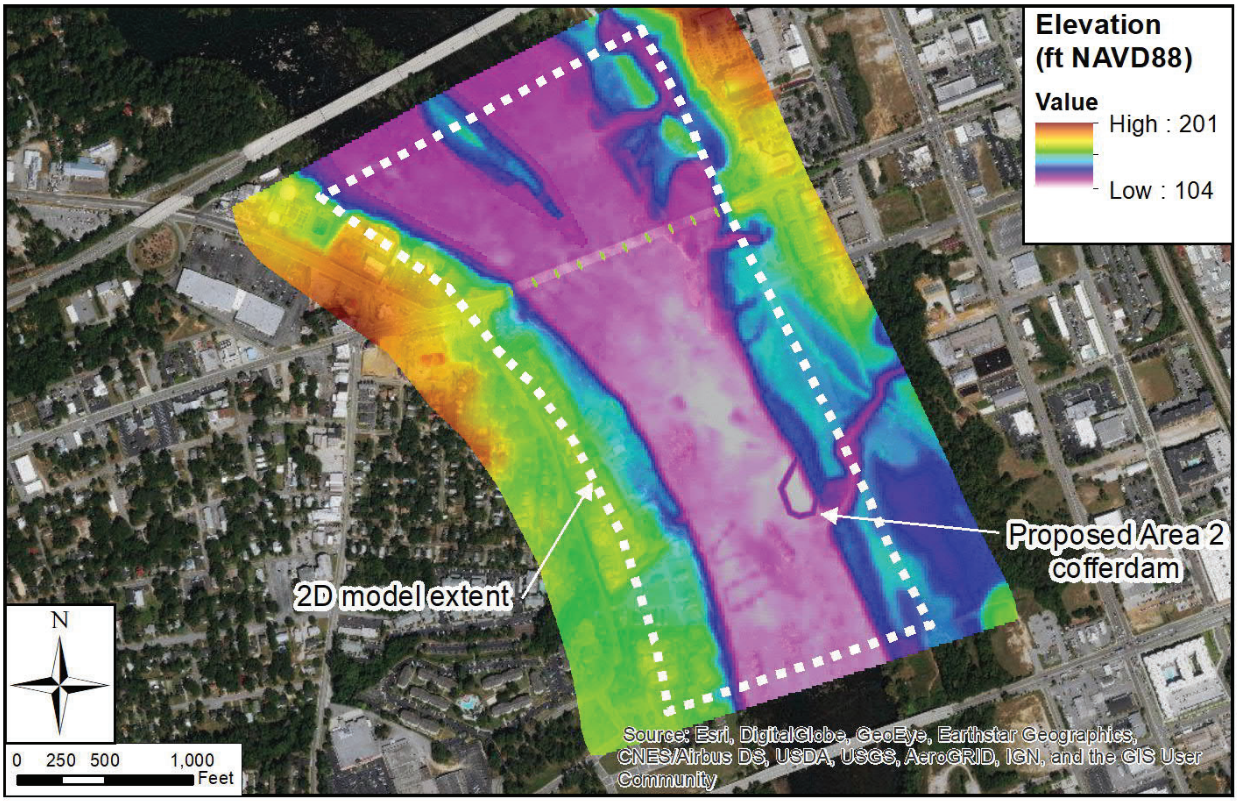



*Figure 6: Proposed Area 2 Cofferdam Digital Elevation Model*

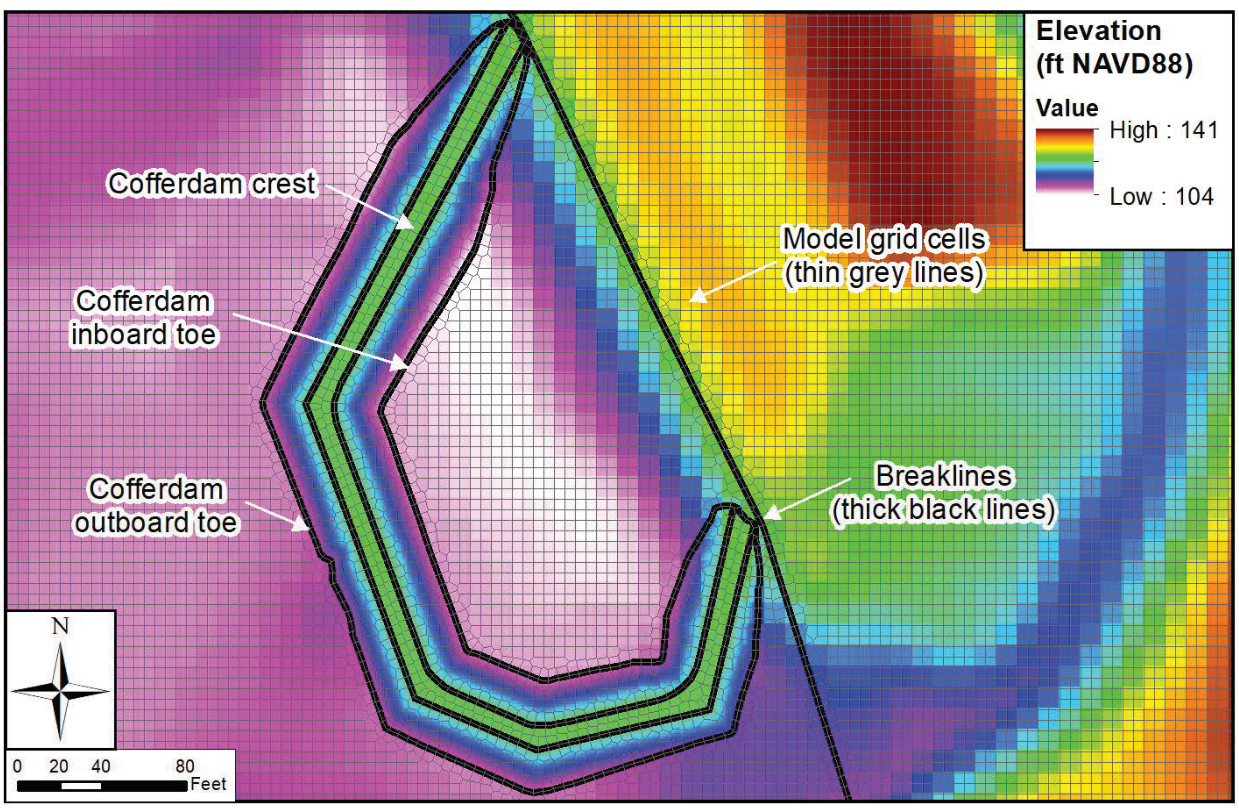



*Figure 7: Proposed Area 2 Cofferdam Mesh Details*

Figure 8 shows the upstream and downstream boundary conditions used for the model runs. The upstream inflow and downstream water level during the first hour of the run represents the “normal flow condition” of 8,564 cfs. Over the next four hours of the run, the boundary conditions ramp-up to the “crest flow condition” of 26,000 cfs, which is then maintained for the final two hours of the run. During development of the model, initial runs were completed to develop initial condition files at the start of the run for the Existing, Proposed Area 1 and Proposed Area 2 models.

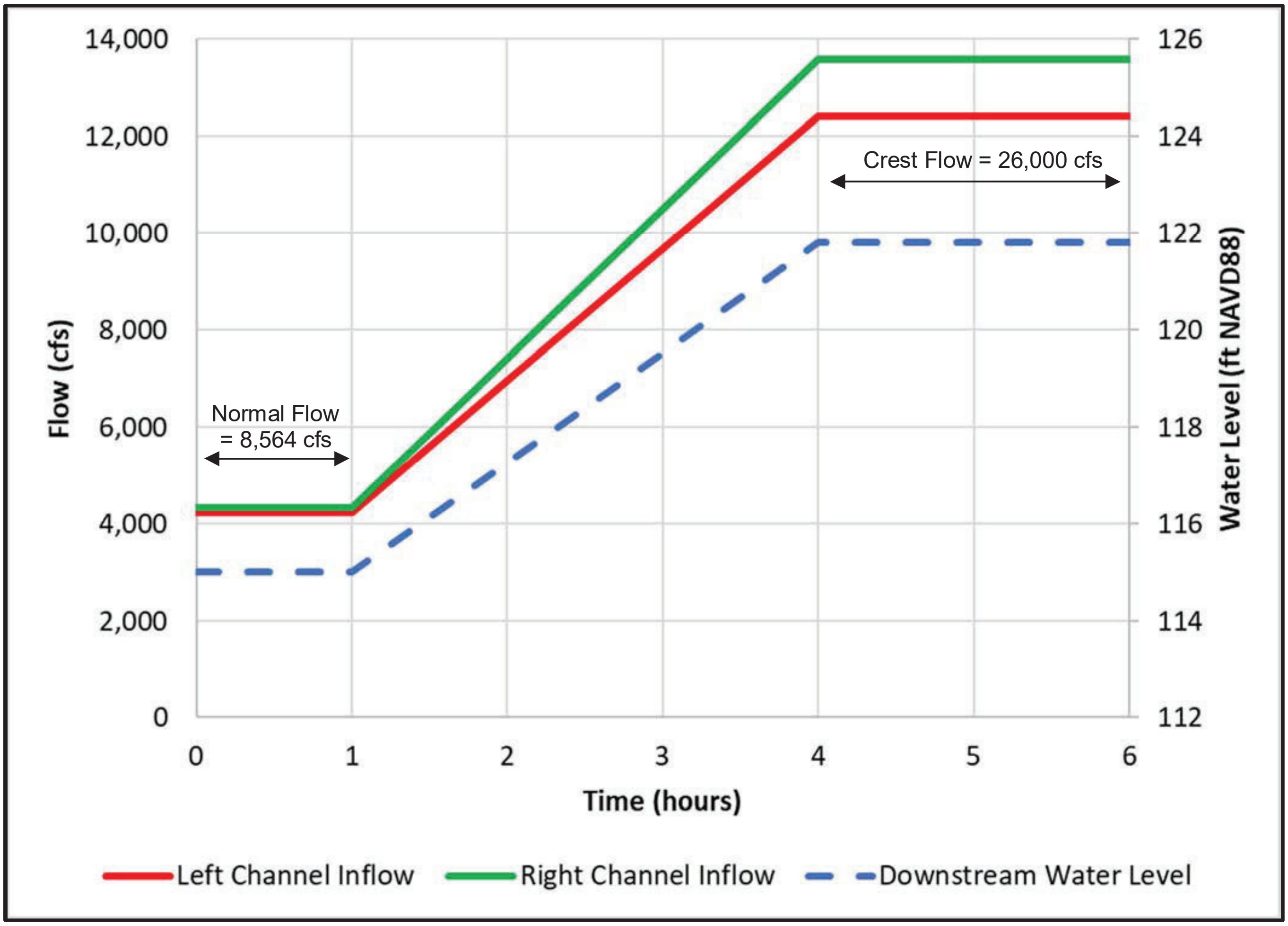



*Figure 8: Upstream and Downstream Boundary Conditions*

## 2D MODEL RESULTS

Separate two-dimensional unsteady flow analyses were performed for the Existing, Proposed Area 1, and Proposed Area 2 models. Additional trial analyses were also performed to test the model’s sensitivity to the computational timestep interval and the application of the full momentum equations. After our initial quality assurance review, we determined that the adaptive computational interval and the full momentum equations should be utilized for the final model runs, in accordance with the HEC-RAS 2D Modeling User’s Manual.

The velocity and shear stress results were extracted from all of the models after one hour to represent the normal flow condition of 8,564 cfs, and after six hours to represent the crest flow condition of 26,000 cfs. The results were used to develop figures that show the spatial variation of flow velocity/shear stress throughout the Congaree River channel and to show changes in velocity due to the construction of the Area 1 and Area 2 cofferdams.

The following figures are provided in Attachment A:

- Figure A1: Normal Flow (8,564 cfs) Existing Scenario – Flow Velocity
- Figure A2: Crest Flow (26,000 cfs) Existing Scenario – Flow Velocity
- Figure A3: Normal Flow (8,564 cfs) Proposed Area-1 Scenario – Flow Velocity
- Figure A4: Crest Flow (26,000 cfs) Proposed Area-1 Scenario – Flow Velocity
- Figure A5: Normal Flow (8,564 cfs) Proposed Area-1 Scenario – Change in Flow Velocity
- Figure A6: Crest Flow (26,000 cfs) Proposed Area-1 Scenario – Change in Flow Velocity
- Figure A7: Normal Flow (8,564 cfs) Proposed Area-2 Scenario – Flow Velocity
- Figure A8: Crest Flow (26,000 cfs) Proposed Area-2 Scenario – Flow Velocity
- Figure A9: Normal Flow (8,564 cfs) Proposed Area-2 Scenario – Change in Flow Velocity
- Figure A10: Crest Flow (26,000 cfs) Proposed Area-2 Scenario – Change in Flow Velocity
- Figure A11: Crest Flow (26,000 cfs) Existing Scenario – Shear Stress
- Figure A12: Crest Flow (26,000 cfs) Proposed Area-1 Scenario – Shear Stress
- Figure A13: Crest Flow (26,000 cfs) Proposed Area-2 Scenario – Shear Stress

The following sections discuss the velocity and shear stress results for the west bank of the Congaree River in the vicinity of the project area for the Existing, Proposed Area-1, and Proposed Area-2 scenarios.

## EXISTING SCENARIO

The velocity results along the west bank show that during normal flow conditions (8,564 cfs), the river velocity ranges between 2 to 4 feet per second (ft/s) approximately 550 feet downstream of the Gervais Street Bridge. The river velocity for the next 1,200 feet downstream ranges between 0.5 to 2 ft/s. The river velocity throughout the remaining 800 feet of the model ranges from 2 to 4 ft/s, with some localized areas of 5 ft/s. Upstream of the Gervais Street bridge, the river velocity ranges between 3 to 5 ft/s.

The velocity results along the west bank during crest flow conditions (26,000 cfs) range between 2 to 4 ft/s downstream of the Gervais Street bridge. Upstream of the bridge, the river velocity ranges between 4 to 5 ft/s.

### PROPOSED AREA-1 SCENARIO

During normal flow conditions, the construction of the Area-1 cofferdam increases the river velocity between 0.1 to 1 ft/s for approximately 1,400 feet of the west bank area opposite the structure. During crest flow conditions, the river velocity increases up to 0.5 ft/s on the west bank upstream of the Gervais Street Bridge. The river velocity increases between 0.1 to 1 ft/s for approximately 1,600 feet of the west bank area opposite the structure. There are some localized areas along the bank which show a river velocity increase up to 1.5 ft/s.

### PROPOSED AREA-2 SCENARIO

During normal flow conditions, the construction of the Area-2 cofferdam increases the river velocity between 0.1 to 0.5 ft/s for approximately 1,000 feet of the west bank area opposite the structure. During crest flow conditions, the river velocity increases between 0.5 to 1 ft/s for approximately 700 feet of the west bank opposite the structure. Upstream and downstream of Area 2, the river velocity increases between 0.1 to 0.5 ft/s, for bank lengths ranging from 300 to 400 feet.

## WEST BANK EROSION POTENTIAL EVALUATION

The river velocities along the west bank of the Congaree River during normal (8,564 cfs) and crest (26,000 cfs) flow conditions range between 3 to 5 ft/s upstream of the Gervais Street Bridge and range between 0.5 to 4 ft/s downstream of the bridge.

The river velocity along the west bank after the construction of the Area 1 cofferdam increases up to 1 ft/s during normal flow conditions. The area affected is opposite the cofferdam structure and the velocities in this area remain within the 2 to 4 ft/s range. During crest flow conditions, there are some localized increases of up to 1.5 ft/s due to the construction of the Area-1 cofferdam. Similar to normal flow conditions, this increase also occurs opposite the proposed structure and the velocities remain within the 2 to 4 ft/s range during crest flow conditions.

The river velocity along the west bank after the construction of the Area 2 cofferdam increases up to 0.5 ft/s during normal conditions and up to 1 ft/s during crest flow conditions. The area affected is opposite the cofferdam structure and the velocities in this area remain within the 2 to 4 ft/s range for normal and crest flow conditions. However, there is a localized area that has a river velocity up to 4.5 ft/s.

The change in velocity due to construction of the cofferdams is relatively small (i.e., less than 1.5 ft/s) and the velocities along the west bank of the Congaree River remain relatively low (i.e., 2 to 4 ft/s). Based on the flow velocities, erosion protection measures such as riprap or bank stabilization revetments are not necessary to provide river bank protection during the construction period.

Additional evaluation of the shear stress values near the west bank also confirms that erosion protection is not required. Table 6.2 of the Pennsylvania Department of Environmental Protection's "Erosion and Sediment Pollution Control Program Manual" provides maximum permissible shear stresses for various channel liners. The maximum permissible shear stress for non-reinforced vegetation is 1.0 $lb/ft^2$ and the average value for unlined soils is approximately 0.1 $lb/ft^2$. The model results show the shear stress along the west bank is typically less than 0.1 $lb/ft^2$ for the Existing, Proposed Area 1, and Proposed Area 2 scenarios.

If you have any questions or need any additional information, please contact John Osterle at 412-535-9823 or john.osterle@wsp.com, or Tom Edwards at 412-535-9889 or thomas.edwards@wsp.com.

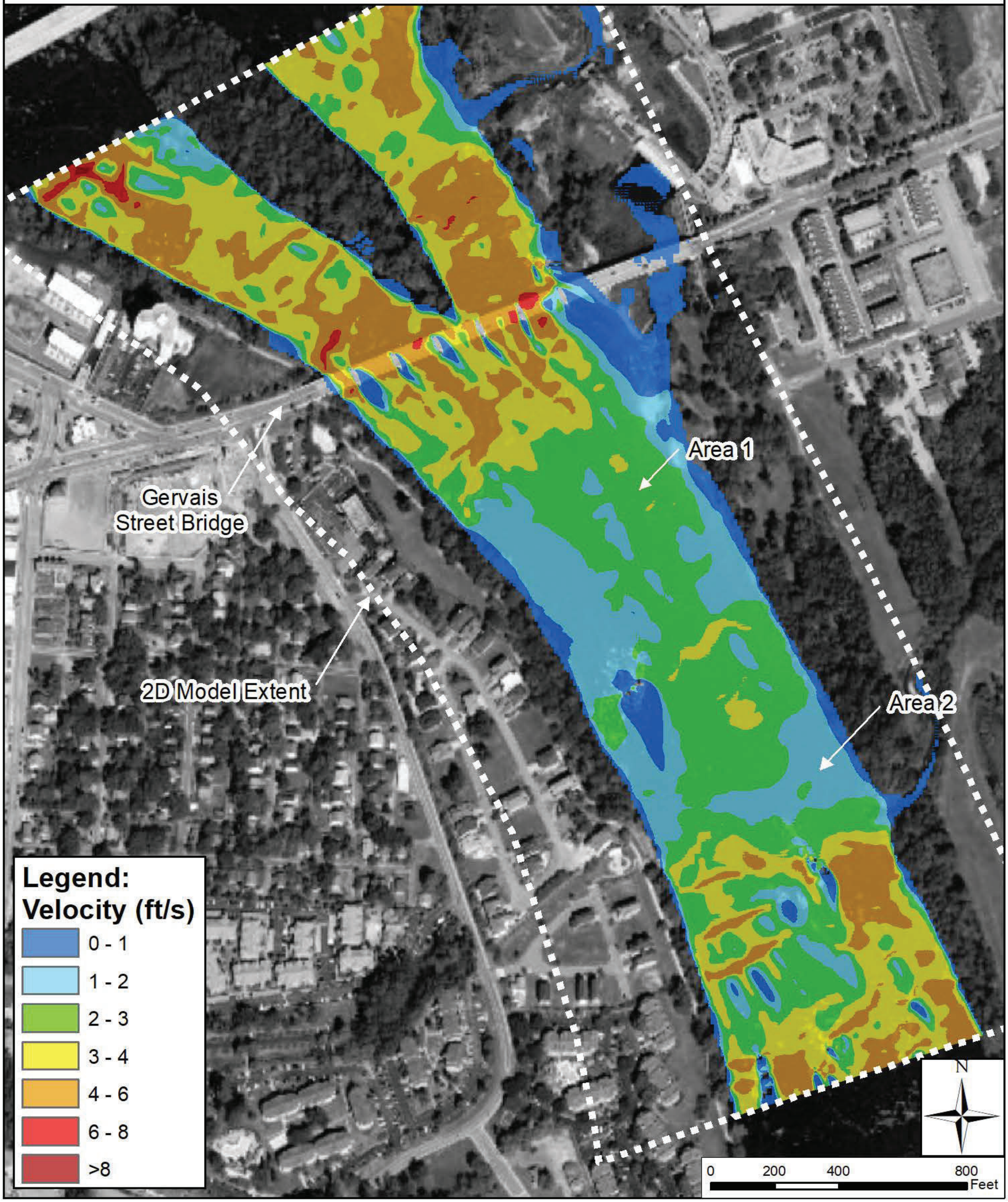
Kind regards,

| | |
|---|---|
| John P. Osterle, P.E.<br>Project Manager | Tom Edwards, P.E.<br>Water Resources Engineer |

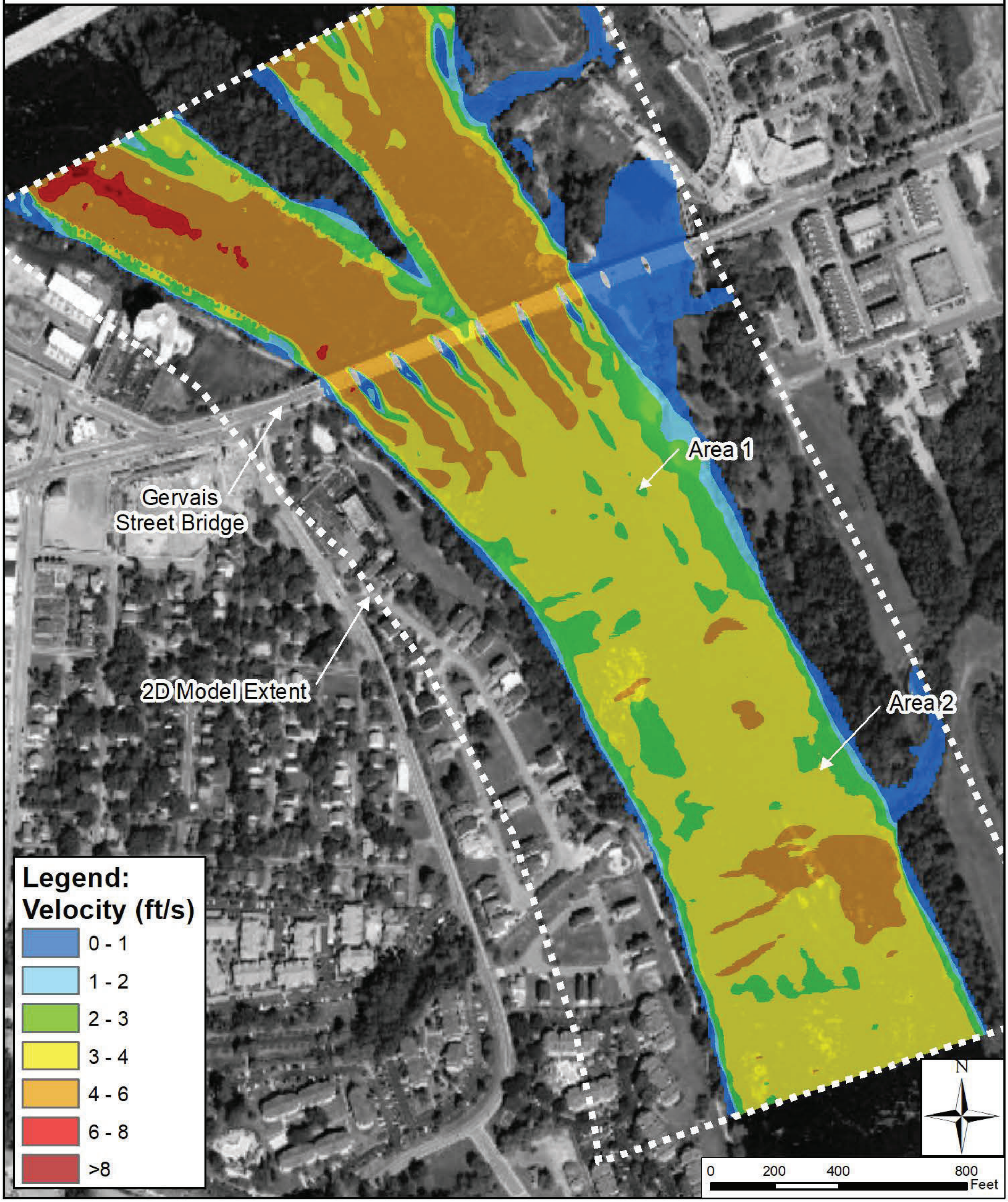
TE: JPO

# ATTACHMENT A: FIGURES

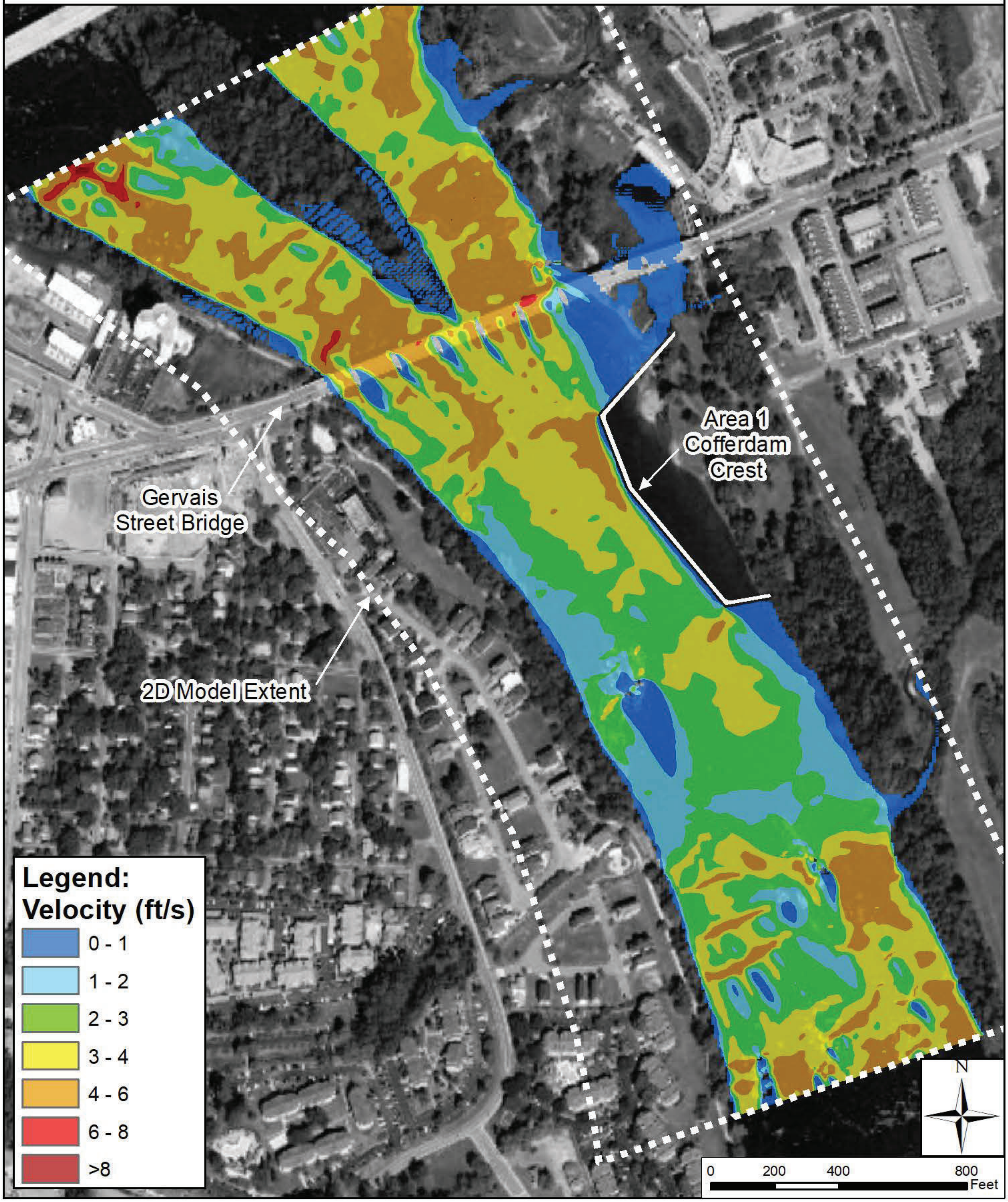
# Congaree River Remediation Project
# West Bank Erosion Potential Evaluation
# Figure A1: Normal Flow (8,564 cfs)
# Existing Scenario: Flow Velocity



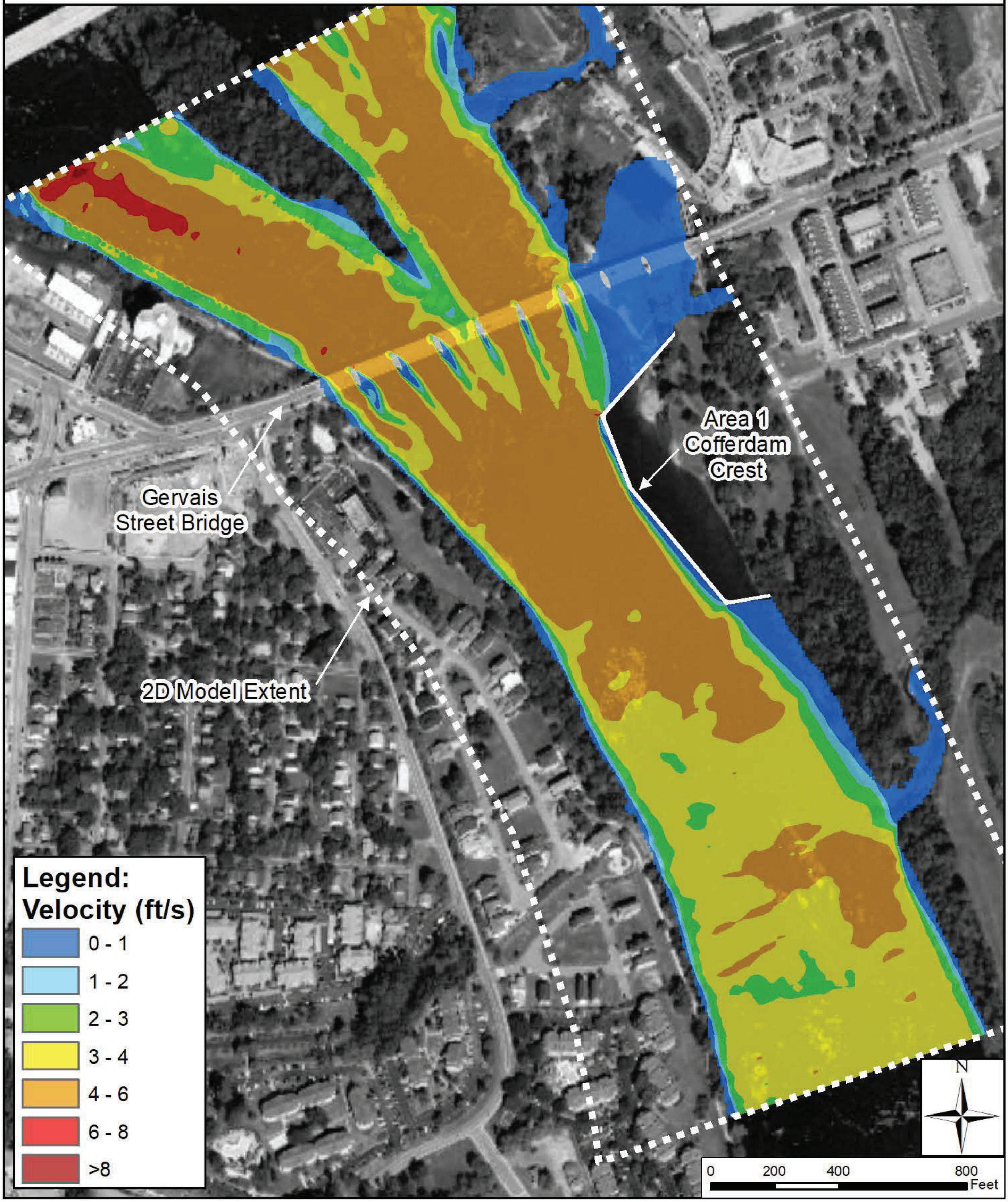
## Congaree River Remediation Project
## West Bank Erosion Potential Evaluation
## Figure A2: Crest Flow (26,000 cfs)
## Existing Scenario: Flow Velocity



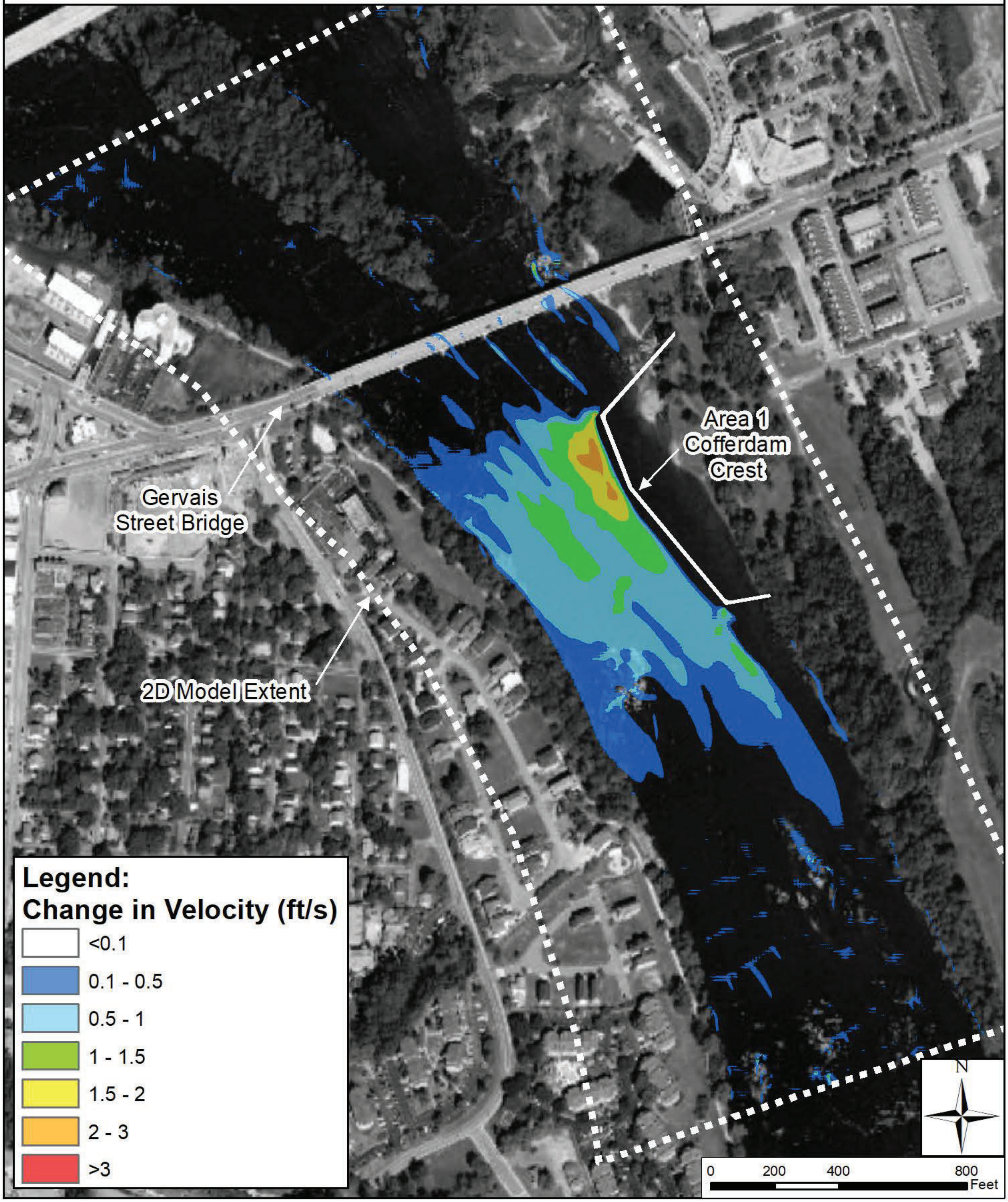
**Congaree River Remediation Project**
**West Bank Erosion Potential Evaluation**
**Figure A3: Normal Flow (8,564 cfs)**
**Proposed Area-1 Scenario: Flow Velocity**



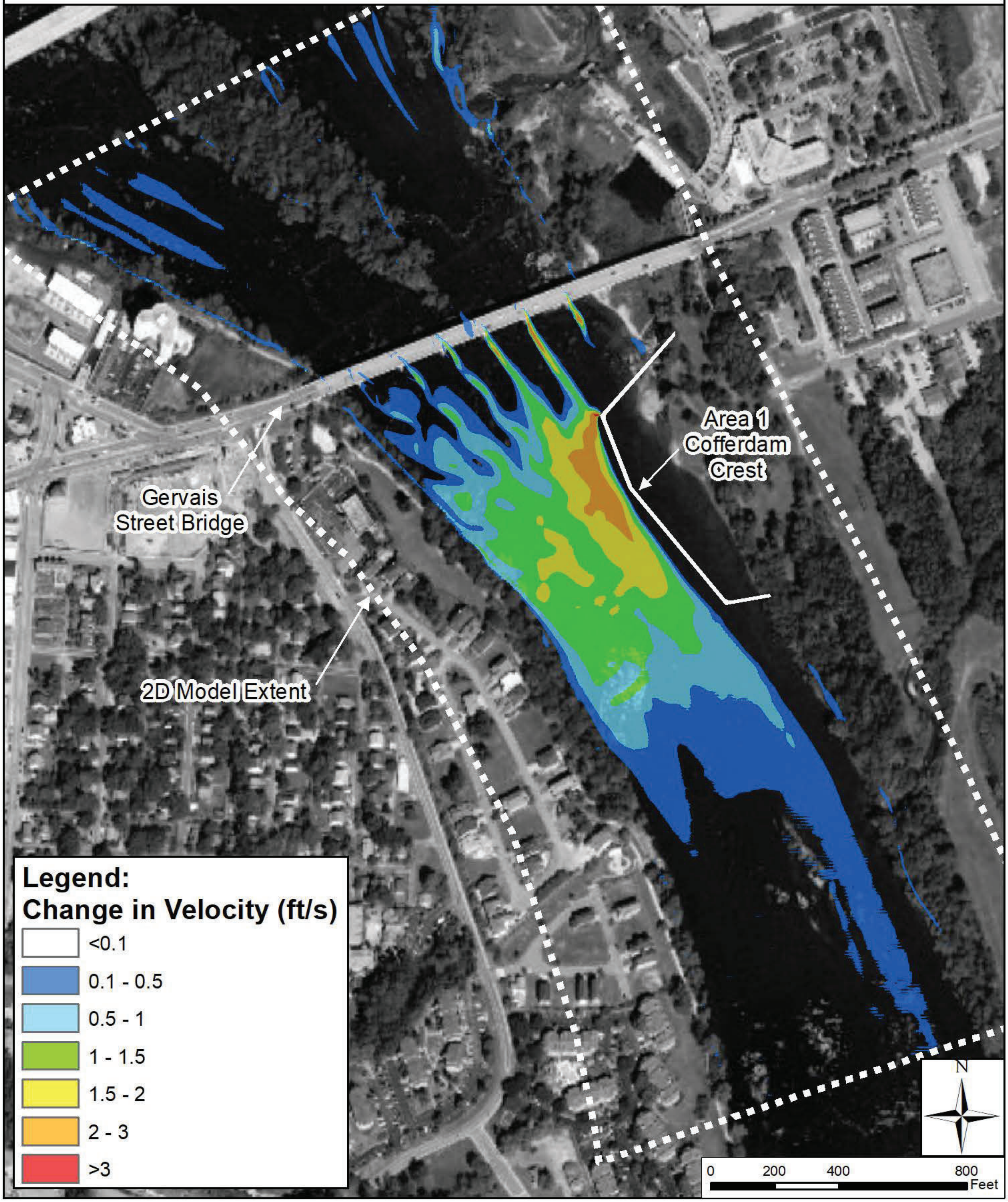
**Congaree River Remediation Project**
**West Bank Erosion Potential Evaluation**
**Figure A4: Crest Flow (26,000 cfs)**
**Proposed Area-1 Scenario: Flow Velocity**



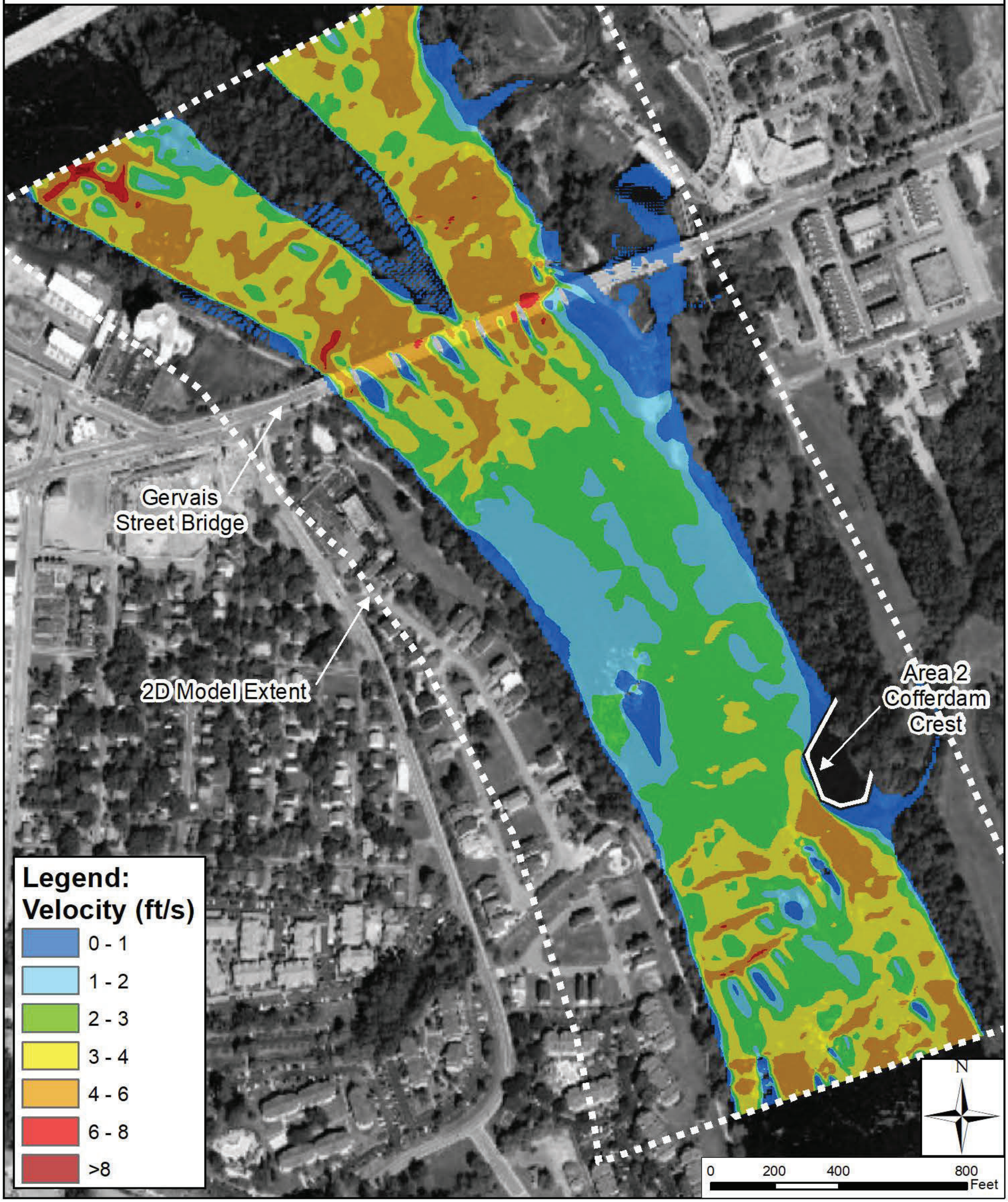
**Congaree River Remediation Project**
**West Bank Erosion Potential Evaluation**
**Figure A5: Normal Flow (8,564 cfs)**
**Proposed Area-1 Scenario: Change in Flow Velocity**



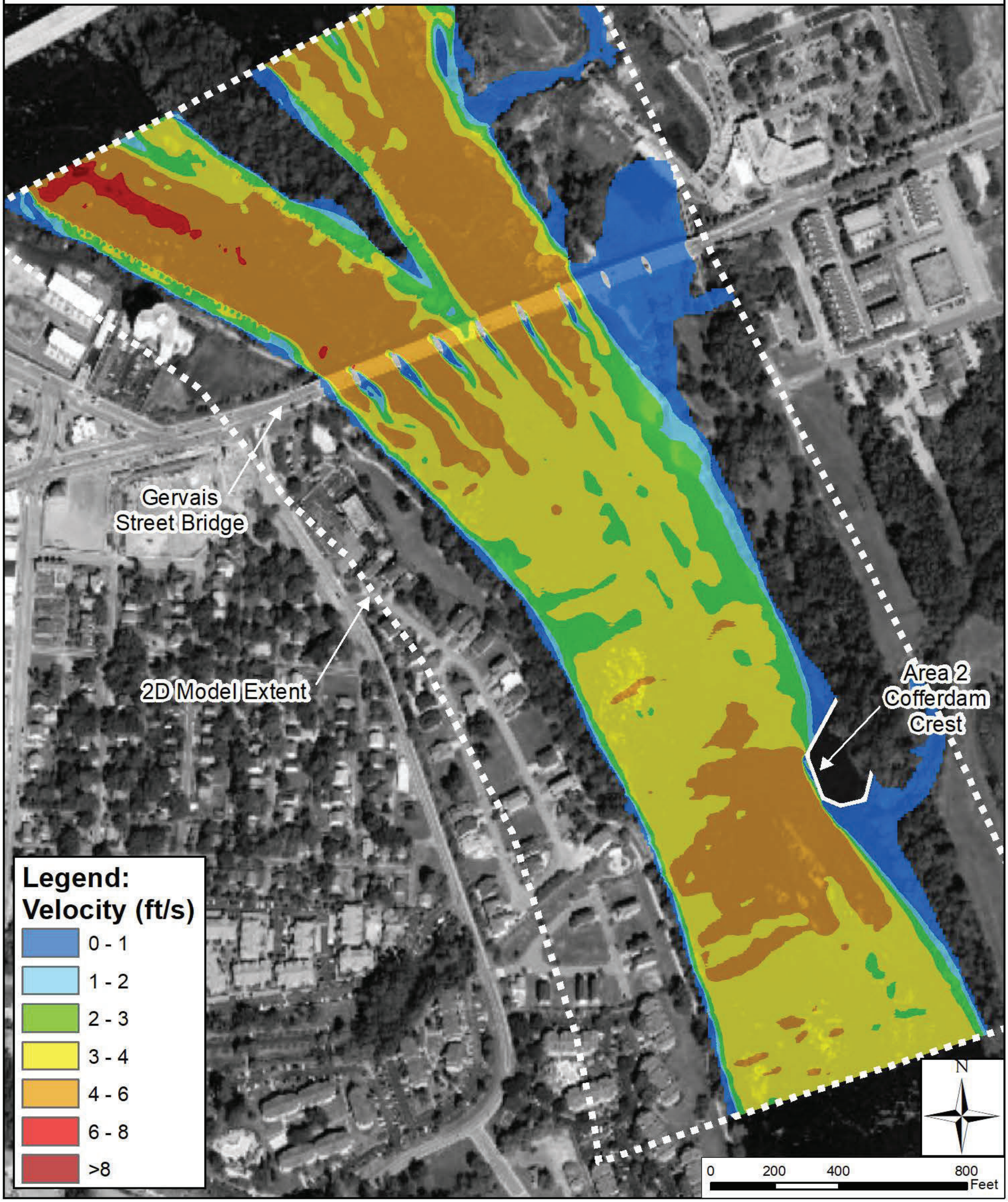
## Congaree River Remediation Project
## West Bank Erosion Potential Evaluation
## Figure A6: Crest Flow (26,000 cfs)
## Proposed Area-1 Scenario: Change in Flow Velocity



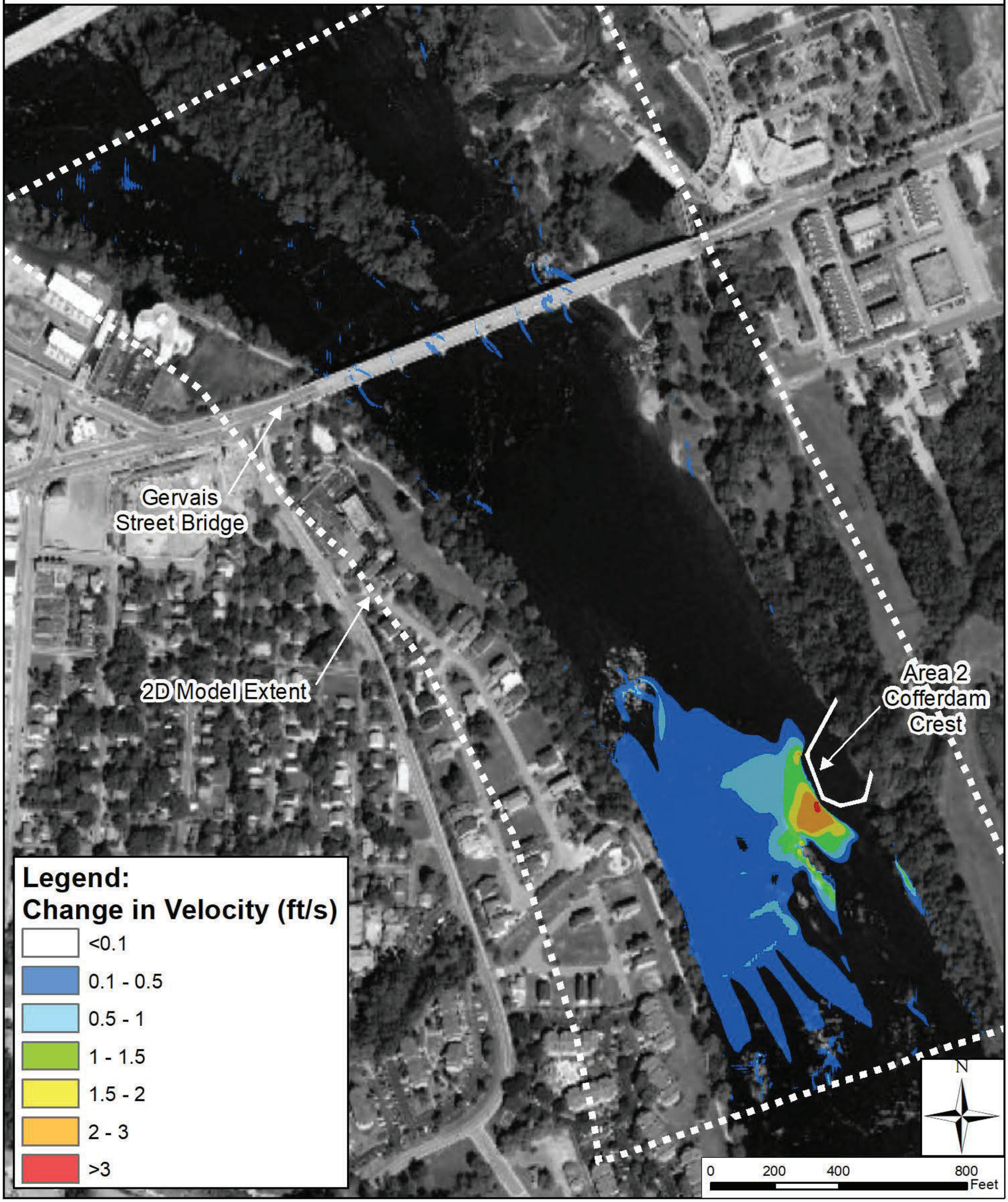
**Congaree River Remediation Project**
**West Bank Erosion Potential Evaluation**
**Figure A7: Normal Flow (8,564 cfs)**
**Proposed Area-2 Scenario: Flow Velocity**



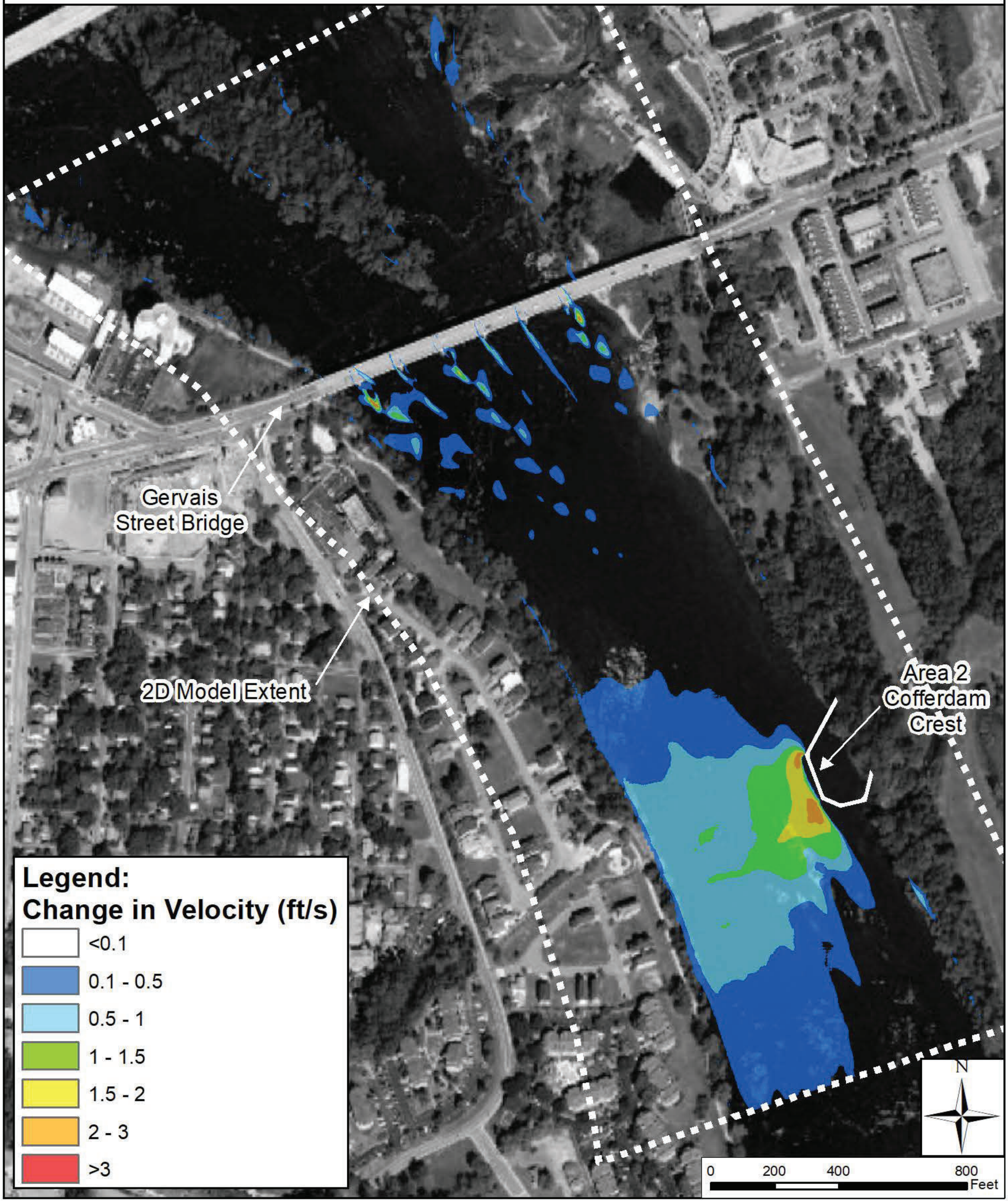
## Congaree River Remediation Project
## West Bank Erosion Potential Evaluation
## Figure A8: Crest Flow (26,000 cfs)
## Proposed Area-2 Scenario: Flow Velocity



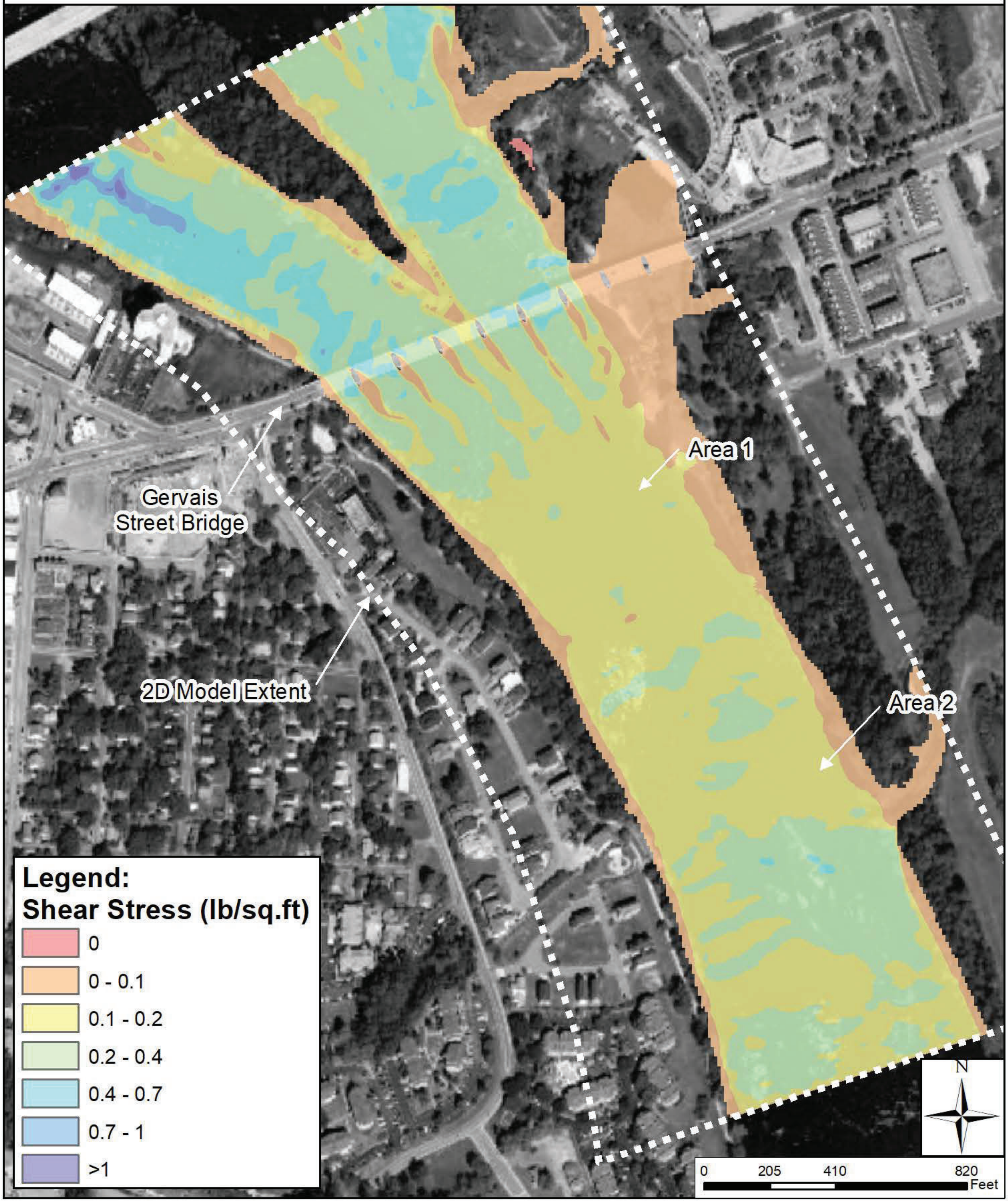
**Congaree River Remediation Project**
**West Bank Erosion Potential Evaluation**
**Figure A9: Normal Flow (8,564 cfs)**
**Proposed Area-2 Scenario: Change in Flow Velocity**



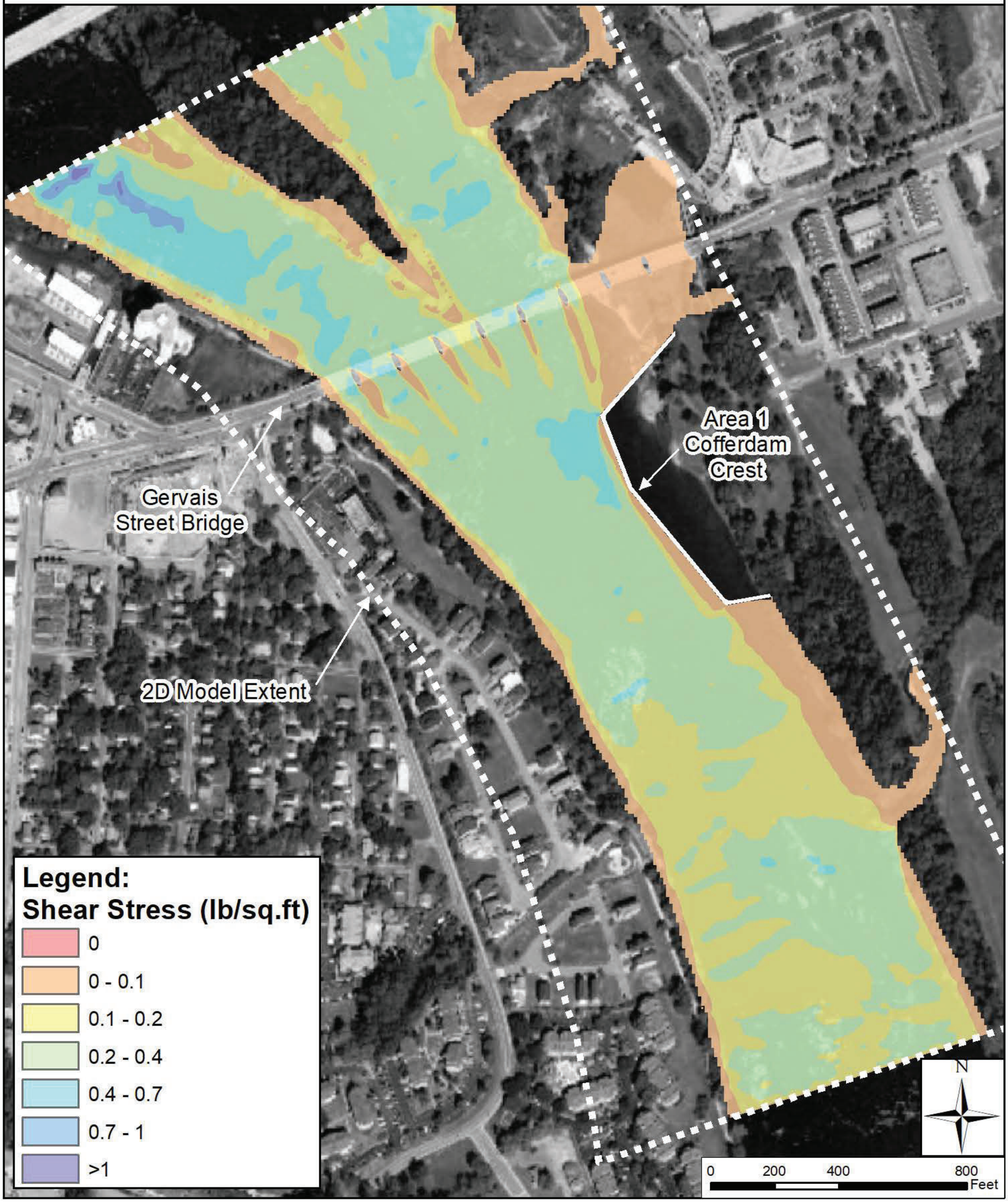
**Congaree River Remediation Project**
**West Bank Erosion Potential Evaluation**
**Figure A10: Crest Flow (26,000 cfs)**
**Proposed Area-2 Scenario: Change in Flow Velocity**



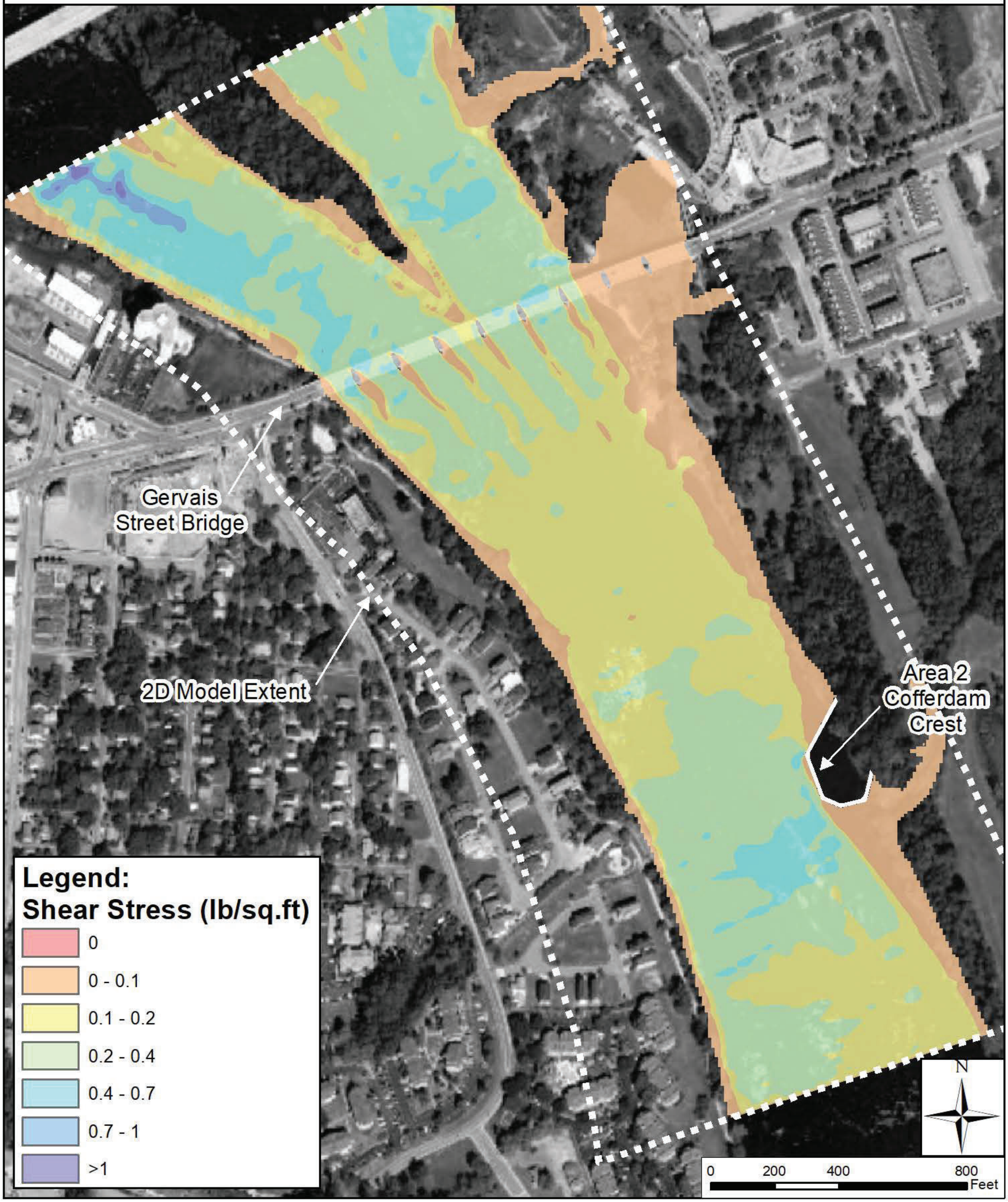
**Congaree River Remediation Project**
**West Bank Erosion Potential Evaluation**
**Figure A11: Crest Flow (26,000 cfs)**
**Existing Scenario: Shear Stress**



**Congaree River Remediation Project**
**West Bank Erosion Potential Evaluation**
**Figure A12: Crest Flow (26,000 cfs)**
**Proposed Area-1 Scenario: Shear Stress**



**Congaree River Remediation Project**
**West Bank Erosion Potential Evaluation**
**Figure A13: Crest Flow (26,000 cfs)**
**Proposed Area-2 Scenario: Shear Stress**



Healthy People. Healthy Communities.

June 8, 2020

Mr. Paul Biery
Senior Project Manager
Dominion Energy South Carolina
400 Otarre Parkway
Cayce, SC 29033

RE: River Bottom Erosion Potential Evaluation
SCE&G Fleet Maintenance Site (Congaree River)
Columbia, South Carolina

Dear Mr. Biery,

The State Voluntary Cleanup Program has reviewed the River Bottom Erosion Potential Evaluation received by the Department on June 3, 2020. The Department approves of the submittal and the conclusions made in the report.

If you have any questions or comments please contact me at (803) 898-0747 or cassidga@dhec.sc.gov.

Sincerely,

Greg Cassidy
State Voluntary Cleanup Program
Bureau of Land and Waste Management

cc: File 52561
Lucas Berresford, BLWM
Veronica Barringer, Midlands EA Region
Al Peeples, Midlands EA Region

**VIA ELECTRONIC MAIL**

March 10, 2020

William Zeli, P.E., Environment Program Manager
Apex Companies, LLC
1600 Commerce Circle
Trafford, PA 15085

**Subject:** **River Bottom Erosion Potential Evaluation**
**Congaree River Remediation Project**
**Columbia, South Carolina**

Dear Mr. Zeli:

This letter presents a summary of WSP USA's (WSP) river bottom erosion potential evaluation completed using a two-dimensional (2D) HEC-RAS model of the Congaree River near the proposed Area 1 and Area 2 cofferdams.

## 2D MODEL DEVELOPMENT

A 2D HEC-RAS model was developed for the purposes of completing the erosion potential evaluation. The model was constructed using the same bathymetry, topographic survey, and LiDAR data used to develop a one-dimensional (1D) HEC-RAS model for the Hydraulic Analysis (WSP; April 12, 2019) and Low Flow Sensitivity Analysis (WSP; July 26, 2019). Boundary conditions were determined from the Low Flow Sensitivity Analysis model outputs.

The key characteristics of the 2D model are listed below:

- Upstream extent located approximately 1,000 feet (ft) upstream of Gervais Street bridge
- Downstream extent located approximately 500 ft upstream of Blossom Street bridge, at 1D model Sta. 282071
- Typical cell size of 5 ft x 5 ft, giving a total of approximately 225,000 cells
- Constant Manning's roughness value of 0.038 specified for existing river channel (as per 1D model) and proposed cofferdam structures.
- Upstream inflow boundary conditions for normal flow (8,564 cubic feet per second [cfs]) and crest flow (26,000 cfs) from 1D model. Flow split between left and right channels calculated based on flow area of

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Pittsburgh, PA 15222

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Fax: +1 412 281-2056
wsp.com

each side of channel at normal/crest flow conditions from 1D model outputs. Results in approximately 50-50 split between channels.

- Downstream water level boundary conditions for normal and crest flow conditions determined from 1D model outputs as 115.0 and 121.8 ft NAVD 88, respectively.
- Separate Digital Elevation Models (DEMs) developed for Existing, Proposed Area-1 Cofferdam, and Proposed Area-2 Cofferdam scenarios. Cofferdams and river banks specified as break lines for all scenarios, ensuring a consistent 2D flow area with identical computation point locations is used for all models. Therefore, any changes in results can be attributed to elevation changes, not model schematization.
- Gervais Street bridge piers are represented in the models assuming an ellipse shape approximately 60 ft long and 20ft wide, based on Google Earth imagery.
- Final model simulations run using the full momentum equations and an adaptive computation interval with a maximum value of 30-seconds.

Figures 1 through 7 provide a summary of the model setup and input data.

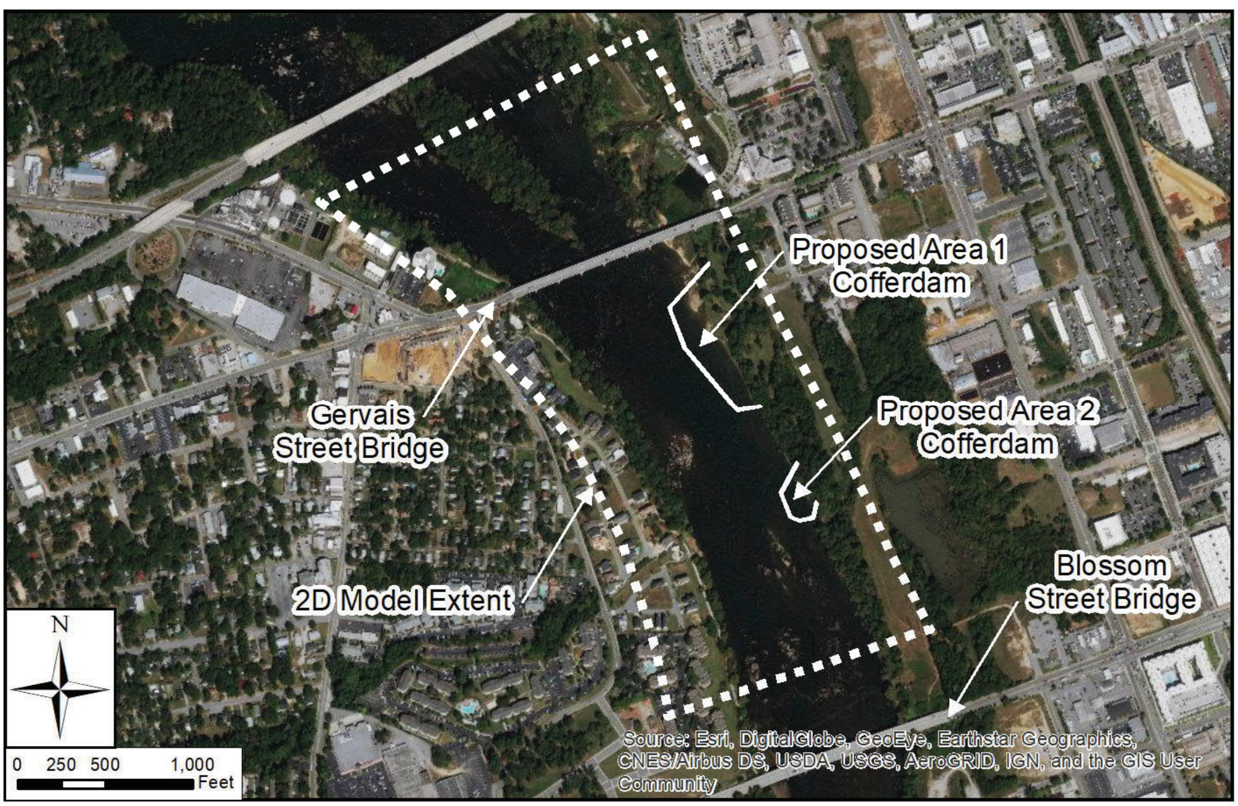


*Figure 1: Model Extent*

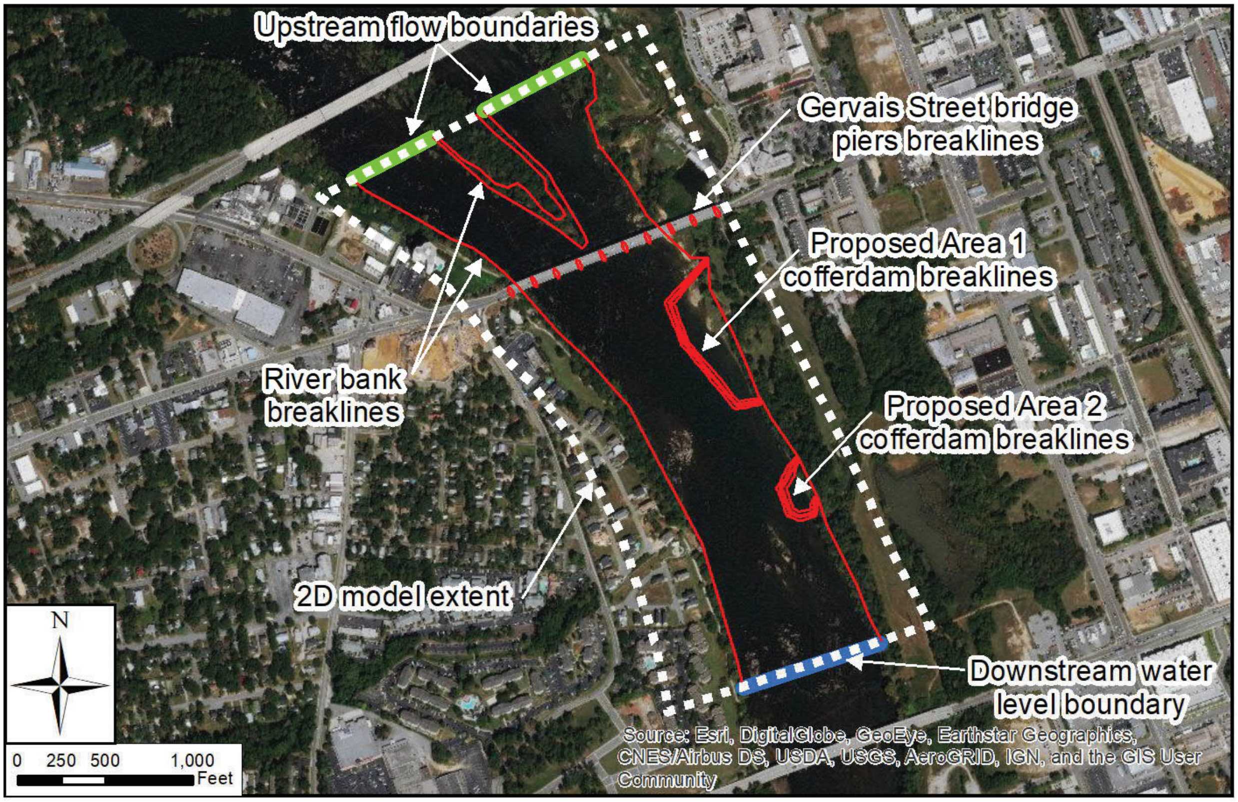


*Figure 2: Model Details*

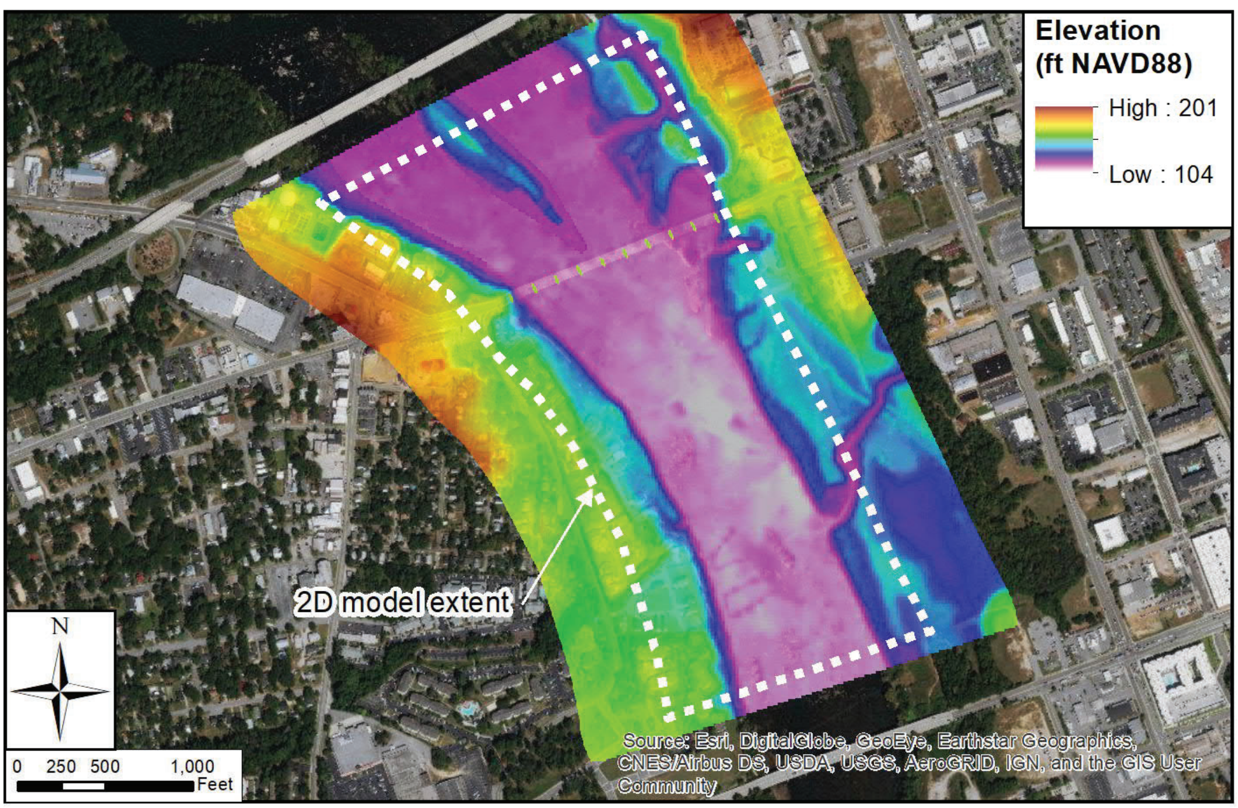


*Figure 3: Existing Digital Elevation Model*

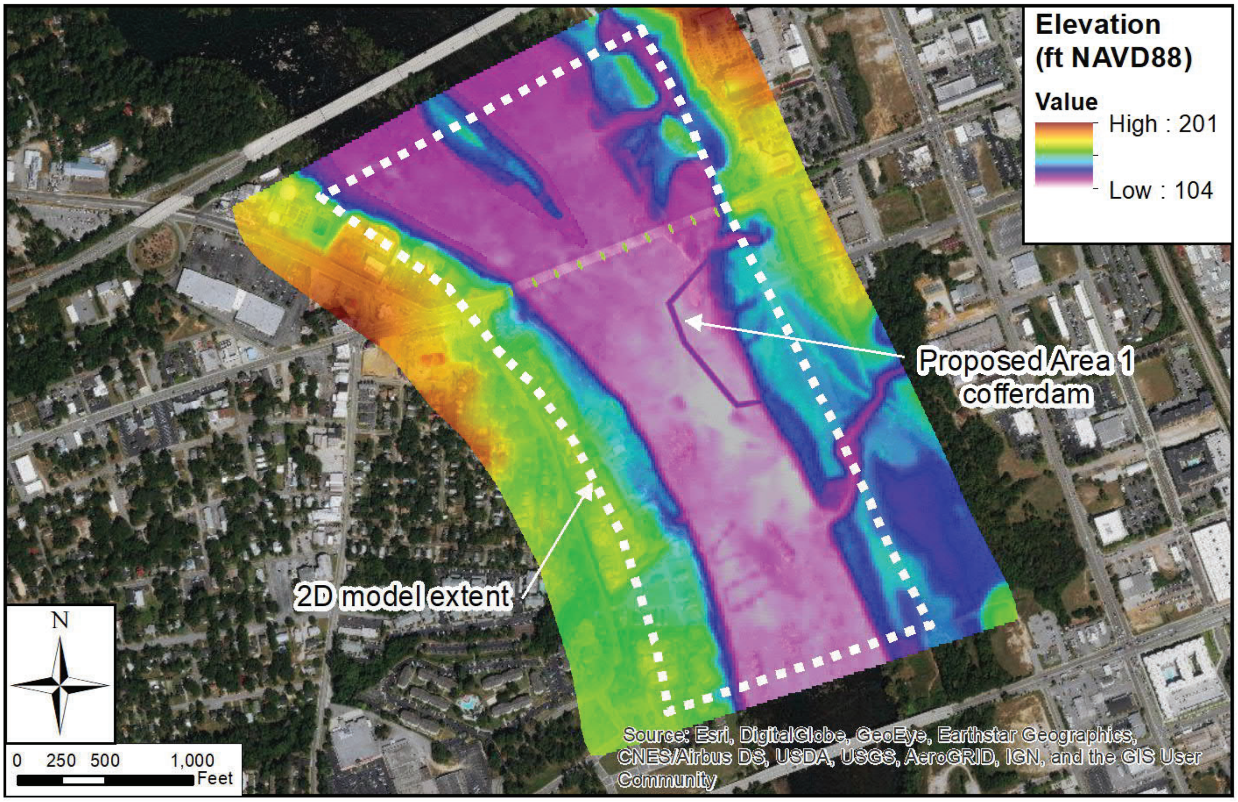


*Figure 4: Proposed Area 1 Cofferdam Digital Elevation Model*

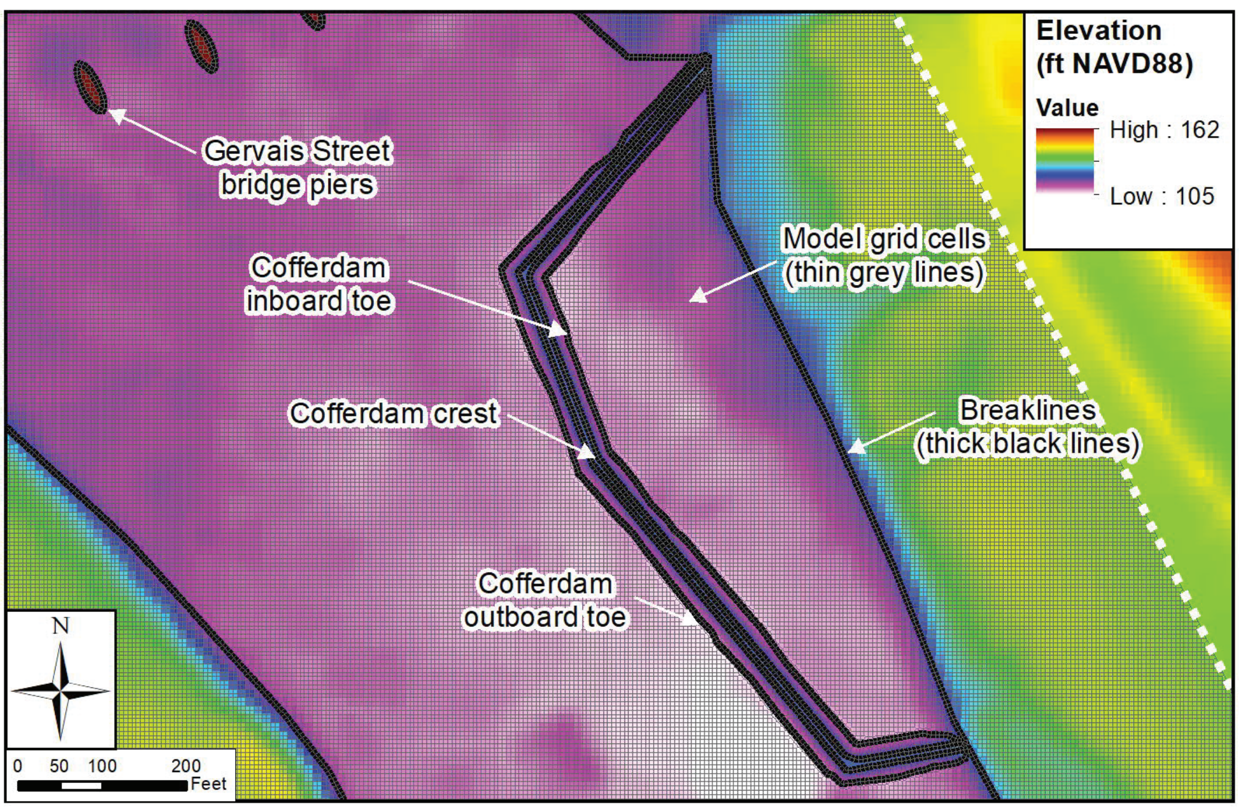


*Figure 5: Proposed Area 1 Cofferdam Mesh Details*

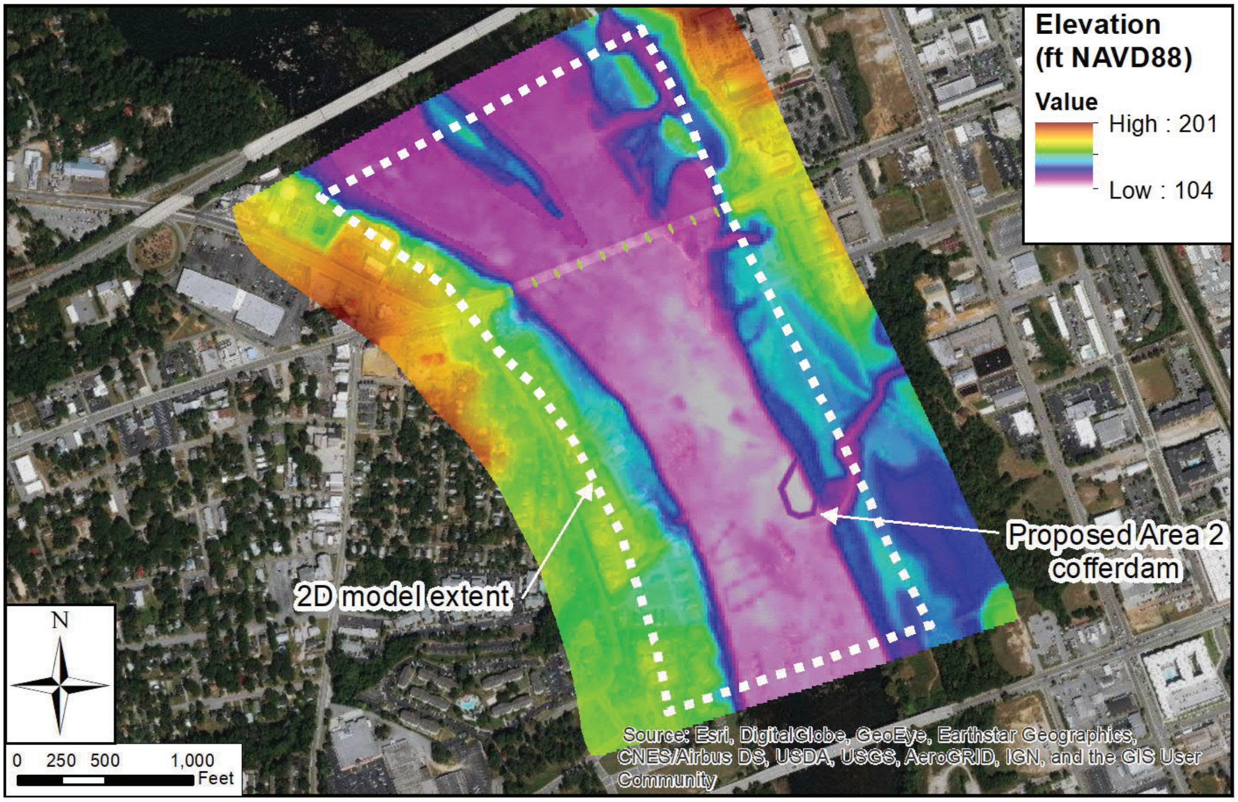


*Figure 6: Proposed Area 2 Cofferdam Digital Elevation Model*

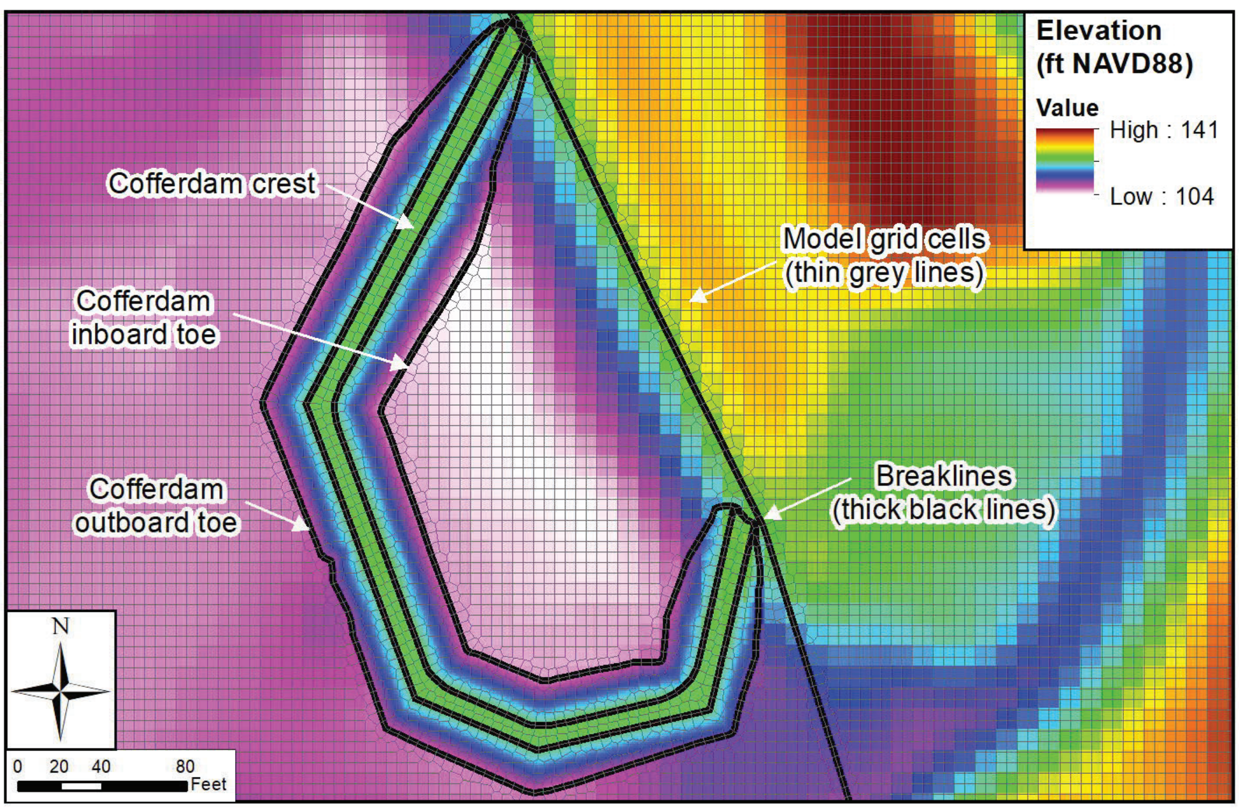


*Figure 7: Proposed Area 2 Cofferdam Mesh Details*

Figure 8 shows the upstream and downstream boundary conditions used for the model runs. The upstream inflow and downstream water level during the first hour of the run represents the "normal flow condition" of 8,564 cfs. Over the next four hours of the run, the boundary conditions ramp-up to the "crest flow condition" of 26,000 cfs, which is then maintained for the final two hours of the run. During development of the model, initial runs were completed to develop initial condition files at the start of the run for the Existing, Proposed Area 1 and Proposed Area 2 models.

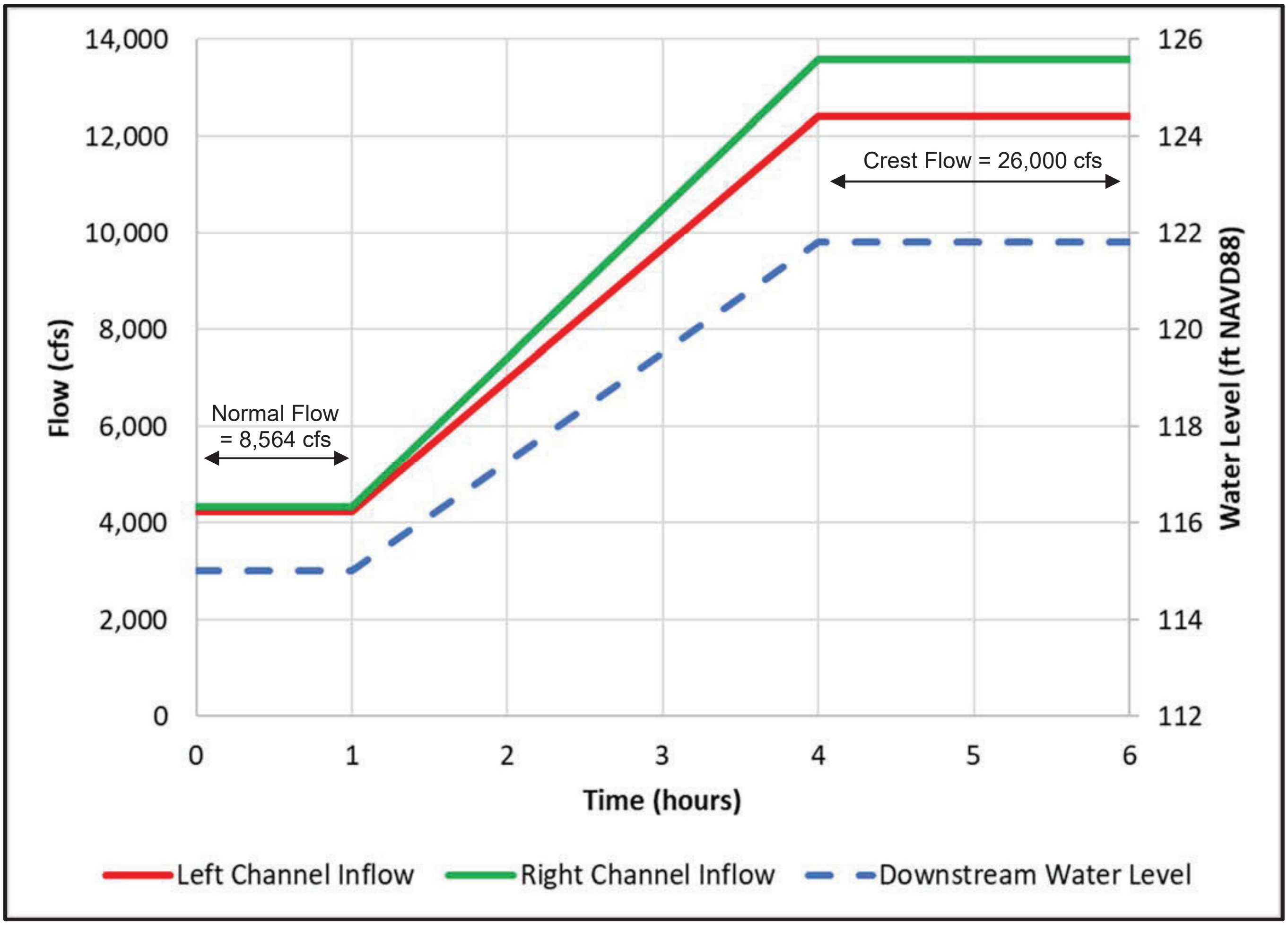


*Figure 8: Upstream and Downstream Boundary Conditions*

## 2D MODEL RESULTS

Separate two-dimensional unsteady flow analyses were performed for the Existing, Proposed Area 1, and Proposed Area 2 models. Additional trial analyses were also performed to test the model's sensitivity to the computational timestep interval and the application of the full momentum equations. After our initial quality assurance review, we determined that the adaptive computational interval and the full momentum equations should be utilized for the final model runs, in accordance with the HEC-RAS 2D Modeling User's Manual.

The velocity and shear stress results were extracted from all of the models after one hour to represent the normal flow condition of 8,564 cfs, and after six hours to represent the crest flow condition of 26,000 cfs. The results were used to develop figures that show the spatial variation of flow velocity/shear stress throughout the Congaree River channel and to show changes in velocity due to the construction of the Area 1 and Area 2 cofferdams.

The following figures are provided in Attachment A:

- Figure A1: Normal Flow (8,564 cfs) Existing Scenario – Flow Velocity
- Figure A2: Crest Flow (26,000 cfs) Existing Scenario – Flow Velocity
- Figure A3: Normal Flow (8,564 cfs) Proposed Area-1 Scenario – Flow Velocity
- Figure A4: Crest Flow (26,000 cfs) Proposed Area-1 Scenario – Flow Velocity
- Figure A5: Normal Flow (8,564 cfs) Proposed Area-1 Scenario – Change in Flow Velocity
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- Figure A8: Crest Flow (26,000 cfs) Proposed Area-2 Scenario – Flow Velocity
- Figure A9: Normal Flow (8,564 cfs) Proposed Area-2 Scenario – Change in Flow Velocity
- Figure A10: Crest Flow (26,000 cfs) Proposed Area-2 Scenario – Change in Flow Velocity
- Figure A11: Normal Flow (8,564 cfs) Existing Scenario – Shear Stress
- Figure A12: Crest Flow (26,000 cfs) Existing Scenario – Shear Stress
- Figure A13: Normal Flow (8,564 cfs) Proposed Area-1 Scenario – Shear Stress
- Figure A14: Crest Flow (26,000 cfs) Proposed Area-1 Scenario – Shear Stress
- Figure A15: Normal Flow (8,564 cfs) Proposed Area-1 Scenario – Change in Shear Stress
- Figure A16: Crest Flow (26,000 cfs) Proposed Area-1 Scenario – Change in Shear Stress
- Figure A17: Normal Flow (8,564 cfs) Proposed Area-2 Scenario – Shear Stress
- Figure A18: Crest Flow (26,000 cfs) Proposed Area-2 Scenario – Shear Stress
- Figure A19: Normal Flow (8,564 cfs) Proposed Area-2 Scenario – Change in Shear Stress
- Figure A20: Crest Flow (26,000 cfs) Proposed Area-2 Scenario – Change in Shear Stress

The following sections discuss the **velocity and shear stress results for the Congaree River in the vicinity of the project area** for the Existing, Proposed Area-1, and Proposed Area-2 scenarios. A summary of the velocity and shear stress results is provided in Table 1 and 2, respectively.

*Table 1: Velocity Results Summary*

| Velocity (ft/s) | Reference Values (USBR, 2015) | Existing Scenario | | Proposed Area-1 Scenario | | Proposed Area-2 Scenario | |
|---|---|---|---|---|---|---|---|
| | | Normal Flow (8,564 cfs) | Crest Flow (26,000 cfs) | Normal Flow (8,564 cfs) | Crest Flow (26,000 cfs) | Normal Flow (8,564 cfs) | Crest Flow (26,000 cfs) |
| Upstream and immediately downstream of Gervais St Bridge | 1.5 – 6 | 3 – 5 | 4 – 6 | 3 – 5 | 4 – 6 | 3 – 5 | 4 – 6 |
| Next 1,200 feet | | 1 – 3 | 2 – 4, some localized 5 | 2 – 4, some localized 4.5 | 4 – 6, some localized 6.5 | 1 – 3 | 2 – 4, some localized 5 |
| Final 800 feet | | 2 – 4, some localized 5 | 2 – 4, some localized 5 | 2 – 4, some localized 5 | 2 – 4, some localized 5 | 2 – 4, some localized 6 | 3.5 – 5.5, some localized 6 |

*Table 2: Shear Stress Results Summary*

| Shear Stress (lb/ft$^2$) | Reference Values (USBR, 2015) | Existing Scenario | | Proposed Area-1 Scenario | | Proposed Area-2 Scenario | |
|---|---|---|---|---|---|---|---|
| | | Normal Flow (8,564 cfs) | Crest Flow (26,000 cfs) | Normal Flow (8,564 cfs) | Crest Flow (26,000 cfs) | Normal Flow (8,564 cfs) | Crest Flow (26,000 cfs) |
| Upstream and immediately downstream of Gervais St Bridge | 0.02 – 0.67 | 0.2 – 0.5, some localized 0.7 | 0.3 – 0.5, some localized >0.7 | 0.2 – 0.5, some localized 0.7 | 0.3 – 0.5, some localized >0.7 | 0.2 – 0.5, some localized 0.7 | 0.3 – 0.5, some localized >0.7 |
| Next 1,200 feet | | 0.05 – 0.2 | 0.1 – 0.2 | 0.1 – 0.4, some localized 0.6 | 0.2 – 0.5, some localized 0.7 | 0.05 – 0.2 | 0.1 – 0.2 |
| Final 800 feet | | 0.1 – 0.5, some localized 0.7 | 0.1 – 0.4, some localized 0.5 | 0.1 – 0.5, some localized 0.7 | 0.1 – 0.4, some localized 0.5 | 0.1 – 0.4, some localized >0.9 | 0.2 – 0.5, some localized 0.7 |

## RIVER BOTTOM EROSION POTENTIAL EVALUATION

For existing conditions, the river velocities within the Congaree River during normal (8,564 cfs) and crest (26,000 cfs) flow conditions vary between 1 and 6 ft/s. Shear stresses range between 0.05 and 0.5 lb/ft$^2$, with some localized areas of increased shear of approximately 0.7 lb/ft$^2$. Note that the annual probability of exceedance for crest flow conditions is approximately 50%, i.e., a 1 in 2-year flood event.

The maximum increase in flow velocity across the river after cofferdam construction is up to 1.5 ft/s during normal and crest flow conditions. However, the velocities in this area remain within the 4 to 6 ft/s range. The maximum flow velocity increase within the immediate vicinity of the cofferdams is up to 3 ft/s but the velocities remain within the 5.5 to 6.5 ft/s range.

The change in shear stress after cofferdam construction follows a similar pattern, with increases between 0.1 and 0.4 lb/ft$^2$ adjacent to the structures, and the highest increases in close proximity to the structure, with peak values typically up to 0.5 lb/ft$^2$. Further out into the main river channel, the increase in shear stress typically ranges between 0 and 0.2 lb/ft$^2$. Some localized areas of higher shear values are located where rock outcrops are visible in the aerial imagery. The velocities suddenly increase at these locations to account for a reduced flow depth.

The U.S Department of the Interior, Bureau of Reclamation's (USBR's) Bank Stabilization Guidelines, Report No. SRH-2015-25 provides shear and velocity resistance values for various liner materials in Table 4-2. The table indicates that 'Soils' can withstand a shear stresses ranging between 0.02 to 0.67 lb/ft$^2$ and velocities ranging between 1.5 and 6 ft/s before eroding, depending upon the specific soil type. The sands and clays encountered in the soil samples and borings advanced along the river bottom at the project location can withstand velocities and shear stresses towards the lower end of the published range. Therefore, during existing flow conditions, some erosion of the river bottom should be anticipated. This is consistent with visual observations of the river that show cloudy water from suspended sediment during higher than normal flow conditions.

Figure B1 provided in Attachment B shows the anticipated depth of sediment in the river at the location of the proposed cofferdams based on a 2018 bathymetric survey and top of bedrock estimates from soil borings advanced between 2010 to 2012. The figure shows that the sediment depth around the perimeter of the cofferdam structures varies between 0 and 3 feet before top of rock is encountered.

The results of our hydraulic analyses indicate that the construction of the proposed cofferdams during normal and crest flow conditions will result in some localized increases in flow velocity and shear stress in the channel. However, the maximum reported values are already experienced in close proximity to the project site under existing conditions; therefore, the proposed cofferdams are unlikely to result in any significant changes to the river morphology in the area which is currently constantly changing and evolving over time in response to current flows and storm events. Therefore, in our professional opinion, erosion protection measures are not necessary for the river bottom or toe of the cofferdam during the construction period.

The proposed cofferdam design includes erosion protection provided by Articulated Concrete Block (ACB) Mats or Rock Mattresses along the outboard slope and extend onto the river bottom. Rock mattresses and ACB's can withstand maximum flow velocities of 19 and 25 ft/s respectively, which is significantly greater than the maximum values between 5.5 to 6.5 ft/s located in the vicinity of the cofferdams. The ACBs or rock mattresses will provide an additional factor of safety against erosion at the toe of the cofferdam and will also account for any complex localized three-dimensional flow patterns that are not represented using a 2D depth-averaged model.

If you have any questions or need any additional information, please contact John Osterle at 412-535-9823 or john.osterle@wsp.com, or Tom Edwards at 412-535-9818 or thomas.edwards@wsp.com.

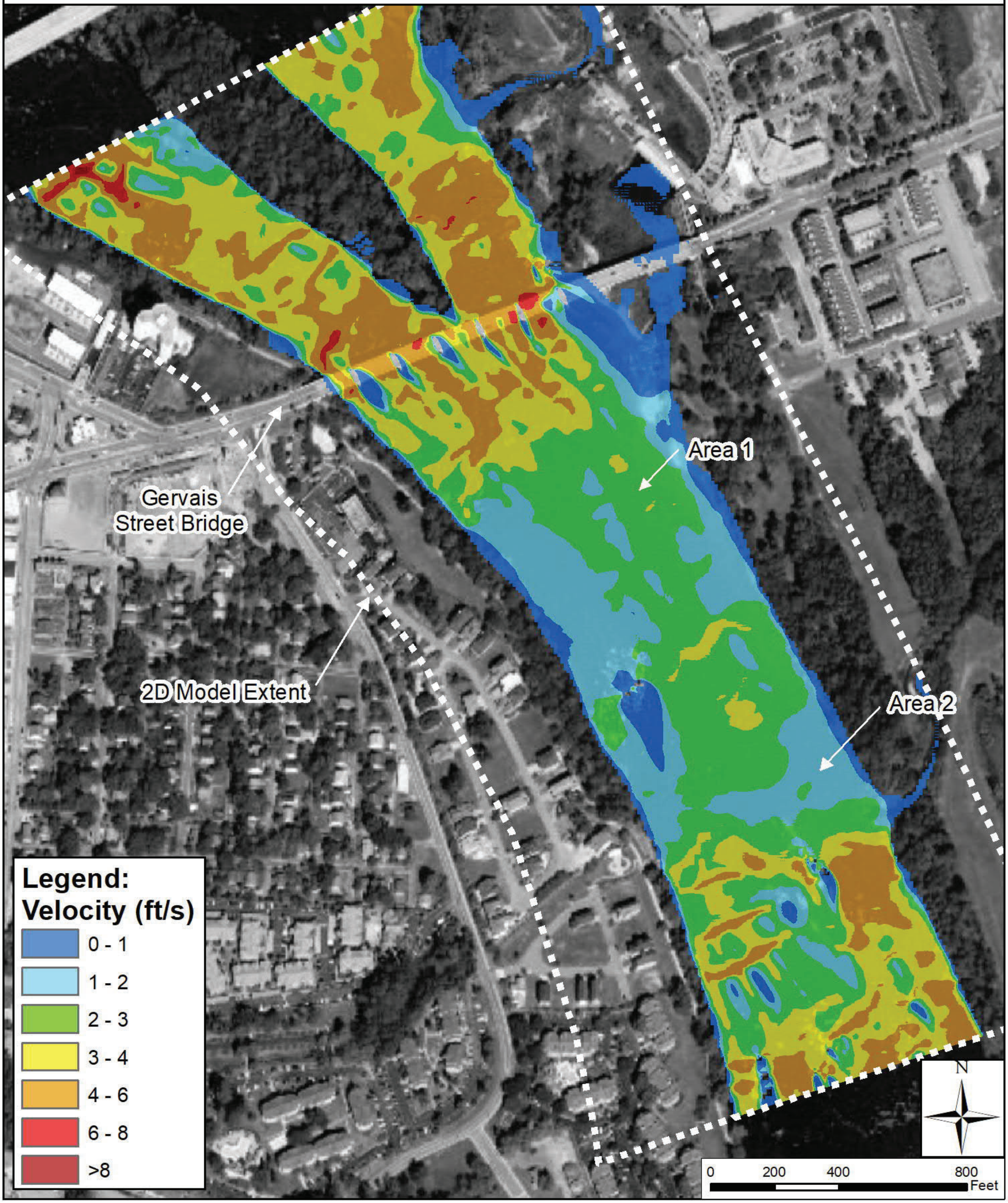
Kind regards,

| | |
|---|---|
| John P. Osterle, P.E.<br>Project Manager | Tom Edwards<br>Water Resources Engineer |

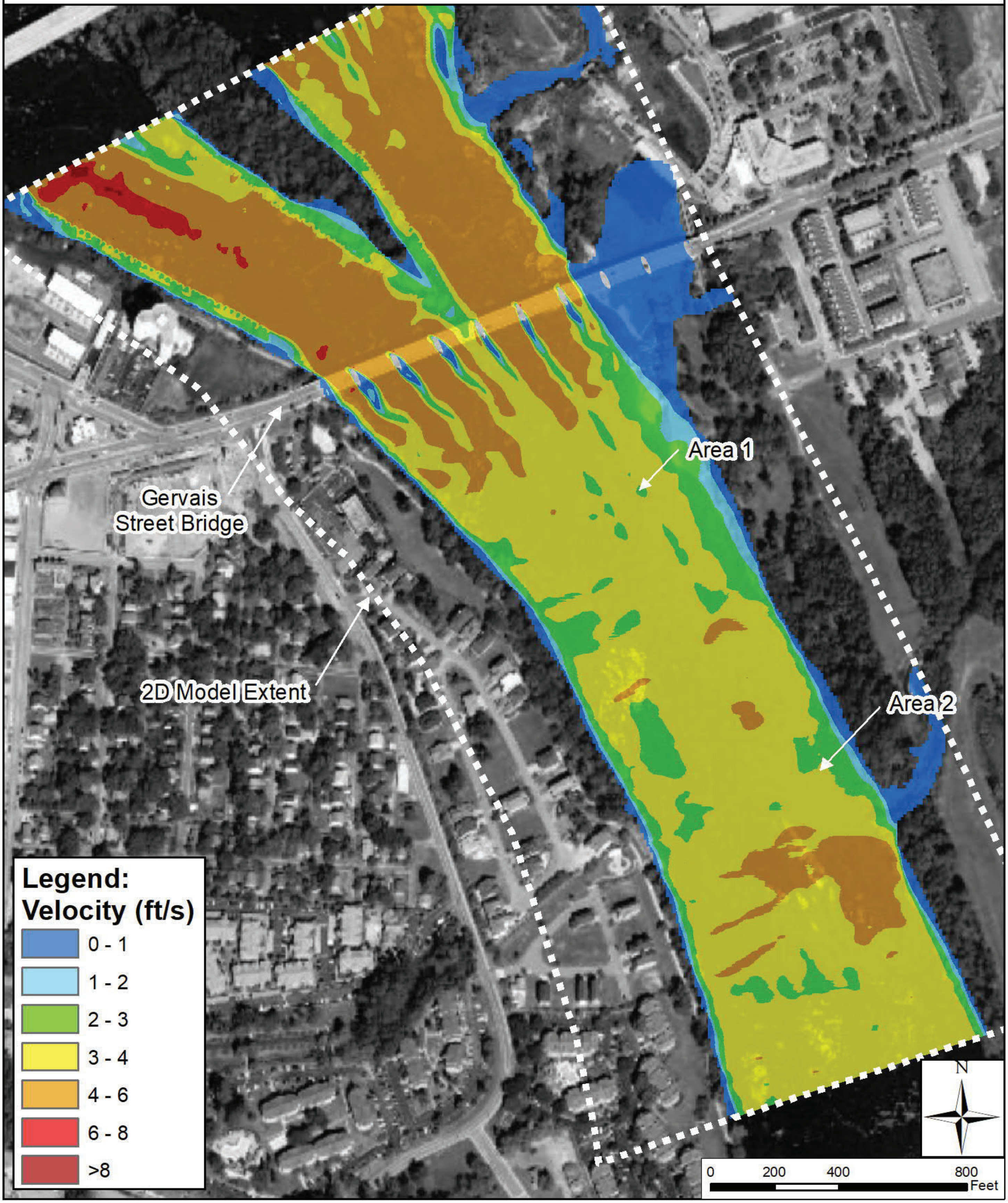
TE: JPO

# ATTACHMENT A: FIGURES

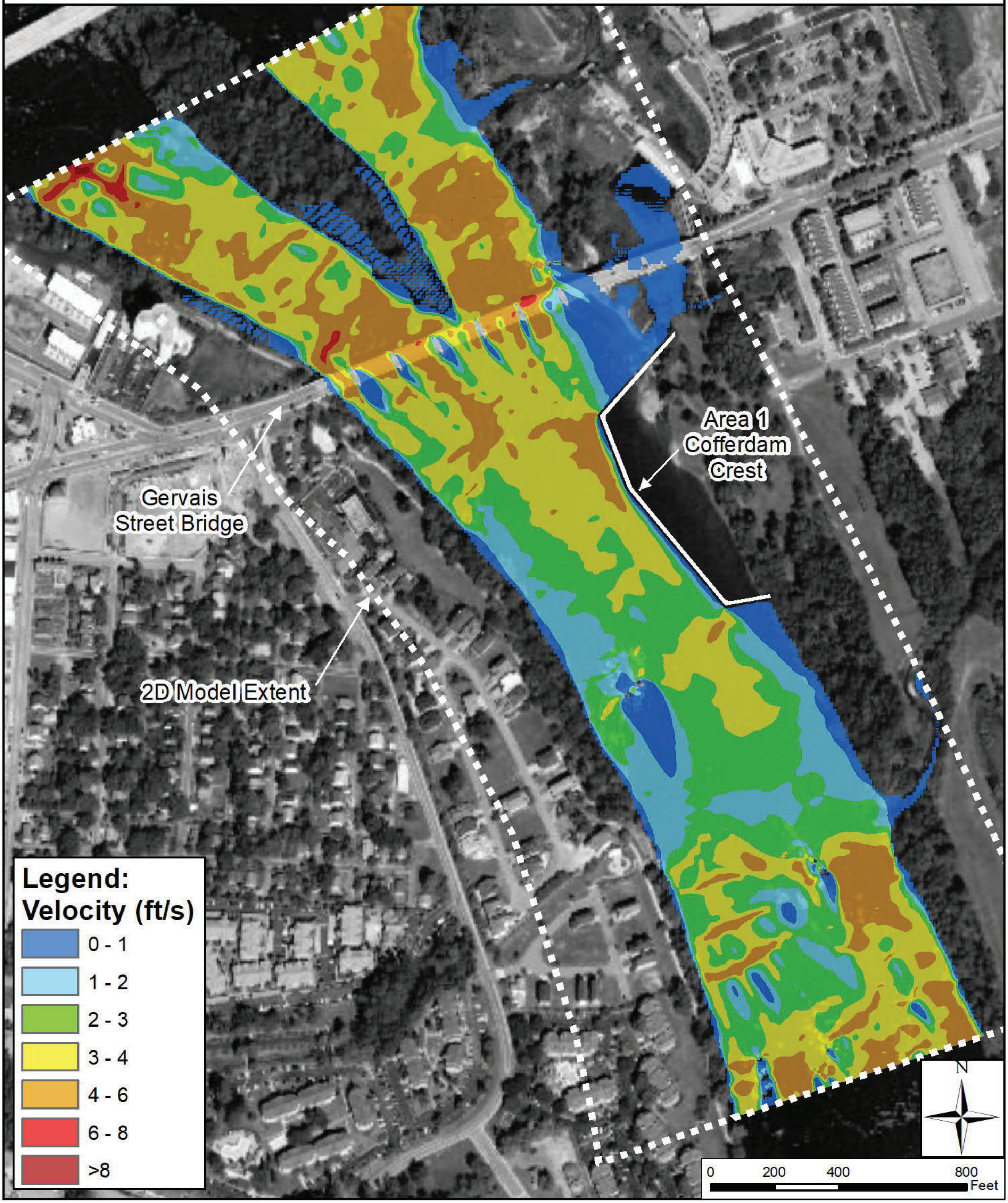
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A1: Normal Flow (8,564 cfs)**
**Existing Scenario: Flow Velocity**



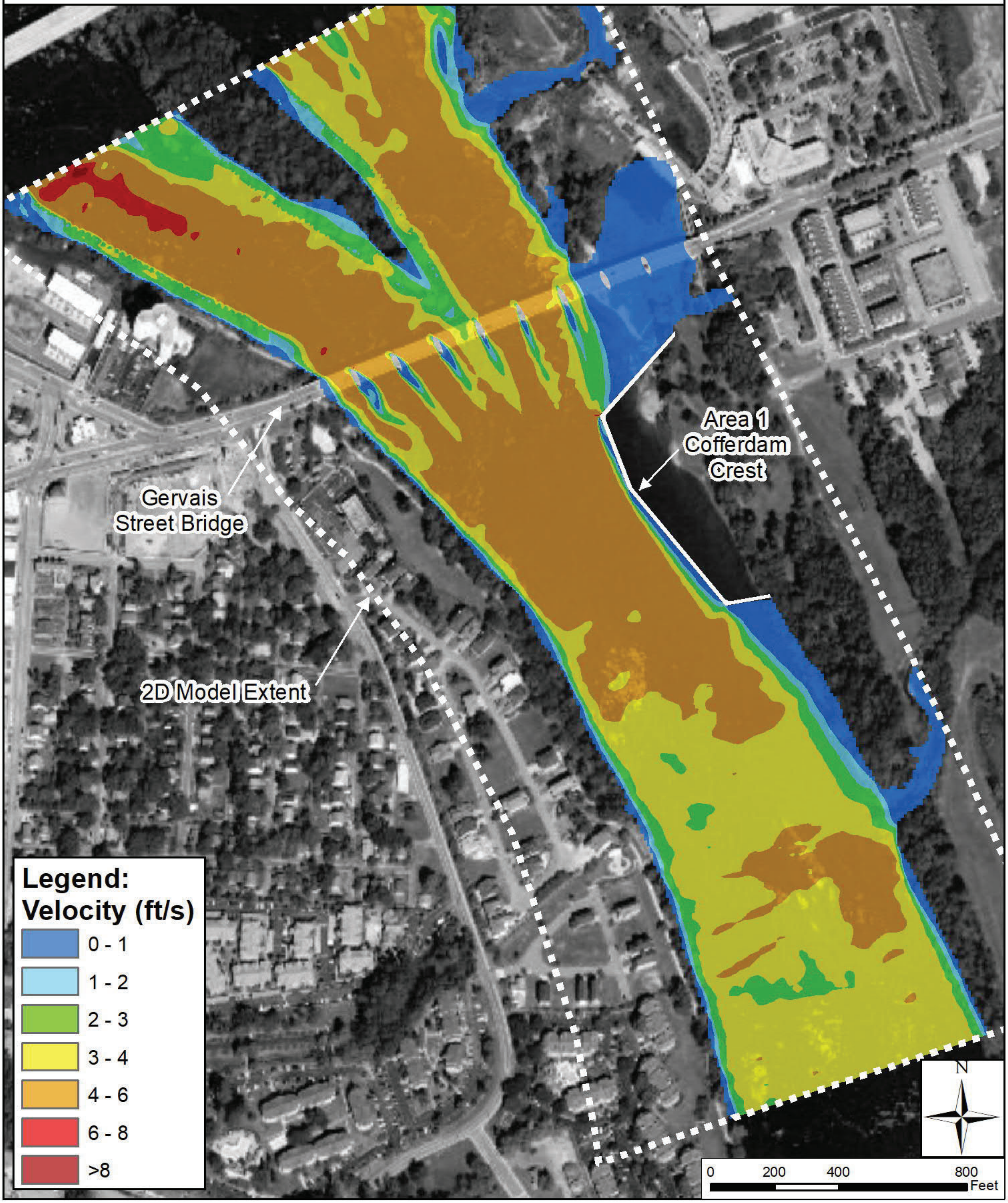
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A2: Crest Flow (26,000 cfs)**
**Existing Scenario: Flow Velocity**



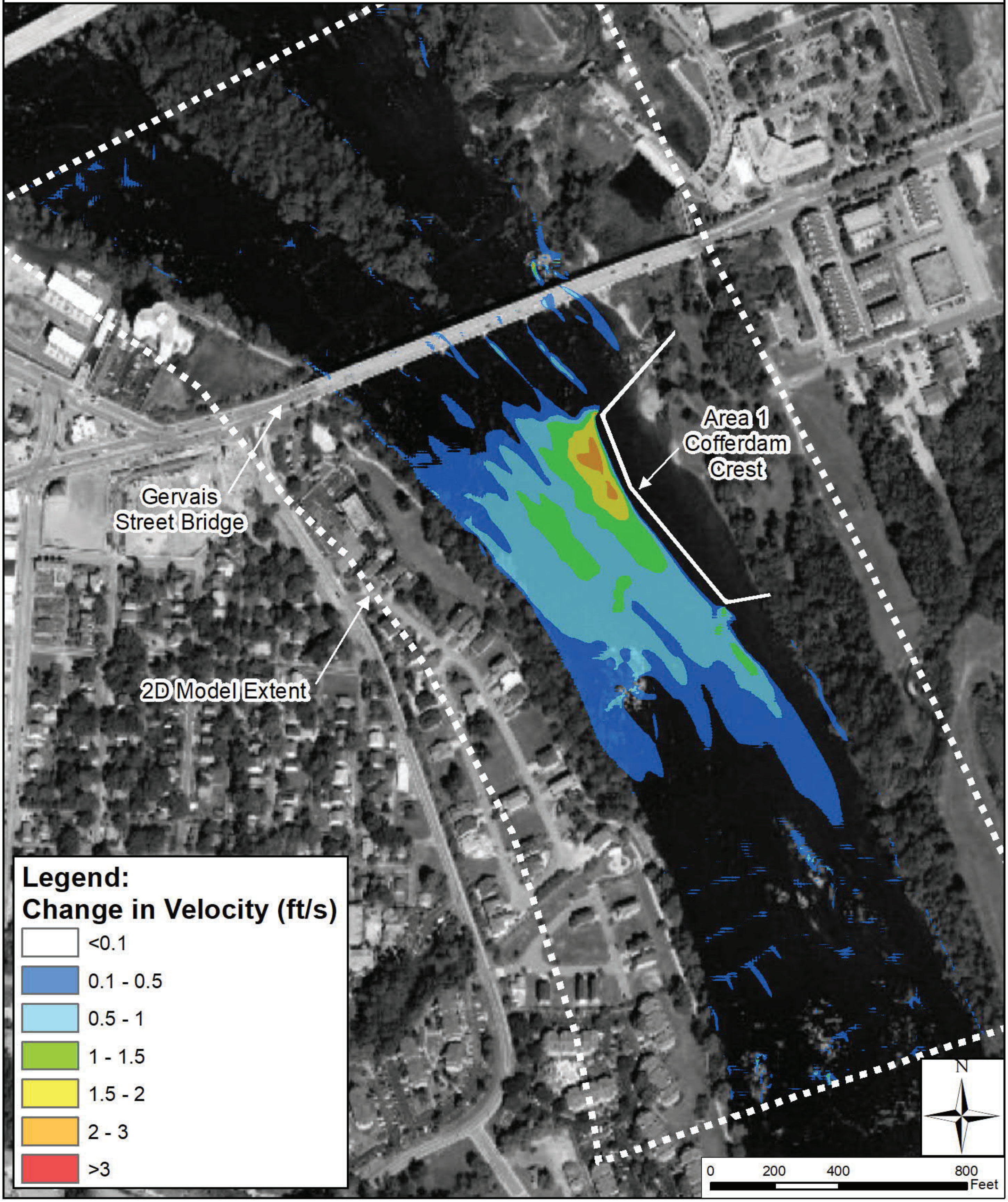
Congaree River Remediation Project
River Bottom Erosion Potential Evaluation
Figure A3: Normal Flow (8,564 cfs)
Proposed Area-1 Scenario: Flow Velocity



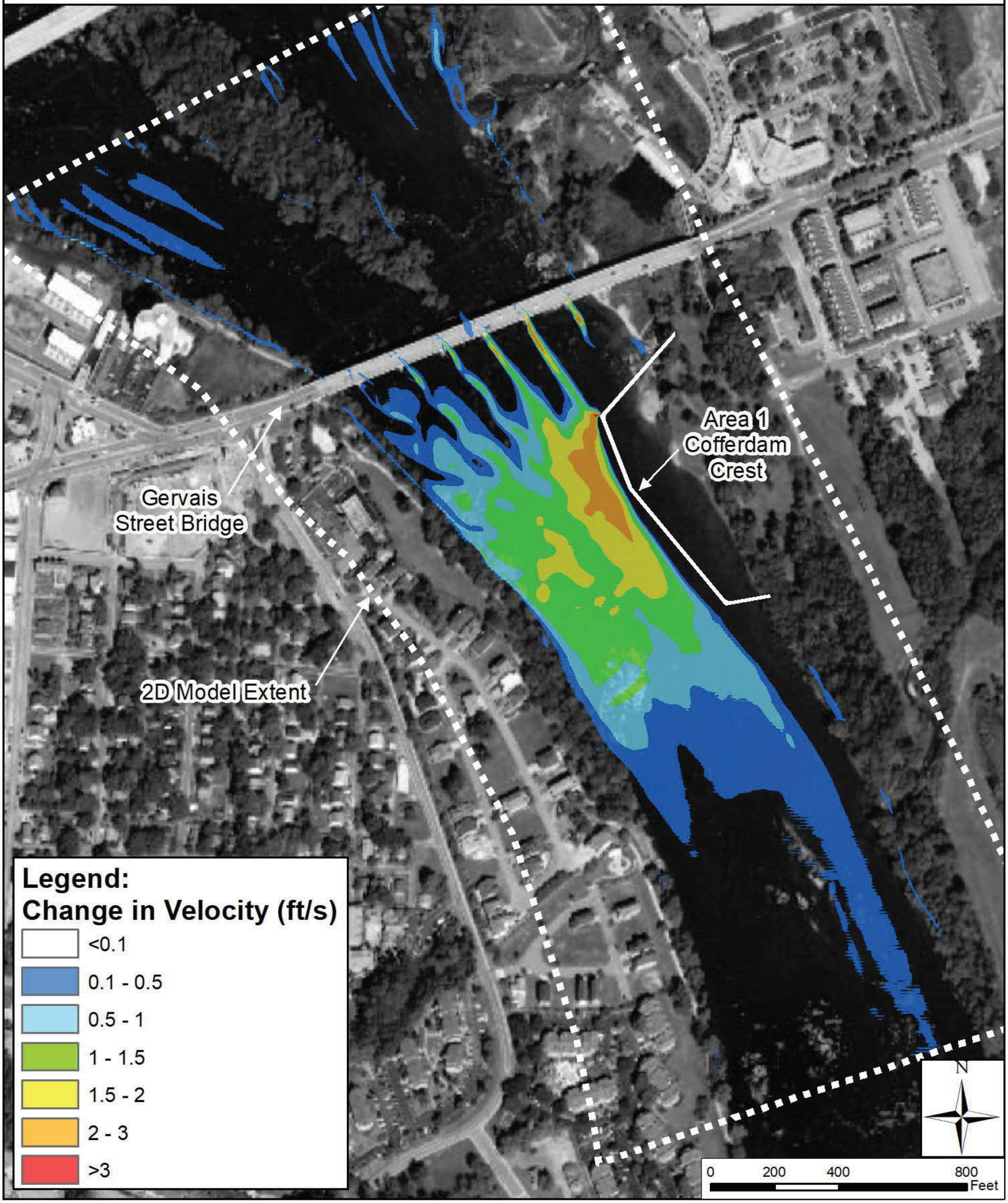
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A4: Crest Flow (26,000 cfs)**
**Proposed Area-1 Scenario: Flow Velocity**



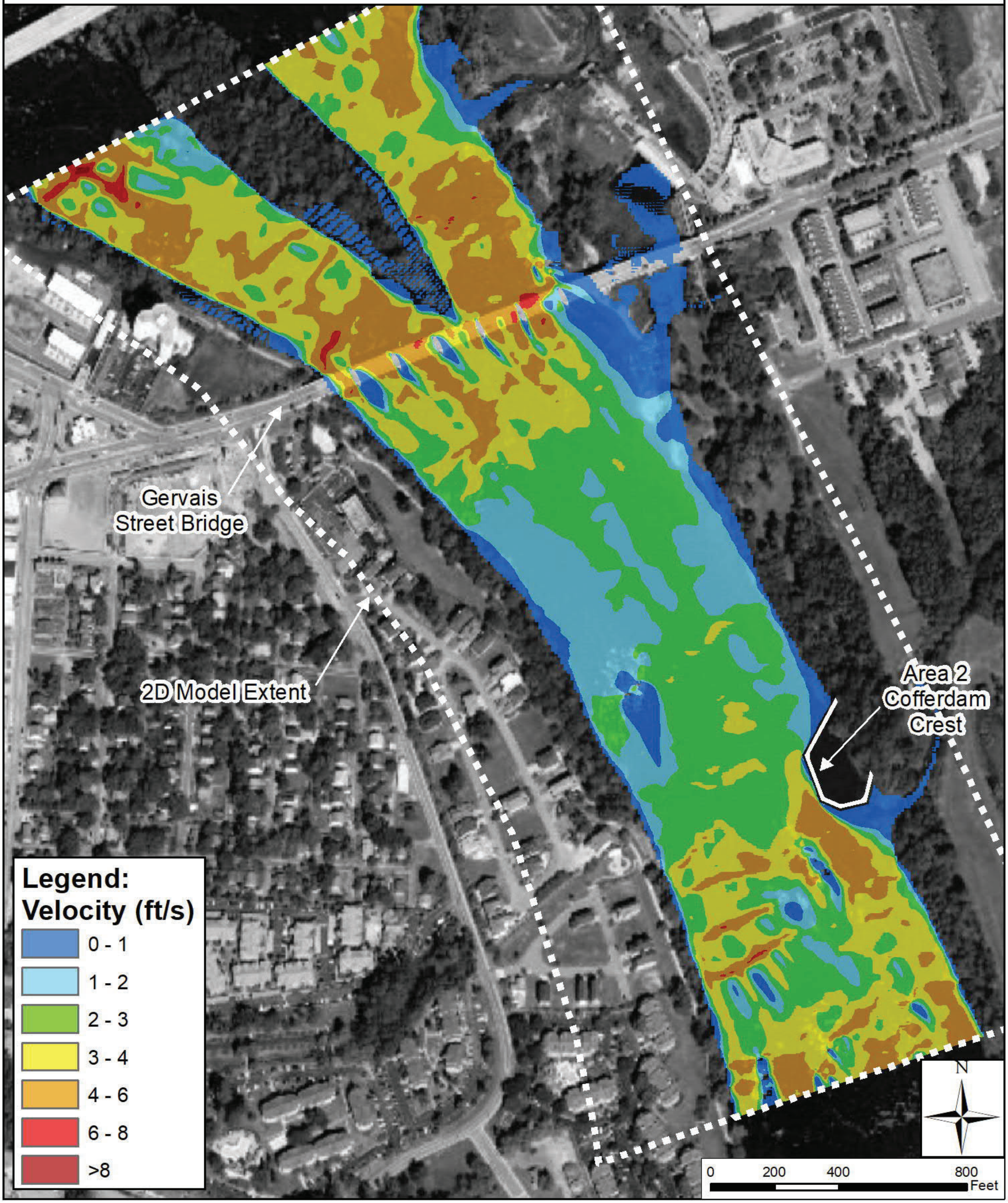
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A5: Normal Flow (8,564 cfs)**
**Proposed Area-1 Scenario: Change in Flow Velocity**



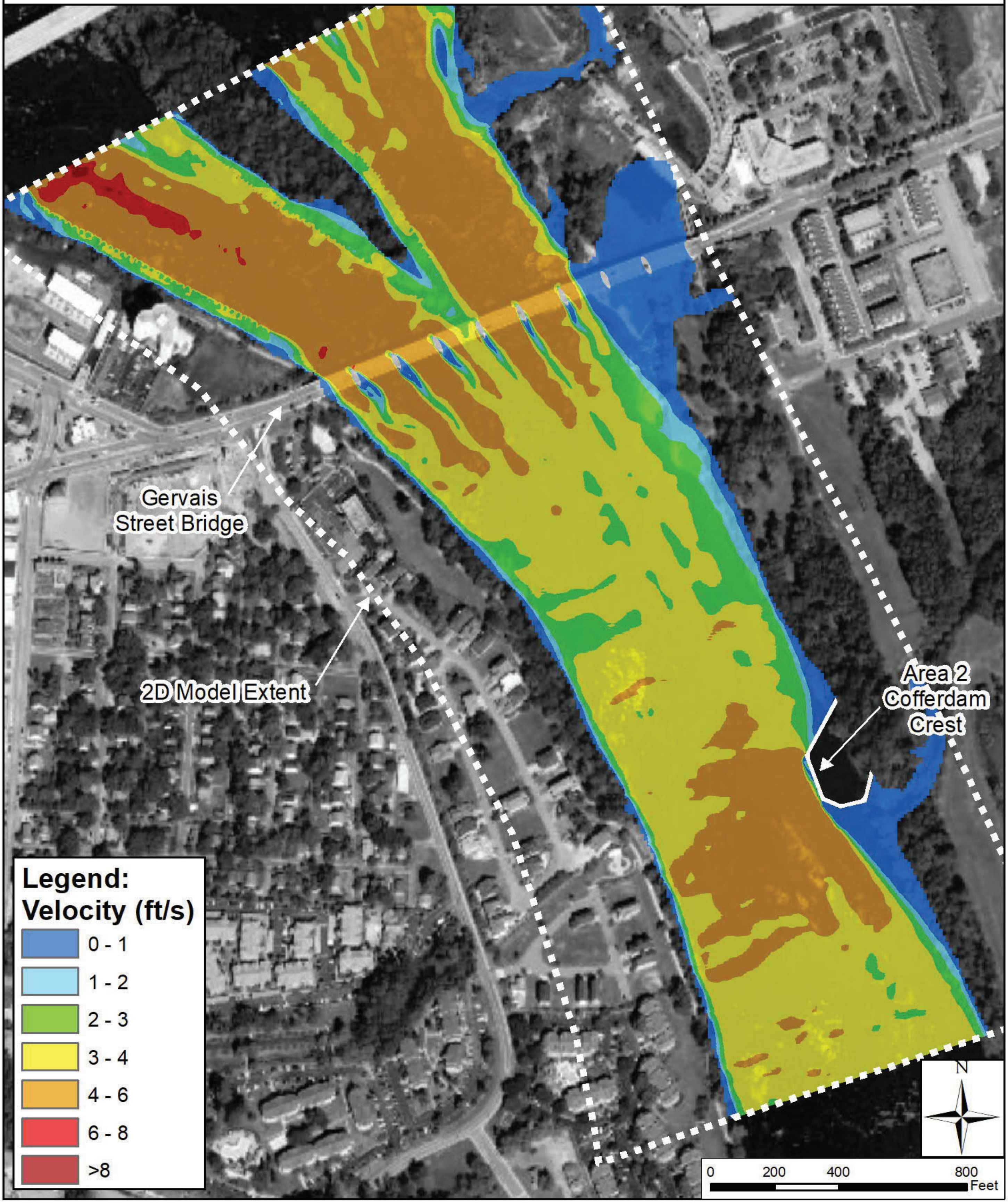
Congaree River Remediation Project
River Bottom Erosion Potential Evaluation
Figure A6: Crest Flow (26,000 cfs)
Proposed Area-1 Scenario: Change in Flow Velocity



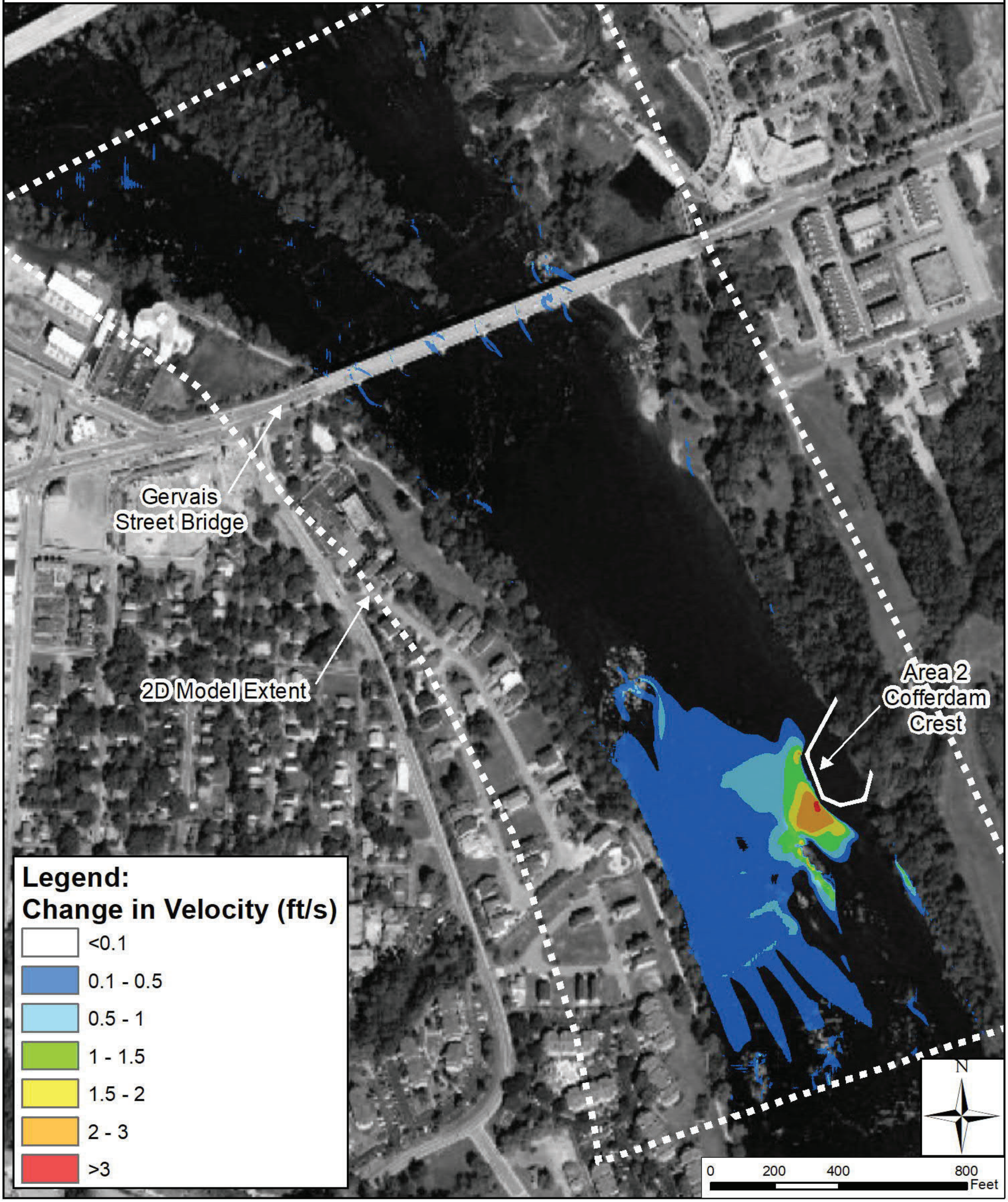
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A7: Normal Flow (8,564 cfs)**
**Proposed Area-2 Scenario: Flow Velocity**



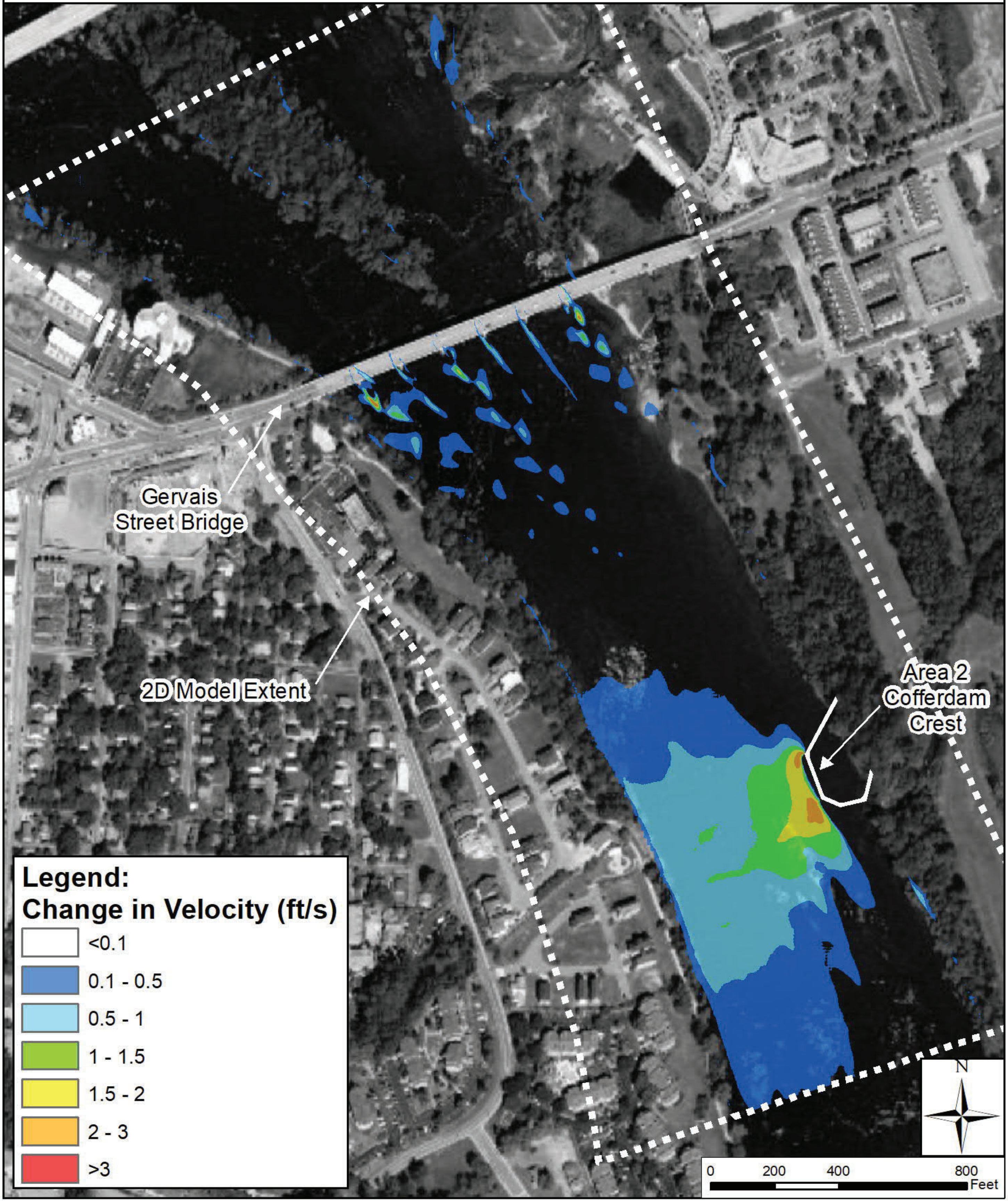
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A8: Crest Flow (26,000 cfs)**
**Proposed Area-2 Scenario: Flow Velocity**



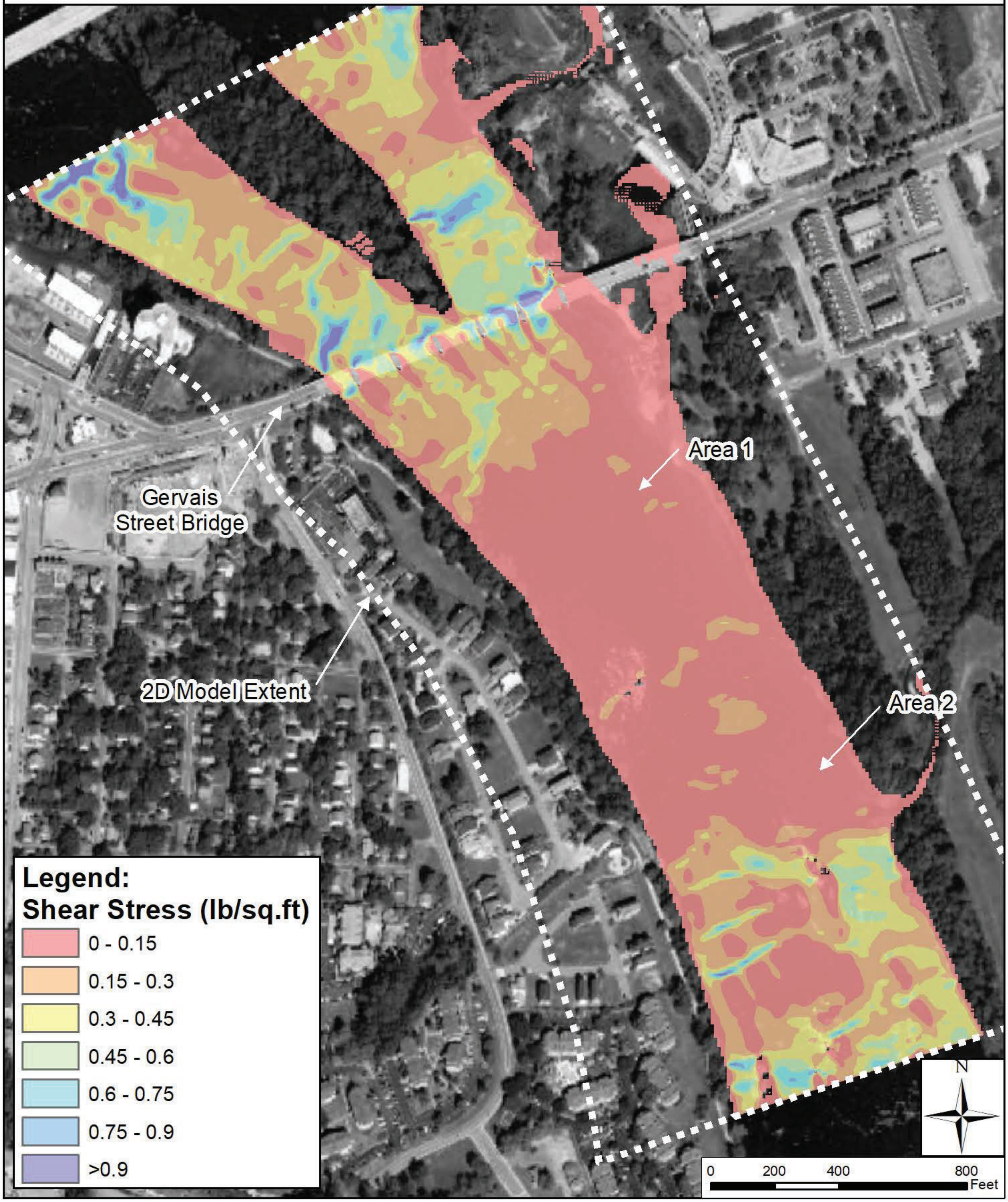
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A9: Normal Flow (8,564 cfs)**
**Proposed Area-2 Scenario: Change in Flow Velocity**



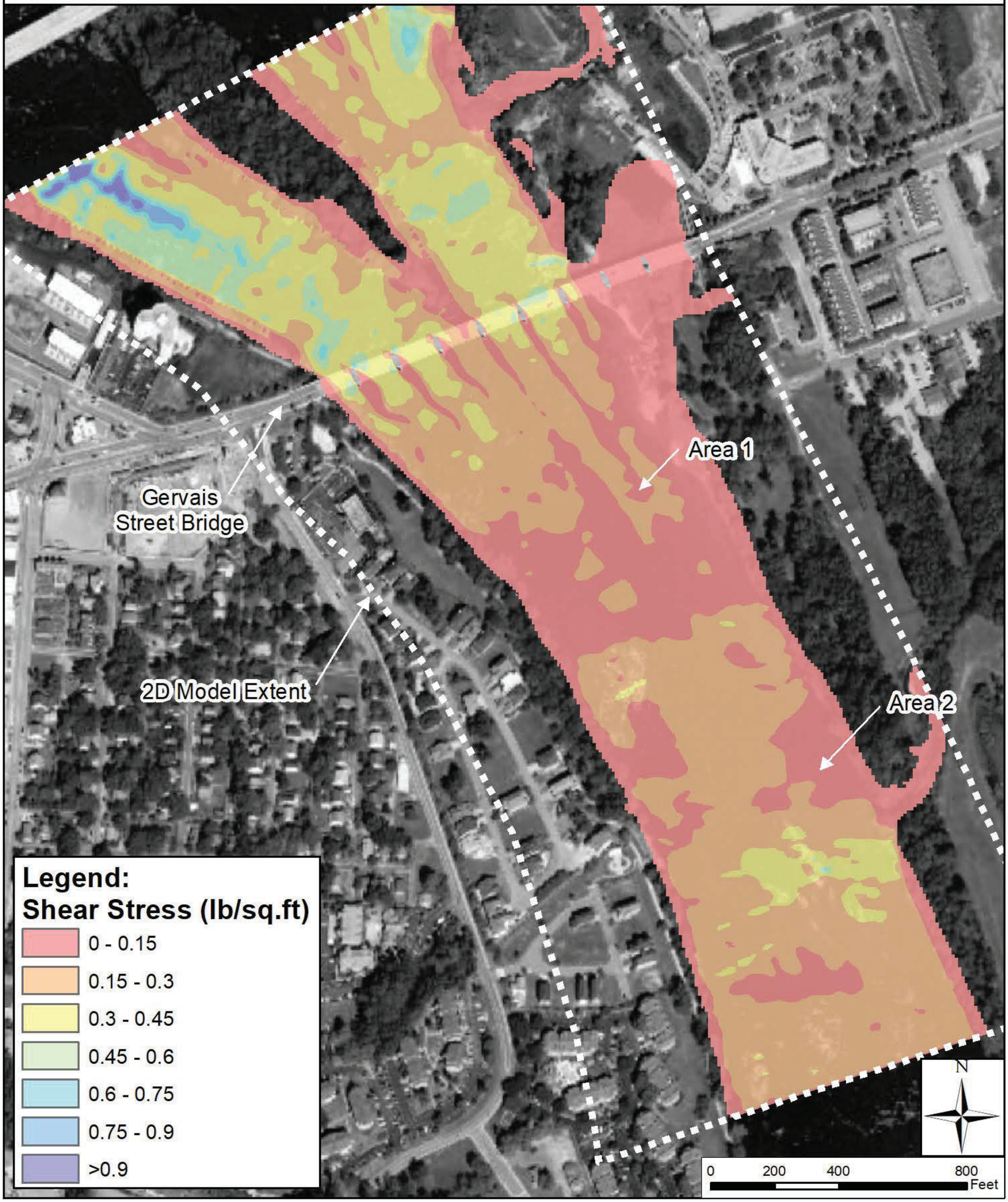
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A10: Crest Flow (26,000 cfs)**
**Proposed Area-2 Scenario: Change in Flow Velocity**



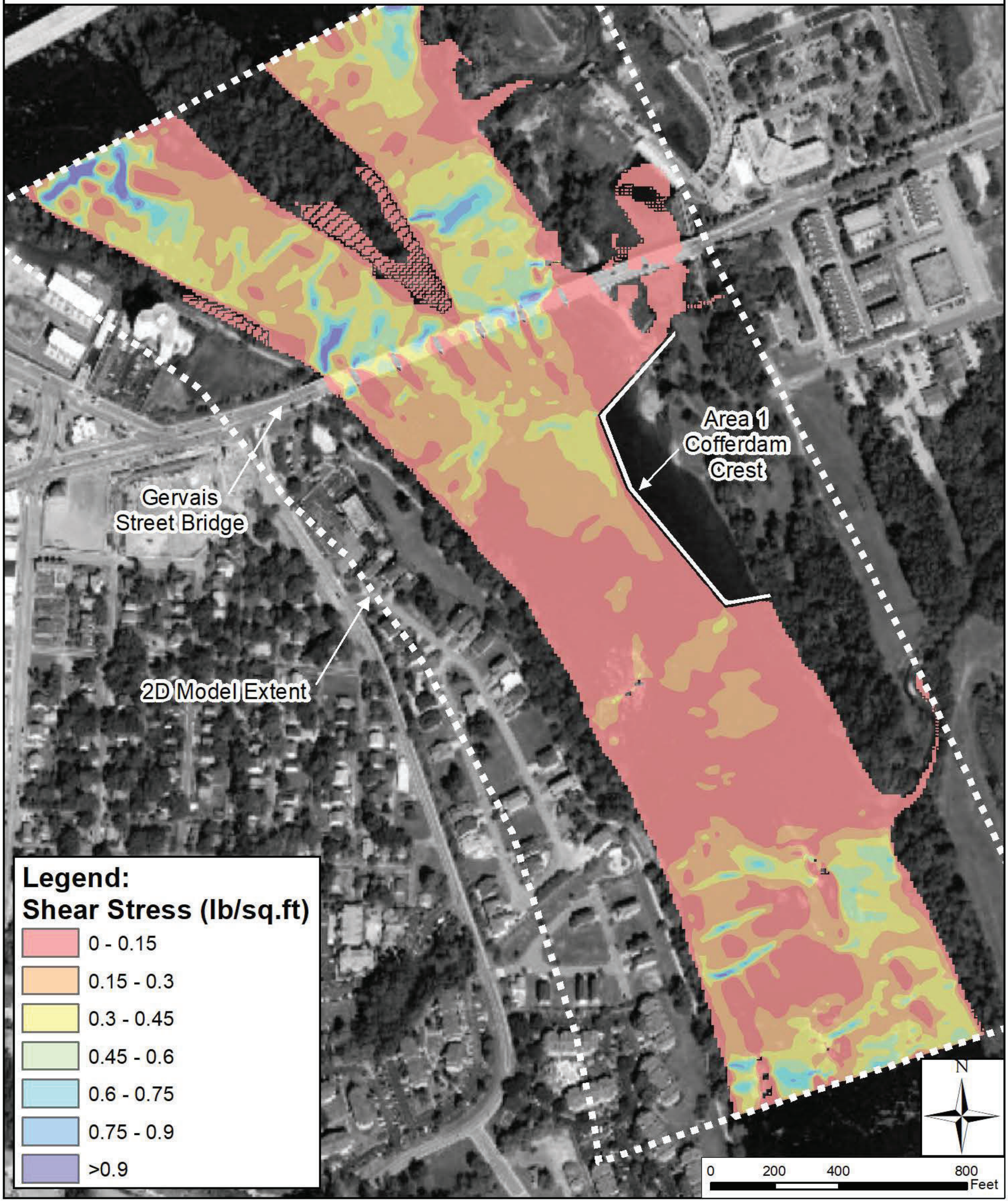
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A11: Normal Flow (8,564 cfs)**
**Existing Scenario: Shear Stress**



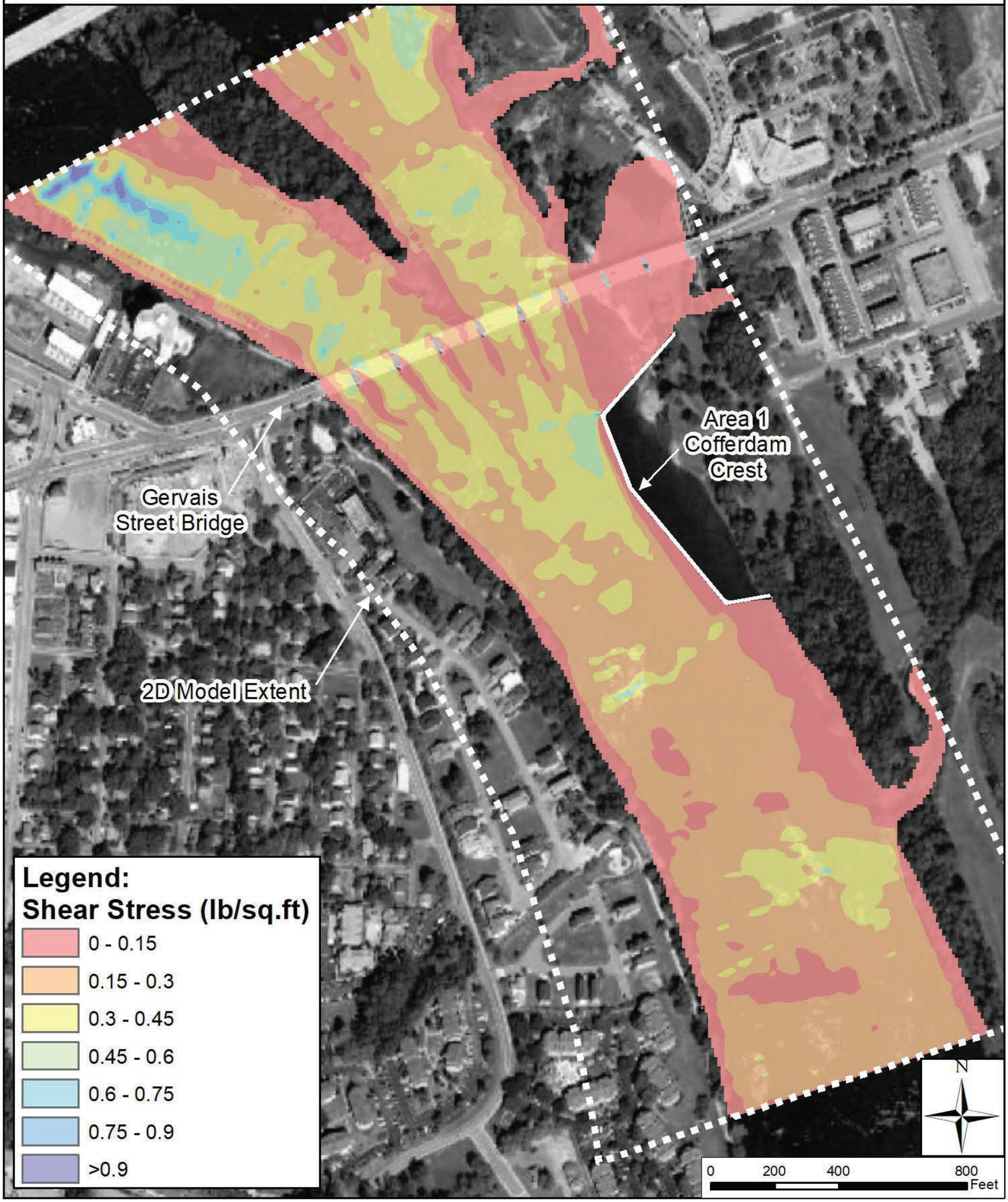
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A12: Crest Flow (26,000 cfs)**
**Existing Scenario: Shear Stress**



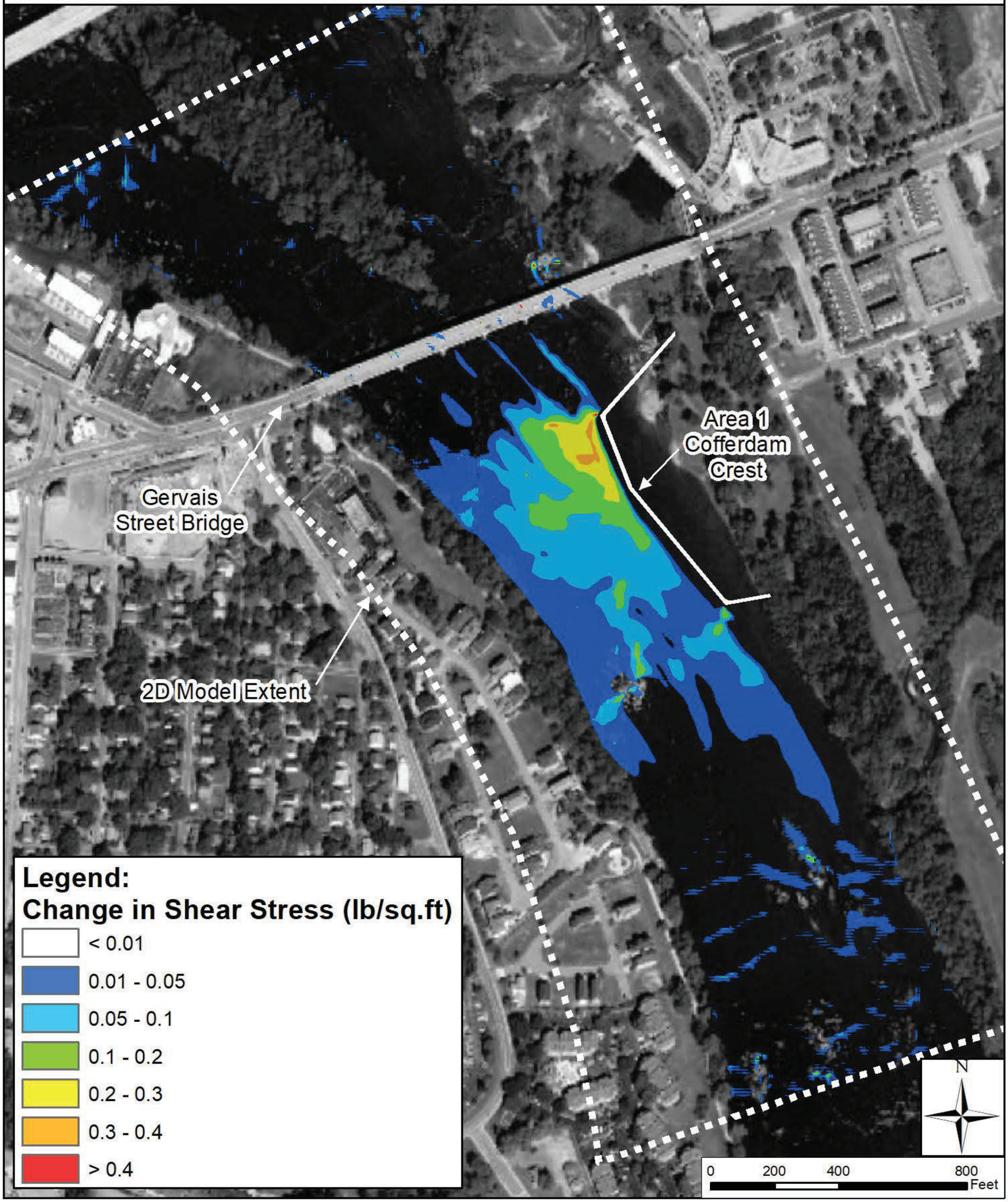
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A13: Normal Flow (8,564 cfs)**
**Proposed Area-1 Scenario: Shear Stress**



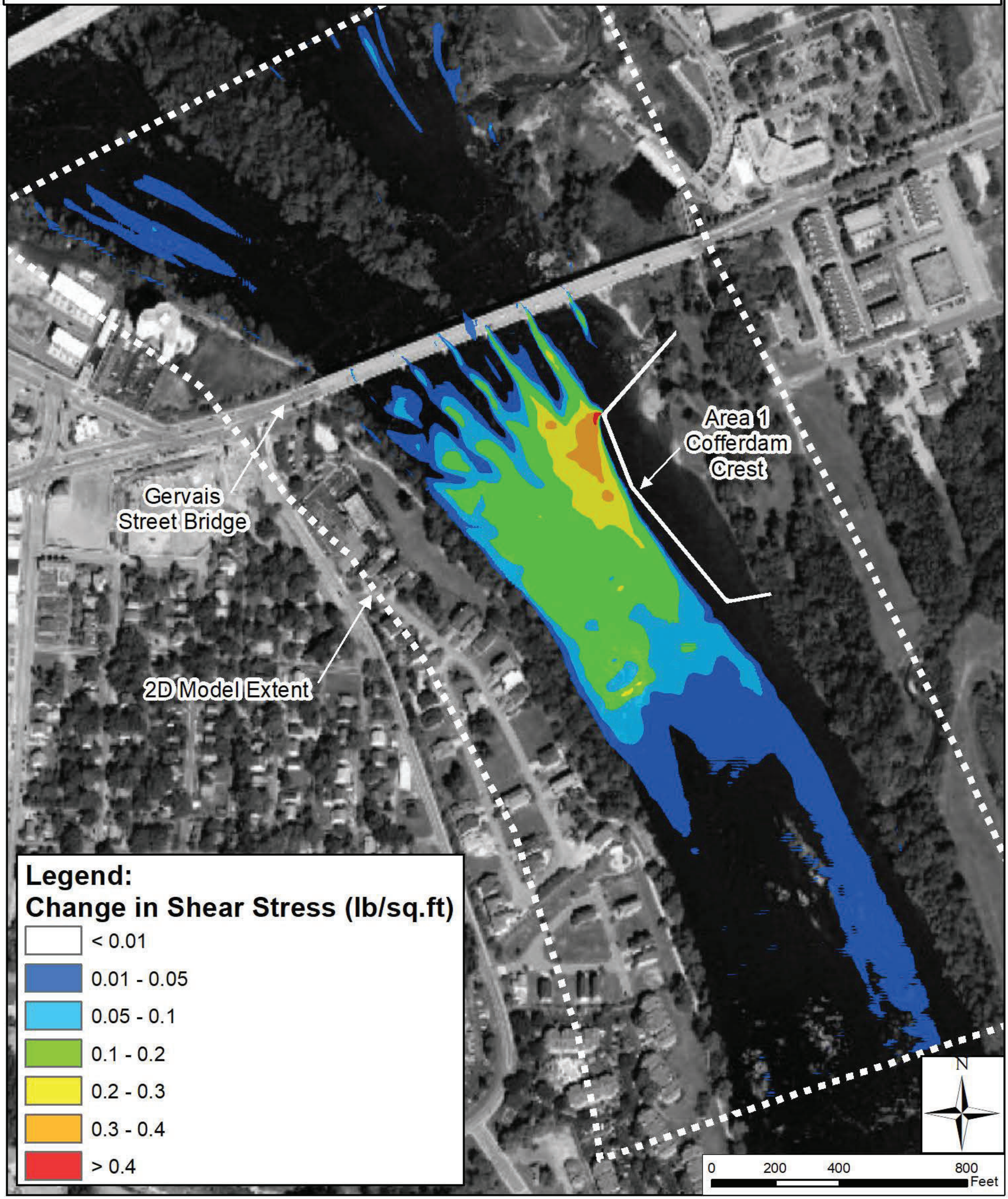
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A14: Crest Flow (26,000 cfs)**
**Proposed Area-1 Scenario: Shear Stress**



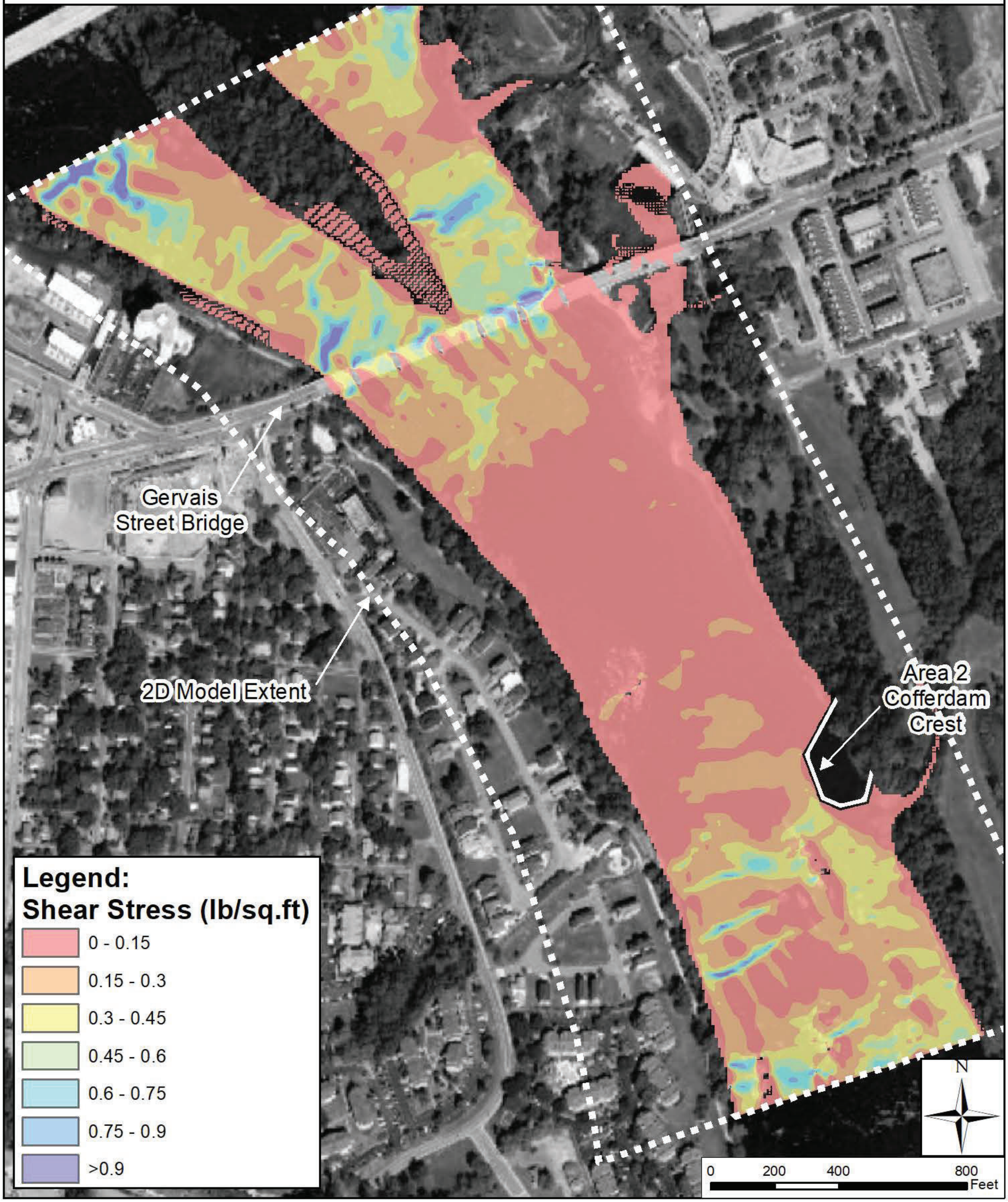
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A15: Normal Flow (8,564 cfs)**
**Proposed Area-1 Scenario: Change in Shear Stress**



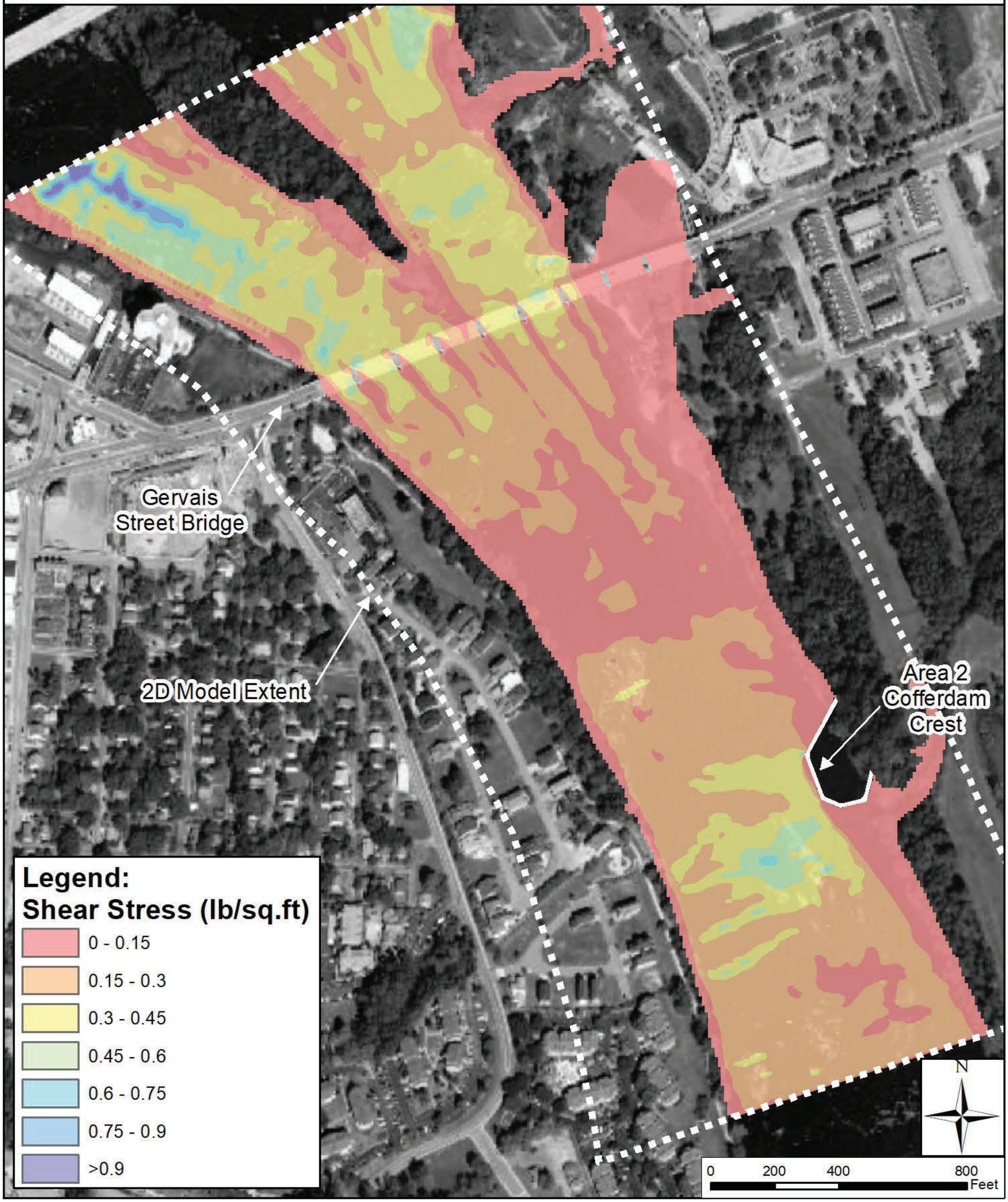
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A16: Crest Flow (26,000 cfs)**
**Proposed Area-1 Scenario: Change in Shear Stress**



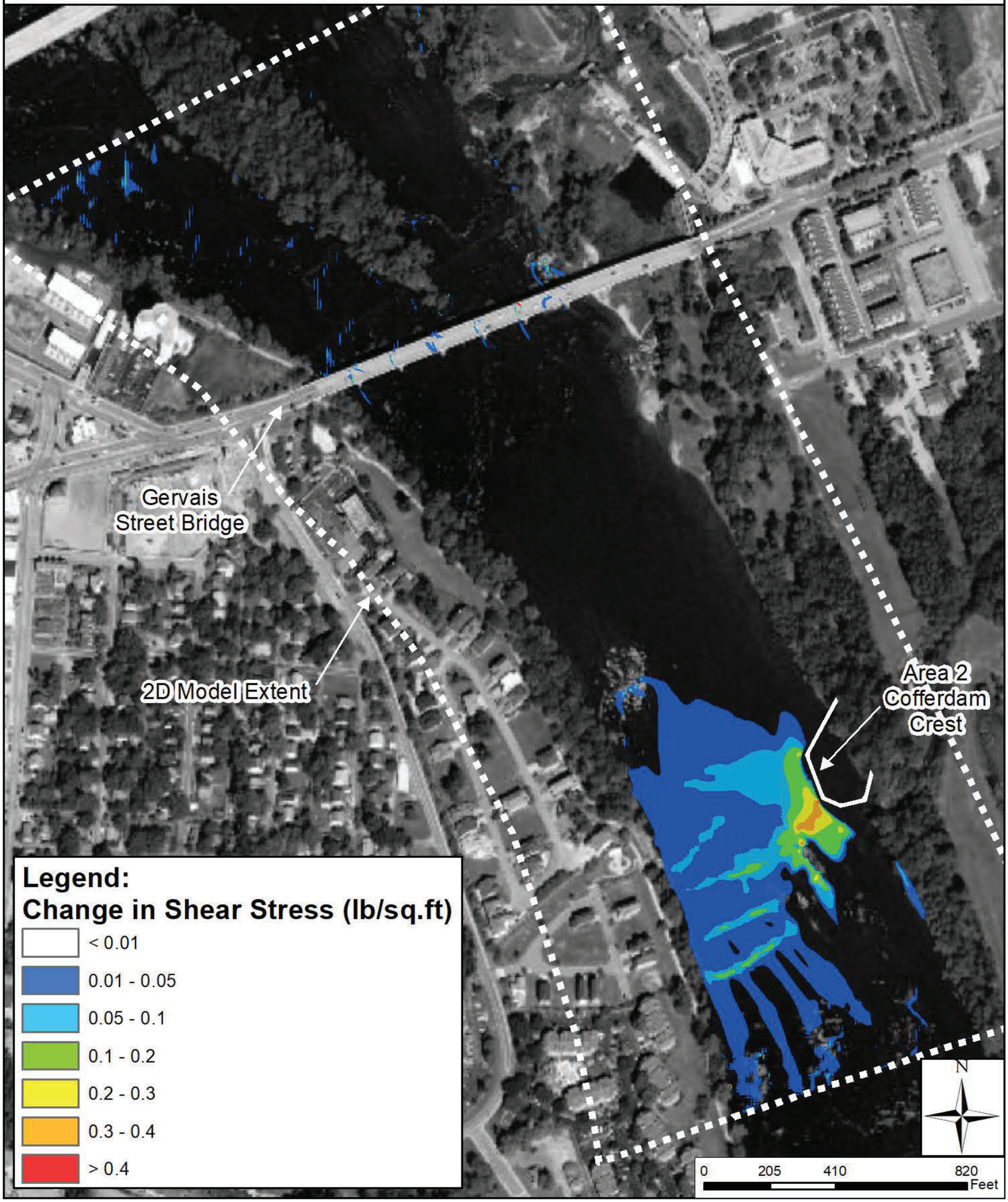
## Congaree River Remediation Project
## River Bottom Erosion Potential Evaluation
## Figure A17: Normal Flow (8,564 cfs)
## Proposed Area-2 Scenario: Shear Stress



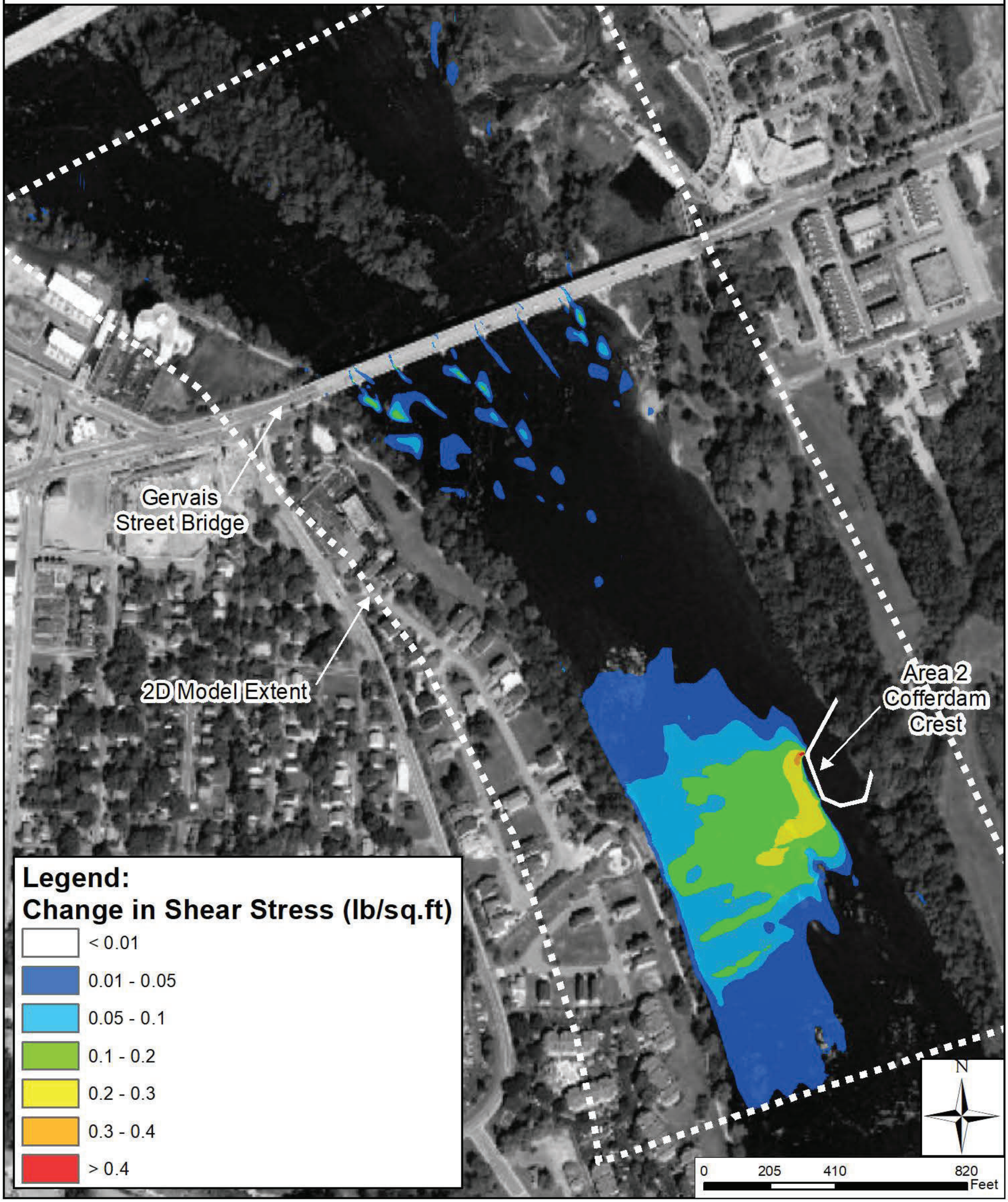
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A18: Crest Flow (26,000 cfs)**
**Proposed Area-2 Scenario: Shear Stress**



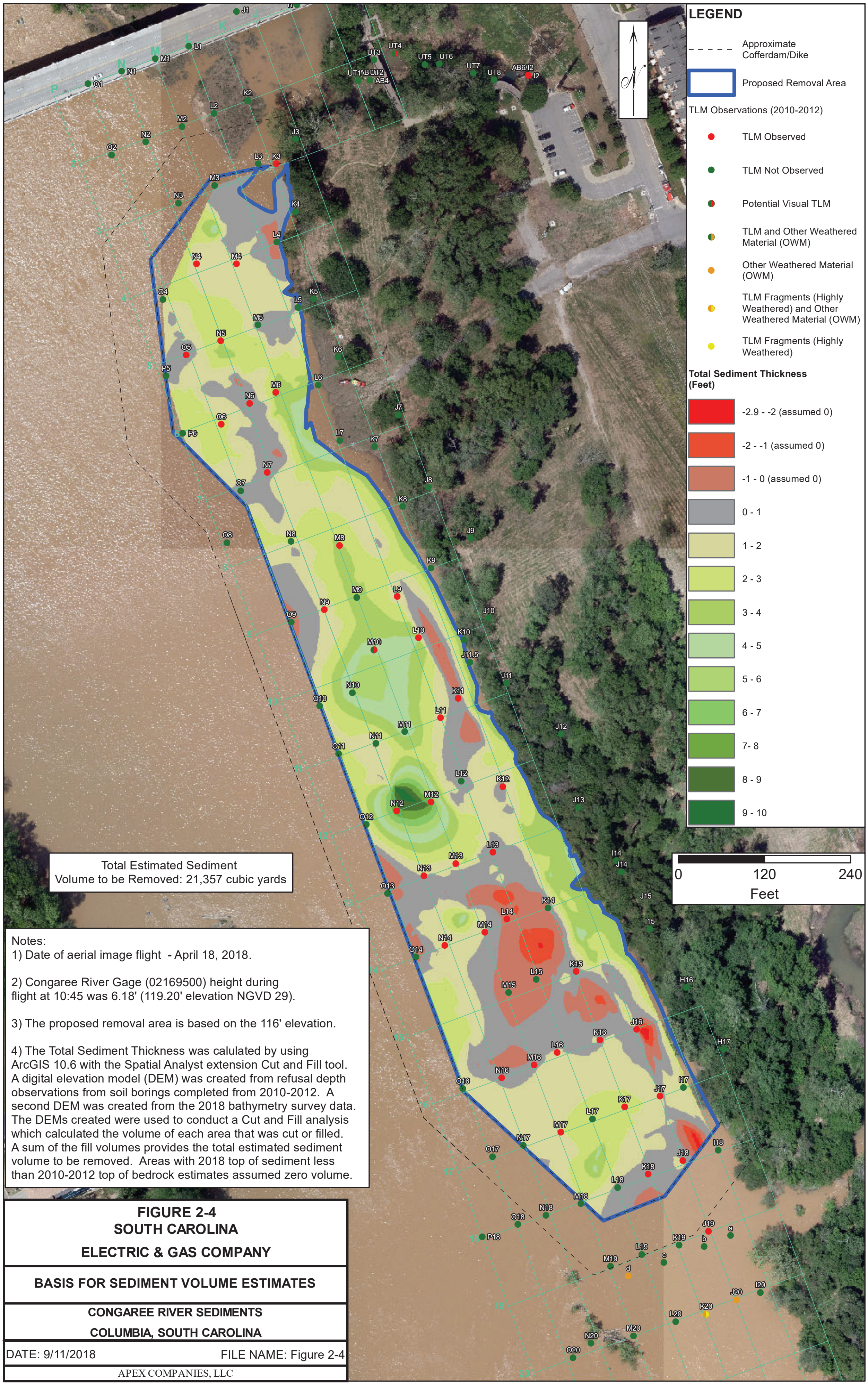
**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A19: Normal Flow (8,564 cfs)**
**Proposed Area-2 Scenario: Change in Shear Stress**



**Congaree River Remediation Project**
**River Bottom Erosion Potential Evaluation**
**Figure A20: Crest Flow (26,000 cfs)**
**Proposed Area-2 Scenario: Change in Shear Stress**



# ATTACHMENT B: RIVER BOTTOM SEDIMENT DEPTHS




Total Estimated Sediment Volume to be Removed: 21,357 cubic yards

Notes:
1) Date of aerial image flight - April 18, 2018.

2) Congaree River Gage (02169500) height during flight at 10:45 was 6.18' (119.20' elevation NGVD 29).

3) The proposed removal area is based on the 116' elevation.

4) The Total Sediment Thickness was calulated by using ArcGIS 10.6 with the Spatial Analyst extension Cut and Fill tool. A digital elevation model (DEM) was created from refusal depth observations from soil borings completed from 2010-2012. A second DEM was created from the 2018 bathymetry survey data. The DEMs created were used to conduct a Cut and Fill analysis which calculated the volume of each area that was cut or filled. A sum of the fill volumes provides the total estimated sediment volume to be removed. Areas with 2018 top of sediment less than 2010-2012 top of bedrock estimates assumed zero volume.

**FIGURE 2-4**
**SOUTH CAROLINA**
**ELECTRIC & GAS COMPANY**

**BASIS FOR SEDIMENT VOLUME ESTIMATES**

**CONGAREE RIVER SEDIMENTS**
**COLUMBIA, SOUTH CAROLINA**

DATE: 9/11/2018 FILE NAME: Figure 2-4

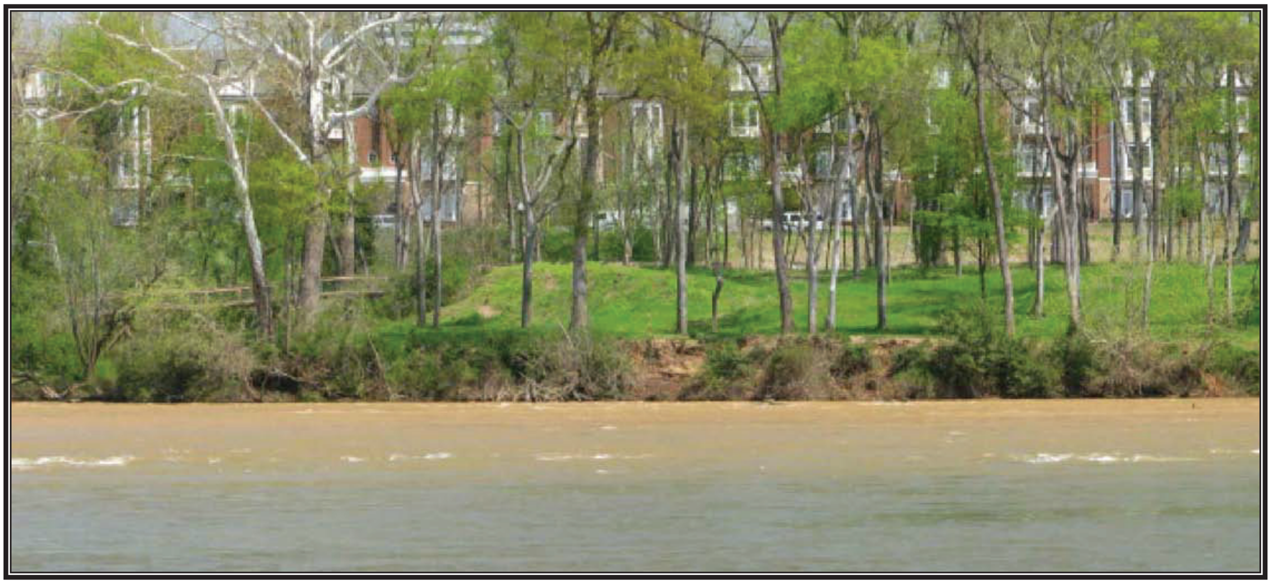
APEX COMPANIES, LLC

## ATTACHMENT P

## RESTORATION OPERATION, MAINTENANCE AND MONITORING PLAN

**RESTORATION OPERATION, MAINTENANCE AND MONITORING PLAN**

**CONGAREE RIVER SITE**
**COLUMBIA, SOUTH CAROLINA**



September 2020

*Prepared for:*

**Dominion Energy South Carolina, Inc.**
400 Otarre Parkway
Cayce, SC 29033

*Prepared by:*

**Apex Companies, LLC**
1600 Commerce Circle
Trafford, PA 15085

## RESTORATION OPERATION, MAINTENANCE AND MONITORING PLAN

## CONGAREE RIVER SITE
## COLUMBIA, SOUTH CAROLINA

### INTRODUCTION

Dominion Energy South Carolina, Inc. (DESC) plans to complete a Stakeholder-Developed Modified Removal Action (MRA) to address the occurrence of a tar-like material (TLM) that is commingled with sediment along the eastern shoreline of the Congaree River, just south of the Gervais Street Bridge in Columbia, South Carolina. The project area location is shown on Figure 1. The TLM is believed to be a coal tar material that originated from the Huger Street former Manufactured Gas Plant (MGP) site, located approximately 1,000 feet to the northeast of the project area. The proposed work is being performed by DESC at the direction of South Carolina Department of Health and Environmental Control (SCDHEC) and is subject to permits and approvals from the U.S. Army Corps of Engineers (USACE) and other agencies.

The overall objective of this project is to remove impacted sediment from the Congaree River. The current plan is to complete an MRA that consists of the removal of impacted sediment from two separate areas as depicted in Figure 2. The removal areas are close to the shoreline and therefore more susceptible to human dermal contact or exposure, and include locations where more concentrated or thicker deposits of TLM are known to exist. A temporary cofferdam will be constructed for each area to facilitate removal of the impacted sediment in phases. After the temporary cofferdam is constructed, the isolated area will be dewatered, and the impacted sediment removed and transported off-site for disposal. Following completion of the impacted sediment removal activities in each phase and removal of the cofferdam, this Restoration Operation, Maintenance and Monitoring Plan will be implemented.

The active, or in-the-river construction season for building or relocating the cofferdam will be from May through October of each year. DESC has also requested permission to work behind the cofferdam year-round, with minimal site activity projected during the months of December through April.

This Plan was developed to provide additional details regarding restoration activities, in particular the planned riverbank and shoreline restoration activities that will be completed. This Plan includes the use of bio-restoration techniques for the riverbank and riparian areas disturbed by MRA activities. Due to unknown factors such as the exact extent and depth of TLM impacts immediately adjacent to the shoreline, and the resulting uncertainty of slope stability while removing the impacted sediment, the actual approach, locations and techniques for shoreline protection are assumed and may need modified during installation. This plan will serve as a guide for the planned restoration techniques and recognizes that actual site conditions will dictate the exact extent, location, and materials of construction for the shoreline restoration.

### REMOVAL ACTION ACTIVITIES

Initial project activities will consist of constructing the landside support zone prior to installing the cofferdam around each MRA area. Figure 2 shows the MRA areas and conceptual site operations layout with landside support zone components. The landside support zone will consist of a series of gravel roads and equipment/material storage areas and temporary structures.

The cofferdams will be constructed to isolate the planned work areas from the remainder of the river and facilitate dewatering and excavation of the impacted sediment. After the cofferdam is in place and the area dewatered, the sediment removal activities will commence. To the extent practical, the existing riverbank will remain undisturbed. However, many areas of the existing shoreline/riverbank will be impacted and require restoration. After sediment removal in each area is completed, the cofferdam components will be completely removed from the river and disturbed portions of the riverbank will be restored. Landside support zone equipment and structures will be demobilized after sediment removal is completed and the landside operations area will be restored to pre-MRA conditions. Specific site restoration activities associated with the river, landside operations, and riverbank and shoreline areas are described below.

## RESTORATION PLANS

### River Restoration

DESC plans on removing all sediment and gravel, small rocks, etc. (both visually impacted with TLM and visually unimpacted material) from the removal areas to the extent practical. Large rocks that are visually unimpacted may be temporarily relocated within the work area to facilitate sediment removal and then returned to their approximate original locations. As an additional measure, DESC plans to pressure wash the exposed bedrock bottom of the river where necessary. Water generated during the pressure washing stage will be collected and removed from the excavation for treatment and discharge to the City of Columbia Public Owned Treatment Works (POTW). The intent is to remove any residual staining or impacts due to the presence of TLM, if practical.

Current plans do not include replacing any removed material with backfill. The impacted sediment will be removed down to the top of the underlying bedrock. In many areas, this will only require removal of several inches of sediment. Following completion of the removal activities, the cofferdam will be removed and over time, the natural depositional processes of the river will restore the river bottom to natural conditions. This process will allow for natural re-deposition of sediment within the removal area based on current river hydraulics. Not replacing the impacted sediment with fill material will also eliminate the potential for backfill materials to be washed downstream and deposited in other areas or degrade other habitats through siltation, etc.

### Landside Restoration

Prior to mobilization, a Notice of Intent will be submitted to the City of Columbia for coverage under South Carolina NPDES General Permit For Stormwater Discharges From Construction Activities SC100000. This submittal will include a Comprehensive Stormwater Pollution Prevention Plan which includes a Stormwater Management and Sediment Control Plan (SMSCP). The SMSCP provides details on erosion and sediment control methods to be established, maintained and inspected at the site during active operations, as well as plans for final restoration following completion of landside activities. The general approach to final restoration of the landside operations areas is to restore the locations to pre-MRA conditions to the extent practical.

**Riverbank and Shoreline Restoration**

Figure 2 provides the site operations plan scenario and highlights the approximate areas where the eastern shoreline of the riverbank will likely be disturbed as a result of MRA activities. It is estimated that approximately 1,300 linear feet of the project area shoreline may be impacted by MRA activities. Shoreline disturbances will be limited to the extent practical. These locations include access roads and cofferdam/riverbank tie-in locations. Available delineation data suggest that TLM is not located within the riverbank soil and as a result, much of the riverbank and riparian corridor may be left undisturbed.

Areas where disturbance may not be necessary will be demarcated with flagging or fencing to ensure they are not impacted by removal operations or heavy equipment movement unless required. Oversight personnel will routinely monitor these areas in order to prevent unnecessary impacts. In areas where shoreline impacts are necessary, and/or the removal of impacted sediment results in slope failure, DESC will conduct restoration activities. Restoration will include recreating the approximate shoreline slope, stabilization of the bank via riprap and/or bioengineered solutions, and restoration of vegetative cover where practical. DESC's goals are to minimize riverbank disturbance where possible, to restore disturbed areas to natural pre-MRA conditions, and to utilize bioengineering techniques and structures to the extent practical when repairing impacted shoreline. Figure 2 provides the currently envisioned shoreline restoration scenario. Figures 3 through 6 show details of riverbank restoration/stabilization alternatives and examples of potential techniques that will be utilized. The restoration approach consists of four major components:

1. Minimization of impacts and protection of areas where disturbance is not required (Figure 2);
2. Use of "hardscaping" or riprap type stabilization measures in high velocity/high turbulence areas to safeguard against future bank erosion (primarily limited to northern portion of Area 1) [refer to details on Figure 3];
3. Use of riprap to stabilize the transition area between the excavated area and the undisturbed shoreline at and below normal water level (refer to Detail 4-1 on Figure 4); and
4. Use of bioengineered solutions in areas less susceptible to future erosion (refer to details on Figures 4 through 6).

As stated above, portions of the riparian corridor where disturbance may not be necessary will be demarcated to ensure that they are not impacted unless required. This preservation technique will be a key component of the overall project. In high water velocity or turbulent areas, stabilization of the shoreline will take priority over re-establishing vegetative cover. As a result, in some areas it will be necessary to utilize restoration techniques and material that is more resistant to erosion (i.e., hardscape) in order to ensure that the bank is capable of withstanding high velocity and turbulent flows. Typical techniques utilized in these areas include placement of geotextile and riprap, which will serve to fortify the bank and resist future erosion over time (Figure 3). As currently envisioned, these stabilization practices will likely be necessary in the northern portion of Area 1.

Removal operations will necessitate creation of a small cut at the toe of the existing riverbank slope where excavation of material is discontinued. Geotextile and riprap will be placed in this transition zone in order to support and protect the riverbank from sloughing or collapsing. The specific detail for this technique is provided as Detail 4-1 on Figure 4. The riprap placement will be minimized to the extent practical and should not significantly extend above the normal waterline in most areas. Over time, sediment will likely accumulate in the voids within the riprap placement area and serve to re-establish the current shoreline aesthetic characteristics.

In areas where river flow characteristics are more conducive, bioengineered solutions, such as those shown on Figures 4 through 6, will be employed. These alternatives primarily focus on incorporating vegetative restoration with stabilization. Shoreline cover recreation such as staging partially submerged trees (Figure 5) or other habitat enhancements will also be conducted, as feasible. In some areas, it may be appropriate to plant native southeastern shrubs, grasses and forbs (Figure 6) secured by a biodegradable mat. As currently envisioned, the disturbed shoreline downstream of the Senate Street alluvial fan can be restored using these techniques (Figure 2).

Following completion of the MRA sediment removal and restoration activities, the riverbank and shoreline area will be monitored to assure restoration was successful. Periodic inspections will occur on a monthly basis or following significant weather-related events for a period of one year, unless property owner redevelopment plans result in an earlier change to restored conditions. Should issues be identified during inspections that warrant mitigation, DESC will implement repairs to the affected area(s), as necessary, to assure sufficient stabilization.

As project plans are further developed, certain details or specifications regarding restoration may be modified in order to reflect minor changes or input from applicable experts and/or the property owner. The USACE, SCDHEC and other agencies, as may be appropriate, will be made aware of any major modifications to planned activities prior to implementation.

## Attachment A

## Table and Figures

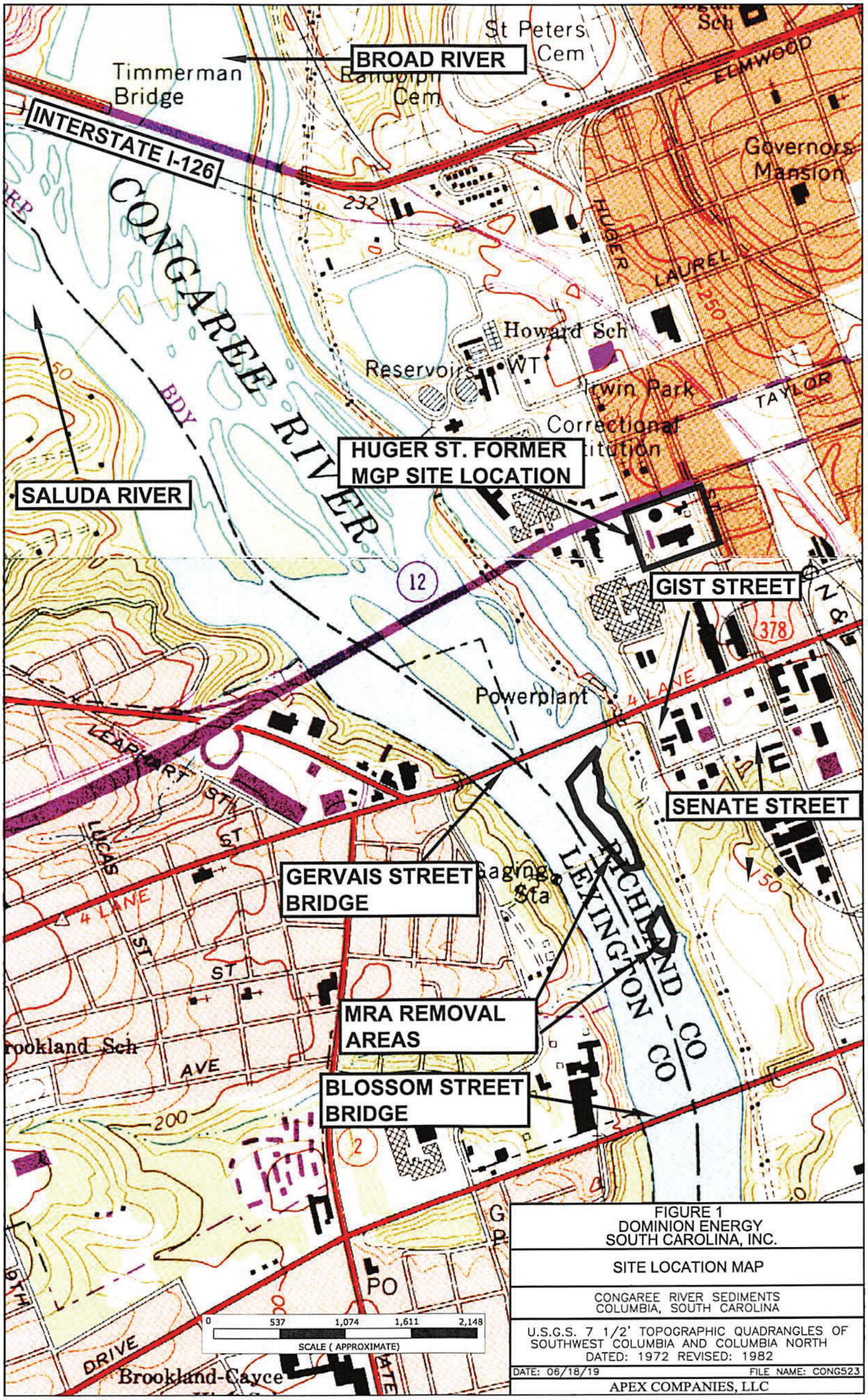



FIGURE 1
DOMINION ENERGY
SOUTH CAROLINA, INC.

SITE LOCATION MAP

CONGAREE RIVER SEDIMENTS
COLUMBIA, SOUTH CAROLINA

U.S.G.S. 7 1/2' TOPOGRAPHIC QUADRANGLES OF
SOUTHWEST COLUMBIA AND COLUMBIA NORTH
DATED: 1972 REVISED: 1982

DATE: 06/18/19 FILE NAME: CONG523

APEX COMPANIES, LLC

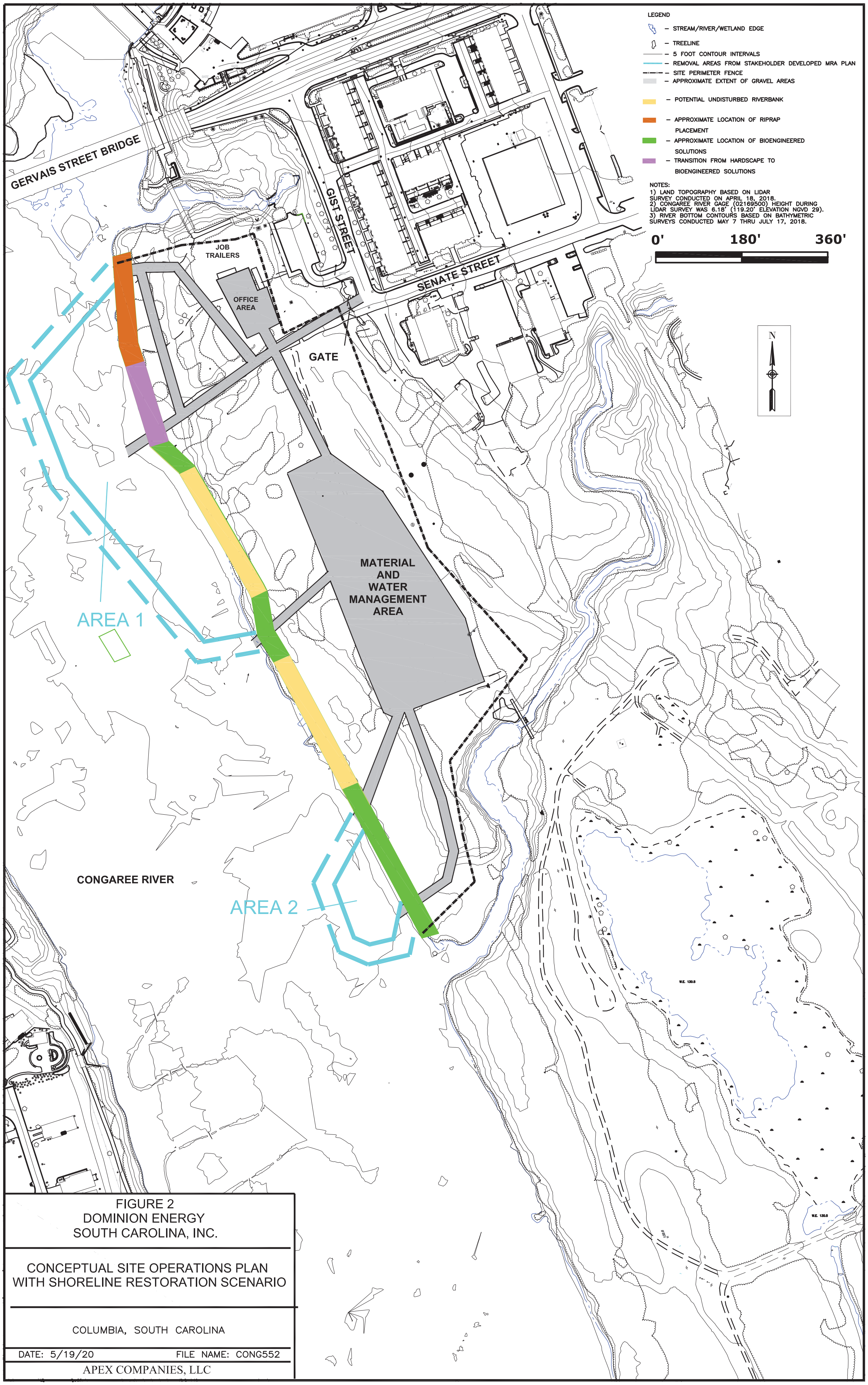


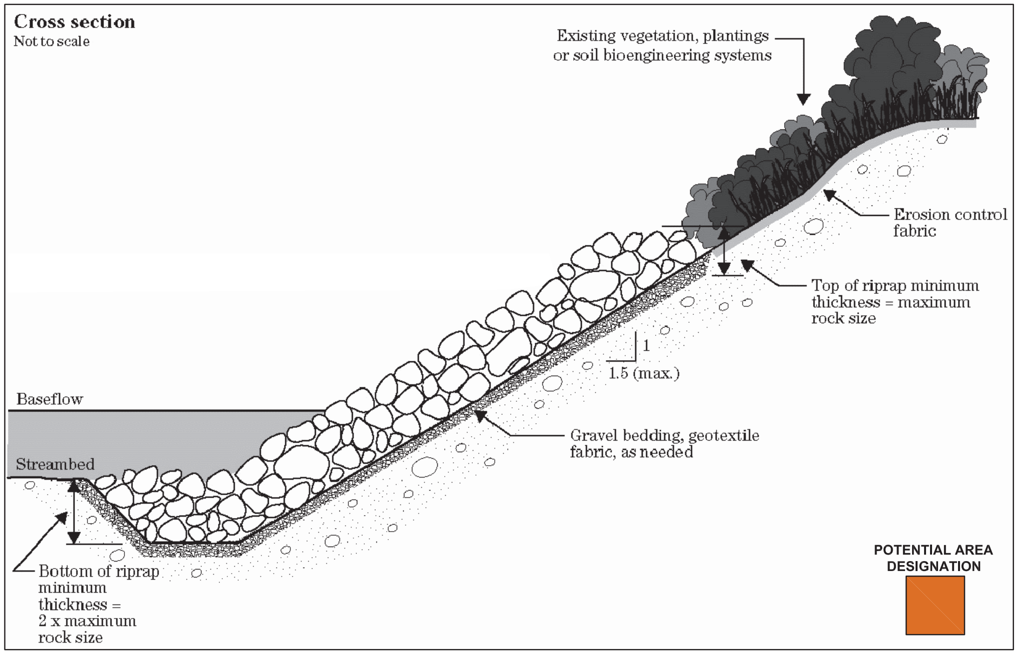

FIGURE 2
DOMINION ENERGY
SOUTH CAROLINA, INC.

CONCEPTUAL SITE OPERATIONS PLAN
WITH SHORELINE RESTORATION SCENARIO

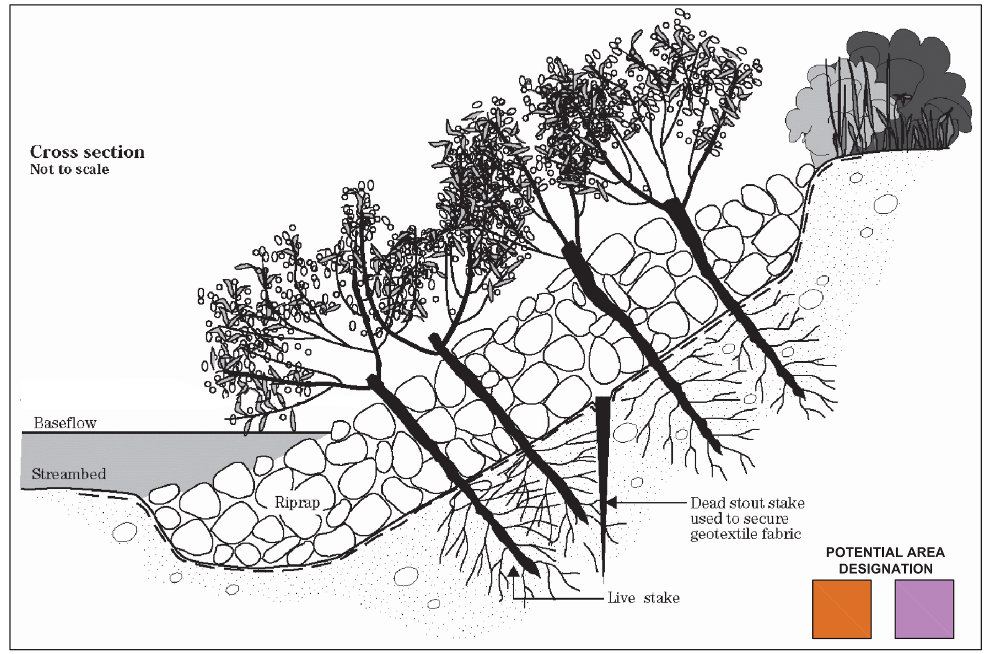
COLUMBIA, SOUTH CAROLINA

DATE: 5/19/20 FILE NAME: CONG552

APEX COMPANIES, LLC




3-1 TYPICAL RIPRAP RIVER BANK STABILIZATION
(OR OTHER HARDSCAPE MATERIAL)




3-2 TYPICAL RIPRAP RIVER BANK STABILIZATION WITH JOINT PLANTING
(OR OTHER HARDSCAPE MATERIAL)

NOTES:
1. RIPRAP BANK STABILIZATION WILL BE UTILIZED IN AREAS WITH HIGH VELOCITY AND OR TURBULENT RIVER FLOWS TO GUARD AGAINST FUTURE RIVERBANK EROSION.
2. JOINT PLANTING (DETAIL 3-2) WILL BE CONDUCTED, IF FEASIBLE, TO PROVIDE VEGETATIVE COVER IN RIPRAP AREAS AND TO PROVIDE A TRANSITION TO OTHER BIOENGINEERED AREAS.
3. DETAILS OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE ENGINEERING FIELD HANDBOOK (ISSUED 1996) - PART 650 - CHAPTER 16 STREAMBANK AND SHORELINE PROTECTION.
4. INSTALLATION OF SHORELINE RESTORATION COMPONENTS WILL BE CONDUCTED IN ACCORDANCE WITH ESTABLISHED STANDARDS AS OUTLINE IN THE ABOVE REFERENCE ENGINEERING FIELD HANDBOOK.
5. TABLES 1, 2 AND 3 ON FIGURE 6 PROVIDE PLANT SPECIFICATIONS.

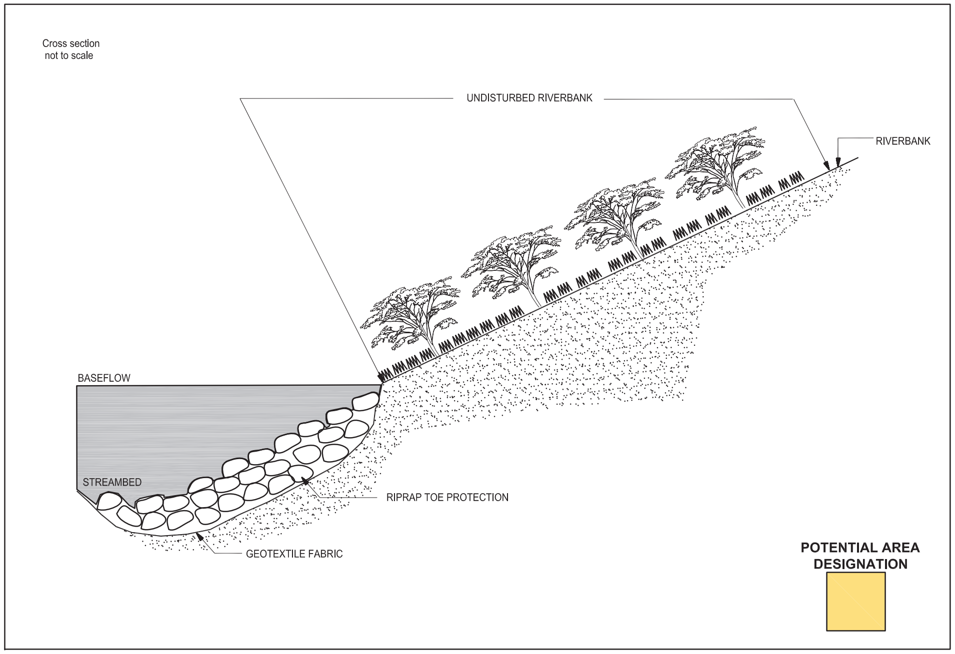
FIGURE 3
DOMINION ENERGY
SOUTH CAROLINA, INC.

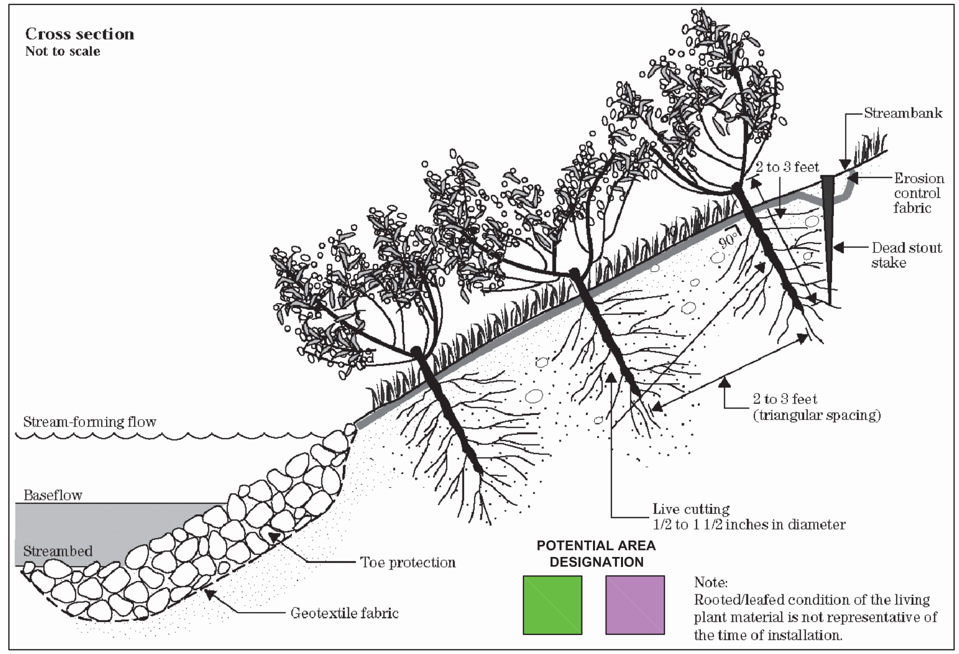
RIVERBANK STABILIZATION
DETAILS

CONGAREE RIVER SEDIMENTS
COLUMBIA, SOUTH CAROLINA

DATE: 5/4/20
FILE NAME: CONG547

APEX COMPANIES, LLC




4-1 UNDISTURBED RIVER BANK TOE STABILIZATION

4-2 JOINT PLANTING BIOENGINEERED BANK STABILIZATION OPTION DETAIL

NOTES:

1. GEOTEXTILE AND RIPRAP (DETAIL 4-1) WILL BE UTILIZED TO STABILIZE EXCAVATED AREAS AT THE TOE OF RIVERBANK SLOPES TO PREVENT SLOUGHING OR COLLAPSING. RIPRAP PLACEMENT WILL TERMINATE AT OR BELOW THE APPROXIMATE NORMAL WATERLINE.
2. LIVE STAKES (DETAIL 4-2) WILL POTENTIALLY BE UTILIZED IN CONJUNCTION WITH OTHER BIOENGINEERED SOLUTIONS, AS NEEDED, IN AREAS WHERE RIVERBANK DISTURBANCE EXTENDS SIGNIFICANTLY ABOVE THE NORMAL WATERLINE AND RIVER FLOW VELOCITY AND TURBULENCE CONDITIONS DO NOT REQUIRE ADDITIONAL STABILIZATION MEASURES.
3. DETAILS OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE ENGINEERING FIELD HANDBOOK (ISSUED 1996) - PART 650 - CHAPTER 16 STREAMBANK AND SHORELINE PROTECTION.
4. INSTALLATION OF SHORELINE RESTORATION COMPONENTS WILL BE CONDUCTED IN ACCORDANCE WITH ESTABLISHED STANDARDS AS OUTLINE IN THE ABOVE REFERENCE ENGINEERING FIELD HANDBOOK.
5. TABLES 1, 2 AND 3 ON FIGURE 5 PROVIDE PLANT SPECIFICATIONS.

FIGURE 4

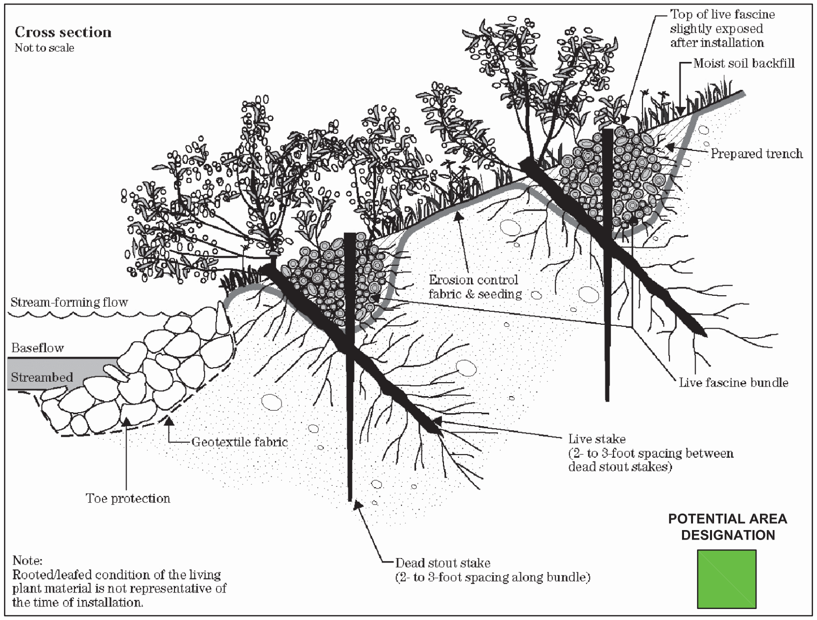
DOMINION ENERGY
SOUTH CAROLINA, INC.

RIVERBANK TOE STABILIZATION
AND BIOENGINEERING OPTION DETAILS

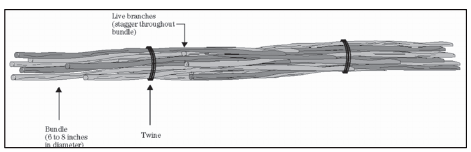
CONGAREE RIVER SEDIMENTS
COLUMBIA, SOUTH CAROLINA

DATE: 5/4/20 FILE NAME: CONG547

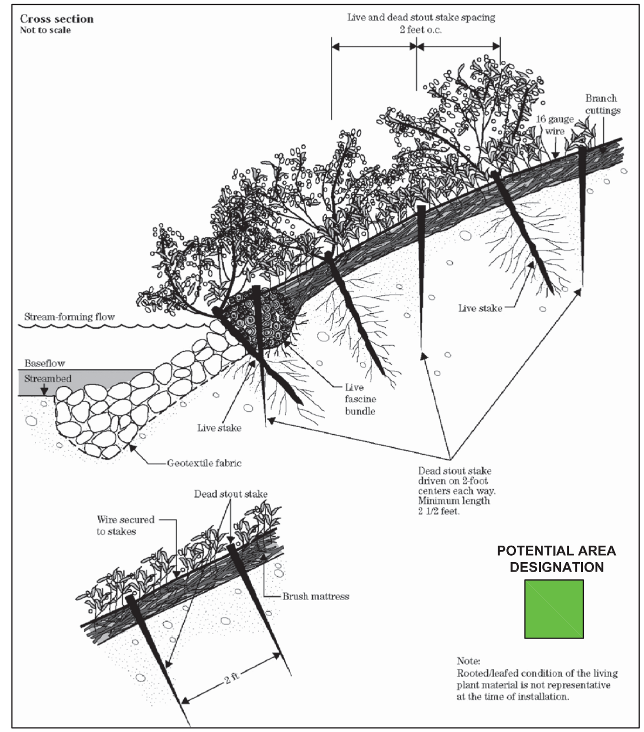
APEX COMPANIES, LLC




5-1 LIVE FASCINE STABILIZATION OPTION




5-2 LIVE FASCINE DETAIL




5-3 BRUSHMATTRESS BANK STABILIZATION OPTION DETAIL

NOTES:

1. LIVE FASCINES (DETAIL 5-1) ARE AN OPTION FOR FLATTER SLOPE (3:1 OR FLATTER) STABILIZATION IN AREAS WHERE RIVER VELOCITY AND TURBULENCE CONDITIONS DO NOT REQUIRE ADDITIONAL STABILIZATION MEASURES.
2. LIVE FASCINES (DETAIL 5-2) ARE LONG BUNDLES OF BRANCH CUTTINGS THAT CONTAIN SOME LIVE BRANCHES.
3. BRUSHMATTRESS PROVIDE A COMBINATION OF LIVE STAKES, LIVE FASCINES AND BRANCH CUTTINGS AND PROVIDE MORE PROTECTION FROM EROSION OF STEEPER SLOPES OR AREAS OF HIGHER VELOCITY RIVER FLOW.
4. DETAILS OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE ENGINEERING FIELD HANDBOOK (ISSUED 1996) - PART 650 - CHAPTER 16 STREAMBANK AND SHORELINE PROTECTION.
5. INSTALLATION OF SHORELINE RESTORATION COMPONENTS WILL BE CONDUCTED IN ACCORDANCE WITH ESTABLISHED STANDARDS AS OUTLINE IN THE ABOVE REFERENCE ENGINEERING FIELD HANDBOOK.
6. TABLES 1, 2 AND 3 ON FIGURE 6 PROVIDE PLANT SPECIFICATIONS.

FIGURE 5

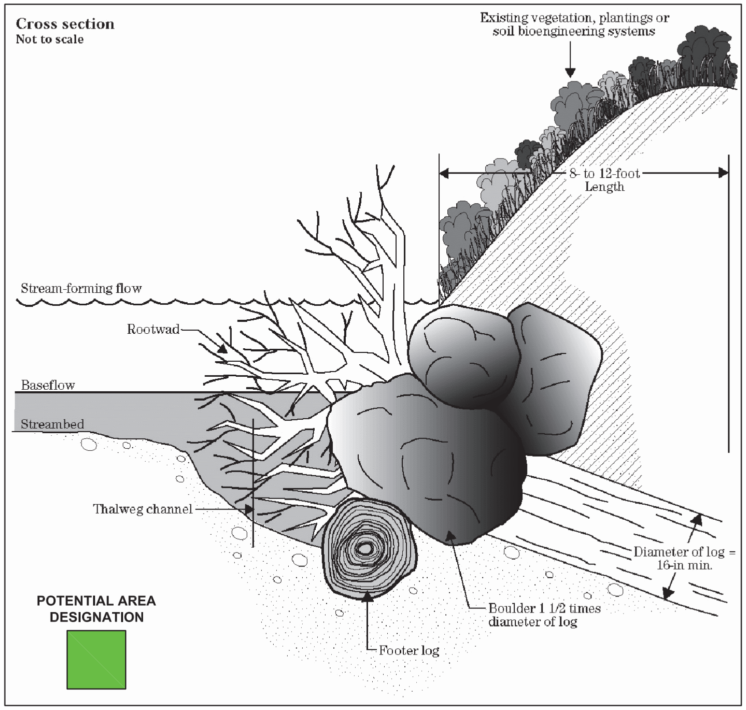
DOMINION ENERGY
SOUTH CAROLINA, INC.

BIOENGINEERED STABILIZATION
OPTION DETAILS

CONGAREE RIVER SEDIMENTS
COLUMBIA, SOUTH CAROLINA

DATE: 5/4/20 FILE NAME: CONG547

APEX COMPANIES, LLC




6-1 LOG, ROOTWAD AND BOULDER REVETMENT
STABILIZATION OPTION DETAIL

**TABLE 1**
**GRASSES AND FORBES**

| Schientific Name | Common Name | Soil Preference | Drought Tolerance | Shade Tolerance | Flood Tolerance |
|---|---|---|---|---|---|
| *Ammophila breviligulata* | American beachgrass | sands | fair | poor | |
| *Andropogon gerardii* | Big bluestem | loams | good | poor | fair |
| *Arundo donax* | Giant reed | sandy | good | poor | poor |
| *Herarthria altissima* | Limpograss | sandy | poor | poor | good |
| *Panicum amarulum* | Coastal panicgrass | sands to loams | good | poor | good |
| *Panicum virgatum* | Switchgrass | loams to sands | good | poor | good |
| *Paspalum vaginatum* | Seashore paspalum | sandy | | poor | good |
| *Pennisetum purpureum* | Elephant grass | | | poor | |
| *Spartina pectinata* | Prairie cordgrass | sands to loams | good | fair | fair |
| *Zizaniopsis miliacea* | Giant cutgrass | loam | poor | poor | good |

**TABLE 2**
**PLANTS SUITABLE FOR ROOTING**

| Scientific Name | Common Name | Plant Type | Rooting Ability (from cutting) |
|---|---|---|---|
| *Acer negundo* | Boxelder | | |
| *Asimina triloba* | Pawpaw | small tree | poor to fair |
| *Baccharis balimifolia* | Groundsel bush | medium shrub | good |
| *Cephalanthus occidentalis* | Buttonbush | large shrub | fair to good |
| *Cornus amomum* | Silky dogwood | small shrub | fair |
| *Cornus sericia* | Red osier dogwood | | |
| *Gleditsia triacanthos* | Honeylocust | medium tree | poor to fair |
| *Populus deltoides* | Eastern cottonwood | tall tree | very good |
| *Robinia sp.* | Black locust | | |
| *Salix discolor* | Pussy willow | large shrub | very good |
| *Salix nigra* | Black willow | small to large tree | good to excel |
| *Salix purpurea* | Purpleosier willow | medium tree | excel |
| *Sambucus canadensis* | American elder | medium shrub | good |
| *Viburnum dentatum* | Arrowwood | medium to tall shrub | good |
| *Viburnum lentago* | Nannyberry | large shrub | fair to good |

**TABLE 3**
**WOODY PLANTS**

| Scientific Name | Common Name | Plant Type | Establishment Speed |
|---|---|---|---|
| *Acer negundo* | Boxelder | small to medium tree | fast |
| *Acer rubrum* | Red maple | medium tree | fast |
| *Alnus serrulata* | Smooth alder | large shrub | medium |
| *Amorpha fruitcosa* | False indigo | shrub | fast |
| *Aronia arbutifolia* | Red Chokeberry | shrub | fast |
| *Asimina triloba* | Pawpaw | small tree | |
| *Betula nigra* | River birch | medium to large tree | fast |
| *Carpinis caroliniana* | American hornbeam | small tree | slow |
| *Carya cordiformis* | Bitternut hickory | tree | |
| *Catalpa bignonioides* | Southern catalpa | tree | fair |
| *Celtis laevigata* | Sugarberry | medium tree | slow |
| *Celtis occidentalis* | Hackberry | medium tree | slow |
| *Cephalanthus occidentalis* | Buttonbush | large shrub | medium |
| *Chionanthus virginicus* | Fringe tree | small tree | |
| *Clethera ainifolia* | Sweet Pepperbush | shrub | |
| *Cornus amomum* | Silky dogwood | small shrub | medium |
| *Cornus florida* | Flowering dogwood | small tree | fair |
| *Diospyros virginiana* | Persimmon | medium tree | fair |
| *Fraxinus pennsylvanica* | Green ash | medium tree | fast |
| *Gleditsia triacanthos* | Honeylocust | medium tree | fast |
| *Ilex decidua* | Possomhaw | large shrub to small tree | |
| *Ilex opaca* | American holly | small tree | medium |
| *Ilex verticillata* | Winterberry | small to large shrub | |
| *Juglans nigra* | Balck walnut | medium tree | fair |
| *Juniperus virginiana* | Eastern redcedar | large tree | medium |
| *Liquidambar styraciflua* | Sweetgum | large tree | |
| *Liriodendron tulipifera* | Tulip poplar | large tree | fast |
| *Magnolia virginiana* | Sweetbay | small tree | |
| *Nyssa sylcatica* | Blackgum | tall tree | slow |
| *Ostrya virginiana* | Hophornbean | small tree | slow |
| *Platanus occidentalis* | Sycamore | large tree | fast |
| *Populus deltoides* | Eastern cottonwood | tall tree | fast |
| *Quercus alba* | White oak | large tree | slow |
| *Quercus lyrata* | Overcup oak | medium tree | slow |
| *Quercus michauxii* | Swamp chestnut oak | medium tree | fair |
| *Quercus nigra* | Water oak | medium tree | slow |
| *Quercus phellos* | Willow oak | medium to large tree | medium |
| *Quercus shumardii* | Shumard oak | large tree | slow |
| *Rhododenron atlanticum* | Coast azalea | small shrub | |
| *Rhododendron viscosum* | Swamp azalea | shrub | |
| *Salix nigra* | Black willow | small to large tree | fast |
| *Viburnum nudum* | Swamp haw | large shrub | |

NOTES:

1. LOG, ROOTWAD AND BOULDER REVETMENTS MAY BE UTILIZED SPORADICALLY TO PROVIDE OVERHEAD COVER AND HABITAT IMPROVEMENT ALONG THE DISTURBED SHORELINE.
2. DETAILS OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE ENGINEERING FIELD HANDBOOK (ISSUED 1996) - PART 650 - CHAPTER 16 STREAMBANK AND SHORELINE PROTECTION.
3. INSTALLATION OF SHORELINE RESTORATION COMPONENTS WILL BE CONDUCTED IN ACCORDANCE WITH ESTABLISHED STANDARDS AS OUTLINE IN THE ABOVE REFERENCE ENGINEERING FIELD HANDBOOK.
6. PLANTING OPTIONS OBTAINED FROM THE "STREAMBANK AND SHORELINE STABILIZATION TECHNIQUES TO CONTROL EROSION AND PROTECT PROPERTY" - GEORGIA DEPARTMENT OF NATURAL RESOURCES.

FIGURE 6

DOMINION ENERGY
SOUTH CAROLINA, INC.

BIOENGINEERED STABILIZATION
OPTION DETAILS

CONGAREE RIVER SEDIMENTS
COLUMBIA, SOUTH CAROLINA

DATE: 5/4/20 FILE NAME: CONG547

APEX COMPANIES, LLC