WORLD BANK GROUP

AECOM

Flood Management & Irrigation System Rehabilitation - Solutions in Indian Context

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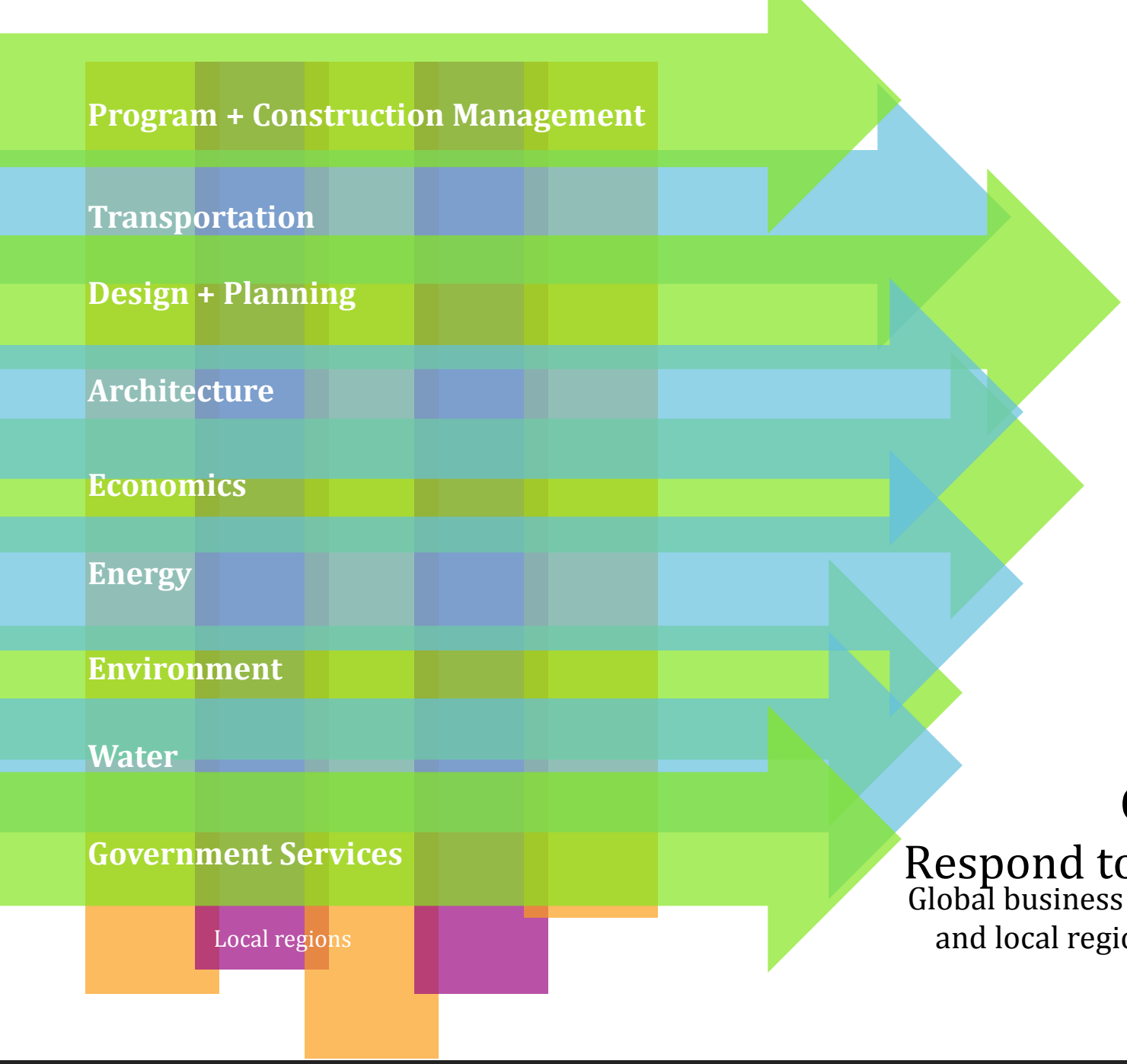
AECOM Worldwide…

Global Professional and Technical Management Support Service Leader

+130 Countries **7** Continents **$8.1B** Revenue **45,000** People



Organized to Respond to your Needs

Global business lines (what we do) and local regions (where we are)

AECOM Worldwide…

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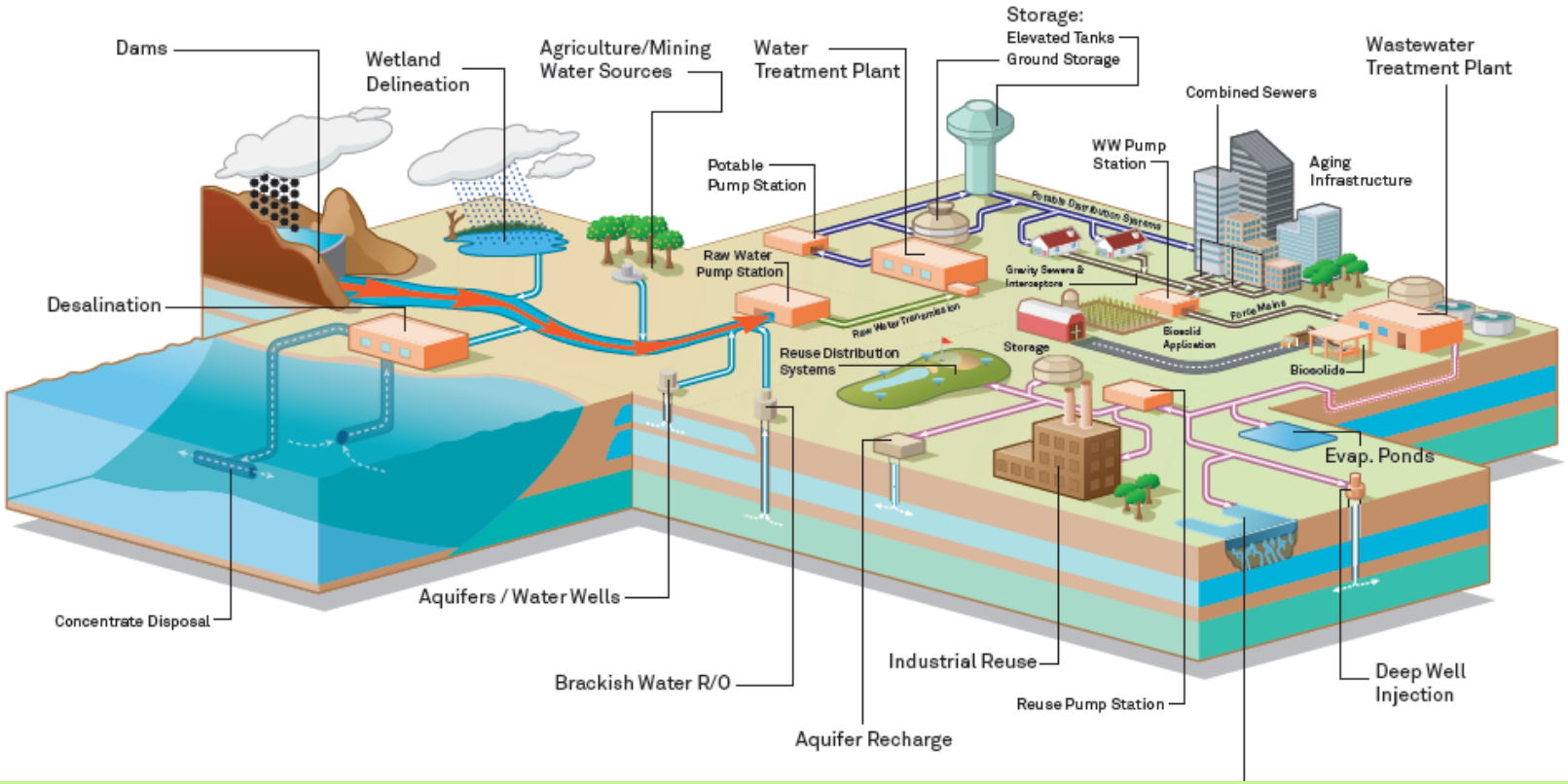
+130 Countries **7** Continents **$8.1B** Revenue **45,000** People

Integrated Water Services
All Encompassing Water-related Capabilities



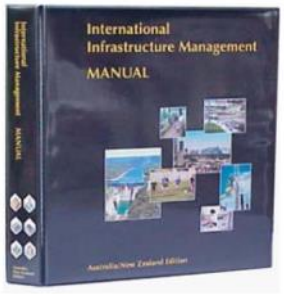
Master Plans, Water Supply & Treatment, Water Transmission & Distribution

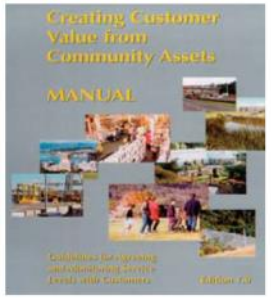
Water Quality Planning, Water Resources Engineering

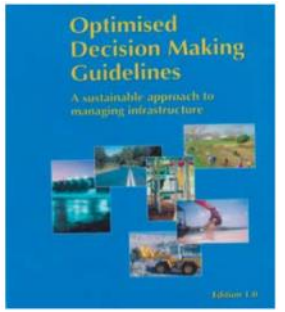
Wastewater Collection & Treatment, Stormwater Treatment & Disposal

AECOM as a Leading Technology Integrator

- **Wet Weather Technology**
  - Advanced hydraulic modeling
  - Real time control solutions
  - Peak Flow attenuation
  - Overflow treatment process technologies
- **Asset Management**
  - Global Bench Marking Leader
  - Integrated GIS, hydraulic and condition models
  - Master planning and utility rate based modeling
- **Climate Change**
  - Watershed impacts
  - Coastal flooding and mapping
  - Water supply forecasting







AECOM's Water Resources Capabilities

- Flood risk Identification and Mitigation
- Flood control and drainage modeling
- Dams and reservoirs
- Hydropower infrastructure and facilities
- Water supply: regional planning, pump stations, canals, inter-basin transfers
- Stormwater management
- Irrigation and agricultural drainage
- Coastal modeling and protection

Contents

Paris

Paris

wea00714, Historic NWS Collection_1969.jpg

James River at Richmond, Va., Main Street Facing West, August 23, 1969 (Courtesy, Richmond Times Dispatch)

FFA Houston 1935


HIGH OCCUPANCY
VEHICLES ONLY
2PM TO 8PM

Flooding issues in Ganga River Basin

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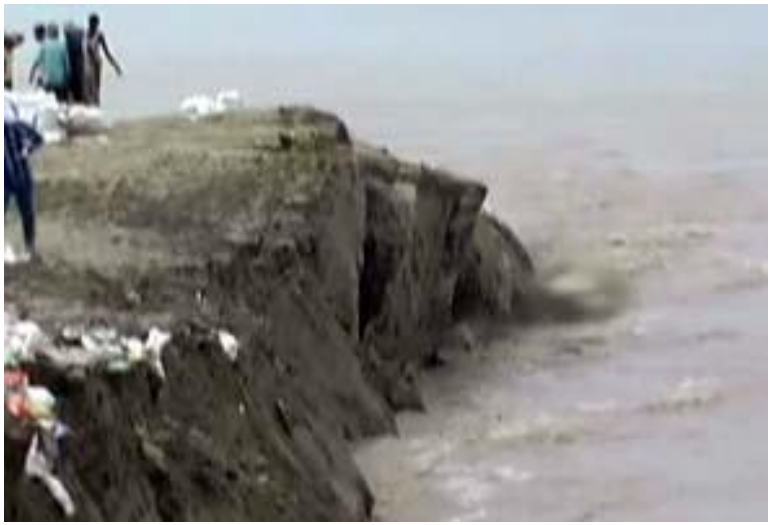
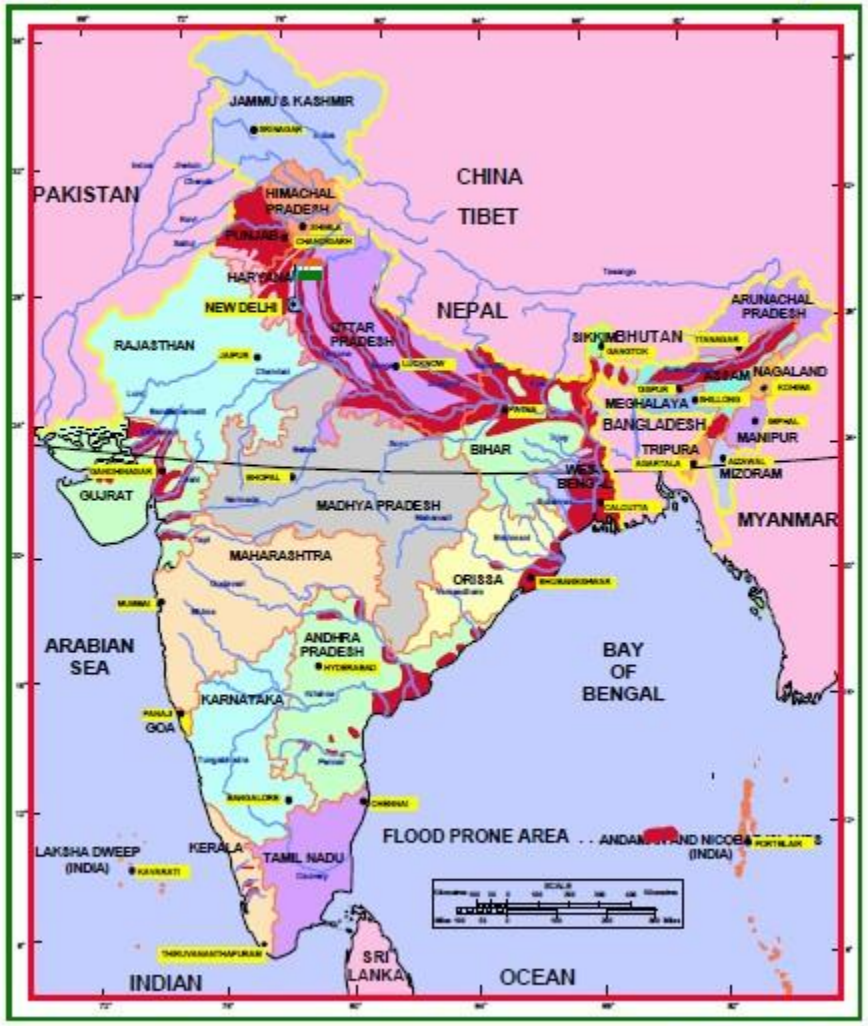
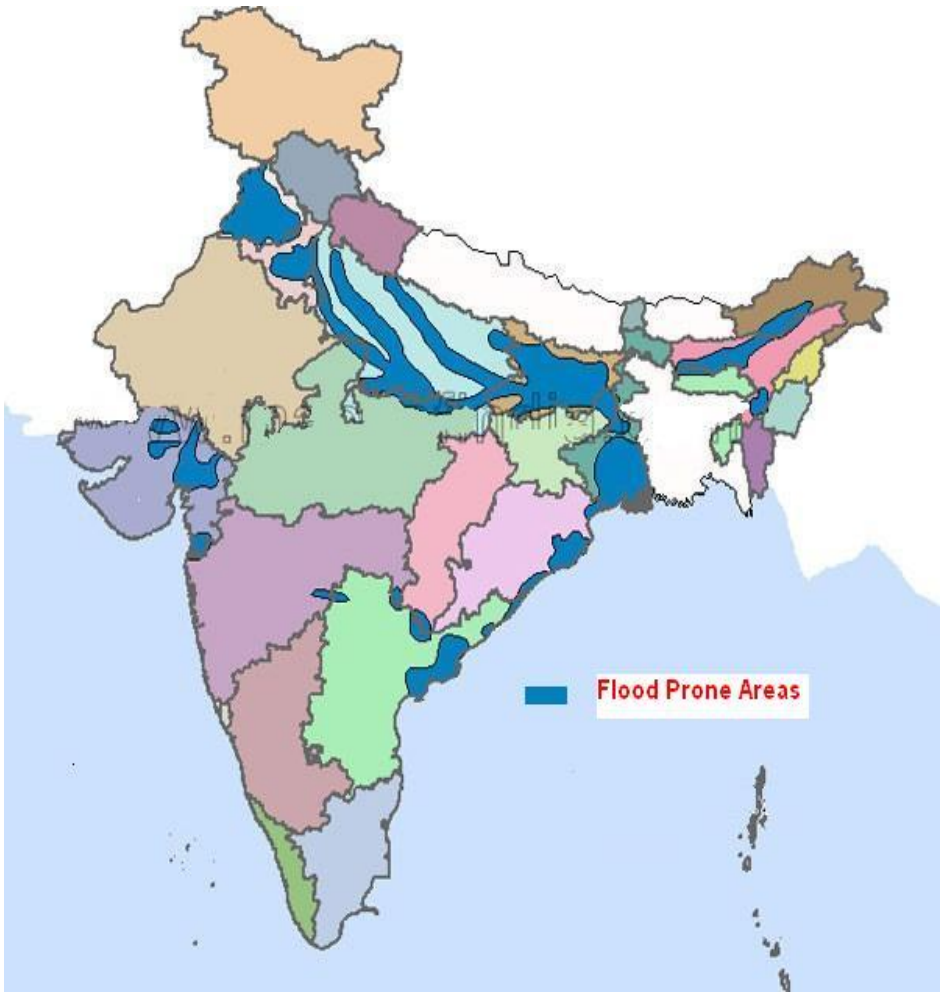
- Flooding caused by Northern Tributaries of Ganga;
- UP, Bihar & West Bengal are worst affected States;
- The rivers causing flooding are Sarda, Ghaghra, Rapti, Gangdak & Ganga;
- Flooding mainly in Monsoon due to spilling over of banks, change of course of rivers;
- Flooding cause damage to crops, dislocation of life & loss of lives, dwelling, infrastructure, installations, properties, communications etc.



AREA LIABLE TO FLOODS

Source: NIH





CWC/FMP/3043

Out of total flood prone area of 40mha, 15.8mha area has been protected (NIH, 2004)

What Level of Study and Type of Model to Use?

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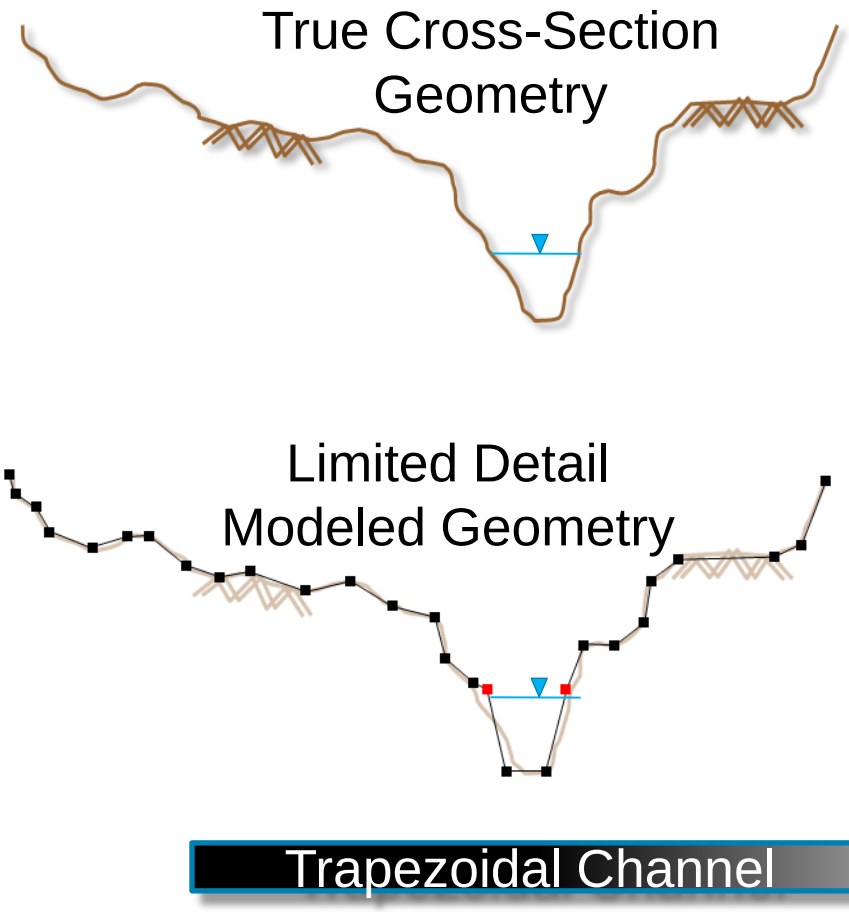
Depends on:

- **Availability and quality of input data**
- **Level of flood risk and population/infrastructure impacted**
- **Availability of Funding**
- **Purpose of Flood Hazard Analysis**
- **Topography of Study Area**
- **Degree of Urbanization**
- **Most situations require a combination of models and type of studies**
  - **Approximate studies** or **limited detail studies** for sparsely populated areas
  - 1-D model for steep to moderately sloped terrains with less floodplain obstructions
  - 2-D model for very flat terrains and densely populated areas or large number of buildings in the floodplain

Approximate, Limited Detail, and Detailed Studies

- **Approximate Study**
  - Flood Elevations not shown on the map
  - No hydraulic structures in models
  - No survey
- **Detail Study**
  - Flood Elevations shown on the map
  - Hydraulic structures included in models
  - Structures and cross-sections surveyed
- **Limited Detail Study**
  - Flood Elevations may or may not be shown on the map
  - Hydraulic structures included in models
  - Structures field-measured
  - Channel cross-section shape is estimated as a trapezoid instead of field surveyed



Riverine Study Matrix – Framework

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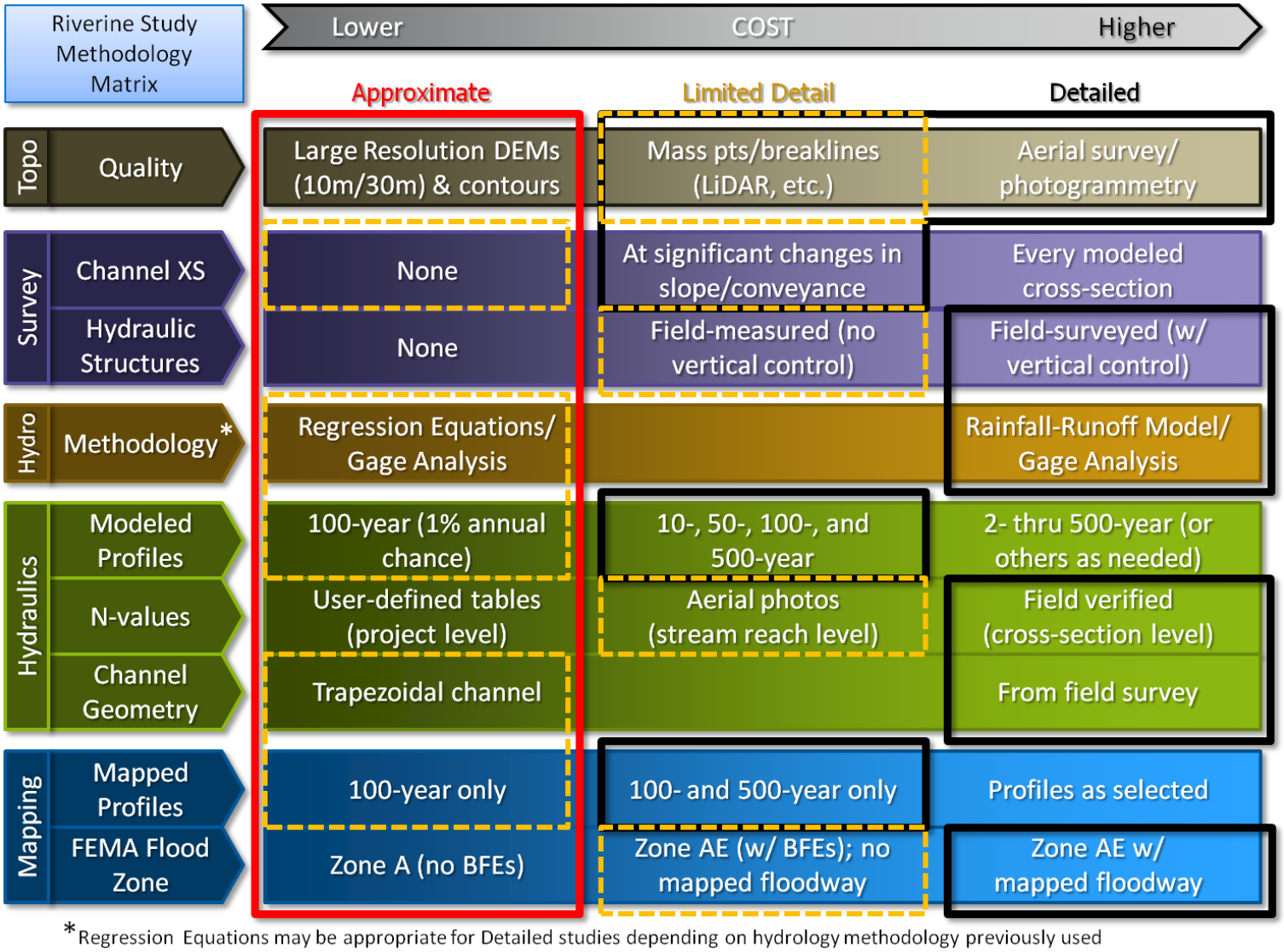
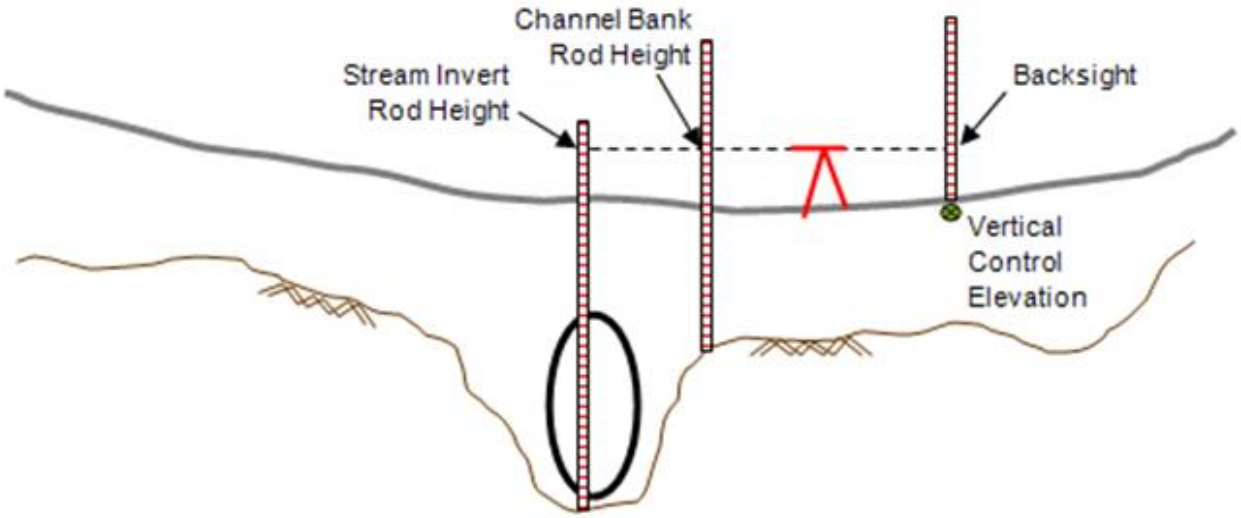


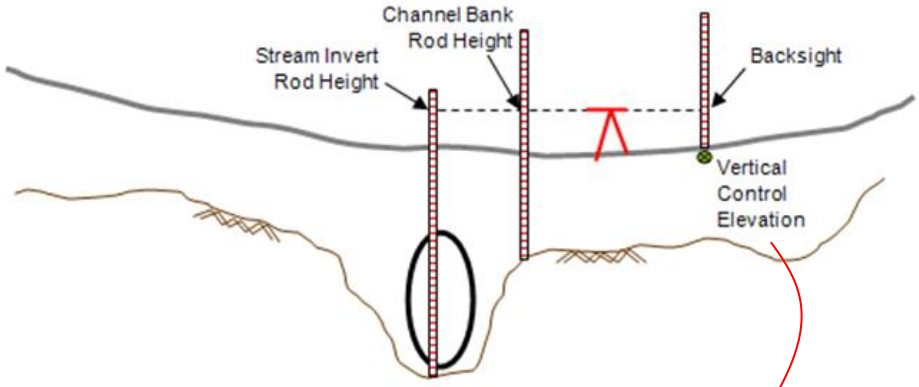
*Regression Equations may be appropriate for Detailed studies depending on hydrology methodology previously used

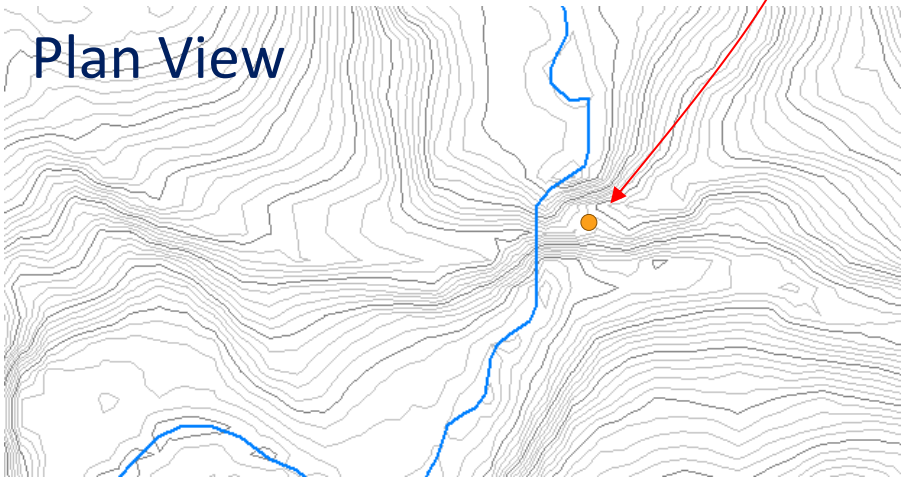
Limited Detail Study Distinctions

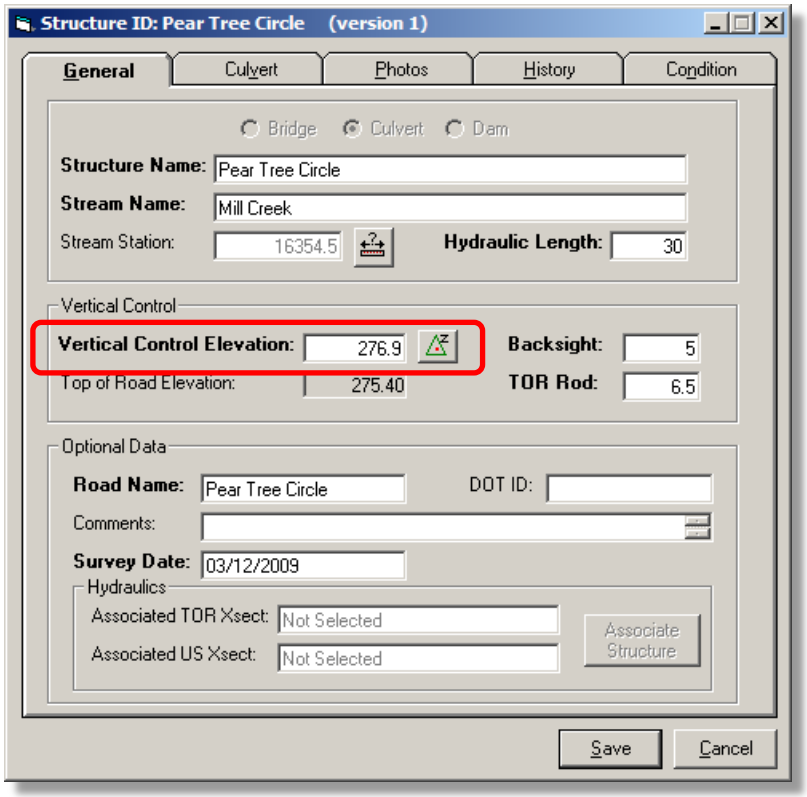
- Hydraulic Structures (Bridges, Culverts, Dams) are Field "Measured" as opposed to Field "Surveyed"
- Modeled structure elevations are referenced to a vertical control elevation (VCE) point collected in the field by GPS
- VCE is estimated using topographic elevation at point



Limited Detail Study Distinctions







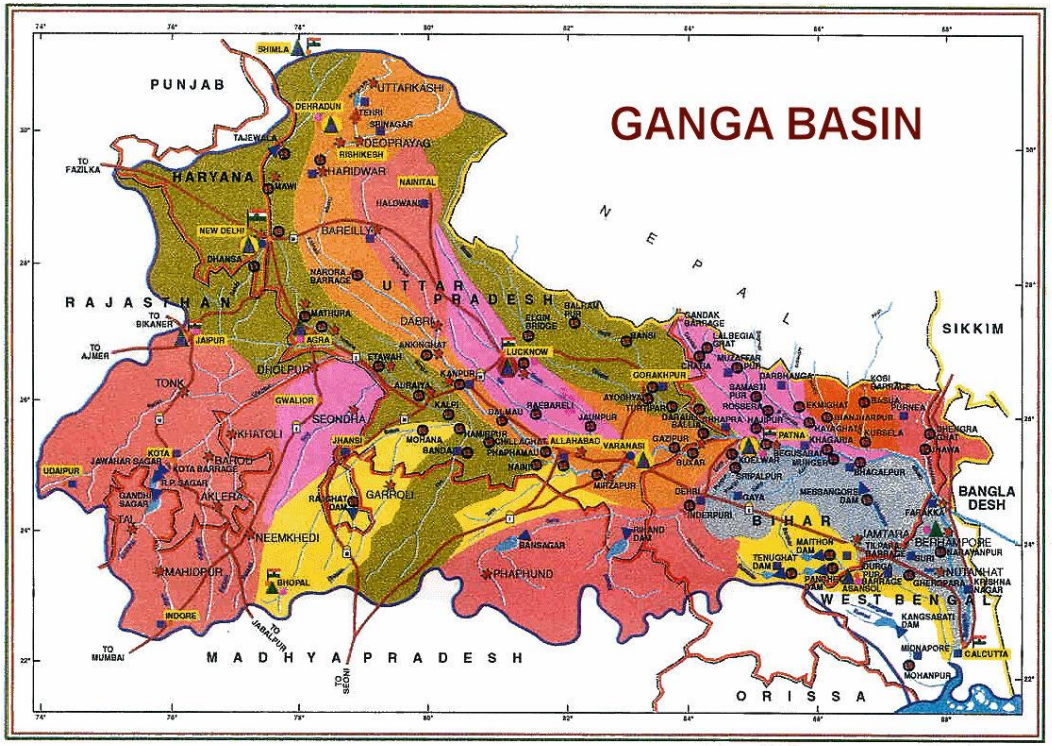
Limited Detail structure data entry tool in WISE®

Limitations of Limited Detail Study

- Accuracy highly dependent upon quality of topographic data –
- Because stream channel geometry is not surveyed, the Limited Detail methodology may be less accurate for very steep or narrow streams where the majority of the conveyance is in the channel
- Studies where the accuracy of the model is more critical at lower recurrence intervals (where the majority of flow may still be within the channel) may be more appropriate using traditional detailed study methods.

Data Requirements for Commonly used Models

- Topographic Data (LiDAR, Survey, others)
- Meteorological Data (rainfall record)
- Hydrologic Data (stream gauging station record)
- Soil Data (type of soil and drainage properties)
- Land Use Data (impervious, pervious, semi pervious)
- Aerial Imagery



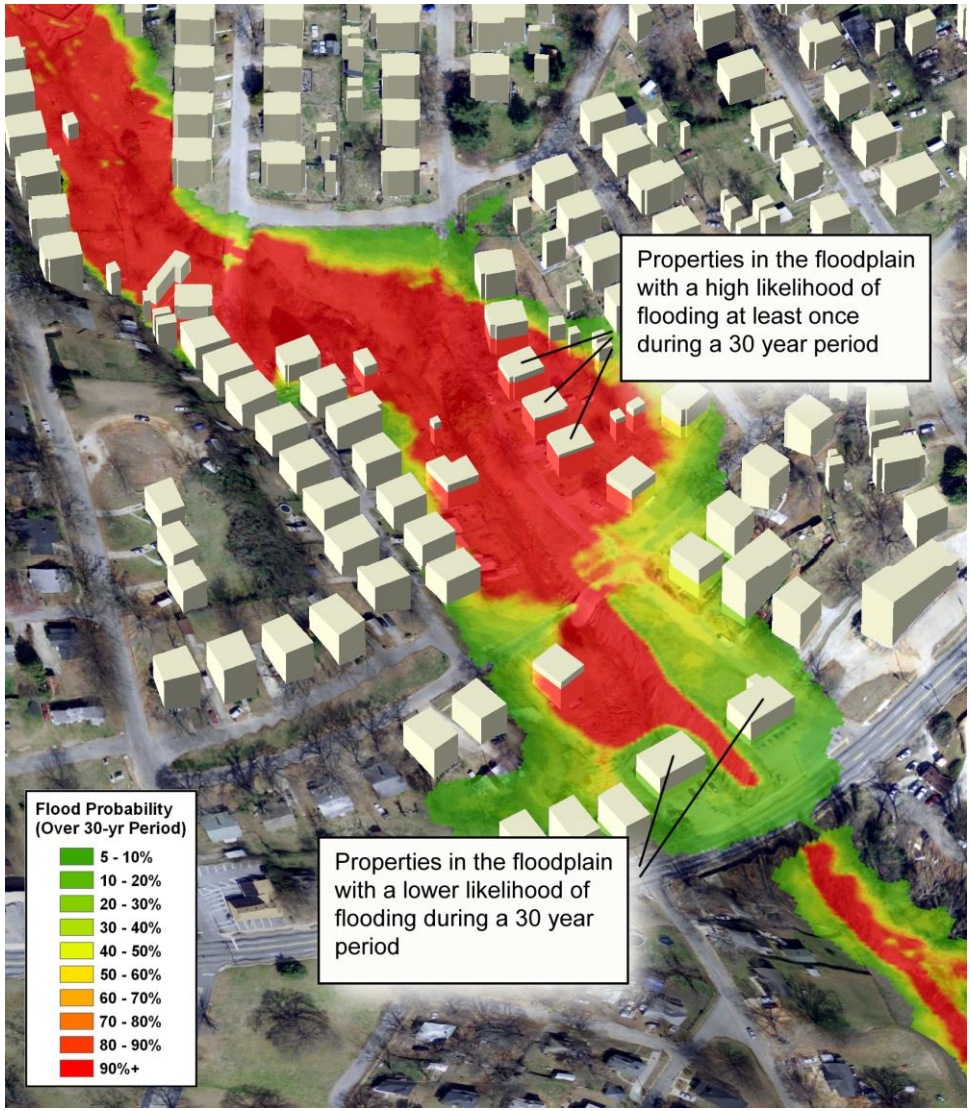
PROJECTS : Existing, Ongoing, Under Consideration

OBSERVATION SITES : Gauge(G), Gauge Discharge(GD), Gauge Discharge Sediment(GDS), Gauge Discharge Water Quality (GWQ), Gauge Discharge Sediment Water Quality(GDSQ), Flood Forecasting(FF)

STATE CAPITALS :

Floodplain Mapping

- Identification of low, moderate, and high risk flood areas
- Flood severity and inundation mapping
- Levee and dam risk mapping
- LiDAR data management
- Flood depth mapping



Flood Mapping & Analysis: Estimated Cost for Ghaghra River

- **Approximate Studies – Rs 3.5 crores to Rs 6 crores**
- **Limited Detail Studies – Rs 5 crores to Rs 25 crores**
- **Detailed Studies – Rs 30 crores to Rs 65 crores**

Assumptions –

Use of Regression Equations for Approximate Studies

Availability of digital topographic, soil, and land use data.

Availability of meteorological and stream gage data

Use of 1-D modeling

Approximate length of Ghaghra River and its tributaries is @ 2000 km

Flood Warning System (FWS) Goals

- Reduce the injuries, loss of life and property damage resulting from floods
- Utilize existing infrastructure to minimize implementation timeframe, but not at the expense of long term effectiveness
- Optimize FWS technologies and procedures to minimize implementation and operational costs
- Identify motivated agencies and reliable funding mechanisms to improve the probability of a long-term sustainable solution

Additional Flood Warning System Goals

- Prioritize areas with the most urgent needs
- Design and implement technology and procedures to address the most urgent needs in advance of the next flood season
- Implement a long term solution to supplement the short term solutions identified for the “urgent needs”
  - Investigate other flood risk mitigation alternatives to determine the appropriate mix of infrastructure improvements, public education, and emergency procedures to effectively and efficiently reduce flood risks to acceptable levels

Flood Warning System – Integrated Process

Proposed Implementation Process

Stage 1: Planning

- Identify Areas to Receive Flood Warning Protection
- Identify Flood Hazards in the Defined Areas
  - Research Historical Floods (known hazards)
  - Prepare Engineering Models to Simulate Flood Scenarios (potentially unknown hazards)
- Identify Populations and Infrastructure at Risk in the Flood Hazard Areas
- Assess Response Capabilities
  - Identify Organizations which Participate in Flood Response in the Defined Areas
  - Estimate Response Capabilities and Timelines
- Identify Responsible Agency
  - Develop a Funding Plan

Determine Needs & Capabilities

Stage 2: Design & Implementation

- Meteorological Forecasting
  - Local Agency and/or 3rd Party
- Precipitation Monitoring
  - Satellite, Radar and Gauges
- Discharge Monitoring
  - Gauges on Dams and Streams
- Data Collection
  - Need Reliable Communications
- Flood Forecasting
  - Engineering Models with Flood Mapping (static or dynamic)
- Develop Response Plans
  - Flood Emergency Action Plan
  - Internal Communications Plan
  - Operations & Maintenance Plan
  - Public Education Plan
  - Public Communications Plan
- System Implementation

Develop Systems & Procedures

Stage 3: Operations

Ongoing Activities:

- Operator Training
- Public Education
- Daily Operations
  - Staff Operations Schedule
  - Maintenance Schedule
  - Monitor Meteorological Forecasts (long & short range)
  - Monitor Flood Forecast Models
  - Follow EAP Guidance for Flood Operation Triggers
- Flood Operations
  - Mobilize, Monitor & Forecast
  - EAP Response Guidance for Warnings & Evacuations
  - Update Forecasts
  - After-action Debriefs
  - Revise Plans as Appropriate

Effective & Sustainable Operations

FWS Schematic

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FWS Operators

Data Telemetry

Base Station Computers

Emergency Managers

Remote Sensor Sites

- Multi user access
- Communications
- Error checking
- Data storage/retrieval
- Alarm triggers
- Hydrologic forecast modeling
- Hydraulic modeling
- Floodplain delineation mapping
- Relational database (mirrored)
- Primary-backup, with automatic fail-over
- Messaging with EMS and external systems

other agencies & services

Automated Warning Devices (optional)

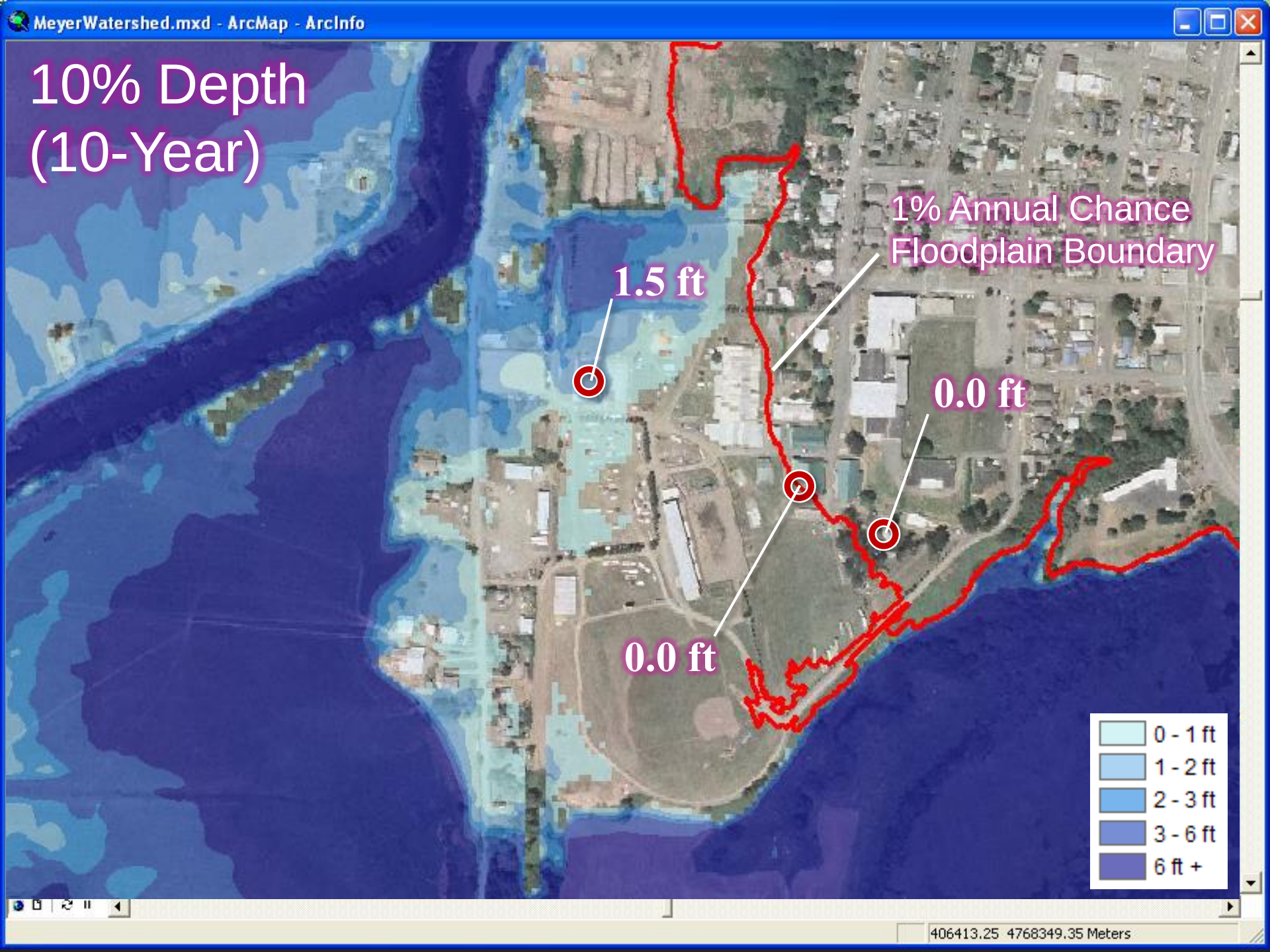
Public

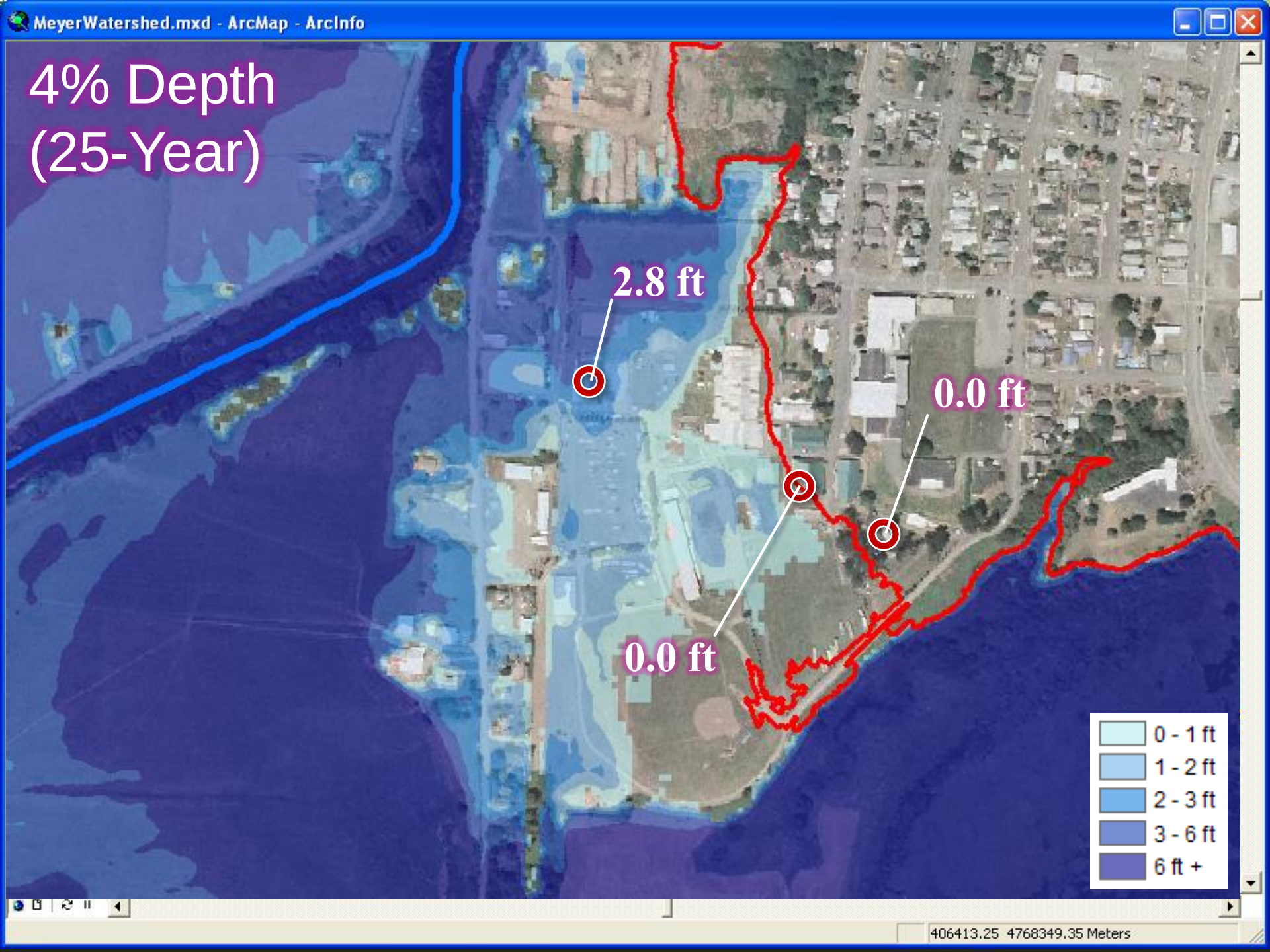
Costs for FWS

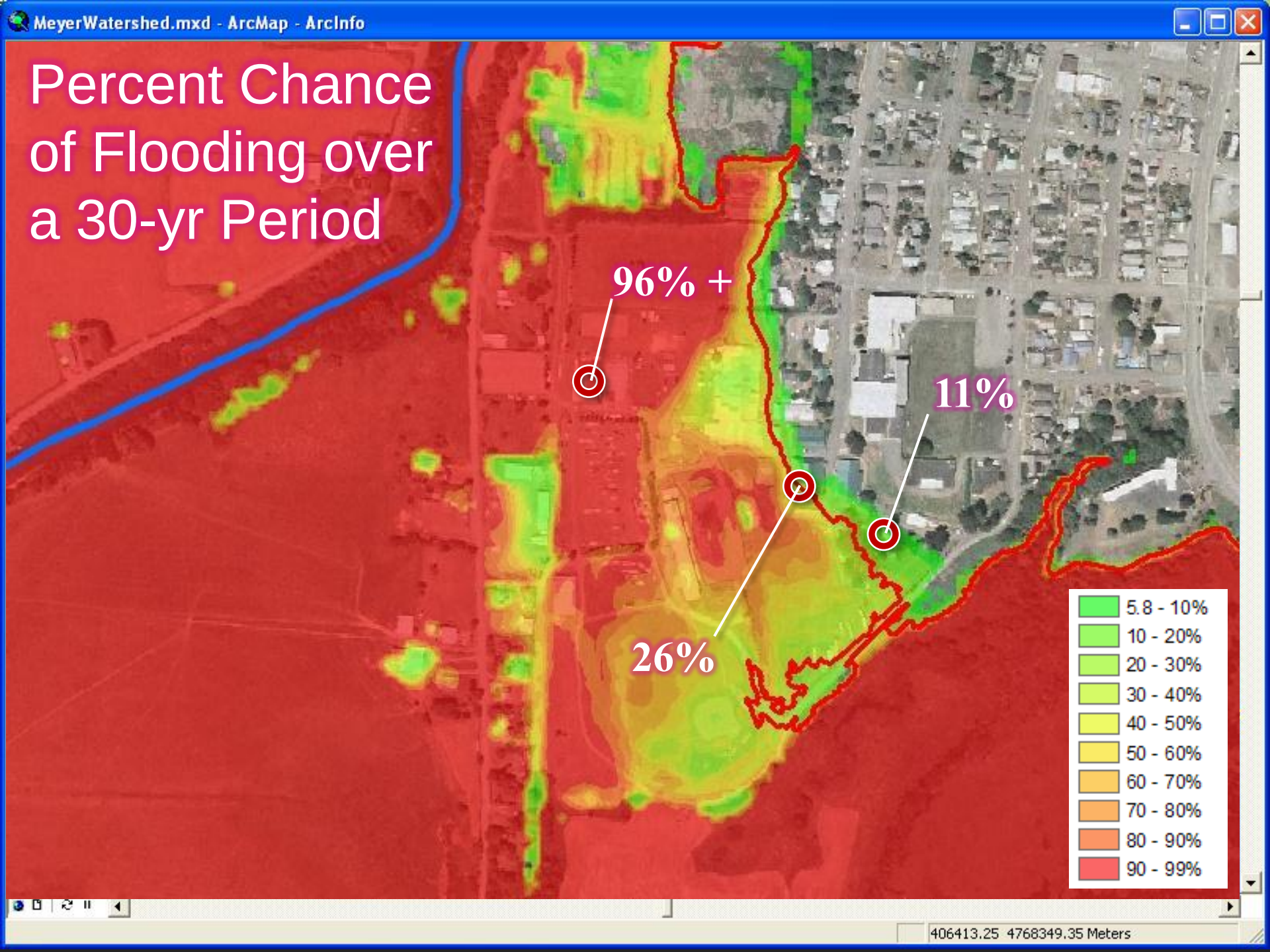
- FWS design process begins with needs assessment of the flood hazards and risk factors. Costs will be dependent on needed FWS components.

- Size of warning area (house, neighborhood, community, region, river basin), nature of threat (urban flash floods, riverine flooding, dam / levee breach), risk level (risk to property - low, med, high) and risk to lives

- Simple approach (few gauges and software) vs Complex approach (radar sites, gauges, redundant communications and computing systems, public education programs, etc)


MeyerWatershed.mxd - ArcMap - ArcInfo
10% Depth
(10-Year)
1% Annual Chance
Floodplain Boundary
1.5 ft
0.0 ft
0.0 ft
0 - 1 ft
1 - 2 ft
2 - 3 ft
3 - 6 ft
6 ft +
406413.25 4768349.35 Meters


MeyerWatershed.mxd - ArcMap - ArcInfo
4% Depth
(25-Year)
2.8 ft
0.0 ft
0.0 ft
0 - 1 ft
1 - 2 ft
2 - 3 ft
3 - 6 ft
6 ft +
406413.25 4768349.35 Meters


MeyerWatershed.mxd - ArcMap - ArcInfo
Percent Chance of Flooding over a 30-yr Period
96% +
11%
26%
5.8 - 10%
10 - 20%
20 - 30%
30 - 40%
40 - 50%
50 - 60%
60 - 70%
70 - 80%
80 - 90%
90 - 99%
406413.25 4768349.35 Meters

What AECOM can do for STATES

- Statewide Flood Mapping Program Management
- Analysis and Prioritization of Risks
- Flood Warning System (FWS) Solutions
- Factoring Climate Change effects in Comprehensive Flood Planning

Try Outsourcing Flood Mapping to make-up Lost Time

What AECOM can do for STATES

- Statewide Risk Mapping program be Prepared
- Analyze and prioritize Risks
- Communicate Risks to Citizens
- Don’t allow New Development in Flood Plains
- Consider Climate Change Impacts
- Your job is never done: the Mapping will never actually be finished because it can always be improved with greater level of Detail

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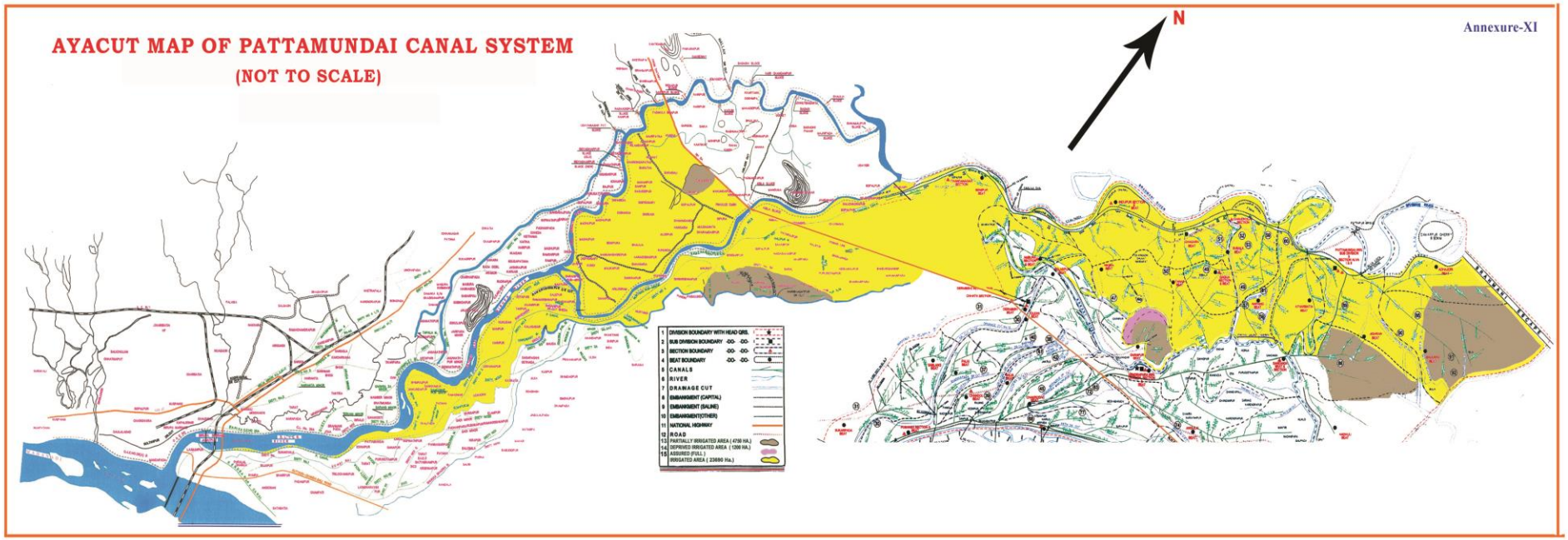
About AECOM

Flood Management

Irrigation System Rehabilitation – Pattamundai Canal System in Odisha

Project Location



Salient Features of the Pattamundai Canal Scheme

1 . Original command area	51,460 Ha
2 . Revised (2008) command area	32,693 Ha
3 . Revised design discharge (app 2011)	36 m3/Sec
4 . Length of main canal / Disty	170 km
5 . Distributary canals off taking from main canal	8
6 . Minors off taking from main canal	16
7 . Sub-minors off taking from main canal	21
8 . Field channels off-taking from main canal	133
9 . Locks (cross regulator cum falls)	9
10 . Escapes (Main Canal)	1
11 .Total number of outlets in command area	2065
12 . Average command area per outlet	16 Ha

Pattamundai Canal System was designed and built in the mid-19th Century, combining navigation & irrigation components.

It was an East India Company commercial project.

Scope of Work

- Topographic and condition surveys for the canals and structures, except where this has already been carried out by the Department;
- Geotechnical investigations for new structures and canals;
- Detailed design and preparation of drawings;
- Preparation of bills of quantities, contract documents and the “Engineer's Estimate" for each contract.

Key Challenges & Solutions

Key Challenges

- Availability of Old Data

-Extensive Field Work for Condition Survey of Old Structures

- Iterations for Finalization of Design Statements and Longitudinal Statements

Solutions Adopted

- GIS Mapping for “Holistic Assessment” of Canal Command Area

- Iterative Process adopted to finalize the DS & LS of Main Canal and its Distributaries;

-Condition Survey of Old Structures Task was Completed during the Field Itself;

-On-the-job training to Dept field officials & Simple Design Model Templates Developed

Methodology Adopted

- **Survey and Geo Technical Investigation:**

  - Topographic and Condition Survey

  - Establishment of Permanent Bench mark & GIS Mapping

  - Canal Surveys for Longitudinal & Cross Sections

  - Topographic Survey for New Structure

  - Existing Structure Condition Survey

  - Plotting of Surveys

  - Geo-technical Investigation for New Structures

  - Investigation along Canal for Seepage Analysis

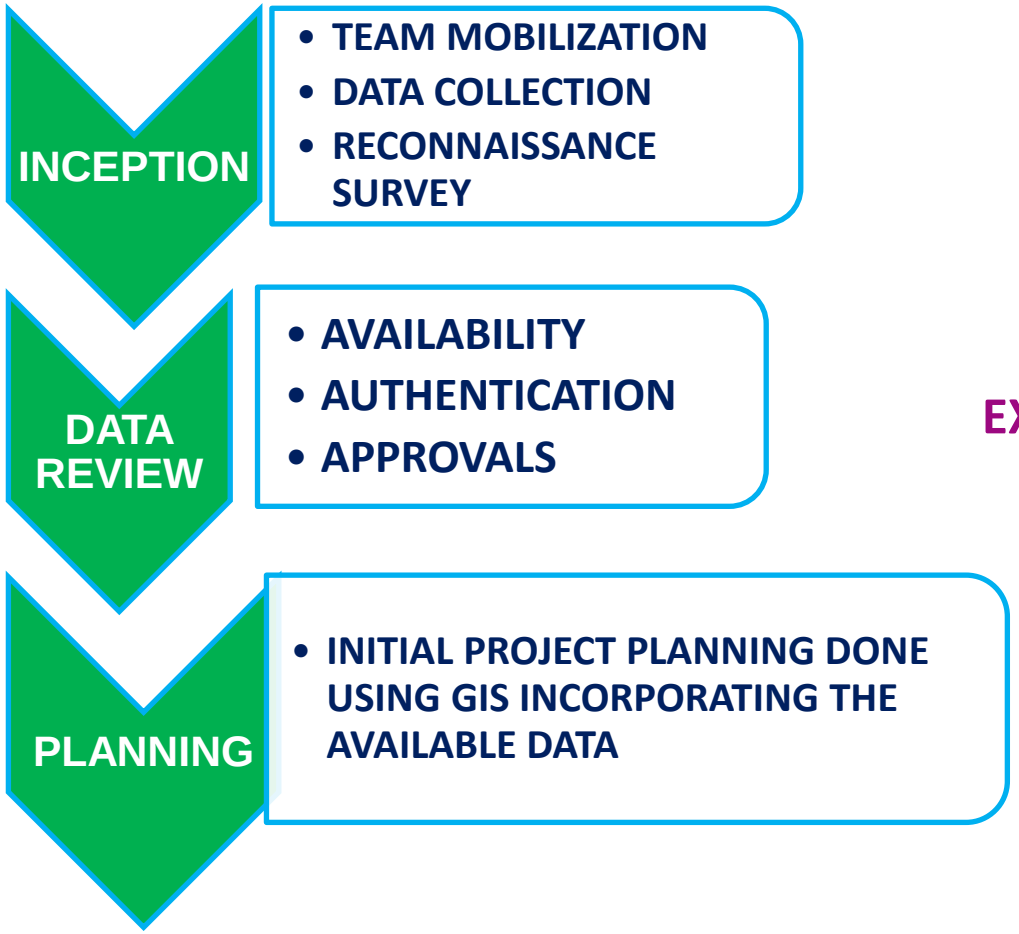
- **Detail Design and Drawings:**

  - Design Modification for Pattamundai Canal System and Distributaries.

- **Bills of Quantities and Packaging of Civil Works Contracts:**

  - As per GoO approved Analysis of Rates and Schedule of Rates.

Process Flow Chart



PHASE-I EXECUTION

Process Flow Chart

SITE SURVEY & PLOTTING

- GTA BM/TBM
- CANAL STRIP SURVEY & LONGITUDINAL SECTIONS
- SITE TOPOGRAPHIC SURVEY FOR NEW STRUCTURES
- EXISTING STRUCTURE TOPOGRAPHIC & CONDITION SURVEY
- GEOTECHNICAL INVESTIGATION AT THE LOCATIONS OF NEW STRUCTURES AND SEEPAGE
- PLOTTING OF SITE SURVEY AFTER CHECKING THE ACCURACY

PLANNING

- AVERAGE EXISTING DIMENSIONS (BED WIDTH, BANK WIDTHS, BANK SLOPES, CANAL SLOPE) & LEVELS
- RECORDING OF ACTUAL PARAMETERS LIKE DISCHARGE, FSL, VELOCITY , FREE BOARD & SCOUR IN CANAL RUNNING CONDITION
- TYPE, LOCATIONS AND CONDITION OF EXISTING SERVICE ROADS & EXTENT OF JUNGLE / BUSHES ON CANAL BANKS
- STANDARDIZATION OF UNIT RATES OF MATERIALS AS PER THE QUARRY LOCATIONS & LATEST SCHEDULE OF RATES

PHASE – II
EXECUTION

Process Flow Chart

DESIGN & DRAWINGS

- REDESIGN OF CANAL AND BRANCHES WHILE CONSIDERING THE EXISTING PARAMETERS
- IDENTIFICATION OF STRUCTURES TO BE RECONSTRUCTED AFTER RENOVATION OF CANALS
- DESIGNS OF NEW STRUCTURES, STRUCTURES PROPOSED FOR RECONSTRUCTION AND MEASUREMENT STRUCTURES AS PER THE FINAL DESIGN PARAMETERS OF CANALS

QUANTITY & COST

- PREPARATION OF ENGINEERING ESTIMATES AS PER THE EXISTING AND FINAL DESIGN PARAMETERS
- GERNERAL ABSTRACT OF COST FROM BOQ AND APPROVED RATE ANALYSIS
- STANDARDIZATION OF CONTRACT DOCUMENTS FOR RENOVATION WORK

PHASE – III
COMPLETION

Photo Gallery : Canal

Photo Gallery: Major Structures

Thank You

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