6 Section Six – Development of CSO Control Alternatives

6.1 Introduction

It is required that the CSO Long Term Control Plan (LTCP) contains an evaluation of a reasonable range of control alternatives. This section describes the process that the City of Terre Haute team used to develop and evaluate CSO control alternatives. The selection process included considerations of the water quality benefits and equivalent affordable cost standards of various alternatives developed to meet the goals of the CSO Long Term Control Plan (LTCP). The focus of the evaluation was the reduction of overflow frequencies and volumes of discharge which in turn would reduce stream bacteria, solids and floatables entering the river.

6.2 Goals of the CSO Control Plan

The CAC and technical committee identified the following goals:

1. Comply with IDEM requirements
2. Reduce in-stream bacteria from CSOs
3. Eliminate / reduce CSOs 005, 006, 007 and 008 in Fairbanks Park
    - This is considered a priority area given the potential access to the river by park users
4. Wastewater Treatment Plant (WWTP) Improvements
    - Provide new preliminary treatment facility
    - Upgrade sustained wet weather peak treatment capacity to 48 MGD in all sections of the plant
    - Replace and upgrade old equipment
    - Eliminate peak flow bottlenecks at the Plant
5. Maximize flow to the WWTP
6. Generally site new CSO control facilities to allow for ISU campus expansion near the river

7. Control and eliminate floatables from CSOs in accordance with NPDES permit requirements
8. Provide Protection Within Wellhead Protection Zone (This was accomplished as an "early action" project through rehabilitation of large diameter pipe within the wellhead protection area).
9. Reasonable sewer rate increase based on total project cost with consideration given to phasing the proposed work
10. Effective Odor Control at WWTP

6.3 Evaluation Factors

The LTCP utilized several factors to screen and evaluate alternatives for CSO Control including cost-effectiveness, regulatory compliance, technical feasibility, and community input.

For the CSO LTCP, the City of Terre Haute developed a range of alternatives based on the typical year rainfall of 1978 approved by IDEM. Alternatives were evaluated ranging from "No Action" to complete closure of all CSO. Costs of each alternative were determined and corresponding affordability was calculated for each alternative. If the alternative to close all outfalls is deemed unaffordable then the City would perform a UAA to seek a Wet Weather Limited Use subcategory for the CSO-receiving waters, which would temporarily suspend the Recreational Use designation.

The CSO Policy requires that the CSO control program that is selected be sufficient to meet water quality standards and other CWA requirements. A post-construction water quality assessment program of monitoring or modeling is necessary to demonstrate compliance with water quality standards, regardless of which approach is taken.

The following evaluation criteria were utilized by the Technical Team to evaluate the CSO control technologies and alternatives under either approach for the selected plan of the LTCP.

6.3.1 Cost Effectiveness

The cost effectiveness of each control alternative will be determined by comparing the reduction on CSO overflows to the cost of the alternative. Alternatives for the different design storms system-wide overflow frequencies will be investigated and the alternative that can achieve the desired goals at the lowest cost will be considered to be most cost effective.

6.3.2 Regulatory Compliance

The Terre Haute CSO LTCP technical team developed and evaluated alternatives in accordance with EPA and IDEM CSO control policies. The selected alternative will comply with appropriate regulatory requirements or amended standards as designated through a UAA.

6.3.3 Non-Monetary Factors

The non-monetary factors included environmental issues/impacts, technical issues, implementation issues, priority areas, and public acceptance. These factors while not deciding factors in the CSO control selection process are considered in the overall evaluation of alternatives.

Environmental Issues/Impacts

Alternatives evaluated take into account environmental issues/impacts, which include wetlands, floodplains, geotechnical and groundwater sources, threatened and endangered species, water quality impacts from construction, and future operational odors from the facilities.

Technical Issues

The evaluation of CSO control alternatives included the following technical issues:

- Construction feasibility – how complex it is to construct the facilities included in each of the alternatives.
- Operability/reliability – the level of complexity of the technologies involved and the impact this would have on the City's ability to operate the systems, and the number of remote facilities that will affect the reliability of the alternative and operational capacity of the utility.
- Expandability – alternatives should have the ability to expand in the future if regulatory requirements dictate.

Implementation Issues

The evaluation of alternatives included implementation considerations, which included the ability to phase the implementation of various elements of an alternative. These factors included land availability, complex construction and interrelation of elements (i.e., building conveyance to a new treatment facility prior to completing the treatment facility.) Ultimately, the ability to construct a comprehensive alternative in multiple phases will allow the utility to defer costs and rate impacts upon the users over a longer period of time while still making progress toward improvement of water quality.

Public Acceptance

The control alternatives were evaluated on the ability to receive public acceptance. Public acceptance is relative to the level of disruption a CSO project would have on local businesses and neighborhoods during construction and during the operation of the facility. Consideration of future community planning and development in proposed project areas was also considered particularly in the Wabash River area as recent planning efforts have been completed for future development and utilization of that area.

6.3.4 Community and Technical Committee Input

As part of the public participation program, the Mayor of the City of Terre Haute appointed a Citizen Advisory Committee (CAC). During the nearly 12 year development of the LTCP, the CAC consisted of two separately appointed groups (with some common members). The CAC was an integral part of the CSO control alternative development and evaluation process during both the original CSO LTCP development stage as well as the revision process/final LTCP development. The input and comments of the CAC during both periods were considered in the completion of the LTCP.

In addition to the CAC, a technical committee team was also established. The technical committee included wastewater treatment plant staff, the City Engineer and staff, and the team of environmental, engineering, financial and legal consultants, led by Hannum Wagle and Cline Engineering. The technical team developed and evaluated alternatives for presentation to the CAC. At the first CAC meeting (during both initial and final phases), a description of the system and regulatory requirements was presented to "educate" the group, and individual CSO control technologies were introduced to the committee and screened based on CAC input. The technical team then integrated the feasible technologies into comprehensive system-wide CSO control alternatives. The integrated comprehensive alternatives were then presented to the CAC. The advantages and disadvantages of each alternative, along with non-monetary benefits, were presented. After receiving feedback from the CAC, the integrated alternatives were further refined. The alternatives were then modeled and costs and performance were estimated at different levels of

CSO control. The final alternatives, along with the present worth costs, were then presented to the CAC for final input and development of the recommended plan.

6.4 Initial Screening of CSO Control Technologies

A wide range of CSO control technologies applicable to Terre Haute's combined sewer system were initially considered by the technical team. The technologies were grouped into the following general categories:

- Collection System Control
- Storage Technologies
- Treatment Technologies

6.4.1 Collection System Control

The objective of using collection system technologies as a control alternative is to reduce the amount of combined sewage into the collection system below the WWTP capacity during wet weather. Collection system controls fall into the following categories:

1. Inflow/Infiltration Reduction
2. Real Time Control
3. Sewer Separation
4. Outfall Consolidation/Relocation

6.4.1.1 Inflow/Infiltration Reduction

Inflow/Infiltration reduction involves the elimination of storm water connections to the combined sewer system. Generally this involves the disconnection of rain leaders from the combined sewer system and the resulting storm runoff is diverted elsewhere. Depending on the neighborhood, the leaders may be run to a dry well, vegetation bed, a lawn, a storm sewer or the street. For most residences in the combined sewer area, the most feasible rain leader disconnection scheme is diversion to the lawn or dry wells. The diversion to the street contributes to nuisance street flooding and only briefly delays the water from entering the combined sewer system through combined sewer connected catch basins.

There are newer "green technology" opportunities for inflow/infiltration reduction which will be discussed in greater detail later in this section.

6.4.1.2 Real Time Control

Real-time control (RTC) is a sophisticated in-line storage method that uses sewer depth and rainfall monitors to control the amount of wastewater being stored, transported, and directed throughout the existing combined sewer system. This method of CSO flow control can be highly automated and can increase efficiency and holding capacity within the existing sewer system by creating real-time response to rain as it falls over the city. Dams or gates allow sewage to flow from one trunk sewer into another during intense rainfall and runoff, and can hold flow back when rain subsides and capacity is needed in another part of the city.

Monitors necessary to control the storage of flow in existing sewers require a power source and telecommunication lines to communicate with a central computer system. The computer system processes the monitoring data every few seconds or minutes, using data to make control decisions at the CSO, such as whether to inflate or deflate in-line dams, or raise/lower flow control weirs. These instantaneous decisions cannot always rely upon depth data alone but must also incorporate rainfall data.

Releasing in-system storage volumes by deflating a dam or lowering a weir is not instantaneous. Therefore, incorporating rainfall data into the decision process is necessary to give the system enough time to react to an approaching storm that has intensities or duration that will breach the storage limit, thus preparing the in-system storage release process before basement or surface flooding occurs. Rain gauges must be spaced to accurately monitor the average storm size of four to five miles. A real-time control system of this type maximizes the full storage capability of the existing collection system while avoiding upstream basement flooding and spills to the environment, thereby minimizing public health concerns and CSO impacts on the receiving water. The size of the Terre Haute system's main combined trunk sewers allows this option to receive serious consideration.

Static flow control devices, such as vortex valves are generally used for flow control in conjunction with other devices that provide the storage, such as inflatable dams, weir structures or concrete storage tanks. The inherent storage capacity of the existing City of Terre Haute sewer collection system allows for a 77% capture. The actual capture rate that might be attained through RTC could be significantly higher if flows are transferred between trunk sewers or if the RTC devices were installed in small diameter sewers also.

However, while RTC does potentially increase storage at a relatively low cost, the risk of flooding basements with raw sewage increase as additional RTC devices are installed in the collection system and as storage is attempted in smaller sewers. While RTC reduces capital costs of CSO controls, operation and maintenance costs can be more expensive over the long-term. Furthermore, proper operation and maintenance of an RTC system is exceptionally critical to protecting citizens from basement flooding. Also, flooded buildings pose a significantly higher likelihood of unintentional human contact and resulting health effects than combined sewer overflow into the streams.

RTC could be used in selective areas of the system and as part of a larger more complex plan and thus, provide the basis for system-wide control and minimization of structural capital improvements that could result in a more cost-effective solution for CSO control. All components of CSO control, including flow, level and rain gauge data, in-line storage, off-line storage, maximization of flow to existing treatment, and additional high-rate treatment could all become an integral part of the RTC System.

6.4.1.3 Sewer Separation

Sewer separation is the conversion of a combined sewer system, or sub-system into a system of separate sanitary sewers and storm sewers. This alternative prevents sanitary wastewater from being discharged to receiving waters. However, when combined sewers are separated, storm sewer discharges will greatly increase and contribute additional pollutant load to the receiving waters since storm water will no longer be captured and treated in the combined sewer system. New stringent storm water regulations may at some point in the future require some type of pollutant control on the storm water system. In addition, this alternative involves substantial citywide excavation, thus exacerbating street disruption problems. Varying degrees of sewer separation could be achieved with rain leader (gutters and downspouts) disconnection, partial separation, and complete separation.

With partial separation, combined sewers are separated in the streets only, or other public right of way. This is accomplished by constructing either a new sanitary wastewater system or a new storm water system.

In addition to separation of sewers in the streets, storm water runoff from each private residence or building such as from rooftops and parking lots is also separated. See Figures 6.3-1A and 6.3-1B for a schematic of how sewer separation can be achieved. For other cities, separation has proved most feasible for CSO areas of 200 acres or less. Terre Haute has approximately 5,000 acres of combined sewers, therefore, this is likely not a feasible option as a stand-alone CSO control alternative except, possibly, in small, discrete areas of the City or portions of CSO basins, and as a part of a more comprehensive CSO LTCP.

6.4.1.4 Outfall Consolidation/Relocation

Outfall consolidation allows nearby outfalls to be joined together, eliminating the number of outfall points. The elimination of outfalls reduces the monitoring requirement and localizes end-of-pipe treatment technologies, like floatable controls. Outfall consolidation, as well as outfall relocation, can be used to direct CSO flows, via larger conveyance relief sewers, away from specific areas. This method may be used to address sensitive and priority areas. As with Fairbanks Park, a priority area with several outfalls within the park, outfalls could be consolidated or relocated to improve the aesthetics and the river water quality at the park. The close proximity of several outfalls in the system allows outfall consolidation and elimination in the Terre Haute system.

6.4.2 Storage Technologies

The objective of using storage technologies as a control alternative is to capture combined sewage in excess of the WWTP capacity during wet weather for controlled release into the collection system for conveyance to the WWTP after storm events. Storage options fall into the following categories:

1. Storm water storage ahead of combined system;
2. In-line Storage - Storage of CSO flows within the sewer system;
3. Off-line storage of CSO flows.

6.4.2.1 Storm Water Storage ahead of Combined System

There are two ways to provide storage of runoff prior to entering the combined system and mixing with the sanitary flow. One method is to require industries or other large property developments to build detention basins and release the storm water after storm events. Terre Haute has a small industry base that is connected to the combined sewer system. However, storm water contributions to the combined sewers from industries are not significant. The other opportunities within this option are to detain, with wet or dry detention basin, runoff from residential or commercial property within the combined sewer service area. Terre Haute's combined sewer service area is fully developed, which would make locating necessary basins very difficult.

The other methods of providing storage of CSO flows are to collect combined sewage prior to the outfall. This can be accomplished with in-line storage, off-line storage tanks, or a combination of the two technologies. The storage volumes required in Terre Haute are large, particularly at higher levels of control. As a result, storage can best be achieved in a cost effective manner by utilization of large earthen basins – which the International Paper lagoons (described later in this section) located adjacent to the Wabash River and the city's main lift station offer. Some flows could be feasibly stored by utilizing storage tanks, while tunnels require large volumes of storage to be cost effective and thus, should also be further considered. The following is a detailed description of feasible storage options for the City.

6.4.2.2 In-line Storage

In-line storage optimizes the use of the existing storage capacity of the combined sewer collection system to reduce overflow volumes. It often proves to be less expensive than other alternatives since there are significantly lower construction costs involved due to the use of existing infrastructure. It also proves to be the most attractive alternative since existing facilities are most efficiently utilized without the disruptions of major construction.

This technology cannot typically be used alone to achieve complete control of substantial wet-weather events. In-line storage can only be used if sufficient capacity is available within the collection system and to a lesser degree at the treatment plant. By utilizing this alternative, there is increased risk of basement or street flooding, increased opportunity for sediment deposition, and higher costs associated with maintenance of regulators, inflatable dams, level control weirs and other features to ensure proper functioning. Some examples of controls are: regulators, vortex valves, inflatable dams, motor- or hydraulically-operated sluice gates or weirs, raising static regulators, and system-wide real-time control.

Each trunk sewer of the Terre Haute collection system was investigated for available storage capacity during the initial LTCP development and reconfirmed during the final plan development. The areas best suited for in-line storage are the large, flat combined sewers associated with the large CSO outfalls such as Hulman/Idaho, Ohio and Walnut Street combined sewers. An example of an end of pipe inflatable dam is shown in Figure 6.3-2.

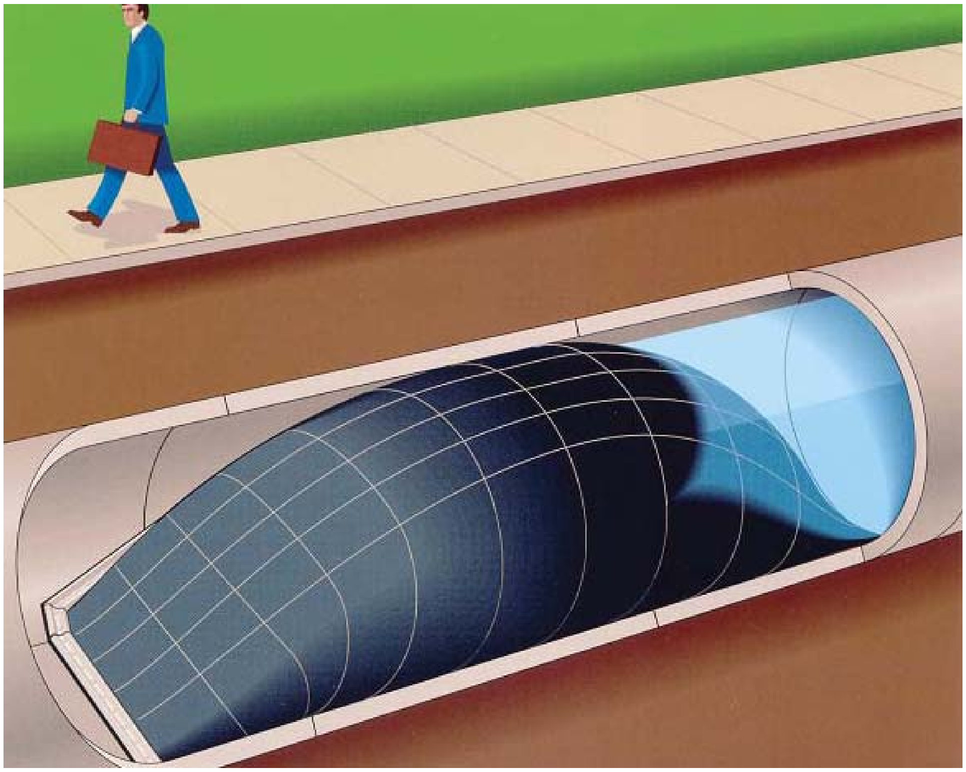


Figure 6.3-2 Inflatable Dam

In-line storage will only extend to a location upstream (the storage limit) where the water elevation in the combined trunk sewer equals the elevation of the outfall pipe or regulator downstream. If an attempt is made to store wastewater above this storage limit, it is likely to overflow into the manholes and basements.

One storage technology that has been evaluated as a control alternative is inflatable dams. Inflatable dams are rubber fabric devices which can be inflated during wet weather conditions to hold wastewater within the sewer and prevent combined sewage from entering the receiving stream. These dams, which are normally in the deflated (closed) position, can be designed to activate (inflate) automatically from a master control center in response to upstream water levels or surface rainfall data. If monitors indicate that the in-line storage volume may exceed the storage limit, then the dam structure is automatically deflated, and a CSO occurs. In the event of an exhaust valve malfunction or other system breakdown (i.e. electrical power failure), the dam contains a safety valve that would deflate the dam and prevent backups into basements and streets.

The air supply to inflate the dam, which is either produced by a compressor or supplied from a storage tank, is located on site in an equipment vault. This on-site equipment vault also contains a manual control to deflate the dam in case of equipment failure.

Since the dams are generally made from a heavy fabric or rubber, they should not require a substantial amount of in-pipe maintenance; however, some maintenance will be required for the instrumentation inside the equipment vault. Also, these dams must include pressure relief valves, mechanical deflation controls and backup manual deflation valves to ensure that basement or street flooding does not occur during a power failure. Finally, installation of the dams does not require major reconstruction of the existing system, therefore limiting the amount of time and manpower needed.

Although the fabric and rubber material used in these structures is durable, sharp objects can penetrate it. In addition, since inflatable dams are installed directly inside the combined sewer outfall pipe, they must be able to accommodate the various pipe shapes in the City's system. Currently an inflatable dam cannot accommodate two pipe shapes: rectangular pipe outfalls with a rise greater than the span and semicircular pipe outfalls that are not rounded at the base.

Another option for in-line storage which would operate similar to inflatable dams would be an operable weir structure. This type of control would include a large concrete structure located near the outfall of a CSO and would contain an adjustable weir/gate which could rise and block flow in the combined sewer based on system conditions. The Hulman, Walnut and Ohio combined sewers were identified as potential locations for this type of control technology. The control or operation of the weir/gate would be very similar to the inflatable dam with similar system monitoring and safety systems to prevent system overflows or basement backups.

6.4.2.3 Off-line Storage

Another CSO control alternative that has been evaluated for a storage option is using off-line structures such as earthen basins or closed concrete tanks. The type of storage structure requires very different operations and design considerations.

Closed concrete tanks typically include odor control systems, washdown/solids removal systems, and access for cleaning and maintenance. Closed concrete tanks have been constructed below grade such that the surface at grade can be used for parks, playgrounds, parking or other light uses. Closed concrete tanks are potentially viable alternatives for Terre Haute's combined sewer system. A typical layout is shown on Figure 6.3-3. Depending upon the elevation of the CSO and surrounding ground, the tanks could be below grade with gravity influent and pumped effluent, or above grade with pumped influent and gravity effluent to the CSO, main interceptor or new relief sewer.

Earthen basins often provide a more cost effective method for CSO flow storage; however, their construction near urbanized areas has often been a problem from a public perception perspective. As a result, earthen basins were initially not considered for off-line CSO flow storage in the original LTCP. However, during the development of the final LTCP, an existing paper manufacturing facility located along the Wabash River and directly north of I-70 and the City's Main Lift Station (along with the Turner (CSO 003) Outfall) became decommissioned and the land and an existing lagoon-type wastewater treatment facility available for purchase. The facility's treatment system consisted of a 5-cell lagoon system which has a capacity to hold and store up to 60 MG of combined wastewater by utilizing the two larger basins as shown in Figure 6.3-4. Given the ideal location of this facility and the fact that the facilities for storage exist, the technical team concurred that the City should consider this off-line storage option in some or all potential comprehensive control alternatives for the system. The ponds to be utilized would require a new liner system with piping and control structures be installed along with wash-down facilities.

An existing wastewater treatment facility, Wabash Environmental Technologies (WET), exists just north of the Hulman (004) outfall. The facility has storage tanks available on site which could be used for CSO storage in lieu of or in combination with new off-line storage tanks. However, given the daily treatment and storage capacity of the facility of 1.9 MGD, and given the rate of CSO flows at this location (assuming only the Hulman/Idaho systems, and not upstream flows) and the subsequent volume of storage required, this facility would not be adequate nor economical for use as a CSO off-line storage facility. The existing tanks would fill up in less than 20 minutes at the start of a CSO event that last several hours.

6.4.3 Treatment and Floatables Controls Technologies

There are two types of treatment technologies for CSO flows: treatment at the CSO outfall and treatment expansion of the existing treatment plant. Given its condition and capacity, expansion of the existing treatment plant is considered common to any CSO plan developed and will be discussed in detail elsewhere in the report. Terre Haute CSO outfalls are all located near the riverbanks and in the floodplain of the Wabash River, thus locating and constructing a treatment facility near any of the outfalls would prove difficult. There are two types of CSO outfall treatment facilities: high-rate treatment and floatables control.

Providing high rate treatment facilities at each of the outfalls would be expensive because the peak wet weather flow rate in the collection system would have to be pumped up to each treatment unit. Also, disinfection chemicals would have to be handled at each treatment unit. Additionally, and perhaps most importantly, the remoteness of some of the outfalls would make operation of a "satellite" treatment facility difficult, and the construction of this type of facility(s) would require additional NPDES permits for the City. Providing a high rate treatment facility at the IP site could be an alternative to providing high rate treatment facilities at each outfall. This facility could utilize the main lift station to pump flows up to the treatment unit. Also, similar to a new facility at each outfall, use of this facility would require an additional NPDES permit to be held by the City. High rate treatment is discussed in more detail in Section 6.4.3.4.

Conversely, floatable controls provide screening and removal of floatables from combined sewer overflows only and are actually an NPDES permit requirement for existing outfalls. As a result, a form of floatable controls will be provided at each outfall which will remain as a result of the CSO LTCP selected plan implementation. In 2005, after submission of the original LTCP, a study was completed by Malcolm Pirnie for the selection of and installation of floatables control on the Terre Haute CSO's. The study was conducted prior to the consideration of consolidation or elimination of any of the outfalls as a result of the selected plan of the final LTCP. The following sections describe various technologies considered available and feasible for the Terre Haute outfalls for floatables control as detailed in the Malcolm Pirnie study.

6.4.3.1 Screens

Screening devices can be used to prevent floatables from being discharged from CSOs to receiving water bodies during wet weather after floatables have entered the combined sewer system. Screening of CSOs can potentially be challenging because the quantities and loading rates of floatables and solids vary widely during CSO events, from first flush at the initiation of the event to more dilute conditions towards the end of the event. If a period of drought is followed by a significant storm event, the quantity of floatables and solids discharged from CSOs will likely be high. However, if two storm events occur on consecutive days, the quantity of floatables and solids discharges from the CSOs from the second day's storm would be reduced. Selected screening systems for CSO control must be designed with sufficient flexibility to adapt to the fluctuations in floatables and solids loading conditions. Screening systems for floatables control in combined systems are typically installed in regulator chambers to prevent solids from being discharged from CSO outfalls. Screening devices that were included in the technology screening process for Terre Haute's System include:

- Static bar screens
- Vertical mechanical screens
- Horizontal mechanical bar screens

<u>Static Bar Screens</u>

Static bar screens are one of the least expensive forms of screening technologies available. The static bar screen consists of sturdy bars, aligned in parallel to one another and typically spaced 0.5 to 1.0 inches apart. The screens are fixed in place, trapping solids and floatable material. Static bar screens are manual, stand-alone systems without any mechanical moving parts or any automated cleaning mechanisms, thus requiring intensive operation labor. The advantages of static bar screens include:

- Capital installation costs are low.
- Since there are no moving parts, no mechanical repairs are needed.

- The disadvantages of static bar screens include:
- Periodic manual raking and removal of solids and floatables from the screen is required. Maintenance crews are generally required to visit each screen during and after each storm event to ensure that screens do not become clogged and restrict flows.
- Manual raking and removal of screenings during overflow events is impossible.
- Regular visitation of bar screens increases the frequency of confined space entry by maintenance personnel.
- Static bar screens typically require significant space for installation when high flows are expected.
- Static bar screens have the potential to clog with solids and floatables, which could cause flow restrictions and surcharges in upstream trunk sewers, which could lead to basement backups and street flooding around catch basins.

For the CSO outfalls that discharge infrequently and low volumes, static screens can be used. Some commercially available static screens are equipped with flushing water devices that can be activated after overflow events. For high volume discharges, clogging is certain without the addition of an automatic cleaning device and operators will have to be present at each location during or immediately after each storm event to ensure that the screens will not become clogged.

Vertical Mechanical Screens

Vertical mechanical bar screens are typically equipped with a vertical, inclined, static bar screen rack which remains submerged below the water surface, and a mechanical rake arm which remains above the water surface. When the bar rack requires cleaning, the mechanism periodically drives the rake arm vertically down below the water surface and on to the bar rack and then rakes the bars clean. The rake arm continues to rake upward on the screen to a discharge chute, where the solids and floatables are dumped into a storage container. Mechanical screens with perforated plate belts are also available. The perforated plate screen belt moves vertically upward continuous or intermittent. The perforated plate is typically cleaned with brushes and water sprays at the discharge chute. The advantages of vertical mechanical screens include:

- Having been used in wastewater treatment for decades, the technology is well known, understood, and reliable.
- The cleaning mechanisms prevent the screen from clogging and may be programmed to activate when high water levels are detected in a chamber.
- Addition of water is possible to flush solids and floatables back to the interceptor.
- Mechanical screens are effective for removal of solids and floatables of 114 inches and greater in size.
- The disadvantages of vertical mechanical screens include:
- The mechanical and electrical components have more O&M requirements than other non-mechanical screening options.
- High height clearances are involved, which may present a problem at some overflow locations.
- Additional concrete or other structures may be required to house the screening facilities.

Horizontal Mechanical Bar Screens

Horizontal mechanical bar screens are a relatively new technology being utilized in the United States to screen solids and floatables, though the screens are already being utilized in Europe for CSO control. The screens are rigid, weir-mounted, and constructed of narrow, corrosion resistant stainless steel bars with evenly spaced openings. The screening bars are designed in continuous runs with no intermediate supports to collect solids. The screen is activated automatically by a level sensor as storm water rises sufficiently to overflow the weir of the screen. When the screen requires cleaning, a hydraulically-driven rake assembly travels horizontally back and forth across the screen, combing away solids trapped on the screen. The combing tines carry the solids to one end of the screen for disposal back into the wastewater channel. The advantages of horizontal mechanical bar screens include:

- The rake arm assembly prevents the bar screen from clogging and may be programmed to activate when high water levels are detected in the chamber.

- Bar screens consist of thick, heavy-duty bars, which are more structurally sturdy during high storm flows than other wire mesh-type screens.
- Solids and floatables are "pushed back" into the wastewater channel to be handled at the treatment plant. Therefore, there are minimal maintenance personnel costs for screenings pickup and transportation.
- Horizontal mechanical bar screens are effective for removal of solids and floatables of 1/6 inches and greater in size.
- The disadvantages of horizontal mechanical bar screens include:
- The technology is relatively new.
- The mechanical and electrical components have more O&M requirements than other non-mechanical screening systems.

<u>Vortex-Type Separators</u>

A vortex separator is a cylindrical unit, which uses the hydrodynamics of swirling or vortex velocities to concentrate and remove solids and grit. The unit has no moving parts. Storm flows enter the unit tangent to the cylindrical chamber to create a swirling vortex that imparts velocities beneficial to separating solids out of liquids. Vortex separation occurs when the circulating suspended solids are drawn to the center of the swirl and are directed down toward the center of the unit where the solids concentrate. This mixture of concentrated solids and wastewater is then removed from the bottom of the unit by a "foul" sewer pipe, which directs the foul sewer flow back to the interceptor continuing flow to the treatment plant. The clarified effluent exits the top of the unit and is discharged to the receiving outfall through an outfall pipe from the vortex separator unit.

Currently, there are various model types of vortex separators in use; despite variations among the different types, the principles of operation of most models are essentially the same. The advantages of vortex separators include:

- Vortex separators are a viable CSO control technology that has been installed in several locations in the U.S., Britain, Germany, Japan, and other countries.

- Depending on the type of vortex separator, it is possible to pump the floatables and solids collected by the vortex separator into the interceptor with a cleanout pump, thus eliminating the need for mechanical cleaning.
- Smaller manufactured vortex units are commercially available.

The disadvantages of vortex separators include:

- Vortex separator units for large urbanized areas may require a large footprint area for installation. In general, the spatial requirements are higher than those required for screening or netting technologies.
- More extensive construction is needed for vortex separator systems. Typical vortex separator units would approach an average depth of 30 ft, which is more than three times the depth required for concrete chambers for screening or netting technologies.
- Depending on the type of vortex separator, removal of solids from the vortex units would require mechanical cleaning, which would incur additional O&M costs. A vortex separator system with a cleanout pump included in the design would also incur additional O&M costs associated with pump operation and maintenance.

6.4.3.2 Netting Systems

Two types of netting systems were identified in development of the system-wide alternatives:

- End-of-pipe
- In-line

End-of-Pipe Netting System

End-of-pipe netting systems are designed to "catch" floatable materials shortly after being discharged by CSOs. Most applications consist of simple construction materials and components, such as nylon netting and support platform and framing. The end of the outfall pipe is channeled into the mesh bags, which are each sized to capture a given volume of floatable material. The mouth of the mesh bags is fabricated with wooden frames, which slide into channels to connect to the rectangular frames.

When the mesh bags are full, they are removed and hauled away. The bags are usually disposed of with the solids and floatables. The waste materials are usually landfilled and new clean nets are replaced on the system.

The advantages of this system include:

- Capital costs are lower than other mechanical screens.
- Few mechanical components and mechanical repair costs are lower when compared to other screening alternatives.
- Construction of an on-land concrete chamber to hold screening equipment is not required.
- The system can be constructed without interfering with current operation of existing CSOs.
- End-of-pipe netting is effective for removal of solids and floatables of 0.5 inches and greater in size.
- The mesh bags provide more screening surface area per unit flow area than any other screening alternative.
- The system may be easily expanded with additional mesh bags for only minimal design and construction effort relative to other alternatives where expansion may not be economically feasible.
- The disadvantages of this system include:
- Full mesh bags are manually removed. Operation personnel labor costs will increase due to required localized screenings pickup, transportation, and disposal, and to install new nets.
- A mobile hoisting crane will be required to retrieve and remove the full mesh bags.
- Access to the nets may be difficult in some areas when major storm events cause high water elevations.

In-Line Netting System

In addition to the end-of-pipe netting system, in-line netting can be installed where end-of-pipe installations are not technically feasible. This system operates on the same principle as the end-of-pipe nets but consists of a concrete chamber to hold the mesh bag netting, net support guides, and access hatches, and a mesh bag net insert.

This system allows for the netting, floatables, and solids to be removed from the chamber by hoisting the nets out of the chamber with a crane, which may then be loaded on a truck for disposal. In addition to the advantages mentioned for the end-of-pipe netting system, advantages for this alternative include:

- Personnel and equipment will be more accessible for removal and disposal of the nets than the end-of-pipe netting alternative.
- Disadvantages of the in-line netting system include:
- Operation personnel labor costs will increase because screenings pickup, transportation, and disposal will be required with this alternative for the manual disposal of the solids and floatables captured in the netting and to install new nets.
- A mobile hoisting crane will be required to retrieve and remove the full nets.

Due to the disadvantages detailed in this section, netting systems were eliminated from consideration for further evaluation.

6.4.3.3 Floatables Source Control

Floatables source controls are methods of reducing floatables and solids at their source. Floatables source control methods include:

- Catch basin cleaning – This measure typically involves cleaning of catch basins by maintenance crews using a vacuum truck.
- Catch basin modifications – Catch basins are modified to capture floatables prior to discharging to the combined trunk sewers. These measures include baffles installed in catch basins, screen blankets installed at inlet gratings, or mesh bags inserted in catch basins.

- Street cleaning – This measure involves cleaning of street litter by mechanical or manual street cleaning. The USEPA recommends that street cleahing should be done as often as once or twice per week and before each storm. However, street sweeping performed at that high of a frequency may not be feasible due to O&M costs incurred and logistical difficulties in large urban areas.

- Trash receptacles – This measure involves the provision of standard trash receptacles throughout major public areas within the system.

- Public education programs – This measure involves the implementation of programs to educate the public on initiatives such as litter control (with information regarding associated fines and penalties), illegal disposal, and the link between litter and CSO impacts. Public notification typically includes postings in public places, radio and television advertisements, and letter notification to residents and commercial entities.

The primary advantage of the use of source controls is low capital cost. The primary disadvantages include increased O&M costs required for cleaning streets, inlets, and potential for street and yard flooding. Due to the nature of these kinds of controls, numerical estimation of their effectiveness on the river water aesthetics is not feasible. Also, these source control methods are typically considered to be insufficient for total floatables control. Source controls were not considered as an effective floatable control method.

The actual method proposed for floatables control for the CSO's to remain in the developed comprehensive system-wide alternatives will be discussed with each respective alternative evaluated.

6.4.3.4 Remote Treatment

High Rate Clarification

High rate clarification treatment can provide secondary-level treatment to wastewater. Typically, clarification is accomplished by providing quiescent conditions in a tank or basin so that the suspended solids in the wastewater can bind together, thus creating heavier floc, which slowly settle to the bottom while the cleaner water overflows at the top. To provide non-turbulent conditions, long detention times and low overflow rates are required, which necessitates large volume/large surface area tanks or basins.

In high rate clarification, a coagulant is added to the wastewater so that solids bind together more readily and a polymer and ballast, such as sand, is added to increase the weight of the floc so it settles out more quickly. This type of system allows for high overflow rates and short detention times, each of which reduces the size or footprint of the facility. The ballast is removed from the settled sludge and recycled for use in the system. The settled sludge is conveyed in a waste stream to the wastewater treatment facility. Overflows can also be disinfected before entering the receiving stream. The advantages of high rate clarification include:

- High rate clarification facilities have been installed for CSO LTCPs in Indiana and other states, as well as in other countries, and have proved to be effective
- High rate clarification facilities have a relatively small footprint compared to storage facilities
- Facilities emit practically no odors from combined sewage
- Facilities can be obscured in a building that is blended in with the surroundings
- Facility controls can be integrated into a SCADA system to allow for remote monitoring and control

Disadvantages with this alternative include:

- High rate clarification facilities consists of mechanical equipment that will require typical operation (power, chemicals and labor) and maintenance (numerous pumps and motors)
- High rate clarification facilities have a relatively large footprint compared with other screening and netting technologies
- High rate clarification is considered satellite treatment. As such, IDEM will require the City's NPDES permit to be modified to recognize and establish water quality limits for the HRC effluent. The City will have to perform ongoing monitoring and testing of its effluent water to ensure compliance.

6.4.4 Summary of Screening Process of CSO Control Technologies

On September 12, 2008 the Technical Team conducted a planning meeting to evaluate and screen the various CSO control technologies developed for Terre Haute, and based on this screening, develop comprehensive system wide control alternatives based on the use of screened technologies in the various areas of the system.

The first step in the CSO technology screening process was to assess each of the major and minor technologies and their environmental impact (high or low). Table 6.4-1 displays the results of this assessment on the various technologies.

After assessing each of the technologies, a matrix was developed in which the decision to eliminate or consider each of the various technologies was made. Table 6.4-2 displays this decision matrix and it should be noted the some of the technologies were noted to be common to any and all alternatives.

Table 6.4-1
Initial CSO Technology Screening

TECHNOLOGIES	ENVIRONMENTAL IMPACTS AND IMPROVEMENTS							IMPLEMENTATION & OPERATION FACTORS
	Flow Reduction	BOD Reduction	DO Enhancement	Settleableu Solids Removal	Bacteria Reduction	Floatables Reduction	Other	
MAJOR								
I. STORAGE TECHNOLOGIES								
A. In-line Storage – Trunk Sewer	High	High	High	High	High	High		
B. Tunnels	High	High	High	High	High	High		
C. Vertical Shaft	High	High	High	High	High	High		
D. Earthen Lined Storage Basins	High	Low	Low	Low	Low	High		
E. Off-line Covered Storage Tanks	High	High	High	High	High	High		
F. Off-line Open Storage Tanks	High	High	High	High	High	High		
II. TREATMENT TECHNOLOGIES								
A. Maximize Capacity at WWTP Plant	High	High	High	High	High	High		
B. Treatment Tanks	High	High	High	High	High	High		
C. Enhanced Treatment Tanks	High	High	High	High	High	High		
D. High Rate Clarification	High	High	High	High	High	High		
MINOR								
III. COLLECTION SYSTEM CONTROLS (O & M)								
A. Infiltration/Inflow Reduction (Private/Public)	High	Low	Low	Low	Low	Low		
B. Sewer System Cleaning	Low	High	Low	High	Low	High		
C. House Lateral Repairs	High	Low	Low	Low	Low	None		
D. CSO Diversion Structure Improvement Program	Low	Low	Low	Low	Low	Low		
E. Real Time Control / w/Inline Storage	High	High	High	High	High	Low		
F. Illicit Disconnect Program	Low	Low	Low	Low	Low	Low		
IV. SOURCE CONTROL TECHNOLOGIES								
A. Sewer Separation								
- Partial – New Storm Sewers	High	High	High	High	High	High		
- Total – Sanitary Sewers	High	High	High	High	High	High		

TECHNOLOGIES	ENVIRONMENTAL IMPACTS AND IMPROVEMENTS							IMPLEMENTATION & OPERATION FACTORS
	Flow Reduction	BOD Reduction	DO Enhancement	Settleableu Solids Removal	Bacteria Reduction	Floatables Reduction	Other	
B. Storage Ponds - Stormwater	High	Low	Low	High	Low	High		
C. Street Storage (Catch Basin Inlet Control)	High	Low	Low	Low	Low	High		
D. Leaching Catch Basins (Dry Well)	Low	Low	Low	Low	Low	Low		
E. Porous Pavement	Low	Low	Low	Low	Low	Low		
F. Swales & Filter Strips	Low	Low	Low	Low	Low	High		
G. Rain Gardens	Low	Low	Low	Low	Low	High		

Table 6.4-2
Consideration of Technologies

TECHNOLOGIES	Eliminate	Consider	Common to All	REASONS/NOTES
MAJOR				
I. STORAGE TECHNOLOGIES				
A. In-line Storage – Trunk Sewer		✓		
B. Tunnels		✓		
C. Vertical Shaft		✓		
D. Earthen Lined Storage Basins	✓			
E. Off-line Covered Storage Tanks		✓		
F. Off-line Open Storage Tanks		✓		
II. TREATMENT TECHNOLOGIES				
A. Maximize Capacity at WWTP Plant		✓		
B. Treatment Tanks		✓		
C. Enhanced Treatment Tanks		✓		
** D. High Rate Clarification		✓		
MINOR				
III. COLLECTION SYSTEM CONTROLS (O & M)				
A. Infiltration/Inflow Reduction (Private/Public)			✓	
B. Sewer System Cleaning			✓	
C. House Lateral Repairs			✓	
D. CSO Diversion Structure Improvement Program			✓	
E. Real Time Control / w/Inline Storage			✓	
F. Illicit Disconnect Program			✓	
IV. SOURCE CONTROL TECHNOLOGIES				
A. Sewer Separation				
- Partial – New Storm Sewers		✓		
- Total – Sanitary Sewers		✓		
B. Storage Ponds - Stormwater	✓			
C. Street Storage (Catch Basin Inlet Control)	✓			
D. Leaching Catch Basins (Dry Well)		✓		
E. Porous Pavement		✓		
F. Swales & Filter Strips		✓		
G. Rain Gardens		✓		

*Minutes and summaries from the technology screening process are included in Appendix 6-1.

**Documentation regarding the decision to evaluate High Rate Clarification as an alternative is included in Appendix 6-5

6.5 Development of Control Alternatives

6.5.1 In-Depth Evaluation of Control Alternatives

Based on the screened CSO control technologies, the technical team began to develop comprehensive alternatives for CSO control for the entire system. The alternatives could then be input into the SWMM model to determine infrastructure sizing required for various levels of control, after which cost estimates for each alternative were developed for evaluation. The various components of each comprehensive system alternative were developed utilizing the following general schemes.

6.5.1.1 Main Lift Station and WWTP Upgrade

The existing main lift station is nearly 45 years old and is in a deteriorated condition which requires significant pump maintenance and rehab annually. Similarly, most components of the wastewater treatment facility were constructed over 40 years ago and flow is limited to 45 – 48 MGD in the primary treatment processes (with the actual sustained capacity being closer to 30 MGD) and 24 MGD capacity in the secondary processes. It is assumed for all comprehensive system alternatives that the plant will be upgraded to rehabilitate or replace all major components and increase the capacity of the entire facility to 48 MGD. Likewise, it is also assumed that the main lift station will be replaced in most alternatives (please note that one alternatives as described later is proposed which will not replace the main lift station.) *If the main lift station is replaced and treatment facility upgrades are constructed as planned, CSO 002 an emergency overflow at the existing main lift station can be eliminated.*

6.5.1.2 In-Line Storage Alternatives

As discussed elsewhere in this report, several of the existing large diameter combined sewers in the system offer favorable conditions for in-line storage of combined wastewater flows. The Walnut, Hulman, and Ohio sewers in particular are of brick construction and are over-sized with diameters as high as 84” to 120”. Accordingly, all comprehensive alternatives for the system will assume common in-line storage concepts which will be utilized in the SWMM model analysis of each of the alternatives. The inline storage will be accomplished by installing weir/back-up structures at the Hulman/Idaho combined outfall and at the 15th/Ohio Street area.

Additional in-line storage opportunities can be developed utilizing relief sewers which will store and ultimately convey combined wastewater flows from one outfall or area to another.

Lastly, large diameter tunnels can be constructed which will operate similar to CSO relief sewers, however, their storage capacities and operation and maintenance differ significantly.

The comprehensive alternatives developed and discussed in Section 6.5.2 utilize a variety of combinations of these in-line storage opportunities.

6.5.1.3 Off-Line Storage Alternatives

Off line storage of combined sewage flows is attained through transferring flows from the combined sewer to a facility which is separated from the combined system. Combined wastewater flows can either be conveyed by gravity to the storage facility and pumped out, or pumped into the facility for gravity conveyance back to the CSO outfall or main interceptor depending upon flow conditions. Two options are essentially available for off-line storage in the Terre Haute system as described by the following two sections.

International Paper Lagoons

During the LTCP revision process, an industrial site directly north of and adjacent to the city's main lift station and Turner outfall ceased operation and the property became available. The site contained a five cell lagoon based wastewater treatment facility (with an existing NPDES permit) along the Wabash River with ultimate capacity to store in excess of 70 MG of combined wastewater. The main issues with the lagoons were sludge removal and disposal, and transfer of the facility from private to municipal use.

Given the location of this facility and the fact that the property could be acquired by the City with the lagoons/basins in-place, it was the recommendation of the tech team to utilize this option for off-line storage of combined sewage flows in some or all comprehensive alternatives.

Storage Tanks

The other viable option for off-line storage which was selected by the Tech Team for evaluation in some alternatives was the use of storage tanks. Given the location of the need for these tanks, most would need to be below grade concrete tanks with mixing/cleaning systems. During the alternative screening process, the use of vertical caissons for storage was also considered however, due to the volume of storage needed and elevation constraints, these type of structures were not considered in the final comprehensive alternative development.

6.5.1.4 Treatment Alternatives

Satellite treatment can be provided at CSO outfalls by removing solids and disinfecting the overflows in. manner which would eliminate CSO's at that location to a specific level of control. A number of treatment technologies are currently available, including vortex separators and high rate clarification facilities. Though not included in the in-depth evaluation of alternatives in the approved LTCP of 2011, additional information gathered during the design of Phase I projects has led the City to evaluate a treatment alternative to be used in lieu of the originally approved storage alternative at the IP site. The City's design consultant provided the City and Program Manager with a Basis of Design for the high rate clarification treatment option at that location in lieu of storage within that comprehensive alternative.

6.5.2 Description of Comprehensive Alternatives Developed

In order to develop the comprehensive system-wide alternatives, the Terre Haute CSO system was divided into four distinct areas: Spruce/Chestnut Outfalls Area (CSO's 009/010), Fairbanks Park Area (CSO's 005, 006, 007 and 008), Hulman/Idaho Outfalls Area (CSO's 004/011) and the Turner Outfall/Main Lift Station Area (CSO's 003/002). Next, the above described CSO control schemes were applied to the specific areas based on applicability and comprehensive CSO control alternative plans were developed for the entire system. During the September 12, 2008 Technical Team meeting, seven alternatives were developed for the system and are described in the following sub-sections.

The infrastructure sizing references are based upon an initial overflow volume predicted for the 4 overflow storm event.

Alternative 1- North Storage/International Paper Storage Option I

- Consolidation of Spruce and Chestnut outfalls via relief sewer from Spruce to Chestnut, closure of Spruce and new storage tank (10 MG).
- Relief Sewer (48" – (2) 144") for conveyance from Fairbanks Park south to International Paper lagoons, closure of outfalls 004, 005, 006, 007, 008 and 009.

- International Paper lagoon modifications, influent and effluent conveyance for lagoons and Turner Outfall conveyance. *Outfall 002 to remain open.*

Alternative 2 – North Storage/International Paper Storage Option II

- Consolidation of Outfalls 007, 008, 009 and 010 via relief sewer (96" to 120") from Walnut Street north to Chestnut, closure of outfalls 007, 008 and 009, and new storage tank (10.8 MG) at outfall 010.
- Relief sewer (60" – (2) 132") for conveyance for Oak Street south to International Paper Lagoons, closure of outfalls 006, 005, and 004.
- International Paper lagoon modifications and Turner Outfall conveyance. *Outfall 002 to remain open.*

Alternative 3 – Conveyance and Storage Option

- Consolidation of Spruce and Chestnut outfalls via relief sewer from Spruce to Chestnut, new Storage tank (10 MG) at Chestnut and closure of outfall 010.
- Relief sewer (48" – 144") for storage and conveyance from Ohio Street to Hulman Street with closure of outfalls 005, 006, and 008 in Fairbanks Park with 007 remaining open for storm water discharge only.
- Hulman Street Storage Tank (7 MG), outfall 011 remains open.
- Turner Street Storage Tank (3.2 MG), outfalls 003 *and 002* remain open.

Alternative 4 – Storage Tanks Option

- North conveyance via relief sewer from Spruce to Chestnut
- North Storage tank (10 MG) at Chestnut, closure of outfalls 009 and 010
- Park conveyance and storage via relief sewer (48" – 144") from Ohio Street to storage tank (2 MG) at south end of the park. Closure of outfalls 005, 006 and 008 with 007 remaining open for storm water only.
- New outfall 005A at new storage tank at south end of Fairbanks Park
- Hulman Street Storage tank (5 MG)

- Turner Storage Tank (3.2 MG), *outfalls 003 and 002 remain open.*

Alternative 5 – North Tunnel

- 17' diameter tunnel from Spruce Street south to Crawford Street, closure of outfalls 006, 007, 008, 009 and 010.
- North Tunnel flow storage evacuation lift station with outlet south of Fairbanks Park
- Idaho Storage Tank (5 MG) with Outfall 011 remaining open.
- Turner Storage Tank (3.2 MG) with Outfall 003 *and 002* remaining open.

Alternative 6 – Tunnel to Idaho Street

- 17' diameter tunnel from Spruce Street (010) to Idaho Street (004), closure of outfalls 004, 005, 006, 008, 009 and 010.
- Idaho Tunnel flow storage Evacuation Lift station
- Idaho Storage Tank (5 MG)
- Turner Storage Tank (3.2 MG), outfall *003 and 002* to remain open.

Alternative 7 – Tunnel to Main Lift Station

- 17' diameter tunnel for conveyance and storage from Spruce Street south to the Main Lift Station, closure of all outfalls but Turner (003) *and Main Lift Station (002).*
- Tunnel flow storage evacuation lift station

6.5.3 Common Alternative Elements

Concurrent to development of the comprehensive alternatives for the system, several common elements were developed which would enhance the effectiveness of any of the CSO control alternatives. The following common alternative elements were combined with each of the comprehensive alternatives.

6.5.3.1 Floatable Controls at CSO's to remain

In all of the comprehensive alternatives developed for the combined sewer system, at least one and in most cases a few outfalls will remain. In accordance with the City's NPDES permit, floatables control shall be placed on each outfall which will remain in service. As described previously in this section, several types of floatables control methods were considered for the Terre Haute CSO's. However, given the location of the outfalls which will likely remain and the volume of flows which the facilities could be required to handle, the technology selected for each outfall will consist of mechanical screening only (either vertical or horizontal). The quantity of floatables control facilities and the associated costs will be included in each of the comprehensive system alternatives.

6.5.3.2 Back-Up Weir Structure at Hulman/Idaho and Floatables Control

All of the SWMM model analysis for the combined sewer system and each alternative for CSO control will assume that a backup weir structure will be constructed at the Hulman Street outfall. This backup weir structure will allow the Hulman and Idaho Street combined sewers to be used to store combined sewer flows until they can be released into other new or existing infrastructure, or released to outfall depending upon the storm conditions. The new structure will also contain floatables control via mechanical screen for the alternatives which require this outfall to remain open.

6.5.3.3 Interim Plant Upgrades – Piping/Hydraulics and Chlorine Contact Tank Upgrades

When the original seven comprehensive alternatives were developed, the new treatment plant upgrades and expansion were not finalized and approved for construction. As a result, the alternatives assumed that piping and hydraulic capacity of the primary treatment processes and the chlorine contact tank would be upgraded to a 48 MGD capacity to allow for primary settling and disinfection of peak wet weather flows. Now, the treatment plant improvements and expansion are approved and a peak capacity of 48 MGD throughout the treatment facility will be the basis of design for all CSO alternatives. Essentially, the Phases II and III of the treatment plant improvements project (see section 6.5.3.8 below) will be the initial phases of the CSO LTCP selected plan as described later in the report and the interim piping and disinfection process improvements will not be required as a common alternative element.

6.5.3.4 Rehabilitation of North Hulman Street Sewer and Weir at 15th and Ohio

In addition to the in-line storage proposed for the Hulman/Idaho combined sewers, in-line storage is proposed in an upstream section of the system. The SWMM model analysis of all alternatives will assume a weir is placed at the intersection of 15th and Ohio Streets to allow for re-routing of combined flows south of the CSO's in the priority area of Fairbanks Park. Also, in order to accommodate this section of in-line storage and flow re-routing, in the system, the existing combined sewers in these areas will require rehabilitation similar to the method used on other large diameter sewers as discussed in the following section.

6.5.3.5 Large Diameter Pipe Rehabilitation

In order to utilize some of the larger combined sewers in the system and to address poor conditions of some of the pipes which will be required to continue to operate in the system, inspection and rehabilitation of several of the systems larger outfalls was necessary. Accordingly, rehabilitation based on inspection of sections of the Spruce, Ohio, Walnut and Hulman Street sewers was completed in 2006/2007. As a result, while this rehabilitation is a common element to all comprehensive alternatives, the costs associated with this work are not included in the costs of any of the LTCP alternatives since this work has been previously completed utilizing proceeds from a revenue bond issued by the City in 2005.

6.5.3.6 New Headworks Facility at Wastewater Treatment Facility

Phase I of the City's wastewater treatment plant improvement/expansion project consists of the construction of a new headworks facility. In the original LTCP development and through the early portions of the final plan development, it was assumed that improvements to the primary treatment and disinfection sections of the treatment facility would require improvements to maximize flow to the plant up to 48 MGD. However, now that the treatment plant project has been approved and is in progress, this requirement as a common alternative element is no longer required. The new headworks facility began in January 2011 and was completed in May 2012. While the costs of this work are not included in the costs of the comprehensive system alternatives, the cost of this WWTF Phase I project (and phases II and III) is included along with CSO LTCP costs in the financial analysis of the wastewater utility included in section 8 of the LTCP.

6.5.3.7 Separation of East area of basin 003 and west end of 009

Given the size of the Terre Haute system, complete separation of the combined sewer system was not a viable option. However, two areas of two of the basins, the east area of the Turner Street basin, and the western area of the Chestnut street basin do offer opportunity to separate combined sewers economically.

The area of the Turner Street basin is along Margaret Avenue, a major transportation route in the City which will be improved in the next several years with combined sewer separation possible through the construction of new storm sewers.

The western section of the Chestnut Street basin can be feasibly separated since it is outside of the main campus area of Indiana State University.

All of the comprehensive alternatives and SWMM model analyses will assume separation of these areas at some point in the LTCP implementation. Additionally, other areas of the Chestnut Street basin could realize a reduction in CSO flows through the implementation of "green technologies" as discussed later in this section.

6.5.3.8 Wastewater Treatment Plant Improvements Phases II and III

As stated previously, the new Headworks proposed for the wastewater treatment facility is Phase I of the overall facility improvements and is scheduled to begin construction in January 2011. The remainder of the improvements to the facility, Phases II and III, are scheduled to be designed and constructed between 2011 and 2016 and will generally replace antiquated equipment, structures and processes, and increase the overall capacity of all sections of the plant to 48 MGD. The various components of the treatment facility improvements project are described in the following sections based on information contained in the Wastewater Treatment Facility's Preliminary Engineering Report completed by HNTB.

<ins>Demolition of Grit Tank and Pre-Aeration Tank</ins>

The existing grit chambers and pre-aeration tanks will be excavated and demolished after the new headworks is operational.

<ins>Anoxic Tank Conversion</ins>

The primary tanks will be converted to four (4) anoxic tanks — concrete will be repaired, weirs replaced, primary sedimentation equipment removed and mixers installed. The walls of the tanks will be raised to hydraulically accommodate 48 MGD peak wet weather flow plus combined return activated sludge (RAS) and internal recycle flows for a total of 144 MGD through secondary treatment.

Internal Recycle Division Structure

Due to the high flow planned through the anoxic tanks, a new flow division structure downstream of the headworks is required. An internal recycle flow division structure will be built to accept the internal recycle flow from the aeration tank effluent (72-96 MGD), the RAS flow (24 MGD) from the secondary clarifiers and the influent flow (design 24 MGD, peak wet weather 48 MGD) and split the flow between the four (4) anoxic tanks.

Proposed Aeration Tanks

Twelve (12) new aeration tanks, an influent division structure, effluent division structure and piping are required to meet the higher flow demands. This structure will be built perpendicular and to the east of the existing aeration tanks. New aeration equipment will be provided including air piping, headers, valves and diffusers, and flow control weirs.

Proposed Blower Building

A new blower building will be built to the south of the new aeration tanks to house six (6) 6000 scfm blowers to aerate all the aeration tanks plus two (2) 1000 scfm blowers to aerate the channels.

Existing Aeration Tank Upgrades

The existing aeration tanks will have upgrades which include concrete replacement of the top two (2) feet of all walls, increased wall height of two (2) feet, additional flow control weirs and replacement of the air piping, valves and diffusers. New influent and effluent flow splitting structures will be provided.

Existing Secondary Clarifier Upgrades

The existing rim flow secondary clarifiers will need equipment replacement as well as minor concrete repairs. Influent and effluent piping will be replaced as needed.

Proposed Secondary Clarifier Tanks and RAS Pump Building

Two new secondary clarifiers will be constructed along with a new RAS pumping building, secondary effluent control box and piping.

Conversion to Ultraviolet Disinfection

The existing chlorine disinfection system will be converted to UV disinfection by modifying the chlorine contact tank and installing UV disinfection equipment. In addition, the existing Parshall Flume will be replaced with a magnetic flow meter and the effluent weir will be lowered by one (1) foot to provide protection to UV equipment up to the 100-year flood level.

Proposed Sludge Process Building

The gravity belt thickeners and belt filter press dewatering systems will be removed and replaced with rotary drum thickeners and centrifuges respectively. Four rotary drum thickeners (including one backup) and three centrifuges (including one backup) will be located in one building south of the dewatered sludge storage pad. The building will also include a 500,000-gallon waste activated sludge (WAS) receiving well, a thickened WAS receiving well and pumps.

The remaining sludge pad, approximately 166 ft by 60 ft, will run west to east and provide approximately 1330 cy of storage for the dewatered sludge from the centrifuges in the new sludge handling facility.

Proposed Liquid Storage Tanks and Odor Control/Pump Building

Four (4) 2.5 million gallon (MG) storage tanks will store either thickened WAS, aerobic sludge or both. The tanks will have wet scrubbers for odor control and jet mixing for aeration. The storage tanks are sized for 90 days of storage and will be located in the southeast corner of the WWTP where the existing lagoons are located.

Administration Building

A new administration building, which will also house a new laboratory and SCADA control center, will be located south of the southernmost entrance to the WWTP.

Plant Water System

The existing process of chlorine disinfection of the final effluent at the Terre Haute WWTP will be replaced by ultraviolet (UV) disinfection. Because the secondary effluent is the source of non-potable water for the existing non-potable water system at the WWTP, a reconfiguration of the non-potable water system is required. The new headworks will require plant water for proper operation.

Plant Side Stream Lift Station

To accommodate upgrades to the WWTP including proposed sludge processes, a new lift station will be built to receive recycle water waste streams from throughout the WWTP and pump the streams back to the proposed headworks facility.

Proposed Internal Anoxic Recycle Pump Station

A pump station from the effluent division structure is necessary to pump the internal recycle flow to the internal recycle flow division structure upstream of the anoxic tanks.

Proposed Scum Handling Pit

The current collection of scum at the primary and secondary clarifiers and disposal to the landfill will need to be reconfigured with proposed changes to both processes. The collected scum from various processes will be concentrated in a scum pit, pumped to a truck, and then transported to a landfill for final disposal.

Flow Equalization Basins and Odor Control System

The existing basins have liners that have pulled loose from the anchoring system and need replacement. Odor control provisions using chemical addition and a new water monitor system will also be provided.

Electrical and Instrumentation and Control (IOC)

The electrical and I&C upgrades will be incorporated into the upgrades listed above and include replacing electrical equipment as needed, adding standby power for critical unit processes, and a new Supervisory Control and Data Acquisition (SCADA) system to provide supervisory control and monitoring from strategic remote locations.

6.5.3.9 Combined Sewer Inspection and Cleaning

The City plans to implement a program to inspect and clean the combined sewers in the collection system. Most of the large diameter combined sewers in the system except for those rehabilitated in 2006/2007 have not been inspected or cleaned in several years. The "early action" project completed on several of the large combined sewers suitable for in-line storage consisted of inspecting the following sewers: Ohio, Walnut, Hulman and Spruce/Chestnut. Based on the results of this inspection report, sections of these sewers were cleaned and rehabilitated utilizing a spray-on applied grout, reinforced where necessary. Details of the project and its limits are included in Appendix 6-2.

The program proposed for sewers not included in the "early action" project will involve hiring specialists to assess the conditions of the sewers to evaluate if the sewers are in need of repair. After the inspection is complete the City will then implement a cleaning schedule of the sewers. Either the City will purchase cleaning equipment and clean the sewers or hire a cleaning service to clean the sewers.

6.5.3.10 Wellhead Protection Zone

During one of the original plan development CAC meetings, the issue of exfiltration of combined sewage in some of the older sewers was brought to the attention of the group. The CAC expressed their concern of exfiltration of combined sewers in the Wellhead Protection Zone of the City's drinking water supply. A portion of the one-year time of travel wellhead protection zone boundary extends into the northern boundary of the combined sewer collection system. Therefore, costs for lining the sewers in that area with cured-in-place pipe were included in the original LTCP. However, as part of some early action CSO work for which the City issued revenue bonds, this area of the combined system and other area proposed for in-line storage of CSO flows was rehabilitation utilizing a spray-on grout system. This $6 million project was completed in 2006/2007.

6.6 Evaluation of Comprehensive System-Wide Alternatives

After the development of the seven comprehensive system alternatives, evaluation of the alternatives was completed prior to detailed analysis of the final 2 or 3 options. The following two subsections described the screening process completed by the technical team for the alternatives prior to the detailed evaluation of alternatives including SWMM model analysis for various storm events and river quality impacts described in later sections of this report. The results of this process are shown in Appendix 6-3, "Long Term Control Plan Alternative Screening".

6.6.1 Initial Screening (Screen from 1-7 to 1, 5A, 5B and 7)

6.6.1.1 Cost Model

Costs were developed for each of the seven alternatives that had been previously determined by the Technical Team and approved by IDEM for further evaluation. The alternatives were developed to store or treat flows for the design storm resulting in four overflows per year for the system. The seven alternatives were:

- Alternative 1 – North Storage/International paper Storage Option I
- Alternative 2 – North Storage/International Paper Storage Option II
- Alternative 3 – Conveyance and Storage Option
- Alternative 4 – Storage Tanks Option
- Alternative 5 – North Tunnel
- Alternative 6 – Tunnel to Idaho Street
- Alternative 7 – Tunnel to Main Lift Station

The costs for each of the seven options are shown in Table 6.6-1.

Table 6.6-1
Preliminary Opinion of Construction Cost Summary – Initial Alternatives Sized for 4 Overflows per Year

Alternative	Description	Capital Cost
1	North Storage/International Paper Storage Option I	$125,000,000
2	North Storage/International Paper Storage Option II	$120,000,000
3	Conveyance and Storage Option	$179,000,000
4	Storage Tank Option	$171,000,000
5	North Tunnel	$130,000,000
6	Tunnel to Idaho	$149,000,000
7	Tunnel to Main Lift Station	$120,000,000

*Note – Costs indicated are for construction only and do not include common items nor non-construction costs.
Costs were developed using bid tabulations from several communities for similar projects. Bid tabulations are generally the best indication of costs. Material and equipment and labor costs were determined from supplier estimates.

Table 6.6-2
Preliminary Opinion of Operations and Maintenance Costs Summary – Initial Alternatives Sized for 4 Overflows per Year

Alternative	Description	O&M Cost
1	North Storage/International Paper Storage Option I	$1,250,000
2	North Storage/International Paper Storage Option II	$1,230,000
3	Conveyance and Storage Option	$2,020,000
4	Storage Tank Option	$2,010,000
5	North Tunnel	$1,180,000
6	Tunnel to Idaho	$1,280,000
7	Tunnel to Main Lift Station	$650,000

The Operations and Maintenance costs for each alternative were developed by using a percentage based on the type of project was to be constructed. The percentages used are 0.5% for primarily pipeline projects and 1.65% for projects that include a combination of pipeline, structures and lift stations as seen in Table6.5-2.

6.6.1.2 Screening Criteria

The Technical Team concluded that eight different criteria would be used for further screening of the alternatives.

- Capital Cost
- Adaptability to Future Regulatory Regulations
- Inconvenience During Construction
- O&M Staff Requirements/Reliability
- O&M Costs
- Potential for Regulatory Support
- Smoothness of Rate Impact (Phasing)
- Uncertainty/Risk

Each criterion was weighted by the Technical Team. The goal was to determine the relative importance of each criterion. A score of 0 to 25 was given to each criterion. A score of 25 would represent the most important criteria and 0 would represent the least important. The weighting of the given criteria is given in Table 6.6-3.

Table 6.6-3
Evaluation Criteria Weighting

Criterion	Weight (0 to 25)
Capital Cost	25
Adaptability to Future Regulatory Regulations	10
Inconvenience During Construction	20
Operations and Maintenance Staff Requirements/Reliability	15
Operations and Maintenance Costs	15
Potential for Regulatory Support	20
Smoothness of Rate Impact (Phasing)	15
Uncertainty/Risk	15

After the criteria were weighted, each alternative was ranked according to each scoring criterion by the Technical Team. Each criterion was given a score of 0 to 5. A score of 5 points meant that the alternative met the criterion completely. A score of 0 points meant that the alternative did not meet the criterion. The scoring was then multiplied by the weighting of each criterion to determine a total score and overall ranking. A total score was determined for each alternative by adding all of the weighted scores. Table 6.6-4 shows the weighted scores of each criterion as well as the overall score of each alternative.

Table 6.6-4
Terre Haute CSO LTCP Alternative Screening
Alternative Scoring/Ranking

Alternative	Description	Capital Cost	Weight	Score	Adaptability to Future Regulations	Weight	Score	Inconvenience During Construction	Weight	Score	O&M Staff Requirements/ Reliability	Weight	Score	O&M Costs	Weight	Score	Potential for Regulatory Support	Weight	Score	Smoothness of Rate Impact (Phasing)	Weight	Score	Uncertainty/Risk	Weight	Score	Total Score
1	North/IP Storage I	5	25	125	4	10	40	1	20	20	5	15	75	3	15	45	3	20	60	3	15	45	3	15	45	455
2	North/IP Storage II	5	25	125	4	10	40	1	20	20	5	15	75	3	15	45	3	20	60	3	15	45	3	15	45	455
3	Conveyance and Storage	1	25	25	1	10	10	1	20	20	1	15	15	1	15	15	1	20	20	4	15	60	2	15	30	195
4	Storage Tanks	2	25	50	1	10	10	1	20	20	1	15	15	1	15	15	1	20	20	4	15	60	2	15	30	220
5	North Tunnel	4	25	100	3	10	30	4	20	80	3	15	45	3	15	45	3	20	60	2	15	30	1	15	15	405
6	Tunnel to Idaho	3	25	75	2	10	20	5	20	100	3	15	45	3	15	45	3	20	60	2	15	30	1	15	15	390
7	Tunnel to Main Lift	5	25	125	4	10	40	5	20	100	3	15	45	5	15	75	5	20	100	1	15	15	1	15	15	515

As seen in Table 6.6-4, the highest ranking alternative is Alternative 7 – Tunnel to Main Lift Station. The second highest ranking alternatives were Alternatives 1 and 2 – both of which make use of the existing ponds at the International Paper site. Alternative 2 was eliminated because it conveys additional flow to the north. The north area is already heavily impacted by high CSO volumes and the goal is to take flow away from the northern outfalls. A third alternative was deemed necessary because at the time of screening, some uncertainty existed in terms of property acquisition of the International Paper site. In the event that the property could not be acquired, a third alternative that did not involve the IP property was chosen. Alternative 5 was selected to be evaluated as a third alternative.

In addition, Alternative 5 was broken into Alternative 5A and Alternative 5B. Alternative 5B included the use of the International Paper ponds. The use of the ponds in this alternative could result in a decrease in overall capital cost, but again, at the time of screening, the uncertainty of the property acquisition did not allow for its use as a primary alternative.

Accordingly, the four screened alternatives and their descriptions are as follows:

- Alternative 1 – North Storage/International Paper Storage Option I
  - Storage facility on the north side of Terre Haute to handle flows at the Chestnut (010) and Spruce (009) outfalls.
    - Closure of the Spruce outfall with all of the flows routed to the Chestnut outfall.
    - A floatable control facility constructed at Chestnut.
  - The International Paper Lagoons would be utilized for flows from Ohio (008) to Turner (003).
    - Conveyance piping from the Ohio Outfall constructed south to a new pump station at Hulman Street.
    - The Conveyance piping sized for ultimate conveyance of all flows within the park allowing all of the outfalls with Fairbanks Park to be closed.
    - A pump station constructed at Hulman Street to convey flows via force main from the park as well as flows from the Hulman and Idaho conveyance to the existing lagoons at the International Paper site.

    - Closure of the Hulman outfall as (004) would be closed and Idaho will remain open for storm events greater than the 4 overflow per year design storm and installation of floatable controls.
    - Conveyance of the Turner outfall (003) to the International Paper lagoons. Turner *and 002* will remain open for storm events greater than the 4 overflow per year design storm and floatable controls will be installed *on 003*.
    - Utilization of the International Paper Lagoons for storage of CSO overflows until the existing wastewater treatment facility can provide treatment.

- Alternative 5A – North Tunnel with Storage Tanks
  - Construction of a tunnel from the Spruce outfall (010) to the Crawford Outfall (005).
    - The tunnel sized for conveyance and storage.
    - Closure of Outfalls 010 (Crawford), 009 (Spruce), 008 (Ohio), 007 (Walnut), and 006 (Oak) with all flow for storm events larger than the 4 overflow per year design storm conveyed to the Crawford (005) outfall.
    - Floatable Controls will be installed on the Crawford (005) outfall.
  - Storage facility (5 MG) at Hulman Street to store all volumes up to the 4 overflow per year design storm.
    - Closure of the Hulman outfall (004) and floatable controls installed on the Idaho (010) outfall.
  - Storage Facility (3.2 MG) at the Turner Outfall (003) to store volumes up to the 4 overflow per year design storm.
    - Floatable Controls installed on the Turner outfall.
    - *Outfall 002 to remain open.*
- Alternative 5B – North Tunnel with International Paper Storage
  - Construction of a tunnel from the Spruce outfall (010) to the Crawford Outfall (005).
    - The tunnel sized for conveyance and storage.
    - Closure of outfalls 010 (Chestnut), 009 (Spruce), 008 (Ohio), 007 (Walnut), and 006 (Oak) with all flow for storm events larger than the 4 overflow per year design storm conveyed to the Crawford (005) outfall.
    - Floatable Controls installed on the Crawford (005) outfall.

  - Utilization of the International Paper Lagoons for flows from Hulman (004) to Turner (003).
    - The Hulman (004) and Idaho (010) flows conveyed to the International Paper Lagoons for storage.
    - A pump station constructed at Hulman Street to convey flows via force main from the Hulman and Idaho conveyance to the existing lagoons at the International Paper site.
    - Closure of the Hulman outfall (004) and Idaho will remain open for storm events greater than the 4 overflow per year design storm and floatable controls will be installed.
    - The Turner outfall (003) conveyed to the International paper lagoons. Turner to remain open for storm events greater than the 4 overflow per year design storm and floatable controls installed. *Outfall 002 to remain open.*
    - Utilization of the International Paper Lagoons for storage of CSO overflows until the existing wastewater treatment facility can provide treatment.

- Alternative 7 – Tunnel to Main Lift Station
  - Construction of a tunnel for conveyance and storage of all flows from Chestnut (010) to Turner (003).
  - Closure of all outfalls in the system. No floatable controls required.
  - Construction of a pump station at the south end of the tunnel in order to evacuate the tunnel and convey the flows to the existing wastewater treatment facility. *New pump station would allow closure of 002.*

6.6.1.3 **Common Alternatives**

Based on each alternative, the common elements that have been previously proposed may be modified. For example, no floatable requirements will be necessary for Alternative 7 – Tunnel to Main Lift Station since all of the existing outfalls would be closed and floatable control would be unnecessary. Floatable controls are included in the Common Alternatives, but would not be required for Alternative 7. The Common Alternatives described previously will be included as appropriate for each respective alternative in Section 7 for the final alternatives evaluation..

Based on this screening process, the City of Terre Haute Long Term Control Plan Technical Team narrowed down the comprehensive alternatives previously defined and approved by the Indiana Department of Environmental Management (IDEM). The process resulted in four alternatives that would be evaluated in detail at different overflow event design storms. A graphic representation of each of these screened alternatives is included in Appendix 6-3 and in Figures 6.6-1 through 6.6-4. The four alternatives screened for detailed evaluation from the original seven are as follows:

- Alternative 1 – North Storage/International Paper Storage Option I
- Alternative 5A – North Tunnel with Storage Tanks
- Alternative 5B – North Tunnel with International Paper Storage
- Alternative 7 – Tunnel to Main Lift Station

6.6.2 Final Screening and Evaluation (Screen from 1, 5A, 5B and 7 to 7, 11, 11B and Hybrid)

After the technical team screened the original seven alternatives to four for detailed evaluation, a few key events prompted further analysis and alternative development including the following:

- Acquisition of the International Paper Property – The City acquired the property and thus given its location and size, it was logical to include its use in all alternatives included in the final detailed evaluation.

- Approval of Wastewater Treatment Facility Upgrade and Expansion – The City approved a plan for upgrading and expanding the wastewater treatment plant in 2009 and actual user rate increases for the approximate $120 million phased project were initiated in 2010. The cost burden of this project created a greater emphasis on cost considerations for the CSO LTCP. Additionally, the opportunities the facility upgrade offered to the CSO control alternatives necessitated some re-evaluation.

- Indiana State University Master Plan – During this period, Indiana State University finalized a master plan of its current campus which included proposed development near the Chestnut/Spruce outfalls. The plan required some additional analysis and re-consideration of options for this area within the alternatives.

- Wabash River Riverscape Planning Efforts – A community group and its consultant completed a plan for future development along the Wabash River in order to enhance its value to the community. This plan required some additional consideration within the alternatives, particularly in the Fairbanks Park and Main Lift Station areas – including the newly acquired International Paper lagoons site.
- Consultant's Basis of Design (BOD) Report for International Paper storage – During this period, the City's Design Consultant Engineers finalized a Basis of Design Report analyzing the proposed project at the IP site. The report evaluates the feasibility of using the IP lagoons, as well as alternatives to the off-line storage at the site.

In consideration of these key elements, several months of re-analysis of the alternatives were conducted and new alternatives which were simply variations of the screened four alternatives were developed. Alternative 11 was developed as a variation of Alternative 1, and the "Hybrid" alternative was developed as a lower cost alternative to Alternative 11 utilizing similar technology schemes as 11, without the replacement of the Main Lift Station. Alternative 7 remained viable utilizing the International Paper lagoons and extending the tunnel from Spruce to the Main Lift station site near Turner's outfall and the lagoons. 5A was dropped from consideration due to its lack of utilization of the newly acquired lagoons, and 5B was eliminated due to the increasing costs of the necessary storage tanks when compared to alternatives 11 and the "hybrid". Alternative 11B was developed after approval of the LTCP based on information in Consultant's BOD report, which includes the use of high rate treatment facility with UV disinfection at the IP site. Other alternatives were ultimately developed including 8A/8B, 9A/9B and 10 each of which was a variation of Alternatives 1, 5 or 7; however, these options were screened out by the technical team in lieu of the final 4 alternatives described in detail in section 6.8.

6.7 Green Infrastructure Opportunities

USEPA has expressed support for CSO communities to utilize green infrastructure in their CSO control solutions (USEPA 2007, USEPA 2010). The City of Terre Haute identified green infrastructure as a potential means of reducing volume or the size of gray infrastructure in the collection system in the CSO basins upstream of Fairbanks Park (e.g. CSO-009 and CSO-010) because extending traditional gray technologies to these basins is cost-prohibitive. The City conducted a detailed analysis green infrastructure retrofit potential in CSO basin 009 drainage area. The goal of this evaluation was to identify potential green infrastructure retrofits in Terre Haute's CSO-009 drainage area, estimate the cost of those retrofits and assess their benefit in terms of storm water volume capture. The detailed report is presented in Appendix 6-4.

Based on this evaluation, it was found that there are widespread opportunities for green infrastructure implementation in the CSO 009 drainage area (Figure 6.7-1). These opportunities are more prominent in part of the drainage area occupied by the Indiana State University (ISU) campus, as compared to other areas occupied mainly by single family residences. On the ISU campus, the large impervious areas created by large buildings, surface parking lots, and streets present a variety of green infrastructure retrofit opportunities. Controlling stormwater runoff from these impervious areas can potentially have significant impact on reducing wet weather flows from the drainage area. In addition, large athletic fields, in combination with permeable soils, present a unique opportunity for construction of infiltration beds that can provide large stormwater storage volume without compromising the primary use of the fields.

Basins 009 and 010 were looked at for possible green technologies because each basin has large, single owners for portions of the basins (Indiana State University and Union Hospital) and very large flows come from these basins. CSO controls are also more difficult in these basins due to the distance from the existing wastewater treatment facility.

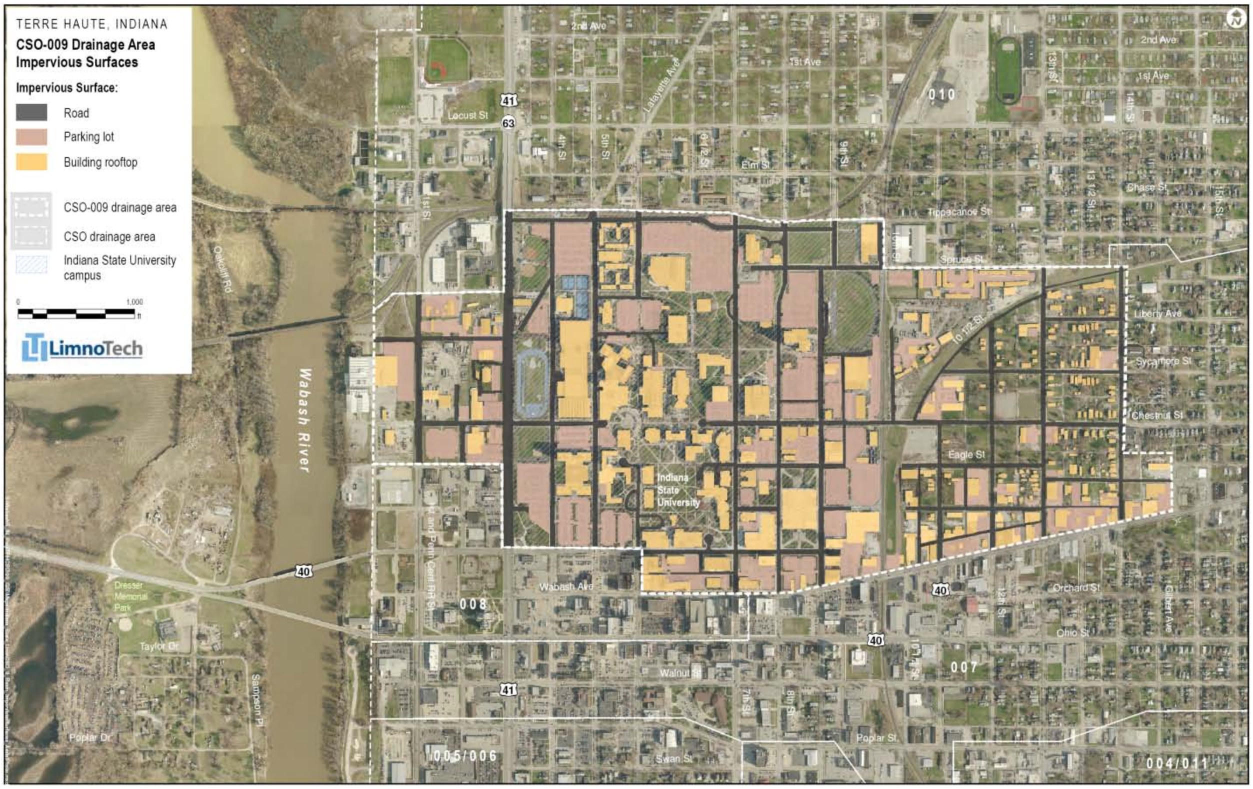


Figure 6.7-1. Impervious Surface (Green Infrastructure Opportunities) in CSO-009 Drainage Area.

Conceptual designs that illustrate several green infrastructure retrofit opportunity types were developed as part of this evaluation. Extrapolating the storage volume and cost estimates for these conceptual designs to the overall campus area provides estimates of the total potential cost and benefit of green infrastructure in the CSO 009 drainage area. The total estimated storage volume that could potentially be provided by green infrastructure retrofits on the campus alone, assuming 100% buildout, is 6.2 million gallons, which is more than sufficient to store all runoff from the 1.0" rainfall event. The total estimated cost for complete green infrastructure buildout is $16.1 million, which yields an estimated unit storage cost of $2.60/gallon.

While it is unlikely that 100% implementation of green infrastructure retrofits can be achieved on the ISU campus, these estimates clearly show that significant stormwater storage potential exists for even partial implementation. This storage potential can be further enhanced by extending green infrastructure retrofits in other parts of the CSO 009 drainage area, including the predominantly residential area to the east, as well as to the area in the CSO 010 basin. Based on this analysis, it appears possible that green infrastructure implementation can provide equivalent storage to offset the need for millions of gallons in storage tank volume to control overflows from CSO basins 009 and 010.

Implementation of green infrastructure at the levels needed to affect storage tank volume will require the City to partner with other public and private entities within CSO basins 009 and 010. The City intends to explore the feasibility of utilizing green infrastructure controls in these basins during the implementation of the preferred alternative.

The plan will be implemented as shown with green technologies, but if the green technologies are unsuccessful, the City is committed to building traditional grey infrastructure.

6.8 Conclusion

Several factors were taken into consideration when developing and evaluating the CSO control alternatives, such as:

- Cost Effectiveness
- Non-Monetary Factors
- Goals of the CSO Control Plan

Based on these factors, the technical team selected the following four alternatives for detailed analysis. The detailed analysis of these four alternatives will include SWMM model analysis and several storm events for varying overflow frequencies which will in turn predict infrastructure sizing required. Detailed costs for each overflow scenario of each of the three alternatives will be developed as well as water quality impacts. Discussion of this detailed analysis is included in Section 7 which will demonstrate the rationale for identification of the final selected plan.

6.8.1 Alternatives Screened for Detailed Evaluation

6.8.1.1 Alternative 7B

Alternative 7B is a variation of one of the original 7 comprehensive alternatives developed for the system which consists of a large diameter tunnel constructed from the Spruce Street outfall south to the main lift station. This variation of Alternative 7 utilizes the International Paper lagoons for storage of CSO flows in addition to the storage offered in the tunnel. This combination of storage will allow the tunnel to be smaller in size under all levels of control. A new main lift station which will replace the existing facility will evacuate flows from the tunnel and allow flows to be pumped to the treatment plant and the storage lagoons. This option can close all outfalls dependent upon the level of control the design is based upon. The detailed analysis of the SWMM model for various levels of control will predict the size of the tunnel required and be the basis for cost estimates presented in Section 7 for this alternative. (Figure 6.8-1)

6.8.1.2 Alternative 11

Alternative 11 selected for detailed evaluation is a variation of the screened original alternative #1 with the major difference being that the conveyance relief sewer included in alternative 1 in Fairbanks Park is extended south to the main lift station and International Paper lagoons. This alternative includes consolidation of Spruce and Chestnut outfalls, closure of the Spruce outfall, and a storage tank at the Chestnut outfall. The new relief sewer will allow closure of outfalls 005,006,007 and 008 in the park, and Turner (003) which will outlet to the new main lift station. The new main lift station will convey flows to either the lagoons or the treatment facility. *(002 will also be eliminated.)* The new piping installed at the lagoons will allow flows to be drained back to the new main lift station for transfer to the treatment facility as wet weather flows subside. The detailed analysis for this alternative in the SWMM model will predict sizes for the conveyance/relief sewers, pumping facilities and storage structure under the various levels of control, for which costs will be presented in Section 7. (Figure 6.8-2)

6.8.1.3 Alternative "Hybrid"

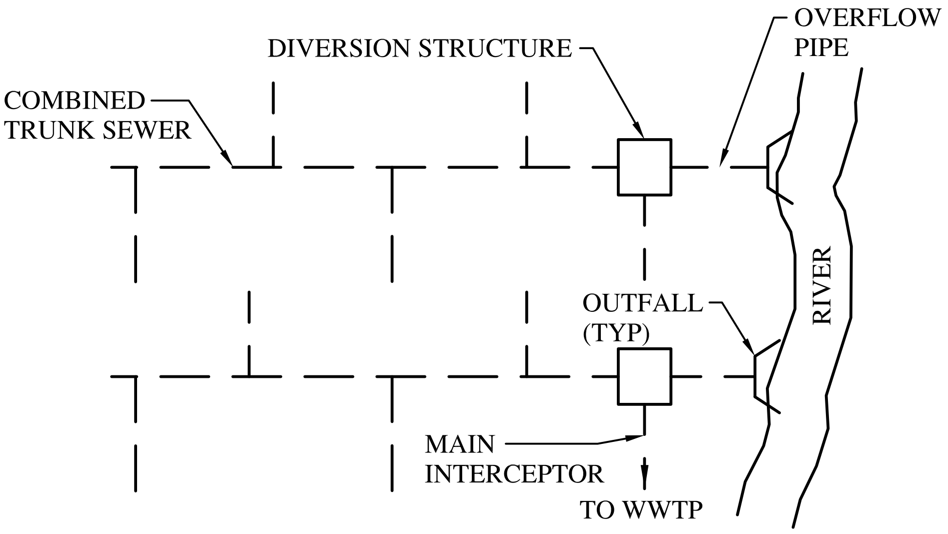
The "hybrid" alternative was developed as a "lower cost" alternative developed for evaluation and is based upon the same technologies and principles of Alternative 11. The main difference between the "hybrid" and Alternative 11 is that the hybrid does NOT replace the main lift station, *thus 002 would remain open.* Instead, a CSO pumping station is proposed at the end of the relief sewer from the park area which contains large low head, high flow pumps which will lift conveyed CSO flows into the storage lagoons. The lagoons will outlet to the existing main lift station when flows subside. The detailed analysis for this alternative in the SWMM model will predict sizes for the conveyance/relief sewers, pumping facilities and storage structure under the various levels of control, for which costs will be presented in Section 7. (Figure 6.8-3)

6.8.1.4 Alternative 11B

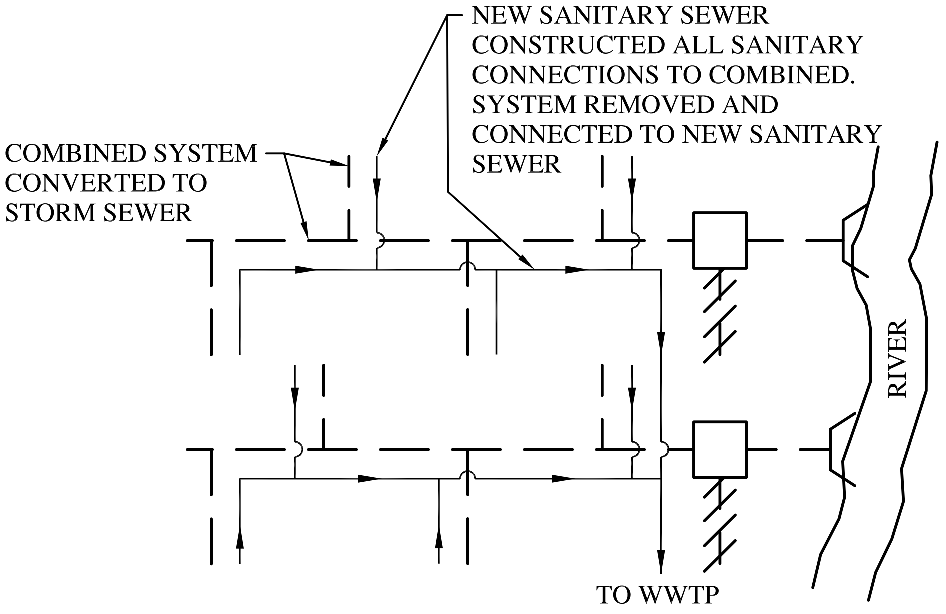
Alternative 11B is a variation of Alternative 11 with the major difference being that the International Paper lagoons will not be utilized for off-line storage. This alternative will use the International Paper site as the location for secondary treatment, consisting of a High Rate Clarification (HRC) system with UV disinfection and direct discharge to the river. As with Alternative 11, outfalls 004, 005, 006, 007, 008, 009, Turner (003), and 002 will all be closed. The detailed analysis for this alternative was conducted by the City's Design Consultant for this site in 2012/2013 and is included in the basis of design report, some of which is included in Appendix 6-5. Costs are presented in Section 7. (Figure 6.8.4)

Terre Haute CSO LTCP

TYPICAL STORAGE TANKS



EXISTING COMBINED SEWER SYSTEM SCHEMATIC



SEWER SEPARATION USING
COMBINED SEWERS AS STORM SEWERS

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FIGURE 6.3-1A
COMBINED SEWER SEPARATION

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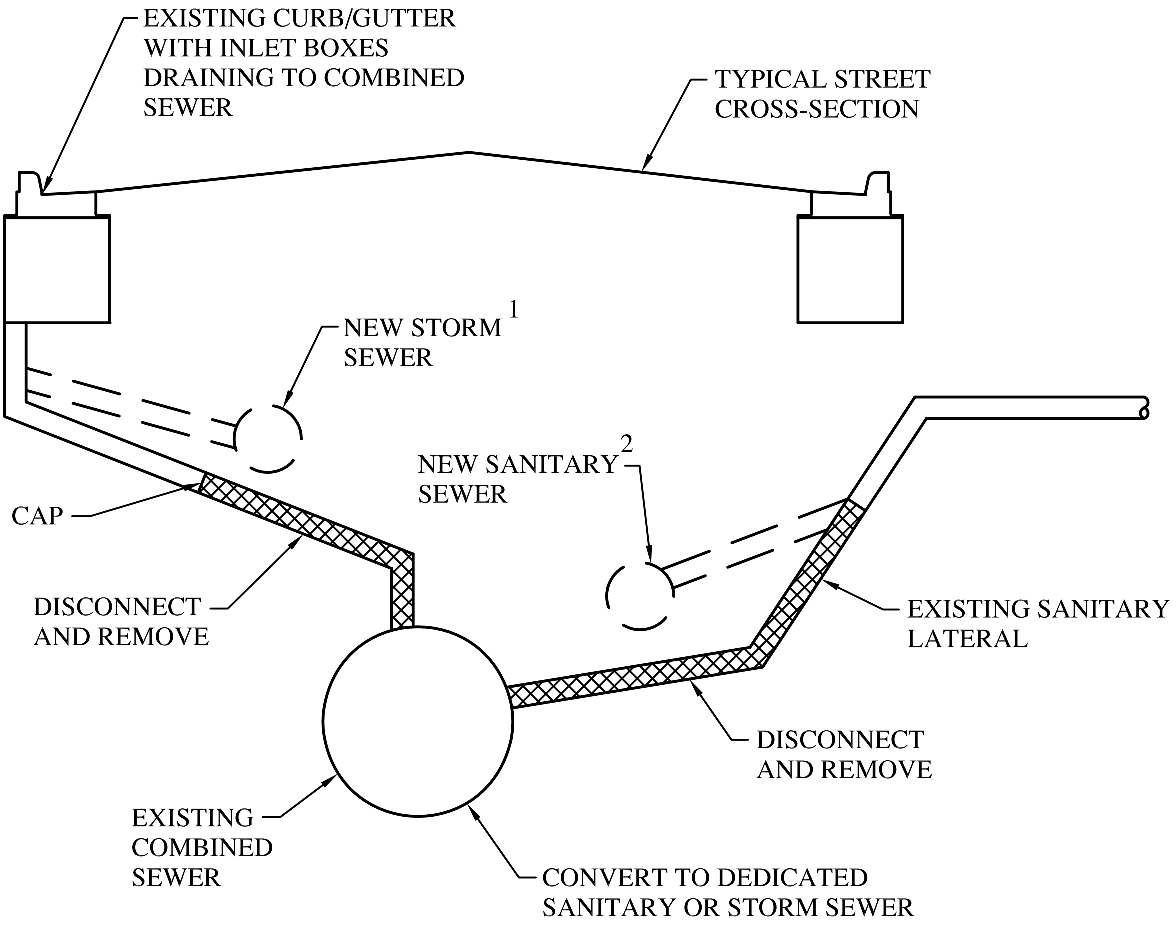
TYPICAL STORAGE TANKS



POTENTIAL SEWER SEPARATION (2 OPTIONS)

1. CONSTRUCT NEW STORM SEWERS, CONNECT INLETS AND STORM OUTLETS TO NEW STORM SEWER WITH DEDICATED OUTLET. EXISTING COMBINED SEWER CONVERTED TO SANITARY SEWER.

2. CONSTRUCT NEW SANITARY SEWER AND RECONNECT ALL SANITARY LATERALS TO NEW SEWER. EXISTING COMBINED SEWER CONVERTED TO STORM SEWER WITH EXISTING STORM WATER CONNECTIONS TO REMAIN.

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FIGURE 6.3-1B
COMBINED SEWER
SEPARATION OPTIONS

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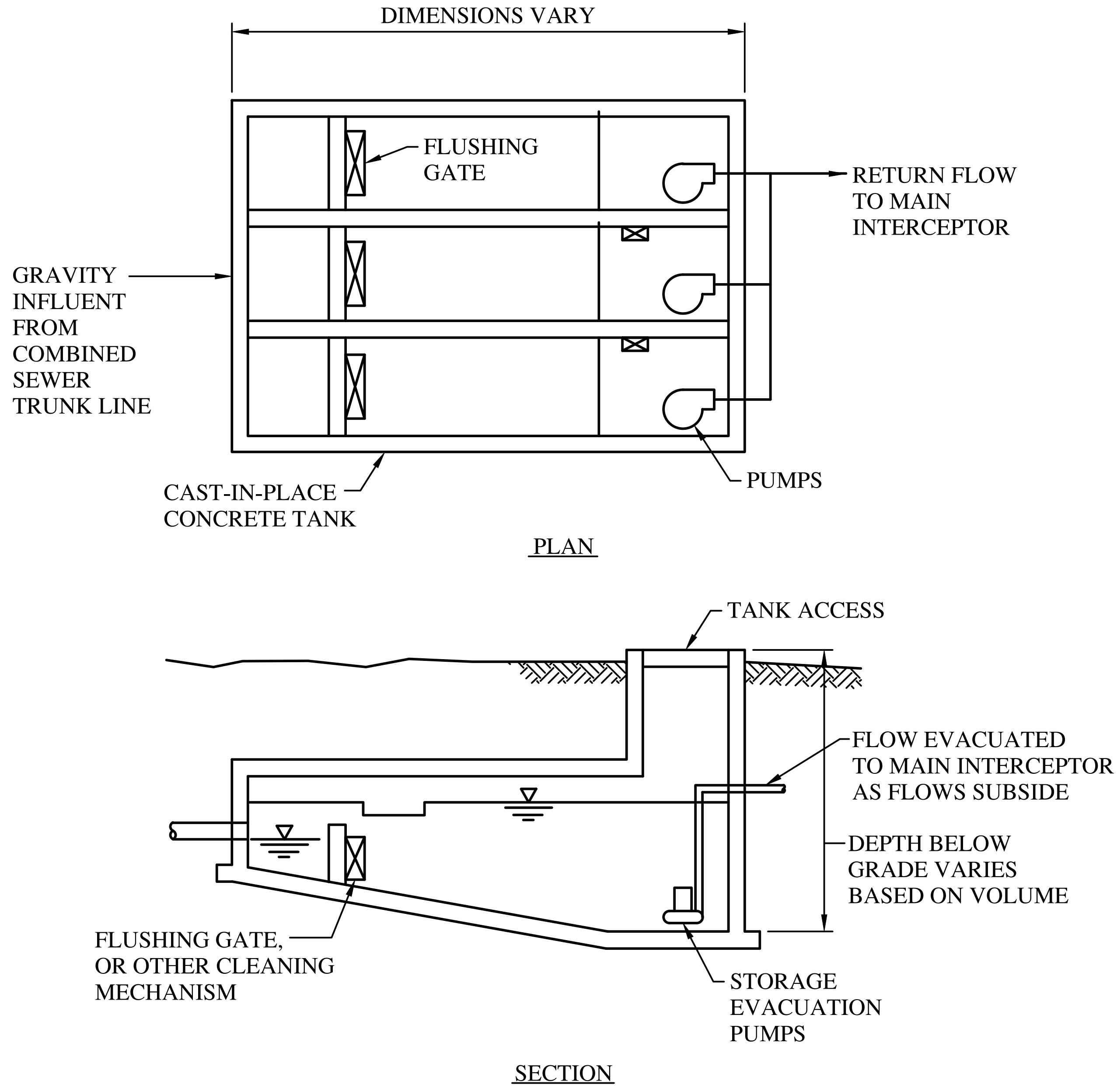
TYPICAL STORAGE TANKS



TYPICAL SUB-GRADE COVERED CONCRETE STORAGE TANK

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FIGURE 6.3-3
TYPICAL CONCRETE
STORAGE TANK

FIGURE 6.3-4
INTERNATIONAL PAPER SITE LAYOUT

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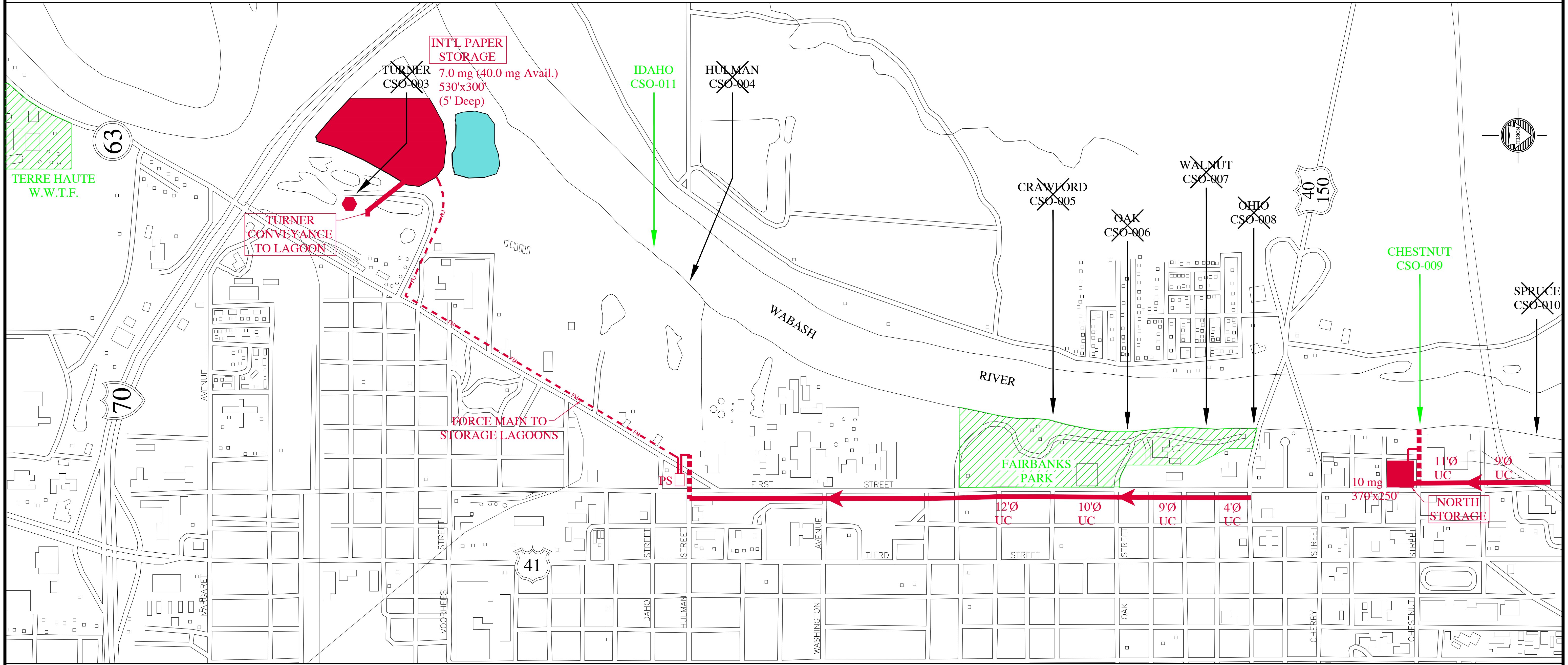

LEGEND

←	RELIEF SEWER AND FLOW
⬢	MAIN LIFT STATION
■	STORAGE TANK (INCLUDES SIZE AND VOLUME)
UC	ULTIMATE CONVEYANCE
12"Ø	RELIEF SEWER SIZE
□	NEW PUMP STATION
- - FM - -	NEW FORCE MAIN
CSO-009A ┬	NEW CSO FROM CONSOLIDATION
~~OHIO CSO-008~~	EXISTING CSO TO BE ELIMINATED
OHIO CSO-008	EXISTING CSO TO REMAIN
▬ ▬ ▬ T ▬	CSO TUNNEL
── ─ ──	STORAGE STRUCTURE DISCHARGE

NOTE: SIZES BASED ON 4 OVERFLOWS PER YEAR

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FIGURE 6.6-1
ALTERNATIVE 1
NORTH STORAGE/INTERNATIONAL
PAPER STORAGE - OPTION 1

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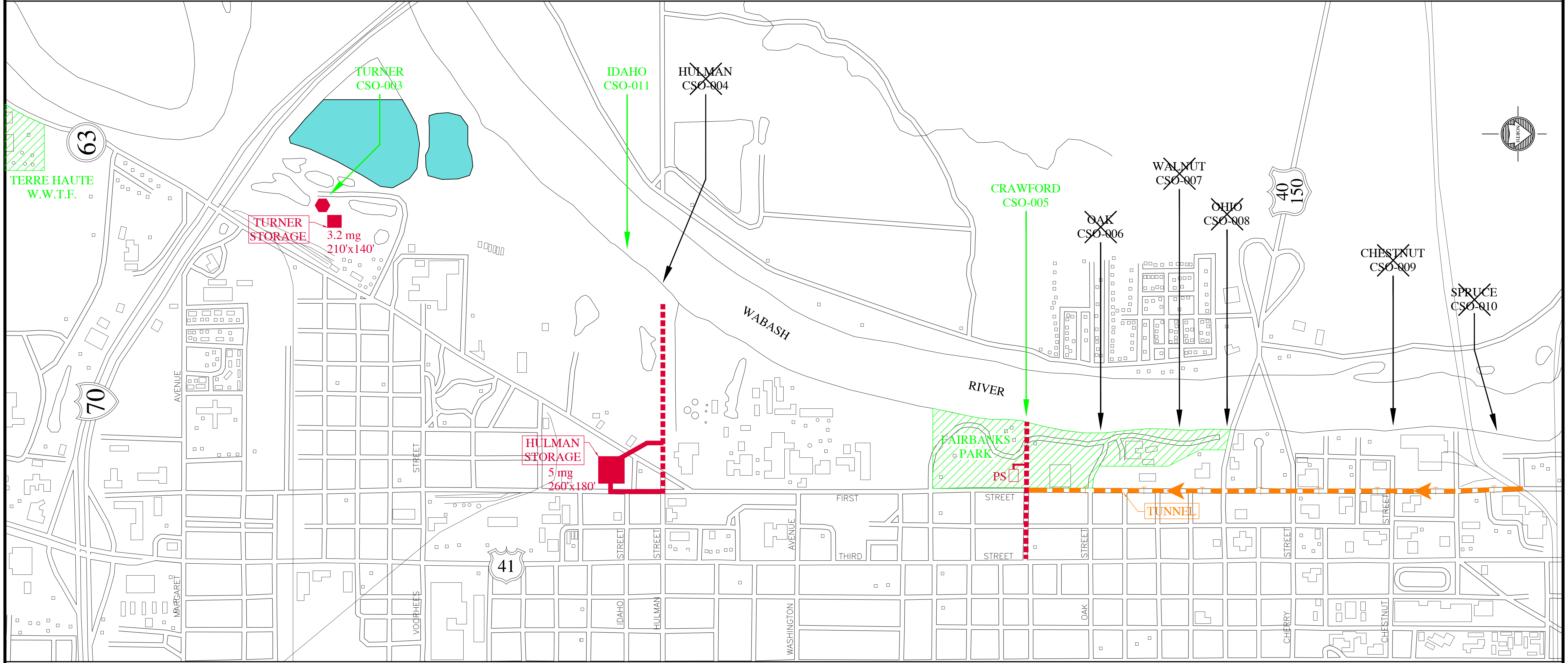

LEGEND

◄—	RELIEF SEWER AND FLOW
⬢	MAIN LIFT STATION
■	STORAGE TANK (INCLUDES SIZE AND VOLUME)
UC	ULTIMATE CONVEYANCE
12"Ø	RELIEF SEWER SIZE
▪▪▪▪▪▪▪	EXISTING INFRASTRUCTURE
CSO-009A ┴	NEW CSO FROM CONSOLIDATION
~~OHIO CSO-008~~	EXISTING CSO TO BE ELIMINATED
OHIO CSO-008	EXISTING CSO TO REMAIN
▬ ▬ ▬	CSO TUNNEL DIAMETER - 17 FEET LENGTH - 5,600 FEET VOLUME - 9.5 mg

NOTE: SIZES BASED ON 4 OVERFLOWS PER YEAR

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FIGURE 6.6-2
ALTERNATIVE 5A
NORTH TUNNEL WITH TANK STORAGE

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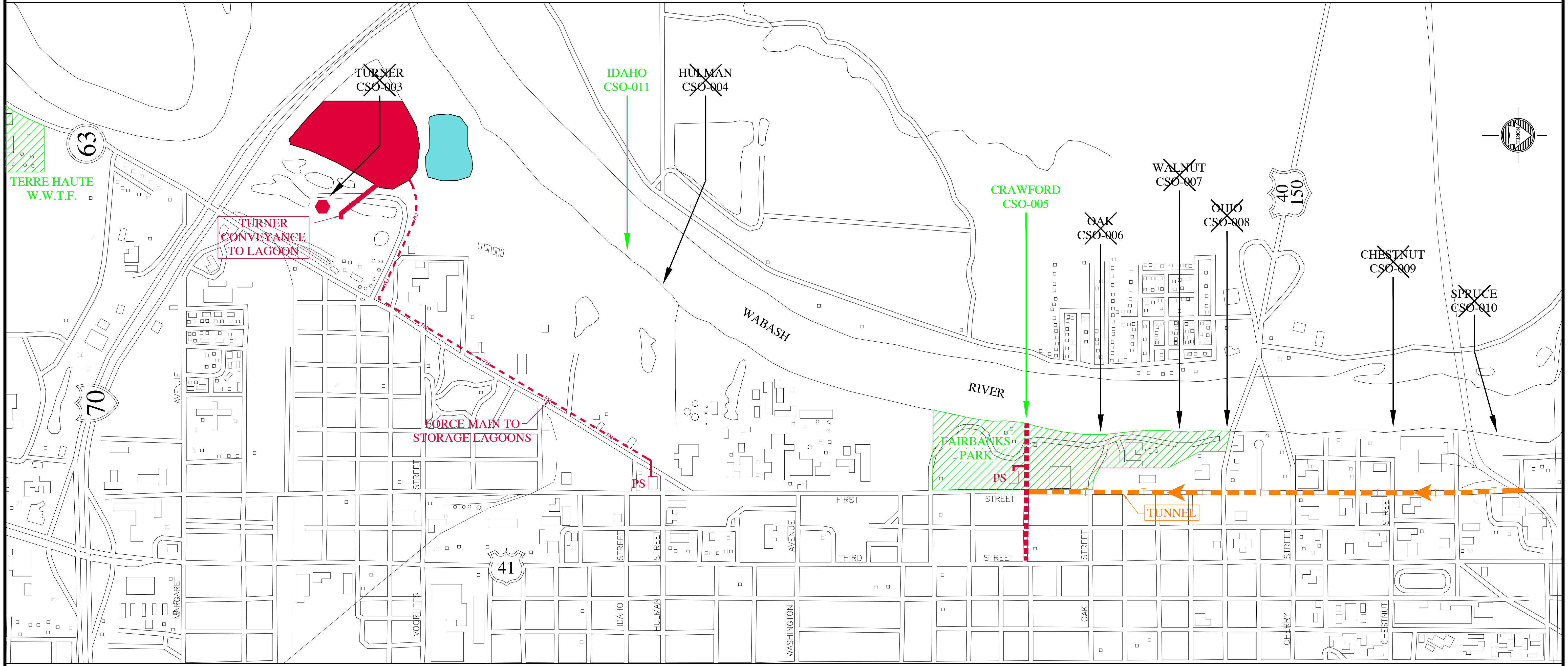

LEGEND

◀━	RELIEF SEWER AND FLOW	CSO-009A ┴	NEW CSO FROM CONSOLIDATION
⬢	MAIN LIFT STATION	~~OHIO CSO-008~~	EXISTING CSO TO BE ELIMINATED
■	STORAGE TANK (INCLUDES SIZE AND VOLUME)	OHIO CSO-008	EXISTING CSO TO REMAIN
UC	ULTIMATE CONVEYANCE	▬ ▬ ▬ T	CSO TUNNEL DIAMETER - 17 FEET LENGTH - 5,600 FEET VOLUME - 9.5 mg
12"Ø	RELIEF SEWER SIZE		
▪▪▪▪▪	EXISTING INFRASTRUCTURE		
□	NEW PUMP STATION		
- - FM - -	NEW FORCE MAIN		

NOTE: SIZES BASED ON 4 OVERFLOWS PER YEAR

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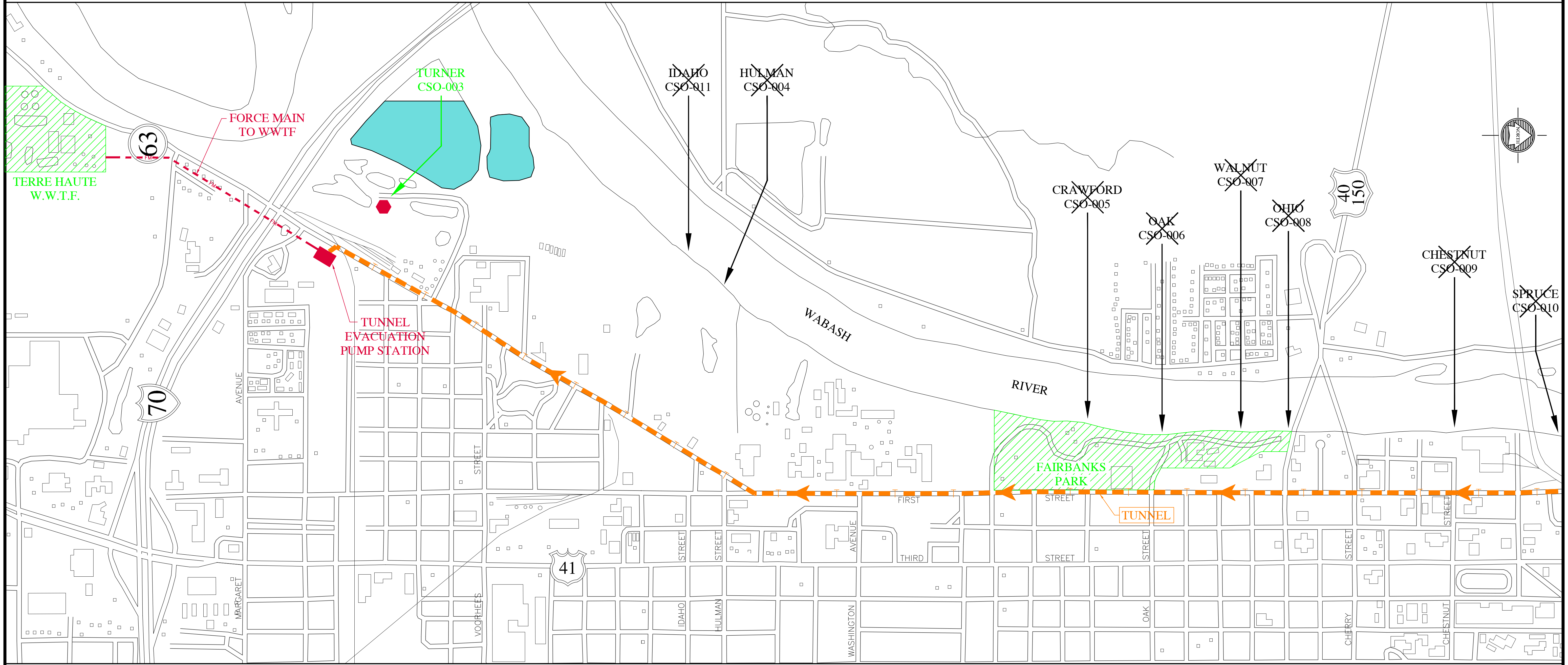
FIGURE 6.6-3
ALTERNATIVE 5B
NORTH TUNNEL WITH INTERNATIONAL
PAPER STORAGE

Terre Haute CSO LTCP



LEGEND

◄━	RELIEF SEWER AND FLOW	CSO-009A ┴	NEW CSO FROM CONSOLIDATION
⬢	MAIN LIFT STATION	~~OHIO CSO-008~~	EXISTING CSO TO BE ELIMINATED
■	STORAGE TANK (INCLUDES SIZE AND VOLUME)	OHIO CSO-008	EXISTING CSO TO REMAIN
UC	ULTIMATE CONVEYANCE	━ ━ ━T	CSO TUNNEL DIAMETER - 17 FEET LENGTH - 14,700 FEET VOLUME - 24.6 mg
12"Ø	RELIEF SEWER SIZE		
▪▪▪▪▪▪	EXISTING INFRASTRUCTURE		
- - -FM- - -	NEW FORCE MAIN		

NOTE: SIZES BASED ON 4 OVERFLOWS PER YEAR

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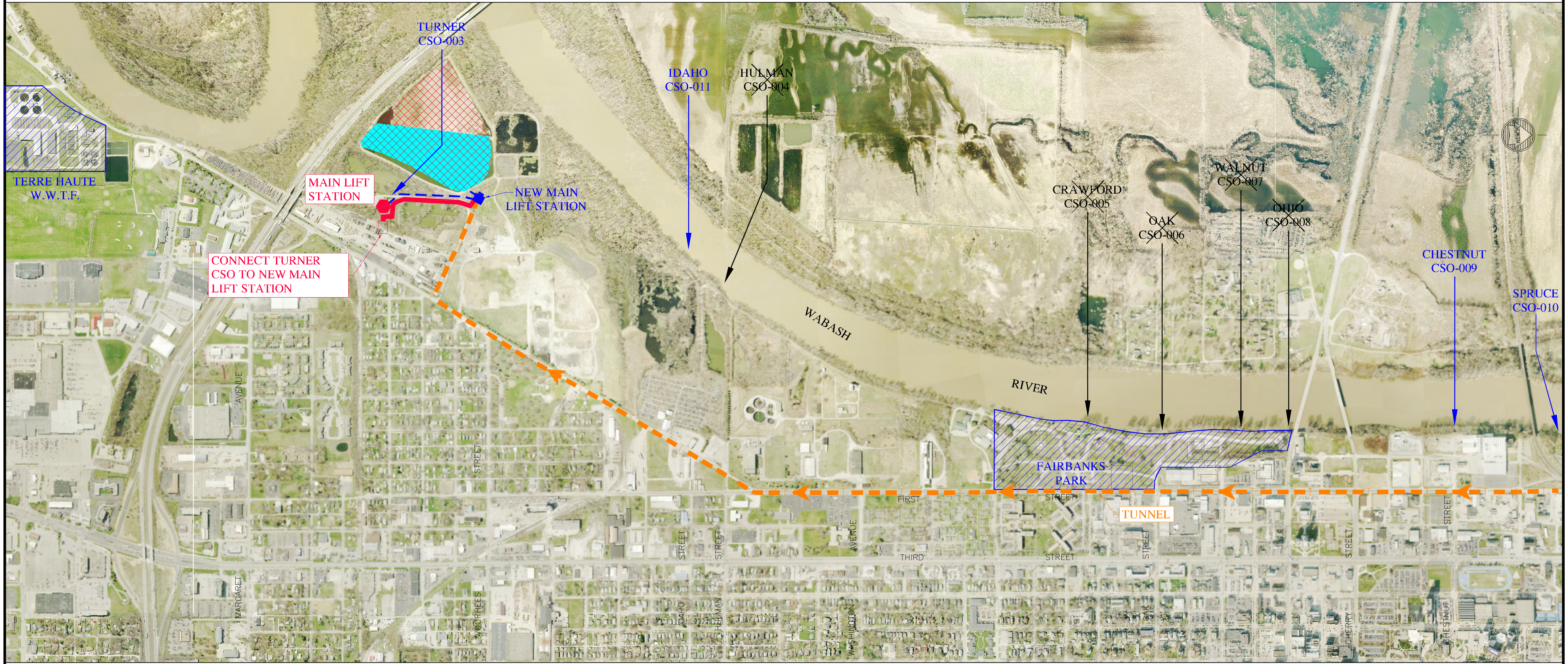
FIGURE 6.6-4
ALTERNATIVE 7
TUNNEL TO MAIN LIFT STATION

Terre Haute CSO LTCP



LEGEND

←	RELIEF SEWER AND FLOW	CSO-009A ┴	NEW CSO FROM CONSOLIDATION
⬢	MAIN LIFT STATION		
■	STORAGE TANK (INCLUDES SIZE AND VOLUME)	~~OHIO CSO-008~~	EXISTING CSO TO BE ELIMINATED
UC	ULTIMATE CONVEYANCE	OHIO CSO-008	EXISTING CSO TO REMAIN (SOME REMAIN OPEN AT LESSER LEVELS OF CONTROL)
12"Ø	RELIEF SEWER SIZE		
- - FM - -	NEW FORCE MAIN	▬ ▬ T ▬	CSO TUNNEL

TERRE HAUTE
A LEVEL ABOVE

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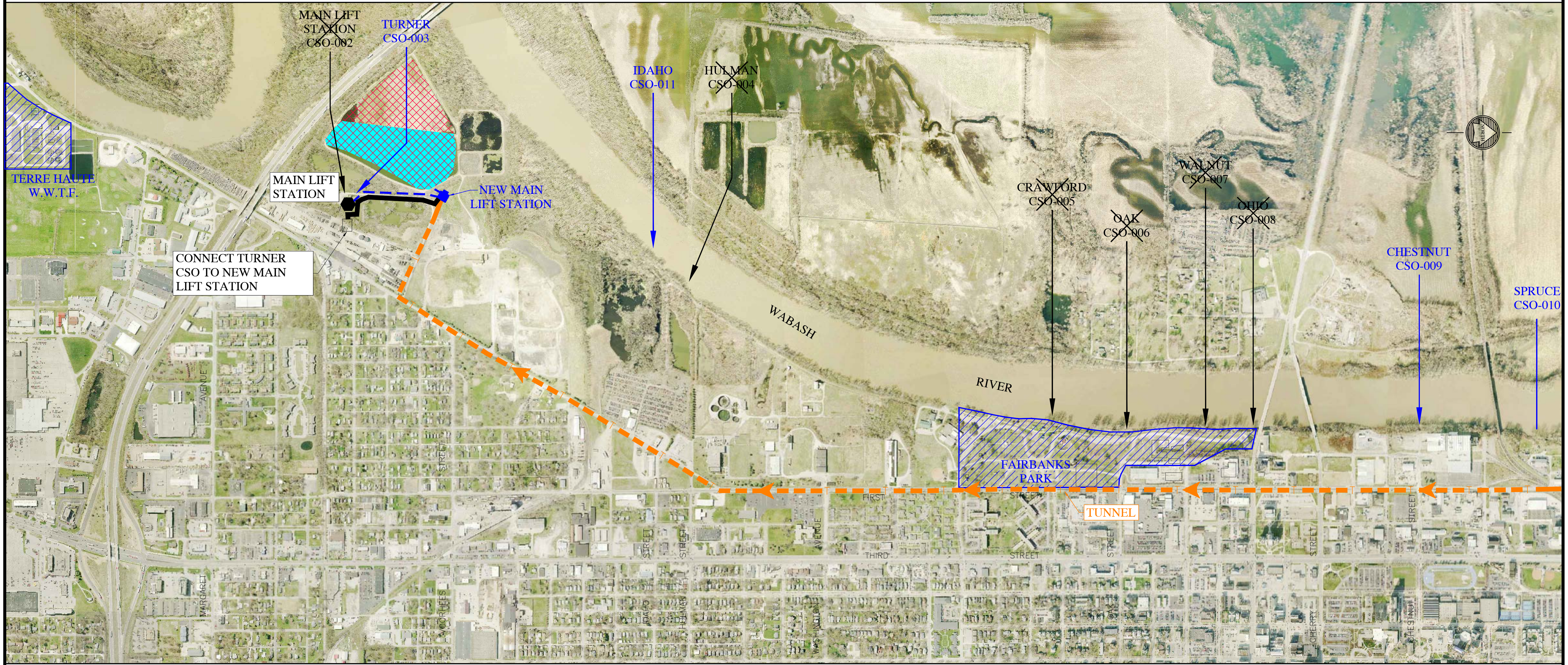
FIGURE 6.7-1
ALTERNATIVE 7B

Terre Haute CSO LTCP



LEGEND

⟵	RELIEF SEWER AND FLOW
⬢	MAIN LIFT STATION
■	STORAGE TANK (INCLUDES SIZE AND VOLUME)
UC	ULTIMATE CONVEYANCE
12"Ø	RELIEF SEWER SIZE
- - -FM- - -	NEW FORCE MAIN
CSO-009A ┬	NEW CSO FROM CONSOLIDATION
~~OHIO CSO-008~~	EXISTING CSO TO BE ELIMINATED
OHIO CSO-008	EXISTING CSO TO REMAIN (SOME REMAIN OPEN AT LESSER LEVELS OF CONTROL)
▬ ▬ T ▬	CSO TUNNEL

TERRE HAUTE A LEVEL ABOVE

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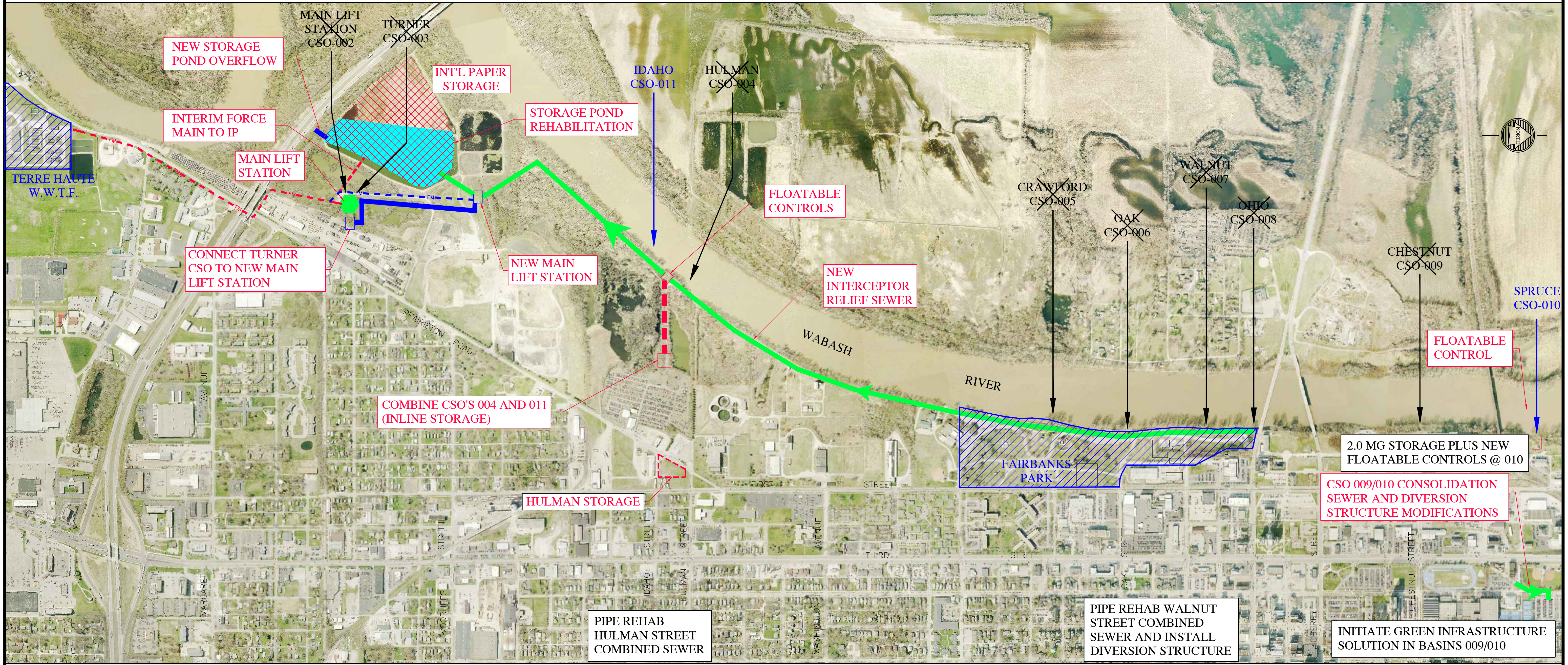
Figure 6.8-1
ALTNERATIVE 7B
REVISED - SEPTEMBER 2014

Terre Haute CSO LTCP



LEGEND

RELIEF SEWER AND FLOW

⬢ EXISTING MAIN LIFT STATION

12"Ø RELIEF SEWER SIZE

☐ NEW PUMP STATION OR STRUCTURE

- - FM - - NEW FORCE MAIN

▬ ▬ ▬ EXISTING COMBINED SEWER OUTFALL

~~OHIO CSO-008~~ EXISTING CSO TO BE ELIMINATED

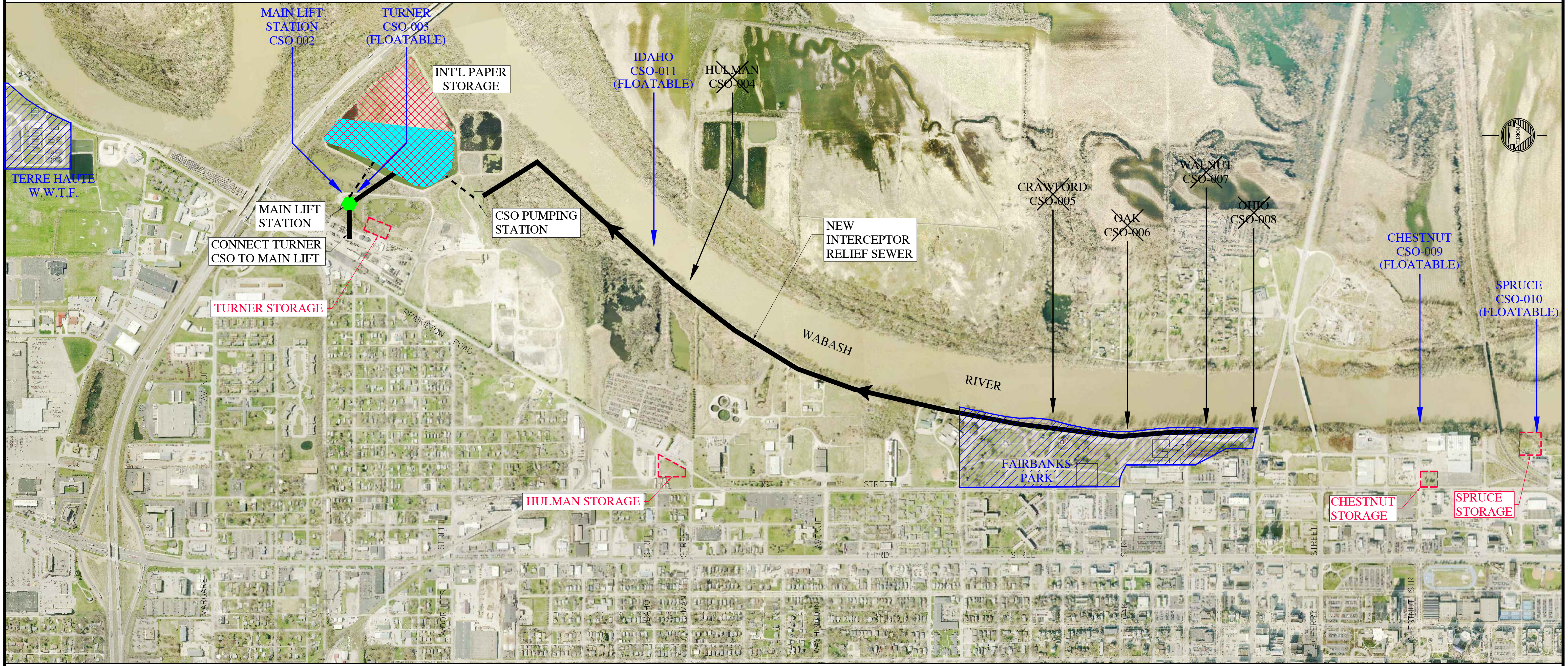
OHIO CSO-008 EXISTING CSO TO REMAIN (SOME REMAIN OPEN AT LESSER LEVELS OF CONTROL)

TERRE HAUTE A LEVEL ABOVE

HWC ENGINEERING

Figure 6.8-2
ALTERNATIVE 11
REVISED - SEPTEMBER 2014

Terre Haute CSO LTCP



LEGEND

◀━━	RELIEF SEWER AND FLOW
⬢	EXISTING MAIN LIFT STATION
12"Ø	RELIEF SEWER SIZE
☐	NEW PUMP STATION OR STRUCTURE
- - FM - -	NEW FORCE MAIN
~~OHIO CSO-008~~	EXISTING CSO TO BE ELIMINATED
OHIO CSO-008	EXISTING CSO TO REMAIN (SOME REMAIN OPEN AT LESSER LEVELS OF CONTROL)

TERRE HAUTE
A LEVEL ABOVE

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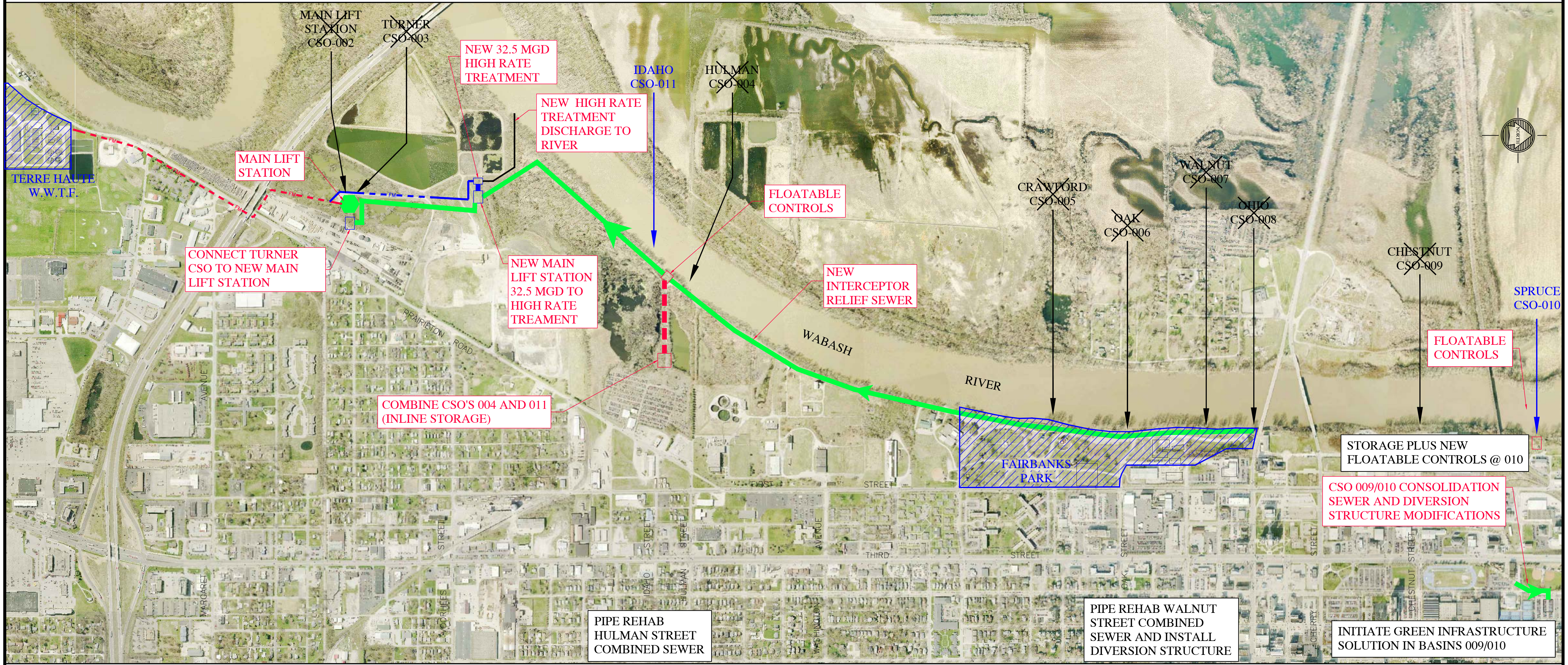
Figure 6.8-3
ALTNERATIVE - HYBRID
REVISED - SEPTEMBER 2014

Terre Haute CSO LTCP



LEGEND

◄━━	RELIEF SEWER AND FLOW	~~OHIO CSO-008~~	EXISTING CSO TO BE ELIMINATED
⬢	EXISTING MAIN LIFT STATION	OHIO CSO-008	EXISTING CSO TO REMAIN (SOME REMAIN OPEN AT LESSER LEVELS OF CONTROL)
12"Ø	RELIEF SEWER SIZE		
☐	NEW PUMP STATION OR STRUCTURE		
- - FM - -	NEW FORCE MAIN		
▬ ▬ ▬	EXISTING COMBINED SEWER OUTFALL		

TERRE HAUTE A LEVEL ABOVE

HWC ENGINEERING

Figure 6.8-4
Alternative 11b
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