversions, storage, and reservoir release schedule modifications based on the operational hydrology), flood control measures, road closures/stabilization, hillslope erosional processes, and other process influences of river stability. Often, a change in management strategies can be very effective in securing stability and function. This often has to be determined based on the recovery potential of various stream types and the short- and long-term goals associated with the stated objectives (including costs). The alternative of self-stabilization is always a key consideration in any stability assessment. The time-trend aerial photography from phase III may help to provide insight into stream recovery potential following disturbance.

Successional stages of channel adjustment (fig. 11–15) can also assist at looking at natural recovery potential. It is very important to ensure that objectives are met through effectiveness monitoring required to provide the documentation on the nature, magnitude, rate, and consequences of natural recovery. If natural recovery potential is poor and/or does not meet specific objectives, phase V would be appropriate (Rosgen geomorphic channel design methodology).

(e) Phase V—The stream restoration and natural channel design using the Rosgen geomorphic channel design methodology

Phase V involves combining the results of the previous phases. A good design can only follow a good assessment. It is preferred not to patch symptoms, but rather provide solutions to restoration that will offset the cause of the problem and allow for the river to be self-maintaining. The practitioner must be very familiar with the processes involved in hydrology, hydraulics, sedimentology, geomorphology, soil science, aquatic habitat, and riparian vegetation. Due to the inherent complexity, it is usually necessary to obtain technical

assistance for assessment and design, depending on the practitioner's experience and training.

The conceptual, generalized flowchart shown in figure 11–16 depicts the general sequence of the mixed use of analog, empirical, and analytical methods in this design procedure. The early sequence is required to determine the existing valley type and potential stream type of the stable form. The proposed channel type must be converted to a dimension, pattern, and profile to initially test whether the hydraulic and sediment relations associated with the watershed are compatible prior to advancing through all of the procedural steps.

The watershed and river assessment that predicts the consequence of streamflow, sediment supply, and channel change is reflected in figure 11–17. The procedure is incorporated into the following sequential analysis steps.

Figure 11–16 Generalized flowchart representing Rosgen geomorphic channel design utilizing analog, analytical, and empirical methodologies

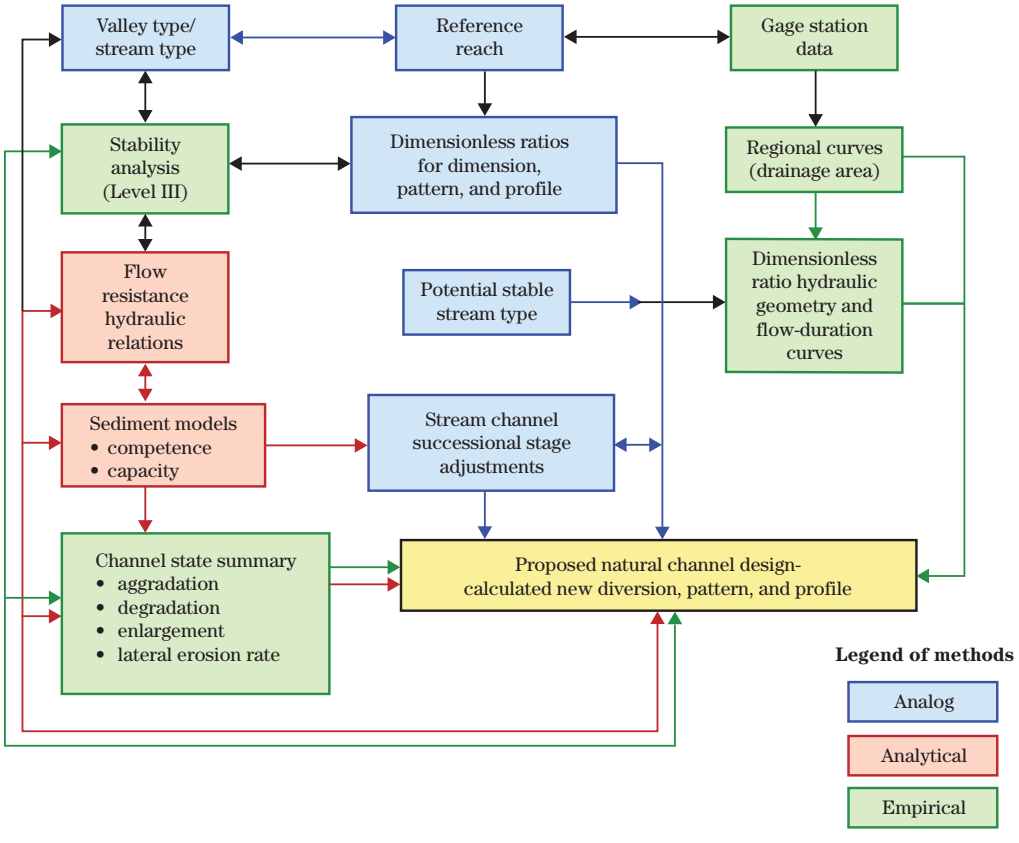
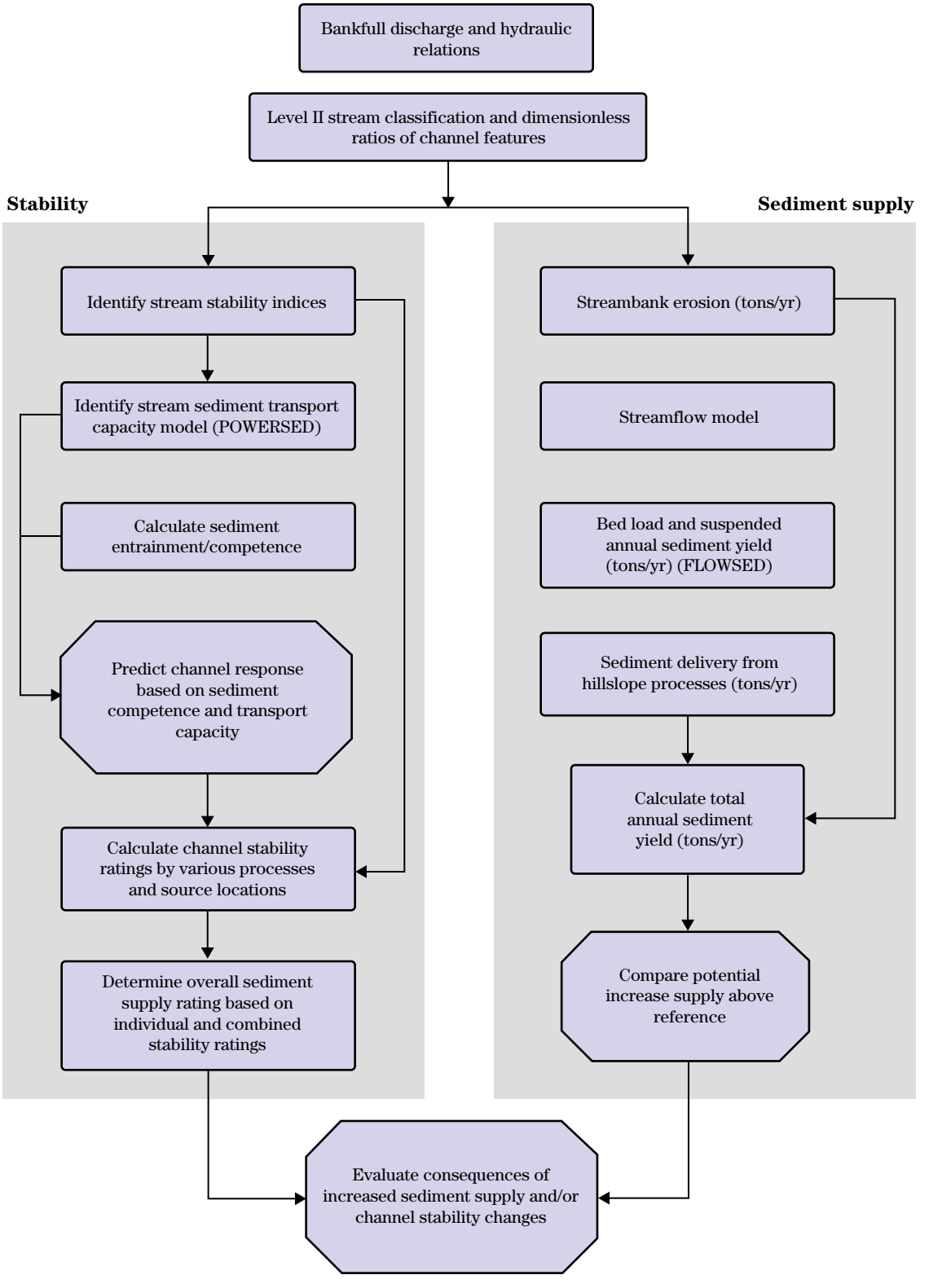


Figure 11–17 Flowchart for determining sediment supply and stability consequences for river assessment



The procedural sequence utilized in the Rosgen geomorphic channel design methodology is shown in the following operational steps:

Step 1 Obtain and/or verify regional curves (bankfull discharge, cross-sectional area, width and depth versus drainage area). The regional curves must be located in the same hydro-physiographic province as that of the restoration reach.

Step 2 Obtain hydraulic geometry (USGS 9–207 forms, summary of current meter measurements) from the gage station stratified by stream type and bed features.

Step 3 Create dimensionless hydraulic geometry by dividing all values by the bankfull value.

Step 4 Obtain flow-duration curves from the gage station for a representative hydro-physiographic region.

Step 5 Create dimensionless flow-duration curve by dividing all flow values by the bankfull discharge.

Step 6 Identify the valley type for the restoration reach(s). Identify stream type(s) of the restoration reach.

Step 7 Obtain corresponding reference reach data for the same valley and stream type. The reference reach is not required to be located within the same watershed or hydro-physiographic province. Examples of the dimensionless ratio and other reference reach data by stream type/valley type are presented in table 11–3.

Step 8 Complete and/or review the stability examination data for the restoration reach (fig. 11–10 and table 11–4). Evaluate variables/states that represent instability relations (width, depth, and slope values that do not meet sediment transport requirements).

Step 9 Select appropriate scenario of successional stages of channel adjustment for channel evolution scenario (fig. 11–15). This determines the stream type of the current state and the potential state to match the valley type. (This step is completed in the stability phase, phase III).

Step 10 Obtain drainage area (mi^2) for the restoration reach.

Step 11 Obtain bankfull cross-sectional area (A_{bkf}) from the regional curves (step 1).

Step 12 Obtain reference reach width-to-depth ratio associated with the stable design stream type commensurate with the valley type (step 7).

Step 13 Calculate design bankfull channel width of riffle reach:

$$W_{bkf} = \left[\left(\frac{W_{bkf}}{d_{bkf}}\right)_{ref} A_{bkf}\right]^{\frac{1}{2}} \qquad \text{(eq. 11– 8)}$$

Step 14 Calculate mean riffle depth:

$$d_{bkf} = \frac{A_{bkf}}{W_{bkf}} \quad \text{or} \quad \left[\frac{W_{bkf}}{\left(\frac{W_{bkf}}{d_{bkf}}\right)_{ref}}\right] \qquad \text{(eq. 11–9)}$$

Step 15 Calculate meander wavelength (Lm) for average and range of values. Obtain meander length ratio average and range of values, where:

$$MLR = \left[\left(\frac{Lm}{W_{bkf}}\right)_{ref}\right] \text{ from reference reach data (step 7, table 11–3).}$$

$$Lm = \left[\left(MLR_{ref}\right)\right] W_{bkf} \text{ (from step 13)} \qquad \text{(eq. 11–10)}$$

Step 16 Calculate belt width (W_{blt}) for average and range of values from meander width ratios (MWR).

$$MWR = \left[\left(\frac{W_{blt}}{W_{bkf}}\right)_{ref}\right] \quad \text{(step 7, table 11–3).}$$

$$W_{blt} = [(MWR)_{ref}]\, W_{bkf} \qquad \text{(eq. 11–11)}$$

Step 17 Calculate radius of curvature (Rc) for average and a range of values from ratio of radius of curvature ratio. (step 7, table 11–3).

$$Rc = \left[\left(\frac{Rc}{W_{bkf}}\right)_{ref}\right] W_{bkf} \qquad \text{(eq. 11–12)}$$

Step 18 Obtain an aerial photo depicting vegetation, channel features and terrain character. Layout the range of values for meander length (Lm), belt width (W_{blt}) and radius of curvature (Rc) on aerial photo or detailed topographic map. Adjust pattern to utilize terrain features and existing vegetation where possible within the range of the

pattern variables. Once the preliminary layout is complete, measure stream length (SL) of the proposed channel. Measure valley length (VL) by following the fall line of the valley, rather than straight line segments between meanders.

Step 19 Calculate sinuosity (k) of the proposed channel where:

$$k = \frac{SL}{VL} \qquad \text{(eq. 11–13)}$$

Step 20 Calculate valley slope (S_{val}). Measure the water surface elevation difference (DE) between the same bed features along the fall line of the valley using valley length (VL), where:

$$S_{val} = \frac{DE}{VL} \qquad \text{(eq. 11–14)}$$

Step 21 Calculate proposed channel average slope (S):

$$S = \frac{S_{val}}{k} \qquad \text{(eq. 11–15)}$$

Step 22 Calculate bankfull channel velocity (u_{bkf}) and check design bankfull discharge with velocity, cross-sectional area (continuity) regional curves:

$$uA = Q \qquad \text{(eq. 11–16)}$$

$$\frac{Q}{A} = u \quad \text{Compare to regional curve (step 1)} \qquad \text{(eq. 11–17)}$$

Steps 23 through 26 Predict stream competence (entrainment) by utilizing particle entrainment computations. A general flowchart depicting the procedural steps is shown in figure 11–18.

First, obtain bar sample gradation from field sampling and sieving procedure upstream of the proposed restoration (Rosgen 1996). A field procedure for bar sampling, pavement/subpavement sample and wet-sieving onsite is presented in tables 11–5 and 11–6. The user is advised to review additional details of particle size sampling by Bunte and Abt (2001). Sediment sampling is also addressed in NEH654 TS13A. Bar samples are field-sieved and recorded in the entrainment worksheet (table 11–7).

The sediment competence computations that determine bed stability (aggradation/degradation) are completed and summarized in table 11–8. This method has shown consistency when actual bed-load/scour chain data are compared to predicted values. Use the value of the largest particle in the bar sample (or subpavement sample), D_{max} in millimeters, and the revised Shields diagram to predict the shear stress required to initiate movement of the largest particle in the bar and/or subpavement (fig. 11–11).

If the protrusion ratios described in equations 11–3 or 11–4 are outside the ranges indicated in table 11–8, the user should use the shear stress equation (eq. 11–2) and apply it with a revised Shields relation using Colorado data or local data if available (fig. 11–11).

$$\tau^* = 0.0834\left(\frac{D_{50}}{\hat{D}_{50}}\right)^{-0.872} \qquad \text{(eq. 11–3)}$$

$$\tau^* = 0.0384\left(\frac{D_{max}}{D_{50}}\right)^{-0.887} \qquad \text{(eq. 11–4)}$$

$$\tau = \gamma RS \qquad \text{(eq. 11–2)}$$

A grain size corresponding with shear stress is selected to determine what sizes the river can potentially move. Based on measured bed-load sizes, in a heterogeneous mixture of bed material comprised of a mixture of sand to gravel and cobble, the previously published Shields relation generally underestimates particle sizes of heterogeneous bed material in the shear stress range of 0.05 pounds per square foot to 1.5 pounds per square foot. The Shields relationship is appropriately used for entrainment sizes below and/or above this value range. Without this adjustment, most computations underestimate the largest sizes of heterogeneous bed material moved during bankfull discharge. The measured data in figure 11–11 indicate the magnitude of the underestimate of particle size entrainment from comparing published relations to measured values.

To determine the ability of the existing stream reach to transport the largest clast size of the bed-load sediment, it is necessary to calculate the bankfull dimensionless shear stress (τ^*). This calculation determines the depth and slope necessary to mobilize and transport the largest particle made available to the channel. The dimensionless shear stress at bankfull stage is used in the entrainment

Figure 11–18 Generalized flowchart depicting procedural steps for sediment competence calculations

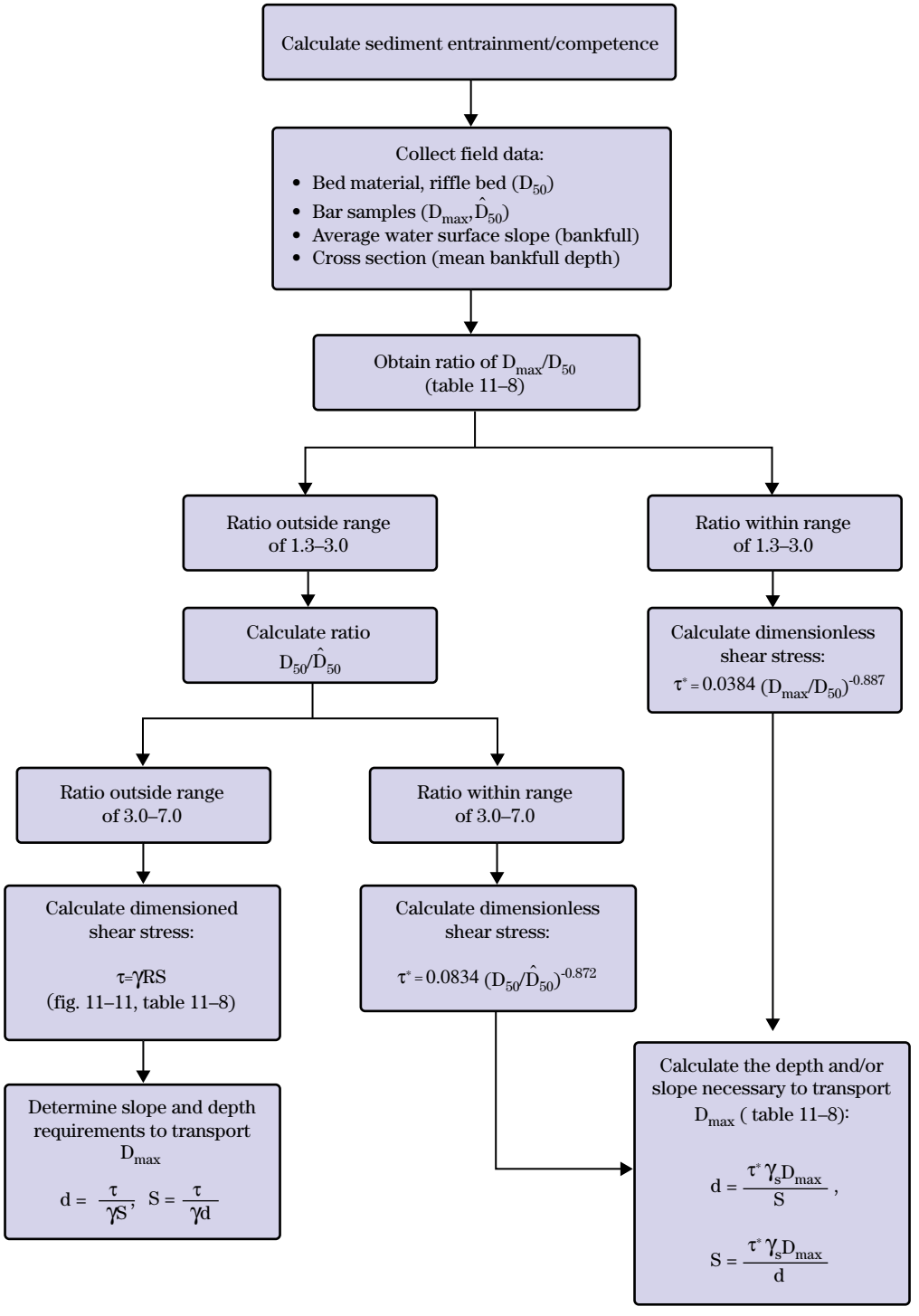


Table 11–5 Field procedure for bar samples*

Bar sample field procedure
Collect sediment core samples from point bars along the project and reference reaches. At least one sample should be collected from each reach associated with a change in stream type. Conduct a critical shear stress analysis using the following procedures: Locate a sampling point on the downstream a third of a meander bend. The sample location on the point bar is halfway between the thalweg elevation (the point of maximum depth) and the bankfull stage elevation. Scan the point bar in this area to determine the sampling location by observing the maximum particles on the surface of the bar. Place a 5-gallon bottomless bucket at the sampling location over one of the representative larger particles that are observed on the lower third of the point bar. Remove the two largest particles from the surface covered by the bottomless bucket. Measure the intermediate axis for each particle and individually weigh the particles. Record these values. The largest particle obtained is D_{max}, the largest particle from the bar sample. Push the bottomless bucket into the bar material. Excavate the materials from the bottomless bucket to a depth that is equal to twice the intermediate axis width of the largest surface particle. Place these materials in a bucket or bag for sieving and weighing. For fine bar materials, follow the directions above, except that when the bottomless bucket is pushed into the bar material, excavate materials from the bucket to a depth of 4 to 6 inches. Place these materials in a bucket or bag for sieving and weighing. Wet-sieve the collected bar materials using water and a standard sieve set with a 2-millimeter screen size for the bottom sieve. Weigh the bucket with sand after draining off as much water as possible. Subtract the tare weight of the bucket to obtain the net weight of the sand. Weigh the sieved materials and record weights (less tare weight) by size class. Be sure to include the intermediate axis measurements and individual weights of the two largest particles that were collected. Determine a material size class distribution for all of the collected materials. The data represents the range of channel materials subject to movement or transport as bed-load sediment materials at bankfull discharge. Plot data; determine size-class indices, D_{16}, D_{35}, D_{50}, D_{84}, D_{95}. The D_{100} should represent the actual intermediate axis width and weight (not the tray size) when plotted. The largest size measured will be plotted at the D_{100} point (Note: $D_{100} = D_{max}$). The intermediate axis measurement of the second largest particle will be the top end of the catch range for the last sieve that retains material (use the record data in the entrainment worksheet, table 11–7). Survey a typical cross section of a riffle reach at a location where the stream is free to adjust its boundaries. Plot the survey data. Determine the hydraulic radius of the cross section. Conduct a Wolman Pebble Count (100 count in riffle) of the bed material in the coarsest portion of the wetted riffle area (active channel). The pebble count should be conducted at multiple transects that represent the riffle. Plot data and determine the size-class indices.

*Sediment sampling is also addressed in NEH654 TS13A.

Table 11–6 Field procedure for pavement/sub-pavement samples

Pavement/subpavement sample field procedure (alternate procedures for obtaining a pavement/sub-pavement sample if you are unable to collect a bar sample)
Locate a sampling point in the same riffle where cross-sectional survey was conducted. The sampling point should be to the left or right of the thalweg, not in the thalweg, in a coarse-grain size portion of the riffle.
Push a 5-gallon bottomless bucket into the riffle at the sampling location to cut off the streamflow. The diameter of the bucket (sample size) should be at least twice the diameter of the largest rock on the bed of the riffle.
Remove the pavement material (surface layer only) by removing the smallest to the coarsest particles. Measure the intermediate axis and weight of the largest and second largest particles. Record these values. Place the remaining pavement materials into a bucket or bag for sieving and weighing.
Remove the sub-pavement material to a depth that is equal to twice the intermediate axis width of the largest particle in the pavement layer, or at least 150-millimeter depth. Caution: if a coarser bed material persists under the sub-pavement, it generally is material remnant of the previous bed. Stop at this condition and do not excavate deeper, even if the depth is not at twice the maximum pavement particle diameter. This residual layer is generally not associated with the size distribution of bed load transported at the bankfull stage. Collect the sub-pavement materials into a separate bucket or a bag. Measure the intermediate axis and weight of the two largest particles in the sub-pavement sample. Record these values. Sieve and weigh the remaining sub-pavement materials. The sub-pavement sample is the equivalent of the bar sample; therefore, use the largest particle from the sub-pavement sample in lieu of the largest particle from a bar sample in the entrainment calculations. Note: If the largest particle collected from the sub-pavement is larger than the pavement layer, the largest rock should be discarded from the sub-pavement layer. Drop back to the next largest particle size to determine the largest particle size to be used in the entrainment calculation.
Wet-sieve the collected pavement materials and then the subpavement materials using water and a standard sieve set with a 2-millimeter screen size for the bottom sieve. Weigh the bucket with sand after draining off as much water as possible. Subtract the tare weight of the bucket to obtain the net weight of the sand.
Weigh the sieved materials and record weights (less tare weight) by size class for both the pavement and sub-pavement samples. Be sure to include the mean intermediate axis width and individual net weights of the two largest particles that were collected (table 11–7).
Determine a material size-class distribution for the materials. The subpavement data represent the range of channel materials subject to movement or transport as bed-load sediment materials at bankfull discharge.
Plot data; determine size-class indices, D_{16}, D_{35}, D_{50}, D_{84}, D_{95}. The D_{100}, should represent the actual intermediate axis width and weight (not the tray size) when plotted. The largest size measured will be plotted at the D_{100} point. (Note: $D_{100} = D_{max}$). The intermediate axis measurement of the second largest particle will be the top end of the catch range for the last sieve that retains material.
The pavement material size class distribution may be used to determine the D_{50} of the riffle bed instead of doing the 100 count in the riffle bed.
Determine the average bankfull slope (approximated by the average water surface slope) for the study reach from the longitudinal profile.
Calculate the bankfull dimensionless shear stress required to mobilize and transport the largest particle from the bar sample (or sub-pavement sample). Use the equations and record the data in the entrainment worksheet (table 11–8).

Table 11–7 Bar sample data collection and sieve analysis form

Point / Side BAR-BULK MATERIALS SAMPLE DATA: Size Distribution Analysis | Party:

Location: | Date: | Notes:

SUB SAMPLES

	Sieve SIZE	Tare Weight	Sample Weights Total	Sample Weights Net
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
Net Wt. Total				
% Grand Tot.				
Accum. % =<				

SURFACE MATERIALS DATA
(Two Largest Particles)

No.	Dia.	WT.
1		
2		

Bucket
+ Materials
Weight_____

Bucket
Tare
Weight_____

Materials
Weight_____
(Materials less than:
_____mm.)

Be Sure to Add Separate Material Weights to Grand Total

GRAND TOTAL SAMPLE WEIGHT

NOTES										

Table 11–8 Sediment competence calculation form to assess bed stability (steps 23–26)

Stream:		Reach:			
Observers:		Date:			
Enter required information					
	D_{50}	Riffle bed material D_{50} (mm)			
	$\hat{D}_{50}$	Bar sample D_{50} (mm)			
	D_{max}	Largest particle from bar sample (ft)		**(mm)**	304.8 mm/ft
	S	Existing bankfull water surface slope (ft/ft)			
	d	Existing bankfull mean depth (ft)			
1.65	γ_s	Submerged specific weight of sediment			
Select the appropriate equation and calculate critical dimensionless shear stress					
	$D_{50}/\hat{D}_{50}$	Range: 3 – 7	Use equation 1:	$\tau^* = 0.0834\left(\frac{D_{50}}{\hat{D}_{50}}\right)^{-0.872}$	
	D_{max}/D_{50}	Range: 1.3 – 3.0	Use equation 2:	$\tau^* = 0.0384\left(\frac{D_{max}}{D_{50}}\right)^{-0.887}$	
	τ^*	Bankfull dimensionless shear stress	Equation used:		
Calculate bankfull mean depth required for entrainment of largest particle in bar sample					
	d	Required bankfull mean depth (ft)	$d = \frac{\tau^* \gamma_s D_{max}}{S}$		
	Circle:	Stable Aggrading Degrading			
Calculate bankfull water surface slope required for entrainment of largest particle in bar sample					
	S	Required bankfull water surface slope (ft/ft)	$s = \frac{\tau^* \gamma_s D_{max}}{d}$		
	Circle:	Stable Aggrading Degrading			
Sediment competence using dimensional shear stress					
	Bankfull shear stress $\tau = \gamma dS$ (lb/ft^2) (substitute hydraulic radius, R, with mean depth, d)				
	Moveable particle size (mm) at bankfull shear stress **(**fig. 11-11**)**				
	Predicted shear stress required to initiate movement of D_{max} (mm) (figure 11-11)				
	Predicted mean depth required to initiate movement of D_{max} (mm)	$d = \frac{\tau}{\gamma S}$			
	Predicted slope required to initiate movement of D_{max} (mm)	$S = \frac{\tau}{\gamma d}$			

analysis for both the reference reach and project reach. This analysis of the reference, stable condition is compared to the potentially disturbed reach. To maintain stability, a stream must be competent to transport the largest size of sediment and have the capacity to transport the load (volume) on an annual basis. These calculations provide a prediction of sediment competence as required in steps 23 through 26.

Step 27 Compute sediment transport capacity. Following this analysis, the depth and/or slope may need to be adjusted by recalculating steps 14 through 27.

FLOWSED and POWERSED are sediment supply/ sediment transport models that predict the following:

- total annual suspended sediment yield
- total annual suspended sand sediment yield
- total annual bed-load sediment yield
- potential aggradation and/or degradation
- flow-related annual sediment yield due to changes in streamflow magnitude and duration

The models are based on the use of dimensionless reference sediment rating and flow-duration curves. The normalization parameters include:

- bankfull discharge
- bankfull stage bed load
- suspended and suspended sand sediment

The appropriate dimensionless sediment curves are selected for representative stream types and stability ratings. The dimensionless flow-duration curves are developed from representative hydrophysiographic province data from USGS stream gage data.

The FLOWSED model reflects sediment supply and generates the total annual sediment yield for both suspended and bed load. Changes in flow are also reflected in flow-duration curves and corresponding sediment yield. To determine annual sediment yield, near-bankfull stage values must be field measured to convert dimensionless sediment and flow-duration curves to actual values.

The POWERSED model compares sediment transport capacity from a stable, reference condition by predicting transport rate change due to channel hydraulics. The hydraulics reflect potential change in morphological variables such as channel width, depth, and slope. The corresponding changes in flow resistance are used to predict velocity, shear stress, and unit stream power (velocity multiplied by shear stress). Sediment rating curves from the FLOWSED model are converted from discharge to unit stream power for a wide range of flows. Revised values of annual sediment transport can then be compared to the reference condition from the subsequent change in the hydraulic geometry of the stream channel and corresponding response in sediment transport. Any flow modifications can also be simulated by revised flow-duration curves.

Detailed descriptions and model tests are provided for FLOWSED/POWERSED in Rosgen (2006). This analysis is complicated and detailed. However, it can be computed by spreadsheet or commercially available computer programs (RIVERMorph® 4.0). The basis of the calculations and model descriptions, however, are described to better understand how the models work. Table 11–9 lists the data required to run the FLOWSED and POWERSED models. With these data, the user can generate average annual sediment yields (tons/yr).

Table 11–9 Data required to run the FLOWSED and POWERSED supply/sediment transport models

Data requirements for FLOWSED/POWERSED
• Background reference data (flow and sediment)
– Dimensionless suspended sediment rating curves by stream type or stability
– Dimensionless bed-load rating curves by stream type or stability
– Dimensionless flow duration (from local or representative hydro-physiographic province)
– Momentary maximum bankfull discharge
– Mean daily bankfull discharge (the mean daily discharge the day bankfull occurs at a gage station)
– Flow-duration curves indicating change in flow regime (increase and/or decrease)
• Field measured values (for both reference and impaired condition)
– Cross section
– Longitudinal profile
– Pebble count on active riffle bed to obtain D_{50} and D_{84} of bed material
– Stream classification (level II)
– Pfankuch channel stability rating
– Measured bankfull discharge (ft^3/s)
– Measured suspended sediment (mg/L)
– Measured suspended sand sediment (mg/L)
– Measured bed-load sediment (kg/s) (Helley-Smith bed-load sampler)

FLOWSED

The FLOWSED model is graphically depicted in figures 11–19 and 11–20. The procedure in table 11–10 and accompanying worksheet depicted in table 11–11 provide a more detailed understanding of the model. The following provides insight into the basis of the model.

Predict runoff response—Several applicable models for runoff exist, including TR–55, WRENSS (EPA 1980), the unit hydrograph approach (U.S. Army Corps of Engineers (USACE) 1998b), and others (EPA 1980; Troendle, Swanson, and Nankervis 2005). This step also considers operational hydrology from reservoirs, diversions, and other flow modifications that influence the magnitude, duration, and timing of streamflow. The input variables for most models are precipitation data, a vegetation alteration map by aspect and elevation, drainage area computations, percent of drainage area in impervious condition, and similar data specified based on the specific model being selected. The output from these models needs to be in the form of flow-duration curves. Flow-duration curves must represent reference conditions (full hydrologic utilization or recovery) and existing departures from reference. Because few stream gages are located on smaller watersheds, dimensionless ratio procedures become essential for data extrapolation in flow models. The data are entered into the flow-duration portion of the FLOWSED worksheet (table 11–11).

Develop dimensionless flow-duration curves—If a water yield model or operational hydrology data with actual flow-duration curve data are not available, it will be necessary to utilize dimensionless flow-duration curves. This information is obtained from gage station data and made dimensionless by dividing the mean daily discharge data by bankfull discharge. Bankfull discharge data are divided into all of the ranges of mean daily discharge and then plotted; see figures 11–9 and 11–21 as an example of the application for Weminuche Creek. The user must develop dimensionless flow-duration curves from gaging stations that represent a hydro-physiographic region similar to the impaired stream being assessed. If the user is applying these relations to a stormflow-generated hydrograph, rather than snowmelt (as in the case of Weminuche Creek), the following changes are recommended:

- Convert bankfull discharge (momentary maximum discharge in ft^3/s) to mean daily bankfull. This is accomplished by obtaining the mean daily discharge on the day during which bankfull discharge occurs. This ratio of mean daily discharge divided by momentary maximum discharge is used to develop the dimensionless flow-duration curves for a stormflow-dominated region. For example, if the mean daily discharge from a gage in a stormflow-dominated hydrograph was 125 cubic feet per second, but bankfull was 550 cubic feet per second, the ratio is 0.227. This ratio would be multiplied by the bankfull discharge from the regional curves or from a flood-frequency curve relation to convert bankfull discharge from a momentary maximum to a mean daily discharge value.

- Divide the mean daily discharge values by mean daily bankfull to establish the dimensionless relations similar to those in figures 11–9 and 11–21.

- Convert from dimensionless to dimensioned mean daily bankfull values. The momentary maximum value must be adjusted by the appropriate ratio, then multiplied by the appropriate ratio value in the dimensionless flow-duration curve. The dimensioned flow-duration curve data are entered into the FLOWSED worksheet (table 11–11). This would be done separately for reference or baseline conditions, and then would be compared to impaired or impacted watershed conditions to calculate annual streamflow and sediment yield.

FLOWSED—Continued

Collect bankfull discharge, suspended sediment, and bed-load sediment—This step is eventually used to convert the reference dimensionless sediment rating curves to actual values. It is very important to capture the bankfull discharge and have several data points to compute an average of the flow and sediment values due to the high spatial and temporal variability of sediment movement. Field methods and equipment used should follow the procedures outlined in book 3, chapter C2 of Field Methods for Measurement of Fluvial Sediment (USGS 1999).

It may be necessary to separate the wash load (silt/clay fraction) from the total suspended sediment load for calculation and interpretation. For channel stability purposes, the silt/clay fraction is not energy limited or hydraulically controlled, and in some settings, it can be subtracted from the suspended sediment yield data for the prediction of potential aggradation. This would not be the case, however, if there were concerns over accelerated fine sediment deposition into extremely low-gradient streams, deltas, reservoirs, lakes, marshes, or estuaries. Colloidal sediments can present problems for impaired waters; thus, wash load may need to be retained in suspended sediment analysis. Enter these measurements in the FLOWSED worksheet (table 11–11).

Obtain or establish reference dimensionless suspended and bed-load rating curves—These curves should be developed for stable reference reach sites representing stable streams. A similar relation can be stratified for poor stability or unstable streams. These reference curves are used to establish sediment rating curves for the calculation of flow-related sediment increases and to establish an annual sediment yield estimate for proportioning contributing sediment sources. The equations for these curve relations are used in the FLOWSED worksheet (table 11–11).

Convert dimensionless suspended and bed-load sediment rating curves to actual (dimensioned) values—Convert dimensionless values by multiplying the field-measured bankfull discharge and sediment values by each of the ratios appropriate for the relation selected. Dimensionless ratio bed-load and suspended rating curves are used to convert data to dimensioned rating curves (fig. 11–20). Examples of dimensioned bed-load and suspended sediment rating curves are shown in figures 11–22 and 11–23 for the Weminuche Creek in Colorado. Tests of this relation are reported in the text in figures 11–13, 11–14, and 11–15, where reference dimensionless rating curves were used to establish sediment rating curves.

If it is not possible to obtain measured bankfull discharge, suspended sediment, and bed-load sediment data to convert dimensionless sediment rating curves to actual values, regional curves can be temporarily substituted. The user must obtain drainage area in square miles to calculate bankfull discharge from a similar hydro-physiographic province. The bankfull flow is used to convert the dimensionless flow-duration to dimensioned flow duration. The bankfull discharge is also used to convert the dimensionless discharge portion of the dimensionless bed-load and suspended rating curve to actual values. The sediment data obtained from the drainage area must be derived from existing measured bankfull suspended sediment and bed-load sediment data, then converted to unit area sediment values from the corresponding drainage area. These data need to represent the same lithology, stream type and stability condition of the stream being evaluated. These data are entered in the FLOWSED worksheet (table 11–11).

An example of unit area suspended sediment data from USGS sites throughout the United States is shown in Simon, Dickerson, and Heins (2004). These measured sediment values were separated by evolutionary stages. Additional stability or stream type data may help to identify appropriate relations for extrapolation. This drainage area extrapolation procedure represents only an interim procedure until measured bankfull values can be obtained.

FLOWSED—Continued

Convert dimensionless flow duration to dimensioned flow duration—The bankfull discharge is multiplied by each of the ratios to convert dimensionless data to actual discharge values representing mean daily discharge for each percentile. An example of a dimensioned flow-duration curve using bankfull discharge to convert from the dimensionless relation (fig. 11–21) is shown in figure 11–24.

Calculate annual sediment yield for both suspended and bed-load sediment—This is accomplished by taking the dimensioned flow-duration curve and multiplying flow increments for duration of time in days by the sediment yield associated with that flow. Enter these calculations in the FLOWSED worksheet (table 11–11).

Calculate flow-related sediment yield—This calculation is accomplished using the output of the flow-duration curves showing the increase in magnitude and duration of flow. The post-treatment flows are routed through the calculation in the FLOWSED worksheet (table 11–11). The excess water calculation output from the WRENSS snowmelt model (EPA 1980) or a similar model integrates the flow with flow-duration changes. Dimensionless flow-duration curves are also converted to dimensioned values by multiplication of the bankfull discharge value. Reference conditions for watersheds in relative hydrologic recovery are compared to watersheds where streamflow has been increased or decreased by change in vegetation or by reservoirs and/or diversions.

Stormflow models, such as TR–55, need to be used to compute new bankfull values, converting dimensionless values to new dimensioned flow durations. It is important to calibrate the bankfull discharge, as the precipitation probability for a given antecedent moisture content and runoff curve number that generates the bankfull discharge needs to be determined. Any greater flow will be distributed on flood plains or a flood-prone area if the stream is not entrenched. Thus, flow-related sediment changes are determined by the use of dimensionless sediment rating curves and dimensionless flow-duration curves. Other appropriate models can also be used for this step, based on the user's familiarity with the various models selected. The output required, regardless of the model, is bankfull discharge and pre- and post-treatment flow-duration curves.

Figure 11–19 General overview of the FLOWSED model

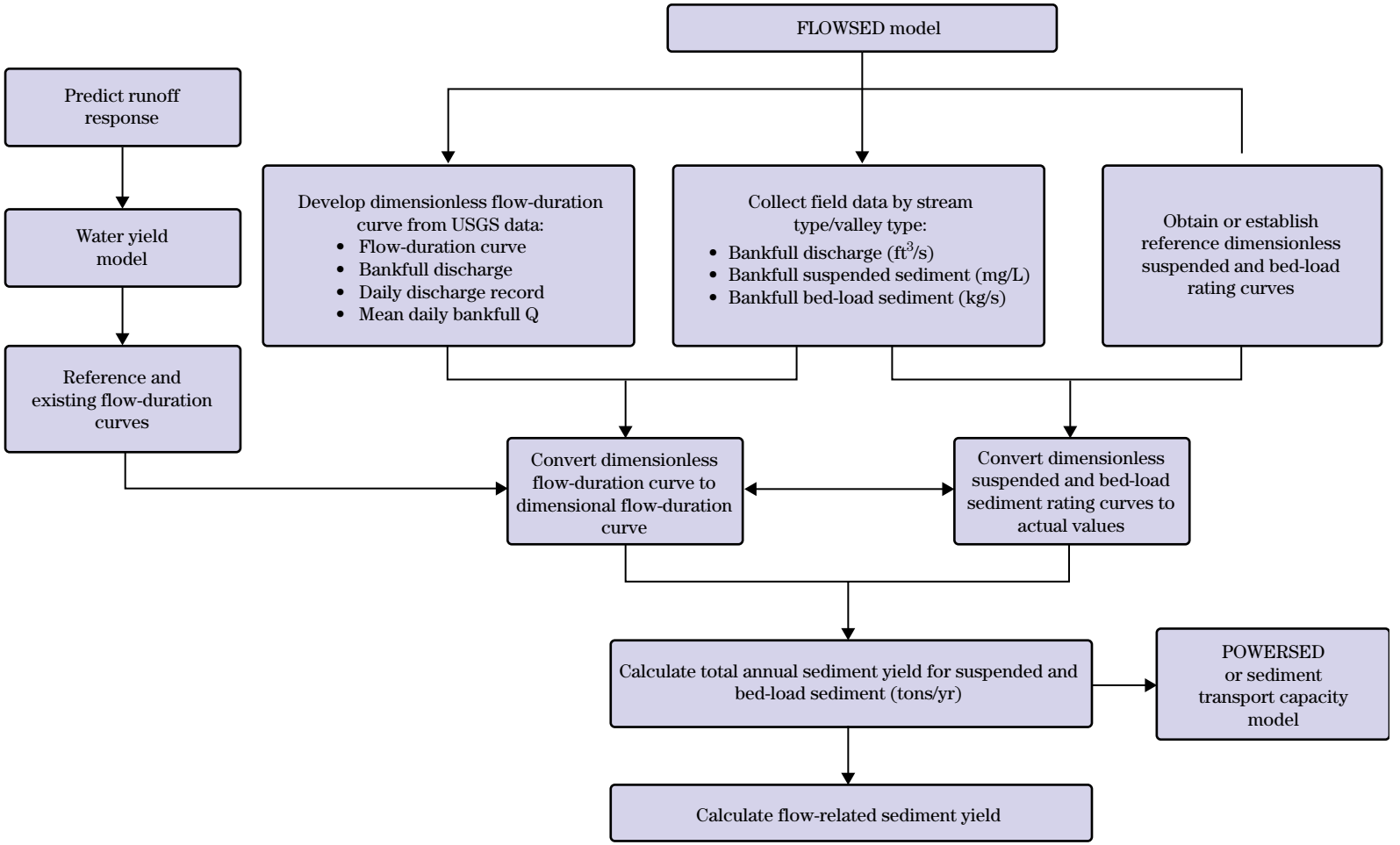


Figure 11–20 Graphical depiction of the FLOWSED model

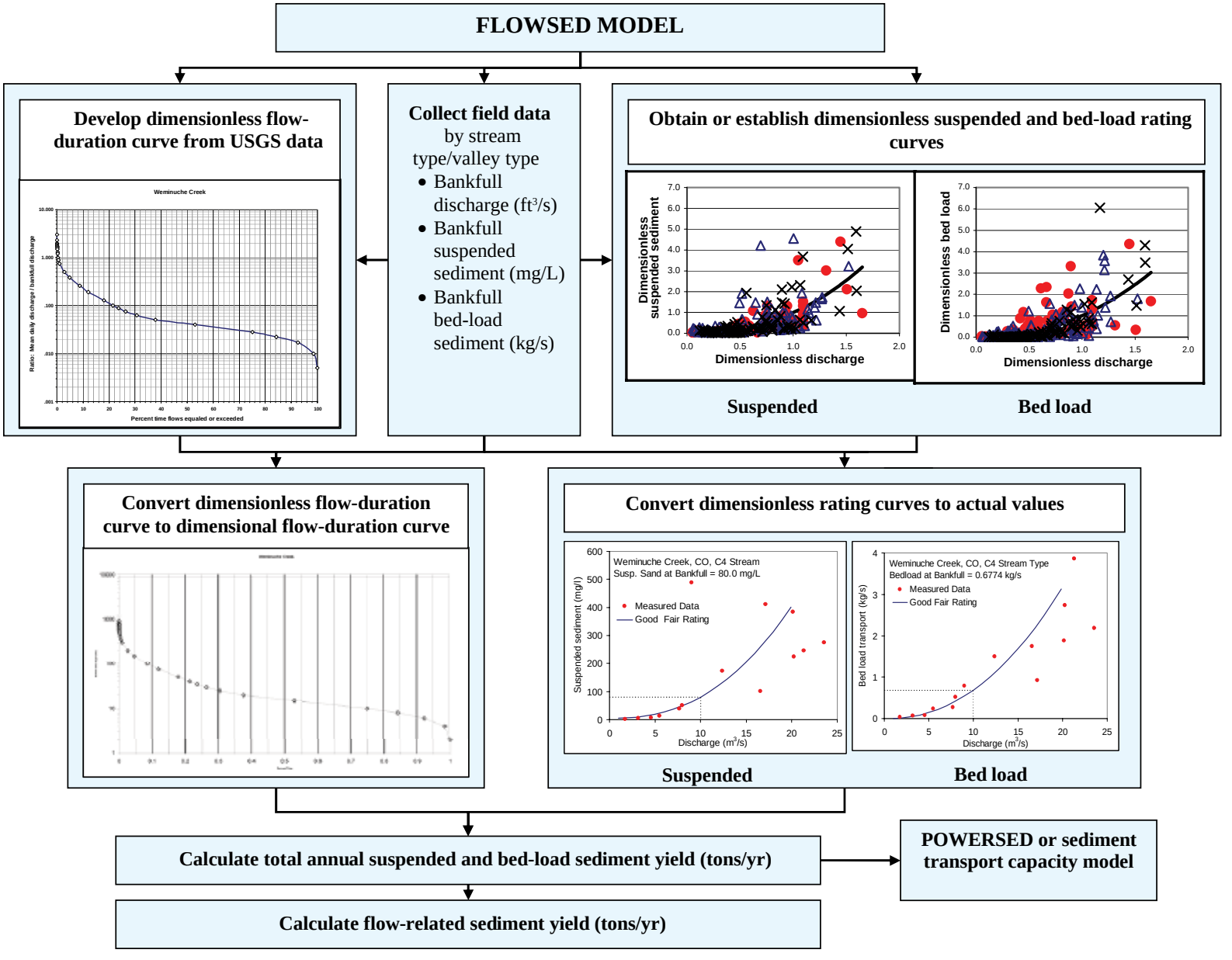


Table 11–10 FLOWSED model procedure to calculate annual bed-load and suspended sediment yield

FLOWSED procedure	
FS–1	Measure stream cross section (on riffle), profile, pattern, and materials.
FS–2	Measure bankfull width, mean depth, and velocity, and compute discharge.
FS–3	Measure suspended sediment at the bankfull stage; separate wash load in lab
FS–4	Measure bed-load sediment at the bankfull stage, sieve particle sizes, and measure largest size.
FS–5	Compute average water surface slope.
FS–6	Collect point bar sample, weigh by size fraction and record D_{50} and largest size (D_{max}).
FS–7	Collect pebble count on active riffle bed: obtain D_{50}, D_{84} sizes (mm).
FS–8	Determine stream type.
FS–9	Conduct channel stability assessment procedure, including Pfankuch channel stability rating.
FS–10	Obtain reference dimensionless bed-load sediment rating curve for appropriate stream type/stability rating.
FS–11	Obtain reference dimensionless suspended sediment rating curve for appropriate stream type/stability rating.
FS–12	Determine ratio of wash load/suspended sediment by Q/Q_{bkf} relation.
FS–13	Construct a bed-load rating curve (enter range of Q/Q_{bkf} ratios into the reference bed-load relation from step 10 and multiply by the measured bankfull bed load from step 4).
FS–14	Construct suspended sediment rating curve in the same manner as in step 13 using reference dimensionless sediment relations (step 11) and bankfull suspended sediment (step 3).
FS–15	Construct a suspended sediment rating curve less wash load (silt/clay) for potential settleable sediment by multiplying ratio of wash load/suspended sediment for appropriate Q/Q_{bkf}.
FS–16	Convert suspended sediment less wash load from mg/L to tons/day on rating curve: tons/d = $0.0027 \times ft^3/s \times mg/L$.
FS–17	Convert suspended sediment less wash load from mg/L to tons/d as in step 16.
FS–18	Convert bed load in lb/s to tons/d, where tons/d = (lb×86,400)/2000 (if metric, convert kg/s to lb/s by multiplying by 2.205).
FS–19	Obtain dimensionless flow-duration curve from either water yield model or regionalized relation.
FS–20	Develop the dimensionless flow-duration curves using the normalization parameter of mean daily bankfull discharge, rather than momentary maximum values from flood-frequency data. Divide the mean daily discharge (the day bankfull discharge occurs) by the momentary maximum value to determine the appropriate conversion ratio.
FS–21	Convert dimensionless flow-duration curve to actual flow by multiplying bankfull discharge (step 2) times the Q/Q_{bkf} ratios from dimensionless flow-duration curve (step 19).
FS–22	Calculate total annual sediment yield for suspended sediment, suspended sediment less wash load, and bed load from sediment rating curve/flow-duration curve procedure (table 11–11). Obtain flow from the water yield model for hydraulically recovered condition to compare departure from existing/proposed condition (step 22). This represents the pre-treatment flow duration/sediment relation.
FS–23	To determine flow-related increase in sediment, multiply post-treatment flow-duration curve times appropriate sediment rating curves for suspended, bed-load and total sediment rating curves to calculate total annual sediment yield using the same procedure as step 21 (table 11–11).

Table 11–11 FLOWSED calculation of total annual sediment yield

Stream: **Notes:**

From flow-duration curve						From sediment rating curves					Calculate	Calculate daily mean sediment yield				
Flow exceedance	Daily mean discharge	Mid-ordinate streamflow	Increment	Mid-ordinate streamflow	Dimensionless streamflow	Dimensionless suspended sediment discharge	Suspended sediment discharge	Suspended sediment minus wash load	Dimensionless bed-load discharge	Bed load	Time adjusted streamflow	Suspended sediment	Suspended sediment minus wash load	Bed load	Bed load plus suspended	Bed load plus suspended minus wash load
(%)	(ft^3/s)	(%)	(%)	(ft^3/s)	(Q/Q_{bkf})	(S/S_{bkf})	(tons/d)	(tons/d)	(b_s/b_{bkf})	(tons/d)	(ft^3/s)	(tons/d)	(tons/d)	(tons/d)	(tons/d)	(tons/d)
									Annual totals:		(acre-ft)	tons/yr)	(tons/yr)	(tons/yr)	(tons/yr)	(tons/yr)

Bankfull discharge (ft^3/s)	
Bankfull bed load (kg/s)	
Bankfull suspended (mg/L)	

Dimensionless sediment rating curve used

Type	Intercept	Coefficient	Exponent	X	Y	Form	Notes
Bed load							
Suspended							

Figure 11–21 Dimensionless flow-duration curve for Weminuche Creek, CO

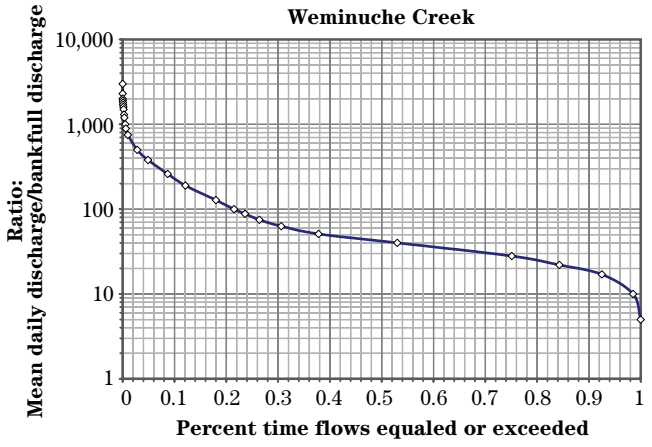


Figure 11–22 Bed-load sediment rating curve for Weminuche Creek, CO

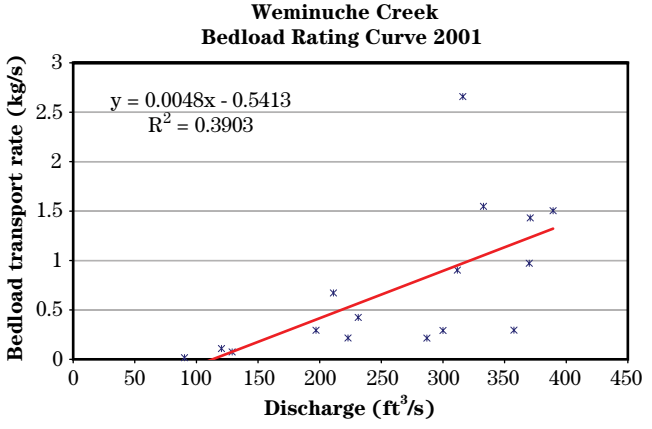


Figure 11–23 Suspended sediment rating curve for Weminuche Creek, CO

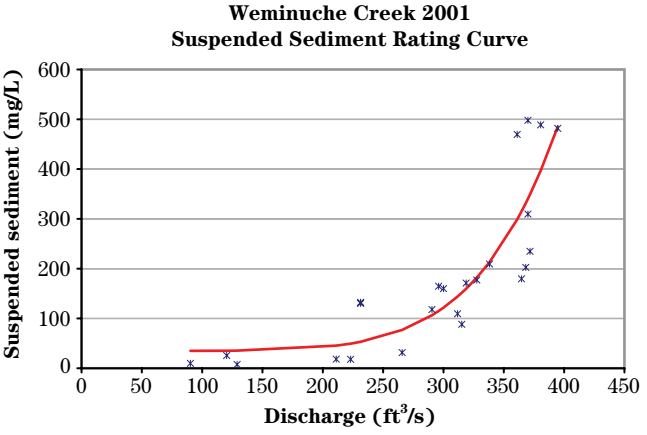
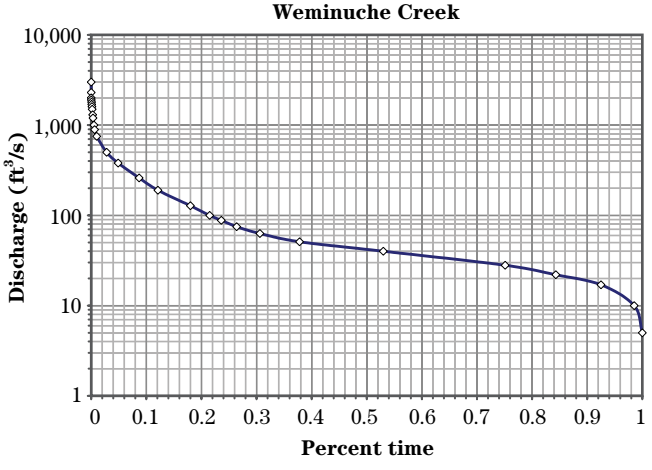


Figure 11–24 Dimensioned flow-duration curve for Weminuche Creek, CO



POWERSED

A generalized flowchart depicting the POWERSED model is shown in figure 11–25, and a graphical depiction of the model is shown in figure 11–26.

Evaluate channel characteristics that change hydraulic and morphological variables—Changes in the cross section and/or pattern (slope) for potentially impaired reaches are measured to determine width, depth, slope and calculated velocity. Comparisons are made between hydraulic characteristics of the reference versus the impaired reach. This analysis is used in the bed-load transport model (POWERSED) or in a comparable bed-load model selected by the user. Shear stress and unit stream power are calculated using equations 11–2 and 11–7:

$$\tau=\gamma dS \qquad \text{(eq. 11–2)}$$

where:
γ = specific weight of the fluid
d = mean depth
S = water surface slope

Unit stream power or power per unit of streambed area (ω_a) is defined as:

$$\omega_a=\tau u \qquad \text{(eq. 11–7)}$$

where:
τ = bankfull shear stress (lb/ft^2)
u = mean velocity

POWERSED can be used to simulate hydraulic geometry (width, depth, slope, velocity, and discharge) for a wide range of stages for reference and impaired reach hydraulic evaluations. POWERSED can also be used to compute changes in hydraulic character due to modified channel dimension, pattern, profile or materials. This information is used to determine changes in unit stream power for increased or decreased discharge. This model predicts channel stability response to imposed sediment load, change in flow, and/or change in distribution of energy due to channel change. The model determines sediment transport and predicts aggradation, stability, or degradation, depending on the nature and extent of the channel and/or flow change. The hydraulic/sediment departure is compared to the corresponding reference or stable condition. A recent comparison of predicted to observed values on an independent data set was shown in Rosgen (2006) where predicted annual sediment yield values were predicted within 3 percent of measured values for a C4 stream type and within 6 percent of measured values for a D4 stream type on Weminuche Creek, Colorado.

Calculate bed-load and suspended sand-bedmaterial load transport (stream power)—Bed load and suspended sand-bed material load transport calculations may use various equations, such as the Bagnold equation. The POWERSED model (figs. 11–25, 11–26 and tables 11–12 and 11–13) assists in the analysis of sediment transport and channel response. This model was developed to predict the effects of channel instability and sediment supply changes in sediment transport. Other bed-load and suspended sand-bed material load transport models can be employed by the user, based on familiarity with and calibration/validation of the model for application to the particular stream types being analyzed.

The POWERSED model applies the suspended sand-bed material and bed-load sediment rating curves/flow duration/revised unit stream power-transport curves or a comparable model selected by the user to predict sediment transport and channel stability. The prediction includes river stability and total annual bed-load sediment yield in tons/year. The equations or computer program generates a change in coarse bed-load transport that will be influenced by changes in channel cross section and/or slope. Changes in streamflow, velocity, unit stream power, critical dimensionless shear stress, and other variables due to land use changes predict changes

POWERSED—Continued

in river stability and total annual bed-load sediment yield. The sediment supply component is predicted using the FLOWSED model and is derived from dimensionless bed-load and suspended sediment rating curves for corresponding stream and stability types. These changes are compared to stable reference conditions for a departure comparison.

Procedural steps for computations of the POWERSED model are presented in table 11–12. Bed-load transport and suspended sand-bed material load is calculated using the POWERSED worksheet (table 11–13).

The POWERSED model is used to predict the transport rate and capacity for each reach independently. Reaches may be stable (sediment in versus sediment out), aggrading, or degrading. The model identifies reaches that may have serious instabilities due to changes in sediment supply and/or hydraulic characteristics. The analysis assists in pinpointing various river reaches for mitigation. The sediment transport changes reflect the sediment supply of the existing condition compared to the reference condition. Annual streambank erosion rates and other sources are compared to the total annual sediment yield.

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Figure 11–25 POWERSED model to predict bed-load and suspended sand-bed-material load transport

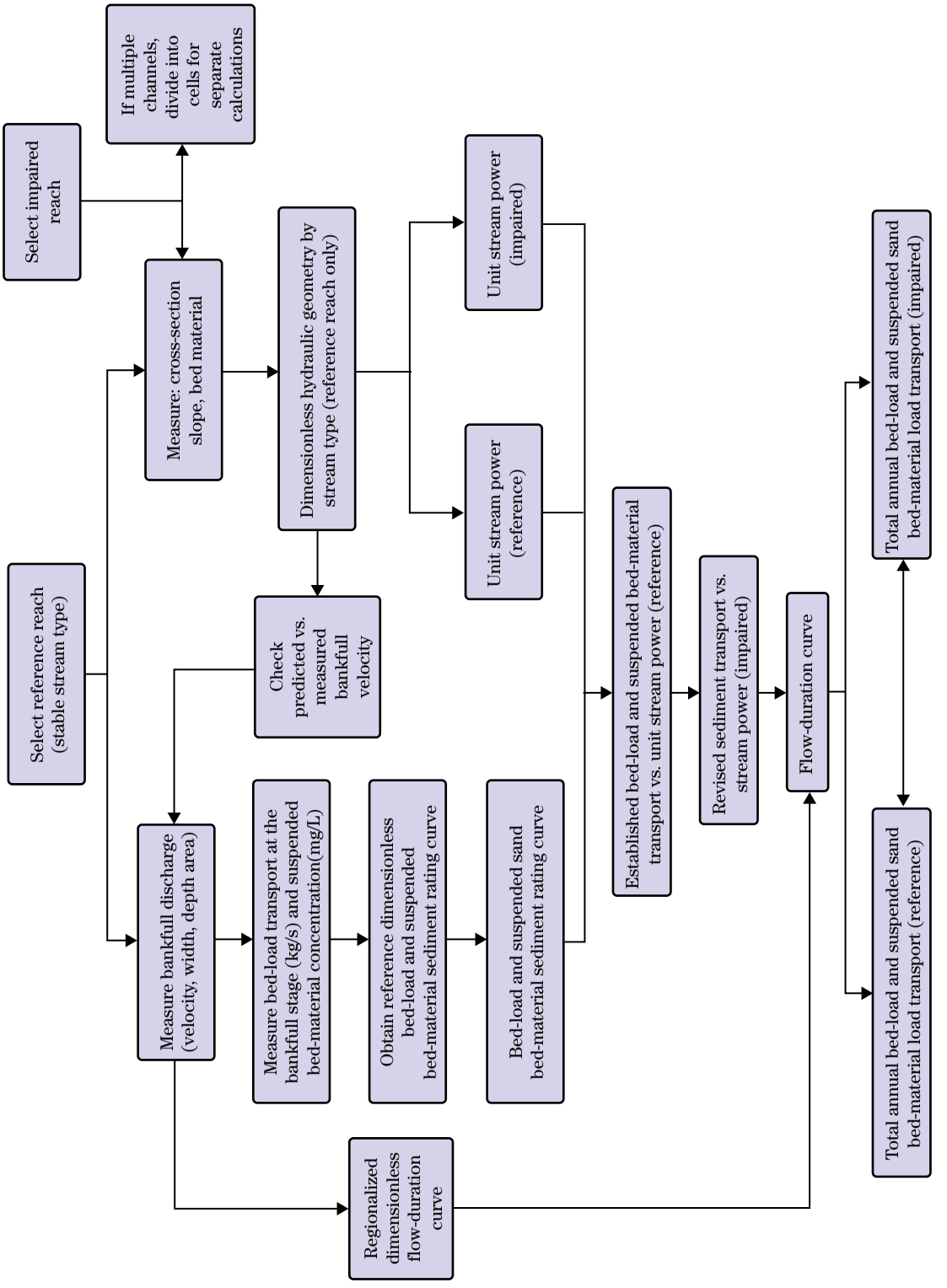


Figure 11–26 Graphical depiction of POWERSED model

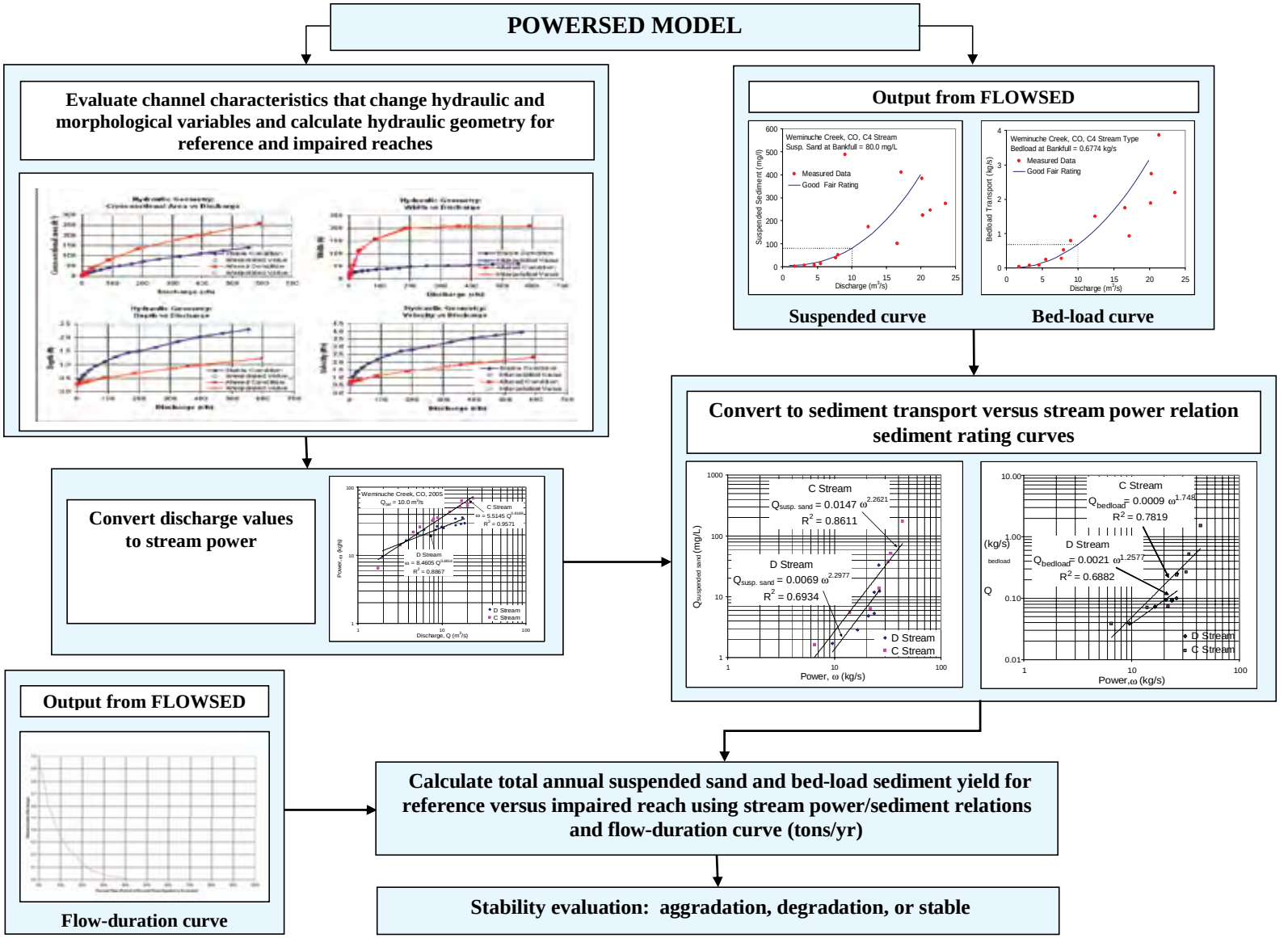


Table 11–12 POWERSED procedural steps of predicted bed-load and suspended sand-bed material transport changes due to alterations of channel dimension or slope (same stream with different bankfull discharges)

POWERSED procedure	
PS–1	Select a reference reach: a. Survey a stable cross section; measure the stream gradient and bed material. b. Measure bankfull discharge (ft^3/s). c. Measure bankfull bed load (kg/s).
PS–2	Obtain an appropriate dimensionless bed load and suspended sand sediment rating curve: a. Construct a dimensional bed load and suspended sand sediment rating curve for the defined range of flow using the measured bankfull discharge, bankfull bed load transport and suspended sand-bed material load.
PS–3	Obtain the drainage area of the reference reach: a. Predict bankfull discharge and cross-sectional dimensions using regional curves. b. Validate the regional curves using the measured bankfull discharge and cross-sectional dimensions.
PS–4	Use dimensionless hydraulic geometry by stream type to predict the hydraulic geometry of the stable cross section for a full range of discharge (baseflow to above bankfull): a. Construct hydraulic geometry curves. b. Check predicted versus measured bankfull velocity. c. Obtain hydraulic geometry for each discharge value within the defined range of flow. d. Calculate unit stream power for each discharge value within the defined range of flow.
PS–5	Select an impaired reach on the same stream: a. Obtain the drainage area. b. Predict bankfull discharge from the validated regional curve. c. Survey the cross section, and measure the stream gradient and bed material.
PS–6	Obtain the stable (potential) dimension, pattern, and profile for the impaired reach. If reference reach is not immediately upstream and/or is of different size or drainage area, complete the following procedure: a. Slope = valley slope/sinuosity. b. Obtain appropriate cross-sectional area from regional curve. c. Obtain width-to-depth ratio (W/d) from reference dimensionless ratios by stream type. d. Calculate appropriate width.
PS–7	Use the RIVERMorph® procedure or applicable spreadsheet calculations to predict the hydraulic geometry of the impaired and potential cross sections for a full range of discharge (baseflow to above bankfull). Follow the step below for the impaired and potential cross sections: a. Construct hydraulic geometry curves. b. Obtain hydraulic geometry for each discharge value within the defined range of flow. * If channel has multiple channels, divide the channels into thirds and treat as a separate channel c. Calculate unit stream power for each discharge value within the defined range of flow.
PS–8	Plot unit stream power vs. bed load and suspended sand-bed material transport for the stable cross section.
PS–9	Construct a unit stream power versus bed-load transport curve for the impaired and potential cross sections using the relationship constructed in step 8.
PS–10	Obtain a dimensionless flow-duration curve for the appropriate region: a. Create a dimensional flow-duration curve using the bankfull discharge for the stable reach. b. Create a dimensional flow-duration curve using the bankfull discharge for the impaired reach.

Table 11–12 POWERSED procedural steps of predicted bed-load and suspended sand-bed material transport changes due to alterations of channel dimension or slope (same stream with different bankfull discharges)—Continued

POWERSED procedure	
PS–11	Calculate total annual sediment yield (bed-load and suspended sand-bed-material load) in tons/yr for all three (stable, impaired, potential) cross sections using the appropriate flow-duration curve: a. Convert the predicted bed-load transport for each discharge value within the defined range of flow from kg/s to tons/d by multiplying kg/s by 95.24. Convert values of suspended sand-bed material load in mg/L to tons/d by multiplying (mg/L)(.0027)(ft^3/s). b. Multiply the predicted bed-load and suspended sand-bed material load transport (tons/d) by the percent time factor from flow-duration curve. c. Sum the time adjusted bed-load transport and multiply by 365 days to obtain annual bed load yield in tons/yr. d. Divide the annual yield for both bed-load and suspended sand-bed material load by the drainage area to obtain the annual unit area bed-load and suspended sand-bed material load yield (tons/yr/mi^2). e. Compare the annual unit area bed-load and suspended sand-bed material load yield predicted for all three conditions (stable, impaired and potential).
PS–12	Record data for impacted and reference condition (separately) in POWERSED worksheet (table 11–13).

Table 11–13 POWERSED model to predict bed-load and suspended sand and bed-material load transport*

Stream:	Gage station#:	Date:

Equation type	B0	B1	B2	Form	Equation name	Enter equation number (1 or 2)	Bankfull discharge (ft^3/s)	Bankfull bed load (lb/s)	Suspended bed-material load (mg/L)
1 Dimensional									
2 Dimensionless									
3 Bed load									
4 Suspended sand-bed concentration									

Flow-duration curve		Calculate	Hydraulic geometry				Measure	Calculate								
Exceedance probability	Daily mean discharge	Mid-ordinate streamflow	Area	Width	Depth	Velocity	Slope	Shear stress	Stream power	Unit power	Time increment	Daily mean bed-load transport	Time adjusted bed-load transport	Daily mean suspended transport	Time adjusted suspended transport	Time adjusted total transport
(%)	(ft^3/s)	(ft^3/s)	(ft^2)	(ft)	(ft)	(ft/s)	(ft/ft)	(lb/ft^2)	(lb/s)	(lb/ft/s)	(%)	(tons/d)	(tons)	(tons/d)	(tons)	(tons)
											Annual total sediment yield (tons/yr):					

*Use this model for both reference and impaired conditions separately. Calculate bed load separately from suspended bed-material load.

Step 28 Obtain maximum bankfull riffle depth (d_{max}) from ratio of maximum riffle depth divided by mean bankfull depth from dimensionless ratios of reference reach data (step 7) (table 11–3).

$$d_{mbkf} = \left[\left(\frac{d_{mbkf}}{d_{bkf}}\right)_{ref}\right] d_{bkf} \qquad \text{(eq. 11–18)}$$

Step 29 Determine entrenchment ratio of proposed channel by measuring the width of the flood-prone area at an elevation of twice the maximum bankfull depth ($d_{max\ bkf}$). Entrenchment ratio is calculated by:

$$ER = \frac{W_{fpa}}{W_{bkf}} \qquad \text{(eq. 11–19)}$$

Step 30 Calculate flood-prone area capacity. This involves estimating velocity associated with the cross-sectional area and slope of the stream channel and flood-prone area. Determine cross-sectional area of the flood-prone area. Plot the bankfull cross-section and flood-prone area elevation ($2 \times d_{max\ bkf}$) and width. Use valley slope for hydraulic calculations for the flood-prone area. Estimate roughness from Manning's equation based on vegetative cover and other roughness elements. HEC–2, HEC–RAS, or other models can be used to obtain the corresponding discharge of the flood-prone area. Calculate the 50- and 100-year flood levels based on the proposed design. Use the bankfull channel capacity from step 22.

Step 31 Calculate depth of pool (ratios from table 11–3):

$$d_{mbkfp} = \left[\left(\frac{d_{mbkfp}}{d_{bkf}}\right)_{ref}\right] d_{bkf} \qquad \text{(eq. 11–20)}$$

Step 32 Calculate depth of glide (ratios from table 11–3):

$$d_g = \left[\left(\frac{d_g}{d_{bkf}}\right)_{ref}\right] (d_{bkf}) \qquad \text{(eq. 11–21)}$$

Step 33 Calculate depth of run (ratios from table 11–3):

$$d_{run} = \left[\left(\frac{d_{run}}{d_{bkf}}\right)_{ref}\right] (d_{bkf}) \qquad \text{(eq. 11–22)}$$

Step 34 Calculate slope of pool (ratios from table 11–3):

$$S_p = \left[\left(\frac{S_p}{S}\right)_{ref}\right] S \qquad \text{(eq. 11–23)}$$

Step 35 Calculate slope of glide (ratios from table 11–3):

$$S_g = \left[\left(\frac{S_g}{S}\right)_{ref}\right] S \qquad \text{(eq. 11–24)}$$

Step 36 Calculate slope of run (ratios from table 11–3):

$$S_{run} = \left[\left(\frac{S_{run}}{S}\right)_{ref}\right] S \qquad \text{(eq. 11–25)}$$

Step 37 Calculate pool-pool spacing (from plan view and profile layout).

Step 38 Design stabilization/fish habitat enhancement measures (grade control, energy dissipation, bank stability, holding cover). See phase VI.

Step 39 Prepare revegetation plan compatible with native plants, soil, and site conditions. Make recommendations on vegetative maintenance and management for long-term solutions.

Step 40 Design a monitoring plan including effectiveness, validation, and implementation monitoring. Prepare maintenance plan to ensure long-term success.

The variables associated with existing, proposed, gage station, and reference reach data are summarized in the form as demonstrated in table 11–14 (Rosgen 1998). The variables used in table 11–14 and forms used in field data collection are in the Reference Reach Field Book (Rosgen, Leopold, and Silvey 1998; Rosgen and Silvey 2005).

Table 11–14 Morphological characteristics of the existing and proposed channel with gage station and reference reach data

Restoration site (name of stream and location):
Reference reach (name of stream and location):

Variables		Existing channel	Proposed reach	USGS station	Reference reach
1	Stream type				
2	Drainage area, mi^2				
3	Mean riffle depth, ft (d_{bkf})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
4	Riffle width, ft (W_{bkf})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
5	Width-to-depth ratio (W_{bkf}/d_{bkf})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
6	Riffle cross-sectional area, ft^2 (A_{bkf})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
7	Max riffle depth (d_{mbkf})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
8	Max riffle depth/mean riffle depth (d_{mbkf}/d_{bkf})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
9	Mean pool depth, ft (d_{bkfp})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
10	Mean pool depth/mean riffle depth	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
11	Pool width, ft (W_{bkfp})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
12	Pool width/riffle width	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
13	Pool cross-sectional area, ft^2 (A_{bkfp})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
14	Pool area/riffle area	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
15	Max pool depth (d_{mbkfp})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
16	Max pool depth/mean riffle depth (d_{mbkfp}/d_{bkf})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:

Table 11–14 Morphological characteristics of the existing and proposed channel with gage station and reference reach data—Continued

Variables		Existing channel	Proposed reach	USGS station	Reference reach
17	Low bank height (LBH)	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
18	Low bank height to max riffle depth (LBH/d_{mbkf})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
19	Width of flood-prone area, ft (W_{fpa})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
20	Entrenchment ratio (W_{fpa}/W_{bkf})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
21	Point bar slope	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
22	Bankfull mean velocity, ft/s (u_{bkf})				
23	Bankfull discharge, ft^3/s (Q_{bkf})				
24	Meander length, ft (Lm)	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
25	Meander length ratio (Lm/W_{bkf})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
26	Radius of curvature, ft (Rc)	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
27	Ratio of radius of curvature to bankfull width (Rc/W_{bkf})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
28	Belt width, ft (W_{blt})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
29	Meander width ratio ($W_{b/t}/W_{bkf}$)	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
30	Individual pool length, ft	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
31	Pool length/riffle width	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
32	Pool to pool spacing (based on pattern), ft (p-p)	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:

Table 11–14 Morphological characteristics of the existing and proposed channel with gage station and reference reach data—Continued

Variables		Existing channel	Proposed reach	USGS station	Reference reach
33	Ratio of p-p spacing to bankfull width (p-p/W_{bkf})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
34	Stream length (SL)				
35	Valley length (VL)				
36	Valley slope (VS)				
37	Average water surface slope (S)		S = VS/k		
38	Sinuosity (k)	SL/VL:	SL/VL:	SL/VL:	SL/VL:
		VS/S:		VS/S:	VS/S:
39	Riffle slope (water surface facet slope) (S_{rif})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
40	Ratio riffle slope to average water surface slope (S_{rif}/S)	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
41	Run slope (water surface facet slope) (S_{run})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
42	Ratio run slope/average water surface slope (S_{run}/S)	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
43	Pool slope (water surface facet slope) (S_p)	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
44	Ratio of pool slope/average water surface slope (S_p/S)	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
45	Glide slope (water surface facet slope) (S_g)	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
46	Ratio glide slope/average water surface slope (S_g/S)	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
47	Max run depth, ft (d_{run})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
48	Ratio max run depth/ bankfull mean depth (d_{run}/d_{bkf})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:
49	Max glide depth, ft (d_g)	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:

Table 11–14 Morphological characteristics of the existing and proposed channel with gage station and reference reach data—Continued

Variables		Existing channel	Proposed reach	USGS station	Reference reach
50	Ratio max glide depth/ bankfull mean depth (d_g/d_{bkf})	Mean:	Mean:	Mean:	Mean:
		Range:	Range:	Range:	Range:

Materials					
51	Particle size distribution of channel material (active bed)				
	D_{16} (mm)				
	D_{35} (mm)				
	D_{50} (mm)				
	D_{84} (mm)				
	D_{95} (mm)				
52	Particle size distribution of bar material				
	D_{16} (mm)				
	D_{35} (mm)				
	D_{50} (mm)				
	D_{84} (mm)				
	D_{95} (mm)				
	Largest size particle at the toe (lower third) of bar (mm)				

Sediment transport validation (Based on Bankfull Shear Stress)		Existing	Proposed
Calculated shear stress value (lb/ft^2) from curve			
Size from Shields diagram - Original data (mm)			
Size from Shields diagram - Colorado data (mm)			
Largest size (mm) to be moved (D_{max})			
Dimensionless shear stress (τ^*)			
Mean d_{bkf} (ft) calculated using dimensionless shear stress equations for given slope			

Remarks:

(f) Phase VI—Selection and design of stabilization and enhancement structures/methodologies

The objectives of river structures are often primarily designed to:

- buy time to protect the new channel from excess erosion until significant riparian vegetation can become established
- reduce accelerated streambank erosion
- provide grade control
- provide recreational boating
- obtain stable flow diversions
- enhance fish habitat including instream cover, holding cover, spawning habitat, and habitat diversity
- reintroduce and stabilize large wood for fishery, stability, and aesthetic purposes
- protect infrastructure adjacent to streams
- protect bridges, culverts, and drainageway crossings
- reduce flood levels
- transport sediment
- provide energy dissipation

River stabilization and enhancement structures are numerous and continue to be improved and developed. The effort here will not be to make a complete listing, but rather present methods used in the Rosgen geomorphic channel design methodology consistent with the objectives. The structures and methods primarily utilize native materials such as natural boulders, logs, rootwads, and vegetative transplants.

Design objectives will be presented to provide the user with alternatives to standard or traditional structures.

Grade control

Often cross-channel check dams are used for grade control. NRCS has successfully used many types of channel grade control structures, but streams with high sediment loads have experienced some adverse channel adjustment in some case. The adjustments are associated with aggradation, lateral erosion, flood stage increase, migration barriers for fish, increased recreational boating risk, land loss, channel incision through lateral migration and channel avulsion. To prevent these stability problems, the cross vane was developed (fig.11–27 (Rosgen 2001e)).

Application of this design is also very effective for bridge pier scour reduction (Johnson, Hey, et al. 2002). A photograph depicting the structure as constructed on the lower Blanco River, Colorado, is shown in figure 11–28. The structure also decreases near-bank shear stress, minimizing streambank erosion.

The photographs in figures 11–29 and 11–30 demonstrate the use of cross vanes in river restoration. In this example, a reconstructed river project on the East Fork Piedra River, Colorado, in a valley type V (glacial trough), converted a braided (D4) stream type to a meandering (C4) stream type. The use of the cross vane structure was effective at maintaining grade control, transporting excessive coarse bed load, reducing bank erosion, buying time for riparian vegetation colonization, and providing trout habitat. The structures located along 3 miles of this project withstood floods at twice the bankfull discharge magnitude in 2004. Logs and rootwads can also be utilized in this structure as designed in Rosgen (2001e) and as shown in figure 11–31. The use of large wood in this structure assists in the visual, as well as biological enhancement objectives. The step in the upper third of the structure dissipates energy, reduces footer scour, and minimizes risk for recreational boating and fish passage.

A structure designed for larger rivers for grade control and streambank protection is the W-weir. This structure can also be effectively used for irrigation diversions, protection of central piers and approach sections on bridges, bed-load transport, recreational boating, and fish habitat. Visually, it is improved over a line of rock often used in grade control. It resembles natural bedrock features in stream channels. Figure 11–32 depicts the design (Rosgen 2001e), and figure 11–33 shows a typical W-weir structure as installed on the Uncompahgre River in Colorado.

Streambank stabilization

Most stream restoration projects require some degree of streambank stabilization. Often the stabilization involves riparian vegetation reestablishment or change in management. Regardless, there is a time element that is needed to establish rooting depth, density, and

Figure 11–27 Cross section, profile, and plan view of a cross vane

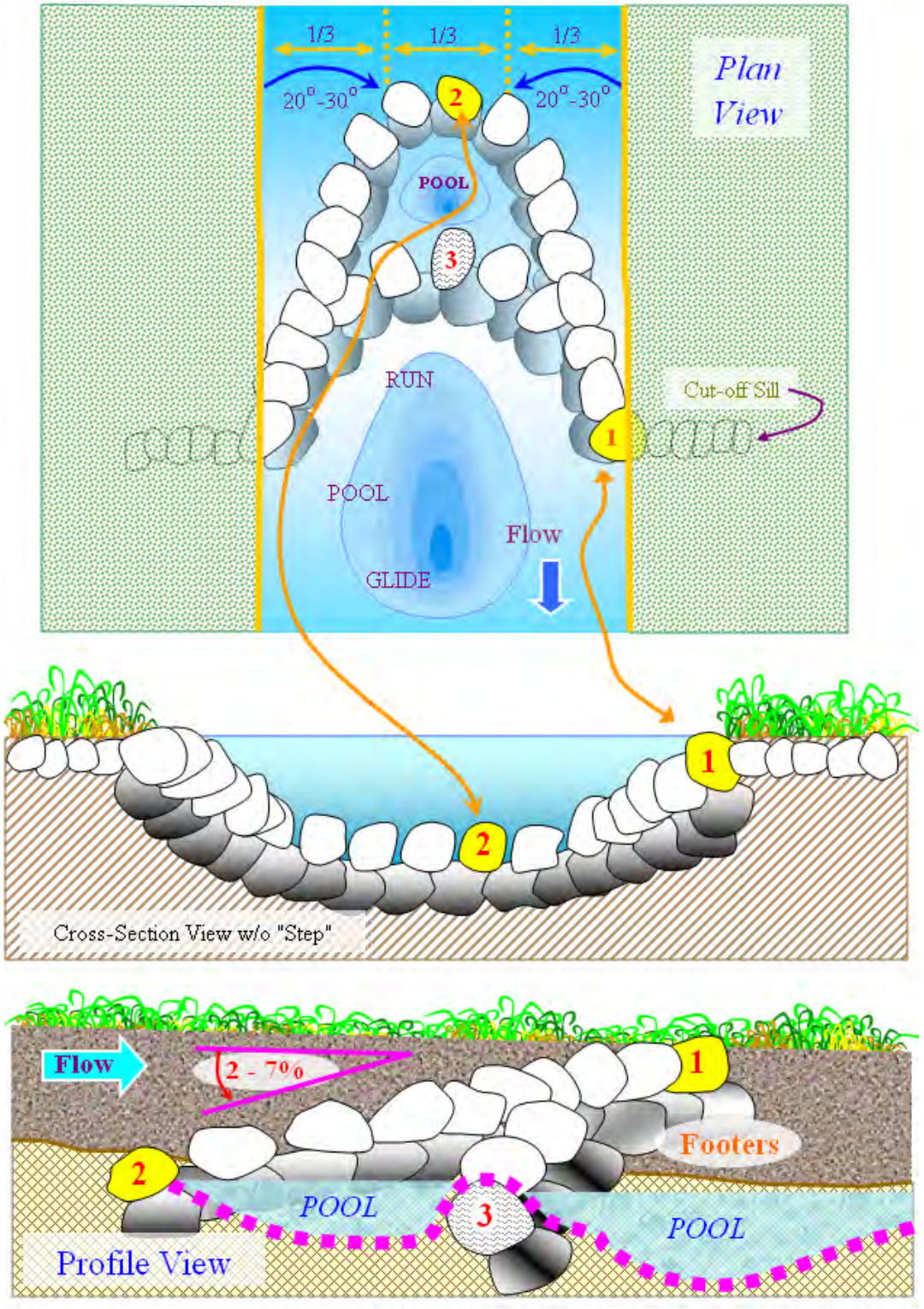


Figure 11–28 Cross vane installed on the lower Blanco River, CO

Figure 11–29 Cross vane structure with step on the East Fork Piedra River, CO

Figure 11–30 Cross vane/step-pool on the East Fork Piedra River, CO

Figure 11–31 Cross vane/rootwad/log vane step-pool, converting a braided D4→C4 stream type on the East Fork Piedra River, CO

Figure 11–32 Plan, cross section, and profile views of a W-weir structure

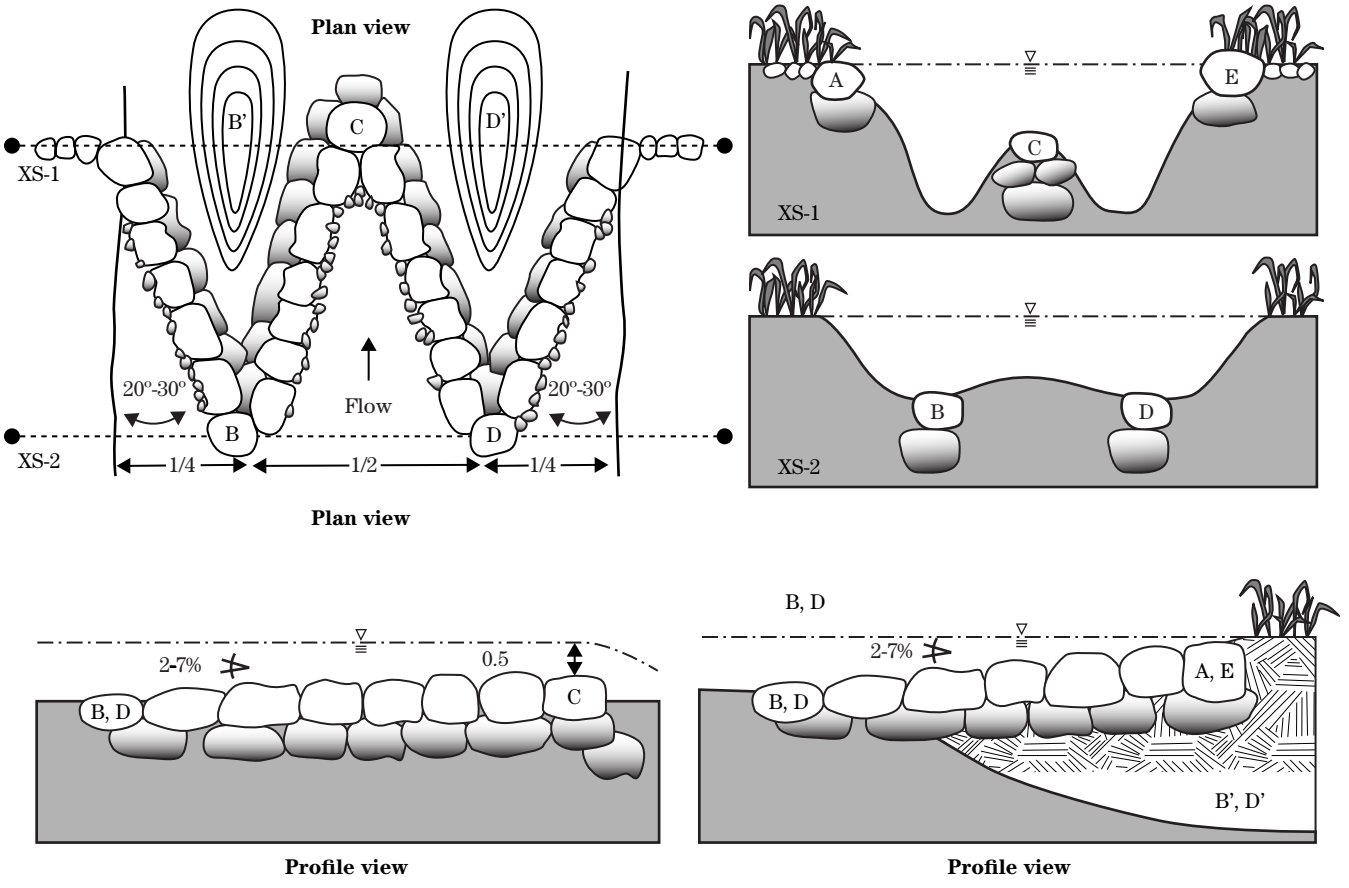


Figure 11–33 W-weir installed on the Uncompahgre River, CO

Figure 11–34 Plan, profile, and section views of the J-hook vane structure

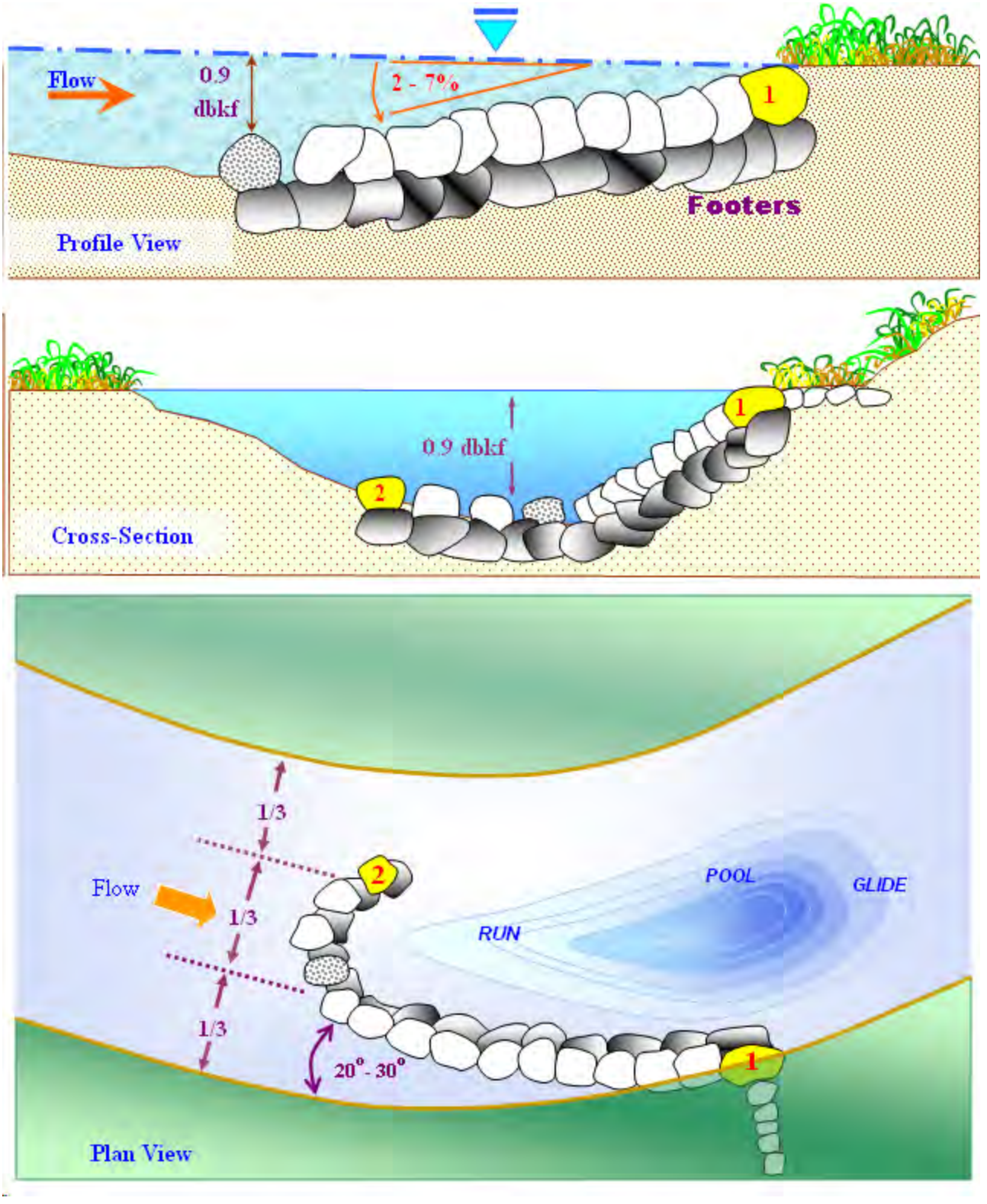


Figure 11–35 Log vane/J-hook combo with rootwad structure

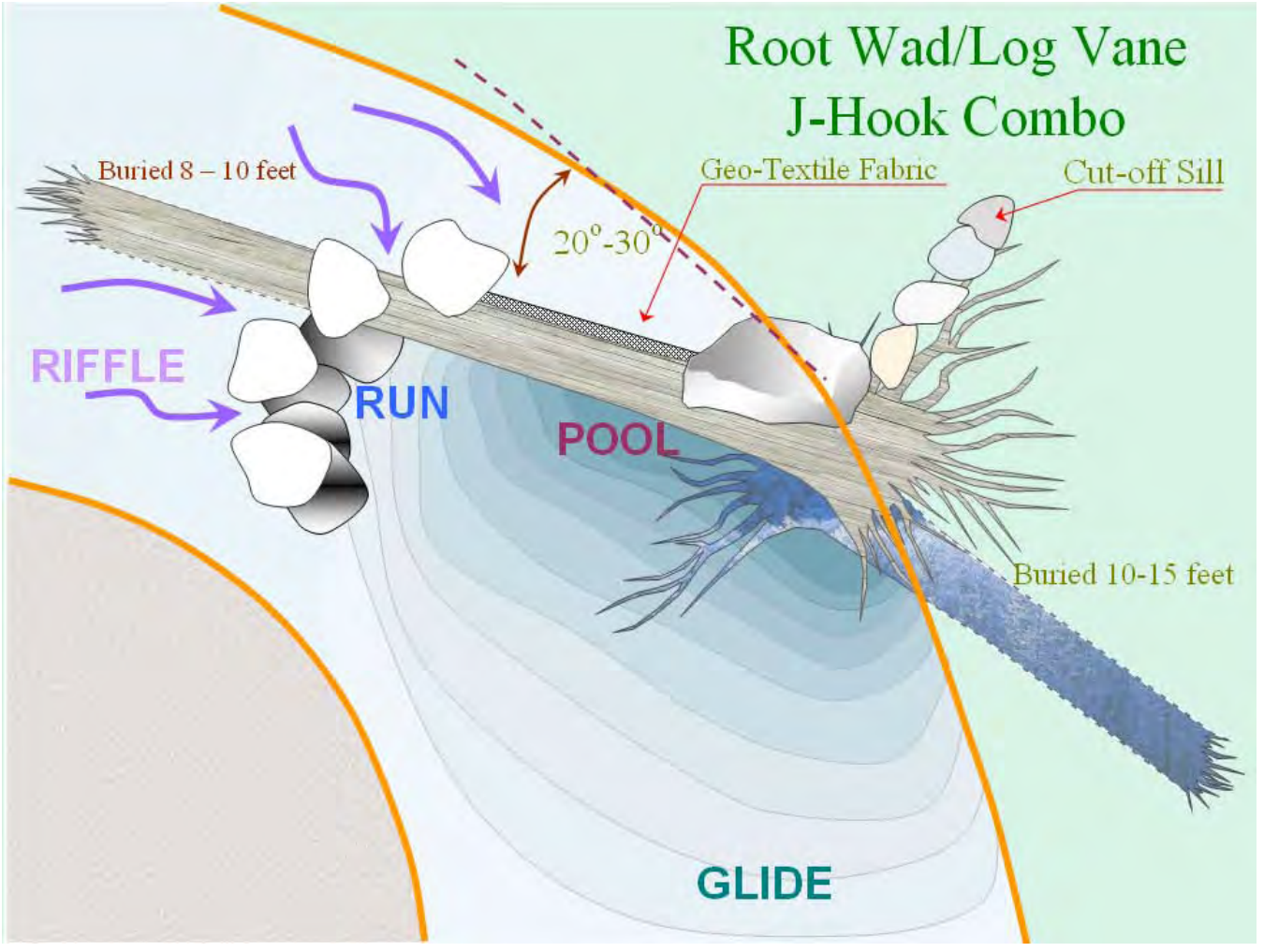


Figure 11–36 Rock vane/J-hook combo with rootwad and log vane footer

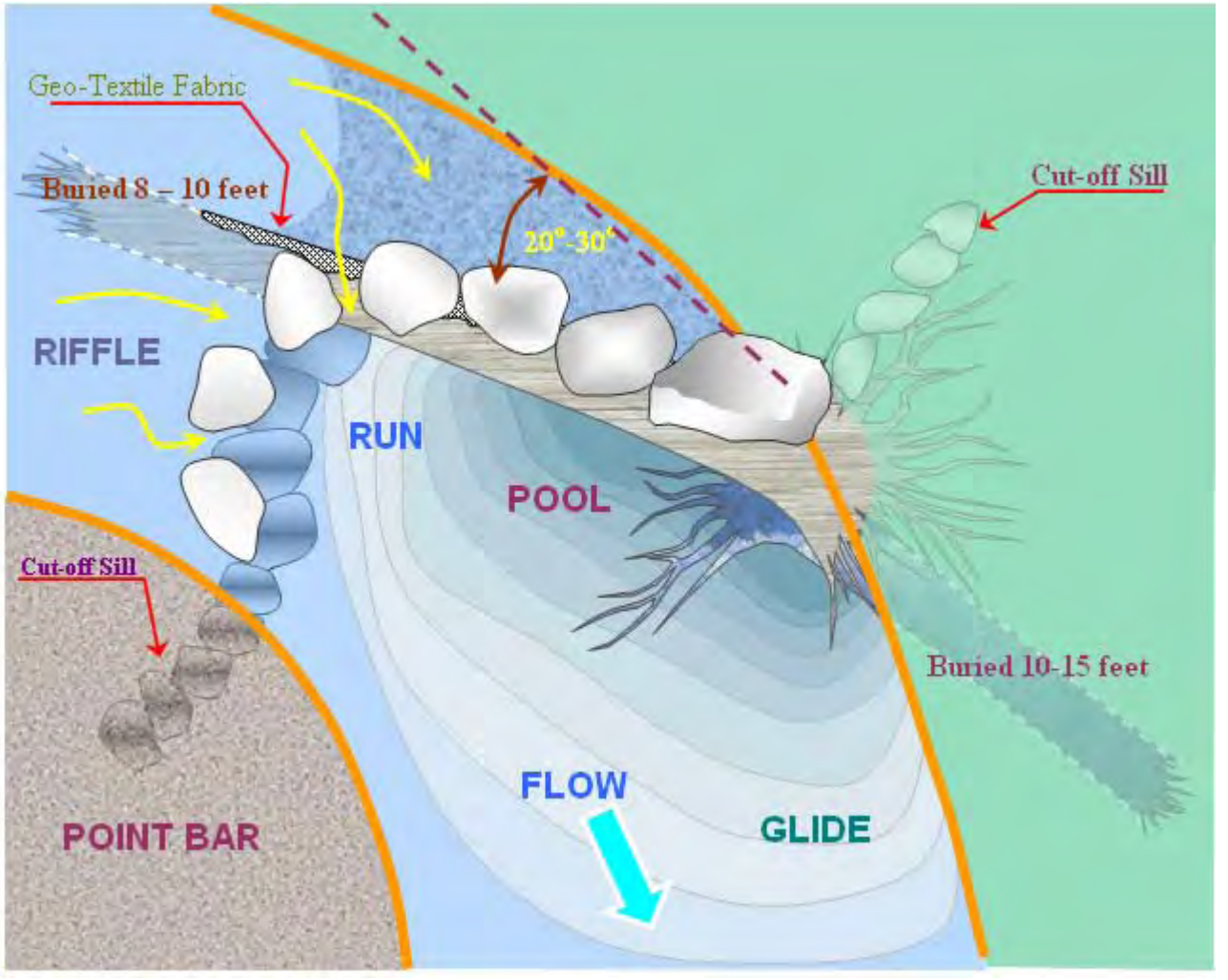
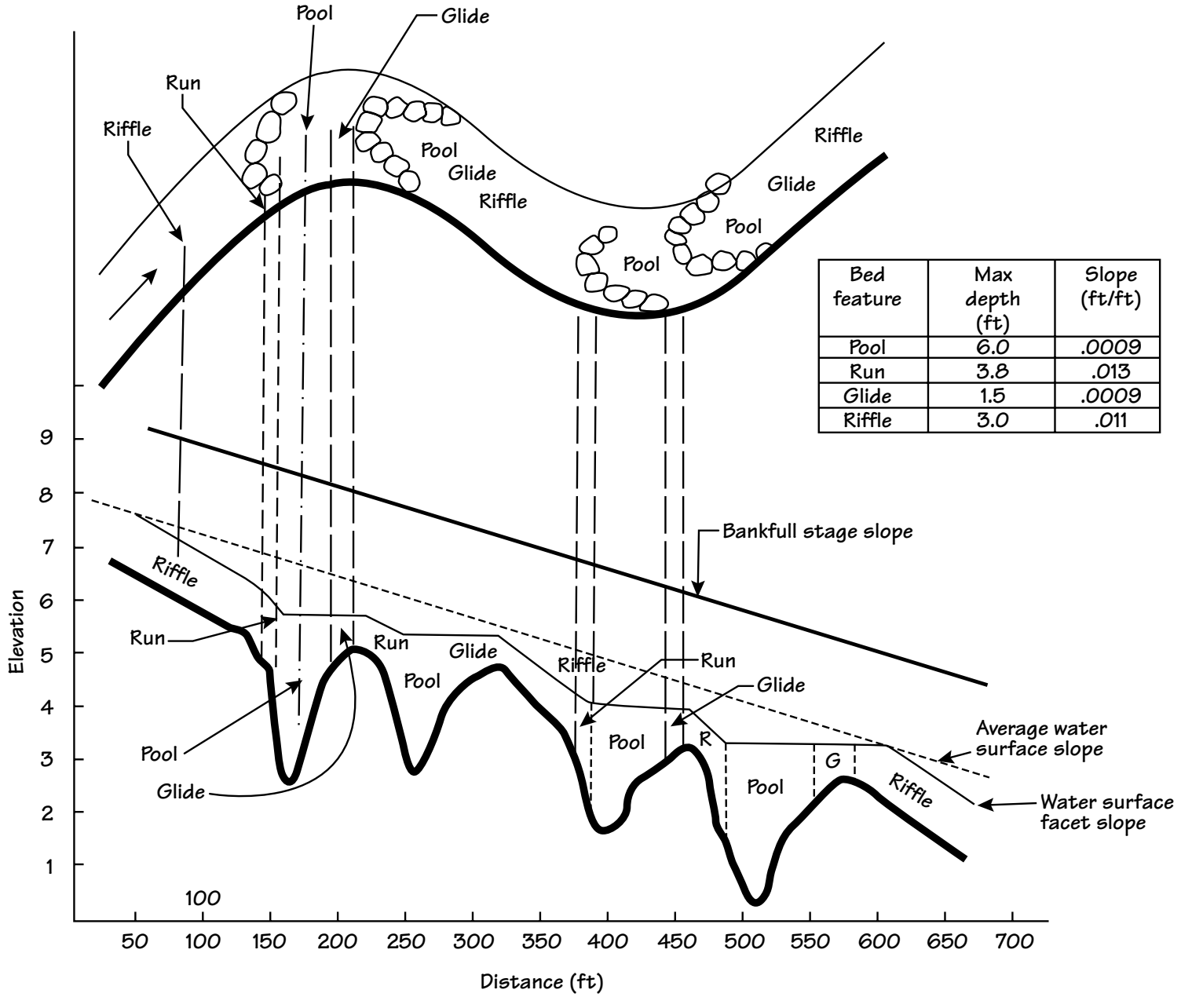


Figure 11–37 Native boulder J-hook with cut-off sill, East Fork Piedra River, CO

Figure 11–38 Rootwad/log vane/J-hook structure, East Fork Piedra River, CO

Figure 11–39 J-hook/log vane/log step with cut-off sill, East Fork Piedra River, CO

Figure 11–40 Longitudinal profile of proposed C4 stream type showing bed features in relation to structure location



Bed feature	Max depth (ft)	Slope (ft/ft)
Pool	6.0	.0009
Run	3.8	.013
Glide	1.5	.0009
Riffle	3.0	.011

Figure 11–41 Boulder cross vane and constructed bankfull bench

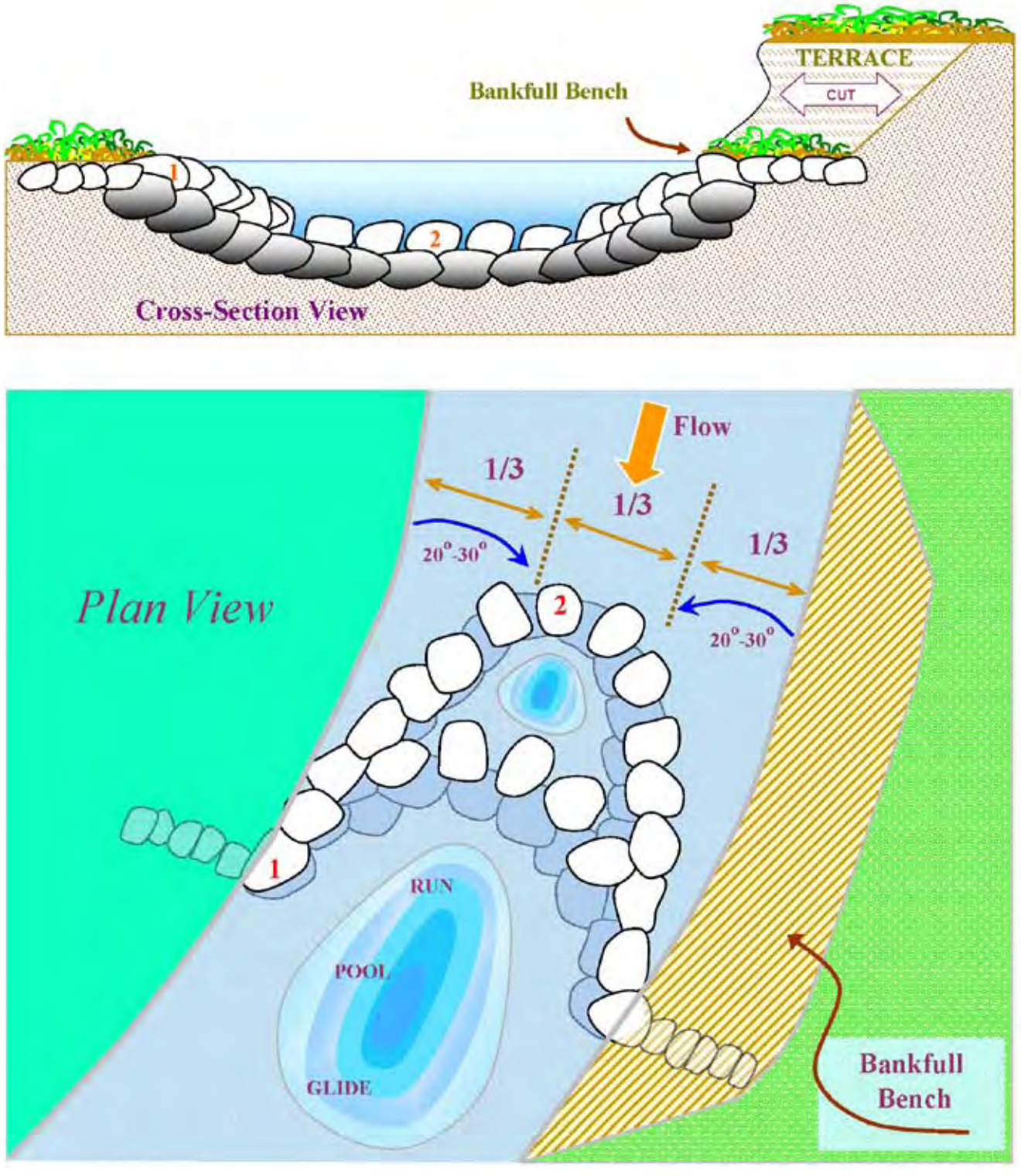
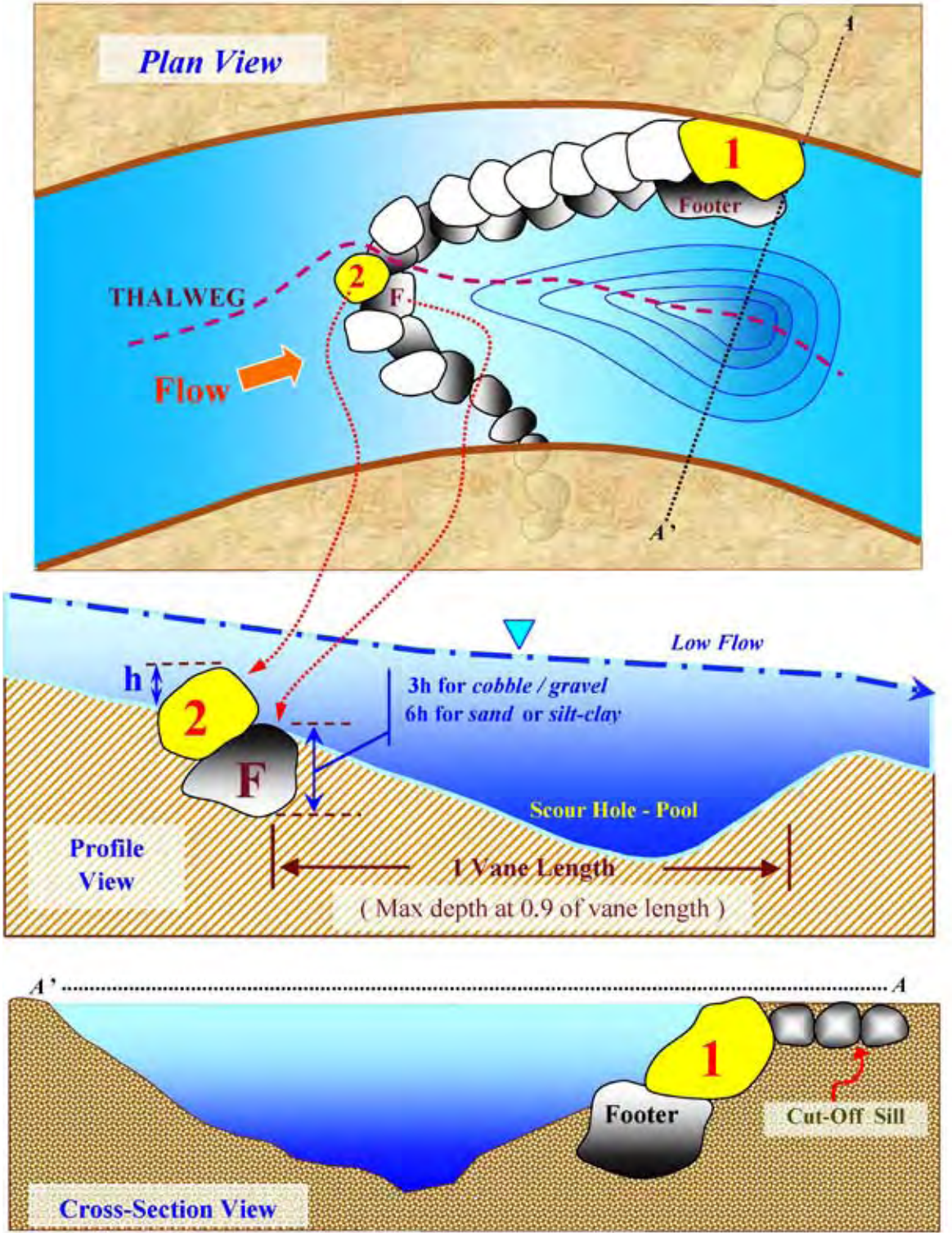


Figure 11–42 Locations/positions of rocks and footers in relation to channel shape and depths



strength to help maintain bank stability. The use of the J–hook (or fish hook) vane was developed to reduce near-bank stress to buy time for root development. The design is shown in figure 11–34 (Rosgen 2001e). Materials other than boulder are used in the J–hook vane. Logs and rootwads can be effectively used for multiple objectives (fig. 11–35 (Rosgen 2001e)). Variations in the use of materials are shown in figure 11–36 (Rosgen 2001e). An example of a J–hook vane is shown in figure 11–37, as constructed out of native boulders located in a reconstructed East Fork Piedra River. The structure also provides fish habitat, energy dissipation, bed-load transport, and provides protection of developments along streambanks. The use of a J–hook vane reduces the need for toe rock stabilization or a surfacing or hardening of the bank with riprap or other resistant structure. The length of bank protected is approximately two and a half to three times the length of the vane. The J–hook vane also is used to protect bridges and structures (Johnson, Hey, et al. 2001). Figures 11–38 and 11–39 provide examples of a J–hook vane using logs, rootwads, and log steps, as well as native boulders.

An example of the use of structure location forming compound pools consistent with meander curvature and bed features is shown in figure 11–40. The accompanying data indicate the slope and depth of the corresponding bed features. Regardless of structures, riparian vegetation establishment and management must be an active part of Rosgen geomorphic channel design.

Vane design specifications

The use of structures must be compatible with curvature and bed features of natural rivers. Figures 11–41 and 11–42 illustrate the use of rock for cross vanes, as well as for footers. Figure 11–43 provides guidance on rock sizing.

Vane slope—The slope of the vane extending from the bankfull stage bank should vary between 2 to 7 percent. Vane slope is defined by the ratio of bank height/vane length. For installation in meander bends, ratios of J-hook vane length/bankfull width is calculated as a function of the ratio of radius of curvature/bankfull width and departure angle (table 11–15). Equations for predicting ratios of J-hook vane spacing/bankfull width on meander bends based on ratio of radius of curvature/bankfull width and departure angle are shown in table 11–16. Vane length is the distance measured from the bankfull bank to the intercept with

Figure 11–43 Rock size

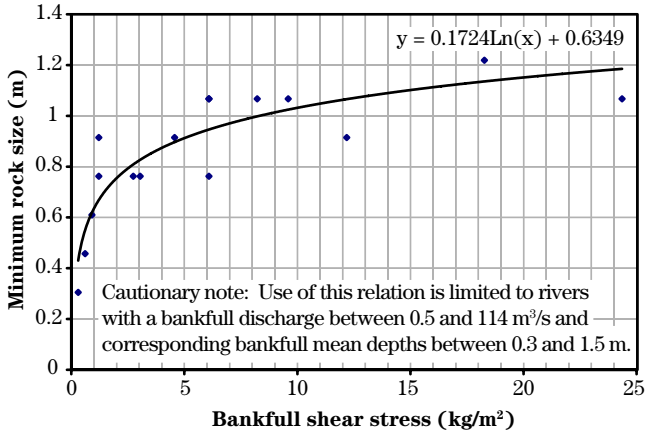


Table 11–15 Equations for predicting ratio of vane length/bankfull width (V_L) as a function of ratio of radius of curvature/width and departure angle, where W = bankfull width (SI units)

Rc/W	Departure angle (degrees)	Equation
3	20	V_L = 0.0057 W+0.9462
3	30	V_L = 0.0089 W+0.5933
5	20	V_L = 0.0057 W+1.0462
5	30	V_L = 0.0057 W+0.8462

Table 11–16 Equations for predicting ratio of vane spacing/width (V_s) as a function of ratio of radius of curvature/width and departure angle, where W = bankfull width (SI units)

Rc/W	Departure angle (degrees)	Equation
3	20	V_s = –0.006 W+2.4781
3	30	V_s = –0.0114 W+1.9077
5	20	V_s = –0.0057 W+2.5538
5	30	V_s = –0.0089 W+2.2067

the invert elevation of the streambed at a third of the bankfull channel width for either cross vanes or J-hook vanes. For very large rivers, where it is impractical to extend the vane length to a third of the bankfull width, vane slope is calculated based on the specified angle of departure and the ratio of bank height/vane length where the vane arm intercepts the proposed invert of the structure.

The spacing of J-hook vanes can be increased by 0.40W for a low BEHI of less than 30 (Rosgen 1996, 2001b).

Bank height—The structure should only extend to the bankfull stage elevation. If the bank is higher, a bankfull bench is constructed adjacent to the higher bank, and the structure is integrated into the bench. The use of a cross vane is shown in figure 11–41 where a bankfull bench is created adjacent to a terrace bank.

Footers—The minimum footer depth at the invert for cobble and gravel-bed streams is associated with a ratio of three times the protrusion height of the invert rock. This is applicable to all three structures and is shown in figure 11–41 for a J-hook vane. For sand-bed streams, the minimum depth is doubled due to the deeper scour depths that occur. All rocks for all three structures require footers. If spaces are left between the invert rocks for cross vane and W-weirs, the top of the footer rocks becomes the invert elevation for grade control. If no gaps are left, the top of the surface rock becomes the base level of the stream.

Rock size—The relationship of bankfull shear stress to minimum rock size used for all three structures is shown in figure 11–43. The application of this empirical relation is limited to size of rivers whose bankfull discharge varies from 0.56 cubic meters per second (20 ft^3/s) to 113.3 cubic meters per second (4,000

ft^3/s). For example, appropriate minimum rock sizes for values of bankfull shear stress less than 1.7 kilograms per square meter (0.35 lb/ft^2) are associated only with stream channel bankfull depths from 0.26 to 1.5 meters (2–5 ft). This relation would not be appropriate for applications outside the limits of the data for a river slope of 0.0003 and a mean depth of 6.1 meters, even though a similar shear stress results, as in the example presented.

(g) Phase VII—Design implementation

A key requirement at this phase is to correctly implement the proposed design. This involves the layout, construction supervision, and water quality controls during construction.

Layout

It is necessary to pre-stake the alignment of the channel and to provide for protection of existing vegetation outside of the construction alignment. The layout involves making necessary onsite adjustments to the design based on constraints that may have been previously overlooked. Terrain irregularities, vegetation, property boundaries, and channel changes since the field data were collected can all require local modifications to placement. Staging areas for materials must be located for both the collection and temporary storage of materials. Stockpile areas, vegetative donor sites, and boundary references/facilities requiring special identification must be flagged. Locations of structure placement and type must be flagged.

Construction supervision (oversight)

Without exception, it is critical to have daily onsite inspection and construction coordination. It is essential to check grades, dimensions, structure placement, slopes, angles, and footers as an on-going requirement. It is most effective to coordinate this work during construction, rather than wait and provide a postconstruction inspection and find problems after the work is completed. The daily field review and documentation at this phase is very helpful to properly implement the design.

Water quality controls

As part of the layout, sediment detention basins, diversions, silt fences, and pump sites must be located to prevent onsite and downstream sediment problems and as required by Federal, state, and local ordinances. Staging of construction should also be conducted in such a manner to minimize sedimentation problems. Monitoring of water quality during construction may be required; thus, preventative measures will reduce future potential problems.

(h) Phase VIII—Monitoring and maintenance

Monitoring
The key to a successful monitoring program is the focus on the question or the specific objectives of monitoring. Monitoring is generally recommended to:

- measure the response of a system from combined process interaction due to imposed change
- document or observe the response of a specific process and compare to predicted response for a prescribed treatment
- define short-term versus long-term changes
- document spatial variability of process and system response
- ease the anxiety of uncertainty of prediction
- provide confidence in specific management practice modifications or mitigation recommendations to offset adverse water resource impacts
- evaluate effectiveness of stabilization or restoration approaches
- reduce risk once predictions and/or practices are assessed
- build a data base to extrapolate for similar applications
- determine specific maintenance requirements

Watershed and river assessments leading to restoration involve complex process interactions, making accurate predictions somewhat precarious. Measured data reflecting specific processes will continually improve understanding and prediction of sedimentological, hydrological, morphological, and biological process relations. Another great benefit resulting from monitoring is the demonstration of the effectiveness of reduced sediment problems and improved river stability due to management/mitigation—the central purpose of watershed and sediment assessments and restoration.

The state of the science cannot be advanced, nor can the understanding of complex processes be improved without monitoring. This phase is divided into three major categories:

- implementation monitoring to ensure restoration designs were laid out and constructed correctly
- validation monitoring (matching predicted to observed response, including model calibration and model validation)
- effectiveness monitoring (response of a process or system to imposed change)

Field methods/procedures are also addressed.

Implementation monitoring—Often the best-laid design plans are not implemented correctly due to various reasons. Response of a process and/or system must first address the question or possible variable of potential problem in instituting the design and stabilization/enhancement structures correctly. Riparian vegetation response may be ineffective if heavy grazing of livestock occurred. Exclusion fence maintenance can also be a key in vegetative recovery. If restoration designs were correct, but the contractor installed structures at the wrong angle, slope, or position on the bank, then near-bank stress reduction or erosion rate would not be a correct design implementation related to the effectiveness of the mitigation structure.

As-built measurements of dimension, pattern, and profile are essential to compare to design plans. Documentation of exact locations and types of stabilization and/or enhancement structures is also required. Many failures observed in monitoring are due to poor structure placement locations, construction problems, as well as inability to implement correct design specifications.

Vegetation establishment problems are often traced to establishing the wrong plant associations (species), planting at the wrong time of year and at the wrong elevations on the bank (water table), using the wrong techniques in transplanting and/or cutting plantings, and lacking an irrigation plan, if needed. This monitoring leads the designer to be very thorough in the vegetative planning and implementation phase of restoration.

Validation monitoring—For every prediction methodology, there is a procedure to validate the model. Some methods are more difficult and time consuming to validate than others, while some results can be determined on a short-term, rather than a long-term basis.

The monitoring will improve predictive capability for the future and potentially reduce mitigation measures that would not be effective for continued implementation. Conversely, if management practices indicate that sediment and/or stability conditions create obvious impairment, revised practices or specific process-based mitigation such as restoration may be recommended. The restoration specialist will gain the most confidence in the procedure only by field measurements, which not only validate a prediction, but determine if the initial assessment objectives were met. The various categories of validation monitoring include calibration and validation.

- **Validation**—Model validation involves testing of a model with a data set representing local field data. This data set represents an independent source (different from the data used to develop the relation). Often these data are used to extend the range of conditions for which the model was developed. Due to the uncertainty of prediction, this step is very important prior to widespread application of model output. Models can be extremely helpful in comparative analysis, even if observed values depart from measured. It is important, however, to be aware of the variability in the prediction. Often this monitoring outcome develops tighter relations or subsets of the initial relation, improving the understanding of the processes being predicted. An example of this type of monitoring would be similar to the effectiveness monitoring of streambank erosion rates presented previously. However, beyond measuring bank erosion rate, the observer is additionally required to measure the same parameters used to predict streambank erosion. The streambank prediction involves calculating a bank erosion hazard index (BEHI) and near-bank stress (NBS) (Rosgen 1996, 2001b). The analysis involves plotting the observed values with the predicted values for the same prediction variables. In many cases (with sufficient numbers of observations), this monitoring can lead to improved local or regional models, adapted for unique soil types and vegetation. Validation modeling provides documentation not only on how well the mitigation performed but also on the performance of the model.

  Validation modeling is designed to answer specific questions at specific sites/reaches. Design must be matched with a strong understanding of the prediction model. Validation modeling for the dimensionless ratio sediment rating curves would involve sampling sediment over the full range of streamflows to compare predicted to observed values. The measurements would need to be stratified by the same stream type and stability rating used for the prediction.

- **Calibration**—Models are often used to predict potential impairment. Model calibration is the initial testing of a model and tuning it to a set of field data. Field data are necessary to guide the modeler in choosing the empirical coefficients used to predict the effect of management techniques. An example of this is the data set of measured suspended sediment and bed-load sediment by stream type and stability to establish dimensionless ratio sediment rating curves used for design. These data were not collected in all areas where the model would potentially be applied; thus, another type of monitoring (validation) is helpful to determine if the model is appropriate for extrapolation to a particular region.

Effectiveness monitoring—The specific restoration design and implementation needs to be monitored. Monitoring will determine the appropriateness or effectiveness of specific designs and is implemented to reduce potential adverse sediment and/or river stability effects. Since monitoring requires site-specific measurements, temporal, spatial, scale, streamflow variation, and site/reach, monitoring is required to properly represent such variability and extrapolate findings of a process and/or system response to imposed change. Such variability factors are summarized as:

- **Temporal**—To isolate the variability of season and/or annual change, designs of monitoring should include monitoring over time scales. For example, measuring annual lateral erosion rates should include measurements once per year at the same time of year. If the objectives are to identify seasons where disproportionate erosion occurs, measurements may be obtained during snowmelt runoff, later post stormflow runoff, ice-off, and other periods of time associated with a given erosional process. Annual replicate surveys of particle size gradation of bed material under a permanent glide cross section will provide valuable information of

magnitude, direction, and consequence of annual shifts. Temporal measurements must also cover a range of time during bed-load sampling as surges occur or slugs of bed load often appear as discontinuities of time. Sampling over recommended time periods for a given flow (generally 20 minutes) helps the probability of observing this variability (as opposed to an instantaneous point sample). Short-term versus long-term monitoring must also be considered based on the probability of change, the severity and consequence of effects, and the likelihood of variation. Sampling over many years, although costly, may be warranted to cover changes in wet/dry periods.

- **Spatial**—Variability of change/response involving spatial considerations can be identified by measurements of the same process at more than one site (cross section) or even more intense on the same site. For example, a longitudinal profile measured over a couple of meander wavelengths will indicate changes in the maximum depth and/or slope of pools, rather than just monitoring one pool at one location. Identifying more than one reach of the same morphological type can also be used to understand response trends. Sampling the spatial variability (both vertically and laterally) within a cross section of velocity and sediment helps identify or at least integrate such variability into a documented observation.
- **Scale**—Monitoring streams of various sizes and/or stream orders, but of the same morphological type and condition, will help identify variability in system response for proper extrapolation of results. For example, vertical stability measurements should be made on river reaches of the same condition and the same type, but at locations that reflect various stream widths (size) and stream order.
- **Streamflow variation**—Measurements of channel process relations need to be stratified over a range of seasonal and annual flows. For example, both suspended and bed-load sediment should be measured over a wide range of flows during the freshet, low-elevation snowmelt, high-elevation snowmelt, rising versus recession stages, stormflow runoff, and baseflow. This stratification for streamflow allows the field observer to plot a sediment rating curve that represents the widest range of seasonal flows where changes in sediment supply can vary.
- **Site or reach variation**—Monitoring a site for soil loss should include a soil type designation for potential extrapolation for similar conditions on similar soil types. The same is true for stream types. Sediment, hydraulic, and stability monitoring need to be stratified by stream type since such data will naturally vary for the reference (stable) reach between stream types. This information is helpful to be able to readily detect departure from a reference stream type, rather than differences between stream types.
- **Design concepts for effectiveness monitoring**—The key information summary from the assessments used to identify impairment and resultant restoration designs are as follows:
  - Summarize the causes of land use impacts responsible for the impairment.
  - Understand the processes affected.
  - Identify specific locations and reaches associated with adverse impacts.
  - Determine the time trends of impacts (potential recovery periods).
  - Identify the specific nature of impairment (direction, magnitude, and trend of change).
  - Evaluate the consequence of change.
  - Determine the nature, location, extent and quality of mitigation (implementation).

The information supplied in the following list leads the observer to identify the locations, nature of processes affected, the extent of the impact, and quality of the mitigation implementation. For example, if the dominant process impacted by a land use is causing disproportionate sediment supply, land loss and river instability, and is determined to be accelerated streambank erosion, then the lateral stability monitoring would emulate the following design:

- Locate reaches of the same stream type that represent an unstable bank.
- Locate reaches of the same stream type that represent a stable bank.

- Install permanent cross sections on each set of reaches.
- Install bank pins (if conditions warrant) and/or toe pins (see monitoring methods).
- Inventory vegetation, bank material, and slope for each site (see monitoring methods).
- Resurvey both streambanks at least once per year to measure soil loss (lateral erosion) and total volume (in cubic feet and tons/year).
- Compare annual lateral erosion rates over time to the stable reach and document rate of recovery based on the nature of the mitigation.

Vertical stability and enlargement rates and direction can also be monitored using permanent cross sections in a similar stratification procedure (comparison to reference reach, above versus below, before versus after).

Physical and biological monitoring—The sediment and river stability changes associated with assessment and design are primarily related to physical changes. However, the consequences of such physical changes are directly related to potential impairment of the biological function. Changes in river stability, such as aggradation, degradation, enlargement, and stream type changes, are also related to habitat and food chains. Limiting factor analyses assesses habitat loss due to river instability and/or excess sediment such as relations of holding cover, instream/overhead cover, water temperature, dissolved oxygen, and benthics. A range of information associated with stream condition can be stratified by stream type by stream stability including diversity index, population dynamics, age class distribution, spawning, rearing habitat, and many more attributes related to stream health. Biological monitoring should follow similar rules of inventory stratification based on the diverse nature of streams and their natural variability.

If a biologist is studying only the biological parameters within a specific ecoregion, the natural stable differences between reference reach stream types cannot be identified if the stratification of the inventory does not include stream types. In other words, a stable C4 stream type will not have the attributes of a stable E4 or B4 stream type, even though they are all gravel-bed streams. If the biological inventory is not stratified by stream type or stream stability, departure of habitat conditions between a stable C4 and an unstable C4 cannot be easily identified. Reference conditions that reflect biological potential must be stratified as a minimum by stream type and stream stability for adequate departure analysis to identify degree, direction, and magnitude of impairment. Companion biological inventories of assessment and monitoring can be very compatible with the monitoring methods of the physical system described.

Once this information is analyzed, the monitoring design can proceed. The next step is to identify a strategy of monitoring. Effectiveness monitoring should always be conducted near the activity responsible for the initial impairment. Four primary design strategies often utilized are as follows:

- Measurements obtained before versus after the initiation of a management change in the land use activity, mitigation, restoration, and enhancement. This can be very effective as it establishes a precalibration period that identifies premitigation variability of the measured parameters. Following mitigation, departure can be readily determined, assuming measurements take into consideration the aforementioned variability factors.
- Measurements or observations taken above versus below impact areas related to specific land uses and specific mitigation. For example, if two different grazing strategies are implemented, measurements of effectiveness can be observed above versus below fence line contrasts. This can also be implemented where a mitigation may only influence the lower reach of a river compared to the upper reach (assuming the same stream type).
- Measurements obtained determining departure from a paired watershed are often helpful as similar climatic events similarly impact both watersheds. The pairing would contrast a watershed that had extensive mitigation or land management change with one that had not been changed. This also assumes variability of scale, temporal, and spatial variability and comparisons of similar landscapes and stream types have been identified.

- Measurements obtained of a disturbed reach or site, receiving mitigation compared to a reference condition. This type of monitoring can occur at locations far removed from the reference reach. The reference condition, however, must be of the same soil type, stream type, valley type, lithology, and vegetative type.

Maintenance plan

To ensure that the implemented design is successful, it is key to have a maintenance plan. The maintenance plan must ensure the following:

- Survival of the riparian vegetation reestablishment—This could involve an irrigation supply or replanting/interplanting.
- Structure stability—Post-runoff inspections must be conducted of structures for grade control, bank stabilization and/or fish habitat enhancement. Maintenance needs are assessed and implemented to prevent future failures and to secure proper function.
- The dimension, pattern, and profile must stay within the natural variability or range as depicted in table 11–5 for each variable. Maintenance of these variables is recommended only if the values exceed the design channel ranges.
- The biological maintenance may involve reestablishment of described populations of various age classes and/or species of fish and/or food sources.

654.1103 Conclusion

The individual(s) responsible for the project should also become experienced by being involved in all phases of this methodology. If the same individual conducts the assessment and also completes the design, implementation, and monitoring, the desired objectives of restoration are the most likely to be accomplished. The complexity of this method requires great attention to detail, training, and an understanding of processes. The monitoring of the project, including the implementation, validation and effectiveness procedures, is the best approach to become experienced and knowledgeable about the Rosgen geomorphic channel design methodology.

Mathematical definitions

Variables	
Riffle cross-sectional area at bankfull	A_{bkf}
Pool cross-sectional area at bankfull	A_{bkfp}
Mean riffle depth at bankfull	d_{bkf}
Mean pool depth at bankfull	d_{bkfp}
Maximum glide depth at bankfull	d_{g}
Maximum riffle depth at bankfull	d_{mbkf}
Maximum pool depth at bankfull	d_{mbkfp}
Maximum run depth at bankfull	d_{run}
Diameter of riffle particle at 50% finer than size	D_{50}
Diameter of bar sample particle at 50% finer than size	$\hat{D}_{50}$
Diameter of riffle particle at 84% finer than size	D_{84}
Maximum size of particle on bar	D_{max}
Gravitational acceleration	g
Weight density of water	γ
Sinuosity	k
Low bank height	LBH
Meander length	Lm
Meander-length ratio	(Lm/W_{bkf})
Manning's n	n
Pool-to-pool spacing (based on pattern)	(p-p)
Bankfull discharge	Q_{bkf}
Hydraulic radius	R
Radius of curvature of meander	Rc
Average water surface slope (bankfull slope)	S
Slope of glide (water surface facet slope)	S_{g}
Stream length	SL
Slope of pool (water surface facet slope)	S_{p}
Slope of riffle (water surface facet slope)	S_{rif}
Slope of run (water surface facet slope)	S_{run}
Bankfull shear stress	τ
Dimensionless bankfull shear stress	τ^{*}
Bankfull mean velocity	u_{bkf}
Shear velocity	u^{*}

Variables	
Valley length	V_{L}
Valley slope	V_{S}
Riffle width at bankfull	W_{bkf}
Width-to-depth ratio at bankfull	(W_{bkf}/d_{bkf})
Width-to-depth ratio at bankfull of reference reach	$(W_{bkf}/d_{bkf})_{ref}$
Pool width at bankfull	W_{bkfp}
Belt width	W_{blt}
Meander-width ratio	(W_{blt}/W_{bkf})
Width of flood-prone area	W_{fpa}
Entrenchment ratio	(W_{fpa}/W_{bkf})
Stream power	ω

Subscripts	
Bankfull	bkf
Meander belt	blt
Flood-prone area	fpa
Glide	g
Maximum at bankfull	mbkf
Maximum at bankfull in pool	mbkfp
Pool	p
Reference reach	ref
Riffle	rif
Run	run

RESOLUTION B
Denying the Conditional Zoning Application

A RESOLUTION DENYING AN AMENDMENT OF THE CHAPEL HILL ZONING ATLAS TO REZONE THE PROPERTY LOCATED AT 100-998 EASTOWNE DRIVE TO OFFICE/INSTITUTIONAL-3-CONDITIONAL ZONING DISTRICT (OI-3-CZD) (PROJECT #CZD-22-7) (2023-05-24/R-14)

BE IT RESOLVED by the Council of the Town of Chapel Hill that it finds that a Conditional Zoning application, proposed by McAdams, on behalf of owner Health System Properties, LLC, to rezone six parcels totaling approximately 50-acres located at 100, 200, 300, 400, 500, 600, 700, 800, 901 and 998 Eastowne Drive on property identified as Orange County Property Identifier Numbers 9890-80-0195, 9890-80-7564, 9890-80-0643, 9890-80-2764, 9890-80-3947 and 9890-91-1209, if rezoned to Office/Institutional-3-Conditional Zoning District (OI-3-CZD) according to the rezoning plan dated April 6, 2023 would not:

a) Conform with the applicable provisions of the Land Use Management Ordinance and Town Code

b) Conform with the Comprehensive Plan

c) Be compatible with adjoining uses

d) Mitigate impacts on surrounding properties and the Town as a whole

e) Be harmonious with existing and proposed built systems including utility infrastructure, transportation facilities, police and fire coverage, and other public services and facilities

f) Be harmonious with natural systems such as hydrology, topography, and other environmental constraints

BE IT FURTHER RESOLVED that the Council hereby denies the proposed application for an amendment of the Chapel Hill Zoning Atlas.

This the 24th day of May, 2023.

Eastowne Conditional Zoning

Town Council

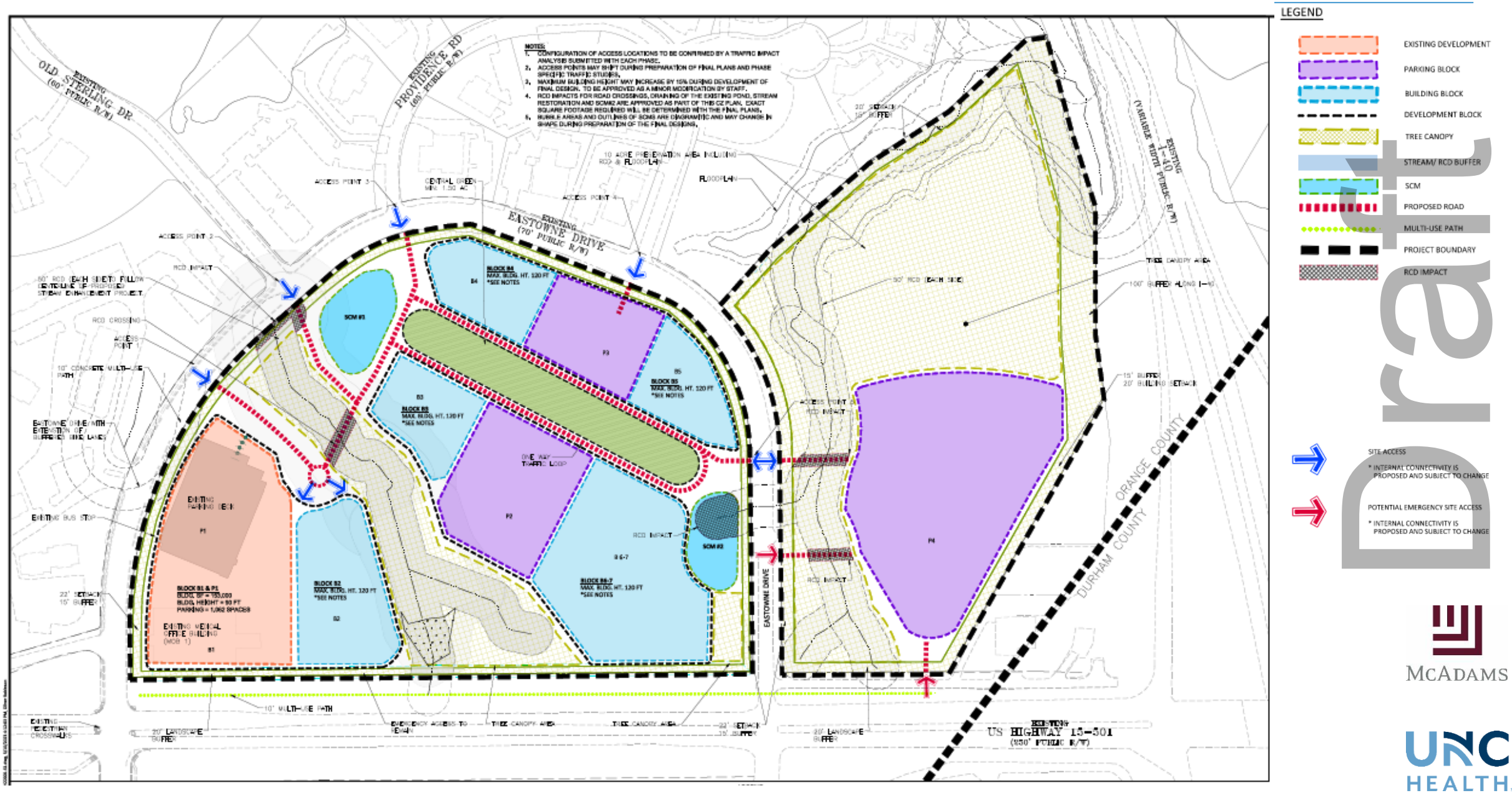
May 24, 2023

UNC HEALTH

Summary of Work Since Opening Public Hearing

- ❑ Continued discussion on parking needs and the Northern 20 acres
- ❑ Community Benefits
- ❑ Finalizing the site specific ordinance

Revised Concept Site Plan



Eastowne Development at Full Build Out with Parking on N20 (if required)

GAD
GESTALT ARCHITECTURE + DESIGN

UNC HEALTH

Northern 20 acres (N20)

UNC Health will place a minimum of 10 acres in to perpetual preservation

UNC Health have accepted an easement request from ToCH for a potential future road across the N20 (stip. #52)

Maximum 1,200-space parking structure, shall be subsequently authorized by the Town Manager upon demonstration of additional need to include:

- Surveys of existing parking lot utilization with documentation provided by UNCH of vehicular parking utilization at peak hours, number of staff on-site, number of patients, and use of bicycle parking spaces
- If peak hour utilization of the vehicular parking spaces exceed 80% of the capacity, a parking structure to provide the additional parking necessary to meet the overall demonstrated need for the Eastowne development will be approved on the N20

Community Benefit

UNC Health presented the following community benefit options to the Town:

- $5M 10-year loan at 0% interest with a 10-year renewal option (UNC Health's discretion)

Loan Opportunity Cost

- Using a 6% annual interest rate, a 10-year $5M loan would cost UNC Health ~$4M in opportunity costs:
  - UNC Health would otherwise use the $5M to invest in improving healthcare delivery
  - The ~$4M in appreciation is occurring during a time that UNC Health is experiencing increasing costs and capital needs relative to cash available
  - These factors affect UNC Health's ability to continue providing affordable care to the community

Note: In 2022, UNC Health provided ~$34M in unreimbursed care to patients within the Town of Chapel Hill

Each year, UNC Health and/or its subsidiaries directly pay (payments in-lieu) and indirectly pay (reimbursement of property taxes to third-party landlords) ~$1.6M to Orange County and the Town of Chapel Hill

UNC HEALTH

Action Requested

Vote of approval by Council for the Conditional Zoning application

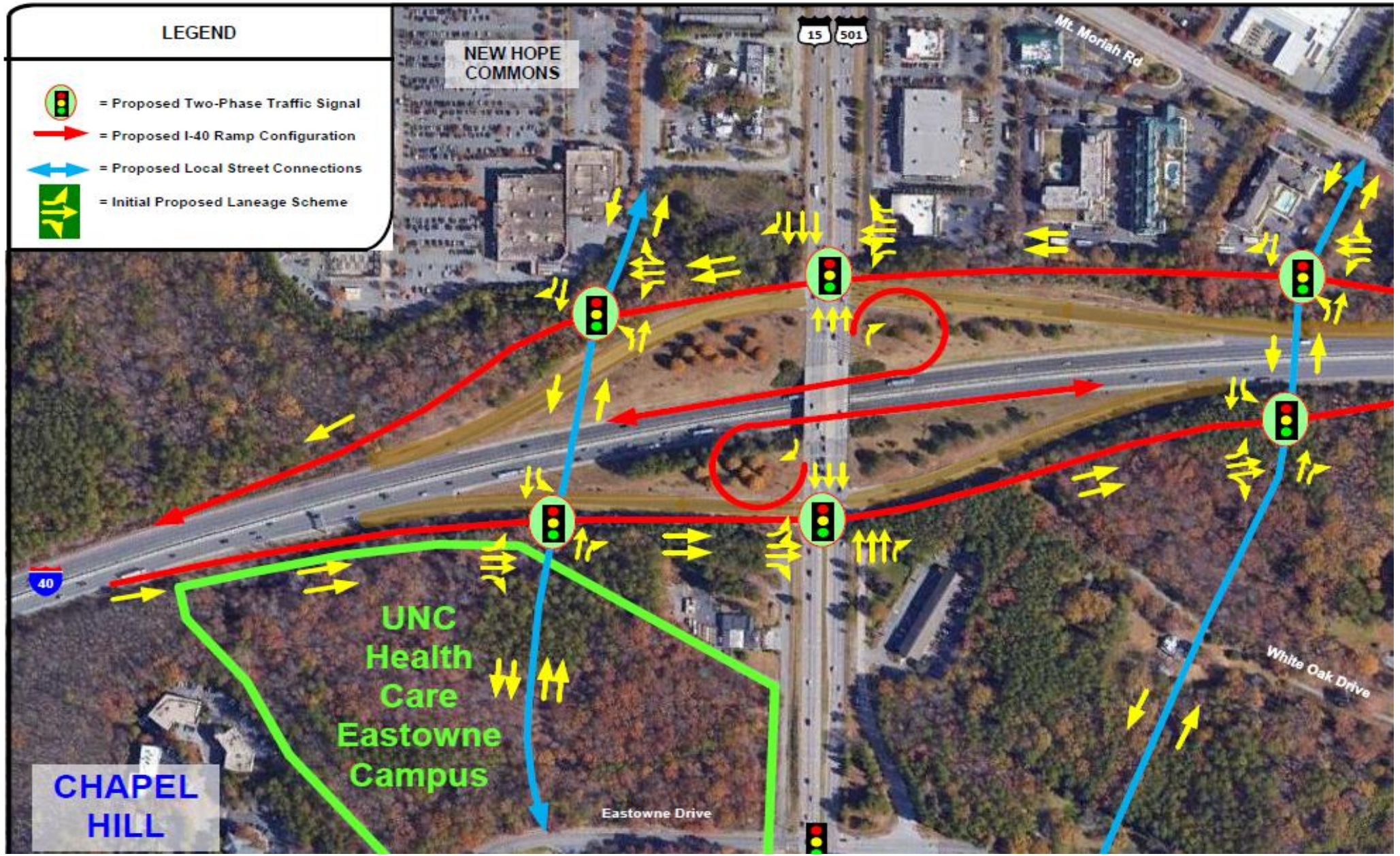
Questions & Discussion

Appendix

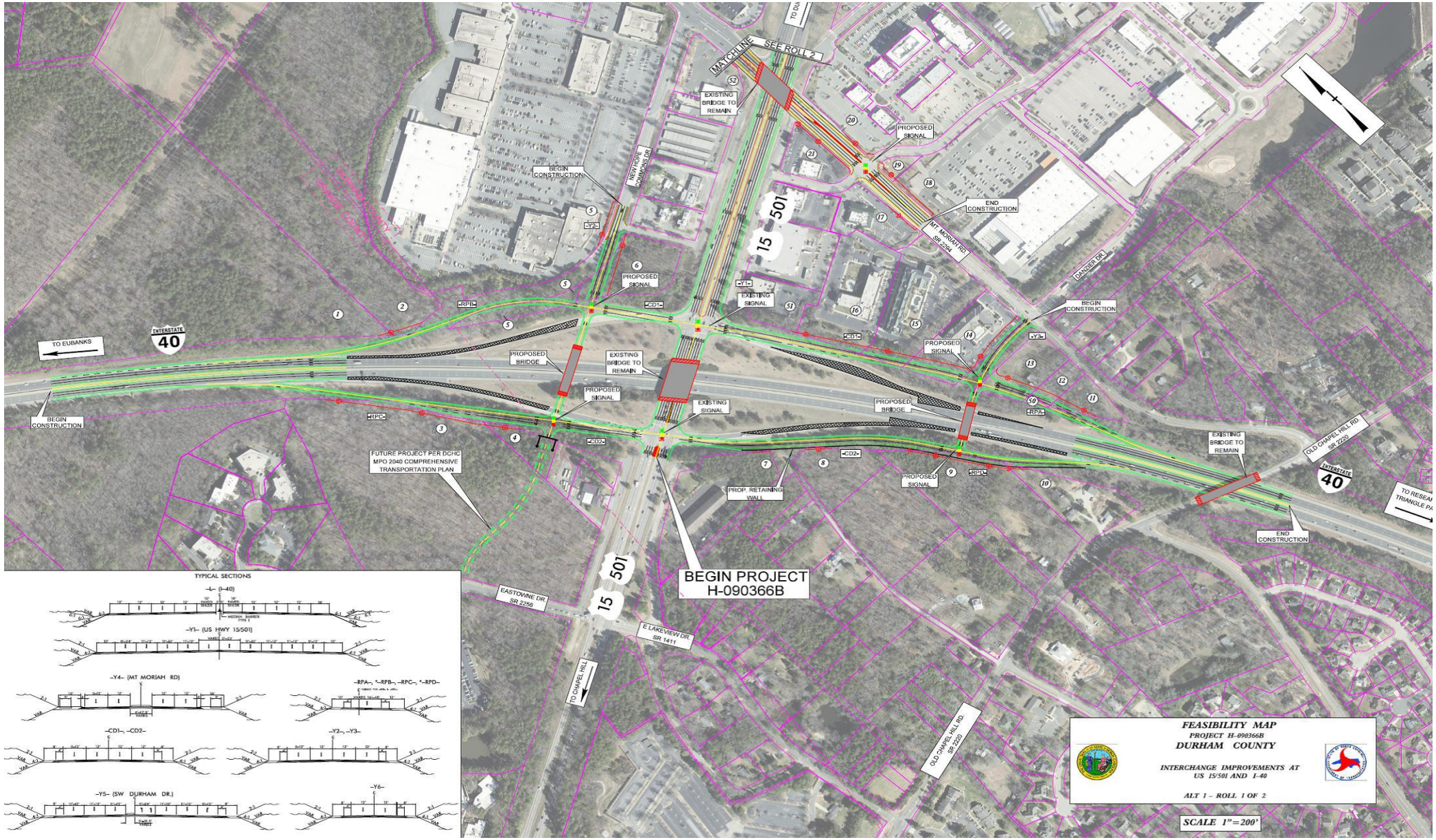
Revised Proposed Eastowne Development – Use, Size, & Timeline

Primary Use:	Health care and associated functions, research, and site-specific retail
Size:	~1.1M sq. ft. net new (excluding ET1)
Number of buildings:	6 (plus 3-4 structured parking) (excluding ET1)
Development Timeline:	1 building every 3-5 years
	Full build out 25+ years
	Medical Office Building 2 - ASAP

New Hope Connector



New Hope Connector



UNC HEALTH

New Hope Connector

Northern 20 acres – Natural Area

Key Points for Today

- ❑ The Importance of Eastowne
- ❑ Summary of Work to Date
- ❑ Review Updated Concept (Bubble) Plan
- ❑ Review of Masterplan
- ❑ Discuss Community Benefits Options
- ❑ Questions

Eastowne Development – Why?

- ❑ Provide affordable and accessible health care
- ❑ Better patient experience
- ❑ Keep it local – within the Chapel Hill community
- ❑ Move and decompress outpatient services from the Medical Center
- ❑ Increase bed capacity and throughput at the Medical Center

Healthcare Was Changing Prior to the Pandemic

Personalization

Convenience

Affordability

Transparency

The Pandemic Accelerated that Change and Spurred More

How COVID Has Impacted Chronic Disease

Aside from its own direct and terrible death toll, the COVID-19 pandemic is intertwined with the trajectories of other dangerous health conditions – and the consequences are still playing out.

By Steven Ross Johnson | March 10, 2022, at 4:38 p.m.

U.S.News & WORLD REPORT

The Impact of COVID-19 on Cancer Screening: Challenges and Opportunities

Ramon S Cancino [1, 2]; Zhaohui Su [2]; Ruben Mesa [2, 3]; Gail E Tomlinson [2, 4]; Jing Wang [2, 5]

JMIR Cancer
Patient-Centered Innovations, Education and Technology for Cancer
Published on 29.10.2020 in Vol 6, No 2 (2020): Jul-Dec

COVID-19 pandemic triggers 25% increase in prevalence of anxiety and depression worldwide

World Health Organization

2 March 2022 News release Reading time: 3 min (927 words)

Prepare for Shifts in Alternative Care Settings

2022 Environmental Scan

American Hospital Association

Pandemic-Driven Health Policies To Address Social Needs And Health Equity

HealthAffairs

MARCH 10, 2022

William K. Bleser, Humphrey Shen, Hannah L. Crook, Andrea Thoumi, Rushina Cholera, Jay Pearson, Rebecca G. Whitaker, Robert S. Saunders

How COVID-19 has changed the way US consumers think about healthcare

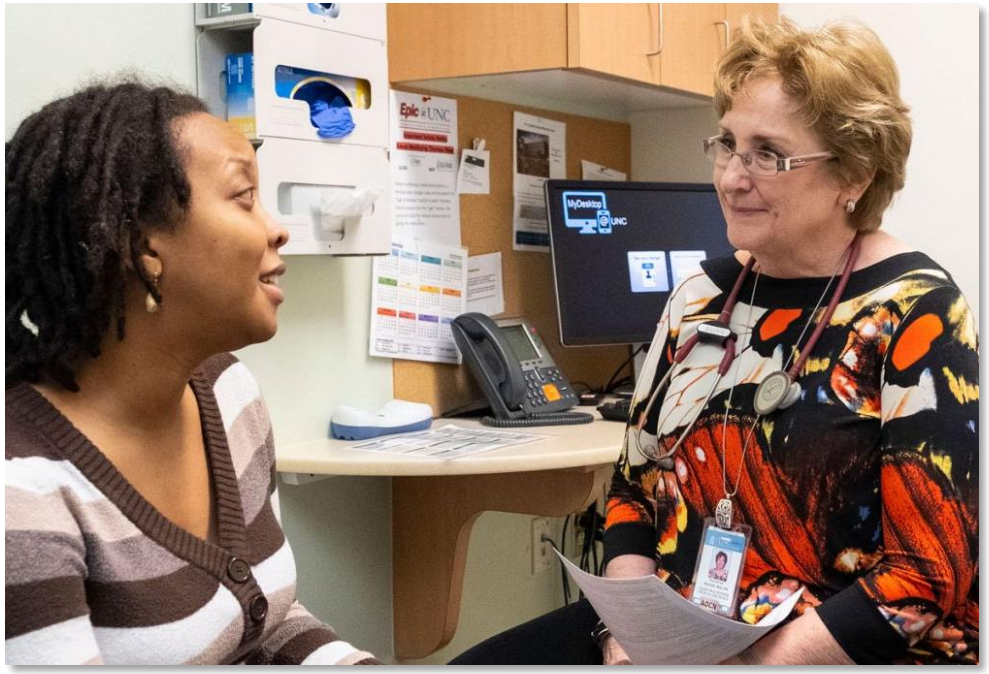
June 4, 2021 | Article

by Jenny Cordina, Eric Levin, Andrew Ramish, and Nikhil Seshan

McKinsey&Company

UNC HEALTH

Our Patients' & Community's Expectations Have Evolved



Easy, affordable access is a must for our patients & community

UNC Health must respond to the changing needs and expectations of those we serve

Original Proposed Eastowne Development – Use, Size, & Timeline

Primary Use:	Health care and associated functions, research, and site specific retail
Size:	~1.6M sq. ft. - ~1.8M sq. ft.
Number of buildings:	~8 (plus structured parking)
Development Timeline:	1 building every 3-5 years
	Full build out 25+ years
	Medical Office Building 2 - ASAP

Recent Progress

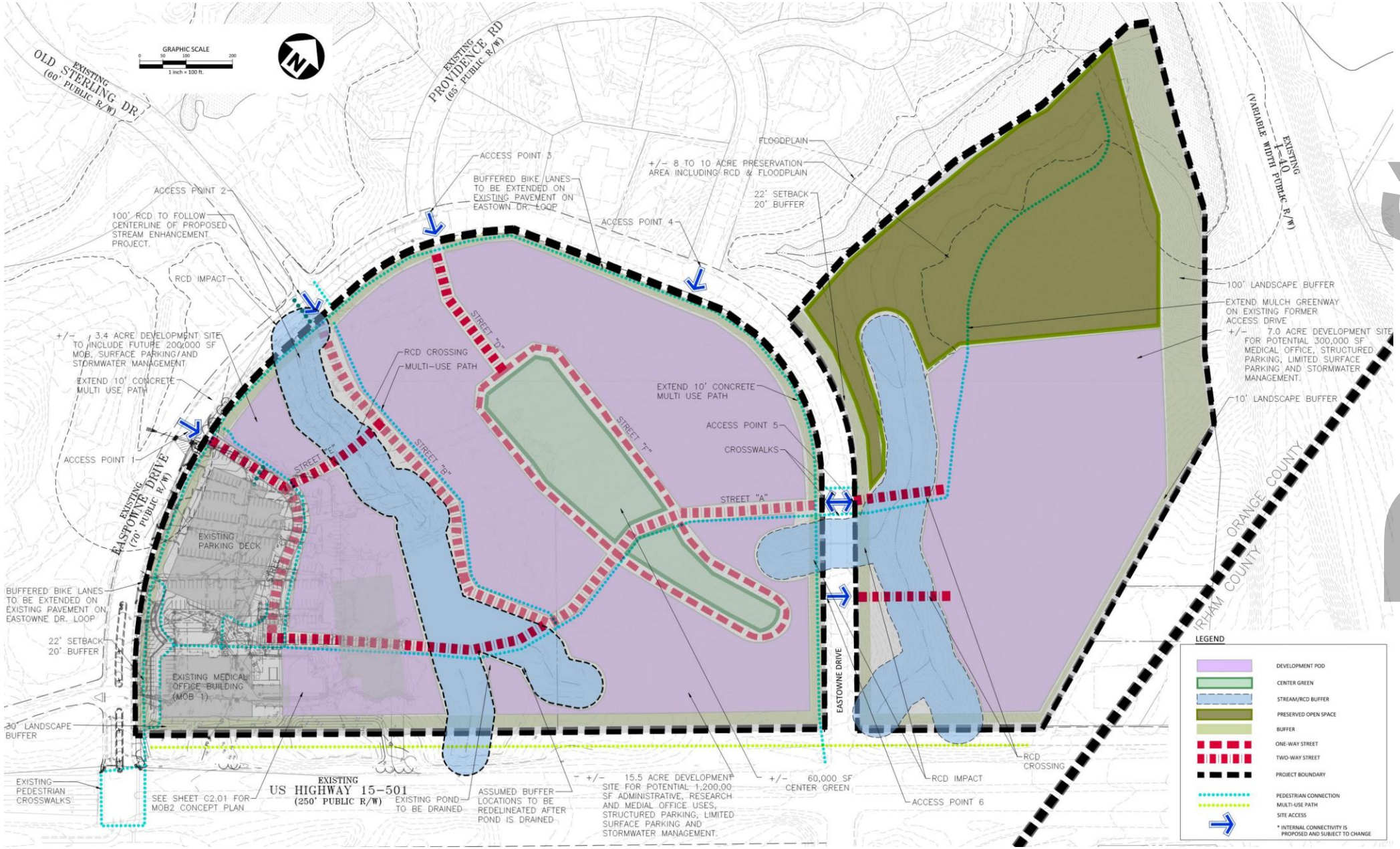
Many productive meetings between Planning Staff and UNC Health team

Conducted Traffic Impact Analysis that shows if we build more than 1.1M net new sq. ft. major road improvements at 15-501 and I-40 would be required

Continue to refine campus layout options for Eastowne campus

Continued discussion regarding affordable housing

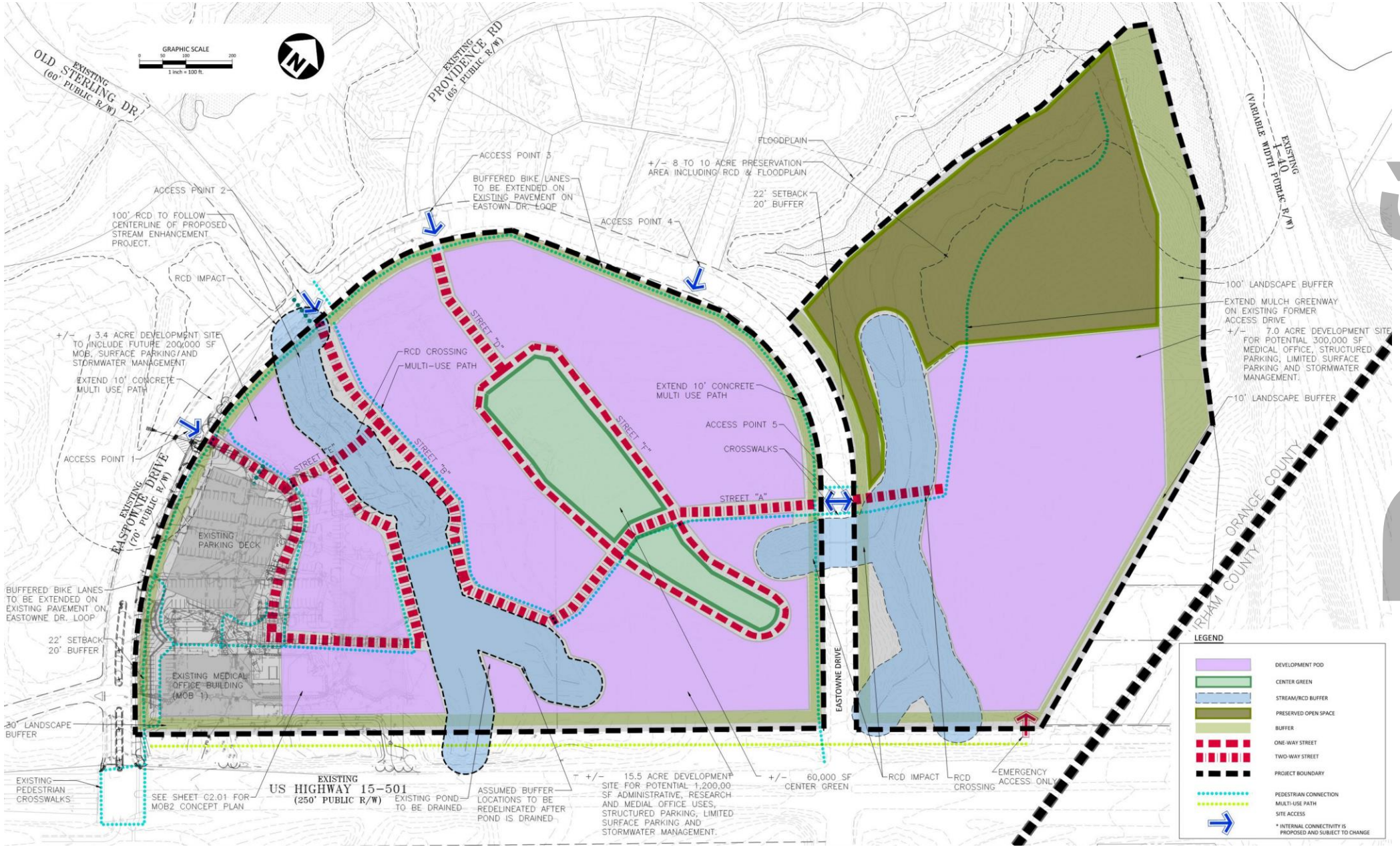
Submitted Concept Site Plan



McAdams

UNC HEALTH

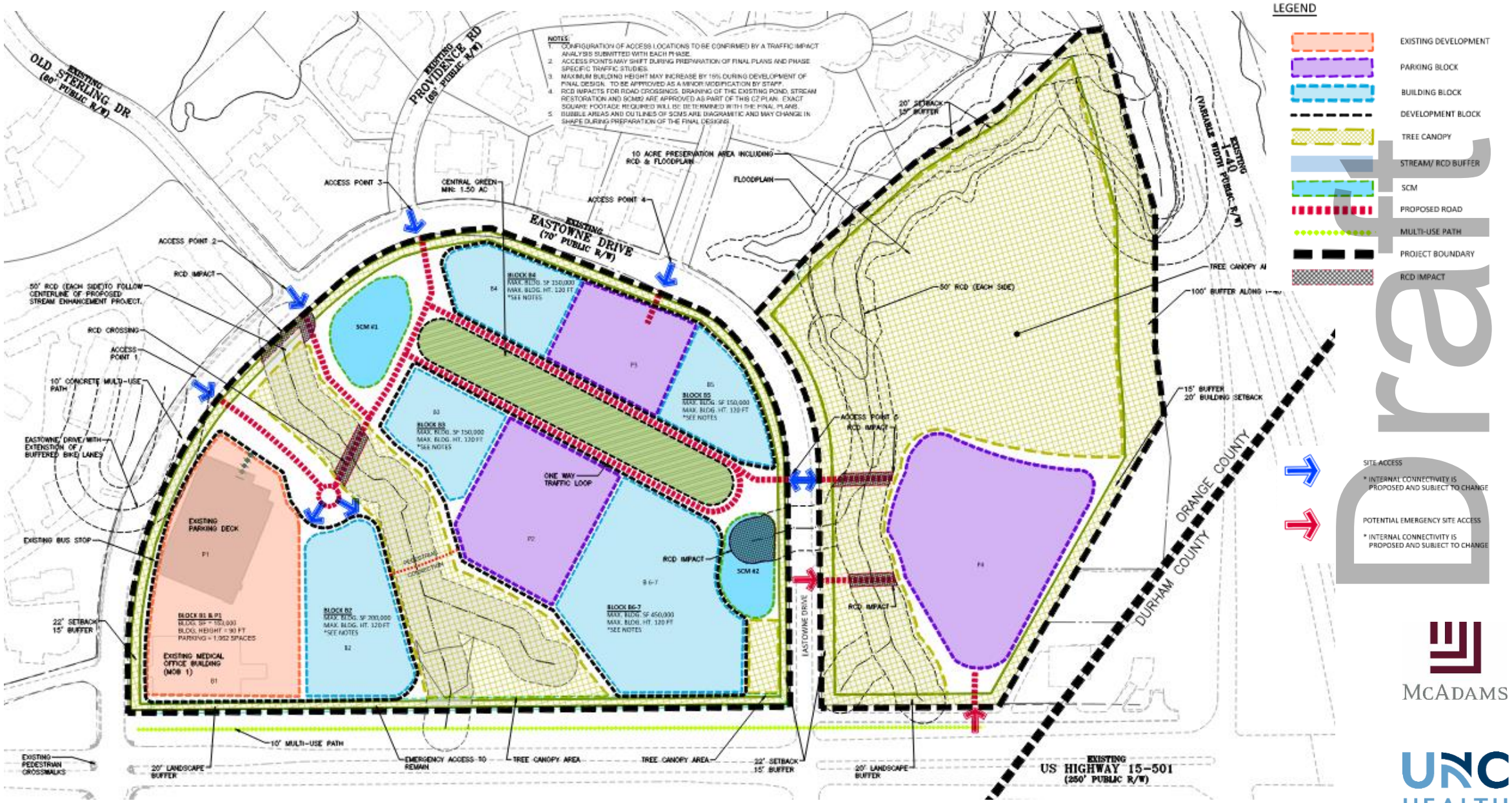
Revised Concept Site Plan



McAdams

UNC HEALTH

Revised Concept Site Plan



Eastowne Development at Phase 2

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GESTALT ARCHITECTURE + DESIGN

UNC HEALTH

Eastowne Development at Full Build Out

GAD
GESTALT ARCHITECTURE + DESIGN

UNC HEALTH

Eastowne Development at Full Build Out with Parking on N20 (if required)

GAD
GESTALT ARCHITECTURE + DESIGN

UNC HEALTH

View from Parkline/ 15-501

We are using this rendering to express massing and general circulation only and DOES NOT illustrate intended building or site design. ALL existing and or negotiated standards for planting and pedestrian paths will be followed.

East Entrance to center green with six story parking decks

GAD
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* We are using this rendering to express massing and general circulation only and DOES NOT illustrate intended building or site design. ALL existing and or negotiated standards for planting and pedestrian paths will be followed.

East Entrance to center green with six story parking decks

* We are using this rendering to express massing and general circulation only and DOES NOT illustrate intended building or site design. ALL existing and or negotiated standards for planting and pedestrian paths will be followed.

West Entrance to center green with six story parking decks

* We are using this rendering to express massing and general circulation only and DOES NOT illustrate intended building or site design. ALL existing and or negotiated standards for planting and pedestrian paths will be followed.

View from existing parking deck with MOB II on the right

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UNC HEALTH

* We are using this rendering to express massing and general circulation only and DOES NOT illustrate intended building or site design. ALL existing and or negotiated standards for planting and pedestrian paths will be followed.

View from MOB I with MOB II (and walkway) on the right

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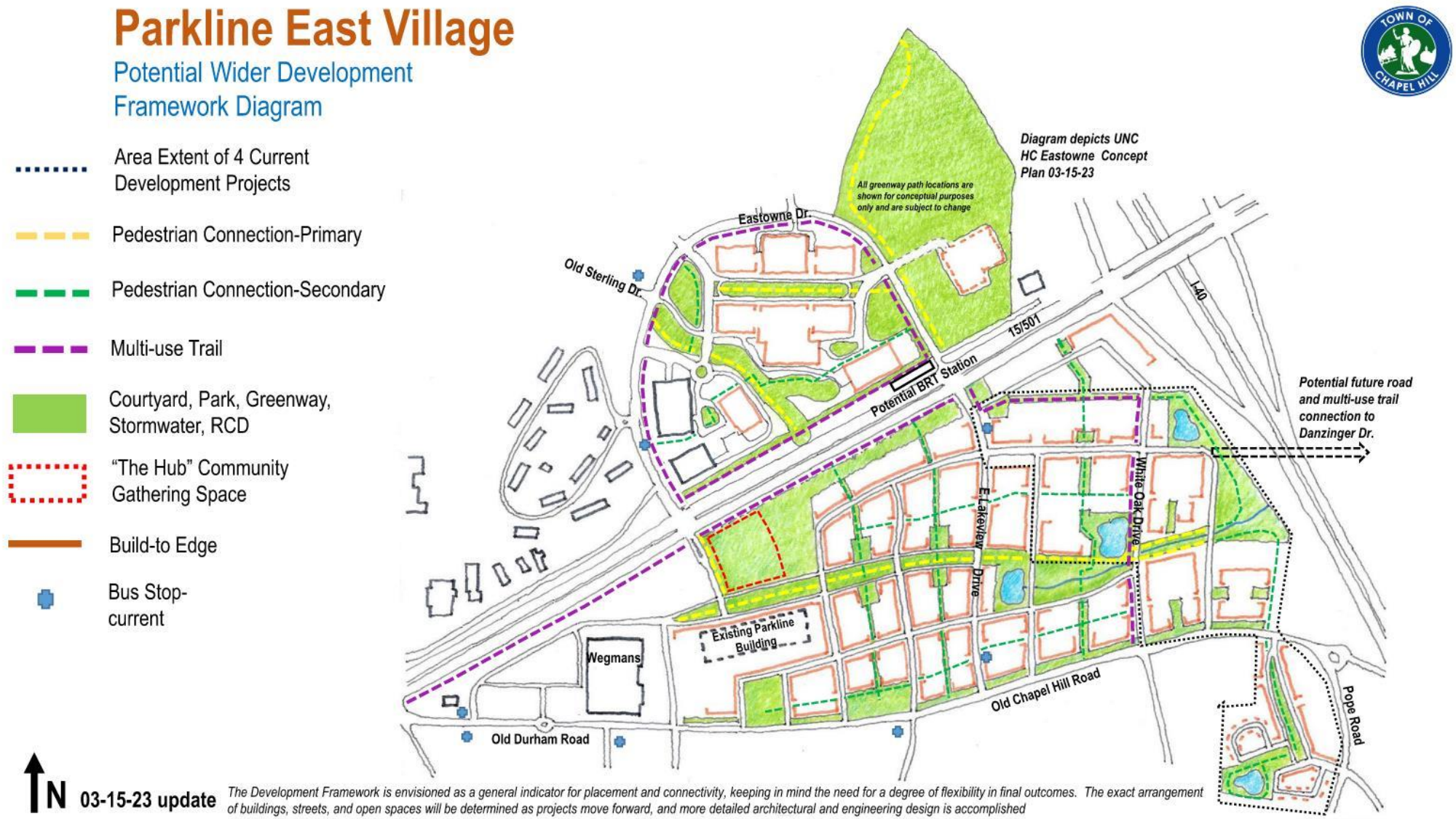
UNC HEALTH

* We are using this rendering to express massing and general circulation only and DOES NOT illustrate intended building or site design. ALL existing and or negotiated standards for planting and pedestrian paths will be followed.

Connectivity Through and Around the Site

All pedestrian path locations are shown for conceptual progress only and are subject to change

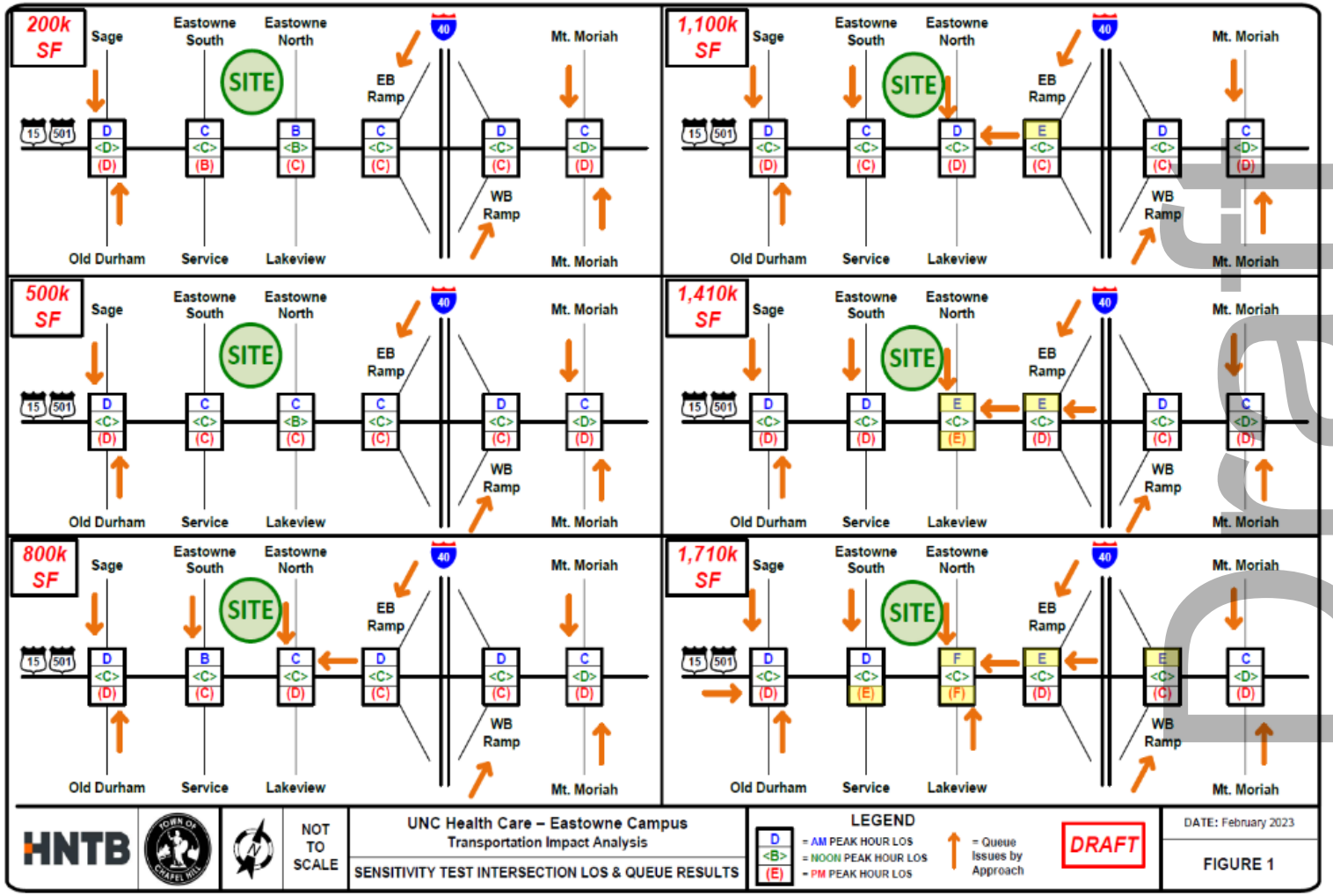
Complete Community Diagram



Complete Community Framework Diagram

Traffic Sensitivity Study

- Traffic mitigation requirements were studied for 6 development densities.
- Significant coordination with Town Staff, HNTB and UNC Health Team to determine appropriate study points and methodology
- UNC Health rightsized the Eastowne development based on practical road network improvements and patient needs.
- To avoid heavy modification to I-40/15-501 interchange, 1.1MSF was selected for max density.



Traffic Impact Analysis

Our original plan was to develop up to 1.7 million square feet of medical office, research and support services during the next 20-25 years

At the beginning of 2023, an incremental sensitivity analysis, to understand what thresholds of development on the Eastowne site would begin to stress the adjacent roadways

Based on the sensitivity analysis of the adjacent roadways, 1.7 million square feet of development would stress the system to a point of requiring roadway improvements beyond UNC Health's ability to mitigate, specifically modifications to the I-40 / 15-501 interchange

Therefore, the proposed development at Eastowne should be held to 1.1 million square feet net new (1.25M sq. ft with ET 1) to limit the traffic improvements that would be triggered by a larger development

Current Timeline

April 18	Planning Commission
April 26	Open Public Hearing
May 24	Town Council Vote on Conditional Zoning for Eastowne

Complete Community Framework

Assets	
Mature Tree Canopy	
	Preservation of a minimum of 10-acres of mature tree canopy on the northern 20
	Preservation of tree canopy at the corner of Eastowne Drive & 15-501 and along the 15-501 frontage
Natural landscapes, waterways, features	
	1,000 foot stream restoration from 15-501 to Eastowne Drive inside the loop
	Limited crossings of streams / RCD
	Preservation of a minimum of 10-acres of mature tree canopy on the northern 20
Opportunity to add density & create critical mass	
	Redevelopment of an aged, low density, sub-urban office park into a high density medical/ research campus
UNC Presence	
	Allowing the growth and improvement of services by UNCH within the Town
Willingness to Innovate	
	This conditional zoning is designed to be a innovative sustainable development integrated into the complete community it will be a part of, day one. It is also flexible to adapt to the changes in the community over time.

Complete Community Framework

Design Attributes	
Friendly to Children and Seniors	
	Structured visitor parking adjacent to all buildings
	One way traffic for all building drop offs
	Minimize pedestrian and vehicular crossings
	All efforts will be made to insure as much of this site as possible is meet the requirements for ADA accessibility
Mitigate climate risks: Green infrastructure	
	Stormwater management exceeding the Town's requirements
	Green stormwater infrastructure treating a minimum of 1-acre of impervious area
Walkable	
	Closely spaced buildings to parking structures
	Multi-Use Paths are designed to surround the perimeter of the development and connect to the planned multi-use paths by the town outside the scope of this development
	Multiuse paths such that they are inviting and connective
Human scale	
	All buildings will have canopies connecting each building to the parking structure that serve it, at a minimum. This canopy will also be sized to ensure the passenger side of vehicles in all drop off lanes are covered, at a minimum
	The ground floor of each building will be inviting and articulated to reinforce the pedestrian scale
	Site furniture and landscaping will be used to reinforce this experience
	No building will have an unbroken façade for more than 250 feet. If a Building façade exceeds 250 feet a recess in the building façade will be provided at a minimum of 10 feet wide and 10 feet deep

UNC HEALTH

Complete Community Framework

Design Attributes	
Identifiable & Distinct	
	The outer most corner of each building on the central green will be glazed to erode the building's higher elevations
	All four side of each building will be designed with similar materials, percentage of glazing and design
	Building designs provide a depth and layering in the facades to minimize flatness in material expressions
	The building elements and features organically express the building's function
	Façades use fenestration and design features to appear largely open and transparent
Everywhere to everywhere greenways	
	Completing the multi-use path around the Eastowne Drive loop
	Completing the section of the multi-use path along the 15-501 frontage
	Negotiating pedestrian crossing options for pedestrians to safely cross 15-501
Watersheds as pedestrian and cycling options	
	Pedestrian trail along the restored stream inside the Eastowne Drive loop
Program & Amenities	
	UNCH is excited to be a part of this complete community and looks forward to supporting the residential and commercial components existing currently and planned for the future
Research & Development	R&D is an anticipated part of this campus as it grows.

UNC HEALTH

Complete Community Framework

Social Equity Drivers	
Active transportation options	Coordinating & constructing new bus stop locations with Chapel Hill Transit
	Completing bike lanes around the Eastowne Drive loop
	Commitment to support future BRT station on 15-501
	Providing bicycle parking and bicycle fix-it stations
Access to parks and green space	
	Internal central green
	Stream restoration project is adjacent pedestrian trail
	Commitment for easement for pedestrian connections to Dry Creek Trail and New Hope Commons Drive when needed
New affordable housing models	
	UNCH providing no-cost line of credit
Access to homeownership for historically marginalized communities	
	UNCH providing no-cost line of credit
Live/work neighborhoods	
	Eastowne provides the work for existing and future adjacent residential developments

Findings of Fact

Finding #1: Proposed zoning amendment is necessary to correct a manifest error.

- No manifest error in the Town's Zoning Atlas is being corrected by the requested action.=

Finding #2: The proposed zoning amendment is necessary because of a changed or changing conditions in a particular are or in the jurisdiction generally.

- Growth in the healthcare needs for the Town of Chapel Hill and the entire region require the decompression of the medical center by relocating outpatient services.
- The growth of UNC Health and need to provide regional access to healthcare, without entering the center of Chapel Hill is a changed condition due access challenges created by the increased development density within the Town.

Finding #3: The proposed zoning amendment is necessary to achieve the purposes of the comprehensive plan.

- Facilitates the development as designated on the Future Land Use Map – North 15-501 Corridor Focus Area for higher intensity uses.
- Supports the Chapel Hill 2020 Plan including *A Place for Everyone, Community Prosperity & Engagement, Getting Around, Good Places-New Spaces,* and *Nurturing our Community.*
- Rezoning will promote public health, safety and general welfare, and is in conformance with the comprehensive plan.

UNC HEALTH

Town of Chapel Hill, NC

4/10/2023

CZD-22-7

Conditional Zoning Application

Status: Active

Submitted On: 11/21/2022

Primary Location

400 EASTOWNE DR

CHAPEL HILL, NC 27514

Applicant

Jessie Hardesty

919-287-0824

hardesty@mcadamsco.com

621 Hillsborough St

Suite 500

Raleigh, NC 27603

Application Information

Project Name *

UNC Health Eastowne

Application Type*

New Conditional Zoning District (CZD)

Application Type

–

Additional Addresses / PINs associated with Project

Existing Zoning District(s)*

OI-3, OI-2, and MU-OI-1

Proposed Zoning District(s)*

OI-3

Proposed Address(es)

Existing Use(s) *

MOB and Head Start

Existing Use Group

–

Existing Use Group(s) (A, B, C)

B

Proposed Use(s) *

Office (medical office buildings)

Proposed Use Group(s) (A, B, C)

B

Are new residential dwelling units proposed?*

No

Project Description*

Medical Office Building Campus

Applicant Authorization

The undersigned applicant hereby certifies that, to the best of the applicant's knowledge and belief, all information supplied with this application is true and accurate.

Applicant Signature*

Jessica Hardesty
Nov 16, 2022

Relationship to Property Owner*

Other

If other, please explain relationship to property owner. *

Engineering and Planning Consultant

Proposed Use Group(s)

If the applicant is an entity, provide detailed information regarding the principals of the entity.

Pursuant to NCGS § 160D-703(b), a request for rezoning to a conditional zoning district shall only be made by application from all the owner(s) of property included in the area proposed to be rezoned.

A Property Owner Authorization Form must accompany this application if it's submitted by an individual or entity other than the current property owner of record.

Property Owner Information

Address / PIN of Lot Included in Proposal *

9890800195, 9890800643, 9890802764, 9890803947, 9890807564, 9890911209

Property Owner Name *

Health System Properties LLC

If the property owner is an entity, provide detailed information regarding the principals of the entity. *

Simon George, VP of Real Estate and Development UNC Health Care

Property Owner Address *

5221 Paramount Pkwy Suite 460,
Morrisville, NC 27560

Property Owner Email*

Simon.George@unchealth.unc.edu

Property Owner Phone*

984-974-0240

Relationship to Applicant *

Applicant is the consultant

Project Contacts

Name

Simon George

Email

simon.george@unchealth.unc.edu

Phone

Role

Name

Bill Derks

Email

derks@mcadamsco.com

Phone

Role

Name

James Eason

Email

eason@mcadamsco.com

Phone

Role

Name	Email
Karla Carson	Karla.Carson@unchealth.unc.edu
Phone	**Role**

Name	Email
Cameron Ebron	cameron.ebron@unchealth.unc.edu
Phone	**Role**

Name	Email
David Parker	david@dcinsightllc.com
Phone	**Role**

Name	Email
Andy King	Aking@Gestaltad.com
Phone	**Role**

Site Conditions

Overlay Districts - Check all overlay districts that are present on the property, whether or not the project will intersect with them.

Resource Conservation District (RCD)	**Jordan Buffer**
☑	☑
Watershed Protection District (WPD)	**100 Year Floodplain**
☐	☐

Neighborhood Conservation District (NCD)

☐

Historic District

☐

Type of Proposed Uses / Activities in Jordan Buffer

Allowable

Land Area

Net Land Area (NLA) (sq. ft.)*

2202829

Choose credited street area, permanent open space, or both, not to exceed 10% of NLA

Credited Street Area (sq. ft.)

220283

Credited Permanent Open Space (sq. ft.)

435600

Gross Land Area (GLA) (sq. ft.)*

2423112

Total Land Area in RCD (sq. ft.)*

288974

Project Area, if different from GLA (sq. ft.)

–

Land Disturbance Area

Proposed Land Disturbance (sq. ft.) *

1742400

Proposed Land Disturbance (ac.)*

40

Proposed Total Disturbance in Jordan Buffer (sq. ft.) *

43560

Disturbance in Zone One, in SQFT

Zone One Disturbance (sq. ft.)

–

Zone Two Disturbance (sq. ft.)

–

Proposed Total Disturbance in RCD (sq. ft.) *

43560

Stream Side Zone Disturbance (sq. ft.)

43560

Managed Use Zone Disturbance (sq. ft.)

–

Upland Zone Disturbance (sq. ft.)

–

Impervious Surface Area (ISA)

Existing ISA (sq. ft.) *

403365

ISA to be Removed (sq. ft.) *

268329

New ISA (sq. ft.) *

1420056

Street Setback, in Feet

–

Interior Setback, in Feet

–

Total Proposed ISA (sq. ft.) *

1555092

Net Change in ISA (-/+) (sq. ft.)

Existing ISA Ratio*

0.18

Solar Setback, Feet

–

Lot Width, in Feet

–

Proposed ISA Ratio*

0.7

Impervious Surface Area (ISA) in Resource Conservation District (RCD)

Street Frontage, in Feet

–

Primary Building Height, in Feet

–

Is the area sewered or unsewered?

–

Stream Side: Existing ISA (sq. ft.)

–

Secondary Building Height, in Feet

–

Stream Side: Removed ISA (sq. ft.)

–

Stream Side: New ISA (sq. ft.)

–

Stream Side: Total ISA (sq. ft.)

–

Managed Use: Existing ISA (sq. ft.)

–

Managed Use: Removed ISA (sq. ft.)

–

Stream Side: Net ISA Change (-/+) (sq. ft.)

Managed Use: New ISA (sq. ft.)

–

Managed Use: Total ISA (sq. ft.)

–

Upland: Existing ISA (sq. ft.)

–

Upland: Removed ISA (sq. ft.)

–

Upland: Proposed ISA (sq. ft.)

–

Managed Used: Net ISA Change (-/+) (sq. ft.)

Upland: Total ISA (sq. ft.)

–

Proposed Setbacks and Height

Street Setback (ft.)*

22

Interior Setback (ft.)*

8

Solar Setback (ft.)*

9

Upland Zone: Net ISA Change (-/+) (sq. ft.)

Lot Width (ft.)*

15

Street Frontage (ft.)*

15

Primary Building Height (ft.)*

125

Secondary Building Height (ft.)*

125

Please list proposed setback, height, and street frontage dimensions if project intesects multiple properties.

n/a

Proposed Net Change in ISA

–

Floor Area and Dwelling Units

Number of Buildings

Existing Buildings*

5

Buildings to be Demolished*

4

Buildings to be Constructed *

7

Total Buildings*

8

Floor Area

Provide a data table with a breakdown of the proposed total floor area by use (residential and non-residential) in the site plan.

Existing Floor Area (sq. ft.)*

228000

Floor Area to be Removed (sq. ft.)*

78000

New Floor Area (sq. ft.)*

1710000

Net Change in Floor Area (-/+) (sq. ft.)

Total Floor Area (sq. ft.)*

1860000

Proposed Floor Area Ratios (FAR) and Associated Zoning District(s)

Streamside Zone: Proposed Floor Area, in SQFT, and Floor Area Ratio (FAR)

Floor Area in Resource Conservation District (RCD)

Stream Side: Existing Floor Area (sq. ft.)

12708

Managed Use Zone: Proposed Floor Area, in SQFT, and Floor Area Ratio (FAR)

Proposed Floor Area in Resource Conservation District, if applicable

Proposed New Residential Floor Area, in SQFT

–

Streamside Zone: Proposed Floor Area, in SQFT, and Floor Area Ratio (FAR

–

Upland Zone: Proposed Floor Area, in SQFT, and Floor Area Ratio (FAR)

Stream Side: Removed Floor Area (sq. ft.)

12708

Stream Side: New Floor Area (sq. ft.)

–

Stream Side: Total Floor Area (sq. ft.)

–

Stream Side: Existing Floor Area Ratio

–

Stream Side: Proposed Floor Area Ratio

–

Managed Use: Existing Floor Area (sq. ft.)

–

Managed Use: Removed Floor Area (sq. ft.)

–

Managed Use: Proposed Floor Area in SQFT

–

Managed Use: Total Floor Area (sq. ft.)

–

Managed Use: Existing Floor Area Ratio

–

Provide a breakdown of the project floor area by use in the site data table in the site plan.

New Field

–

Commercial

Managed Use: Proposed Floor Area Ratio

–

Existing Commercial Floor Area, in SQFT

–

New Total Commercial Floor Area, in SQFT

–

Upland: Existing Floor Area (sq. ft.)

–

Upland: Removed Floor Area (sq. ft.)

–

Office

Existing Office Floor Area, in SQFT

–

Upland: Proposed Floor Area (sq. ft.)

–

Upland: Total Floor Area (sq. ft.)

–

Proposed Total Office Floor Area, in SQFT

–

Institutional

Upland: Existing Floor Area Ratio

–

Upland: Proposed Floor Area Ratio

–

Existing Institutional Floor Area, in SQFT

–

Proposed Total Institutional Floor Area, in SQFT

–

Uses

Proposed Number of Hotel Rooms

–

Proposed Number of Restaurant Seats

–

Proposed Seats in Place of Worship

–

Proposed New

–

New Field

Buffers, Recreation, and Utilities

Landscape Buffers

Required Buffers

North: Required Type / Width (ft.)

20 ft Type C

South: Required Type / Width (ft.)

30 ft Type D

East: Required Type / Width (ft.)

100 ft Type E

West: Required Type / Width (ft.)

20 ft Type C

Northern Buffer Width

–

Southern Buffer Width

–

Proposed Buffers

North: Proposed Type / Width (ft.)*

20 ft Type C

Eastern Buffer Width

–

Western Buffer Width

–

South: Proposed Type / Width (ft.)*

30' Modified

East: Proposed Type / Width (ft.)*

100 ft Type E

West: Proposed Type / Width (ft.)*

20 ft Type C

Percent of Proposed Tree Canopy Coverage*

30

Proposed Combined Total Recreation Space/ Recreation Area

–

Proposed Recreation Space Ratios (RSR) and Associated Zoning District(s)

New Field

–

Utilities

Water*

OWASA

Sewer*

OWASA

Telephone

–

Electrical*

Underground

Solid Waste*

Private

Recycling*

Private

Cable TV / Internet

New Field

Are cable TV, internet, and telephone services available for the development?

Yes

Parking

Vehicular Parking

Existing Vehicular Spaces*

1629

Existing Accessible Vehicular Spaces*

113

Vehicular Spaces to be Removed*

600

New Regular Vehicular Spaces*

–

New Accessible Vehicular Spaces*

–

Total Vehicular Spaces*

–

Motorcycle/Moped Spaces

–

Total Vehicular Spaces

–

Proposed Loading Spaces*

–

Bicycle Parking

Existing Bicycle Spaces*

30

Bicycle Spaces to be Removed*

4

New Bicycle Spaces*

–

New Field

–

New Bicycle Spaces*

–

Property Owner Authorization

Property Owner Name(s)

Property Owner Eamil

Property Owner Address

Property Owner Phone

The undersigned property owner hereby certifies that, to the best of their knowledge and belief, all information supplied with this application is true and accurate.

Property Owner Signature

No signature

Authorizations

Applicant Authorization

The undersigned applicant hereby certifies that, to the best of their knowledge and belief, all information supplied with this application is true and accurate.

Applicant Authorization

Applicant Signature

No signature

Relation to Property Owner

–

Please provide the current Property Owner's Information for the selected zoning lot.

Property Owner Name(s)

Property Owner's Address

Property Owner Email

Property Owner Phone

Property Owner / Contract Purchaser Authorization

Town of Chapel Hill
Planning Department
405 Martin Luther King Jr Blvd
Phone: (919) 968-2728
Email: planning@townofchapelhill.org
www.townofchapelhill.org

Property Owner Authorization of Application for Conditional Zoning District

Staff Use Only
Application Number:

Pursuant to NCGS § 160D-703(b) Conditional Districts, property may be placed in a conditional district only in response to a petition by all owners of the property to be included.

This Property Owner Authorization form must be completed and signed by the current property owner(s) of each zoning lot involved in the proposed Conditional Zoning District application. Please submit a separate form per property owner.

Project Name: UNC Health Eastowne	
Property Address: See Attached Addresses	
Parcel Identifier Number(s) (PINs): See Attached for PINs	
Property Owner Name (must match County tax records): HEALTH SYSTEM PROPERTIES LLC	
Property Owner Address: 5221 PARAMOUNT PKWY, Ste 230, Morrisville, NC 27560	
Email: Simon.George@unchealth.unc.edu	Phone: 984-974-5388
Relationship to Applicant: Vice President - Real Estate Development UNC Health	
If the property owner is an entity, provide detailed information regarding the principals of the entity.	

Property Owner Authorization

The undersigned property owner hereby authorizes the application for Conditional Zoning District and certifies that, to the best of the owner's knowledge and belief, all information supplied with this application is true and accurate. The property owner also confirms their support of the application as proposed.

Signature: Simon George _____ Date: 11/21/2022

Print Name: Simon George

UNC Health Eastowne CZ

PINs

500 Eastowne Drive - 9890800195,

998 Eastowne Drive - 9890807564

600 Eastowne Drive - 9890800643

700 Eastowne Drive - 9890802764

800 Eastowne Drive - 9890803947

4 EASTOWNE OFFICE PARK P73/142 - 9890911209

April 6, 2023

PUBLIC PURPOSE

The Eastowne development being proposed by UNC Health will provide an additional 1,100,000 square feet (1,250,000 square feet total) of state-of-the-art medical office services within the Town of Chapel Hill. The location, immediately adjacent to the interchange at 15-501 and I-40 provides a unique location to provide easily accessible medical services for the citizens of the Town as well as a regional impact. The location will remove the outpatient traffic trips that currently have to go to the main campus medical facility from the Town's streets. In addition, the project size has been dialed in based on anticipated traffic impacts in the area surrounding East Potential LUMO modifications needed for development of Eastowne's full build-out scenario.

The development at Eastowne will also free up, "decompress", the space at the main campus. This will allow for future changes at that location to improve the services and patient experience at that location as well.

At the same time, in conjunction with the Town, many interested groups and citizens, UNC Health has committed to preserving a minimum of 10-acres of a 20-acre parcel of woods, steep slopes and floodplain areas from development. Beyond that, UNC Health has committed that any future development on the remaining 10-acres of the 20-acre total, would be the last piece developed in what is currently seen as a 20-year build-out time frame.

Inside the Eastowne Drive loop UNC Health will undertake a stream restoration project. The existing, manmade pond will be removed and the streams from 15-501 to Eastowne Drive will be restored to its natural stable form. The stream's riparian buffers will be graded and revegetated to ensure stability and re-establishment of the natural riparian processes. The stream and vegetated buffers will become a feature of the development.

Other public benefits from the development include the addition of bike lanes and a multi-use path on Eastowne Drive, a multi-use path along the project frontage on 15-501, pedestrian connections through-out the campus, area for a future BRT stop and support for affordable housing.

These commitments; 1. A connected, state-of-the-art, walkable, multi-modal, dense medical campus, and 2. Preservation of existing developable land will require some modifications to the Town's current regulations. Those required modifications are listed below.

But, at the end of the day, the services provided to the public, both within Chapel Hill and regionally, will all be dramatically improved by the construction of the Eastowne campus. The services will remain in the Town of Chapel Hill. The investments will remain in Chapel Hill both at Eastowne and the main campus. The ongoing partnership between UNC Health and the Town of Chapel Hill and its residents will remain strong.

LUMO MODIFICAITONS REQUIRED

Potential LUMO modifications needed for development of Eastowne full build-out scenario.

Article 3.8 Dimensional Standards

Table 3.8-1 Dimensional Matrix (OI-3)

- FAR
  - Current - 0.566 Proposed – 0.680
  - Clarification that the entire 50-acre property can be used for FAR calculation.

Article 3.6.3 Resource Conservation District

Justification – Impact to the RCD inside the Eastowne Drive loop are necessary to complete the stream restoration project proposed from 15-501 to Eastowne Drive. In conjunction with the restoration a single road crossing of the RCD is included to provide interconnectivity for the project inside the Eastowne Drive loop. A second impact, on the tip of an intermittent stream is proposed for stormwater management. This stream, identified by the Town to be buffered, was not identified as intermittent in a determination by the USACOE.

Modifications.

Table 3.6.3-2 Permitted Uses with Resource Conservation District

- Streets, bridges & other similar transportation facilities.
  - Current – Requires a SUP all zones
    Proposed – Permitted in all zones as part of CZ approval.
- Stream and riparian area restoration and maintenance
  - Current – Pond is allowed with a special use permit. Doesn't specifically list pond draining.
    Proposed – CZ – Allows pond draining / dam removal
  - Current – Lists as restoration not enhancement.
    Proposed – CZ - Enhancement permitted.
- Detention/retention basin and associated infrastructure.
  - Current – Prohibited in stream side zone, permitted in other zones.
  - Proposed – Permitted in all zones for specific locations identified on approved CZ.
- Art. 3.6.3(h)(4) Requirements for Development Activities
  - Current - List of requirements for development applications unless exempted by Town Manager.
  - Proposed – Development or land-disturbing activities in the RCD approved as part of the CZ with final details provided with submittal of Final Plans.

Article 5.14 - Signage

- Current:
  - Commercial Center Sign Dimensions:
    - Height (max) 12'

- Width (max) 10’
- Thickness (max) 12”
- Minimum Letter Height on Panels 9”

- External wall signage: maximum of 3 wall signs per individual establishment per street frontage.
- Ground signs: maximum 1 ground sign per street frontage

- Proposed:
  - Four (4) new UNC Health Eastowne Business Park and/or medical office site type commercial center signs up to 240 square feet on Eastowne Drive for MOB1 shall be allowed for the proposed development on the inner Eastowne loop.
    - Height (max) 12’
    - Width (max) 20’
    - Thickness (max) 18”
    - Minimum Letter Height on Panels 12”
  - External wall signage (to include building address and/or name) shall be permitted on each building and parking structure at a location that allows for optimal visibility and wayfinding.
  - Internal site wayfinding signage shall be permitted at each intersection for vehicular and pedestrian traffic.
  - The northern 20 parcel will be allowed up to two (2) ground mounted signs if the parking structure is constructed.
  - Internal building signage not facing the public right-of-way for identification and wayfinding is not subject to review by the Town.

Article 5.3.2 – Steep Slopes

Justification - The steep slopes being impacted are inside the Eastowne Drive loop and primarily consist of manmade slopes associated with existing parking, buildings, the pond dam and a earth stockpile from MOB1. Redevelopment of this side from a suburban office park to a state-of-the art, high density, walkable development with structured parking requires the ability to impact the steep slopes to a greater extent than allowed by ordinance.

Modifications

- Art. 5.3.2.(c) Applicability
  - Current – Art. 5.3.2.(c)(3) “…shall not apply to existing cut and fill slopes associated with roads, parking lots or driveways.”
  - Proposed – In addition steep slopes shall not apply to manmade slopes associated with development including grading for buildings, building pads, sidewalks, trails, ponds, stormwater treatment facilities, stockpiles, and erosion control facilities.
- Art. 5.3.2.(f) Disturbance Limitations
  - Current – “No more than twenty-five (25) percent of the total combined area of 4:1 (25 %) or steeper slopes shall be disturbed unless a variance is granted by the Board of Adjustment.
  - Proposed – Percentage disturbed shall be approved with the approval of the CZ.

- Proposed – No more than thirty (30) percent of the non-manmade steep slopes shall be impacted.

Article 5.7.6.a.2.iii. – Rare & Specimen Tree Definition

- Current – 6" DBH Proposed – 12" DBH
- Survey required only for areas to be disturbed, or within 20-feet of the disturbed area.

Article 5.6.6 Schedule of Required Buffers & Design Manual Section 3.1

The Eastowne development is intended to provide an attractive gateway entrance along 15-501 for people coming into Chapel Hill. Current philosophy has changed from the LUMO standard of screening and hiding development from view from public streets. Eastowne will provide attractive buildings and architecture. Along with this appearance, the ability to selectively clean-up and thin the existing buffer area to allow visibility will allow visibility into the development to provide an attractive gateway along 15-501 and Eastowne Dr and help with wayfinding to the facility.

Modifications

- Current – 20' Type C buffer along 15-501
- Proposed – 20' Modified buffer along 15-501 to be generally consistent with current buffer planted for MOB1.
- Current – 15' Type B buffer along Eastowne Drive
- Proposed – 15' Modified buffer along Eastowne Dr to be generally consistent with the current buffer planted for MOB1.

Article 5.9.7 Minimum and Maximum Off-Street Parking Space Requirements

Vehicular parking and bicycle parking for use for MOB1 has been monitored by UNCH since it was occupied in 2021. The current use shows that a ratio of 4.5 vehicular parking spaces per 1,000 square feet is required to meet the current demand. Bicycle parking has also been monitored and the project has not experienced full use of the sparces provided with MOB1. Therefore, the modification request is based on actual usage at this site. Monitoring of the existing use of the both the vehicular and bicycle parking within the development will continue and the number of spaces requested / ratio required will be adjusted accordingly.

Modifications

Vehicular Parking

- Business, office-type
  - Current: Max 1 space per 250 sq ft of floor area
- Clinic
  - Current: Max 1 space per 200 sq ft of floor area
- Hospital
  - Current: Max 1 per 0.5 beds

- Proposed: Total project max. 4.5 spaces per 1,000 sq ft of floor area. Owner will provide continued monitoring of the utilization of vehicular parking throughout the project and submit an updated parking analysis with each Final Plan submittal. The number of parking spaces and parking space ratio will be revised as appropriate for the change in demand over time.

Article 5.12.1.a.4 Utilities – Water Main and Fire Hydrant Installation

- Current – No building permit until water mains and hydrants are installed and operational
- Proposed – No building permit for construction with combustible materials until water mains and hydrants necessary for fire protection are installed and functional fire certification provided to the Town and OWASA.

NARRATIVE

UNC Health Eastowne

EXISTING CONDITIONS

The original Eastowne development was constructed with single and two-story office buildings in the 1970's and 1980's that are approaching the end of their useful life. The current site is strategically located adjacent to I-40 and 15-501 with the Phase 1 development being located at the western intersection of Eastowne Drive and 15-501. The first medical office building (MOB 1), completed in 2021, is in the southwest corner of the site which is bound on the eastern and northern boundaries by a Resource Conservation District (RCD). A parking deck was constructed with MOB 1 and accommodates parking for both MOB 1 and the future MOB 2. The balance of the current "inner loop", the property bounded by 15-501 and the Eastowne Drive right-of-way consists of four office buildings and surface parking. The "Northern 20", the property between Eastowne Drive and Interstate 40, is undeveloped.

PROJECT PLAN

When completed, the redevelopment project will consist of approximately 1.1M net new square feet of buildings. The buildings will be modern and energy efficient, constructed with a steel frame, skinned with attractive glass systems and complemented with architectural opaque cladding. The skin will be designed in consideration of the site's prominence at this gateway entrance into Chapel Hill and will be consistent with the UNC Health brand as well as the design of MOB 1.

The second MOB will be built adjacent to the MOB 1 site, optimize access for patients, and serve as the second phase of a welcoming, urban gateway for this project and to the Town. Parking will be accommodated via the existing parking garage and limited accessible surface parking near the second building. To promote walkability, a pedestrian bridge will be installed across the newly enhanced stream after the pond is drained. This bridge will provide access across the RCD to the balance of the existing buildings and will allow staff to move throughout the inner loop.

Future phases of the inner loop will front a center green that provides calming, natural views for patients, staff and visitors. The buildings will be oriented to maximize energy efficiency and views for patients and staff inside the facilities. A one-way loop around the center green will allow vehicles to drop off patients at the front entrances and then quickly move to vertical parking structures while providing a traffic calming measure due to its smaller cross section. There will ultimately be two internal roads that connect MOB 1 and MOB 2 to the balance of the inner loop. This road section will be designed for efficient movement of patients and visitors throughout the campus and will be phased as required once future phases are developed. The internal roads will be designed for multimodal traffic.

GOALS AND OBJECTIVES

The project's primary goal is to redevelop this site with modern, higher density medical, research and associated uses that allow UNC Health to meet the demands for outpatient services while decompressing the Medical Center which will allow for more inpatient bed capacity. Moving and increasing the outpatient services from the Medical Center to Eastowne will enable UNC Health to provide a modern, welcoming, patient centered and family-friendly care delivery system while simultaneously allowing for backfill of vacated space at main campus with inpatient beds.

The development will add a critical and significant component to the gateway into Chapel Hill along 15-501 and the Complete Community vision for this area. The project will be a mixture of modern, sophisticated buildings that complement the architecture achieved at MOB 1 but will vary in size and scale as the needs are defined. Parking will be provided vertically by parking structures with architecture complementary of the adjacent buildings visible from 15-501 or Eastowne Drive.

Connectivity via pedestrian, biking, vehicular and public transit will be provided to give patients, staff and visitors multiple ways to ingress and egress into the campus. The goal is to create an inviting development that effectively and efficiently gets patients parked and safely moving throughout the campus.

Timing is also a critically important goal of this project. To stay competitive in the increasingly challenging healthcare landscape, UNC Health must quickly adapt to the healthcare needs of the State. Building on UNC Health's strong relationship with the Town of Chapel Hill will be instrumental to reach our goal of commencing the design and construction processes for MOB 2 in the Fall of 2023, and to provide us with the flexibility needed to move rapidly as the healthcare landscape inevitably changes in the future.

April 5, 2023

Judy Johnson
Town of Chapel Hill Planning Department
405 Martin Luther King Jr Boulevard
Chapel Hill, North Carolina 27514

RE: UNC Health Eastowne Statements of Compliance with the Comprehensive Plan and Design Guidelines

STATEMENT OF JUSTIFICATION

The proposed zoning brings the subject parcels into greater conformance with the Town's Comprehensive Plan. The property is currently zoned OI-3, OI-2, and MU-OI-1, and OI-3 zoning is requested for all parcels to fulfill the themes and goals of the comprehensive plan elaborated on below. Land uses envisioned within the North 15-501 Corridor Sub-Area A include multifamily, shops & offices, commercial/office, and parks as primary uses and townhomes and institutional as secondary uses. A large portion of the land located in Sub Area A across 15-501 is planned as residential. The proposal for a medical office campus contributes to the mix of land uses desired in this area to create a well-rounded community. Statements below further support the case for the requested OI-3 zoning district.

STATEMENT OF COMPLIANCE WITH COMPREHENSIVE PLAN

The UNC Health Eastowne submittal is proposed in accordance with the CH2020 Comprehensive Plan. The proposed plan addresses the following themes with their corresponding goals: A Place for Everyone, Community Prosperity and Engagement, Getting Around, Good Places, New Spaces, Nurturing our Community, and Town and Gown Collaboration.

THEME 1: A PLACE FOR EVERYONE

UNC Health Eastowne will meet the following goals under Theme 1:

- Family-friendly, accessible exterior and interior places throughout the town for a variety of active uses.
- A welcoming and friendly community that provides all people with access to opportunities

Redevelopment of this site will add new medical offices to the Town's inventory. The new medical offices will allow for improved levels of medical service to the citizens of Chapel Hill and surrounding areas. The master plan has been designed to emphasize green space internal to the development and integrate into the surrounding community. Development of this site will provide an abundance of job opportunities in a well-designed, welcoming medical campus. Development of the site will also include structured parking which will allow for vertical development of the parcel to lessen the environmental impacts typically caused by areas of sprawling surface parking with associated land disturbance and run-off.

THEME 2: COMMUNITY PROSPERITY AND ENGAGEMENT

UNC Health Eastowne meets the following goals under Theme 2:

- Foster success of local businesses
- Promote a safe, vibrant, and connected (physical and person) community

Development of new, energy-efficient modern medical office facilities will add to the prosperity of the Chapel Hill community by allowing denser non-residential growth in the North 15-501 corridor. The UNC Health System will be able to expand to provide jobs to many Chapel Hill residents and attract new residents as well.

THEME 3: GETTING AROUND

UNC Health Eastowne meets the following goals under Theme 3:

- A connected community that links neighborhoods, businesses, and schools through the provision of greenways, sidewalks, bike facilities, and public transportation
- Connect to a comprehensive regional transportation system
- Create a comprehensive transportation system that provides everybody safe and reasonable access to all the community offers
- A community that has a parking system based on strategies that support the overall goals of a holistic transportation system

This redevelopment project is located adjacent to an existing major transportation corridor, US 15-501, which will allow for easy ingress and egress. Additionally, it is located along an existing bus route to promote and support alternative means of transportation. The project will provide a pedestrian network including greenways and sidewalks to allow for connectivity within and outside of the medical campus. This project supports the initiative to create a connected community by linking neighborhoods through various means of transportation.

THEME 4: GOOD PLACES, NEW SPACES

UNC Health Eastowne meets the following goals under Theme 4:

- A development decision-making process that provides clarity and consistency with the goals of the Chapel Hill 2020 comprehensive plan
- A range of neighborhood types that addresses residential, commercial, social, and cultural needs and uses while building and evolving Chapel Hill's character for residents, visitors, and students
- Open and accessible common spaces for community gathering, cultural uses, and community development
- Future land use, form, and density that strengthen the community, social equity, economic prosperity, and natural environment

The UNC Health Eastowne development will add new, modern medical offices to a site that is currently occupied by older, obsolete buildings. The new buildings will be designed to meet the requirements of the Land Use Management Ordinance which will allow for the development of interesting buildings and spaces to serve the

citizens of Chapel Hill and surrounding areas. It will contribute to the mix of land uses envisioned for the North 15-501 Corridor, balancing the planned residential developments across 15-501 with the non-residential UNC Health Eastowne component. The development plans to incorporate a central green space as a spine to the development that correlates with the planned green space in Parkline East, creating a well-connected community.

THEME 5: NURTURING OUR COMMUNITY

UNC Health Eastowne meets the following goals under Theme 5:

- Maintain and improve air quality and water quality, and manage stormwater to heal local waterways and conserve biological ecosystems within the town boundaries and the Extra Territorial Jurisdiction
- Protect, acquire, and maintain natural/undeveloped open spaces and historic sites in order to protect wildlife corridors, provide recreation, and ensure safe pedestrian and bicycle connections. These spaces could include, among other things, Significant Natural Heritage Areas (SNHA) lands adjacent to and connecting various properties such as riparian lands, etc.
- Support the Parks and Recreation Master Plan and the Greenways Master Plan to provide recreation opportunities and ensure safe pedestrian and bicycle connections
- Protect neighborhoods from the impact of development such as stormwater runoff, light and noise pollution, and traffic

Redevelopment of the subject parcel will enable the construction of upgraded structures, as well as an upgrade on all associated site improvements, such as stormwater controls, impervious surfaces, landscaping, open spaces, etc. While some stream crossings will be necessary, UNC Health Eastowne will strive to protect a majority of the environmentally sensitive areas on site and commit to maintaining open space throughout the development. Pedestrian and bicycle routes will be provided throughout and connect to the overall transportation system to provide alternative means of transportation that support the climate action goals of the Town.

THEME 6: TOWN AND GOWN COLLABORATION

UNC Health Eastowne meets the following goals under Theme 6:

- The University, the UNC Health Care System, and the Town will coordinate closely to manage development in ways that respect history, traditions, and the environment while fostering revitalization and innovation
- Promote access for all residents to health-care centers, public services, and active lifestyle opportunities

Modern medical office facilities will allow UNC Health Care to better attract talent to keep them in and around Chapel Hill after graduation. The new buildings will also meet all accessibility requirements so that all citizens are able to utilize the facility without the issues typically found in older office buildings. The project promotes easy access for students and residents to health care centers, public services, and creates a platform for more active lifestyle opportunities.

Sincerely,

MCADAMS

Jessie Hardesty
Planner III, Planning + Design

UNC Health Eastowne

Facility Energy Management Plan

Overall:

The energy management plan for the UNC Health Eastowne development will attempt to exceed the standards in ASHRAE 90.1 by 20 percent (current North Carolina version). Building envelope design, major building systems design, and site related elements all will contribute to the success of the energy reduction goal. Systems that will be explored include the use of higher insulated building materials, high performance glazing, higher efficiency mechanical equipment, and LED lighting. The project will also evaluate the use of low flow/reduced flow plumbing fixtures, as well as implementation of photovoltaic panels mounted on the roof of the medical office buildings where not in conflict with mechanical, plumbing, electrical devices or life safety and maintenance areas. Final PV sizes will depend on final architecture, available roof area, solar orientation considerations, and use in a net metering format or as allowed by the utility company. Energy modeling will be performed to evaluate options and verify compliance with the energy code and this project's energy goals.

The LEED building standard will be reviewed to assist the design team with its overall approach to energy conservation. Regionalism and proximity to the project site will play a large role in the selection of building products, vegetation materials, and design aesthetics. In addition, a construction waste management plan that includes recycling will be adopted and documented for the project's construction phase to minimize impacts on local landfills.

Site/Landscape:

The vegetation design for this project anticipates implementing drought-tolerant, regional planting materials to minimize the need for irrigation. This site was previously developed as an office park with surface parking lots. The new plan will not release any net new storm water and has a goal of releasing less storm water than the current development releases.

The site lighting design will address pedestrian security and aesthetics, while also considering energy efficiency and light pollution. The project will include sidewalks, pedestrian/bicycle pathways connecting through the site and beyond as well as pedestrian bridges crossing the streams. These walkable connections shall provide access to nature and green spaces throughout the campus.

The parking facility will have dedicated spaces for electric charged vehicles with charging stations, spaces for ride share users and bike lockers.

Building:

Architecture + Materials:
Materials intended to be used on the project are low maintenance, long-term products that when used in concert with high performing insulation materials will provide the owner and community a building that will stand the test of time while maintaining the original design condition. The exterior insulation on the project is within the wall cavity and outboard of the primary air barrier to remove dewpoint from within the building. This simple design decision will also increase the efficiency of the insulation by reducing thermal bridging. In addition, the glazing systems used on the project consists of high performing products that limit air infiltration and maximize thermal breaks through enhanced product design.

The building design intends to utilize high albedo paving and roofing materials. It is intended to utilize a

high albedo concrete for parking structures to help reduce the number of lighting fixtures required to light the egress paths as well as reduce the height island effect associated with impervious materials.

The materials selection for this project will place an emphasis on regional sourcing and recycled content similar to the material requirements in LEED. All paints, sealants, and other off gassing materials will be controlled by placing limitations and requirements in the specifications.

Plumbing:
Plumbing, like storm water management, needs to have an integral approach to the overall conservation of water. Toilet rooms will utilize low flow/limited volume toilet fixtures and faucets, and the design team will evaluate the use of sensor technology for flush activation and faucet operation. In addition, the design team will evaluate the type, configuration and quantity of domestic hot water heating systems to further reduce water and energy consumption.

This project will not include the use of gray water or other reclaimed water strategies.

Mechanical:
As a part of the overall approach to an energy efficient building design, the mechanical system design must be evaluated as part of the overall building's efficiency. The mechanical system type(s) and configuration(s) will be evaluated and confirmed to comply with the ASHRAE 90.1 standard (current North Carolina version). Variable volume air handling and pumping systems will be used where applicable. The mechanical design will incorporate a fresh air input and airflow measurement and control strategies to ensure the health and safety of the occupants.

Day Lighting and Electrical Lighting:
The glazing around the building will be designed to maximize daylighting allowing for a greater opportunity for the end users to have access to natural light and views. Interior improvement projects will be requested to evaluate the use of daylight zoning and occupancy sensors on all interior lighting, with a desired maximum lighting power density. This will reduce future energy consumption and provide the end user with a more natural circadian rhythm lighting scheme. The intent is to utilize LED lighting for all exterior and interior lighting if not in conflict with medical requirements.

Alternative Energy:
The building will provide infrastructure and equipment for the installation of roof mounted solar energy collection. This connection will consist of an electrical panel connection, conduit and pulls, as well as photovoltaic panels.

Construction and Future Tenant Improvement Projects:

As a part of the construction process, systems performance testing will be an integral part of the project. An example of this type of testing includes the AAMA hose stream testing of each different glazing assembly to ensure no water leakage exists in the system. In addition, all sealants that act as a part of the air barrier assembly will require a statement of compatibility to ensure the long-term stability of the materials and will also require an adhesion test to verify the onsite condition aligns with the compatibility statement. The mechanical and electrical system commissioning will be performed for the primary infrastructure by a qualified commissioning authority.

Description of Public Art Proposal

UNC Health Eastowne

UNC Health has always been supportive of the arts, both public and private. We envision public art that is located at the main entrances to the Campus from Eastowne Drive with emphasis on the inner loop development. Public art should complement our mission to improve the health and well-being of North Carolinians and others whom we serve, and reflect our focus on world changing research, and building an inclusive and equitable culture.

UNC Health commits to working with the Chapel Hill Cultural Arts Commission in the selection and placement of public art. UNC Health shall make the final artwork selection in concert with interior pieces that will aid our medical teams in promoting healing, health and wellness.

Working with local artists is preferred when suitable.

April 5, 2023
Conditional Zoning Permit
Ernest Odie-Larbi
Town of Chapel Hill Public Works
405 Martin Luther King Jr Blvd.
Chapel Hill, NC 27514

RE: UNC Health – Eastowne Campus
River Basin: Cape Fear
NMS Watershed: Jordan Lake

Ernest,

The UNC Health Eastowne Campus lies on the north side of Highway 15-501, to the south and to the east of the Eastowne Drive loop. It is proposed that the campus be redeveloped and that the existing buildings, parking lots, and associated infrastructure except the new MOB1 building be redesigned and replaced. The proposed redevelopment of the campus will result in changes to the site's drainage patterns and to an overall increase in the impervious surface area on site.

The proposed development is located in the Cape Fear River basin and within the Jordan Lake Nutrient Management Strategy Watershed. As a result of the redevelopment, the impervious area on site could increase from approximately 18% (405,645 sf) of the site's full area in the pre-development condition to a maximum of 70% (1,538,761 sf) in the post-development condition. All existing impervious will remain on the site until its demolition is required by the proposed phased improvements. Underground detention vaults and underground sand filters are proposed to manage the stormwater runoff from the proposed development.

Pre-development hydrology and routing calculations have been attached as an exhibit, along with a drainage area map of the existing condition of the site.

The Town of Chapel Hill Requirements for stormwater management on the campus are as follows:

LUMO Section 5.4 Stormwater Management

Sec. 5.4.6. General Performance Criteria for Stormwater Management

The following are required stormwater management performance criteria:

- Stormwater treatment shall be designed to achieve average annual eighty-five (85) percent total suspended solids (TSS) removal and must apply to the volume of post-development runoff resulting from the first one-inch of precipitation. Alternative treatment methods to achieve eighty-five (85) percent average annual TSS removal may be acceptable. The eighty-five (85) percent requirement applies to

eighty-five (85) percent of the additional suspended solids that are the result of the new development. (Ord. No. 2004-02-23/O-2).

- The stormwater runoff volume leaving the site post-development shall not exceed the stormwater runoff volume leaving the site pre-development (existing conditions) for the local 2-year frequency, 24-hour duration storm event for all development except single-family and two-family dwellings on lots existing as of January 27, 2003, or on lots pursuant to a preliminary plat that was approved by the town council prior to January 27, 2003. This may be achieved by hydrologic abstraction, recycling and/or reuse, or any other accepted scientific method.
- The stormwater runoff rate leaving the site post-development shall not exceed the stormwater runoff rate leaving the site pre-development (existing conditions) for the local 1-year, 2-year, and 25-year 24-hour storm events.
- Land disturbance within the stream channel of any ephemeral stream shall be minimized, and prohibited unless explicitly authorized by issuance of a zoning compliance permit after demonstration of the necessity for the disturbance.

LUMO Section 5.19 Jordan Watershed Stormwater Protection for New Development

Sec. 5.19.3 Jordan Lake Watershed Management for New Development

- "Redevelopment" means any development on previously-developed land. Redevelopment of structures or improvements that (i) existed prior to December 2001, (ii) would not result in an increase in built-upon area, and (iii) provides stormwater control at least equal to the previous development is not required to meet the nutrient loading targets of this section.

Sec. 5.19.7 Design and Performance Standards for Stormwater Management.

- Nitrogen and phosphorus loading.
    - Stormwater systems shall be designed to control and treat the runoff generated from all surfaces by one (1) inch of rainfall. The treatment volume shall be drawn down pursuant to standards specific to each practice as provided in the state design manual.
    - The nitrogen load contributed by the proposed development shall not exceed 2.2 pounds per acre per year.
    - The phosphorus load contributed by the proposed development shall not exceed 0.82 pound per acre per year.
    - Notwithstanding 15A NCAC 2B. 104(q), redevelopment subject to this section that would replace or expand existing structures or improvements and would result in a net increase in built-upon area shall have the option of either meeting the loading standards identified in subsections 5.19.7(a)(2) and (3) above, or achieve thirty-five (35) percent and five (5) percent reduction for nitrogen and phosphorus, respectively, compared to the existing development.
    - The applicant shall determine the need for and shall design structural best management practices to meet these loading rate targets by using the approved accounting tool.

- Nitrogen and phosphorus standards are supplemental. The nitrogen and phosphorus loading standards in this section are supplemental to, not replacements for, stormwater standards otherwise required by section 5.4 of the town's Land Use Management Ordinance.
- Partial offset of nutrient control requirements. Before using offsite offset options, a development subject to this section shall attain a maximum nitrogen loading rate onsite of six (6) pounds per acre per year for single-family, single-family with accessory apartment, and duplex residential development and ten (10) pounds per acre per year for other development, including multi-family residential, commercial and industrial and shall meet all requirements for structural best management practices otherwise imposed by this section. A person subject to this section may achieve the additional reductions in nitrogen and phosphorus loadings by making offset payments to the North Carolina Ecosystem Enhancement Program (program) contingent upon acceptance of payments by that program. An applicant may propose other offset measures, including providing his or her own offsite offset or utilizing a private seller. All offset measures permitted by this section shall meet the requirements of 15A NCAC 02B.0273(2) through (4) and 15A NCAC 02B.0240.
- Structural best management practices that are designed, constructed, and maintained in accordance with the criteria and specifications in the design manuals and the approved accounting tool will be presumed to meet the minimum water quality performance standards of this section

North Carolina State Law

The Jordan Lake Rules were suspended by Session Law 2013-395 (Senate Bill 515), effective August 23, 2013. Municipalities could voluntarily enforce the rules until Session Law 2015-246 (House Bill 44) prohibited municipalities from requiring voluntary regulations and rules. As such, LUMO 5.19.7 is not required for the site. Session Law 2018-145 (Senate Bill 469) states that stormwater runoff rules and programs shall not require private property owners to install increased stormwater controls for pre-existing development.

The State laws referenced resulted in the following stormwater requirements for the site: peak flow rate detention for the 1-, 2-, and 25-year storm events and treatment of runoff resulting from the net increase in impervious area for TSS removal.

Proposed Stormwater Management Performance Standards

Sec. 5.4.6 - General Performance Criteria for Stormwater Management

Detention

In accordance with and beyond the requirements of Sec. 5.4.6 (c), detention will be provided for the 1-, 2-, 25-, and 50-year 24-hour storm event. 2-year volume control will be provided per Sec. 5.4.6 (b). Underground detention vaults are proposed to detain stormwater runoff from the development. Pre-development peak flow rates have been calculated including all existing impervious onsite.

TSS Removal

Beyond the requirements of Sec. 5.4.6 (a), the Eastowne project will provide TSS removal for the increase in impervious surface from existing to proposed development, as well as 50% of the existing impervious onsite, excluding MOB 1 which has already been addressed.

Nutrient Removal

Though nutrient mitigation is not required for the site, the proposed detention and TSS treatment facilities will reduce the total nitrogen and phosphorous loads generated by the development.

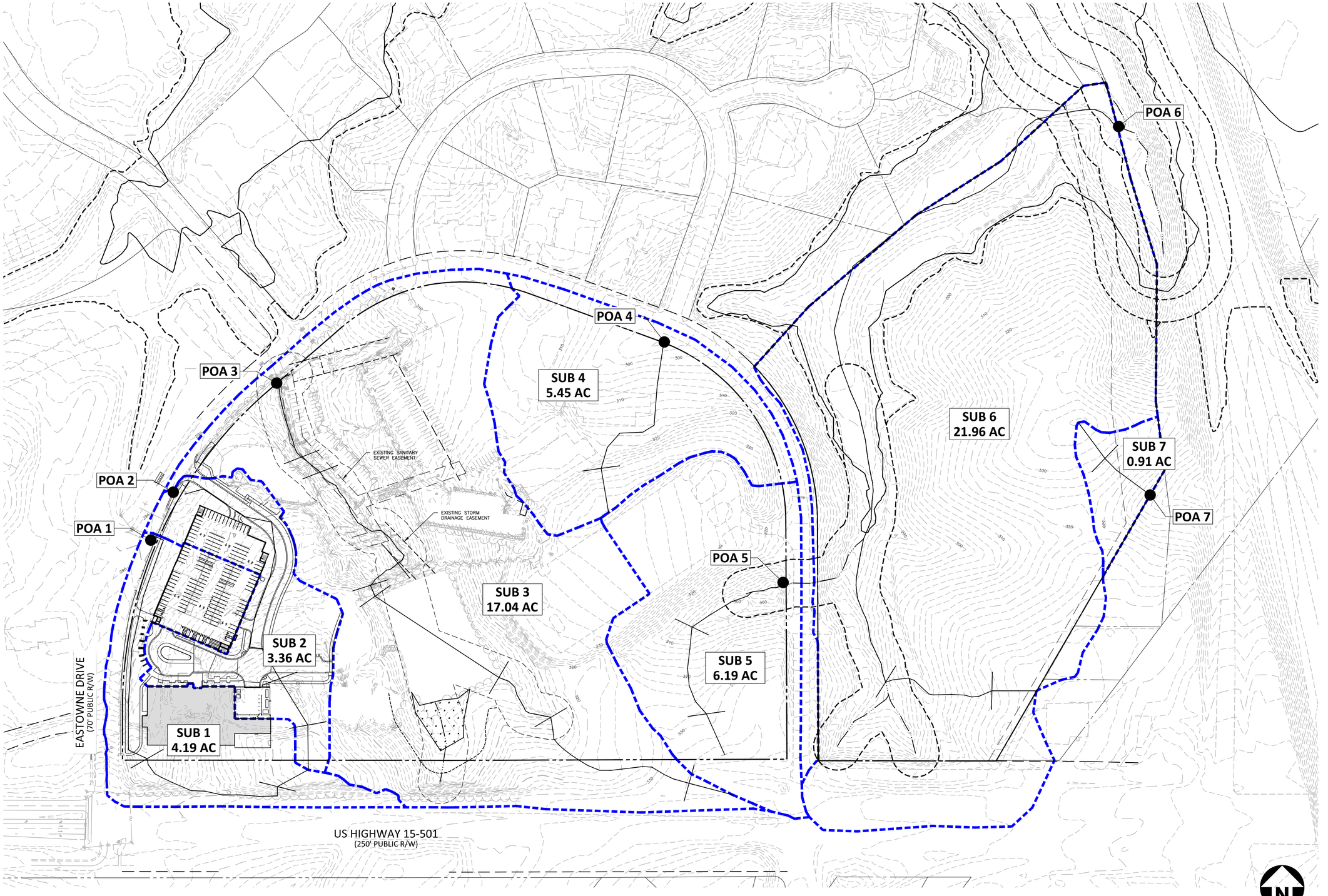
Sincerely,

MCADAMS

Josh Shinn, PE

Stormwater Design Support Practice Lead

PRE-DEVELOPMENT HYDROLOGY CALCULATIONS



PRELIMINARY DRAWING - NOT RELEASED FOR CONSTRUCTION

M:\Projects\UNH\UNH22001\04-Production\Water Resources\Prelim Sizing\Current Drawings\UNH22001-PRE.dwg, 2/7/2023 1:16:02 PM, Maria Torres

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UNC HEALTH EASTOWNE
CONCEPT PLAN
EASTOWNE DRIVE
CHAPEL HILL, NORTH CAROLINA

REVISIONS

NO.	DATE	
1	11. 21. 2022	FIRST SUBMITTAL
2	12. 19. 2022	SECOND SUBMITTAL

PLAN INFORMATION

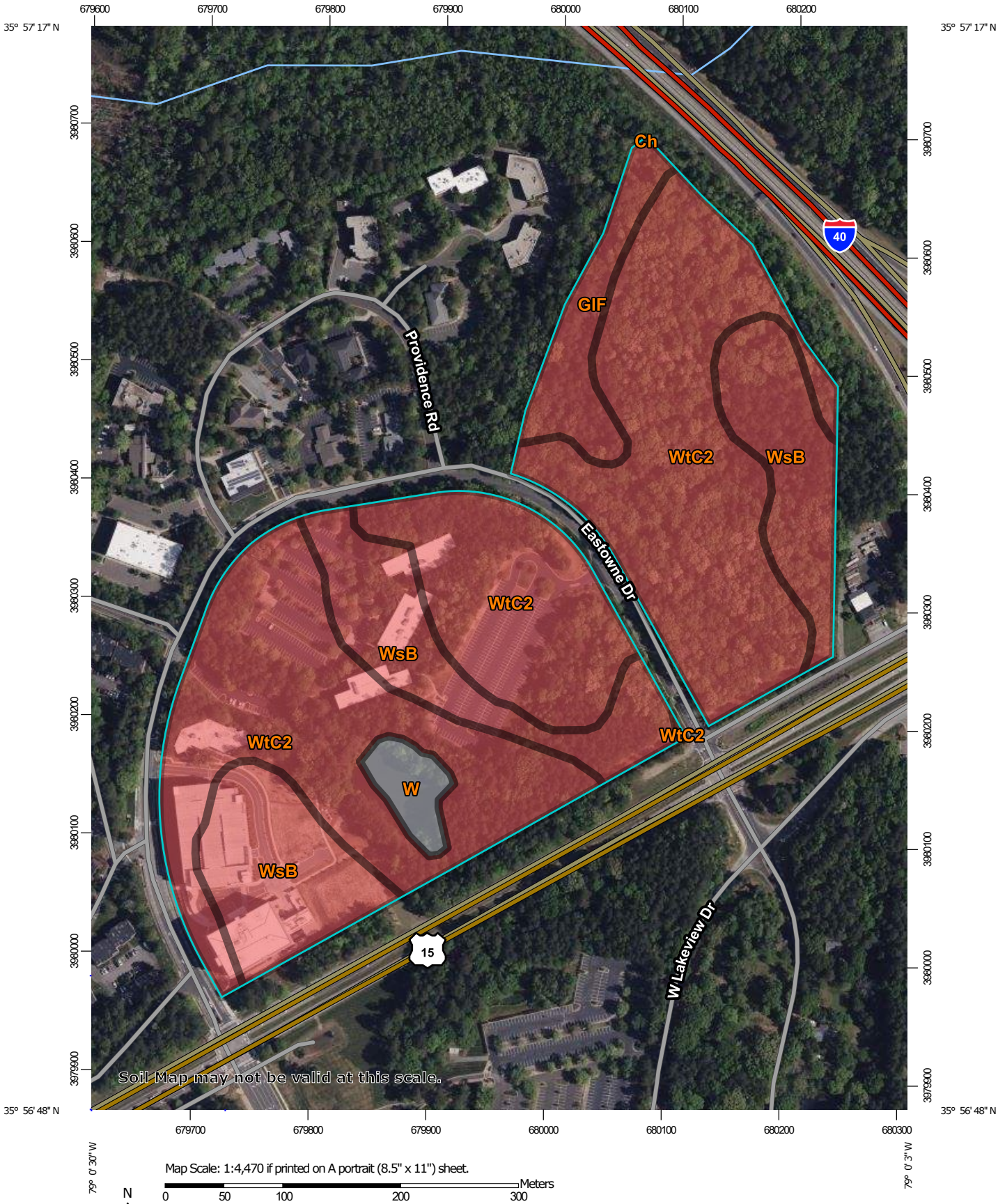
PROJECT NO.	UNH-22001
FILENAME	UNH-22001-PRE
CHECKED BY	JES
DRAWN BY	MCT
SCALE	1" = 100'
DATE	02. 07. 2023

SHEET

PRE- DEVELOPMENT HYDROLOGY MAP

PRE-DA

Hydrologic Soil Group—Orange County, North Carolina
(PL)



Map Scale: 1:4,470 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 50 100 200 300

Feet
0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Orange County, North Carolina
Survey Area Data: Version 23, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 23, 2022—Apr 27, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Ch	Chewacla loam, 0 to 2 percent slopes, frequently flooded	B/D	0.0	0.0%
GlF	Goldston channery silt loam, 15 to 45 percent slopes	D	2.7	5.4%
W	Water		1.1	2.2%
WsB	White Store loam, 2 to 6 percent slopes	D	13.4	26.6%
WtC2	White Store clay loam, 6 to 15 percent slopes, moderately eroded	D	33.2	65.8%
Totals for Area of Interest			**50.5**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Summary of Results

M. Torres, PE
2/7/2023

HYDROLOGY INPUT SUMMARY

Sub-basin ID	Onsite Area [acres]					Offsite Area [acres]					Total Area [acres]	SCS CN	Tc [min]
	Impervious	Open	Wooded	Pond	Total	Impervious	Open	Wooded	Pond	Total			
1	1.66	0.29	0.48	0.00	2.42	0.74	0.54	0.48	0.00	1.76	4.19	90	14.52
2	1.58	1.64	0.00	0.00	3.22	0.09	0.03	0.01	0.00	0.14	3.36	89	12.12
3	3.68	4.07	5.82	0.75	14.31	0.83	0.55	1.36	0.00	2.73	17.04	84	22.60
4	1.28	0.50	3.03	0.00	4.81	0.33	0.07	0.25	0.00	0.65	5.45	83	10.62
5	1.12	1.01	3.07	0.00	5.20	0.41	0.58	0.00	0.00	0.99	6.19	83	13.76
6	0.00	0.36	19.24	0.00	19.59	1.05	1.10	0.21	0.00	2.36	21.96	78	18.82
7	0.00	0.00	0.91	0.00	0.91	0.00	0.00	0.00	0.00	0.00	0.91	77	12.12
Totals =	9.31	7.86	32.54	0.75	**50.46**	3.44	2.89	2.31	0.00	**8.63**	**59.10**		

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Subbasin 1

M. Torres, PE
2/7/2023

I. SCS CURVE NUMBERS

HSG	Impervious	Open	Wooded
A	98	39	30
B	98	61	55
C	98	74	70
D	98	80	77

Assume:

HSG 'A' =	0.0%
HSG 'B' =	0.0%
HSG 'C' =	0.0%
HSG 'D' =	100.0%

Cover Condition	SCS CN	Comments
Impervious	98	-
Open	80	Assume good condition
Wooded	77	Assume good condition

II. PRE-DEVELOPMENT

Watershed Land Use Breakdown

Contributing Area	SCS CN	Area [sf]	Area [acres]	Comments
Onsite impervious	98	72,198	1.66	-
Onsite open	80	12,457	0.29	Assume good condition
Onsite wooded	77	20,961	0.48	Assume good condition
Onsite pond	100	0	0.00	-
Offsite impervious	98	32,105	0.74	-
Offsite open	80	23,669	0.54	Assume good condition
Offsite wooded	77	20,961	0.48	Assume good condition
Offsite pond	100	0	0.00	-

Total area =	4.19	acres
	182,351	sf
Composite SCS CN =	90	
% Impervious =	57.2%	

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Subbasin 1

M. Torres, PE
2/7/2023

III. TIME OF CONCENTRATION INFORMATION

Time of concentration is calculated using the SCS Segmental Approach (TR-55).

Segment 1: Overland Flow

Length =	79	ft
Top Elev =	337.50	ft
Bot Elev =	334.00	ft
Height =	3.5	ft
Slope =	0.0446	ft/ft
Manning's n =	0.40	wooded
P (2-year/24-hour) =	3.5	inches (Durham, NC)
Segment Time =	***12.28***	***minutes***

Segment 2: Concentrated Flow

Length =	343	ft
Top Elev =	334.00	ft
Bot Elev =	309.50	ft
Height =	25	ft
Slope =	0.0715	ft/ft
Paved ? =	No	
Velocity =	4.32	ft/sec
Segment Time =	***1.32***	***minutes***

Segment 3: Pipe Flow

Length =	546	ft
Top Elev =	306.00	ft
Bot Elev =	291.01	ft
Height =	14.99	ft
Slope =	0.0275	ft/ft
Manning's n =	0.013	concrete pipe
Pipe Diameter=	1.50	ft
Flow Area =	1.77	sf
Wetted Perimeter =	4.71	lf (1.5 ft ID pipe)
Channel Velocity =	9.88	ft/sec
Segment Time =	***0.92***	***minutes***

Time of Concentration =	14.52	minutes
SCS Lag Time =	8.71	minutes (SCS Lag = 0.6* Tc)
Time Increment =	2.53	minutes (= 0.29*SCS Lag)

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Subbasin 2

M. Torres, PE
2/7/2023

I. SCS CURVE NUMBERS

HSG	Impervious	Open	Wooded
A	98	39	30
B	98	61	55
C	98	74	70
D	98	80	77

Assume:

HSG 'A' =	0.0%
HSG 'B' =	0.0%
HSG 'C' =	0.0%
HSG 'D' =	100.0%

Cover Condition	SCS CN	Comments
Impervious	98	-
Open	80	Assume good condition
Wooded	77	Assume good condition

II. PRE-DEVELOPMENT

Watershed Land Use Breakdown

Contributing Area	SCS CN	Area [sf]	Area [acres]	Comments
Onsite impervious	98	69,001	1.58	-
Onsite open	80	71,309	1.64	Assume good condition
Onsite wooded	77	0	0.00	Assume good condition
Onsite pond	100	0	0.00	-
Offsite impervious	98	3,990	0.09	-
Offsite open	80	1,470	0.03	Assume good condition
Offsite wooded	77	554	0.01	Assume good condition
Offsite pond	100	0	0.00	-

Total IC area =	3.36	acres
	146,324	sf
Composite SCS CN =	89	
% Impervious =	49.9%	

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Subbasin 2

M. Torres, PE
2/7/2023

III. TIME OF CONCENTRATION INFORMATION

Time of concentration is calculated using the SCS Segmental Approach (TR-55).

Segment 1: Overland Flow

Length =	100	ft
Top Elev =	337.50	ft
Bot Elev =	334.00	ft
Height =	3.5	ft
Slope =	0.0350	ft/ft
Manning's n =	0.24	dense grasses
P (2-year/24-hour) =	3.5	inches (Durham, NC)
Segment Time =	***10.91***	***minutes***

Segment 2: Concentrated Flow

Length =	121	ft
Top Elev =	334.00	ft
Bot Elev =	318.50	ft
Height =	16	ft
Slope =	0.1277	ft/ft
Paved ? =	No	
Velocity =	5.77	ft/sec
Segment Time =	***0.35***	***minutes***

Segment 3: Pipe Flow

Length =	611	ft
Top Elev =	311.00	ft
Bot Elev =	286.80	ft
Height =	24.2	ft
Slope =	0.0396	ft/ft
Manning's n =	0.013	concrete pipe
Pipe Diameter=	1.50	ft
Flow Area =	1.77	sf
Wetted Perimeter =	4.71	lf (1.5 ft ID pipe)
Channel Velocity =	11.86	ft/sec
Segment Time =	***0.86***	***minutes***

Time of Concentration =	12.12	minutes
SCS Lag Time =	7.27	minutes (SCS Lag = 0.6* Tc)
Time Increment =	2.11	minutes (= 0.29*SCS Lag)

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Subbasin 3

M. Torres, PE
2/7/2023

I. SCS CURVE NUMBERS

HSG	Impervious	Open	Wooded
A	98	39	30
B	98	61	55
C	98	74	70
D	98	80	77

Assume:

HSG 'A' =	0.0%
HSG 'B' =	0.0%
HSG 'C' =	0.0%
HSG 'D' =	100.0%

Cover Condition	SCS CN	Comments
Impervious	98	-
Open	80	Assume good condition
Wooded	77	Assume good condition

II. PRE-DEVELOPMENT

Watershed Land Use Breakdown

Contributing Area	SCS CN	Area [sf]	Area [acres]	Comments
Onsite impervious	98	160,226	3.68	-
Onsite open	80	177,291	4.07	Assume good condition
Onsite wooded	77	253,335	5.82	Assume good condition
Onsite pond	100	32,521	0.75	-
Offsite impervious	98	35,957	0.83	-
Offsite open	80	23,852	0.55	Assume good condition
Offsite wooded	77	59,093	1.36	Assume good condition
Offsite pond	100	0	0.00	-

Total IC area =	17.04	acres
	742,275	sf
Composite SCS CN =	84	
% Impervious =	26.4%	

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Subbasin 3

M. Torres, PE
2/7/2023

III. TIME OF CONCENTRATION INFORMATION

Time of concentration is calculated using the SCS Segmental Approach (TR-55).

Segment 1: Overland Flow

Length =	100	ft
Top Elev =	335.00	ft
Bot Elev =	334.00	ft
Height =	1	ft
Slope =	0.0100	ft/ft
Manning's n =	0.24	dense grasses
P (2-year/24-hour) =	3.5	inches (Durham, NC)
Segment Time =	***17.98***	***minutes***

Segment 2: Concentrated Flow

Length =	383	ft
Top Elev =	334.00	ft
Bot Elev =	311.00	ft
Height =	23	ft
Slope =	0.0601	ft/ft
Paved ? =	No	
Velocity =	3.95	ft/sec
Segment Time =	***1.61***	***minutes***

Segment 3: Channel Flow

Length =	160	ft
Top Elev =	311.00	ft
Bot Elev =	306.50	ft
Height =	4.5	ft
Slope =	0.0282	ft/ft
Manning's n =	0.045	natural channel
Flow Area =	8.00	sf (assume 8' x 1' channel)
Wetted Perimeter =	10.00	lf (assume 8' x 1' channel)
Channel Velocity =	4.79	ft/sec
Segment Time =	***0.56***	***minutes***

Segment 4: Surface Water Flow

Length =	330	ft
Segment Time =	***0.00***	***minutes***

Segment 5: Pipe Flow

Length =	26	ft
Top Elev =	306.50	ft
Bot Elev =	305.00	ft
Height =	1.5	ft
Slope =	0.0568	ft/ft
Manning's n =	0.024	CMP Pipe
Pipe Diameter=	1.50	ft
Flow Area =	1.77	sf
Wetted Perimeter =	4.71	lf (1.5 ft ID pipe)
Channel Velocity =	7.70	ft/sec
Segment Time =	***0.06***	***minutes***

Segment 6: Channel Flow

Length =	160	ft
Top Elev =	305.00	ft
Bot Elev =	293.00	ft
Height =	12	ft
Slope =	0.0751	ft/ft
Manning's n =	0.045	natural channel
Flow Area =	1.00	sf (assume 2' x 0.5' channel)
Wetted Perimeter =	3.00	lf (assume 2' x 0.5' channel)
Channel Velocity =	4.36	ft/sec
Segment Time =	***0.61***	***minutes***

Segment 7: Channel Flow

Length =	302	ft
Top Elev =	293.00	ft
Bot Elev =	288.31	ft
Height =	4.69	ft
Slope =	0.0155	ft/ft
Manning's n =	0.045	natural channel
Flow Area =	15.00	sf (assume 10' x 1.5' channel)
Wetted Perimeter =	13.00	lf (assume 10' x 1.5' channel)
Channel Velocity =	4.54	ft/sec
Segment Time =	***1.11***	***minutes***

Segment 8: Pipe Flow

Length =	26	ft
Top Elev =	288.31	ft
Bot Elev =	287.82	ft
Height =	0.49	ft
Slope =	0.0186	ft/ft
Manning's n =	0.012	Concrete Pipe
Pipe Diameter=	2.50	ft
Flow Area =	4.91	sf
Wetted Perimeter =	7.85	lf (2 ft ID pipe)
Channel Velocity =	12.37	ft/sec
Segment Time =	***0.04***	***minutes***

Segment 9: Channel Flow

Length =	188	ft
Top Elev =	287.82	ft
Bot Elev =	285.21	ft
Height =	2.61	ft
Slope =	0.0139	ft/ft
Manning's n =	0.045	natural channel
Flow Area =	20.00	sf (assume 10' x 2' channel)
Wetted Perimeter =	14.00	lf (assume 10' x 2' channel)
Channel Velocity =	4.94	ft/sec
Segment Time =	***0.64***	***minutes***

Time of Concentration =	22.60	minutes
SCS Lag Time =	13.56	minutes (SCS Lag = 0.6* Tc)
Time Increment =	3.93	minutes (= 0.29*SCS Lag)

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Subbasin 4

M. Torres, PE
2/7/2023

I. SCS CURVE NUMBERS

HSG	Impervious	Open	Wooded
A	98	39	30
B	98	61	55
C	98	74	70
D	98	80	77

Assume:

HSG 'A' =	0.0%
HSG 'B' =	0.0%
HSG 'C' =	0.0%
HSG 'D' =	100.0%

Cover Condition	SCS CN	Comments
Impervious	98	-
Open	80	Assume good condition
Wooded	77	Assume good condition

II. PRE-DEVELOPMENT

Watershed Land Use Breakdown

Contributing Area	SCS CN	Area [sf]	Area [acres]	Comments
Onsite impervious	98	55,545	1.28	-
Onsite open	80	21,775	0.50	Assume good condition
Onsite wooded	77	132,041	3.03	Assume good condition
Onsite pond	100	0	0.00	-
Offsite impervious	98	14,186	0.33	-
Offsite open	80	3,249	0.07	Assume good condition
Offsite wooded	77	10,801	0.25	Assume good condition
Offsite pond	100	0	0.00	-

Total IC area =	5.45	acres
	237,597	sf
Composite SCS CN =	83	
% Impervious =	29.3%	

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Subbasin 4

M. Torres, PE
2/7/2023

III. TIME OF CONCENTRATION INFORMATION

Time of concentration is calculated using the SCS Segmental Approach (TR-55).

Segment 1: Overland Flow			***Segment 2: Concentrated Flow***		
Length =	100	ft	Length =	359	ft
Top Elev =	344.00	ft	Top Elev =	330.00	ft
Bot Elev =	330.00	ft	Bot Elev =	296.00	ft
Height =	14	ft	Height =	34	ft
Slope =	0.1401	ft/ft	Slope =	0.0947	ft/ft
Manning's n =	0.40	wooded	Paved ? =	No	
P (2-year/24-hour) =	3.5	inches (Durham, NC)	Velocity =	4.97	ft/sec
Segment Time =	***9.42***	***minutes***	***Segment Time =***	***1.21***	***minutes***

Time of Concentration =	10.62	minutes
SCS Lag Time =	6.37	minutes (SCS Lag = 0.6* Tc)
Time Increment =	1.85	minutes (= 0.29*SCS Lag)

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Subbasin 5

M. Torres, PE
2/7/2023

I. SCS CURVE NUMBERS

HSG	Impervious	Open	Wooded
A	98	39	30
B	98	61	55
C	98	74	70
D	98	80	77

Assume:

HSG 'A' =	0.0%
HSG 'B' =	0.0%
HSG 'C' =	0.0%
HSG 'D' =	100.0%

Cover Condition	SCS CN	Comments
Impervious	98	-
Open	80	Assume good condition
Wooded	77	Assume good condition

II. PRE-DEVELOPMENT

Watershed Land Use Breakdown

Contributing Area	SCS CN	Area [sf]	Area [acres]	Comments
Onsite impervious	98	48,675	1.12	-
Onsite open	80	44,072	1.01	Assume good condition
Onsite wooded	77	133,587	3.07	Assume good condition
Onsite pond	100	0	0.00	-
Offsite impervious	98	17,962	0.41	-
Offsite open	80	25,376	0.58	Assume good condition
Offsite wooded	77	0	0.00	Assume good condition
Offsite pond	100	0	0.00	-

Total IC area =	6.19	acres
	269,672	sf
Composite SCS CN =	83	
% Impervious =	24.7%	

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Subbasin 5

M. Torres, PE
2/7/2023

III. TIME OF CONCENTRATION INFORMATION

Time of concentration is calculated using the SCS Segmental Approach (TR-55).

Segment 1: Overland Flow

Length =	100	ft
Top Elev =	336.00	ft
Bot Elev =	329.00	ft
Height =	7	ft
Slope =	0.0701	ft/ft
Manning's n =	0.40	wooded
P (2-year/24-hour) =	3.5	inches (Durham, NC)
Segment Time =	***12.43***	***minutes***

Segment 2: Concentrated Flow

Length =	207	ft
Top Elev =	329.00	ft
Bot Elev =	304.00	ft
Height =	25	ft
Slope =	0.1208	ft/ft
Paved ? =	No	
Velocity =	5.61	ft/sec
Segment Time =	***0.61***	***minutes***

Segment 3: Channel Flow

Length =	212	ft
Top Elev =	304.00	ft
Bot Elev =	296.00	ft
Height =	8	ft
Slope =	0.0378	ft/ft
Manning's n =	0.045	natural channel
Flow Area =	4.00	sf (assume 4'w x 1'h channel)
Wetted Perimeter =	6.00	lf (assume 4' x 1' channel)
Channel Velocity =	4.91	ft/sec
Segment Time =	***0.72***	***minutes***

Time of Concentration =	13.76	minutes
SCS Lag Time =	8.25	minutes (SCS Lag = 0.6* Tc)
Time Increment =	2.39	minutes (= 0.29*SCS Lag)

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Subbasin 6

M. Torres, PE
2/7/2023

I. SCS CURVE NUMBERS

HSG	Impervious	Open	Wooded
A	98	39	30
B	98	61	55
C	98	74	70
D	98	80	77

Assume:

HSG 'A' =	0.0%
HSG 'B' =	0.0%
HSG 'C' =	0.0%
HSG 'D' =	100.0%

Cover Condition	SCS CN	Comments
Impervious	98	-
Open	80	Assume good condition
Wooded	77	Assume good condition

II. PRE-DEVELOPMENT

Watershed Land Use Breakdown

Contributing Area	SCS CN	Area [sf]	Area [acres]	Comments
Onsite impervious	98	0	0.00	-
Onsite open	80	15,546	0.36	Assume good condition
Onsite wooded	77	838,010	19.24	Assume good condition
Onsite pond	100	0	0.00	-
Offsite impervious	98	45,618	1.05	-
Offsite open	80	48,125	1.10	Assume good condition
Offsite wooded	77	9,099	0.21	Assume good condition
Offsite pond	100	0	0.00	-

Total IC area =	21.96	acres
	956,398	sf
Composite SCS CN =	78	
% Impervious =	4.8%	

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Subbasin 6

M. Torres, PE
2/7/2023

III. TIME OF CONCENTRATION INFORMATION

Time of concentration is calculated using the SCS Segmental Approach (TR-55).

Segment 1: Overland Flow

Length =	100	ft
Top Elev =	336.50	ft
Bot Elev =	330.00	ft
Height =	6.5	ft
Slope =	0.0651	ft/ft
Manning's n =	0.40	wooded
P (2-year/24-hour) =	3.5	inches (Durham, NC)
Segment Time =	***12.80***	***minutes***

Segment 2: Concentrated Flow

Length =	255	ft
Top Elev =	330.00	ft
Bot Elev =	300.00	ft
Height =	30	ft
Slope =	0.1177	ft/ft
Paved ? =	No	
Velocity =	5.54	ft/sec
Segment Time =	***0.77***	***minutes***

Segment 3: Channel Flow

Length =	1712	ft
Top Elev =	300.00	ft
Bot Elev =	262.00	ft
Height =	38	ft
Slope =	0.0222	ft/ft
Manning's n =	0.045	natural channel
Flow Area =	15.00	sf (assume 10'w x 1.5'h channel)
Wetted Perimeter =	13.00	lf (assume 10' x 1.5' channel)
Channel Velocity =	5.43	ft/sec
Segment Time =	***5.26***	***minutes***

Time of Concentration =	18.82	minutes
SCS Lag Time =	11.29	minutes (SCS Lag = 0.6* Tc)
Time Increment =	3.27	minutes (= 0.29*SCS Lag)

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Subbasin 7

M. Torres, PE
2/7/2023

I. SCS CURVE NUMBERS

HSG	Impervious	Open	Wooded
A	98	39	30
B	98	61	55
C	98	74	70
D	98	80	77

Assume:

HSG 'A' =	0.0%
HSG 'B' =	0.0%
HSG 'C' =	0.0%
HSG 'D' =	100.0%

Cover Condition	SCS CN	Comments
Impervious	98	-
Open	80	Assume good condition
Wooded	77	Assume good condition

II. PRE-DEVELOPMENT

Watershed Land Use Breakdown

Contributing Area	SCS CN	Area [sf]	Area [acres]	Comments
Onsite impervious	98	0	0.00	-
Onsite open	80	0	0.00	Assume good condition
Onsite wooded	77	39,679	0.91	Assume good condition
Onsite pond	100	0	0.00	-
Offsite impervious	98	0	0.00	-
Offsite open	80	0	0.00	Assume good condition
Offsite wooded	77	0	0.00	Assume good condition
Offsite pond	100	0	0.00	-

Total IC area =	0.91	acres
	39,679	sf
Composite SCS CN =	77	
% Impervious =	0.0%	

UNC HEALTH EASTOWNE
UNH22001

PRE-DEVELOPMENT HYDROLOGY
Subbasin 7

M. Torres, PE
2/7/2023

III. TIME OF CONCENTRATION INFORMATION

Time of concentration is calculated using the SCS Segmental Approach (TR-55).

Segment 1: Overland Flow			***Segment 2: Concentrated Flow***		
Length =	100	ft	Length =	130	ft
Top Elev =	336.00	ft	Top Elev =	328.00	ft
Bot Elev =	328.00	ft	Bot Elev =	308.00	ft
Height =	8	ft	Height =	20	ft
Slope =	0.0801	ft/ft	Slope =	0.1538	ft/ft
Manning's n =	0.40	wooded	Paved ? =	No	
P (2-year/24-hour) =	3.5	inches (Durham, NC)	Velocity =	6.33	ft/sec
Segment Time =	***11.78***	***minutes***	***Segment Time =***	***0.34***	***minutes***

Time of Concentration =	12.12	minutes
SCS Lag Time =	7.27	minutes (SCS Lag = 0.6* Tc)
Time Increment =	2.11	minutes (= 0.29*SCS Lag)

UNC Health Eastowne

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (min)	Peak Flow (ft³/s)
SUB 1	Pre-Dev 1 yr	1	0.677	727.90	9.77
SUB 1	Pre-Dev 2 yr	2	0.874	727.90	12.30
SUB 1	Pre-Dev 25 yr	25	1.717	727.90	19.55
SUB 1	Pre-Dev 100 yr	100	2.225	727.90	22.67
SUB 2	Pre-Dev 1 yr	1	0.520	725.60	8.15
SUB 2	Pre-Dev 2 yr	2	0.676	725.60	10.34
SUB 2	Pre-Dev 25 yr	25	1.347	725.60	16.67
SUB 2	Pre-Dev 100 yr	100	1.753	725.60	19.38
SUB 3	Pre-Dev 1 yr	1	2.094	732.30	23.76
SUB 3	Pre-Dev 2 yr	2	2.819	732.30	31.75
SUB 3	Pre-Dev 25 yr	25	6.051	732.20	57.86
SUB 3	Pre-Dev 100 yr	100	8.054	732.20	70.03
SUB 4	Pre-Dev 1 yr	1	0.641	725.00	10.55
SUB 4	Pre-Dev 2 yr	2	0.869	725.00	14.13
SUB 4	Pre-Dev 25 yr	25	1.893	725.00	25.29
SUB 4	Pre-Dev 100 yr	100	2.531	725.00	30.26
SUB 5	Pre-Dev 1 yr	1	0.727	726.60	10.63
SUB 5	Pre-Dev 2 yr	2	0.986	726.60	14.29
SUB 5	Pre-Dev 25 yr	25	2.148	726.50	25.88
SUB 5	Pre-Dev 100 yr	100	2.871	726.50	31.10
SUB 6	Pre-Dev 1 yr	1	2.002	730.20	24.29
SUB 6	Pre-Dev 2 yr	2	2.822	730.20	34.61
SUB 6	Pre-Dev 25 yr	25	6.666	730.20	70.58
SUB 6	Pre-Dev 100 yr	100	9.126	730.20	87.88
SUB 7	Pre-Dev 1 yr	1	0.079	727.20	1.17
SUB 7	Pre-Dev 2 yr	2	0.112	727.20	1.68
SUB 7	Pre-Dev 25 yr	25	0.269	725.60	3.43
SUB 7	Pre-Dev 100 yr	100	0.370	725.60	4.27

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (min)	Peak Flow (ft³/s)
POA 3	Pre-Dev 1 yr	1	2.094	732.30	23.76
POA 3	Pre-Dev 2 yr	2	2.819	732.30	31.75
POA 3	Pre-Dev 25 yr	25	6.051	732.20	57.86
POA 3	Pre-Dev 100 yr	100	8.054	732.20	70.03
POA 4	Pre-Dev 1 yr	1	0.641	725.00	10.55
POA 4	Pre-Dev 2 yr	2	0.869	725.00	14.13
POA 4	Pre-Dev 25 yr	25	1.893	725.00	25.29
POA 4	Pre-Dev 100 yr	100	2.531	725.00	30.26
POA 5	Pre-Dev 1 yr	1	0.727	726.60	10.63

UNC Health Eastowne

Subsection: Master Network Summary

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (min)	Peak Flow (ft^3/s)
POA 5	Pre-Dev 2 yr	2	0.986	726.60	14.29
POA 5	Pre-Dev 25 yr	25	2.148	726.50	25.88
POA 5	Pre-Dev 100 yr	100	2.871	726.50	31.10
POA 6	Pre-Dev 1 yr	1	2.002	730.20	24.29
POA 6	Pre-Dev 2 yr	2	2.822	730.20	34.61
POA 6	Pre-Dev 25 yr	25	6.666	730.20	70.58
POA 6	Pre-Dev 100 yr	100	9.126	730.20	87.88
POA 7	Pre-Dev 1 yr	1	0.079	727.20	1.17
POA 7	Pre-Dev 2 yr	2	0.112	727.20	1.68
POA 7	Pre-Dev 25 yr	25	0.269	725.60	3.43
POA 7	Pre-Dev 100 yr	100	0.370	725.60	4.27
1-2	Pre-Dev 1 yr	1	1.197	727.40	17.75
1-2	Pre-Dev 2 yr	2	1.550	726.10	22.46
1-2	Pre-Dev 25 yr	25	3.063	726.10	36.07
1-2	Pre-Dev 100 yr	100	3.979	726.10	41.95
POA 1	Pre-Dev 1 yr	1	0.677	727.90	9.77
POA 1	Pre-Dev 2 yr	2	0.874	727.90	12.30
POA 1	Pre-Dev 25 yr	25	1.717	727.90	19.55
POA 1	Pre-Dev 100 yr	100	2.225	727.90	22.67
POA 2	Pre-Dev 1 yr	1	0.520	725.60	8.15
POA 2	Pre-Dev 2 yr	2	0.676	725.60	10.34
POA 2	Pre-Dev 25 yr	25	1.347	725.60	16.67
POA 2	Pre-Dev 100 yr	100	1.753	725.60	19.38

UNC HEALTHCARE
EASTOWNE MEDICAL OFFICE BUILDING #2

DRAFT TRANSPORTATION IMPACT ANALYSIS

EXECUTIVE SUMMARY

Prepared for:

The Town of Chapel Hill
Public Works Department - Engineering

Prepared by:

HNTB North Carolina, PC

343 East Six Forks Road
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Raleigh, NC 27609

NCBELS License #: C-1554

February 2023

HNTB

UNC HEALTHCARE
EASTOWNE MEDICAL OFFICE BUILDING #2

DRAFT TRANSPORTATION IMPACT ANALYSIS

EXECUTIVE SUMMARY

Prepared for:

The Town of Chapel Hill
Public Works Department – Traffic Engineering

Prepared by:

HNTB North Carolina, PC

343 East Six Forks Road
Suite 200
Raleigh, NC 27609

NCBELS License #: C-1554

February 2023

EXECUTIVE SUMMARY

Project Overview

This study analyzes the continued redevelopment of the existing UNC Health Care property in Chapel Hill, located along US 15-501 (Durham-Chapel Hill Road) and Eastowne Drive, with a second medical-office clinic facility proposed for the site. The project proposes to demolish one existing building with a total size of 24,610 square feet and construct a new building, known as Medical-Office Building #2 (MOB #2) on the existing parcel with an approximate 200,000 square foot size. **Figure ES-1** shows the general location of the site. The project is anticipated to be fully complete by late 2025. This report analyzes the transportation impacts for the build-out scenario for the year 2026 (one year after anticipated completion), the no-build scenario for the 2026 analysis year, as well as 2022 base year traffic conditions.

The proposed site concept plans show several internal transportation network changes from existing conditions, including a relocated access point along Eastowne Drive to serve the new building which will utilize the current structured parking deck that serves MOB #1. The plan also proposes closure of an existing driveway serving existing surface parking lot facilities for the office building to be demolished. **Figure ES-2** displays the preliminary concept plan of the UNC Healthcare Eastowne MOB#2 development, transportation network changes, and nearby land uses and roadways. This report analyzes and presents the transportation impacts that the UNC Healthcare Eastowne MOB#2 redevelopment will have on the following existing and future intersections in the project study area:

- US 15-501 and Sage Road / Old Durham Road
- US 15-501 and Eastowne Drive (South) / Service Road
- US 15-501 and Eastowne Drive (North) / Lakeview Drive
- Eastowne Drive and Old Sterling Drive / UNC Health Care Building 500 Driveway
- Eastowne Drive and Existing UNC Health Care MOB Parking Deck Driveway Access
- Eastowne Drive and Pinegate Circle
- Eastowne Drive and Dobbins Drive

The impacts of the proposed site at the study area intersections were evaluated during the AM, noon, and PM peak hours of an average weekday.

Existing Conditions

Study Area

The site is located in northeast Chapel Hill along US 15-501 in the Eastowne Business Park. The study area contains three signalized intersections along US 15-501 at Sage Road, Eastowne Drive/Service Road and Eastowne Drive/Lakeview Drive. All future site traffic is expected use a proposed full access site driveway along Eastowne Drive that will be relocated from its current locations. Internal driveways shown on the preliminary site plan will circulate site traffic to structured parking and a patient drop-off/pick-up location. US 15-501 is a major arterial facility providing connectivity between Chapel Hill, Durham and the I-40 corridor. Remaining study area network roadways are either minor arterial/collector facilities or local neighborhood access streets.

Site Traffic Generation

With the addition of new peak hour trips during the weekday AM, noon, and PM peak hours, there are potential site traffic impacts to the study area intersections. **Table ES-1** shows the site trip generation details, with generation rates taken from existing traffic count data at the MOB#1 Parking Deck Access Driveway and comparative growth ratios calculated from square footage proposed for MOB #2

compared to MOB #1 building square footage. Data was also compared to information from the Institute of Transportation Engineers (ITE) *Trip Generation Manual, Version 11*. Trips for the existing UNC Health Care Building 500 to demolished as part of the site redevelopment were also generated to estimate "full occupancy" for this entitlement and then removed from the Build Scenario traffic volumes.

Table ES-1. Weekday Vehicle Trip Generation Summary

Description	Density	Daily			AM Peak			Noon Peak			PM Peak		
		Enter	Exit	Total	Enter	Exit	Total	Enter	Exit	Total	Enter	Exit	Total
MOB #2	200k SF	1,999	1,999	3,998	363	68	431	220	195	414	33	329	362
Adjustments													
Transit Reduction	5%	-100	-100	-200	-18	-3	-22	-11	-10	-21	-2	-16	-18
Ped/Bike/Internal Reduction	5%	-100	-100	-200	-18	-3	-22	-11	-10	-21	-2	-16	-18
Total Net Vehicle Trips Added to Network		**1,799**	**1,799**	**3,598**	**327**	**62**	**387**	**198**	**175**	**372**	**29**	**297**	**326**

Background Traffic

Background traffic growth for the 2026 analysis year is expected to come from two sources - ambient regional traffic growth and specific development-related traffic growth. Three developments near the project study area that are currently in the Town planning review process are expected to contribute to specific background traffic generator growth. All remaining estimated traffic volume increases are assumed to occur due to overall region-wide ambient growth (assumed 2.5 percent per year based on NCDOT/Town provided historic growth data and data related to peak hour traffic conditions rebounding from the effects of COVID-19). Additional background traffic adjustments were made for the demolition of the existing UNC Health Care Building 500 currently located on the site.

Impact Analysis

Peak Hour Intersection Level of Service

Existing traffic operations at all study area intersections are acceptable during all three peak hours analyzed, though the intersection of US 15-501 and Sage Road/Old Durham Road is congested and nearing capacity during peak travel periods. The projected ambient and background development traffic growth will increase intersection delay and queue impacts by 2026. With the addition of peak hour site-generated "net" trips to the projected 2026 background traffic volumes, no study area intersections are expected to experience deficient traffic operations in any peak hour. Proposed geometric and signal timing improvements are expected to mitigate anticipated deficient LOS conditions throughout the study area and improve queue storage and safety, as well.

A summary of the traffic operations for each intersection, related to vehicular delays (intersection average as a whole if signalized, critical movement if stop-controlled) and the corresponding traffic microsimulation Level-of-Service (LOS_S) is shown in **Table ES-2**.

Access Analysis

Vehicular site access is to be accommodated by the proposed relocated full movement access driveway connecting to Eastowne Drive for entry/exit to the existing structured parking and on-site surface drop-off areas. Design details related to driveway throat lengths shown on the site plan and driveway spacing from existing intersections and adjacent driveways adhere to NCDOT *Policy on Street and Driveway Access to North Carolina Highways* and the Town of Chapel Hill Design Manual.

Table ES-2. Peak Hour Intersection Capacity Analysis Summary

Intersections	Peak Hour	2022 Existing		2026 No-Build		2026 Build		2026 Mitigated	
		LOSs	Delay	LOSs	Delay	LOSs	Delay	LOSs	Delay
US 15-501 and Sage Road / Scarlett Drive	AM	D	36.5	D	45.2	D	48.1	D	39.9
	NOON	C	31.7	C	32.9	D	41.1	C	33.1
	PM	C	34.0	D	40.6	D	42.5	D	40.7
US 15-501 and Eastowne Drive (South) / Service Road	AM	B	16.7	C	20.4	D	40.5	C	20.9
	NOON	B	16.5	B	17.1	C	23.3	C	22.3
	PM	B	14.9	B	14.6	C	20.5	C	21.6
US 15-501 and Eastowne Drive (North) / Lakeview Drive	AM	B	12.2	B	17.7	B	19.4	B	15.5
	NOON	B	10.3	B	13.2	B	16.6	B	14.8
	PM	B	13.2	B	16.5	B	17.3	C	23.2
Eastowne Drive and Old Sterling Drive / UNC Health Care Building #5 Driveway#	AM	A	5.7	A	5.9	A	6.3	A	6.2
	NOON	A	5.7	A	6.0	A	6.4	A	6.5
	PM	A	6.1	A	6.3	A	6.0	A	5.8
Eastowne Drive and Existing MOB Parking Deck Driveway Access#	AM	A	6.1	A	7.2	A	9.0	A	9.7
	NOON	A	6.0	A	6.3	A	8.9	A	8.9
	PM	A	5.6	A	5.8	***F***	***100***	A	8.6
Eastowne Drive and Pinegate Circle#	AM	A	3.8	A	3.9	A	4.8	A	4.4
	NOON	A	3.9	A	4.5	A	5.4	A	5.3
	PM	A	4.0	A	4.1	***F***	***107***	A	5.2
Eastowne Drive and Dobbins Drive#	AM	A	7.6	A	8.5	B	11.9	B	11.7
	NOON	B	13.0	B	13.3	C	23.4	C	22.2
	PM	C	22.6	D	32.1	***F***	***355***	D	31.8

BOLD/ITALICS **–** Critical Movement or Overall Intersection Requires Mitigation Per Town TIA Guidelines
- Worst-Case LOS/Delay for Unsignalized/Stop-Controlled Critical Movement

Access for pedestrians and bicyclists is subject to some limited connectivity in the project study area. Sidewalk is present on most study area facilities and connections along US 15-501 in the vicinity of Wegmans exist, along with signalized crossings of US 15-501 at Eastowne Drive adjacent to the site and at Sage Road/Old Durham Road. Connectivity is impaired due to lack of continuous sidewalk along other sections of US 15-501. Bicycle lanes exist on Sage Road, Old Sterling Drive, and a short section of Eastowne Drive immediately adjacent to the site, with the remaining cross-section width of Eastowne Drive not inhibiting bicycling, but there is no bicycling connectivity on the US 15-501 corridor.

Signal Warrant Analysis
Based on projected 2026 traffic volumes and proposed access plans, no unsignalized intersection in the project study area would warrant the installation of a traffic signal, based on the methodology found in the *2009 Manual on Uniform Traffic Control Devices (MUTCD).*

Crash Analysis
Data from the NCDOT Traffic Safety Unit was provided for the five-year period 12/1/2017 to 11/30/2022 for the US 15-501 and Eastowne Drive segments in the vicinity of the proposed site. There were 396 crashes reported along the US 15-501 study area corridor between Sage Road and Eastowne

Drive/Lakeview Drive over the five year period, with 26 crashes on Eastowne Drive. The primary crash type was rear end crashes and crashes were primarily clustered near the three signalized intersections. Overall, the number and severity of crashes along US 15-501 in the project study area are higher than state-wide averages for similar urban US highway and secondary roadway facilities.

Other Transportation-Related Analyses
Other transportation-related analyses relevant to the 2001 Town of Chapel Hill Guidelines for the preparation of Traffic Impact Studies were completed as appropriate. The following topics listed in **Table ES-3** are germane to the scope of this study.

Table ES-3. Other Transportation-Related Analyses

Analysis	Comment
Turn Lane Storage Requirements	Storage bay lengths at study area intersections were analyzed using TransModeler maximum queue length estimates for the 2026 Build Scenario. No unsignalized intersection is expected to have excessive peak hour queues or conditions that exceed existing turn lane storage. Recommendations to improve turn lane storage were made for the US 15-501 and Eastowne Drive/Service Road intersection – as this location will have the highest degree of site traffic impact. Storage issues not due to site-related traffic impacts are not easily correctable at other upstream/downstream intersections, given the high traffic volumes along the US 15-501 corridor, but adjustments to signal timing are shown to potentially reduce side street queues at critical locations.
Appropriateness of Acceleration/ Deceleration Lanes	The site concept plan shows no specifics related to acceleration/deceleration lanes. Due to the low speed limit on Eastowne Drive (25 mph) and the presence of some on-street parking in the vicinity, no acceleration/deceleration lanes are recommended for site access. Existing intersections along US 15-501 currently have left-turn and right-turn auxiliary deceleration lanes. No other specific acceleration/deceleration lane issues were analyzed in the project study area.
Pedestrian and Bicycle Analysis	Pedestrian access exists in the project study area but connectivity is limited directly along the US 15-501 corridor. Bicycle lanes extend along Sage Road, Old Sterling Drive, Old Durham Road, and a short section of Eastowne Drive that was included in the MOB #1 project. Very limited bicycle facilities exist along/parallel to the US 15-501 corridor within the project study area. The site plan shows additional sidewalk developed along site frontage. Additional pedestrian and bicycle facilities should be provided along Eastowne Drive to connect the site to the Old Sterling Drive intersection.
Public Transportation Analysis	Public transportation service to the study area, and to the proposed site is adequate, with bus stops and multiple local and regional bus routes on both Eastowne Drive and US 15-501 proximate to the site.

Mitigation Measures/Recommendations

Planned Improvements
There are no Town of Chapel Hill / North Carolina Department of Transportation improvement projects affecting study area roadway facilities within the analysis year time frame of 2022-2026. NCDOT STIP project EB-4707B has completed construction along Old Durham Road/Old Chapel Hill Road east of the project study area and included pedestrian and bicycle improvements connecting to the US 15-501 corridor at the Sage Road/Scarlett Drive intersection. The US 15-501 corridor is currently being studied for capacity improvements as part of NCDOT STIP U-5304F, but these improvements are not known at this time and were not considered to be complete by the 2026 analysis year.

Background Committed Improvements
There are currently no committed background improvements to the project study area from private development projects expected to be complete by the 2026 analysis year. Several development

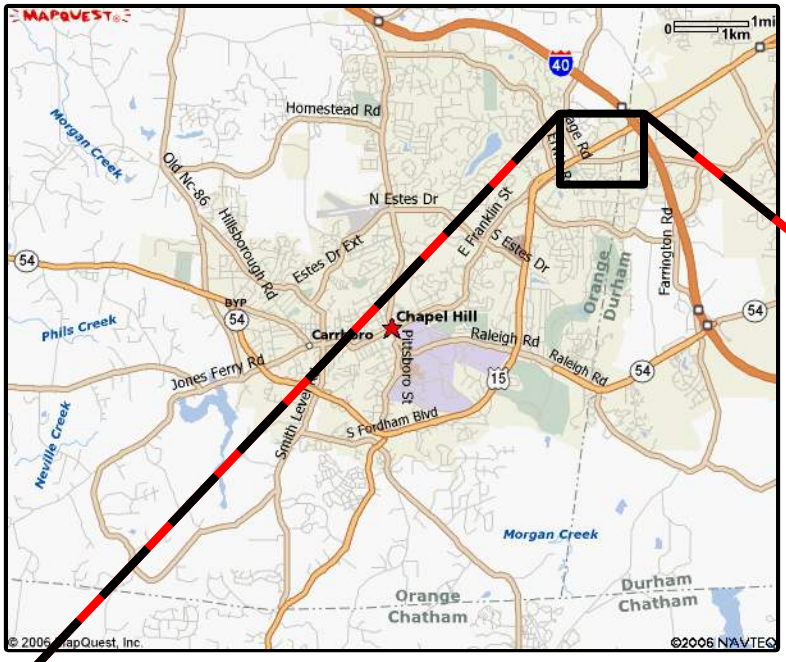
projects are currently under study, but their final required transportation improvements are not known at this time.

Applicant Committed Improvements
Based on the preliminary site plans and supporting development information provided, there are several minor specific transportation-related improvements proposed on or along the frontage of the UNC Health Care Eastowne MOB #2 site. These improvements include the following:

- Extension of existing sidewalk along the site frontage past the proposed relocated MOB Parking Deck Access Driveway.
- Provision of the relocated two-way access driveway with internal traffic circle connecting to future internal roadways on the UNC Health Care Eastowne Property. Driveway parking deck lower floor access connection for employee parking to include a right-turn auxiliary lane to remove this traffic from the patient traffic heading into the site.
- Demolition of the 500 Building and closure of its adjacent surface parking lot and connection to Eastowne Drive.

Necessary Improvements
Based on traffic capacity analyses for the 2026 design year, and analyses of existing study area turning bay storage lengths, site access and multi-modal mobility, the following improvements (see **Figure ES-3**) are recommended as being necessary for adequate transportation network operations:

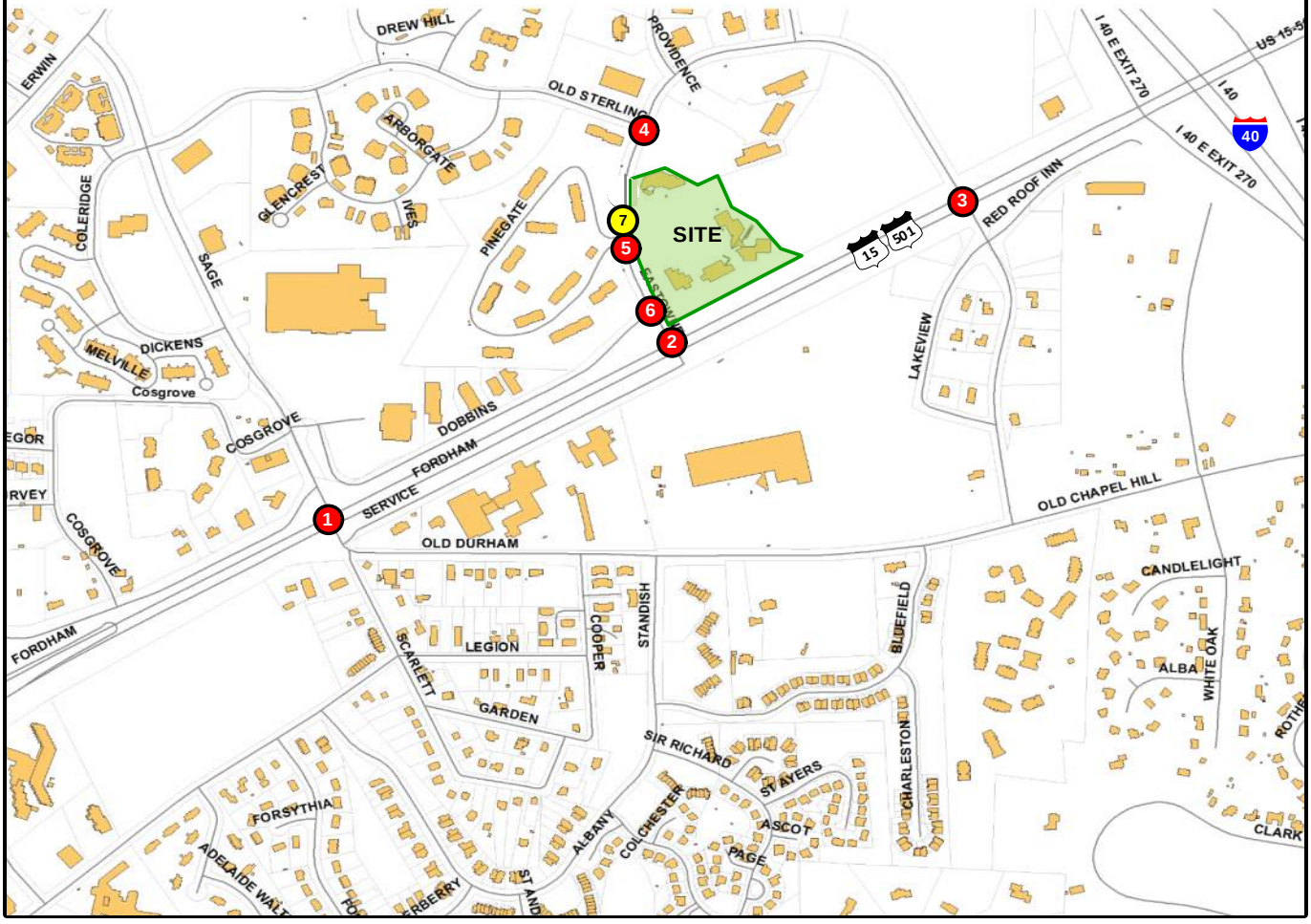
1) To manage projected maximum queue lengths on southbound Eastowne Drive at the US 15-501 signalized intersection, it is recommended that the existing left-turn lane be extended from 300 feet to provide 375 feet of vehicle storage. This will reduce the available left-turn storage for the Pinegate Circle intersection, but capacity analysis and queue results indicate that 75 feet of full storage for that movement should be sufficient.
2) To extend existing pedestrian and bicycle facilities along Eastowne Drive in the vicinity of the proposed redevelopment, the section of Eastowne Drive between the existing MOB Parking Deck Access Driveway and Old Sterling Drive should have on-street parking eliminated and buffered bicycle lanes and a three-lane vehicular cross-section should be implemented, which may require some widening along the site frontage from the existing parking deck driveway to Old Sterling Drive. Left-turn lanes with 100 feet of storage should be delineated in this vicinity for the relocated Parking Deck Access Driveway and Old Sterling Drive.
3) The existing pedestrian sidewalk along Eastowne Drive in front of MOB #1 and the Parking Deck should be extended to Old Sterling Drive and marked crosswalks be provided at this intersection crossing Old Sterling Drive and at the southbound approach along Eastowne Drive.
4) The proposed concept plan for the relocated Parking Deck Access Driveway should include the provision of a right-turn auxiliary lane with at least 75 feet of storage at the Eastowne Drive intersection. Noon and PM peak exiting traffic volumes from the parking deck are expected to be high, with a balanced proportion turning in each direction onto Eastowne Drive. Separate egress lanes would provide additional capacity and prevent the egress traffic from queuing to the vicinity of the internal traffic circle near the parking deck.
5) Signal timings at all three study area intersections should be reoptimized to account for the effects of site-related traffic. Signal timings for the Eastowne Drive approaches to the two US 15-501 intersections need to account for increase traffic volumes requiring more minor street green time to clear queues in one signal phase.



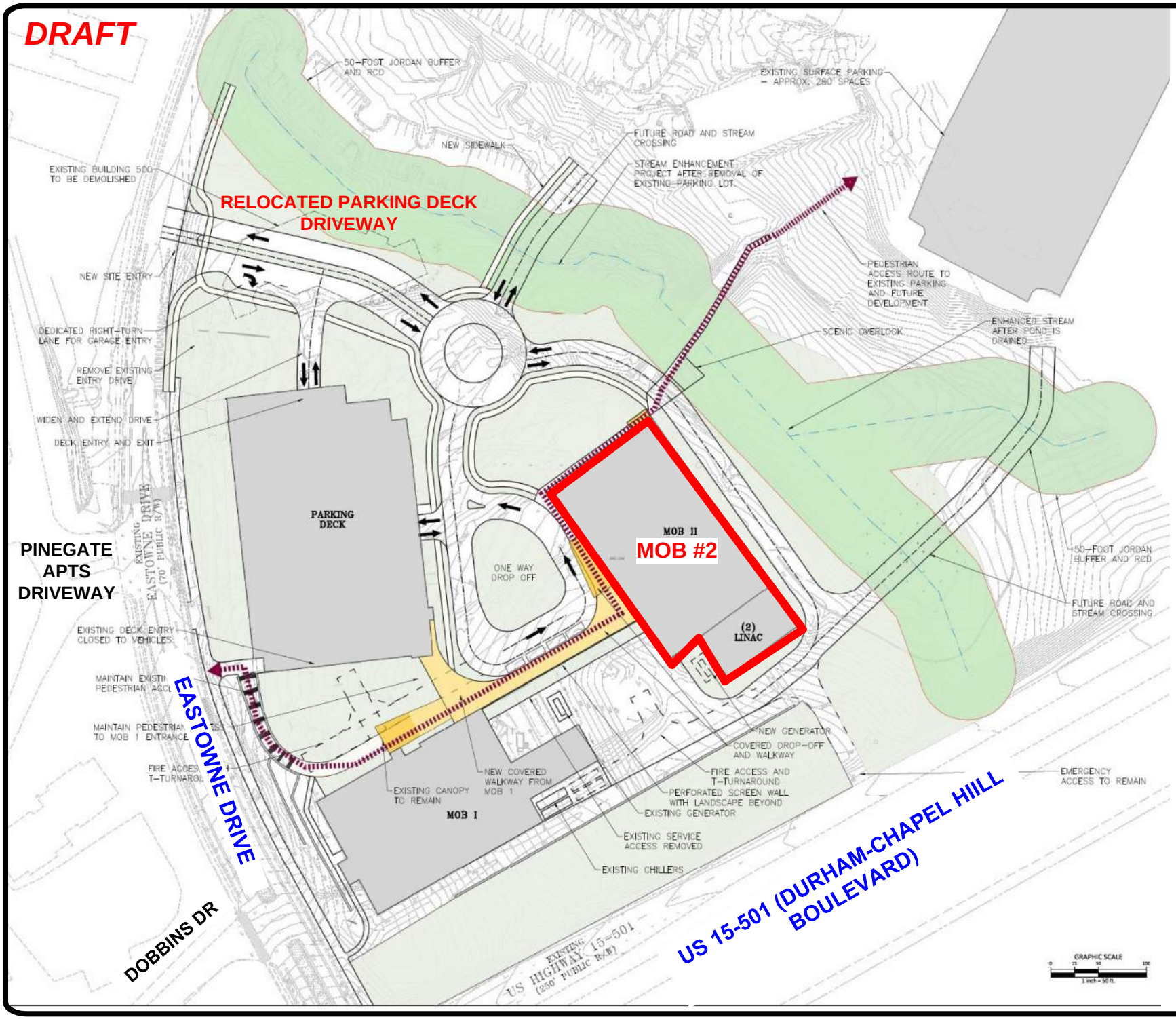
LEGEND

- = Existing Building Footprint
- = Existing Study Area Intersection
- = Proposed Site Driveway
- = Proposed Site Parcel

DRAFT



HNTB	TOWN OF CHAPEL HILL	**UNC Health Care Eastowne MOB #2** **Transportation Impact Analysis**	**DATE:** February 2023
		PROJECT STUDY AREA	**FIGURE ES-1**



NOT TO SCALE

HNTB

TOWN OF CHAPEL HILL

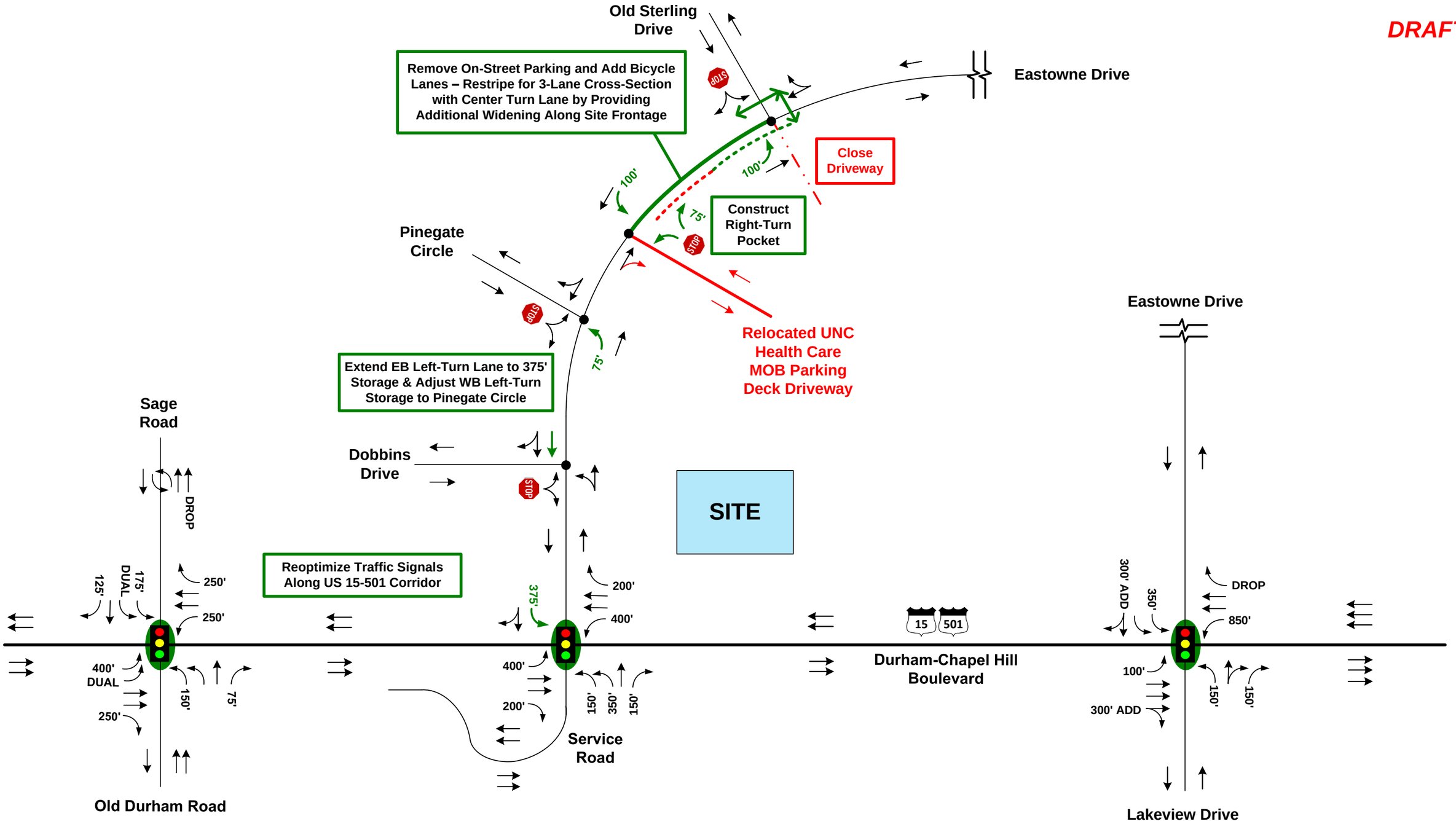
UNC Health Care Eastowne MOB #2
Transportation Impact Analysis

PRELIMINARY SITE PLAN

DATE: February 2023

FIGURE ES-2

DRAFT



HNTB

TOWN OF CHAPEL HILL

NOT TO SCALE

LEGEND

= COMMITTED IMPROVEMENT

= NECESSARY IMPROVEMENT

= SIDEWALK

= UNSIGNALIZED PED CROSSING

UNC Health Care Eastowne MOB #2
Transportation Impact Analysis

COMMITTED AND RECOMMENDED IMPROVEMENTS

DATE: February 2023

FIGURE ES-3

TECHNICAL MEMORANDUM - DRAFT

HNTB

To
Roger Henderson
Traffic Engineering Manager
Town of Chapel Hill

From
Craig Scheffler, P.E., PTOE
HNTB North Carolina, P.C.

Cc
HNTB Project File: 85279

Subject
UNC Health Care Eastowne Campus
Sensitivity Test Evaluation

Date
02/24/23

HNTB North Carolina, PC (HNTB), per direction from Town of Chapel Hill staff and the Applicant for the UNC Health Care Eastowne Campus redevelopment and as part of the scope of services for the UNC Health Care Eastowne Medical-Office Building #2 (MOB #2) Transportation Impact Analysis (TIA), has completed sensitivity tests related to intersection-level traffic operations along the US 15-501 corridor near the Eastowne site. The sensitivity tests focus on a gradation of increasing development densities on the Eastowne Campus site and their corresponding traffic impact to the US 15-501 corridor. The purpose of the analysis is to generally, and broadly, determine at what points of development density will individual intersections fall below acceptable operational standards and require additional capacity (more turn lanes, through travel lanes) to mitigate the impacts.

Methodology and Assumptions

Per a project scoping meeting on December 15, 2022 with Town of Chapel Hill staff, the Applicant, and HNTB, the decision was made to utilize a traffic model in the Synchro 11 software package to evaluate increasing development density impacts on 2022 base year traffic volumes and omit the typical analysis methodology that would also include background traffic growth impacts for future year conditions. This decision was made to attempt to isolate the specific impact of Eastowne Campus development-related traffic on nearby intersections and assess at what level of development density would those intersections require substantial improvements to mitigate the impact. Intersections were analyzed for typical weekday AM, noon, and PM peak hour periods for the following scenarios:

- 2022 Existing Year – 200,000 SF of redevelopment (corresponding to MOB #2)
- 2022 Existing Year – 500,000 SF of redevelopment
- 2022 Existing Year – 800,000 SF of redevelopment
- 2022 Existing Year – 1,100,000 SF of redevelopment
- 2022 Existing Year – 1,410,000 SF of redevelopment (corresponding to the maximum development potential inside the Eastowne Drive loop portion of the property, as provided by the Applicant and studied previously)
- 2022 Existing Year – 1,710,000 SF of redevelopment (corresponding to the 2032 Full Build-Out Scenario previously studied)

The following intersecting streets along US 15-501 were the primary focus of the operational analysis:

- Sage Road/Old Durham Road
- Eastowne Drive/Service Road
- Eastowne Drive/Lakeview Drive
- I-40 Eastbound Ramps
- I-40 Westbound Ramps
- Mt. Moriah Road

Operational analysis output from the model included Level-of-Service (LOS), vehicular delay, and 95th percentile queuing results by approach for each study area intersection.

Traffic Volume Development

Traffic volumes used in the models were taken from balanced 2022 base year counts completed for the *UNC Health Care Eastowne Campus Phase 1 - 2032 Full Build-Out Future Scenario Transportation Impact Analysis* (HNTB, December 2022). All build-out development scenario site traffic distribution and assignment estimates were taken from the full 2032 Build-Out traffic assignments completed in the previously submitted documentation and then assigned a ratio of the proposed scenario development yield in square feet divided by the full build-out estimate of 1,710,000 square feet. Each proportioned traffic assignment scenario was added to the 2022 base year volumes for all peak hours and the results were input into the Synchro capacity analysis software for evaluation. All traffic volume calculation spreadsheets are found in ***Appendix A***.

Scenario Testing Methodology and Assumptions

Synchro traffic capacity analysis models were taken from previous studies completed for the Town and updated with existing coordinated signal timings and the 2022 peak hour balanced traffic volumes. Models were then modified for the following:

- Applied successive traffic volume changes for each development density scenario
- Updated coordinated traffic signal timings (holding cycle lengths constant and adjusting splits, offsets and phase order changes)

Model data (overall intersection LOS and vehicular delays) and 95th percentile queue estimates by movement and approach were extracted from the model. No geometric modifications were made for any model scenario.

Model Results and Comment

Table 1 shows the sensitivity testing results for study area intersections for all six development density scenarios. The table shows AM, noon, and PM peak hour overall intersection LOS and corresponding overall per-vehicle delays. Each intersection may have one or several individual movements or approaches (particularly on the minor side streets) that may operate at worse LOS/delays than the overall values reported. In some cases delays and LOS may actually improve with additional Eastowne development density, due to the assigned traffic volumes benefiting from coordinated traffic movements along US 15-501 or because signal reoptimization calculations for a given set of traffic volumes may progress traffic flows along the entire corridor slightly different for each given intersection.

Table 1. Scenario Sensitivity Testing - Traffic Operations Results

US 15-501 Intersection	AM Peak Hour		Noon Peak Hour		PM Peak Hour	
	LOS	Delay Sec/Veh	LOS	Delay Sec/Veh	LOS	Delay Sec/Veh
Sage Road / Old Durham Road						
2022 MOB #2 (200k SF)	D	41.3	D	35.3	D	43.9
2022 500k SF	D	41.3	C	34.8	D	41.3
2022 800k SF	D	39.3	C	34.3	D	40.6
2022 1,100,000 SF	D	38.3	C	34.0	D	40.2
2022 1,410,000 SF	D	40.1	C	34.1	D	39.9
2022 1,710,000 SF	D	40.3	C	34.1	D	39.5
Eastowne Drive South / Service Road						
2022 MOB #2 (200k SF)	C	25.2	C	20.5	B	19.7
2022 500k SF	C	28.6	C	21.8	C	23.9
2022 800k SF	B	19.4	C	24.7	C	27.2
2022 1,100,000 SF	C	25.4	C	28.3	C	31.5
2022 1,410,000 SF	D	38.3	C	29.6	D	42.2
2022 1,710,000 SF	D	48.4	C	31.1	*E*	*62.0*
Eastowne Drive North / Lakeview Drive						
2022 MOB #2 (200k SF)	B	18.8	B	14.9	C	22.8
2022 500k SF	C	22.2	B	17.7	C	29.0
2022 800k SF	C	32.2	C	20.9	D	38.6
2022 1,100,000 SF	D	50.9	C	23.7	D	49.0
2022 1,410,000 SF	*E*	*73.5*	C	27.2	*E*	*66.6*
2022 1,710,000 SF	*F*	*105.1*	C	31.4	*F*	*80.3*
I-40 Eastbound Ramps						
2022 MOB #2 (200k SF)	C	31.2	C	21.3	C	30.1
2022 500k SF	C	32.6	C	21.7	C	30.6
2022 800k SF	D	42.3	C	21.9	C	31.0
2022 1,100,000 SF	*E*	*55.8*	C	23.4	C	33.2
2022 1,410,000 SF	*E*	*66.2*	C	25.2	D	35.9
2022 1,710,000 SF	*E*	*68.8*	C	28.5	D	46.2
I-40 Westbound Ramps						
2022 MOB #2 (200k SF)	D	42.4	C	26.2	C	26.4
2022 500k SF	D	44.1	C	26.9	C	26.2
2022 800k SF	D	45.8	C	29.6	C	27.8
2022 1,100,000 SF	D	48.2	C	30.1	C	28.7
2022 1,410,000 SF	D	50.7	C	31.5	C	29.5
2022 1,710,000 SF	*E*	*59.7*	C	27.6	C	30.7
Mt. Moriah Road						
2022 MOB #2 (200k SF)	C	33.5	D	50.5	D	46.0
2022 500k SF	C	32.9	D	50.5	D	48.0
2022 800k SF	C	34.1	D	49.4	D	48.3
2022 1,100,000 SF	C	32.5	D	49.7	D	48.8
2022 1,410,000 SF	C	32.9	D	49.4	D	49.0
2022 1,710,000 SF	C	33.6	D	51.1	D	49.4

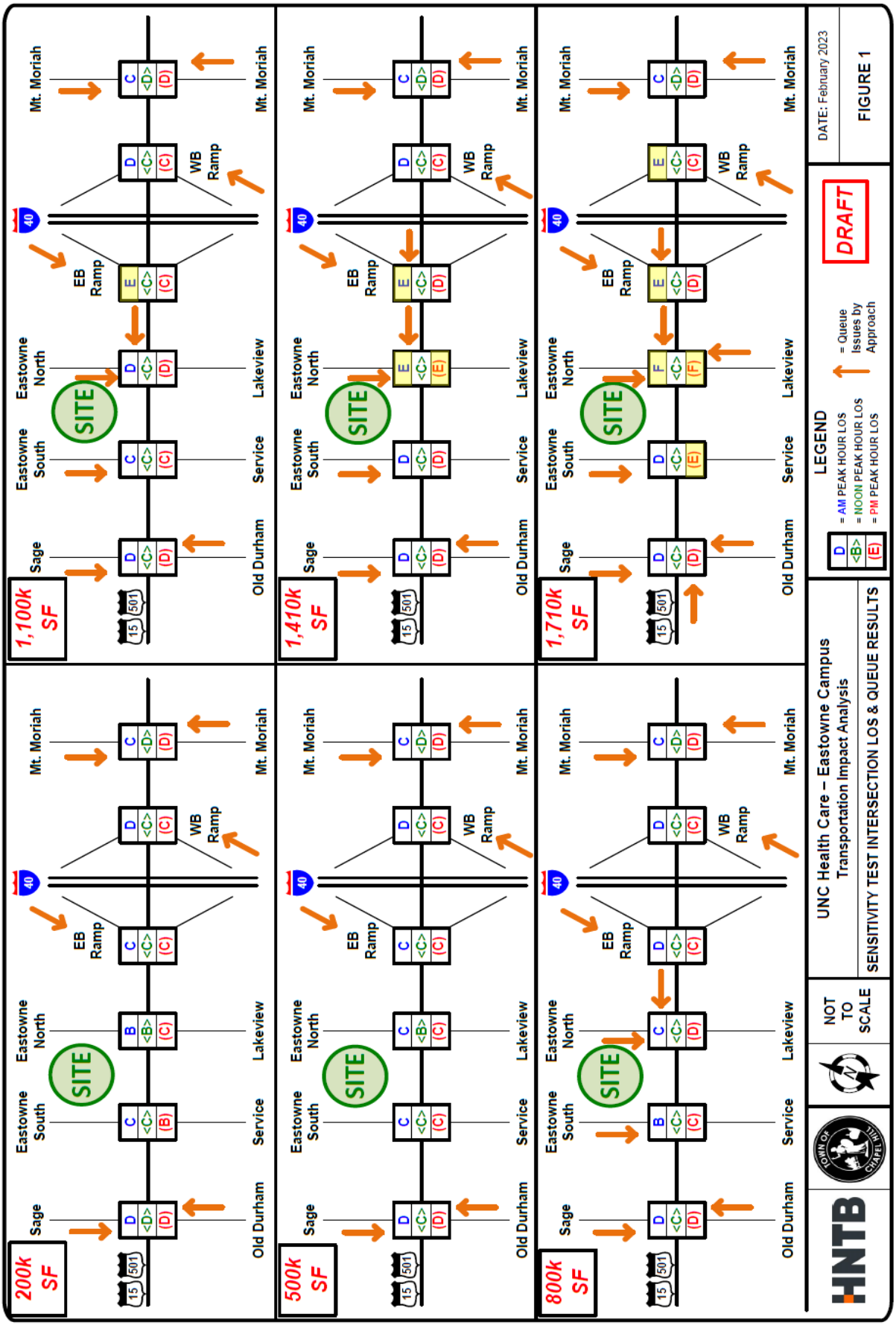
The tabular results indicate that the intersections furthest from the site along US 15-501 – Sage Road/Old Durham Road and Mt. Moriah Road have little variance in delay or LOS results with additional increases in development density. They both are busy intersections with conditions near capacity (LOS D) in at least one peak hour and queue issues at minor street approaches.

The two Eastowne Drive intersections with US 15-501 have the greatest range of impacts, as the majority of all site-related traffic for the Eastowne Campus will use these two intersections for access to the site. Both intersections initially operate well under capacity, with LOS B or LOS C results, but with increasing development densities, they fall to LOS E or F once development densities are in excess of 1,000,000 square feet. To mitigate traffic operations in the vicinity, additional through travel lane capacity and turn lanes may be needed on US 15-501 and side streets serving these intersections.

The I-40 signalized ramp terminal intersections with US 15-501 are likely to facilitate substantial amount of site-related traffic, whether it be regional trips using I-40 or trips using US 15-501 to/from areas in Durham. Below 1,000,000 square feet of development, overall intersection LOS in all peak periods is at least LOS D or better but falls to LOS E in the AM peak hour when 1,100,000 square feet was tested at the I-40 eastbound ramps intersection closest to the site. Addition queue results indicate that there are peak hour queue issues at lower development densities on the off-ramps in each direction approaching US 15-501 – some of which may include queuing back onto the I-40 mainline travel lanes - and at 800,000 square feet of development, queue issues occur for at least one peak hour on US 15-501 southbound between the ramps and Eastowne Drive/Lakeview Drive. Additional development density worsens queues, which start to back up through the interchange.

Overall intersection LOS comparisons and individual intersection approaches with queue issues in at least one peak hour are shown in **Figure 1**. As described above, queue issues are expected to occur at several intersections that feature current queue issues for minor streets in at least one peak hour in 2022. As shown in the figure, though overall intersection LOS does not fall to below LOS D thresholds, queue issues begin to occur at the 800,000 square foot development level for both Eastowne Drive connections to US 15-501 and for US 15-501 southbound just north of the site. Mitigation for queue issues may also be tied to capacity improvements or, at the very least, turn bay storage lengthening.

A final note on this sensitivity analysis study results – since the analysis was limited to increasing traffic volumes from different development densities for the UNC Health Care Eastowne Campus on 2022 base year volumes, no valid comparison can be made from these results to the results presented in the previous TIA of the 2032 Full Eastowne Campus Build-Out Scenario, or any 2026 design year results for the current UNC Health Care Eastowne MOB #2 TIA – as these studies include the effects of projected area-wide and specific local background traffic growth. All future formal TIA analyses for actual redevelopment plans that include the location of buildings and parking facilities will produce different results than what is shown in this sensitivity analysis and will need to include the updated base year traffic volumes at the time the studies are undertaken, as well as inclusion of projected background traffic growth for those studies for each development plan's anticipated build-out year.


200k SF
500k SF
800k SF
1,100k SF
1,410k SF
1,710k SF
SITE
Sage
Old Durham
Eastowne South
Eastowne North
Service
Lakeview
EB Ramp
WB Ramp
Mt. Moriah
LEGEND
= AM PEAK HOUR LOS
= NOON PEAK HOUR LOS
= PM PEAK HOUR LOS
= Queue Issues by Approach
DRAFT
DATE: February 2023
FIGURE 1
HNTB
NOT TO SCALE
UNC Health Care – Eastowne Campus
Transportation Impact Analysis
SENSITIVITY TEST INTERSECTION LOS & QUEUE RESULTS

UNC HEALTH EASTOWNE

EASTOWNE DRIVE
CHAPEL HILL, NC, 27560

CONDITIONAL ZONING PLAN

PROJECT NUMBER: UNH22001
DATE: DECEMBER 19, 2022

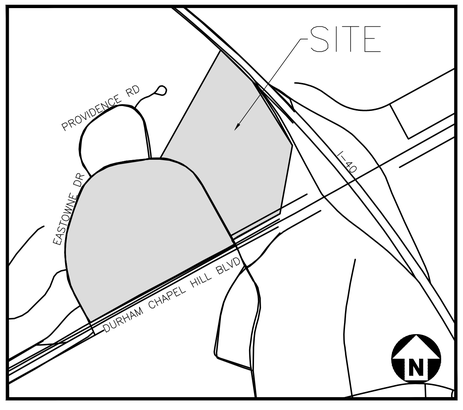
SHEET INDEX

GENERAL NOTES

1. EXISTING FARM POND IS TO BE DRAINED. THE RESULTING STREAMS AND PROPOSED STREAM ENHANCEMENT PROJECT DOWNSTREAM OF THE EXISTING POND DAM WILL BE SUBJECT TO A COINCIDENT 50-FOOT WIDE JORDAN RIPARIAN BUFFER AND RCD.
2. STREETS AND/OR ACCESS POINTS ON EASTOWNE DRIVE MAY BE REQUIRED TO SHIFT TO ADDRESS THE FINAL INTERNAL BLOCK LAYOUT OR TO ACCOMMODATE TRANSPORTATION/TRAFFIC STUDY AND DESIGN REQUIREMENT BY NCDOT AND/OR THE TOWN. FINAL ALIGNMENTS TO BE DETERMINED WITH THE FINAL PLAN (ZCP).
3. IMPROVEMENTS SHOWN ON US HWY 15-501, EASTOWNE DRIVE IN THE PROXIMITY OF THE INTERSECTIONS WITH US HWY 15-501 AND DOBBINS DRIVE ARE SUBJECT TO THE REVIEW AND APPROVAL OF NCDOT.
4. STORMWATER MANAGEMENT WILL BE IN ACCORDANCE WITH THE STORMWATER MANAGEMENT NARRATIVE SUBMITTED WITH THE CONDITIONAL ZONING APPLICATION. FINAL LOCATIONS AND DESIGNS OF THE STORMWATER CONTROL MEASURES WILL BE DETERMINED WITH THE FINAL PLAN (ZCP) SUBMITTAL.
5. EXISTING BUILDINGS AND SURFACE PARKING LOTS MAY REMAIN IN USE AS NEEDED DURING THE DEVELOPMENT OF THE PROJECT.
6. PROPOSED CROSSINGS AND IMPACTS TO THE RCD SHOWN ON THE CONCEPTUAL PLAN ARE APPROVED AS PART OF THE CZ APPROVAL AND WILL MEET THE REQUIREMENTS OF LUMO SECTION 3.6.3-2 PERMITTED USES IN THE RCD AND SEC. 3.6.3.(G) STANDARDS FOR DEVELOPMENT IN THE RCD. DETAILED DESIGN OF THE CROSSINGS OR OTHER IMPACTS TO BE PROVIDED WITH THE FINAL PLAN (ZCP) SUBMITTAL.
7. PROPOSED MULTI-USE PATH, OR GREENWAY, MAY BE CONSTRUCTED IN THE OUTER 20-FEET OF THE JORDAN RIPARIAN AND RCD BUFFERS.
8. THE PROPOSED CENTER GREEN WILL BE A MINIMUM OF 60,000 SQUARE FEET, INCLUDE HARDSCAPE AND LANDSCAPE AREAS AND MAY INCLUDE UN-ENCLOSED ROOFED OR COVERED AREAS.
9. PHASING OF THE DEVELOPMENT WILL BE DETERMINED DEPENDING ON THE NEEDS OF UNC HEALTHCARE. ADDITIONAL PHASE SPECIFIC TRAFFIC STUDIES MAY BE REQUIRED TO IDENTIFY PHASE SPECIFIC TRAFFIC IMPROVEMENTS REQUIRED.

SITE DATA

PHYSICAL ADDRESS	400 EASTOWNE DR	
OWNER	HEALTH SYSTEM PROPERTIES, LLC	
PIN	9890800195, 9890800643, 9890802764, 9890803947, 9890807564, 9890911209	
EXISTING ZONING	OI-3, OI-2, MU-OI-1	
PROPOSED ZONING	OI-3-CZ	
NET LAND AREA (SQ FT)	2,202,829	
CREDITED STREET AREA (SQ FT)	220,283	
GROSS LAND AREA (SQ FT)	2,423,112	
AREA IN RCD (SQ FT)	288,974	
AREA IN FLOODPLAIN (SQ FT)	102,752	
PROPOSED BUILDING HEIGHT (MAX)	120 FT	
FLOOR AREA		
EXISTING FLOOR AREA (SQ FT)	228,000	
FLOOR AREA TO BE REMOVED (SQ FT)	78,000	
NEW FLOOR AREA (SQ FT)	1,100,000	
TOTAL FLOOR AREA (SQ FT)	1,250,000	
MAX FAR (FA/GLA)	.566	
PROPOSED FAR (FA/GLA)	.680	
BUILDING SETBACKS	REQUIRED	PROPOSED
STREET	0'	22'
INTERIOR	0'	8'
SOLAR	0'	9'
IMPERVIOUS		
EXISTING IMPERVIOUS (SQ FT)	405,645	
EXISTING IMPERVIOUS TO BE REMOVED (SQ FT)	268,329	
NEW IMPERVIOUS	1,420,056	
TOTAL IMPERVIOUS	1,538,761 or 70% of GLA	
BUFFERS	REQUIRED	PROPOSED
15-501	20' TYPE C	30' MODIFIED
EASTOWNE DRIVE	15' TYPE B	15' MODIFIED
US 40	30' TYPE D	100' TYPE D
SIDEYARDS	15' TYPE B	15' TYPE B
PARKING		
EXISTING SPACES	1,629	
SPACES TO BE REMOVED	APPROX. 600	
MINIMUM PARKING IN OI-3	N/A	
PROPOSED MAXIMUM PARKING RATIO	4.5 SPACES PER 1000 SQ FT	



VICINITY MAP
N.T.S.

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211 FRIDAY CENTER DRIVE
CHAPEL HILL, NORTH CAROLINA, 27571
PHONE: 984. 974. 5388

PROJECT DIRECTORY

DCI LLC
DAVID PARKER
VICE PRESIDENT
DCI LLC

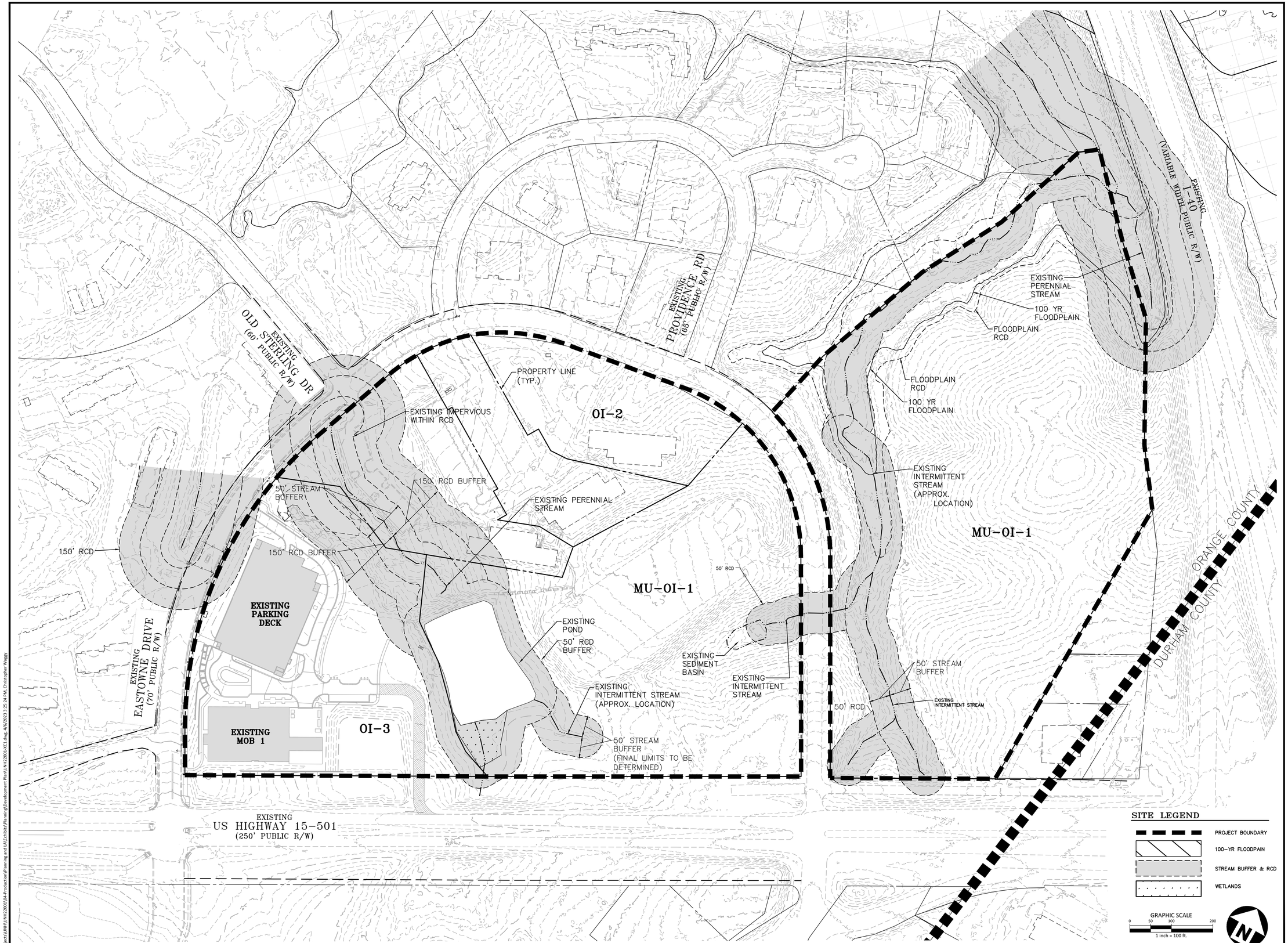
ANDY KING
PARTNER
GESTALT ARCHITECTURE + DESIGN PLLC

REVISIONS

NO.	DATE	
1	11. 21. 2022	FIRST SUBMITTAL
2	12. 19. 2022	SECOND SUBMITTAL
3	04. 06. 2023	THIRD SUBMITTAL

CONDITIONAL ZONING PLAN FOR:

UNC HEALTH EASTOWNE
CHAPEL HILL, NORTH CAROLINA
PROJECT NUMBER: UNH-22001



PRELIMINARY DRAWING - NOT RELEASED FOR CONSTRUCTION

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UNC HEALTH EASTOWNE
CONDITIONAL ZONING PLAN
EASTOWNE DRIVE
CHAPEL HILL, NORTH CAROLINA

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3	04. 06. 2023	THIRD SUBMITTAL

PLAN INFORMATION

PROJECT NO.	UNH-22001
FILENAME	
CHECKED BY	WHD
DRAWN BY	OR
SCALE	
DATE	03. 30. 2023

SHEET

EXISTING CONDITIONS
C1.00

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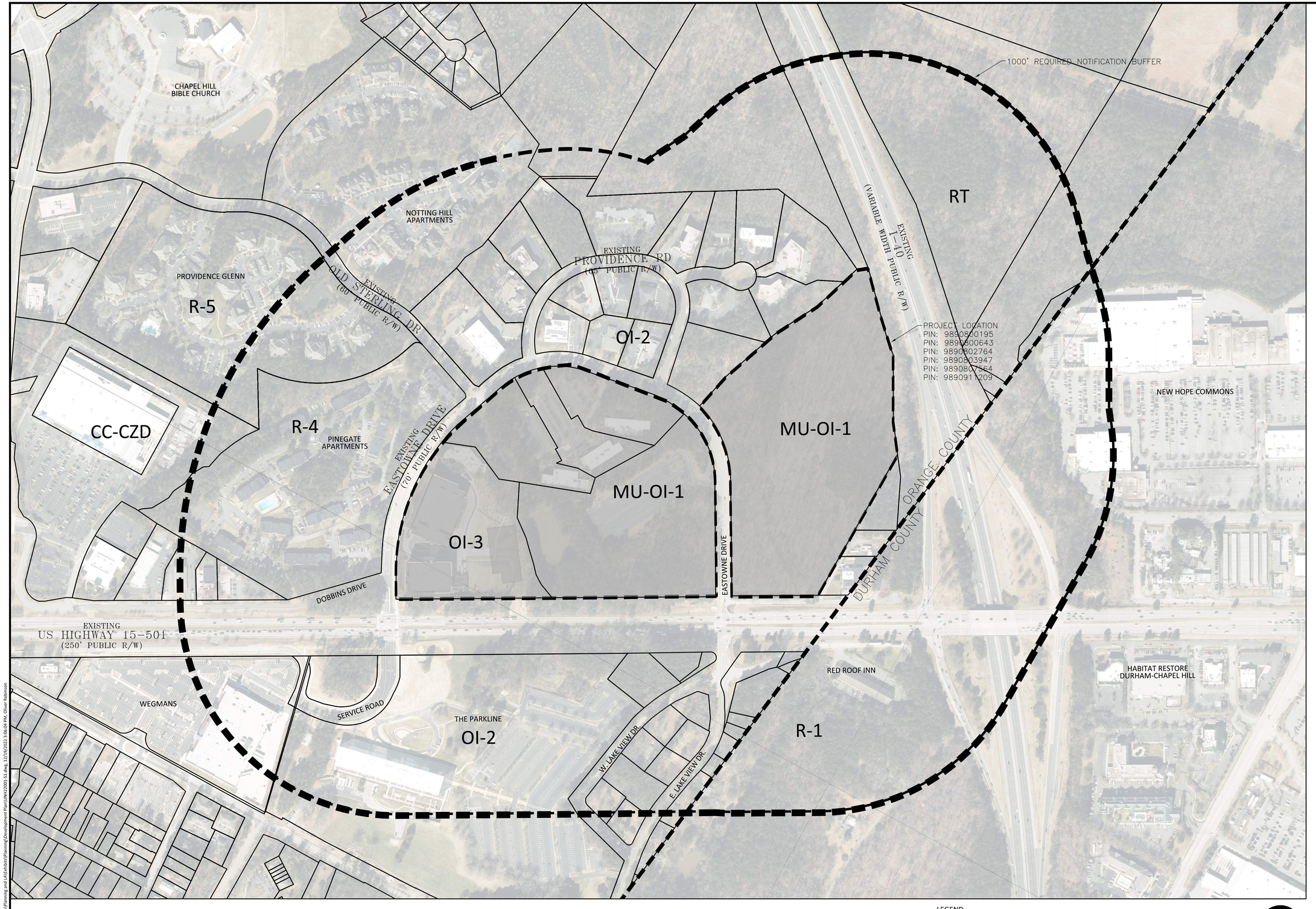

LEGEND

- 1000' REQUIRED NOTIFICATION BOUNDARY
- PROJECT AREA
- APPROXIMATE ZONING DISTRICT LINE (INFORMATION FROM TOWN OF CHAPEL HILL GIS)

GRAPHIC SCALE
0 100 200 400
1 inch = 200 ft.

N

PRELIMINARY DRAWING - NOT RELEASED FOR CONSTRUCTION

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UNC HEALTH EASTOWNE

CONDITIONAL ZONING PLAN
EASTOWNE DRIVE
CHAPEL HILL, NORTH CAROLINA

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PLAN INFORMATION

PROJECT NO.	UNH-22001
FILENAME	UNH22001-S1
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DRAWN BY	OR
SCALE	1"=200'
DATE	12. 19. 2022

SHEET

AREA MAP
C1.01

EXISTING STERLING DR (60' PUBLIC R/W)

EXISTING PROVIDENCE RD (65' PUBLIC R/W)

EXISTING 40' (VARIABLE WIDTH PUBLIC R/W)

EXISTING STREAM CENTERLINE

EXISTING 150' RCD

EXISTING EASTOWNE DRIVE (70' PUBLIC R/W)

ASSUMED REALIGNED STREAM

ASSUMED 50' RCD

100 YR FLOODPLAIN

EXISTING 150' RCD

ASSUMED FORMER HAUL ROAD

100 YR FLOODPLAIN

ASSUMED FORMER HAUL ROAD

EXISTING US HIGHWAY 15-501 (250' PUBLIC R/W)

> 25% SLOPE (APPLICABLE PER UDO)

TOTAL=135,316 SF/3.11 AC

PROPOSED DISTURBED=40,595 SF/30%

> 25% SLOPE (NON-APPLICABLE PER UDO SECTION 5.3.2.D.3)

TOTAL=108,565 SF/2.49 AC

> 25% SLOPE (MAN-MADE NOT RECOGNIZED AS NON-APPLICAPLE UNDER UDO SECTION 5.3.2.C.3)

TOTAL=36,055 SF/0.83 AC

PROPOSED DISTURBED=36,055 SF/100%

GRAPHIC SCALE

0 50 100 200

1 inch = 100 ft.

PRELIMINARY DRAWING - NOT RELEASED FOR CONSTRUCTION

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UNC HEALTH EASTOWNE

CONDITIONAL ZONING PLAN
EASTOWNE DRIVE
CHAPEL HILL, NORTH CAROLINA

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PLAN INFORMATION

PROJECT NO.	UNH-22001
FILENAME	UNH22001-E1
CHECKED BY	WHD
DRAWN BY	CJB
SCALE	1"=100'
DATE	03. 30. 2023

SHEET

STEEP SLOPES

C1.02

NOTES:
1. CONFIGURATION OF ACCESS LOCATIONS TO BE CONFIRMED BY A TRAFFIC IMPACT ANALYSIS SUBMITTED WITH EACH PHASE.
2. ACCESS POINTS MAY SHIFT DURING PREPARATION OF FINAL PLANS AND PHASE SPECIFIC TRAFFIC STUDIES.
3. MAXIMUM BUILDING HEIGHT MAY INCREASE BY 15% DURING DEVELOPMENT OF FINAL DESIGN. TO BE APPROVED AS A MINOR MODIFICATION BY STAFF.
4. RCD IMPACTS FOR ROAD CROSSINGS, DRAINING OF THE EXISTING POND, STREAM RESTORATION AND SCM#2 ARE APPROVED AS PART OF THIS CZ PLAN. EXACT SQUARE FOOTAGE REQUIRED WILL BE DETERMINED WITH THE FINAL PLANS.
5. BUBBLE AREAS AND OUTLINES OF SCMS ARE DIAGRAMITIC AND MAY CHANGE IN SHAPE DURING PREPARATION OF THE FINAL DESIGNS.

EXISTING OLD STERLING DR (60' PUBLIC R/W)
EXISTING PROVIDENCE RD (65' PUBLIC R/W)
EXISTING EASTOWNE DRIVE (70' PUBLIC R/W)
EXISTING I-40 (VARIABLE WIDTH PUBLIC R/W)
EXISTING US HIGHWAY 15-501 (250' PUBLIC R/W)
ORANGE COUNTY
DURHAM COUNTY
EASTOWNE DRIVE

ACCESS POINT 1
ACCESS POINT 2
ACCESS POINT 3
ACCESS POINT 4
ACCESS POINT 5
CENTRAL GREEN MIN: 1.50 AC
10 ACRE PRESERVATION AREA INCLUDING RCD & FLOODPLAIN
FLOODPLAIN
RCD IMPACT
50' RCD (EACH SIDE)TO FOLLOW CENTERLINE OF PROPOSED STREAM ENHANCEMENT PROJECT.
50' RCD (EACH SIDE)
RCD CROSSING
10' CONCRETE MULTI-USE PATH
EASTOWNE DRIVE WITH EXTENSTION OF BUFFERED BIKE LANES
EXISTING BUS STOP
EXISTING PEDESTRIAN CROSSWALKS
20' SETBACK 15' BUFFER
22' SETBACK 15' BUFFER
15' BUFFER 20' BUILDING SETBACK
100' BUFFER ALONG I-40
TREE CANOPY AREA
ONE WAY TRAFFIC LOOP

BLOCK B1 & P1
BLDG. SF = 153,000
BLDG. HEIGHT = 90 FT
PARKING = 1,062 SPACES

BLOCK B2
MAX. BLDG. HT. 120 FT
*SEE NOTES

BLOCK B3
MAX. BLDG. HT. 120 FT
*SEE NOTES

BLOCK B4
MAX. BLDG. HT. 120 FT
*SEE NOTES

BLOCK B5
MAX. BLDG. HT. 120 FT
*SEE NOTES

BLOCK B6-7
MAX. BLDG. HT. 120 FT
*SEE NOTES

EXISTING PARKING DECK
EXISTING MEDICAL OFFICE BUILDING (MOB 1)
B1
B2
B3
B4
B5
B 6-7
P1
P2
P3
P4
SCM #1
SCM #2
10' MULTI-USE PATH
EMERGENCY ACCESS TO REMAIN
TREE CANOPY AREA
TREE CANOPY AREA
22' SETBACK 15' BUFFER
20' LANDSCAPE BUFFER
20' LANDSCAPE BUFFER

LEGEND

- EXISTING DEVELOPMENT
- PARKING BLOCK
- BUILDING BLOCK
- DEVELOPMENT BLOCK
- TREE CANOPY
- STREAM/ RCD BUFFER
- SCM
- PROPOSED ROAD
- MULTI-USE PATH
- PROJECT BOUNDARY
- RCD IMPACT
- SITE ACCESS
  * INTERNAL CONNECTIVITY IS PROPOSED AND SUBJECT TO CHANGE
- POTENTIAL EMERGENCY SITE ACCESS
  * INTERNAL CONNECTIVITY IS PROPOSED AND SUBJECT TO CHANGE

GRAPHIC SCALE
0 50 100 200
1 inch = 100 ft.

PRELIMINARY DRAWING - NOT RELEASED FOR CONSTRUCTION

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UNC HEALTH EASTOWNE
CONDITIONAL ZONING PLAN
EASTOWNE DRIVE
CHAPEL HILL, NORTH CAROLINA

REVISIONS

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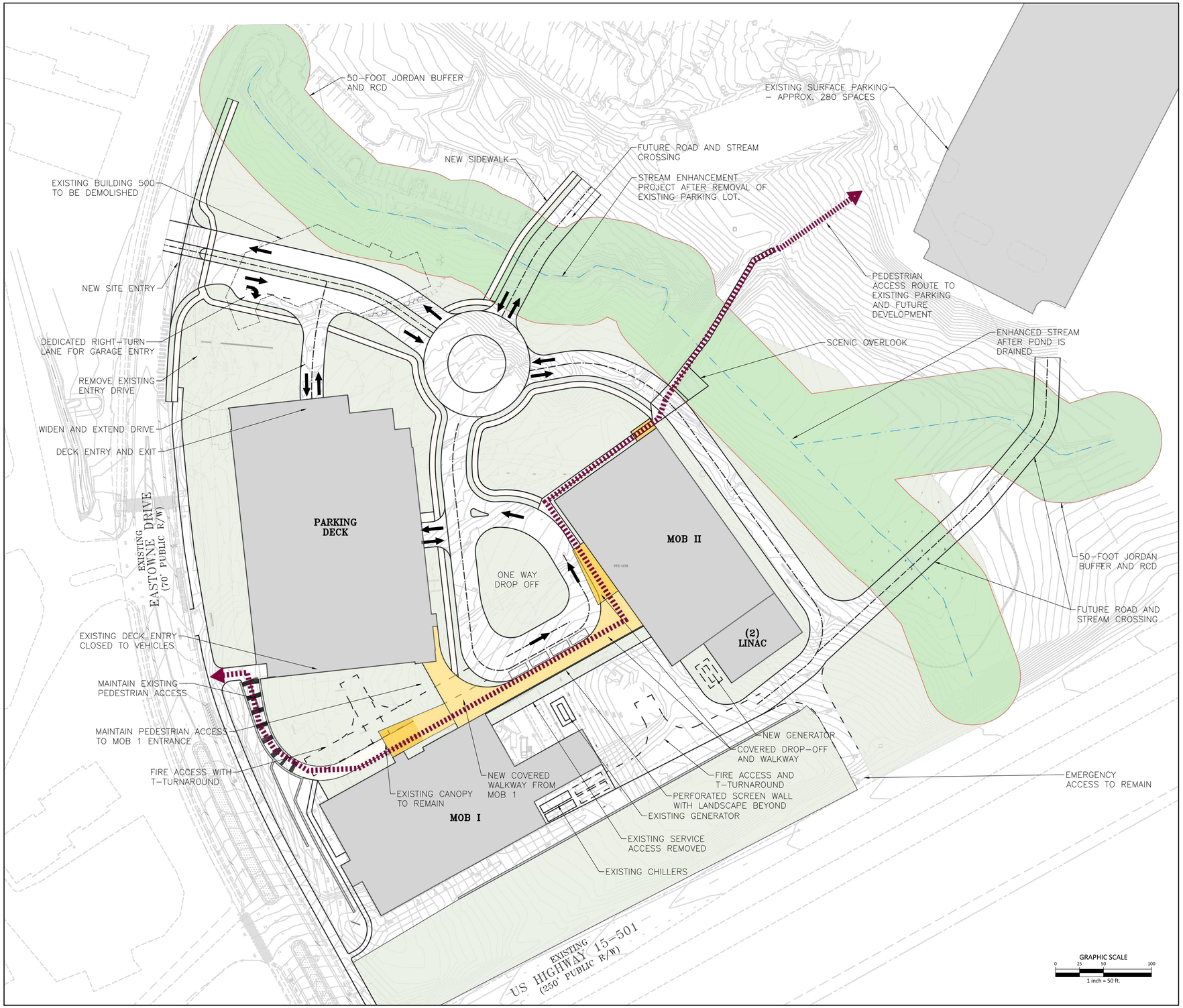
PLAN INFORMATION

PROJECT NO.	UNH-22001
FILENAME	UNH22001-S1
CHECKED BY	WHD
DRAWN BY	OR
SCALE	1"=100'
DATE	03. 30. 2023

SHEET

OVERALL CONCEPT PLAN

C2.00



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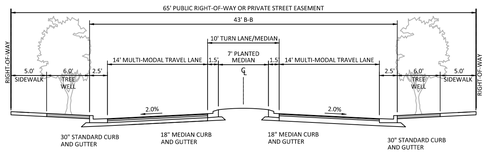
PLAN INFORMATION

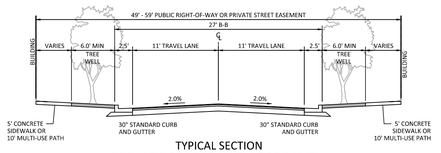
PROJECT NO.	UNH-22001
FILENAME	UNH22001-S1
CHECKED BY	WHD
DRAWN BY	OR
SCALE	1"=50'
DATE	12. 19. 2022

SHEET

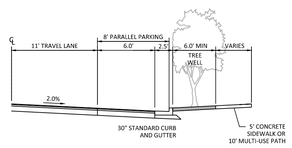
MOB 2
CONCEPT PLAN
C2.01



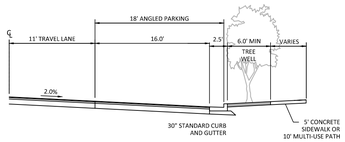
TYPICAL SECTION
PRIVATE STREET-WITH MEDIAN
(65' R/W, 43' B-B)



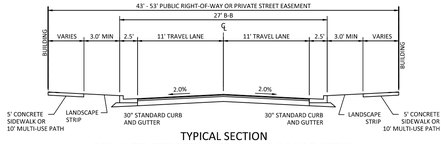
TYPICAL SECTION
PRIVATE STREET WITH TREE WELL
(49' - 59' R/W, 27' B-B)



PARALLEL PARKING OPTION

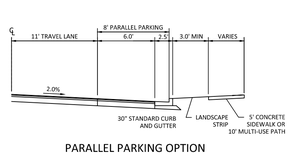


ANGLED PARKING OPTION

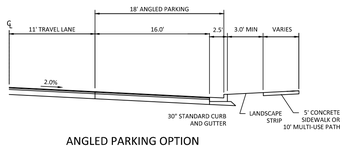


TYPICAL SECTION
PRIVATE STREET WITH LANDSCAPE STRIP
(43' - 53' R/W, 27' B-B)

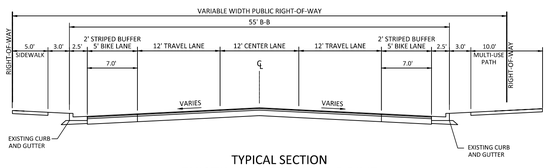
* LANDSCAPE STRIP MAY BE REMOVED WITH 6-FOOT WIDE SIDEWALK AT THE BACK-OF-CURB TO REDUCE STREAM CROSSING WIDTH.



PARALLEL PARKING OPTION



ANGLED PARKING OPTION



TYPICAL SECTION
EXISTING EASTOWNE DRIVE
(VARIABLE WIDTH R/W, ~55' B-B)

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UNC HEALTH EASTOWNE
CONCEPT PLAN
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PLAN INFORMATION

PROJECT NO.	UNH-22001
FILENAME	UNH22001-SECTIONS
CHECKED BY	WHD
DRAWN BY	OR
SCALE	1"=10'
DATE	12. 19. 2022

SHEET

STREET SECTIONS
C3.00

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